Adel DeSoto Minburn CSD
9-12 Science Standards
Scope and Sequence

Board approved:
Revised May 2012

The Iowa Core Curriculum for Science reflects the belief that ALL students should experience science through a curriculum that is rigorous, relevant, global in its perspective, collaborative in nature, and connected by strong visible links to other areas of study. This document follows the format and content of NSES in which there are eight categories of standards. Four of the categories ù Science as Inquiry, Physical Science, Earth and Space Science, and Life Science ù are content specific, while the remaining categories ù Science and Technology, Science in Personal and Social Perspectives, and the History and Nature of Science ù address the application of knowledge. These remaining standards sets call for students to develop abilities to identify and state a problem, design, implement and evaluate a solution, and they complement the abilities developed in the Science as Inquiry Standards. They also help students develop decision-making skills and understand that science reflects its history and is an ongoing, changing enterprise. As such, these standards should be integrated throughout the four content specific categories stated above. These sets include the following at the 9—12 level: Science and Technology ù abilities of technological design, and understanding about science and technology; Science in Personal and Social Perspectives ù personal and community health, population growth, natural resources, environmental quality, natural and human-induced hazards, and science and technology in local, national, and global changes; History and Nature of Science ù science as a human endeavor, nature of scientific knowledge, and historical perspectives (see appendix). Science as Inquiry and the application standards from the NSES are integrated into the knowledge base by design. The content category of Unifying Concepts and Processes complements the other standards. The concepts and procedures in this category provide students with productive and insightful ways of thinking about and integrating basic ideas that explain the natural and designed world (see appendix for details). These concepts and processes include:

* Systems, order, and organization
* Evidence, models, and explanation
* Constancy, change, and measurement
* Evolution and equilibrium
* Form and function

Science is more than a body of knowledge. It is a way of thinking and a way of investigating. Students must have the opportunity to examine the impact science has had, and will continue to have, on the environment and society. These opportunities are the focus of the integrated standards.

The Iowa Core Curriculum for Science emphasizes student inquiry. The depth of understanding required of our students is not possible with lectures, readings, cookbook labs, and plug-and-chug problem solving. Students must be actively investigating: designing experiments, observing, questioning, exploring, making and testing hypotheses, making and comparing predictions, evaluating data, and communicating and defending conclusions. A district's science curriculum cannot align to the Iowa Core Curriculum for Science without including inquiry as a guaranteed and viable, testable component in every science course. The science instruction should be engaging and relevant for the students. Strong connections between the lessons and the students' daily lives must be made. This core curriculum reflects high standards of science achievement for ALL students and not just those who have traditionally succeeded in science classes. The challenge is to create an educational system that connects students to the scientific world. The broad range of understandings and skills possessed by students when they enter 9th grade will require a system that is clearly articulated and masterfully implemented from kindergarten through grade 12. Teachers will need support and time to prepare for this challenge. This is a first bold step toward a vision of scientific literacy for all.

Standards for Science

9-12

Science Inquiry Standards 9-12

Grade 9 students:	Grade 10 students:	Grade 11-12 students:
Identify questions and concepts that guide scientific investigations.		
1. Students formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations. The key is that the student demonstrates knowledge of the scientific concepts through the investigation.	1. Students formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations. The key is that the student demonstrates knowledge of the scientific concepts through the investigation.	1. Students formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and conceptual understanding of scientific investigations. The key is that the student demonstrates knowledge of the scientific concepts through the investigation.
Design and conduct scientific investigations.		
2. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.	2. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.	2. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry, and scientific knowledge obtained from sources other than the actual investigation. The investigation may also require student clarification of the question, method, controls, and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic, and construct an argument for their proposed explanations.
Use technology and mathematics to improve investigations and communications.		
3. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this concept.	3. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this concept.	3. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this concept.

Grade 9 students:	Grade 10 students:	Grade 11-12 students:
4. Mathematics is essential to asking and answering questions about the natural world. Mathematics can be used to ask questions; to gather, organize, and present data; and to structure convincing explanations.	4. Mathematics is essential to asking and answering questions about the natural world. Mathematics can be used to ask questions; to gather, organize, and present data; and to structure convincing explanations.	4. Mathematics is essential to asking and answering questions about the natural world. Mathematics can be used to ask questions; to gather, organize, and present data; and to structure convincing explanations.
Formulate and revise scientific explanations and models using logic and evidence.		
5. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation. 6. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment.	5. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation. 6. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment.	5. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual, and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic, and evidence from their investigation. 6. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment.
Recognize and analyze alternative explanations and models.		
7. This aspect of the standard emphasized the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.	7. This aspect of the standard emphasized the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.	7. This aspect of the standard emphasized the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.

Grade 9 students:	Grade 10 students:	Grade 11-12 students:
Communicate and defend a scientific argument.		
8. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.	8. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.	8. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.
Understand about scientific inquiry.		
9. Scientists usually inquire how physical, living, or designed systems function. 10. Scientists conduct investigations fro a wide variety of reasons. 11. Scientific explanations must abide by the rules of evidence, be open to possible modifications, and satisfy other criteria. 12. Results of scientific inquiry – new knowledge and methods – emerge from different types of investigations and public communication among scientists.	9. Scientists usually inquire how physical, living, or designed systems function. 10. Scientists conduct investigations fro a wide variety of reasons. 11. Scientific explanations must abide by the rules of evidence, be open to possible modifications, and satisfy other criteria. 12. Results of scientific inquiry – new knowledge and methods – emerge from different types of investigations and public communication among scientists.	9. Scientists usually inquire how physical, living, or designed systems function. 10. Scientists conduct investigations fro a wide variety of reasons. 11. Scientific explanations must abide by the rules of evidence, be open to possible modifications, and satisfy other criteria. 12. Results of scientific inquiry – new knowledge and methods – emerge from different types of investigations and public communication among scientists.

Earth and Space Standards 9-12

Earth and space science is the field of study concerned with the planet Earth or one or more of its parts. Earth and space science includes the science used to study the lithosphere (the solid portion of the earth), the atmosphere (the gaseous envelope surrounding the earth), the hydrosphere (the ice, water, and water vapor at or near the earth's surface), the biosphere (the zone at or near the earth's surface that supports life), and space beyond the atmosphere. It is the interactions between these parts, how they impact life on the planet and how we can use observations today to discover what forces created the surface features of the planet centuries ago that form a central portion of this study. Climate, weather, environmental issues, soil science and water quality are all open areas of inquiry in this field.

Earth and space science instruction must include the inquiry knowledge and skills described in the inquiry section of the Iowa Core Curriculum for Science. Instruction should be engaging and relevant and strong connections must be made to students' lives.

Grade 9 students – Earth and Space Science:	Grade 10 students - Biology:	Grade 11 students - Chemistry:
Understand and apply knowledge of energy in the earth system.		
1. Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.	1. Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.	1. Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the earth's original formation.
2. The outward transfer of Earth's internal heat drives convection circulation in the mantle that propels the plates comprising the earth's surface across the face of the globe.	2. The outward transfer of Earth's internal heat drives convection circulation in the mantle that propels the plates comprising the earth's surface across the face of the globe.	2. The outward transfer of Earth's internal heat drives convection circulation in the mantle that propels the plates comprising the earth's surface across the face of the globe.
3. Heating of the earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	3. Heating of the earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	3. Heating of the earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
4. Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.	4. Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.	4. Global climate is determined by energy transfer from the sun at and near the earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the earth's rotation, and static conditions such as the position of mountain ranges and oceans.

Understand and apply knowledge of Geochemical cycles.

5. The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.
6. Movement of matter between reservoirs is driven by the earth's internal and external sources of energy. These movements are often accomplished by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

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Understand and apply knowledge of the origin and evolution of the earth system.

7. The sun, the earth, and the rest of the solar system formed from a nebular could of dust and gas 10 to 15 billion years ago. The early Earth was very different from the planet on which we live today.
8. Geologic time can be estimated by observing rock sequences and using fossils to correlate the sequences at various locations. Current methods for measuring geologic time include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed.
9. Interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the earth system. We can observe some changes such as earthquakes and volcanic eruptions on a human time scale, but many processes such as mountain building and plate movements take place over hundreds of millions of years.
10. Evidence for one-celled forms of life – the microbes – extends back more than 3.5 billion years. The evolution of life caused dramatic changes in the composition of the earth's atmosphere, which did

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not originally contain oxygen.

Understand and apply knowledge of the origin and evolution of the universe.

11. The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billions years ago, when the universe began in a hot dense state: According to this theory, the universe has been expanding ever since.
12. Early in the history of the universe, matter—primarily the light atoms hydrogen and helium – clumped together through gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.
13. Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

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Understand and apply knowledge of the origin and evolution of the earth system.

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Understand and apply knowledge of the origin and evolution of the universe.

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Life Science Standards 9-12

Life science is concerned with the study of living organisms and their interactions with each other and their environments. Life science examines the structure, function, growth, origin, evolution, distribution and classification of living things. Specialized disciplines of life sciences are grouped by the type of organism being studied: botany is the study of plants, zoology the study of animals, microbiology the study of microscopic organisms.

Life science instruction must include the inquiry knowledge and skills described in the inquiry section of the Science ore Curriculum Instruction should be engaging and relevant and strong connections must be made to students' lives.

Grade 9 students – Earth and Space Science:	Grade 10 students - Biology:	Grade 11 students - Chemistry:
Understand and apply knowledge of the cell.		
1. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticulum. Some cells have external structures facilitating movement (cilia and flagella).	1. <u>Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticulum. Some cells have external structures facilitating movement (cilia and flagella).</u>	1. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticulum. Some cells have external structures facilitating movement (cilia and flagella).
2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.	2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.	2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.
3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.	3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.	3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.
4. Cell regulation allows cells to respond to their environment and to control and coordinate cell growth and division. Environmental factors can influence cell division.	4. Cell regulation allows cells to respond to their environment and to control and coordinate cell growth and division. Environmental factors can influence cell division.	4. Cell regulation allows cells to respond to their environment and to control and coordinate cell growth and division. Environmental factors can influence cell division.
5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.	5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.	5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.

Understand and apply knowledge of molecular basis of heredity.

6. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). DNA mutations occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Some mutations can be caused by environmental factors.
7. Each DNA molecule in a cell forms a single chromosome. Most of the cells in a human contain two copies of each of 22 different chromosomes plus two chromosomes that determine sex: a female contains two X chromosomes and a male contains one X and one Y. Transmission of genetic information to offspring occurs through meiosis that produces egg and sperm cells that contain only one representative from each chromosome pair. An egg and a sperm unite to form a new individual.
8. The fact that an organism is formed from cells that contain two copies of each chromosome, and therefore two copies of each gene, explains many features of heredity, such as how variations that are hidden in one generation can be expressed in the next. Different genes coding for the same feature code for it in different ways thus leading to identifiable patterns in heritable traits. These patterns of inheritance can be identified and predicted.

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Understand and apply knowledge of biological evolution.

9. Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing

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selection by the environment of those offspring better able to survive and leave offspring.	selection by the environment of those offspring better able to survive and leave offspring.	selection by the environment of those offspring better able to survive and leave offspring.
10. Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as the striking molecular similarities observed among the diverse species of living organisms. The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.	10. Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as the striking molecular similarities observed among the diverse species of living organisms. The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.	10. Natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms, as well as the striking molecular similarities observed among the diverse species of living organisms. The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.
11. The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.	11. The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.	11. The millions of different species of plants, animals, and microorganisms that live on earth today are related by descent from common ancestors.
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Understand and apply knowledge of the inter-depencence of organisms.		
13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.	13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.	13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.
14. Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers. These topic levels can be illustrated by food chains and food webs.	14. Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers. These topic levels can be illustrated by food chains and food webs.	14. Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers. These topic levels can be illustrated by food chains and food webs.
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16. Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.	16. Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.	16. Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.
Understand and apply knowledge of matter, energy, and organization of living systems.		

17. Living systems require a continuation input of energy, derived primarily from the sun, to maintain their chemical and physical organization. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon containing (organic) molecules. These molecules can be used to assemble larger molecules (proteins, DNA, sugars, and fats). The chemical energy stored in bonds between the atoms can be used as sources of energy for life processes.
18. Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.
19. All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations.
20. As matter and energy flows through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

Understand and apply knowledge of the behavior of organisms.

21. Multi-cellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.

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Grade 11-12 students – Physics:	Grade 11-12 students - Physiology:	Grade 11-12 students – Environmental Science:
Understand and apply knowledge of the cell.		
1. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticulum. Some cells have external structures facilitating movement (cilia and flagella).	1. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticuium. Some cells have external structures facilitating movement (cilia and flagella).	1. Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules that form a variety of specialized structures, notably the nucleus, mitochondria, ribosomes, chloroplasts, and the endoplasmic reticulum. Some cells have external structures facilitating movement (cilia and flagella).
2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.	2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.	2. Most cell functions involve chemical reactions. Food molecules taken into cells react to provide the chemical constituents needed to synthesize other molecules. Both breakdown and synthesis are made possible by protein catalysts, called enzymes.
3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.	3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.	3. The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells temporarily store this energy in phosphate bonds of a small high-energy compound called ATP.
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5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.	5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.	5. Plant cells contain chloroplasts as sites of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy rich organic compounds and release oxygen to the environment.
Understand and apply knowledge of molecular basis of heredity.		
6. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular	6. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular	6. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular

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Understand and apply knowledge of biological evolution.		
9. Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.	9. Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.	9. Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.
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Understand and apply knowledge of the inter-dependence of organisms.		
13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.	13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.	13. The atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.
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Understand and apply knowledge of the behavior of organisms.		
21. Multi-cellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.	21. Multi-cellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.	21. Multi-cellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules. In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.

Physical Science Standards 9-12

Physical science is the term for the study of non-living systems, and includes physics and chemistry. The foundations of physical science rest upon key concepts and theories, each of which explain and/or model a particular aspect of the behavior of nature.

Physics includes describing and measuring motion: the theory of gravity; energy, work, and power; energy forms; kinetic molecular theory; the principals of waves and sound; the principles of electricity, magnetism, and electromagnetism; and the principles, sources, and properties of light.

Chemistry is the science of matter. Its studies include atomic theory; water and its properties; chemical elements, chemical reactions, and energy transformations; nuclear chemistry; and organic chemistry. In all areas of physical science the focus is on the application of the knowledge to solve real life problems. It is the use of the conceptual knowledge and not simply the knowledge itself that should form the core of this discipline. Physical science instruction must include the inquiry knowledge and skills described in the inquiry section of the Science Core Curriculum. Instruction should be engaging and relevant and strong connections must be made to students' lives.

Grade 9 students – Earth and Space Science:	Grade 10 students - Biology:	Grade 11 students - Chemistry:
Understand and apply knowledge of the structure of atoms.		
1. Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.	1. Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.	1. Matter is made of minute particles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atom together.
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Understand and apply knowledge of the structure and properties of matter.

5. The "structure and properties of matter" is an essential concept of a world-class secondary science curriculum.
6. An element is composed of a single type of atom. When elements are listed in order according to the number of protons (called the atomic number), repeating patterns of physicai and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies.
7. Bonds between atoms are created when electrons are paired up by being transferred or shared. A substance composed of a single kind of atom is called an element. The atoms may be bonded together into molecules or crystalline solids. A compound is formed when two or more kinds of atoms bind together chemically.
8. The physical properties of compounds reflect the nature of the interactions among its molecules. These interactions are determined by the structure of the molecule, including the constituent atoms and the distances and angles between them.
9. Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is neatly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.
10. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

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Understand and apply knowledge of chemical reactions.

11. Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carob-based molecules take place constantly in every cell in our bodies.
12. Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.
13. A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules, or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fuels, the formation of polymers, and explosions.
14. Chemical reactions can take place in time periods ranging from the few femtoseconds (10-15 seconds) for an atom to move a fraction of a chemical bond distance to geologic time scales of billions of years. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature, and on the properties—including shape—of the reacting elements.

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Understand and apply knowledge of motions and forces.

15. Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object

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Understand and apply knowledge of conservation of energy and increase in disorder.

20. The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.
21. All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.

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Understands and applies knowledge of interactions of energy and matter.

22. Waves, including sound and seismic waves, waves on water, and light waves have energy and can transfer energy when they interact with matter.
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longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

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Grade 11-12 students – Physics:	Grade 11-12 students - Physiology:	Grade 11-12 students – Environmental Science:
Understand and apply knowledge of the structure of atoms.		
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4. Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike tradition. The decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate. This predictability can be used to estimate the age of materials that contain radioactive isotapes.	4. Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike tradition. The decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate. This predictability can be used to estimate the age of materials that contain radioactive isotapes.	4. Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike tradition. The decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate. This predictability can be used to estimate the age of materials that contain radioactive isotapes.
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repeating patterns of physical and chemical properties identify families of elements with similar properties. This "Periodic Table" is a consequence of the repeating pattern of outermost electrons and their permitted energies.

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9. Solids, liquids, and gases differ in the distances and angles between molecules or atoms and therefore the energy that binds them together. In solids the structure is neatly rigid; in liquids molecules or atoms move around each other but do not move apart; and in gases molecules or atoms move almost independently of each other and are mostly far apart.
10. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.

Understand and apply knowledge of chemical reactions.

11. Chemical reactions occur all around us, for example in health care, cooking, cosmetics, and automobiles. Complex chemical reactions involving carob-based molecules take place constantly in every cell in our bodies.
12. Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.

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Understand and apply knowledge of motions and forces.

15. Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship F = ma, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object
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Understands and applies knowledge of interactions of energy and matter.		
22. Waves, including sound and seismic waves, waves on water, and light waves have energy and can transfer energy when they interact with matter.	22. Waves, including sound and seismic waves, waves on water, and light waves have energy and can transfer energy when they interact with matter.	22. Waves, including sound and seismic waves, waves on water, and light waves have energy and can transfer energy when they interact with matter.
23. Electromagnetic waves result when a charges object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.	23. Electromagnetic waves result when a charges object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.	23. Electromagnetic waves result when a charges object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.

College and Career Readiness Anchor Standards for Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
2. Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.
3. Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

Craft and Structure

4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.
5. Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.
6. Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.*
8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
9. Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

10. Read and comprehend complex literary and informational texts independently and proficiently.

Note on range and content of student reading

Content area literacy is critical to students' post secondary success in higher education and the workplace. To prepare students for these challenges, literacy skills must to be developed across all content areas. Students expand their range when applying literacy skills to a variety of content areas because the academic discourses and disciplinary concepts in those require different approaches to reading, writing, speaking, viewing, and listening. It is through applying literacy skills in a number of content areas that students learn to integrate these skills and strategies into life experience. Teachers in all content areas who make literacy a priority understand that

* Please see "Research to Build Knowledge" in Writing and "Comprehension and Collaboration" in Speaking and Listening for additional standards relevant to gathering, assessing, and applying information from print and digital sources.

Reading Standards for Literacy in Science and Technical Subjects 6-12

Grade 6-8 students:	Grade 9-10 students:	Grade 11-12 students:
Key Ideas and Details		
1. Cite specific textual evidence to support analysis of science and technical texts.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2. Determine the central ideas or conclusions of a distinct from prior knowledge or opinions.	2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
Craft and Structure		
4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6–8 texts and topics.*	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9–10 texts and topics.*	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics.*
5. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.	5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).	5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.	6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.	6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
Integration of Knowledge and Ideas		
7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.	7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8. Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.	8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or	8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or

	technical problem.	challenging conclusions with other sources of information.
9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.	9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity		
10. By the end of grade 8, read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently.	10. By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.	10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.