Core Science Curriculum Framework

An Invitation for Students and Teachers to Explore Science and Its Role in Society

INTRODUCTION

I. A Vision for Connecticut Science Education in the 21st Century

To articulate a vision to guide 21st century science education in Connecticut, the Connecticut State Department of Education engaged in discussions with science educators, school administrators, and university and corporate scientists. The consensus drawn from these discussions was that school science education should support the development of scientific literacy in all students, as well as motivate more students to pursue careers in science, technology and engineering. Science literacy, in the view of Connecticut science educators, is a combination of understanding major science concepts and theories, using scientific reasoning, and recognizing the complex interactions between science, technology and society.

Based on this vision, the department developed a new **Core Science Curriculum Framework**. This framework articulates the main conceptual themes and content standards that **all** students are expected to learn in their elementary, middle and high school science classes. Further, the framework describes the specific performances that will be assessed on the statewide science assessments.

What Is Meant By A "Core" Curriculum?
Since the current body of scientific knowledge represents the cumulative work of scientists over hundreds of years, it is unreasonable to expect K-12 students to learn it all. Therefore, Connecticut's Core Science Curriculum Framework describes *some* of the major science concepts that all students in Connecticut schools can reasonably be expected to learn in order to develop and expand their scientific literacy. This framework does not attempt to spell out all of the science, mathematics and technology goals that can be included in a school science curriculum. Rather, it describes a baseline for what all Connecticut students should know by the end of Grade 10.

Decisions regarding the main science themes and the sequencing of the content standards were guided by the *National Science Education Standards* (National Research Council, 1996), *Project 2061 Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), and Connecticut science educators. School districts may choose to go beyond the scope of these core concepts, but **all** students should have opportunities to learn the content expressed in this framework.

How Does The Framework Promote Scientific Literacy?
Being scientifically literate requires that a person have an essential understanding of key science ideas, along with a fluency in the language and terms used to describe them. The core curriculum articulated through the framework identifies the key ideas and levels of understanding that all students are expected to reach. Throughout the PreK-Grade10 core framework, fundamental concepts from the life, physical and earth sciences are woven together in order to support the holistic understanding required of a scientifically literate individual.

Scientific literacy requires the ability to apply critical thinking skills when dealing with science-related issues. The framework was designed to target the age-appropriate critical thinking – or inquiry – skills that should be infused in the learning of each of the content standards. Further, in limiting the number of content standards required to be taught, the framework allows for the implementation of a hands-on/minds-on science program in which students and teachers have time for in-depth explorations that build an understanding of the way in which scientific knowledge is created, validated and communicated.

A scientifically literate person is able to transfer knowledge of the academic theories and principles of science to practical applications in the real world. To support this concept, Connecticut's Core Science Curriculum Framework is structured around these key real-world issues and technologies, rather than around the subdisciplines of the life, physical and earth sciences.

Scientific literacy also implies having the capacity to pose and evaluate arguments based on evidence and to apply logical conclusions from such arguments. Language arts and mathematics are the communication vehicles that people use to convey, critique and evaluate science-related ideas. Therefore, language arts and mathematics learning expectations are included in the framework as integral components of science learning.

In short, a foundation in scientific literacy prepares students to be confident and capable lifelong learners who are equipped with the skills needed to access, understand, evaluate and apply information in various contexts. Regardless of their academic standing, **all** students should have access to a rich and challenging science curriculum that will promote scientific literacy, while inspiring and supporting advanced study and science-related careers.

II. Role of the Connecticut Core Science Curriculum Framework

The science framework has three main roles:

1. **To articulate the core science ideas, knowledge and skills that all Connecticut students should learn.** Based upon significant science understandings and abilities defined in the *National Science Education Standards* and the *Project 2061 Benchmarks for Science Literacy*, this framework describes a conceptual scope and sequence to guide school districts and science educators in the development of their own science programs. The content standards for each grade level are based on conceptual connections among ideas in the life, physical and earth sciences, and related social and technological applications. District curriculum developers have flexibility to reorganize the content standards by grade level, so long as all students have opportunities to learn the content standards prior to taking the *Connecticut Mastery Test* (CMT) in Grades 5 and 8, and the *Connecticut Academic Performance Test* (CAPT) in Grade 10. Districts may include more content in their science programs, but the framework content standards express the *minimum* that should be learned by all students in Grades PreK to 10.

   In addition to the life, physical and earth science standards, the Core Science Curriculum Framework includes standards and expected performances for inquiry and for science and technology in society. Inquiry performances include the abilities to apply science process skills, as well as the abilities to read and write science-related texts, search scientific databases and use mathematics to make sense out of data. The science and technology in society standards deal with applications of science to everyday and global issues, and reflect content and issues described in *Standards for Technological Literacy* (International Technology Education Association, 2000).

2. **To define the knowledge, abilities and understandings that students are expected to demonstrate on the statewide science assessments.** Whereas content standards provide broad guidelines for the development of the core curriculum, expected performances identify the specific knowledge and skills selected from the core curriculum for which students will be accountable on statewide science assessments. Expected performances express the *maximum* that all students will be expected to demonstrate on the CMT and CAPT science assessments.

3. **To influence the way science is taught and assessed.** Among the factors guiding the selection and organization of the framework's content were its potential to attract and hold the interest of students and inspire them to continue learning about science. While the framework defines key science concepts and skills, it does not dictate how to help students achieve these learning goals. The ways in which districts develop learning units and specific lesson plans will have a significant influence on students' attitudes toward science learning. Given opportunities for meaningful and authentic science experiences that incorporate the expected performances included in the framework, it is hoped that many students will develop the enthusiasm, interest and confidence to continue their science studies and pursue science-related careers. An enrichment science program designed to meet the needs of these advanced students, with suggested content standards for courses in biology, chemistry, physics and earth science, is found in the Appendix to this framework. Enrichment standards that are not included in high school Strands I through V will not be measured on the CAPT.

DEVELOPMENTAL ORGANIZATION OF CORE SCIENCE CURRICULUM FRAMEWORK

PreK-2:	Development of *wonder* about the natural world and the ability to observe, describe and apply basic process skills
Grades 3-5:	Development of *descriptions* of basic natural phenomena and the ability to perform simple experiments and record accurate data
Grades 6-8:	Development of basic *explanations* for natural phenomena, and the ability to ask good questions and apply experimental procedures to collect and analyze data
Grades 9-10:	Development of *interest* in global issues and the ability to collect, analyze and use data to explore and explain related science concepts

ENRICHMENT CURRICULUM

Development of *deep understanding* of science concepts and principles; preparation for future studies and/or careers

CONCEPTUAL STRUCTURE OF FRAMEWORK

The science framework is organized around 11 conceptual themes and guiding questions in the earth, life and physical sciences, with suggested explorations of science-related questions and issues. Each theme is addressed by several content standards and related concepts that spiral through the grades, each time being treated with greater depth and breadth, in accordance with developmental appropriateness for the students. The content standards for Grades 9 and 10 are further organized around five topical strands. Strands I, II and III are related to the physical sciences, while Strands IV and V are related to the life science.

Listed below are the conceptual themes and guiding questions, together with the content standards in each of the grade levels, that contribute to students' eventual abilities to respond to the guiding questions.

I. Inquiry – How is scientific knowledge created and communicated?

- Scientific Inquiry **(PK-2, 3-5, 6-8 and 9-10)**
- Scientific Literacy **(PK-2, 3-5, 6-8 and 9-10)**
- Scientific Numeracy **(PK-2, 3-5, 6-8 and 9-10)**

II. Properties of Matter – How does the structure of matter affect the properties and uses of materials?

- Properties of Objects **(K.1)**
- Properties of Materials **(2.1)**
- States of Matter **(3.1)**
- Elements, Compounds and Mixtures **(6.1)**
- Chemical Reactions **(9.4)**
- Carbon Compounds **(9.5)**

III. Energy Transfer and Transformations – What is the role of energy in our world?

- Electricity and Magnetism **(4.4)**
- Sound and Light **(5.1)**
- Energy and Work **(7.1)**
- Energy Conservation and Transformation **(9.1)**
- Electrical Forces **(9.2)**

IV. Forces and Motion – What makes objects move the way they do?

- Position and Motion of Objects **(1.1)**
- Forces and Motion **(4.1)**
- Forces and Motion **(8.1)**

V. Matter and Energy in Ecosystems – How do matter and energy flow through ecosystems?

- Food Chains **(4.2)**
- Ecosystems **(6.2)**

VI. Structure and Function – How are organisms structured to ensure efficiency and survival?

- Needs of Living Things **(1.2)**
- Life Cycles of Animals **(1.3)**
- Life Cycles of Plants **(2.2)**
- Responses to Stimuli **(5.2)**
- Human Body Systems **(7.2)**
- Cell Structure and Function **(10.1)**

VII. Heredity and Evolution – What processes are responsible for life's unity and diversity?

- Characteristics of Living Things **(K.2)**
- Adaptations **(3.2)**
- Reproduction and Heredity **(8.2)**
- Genetics **(10.4)**
- Evolution **(10.5)**

VIII. The Changing Earth – How do materials cycle through the Earth's systems?

- Properties of Soils **(2.3)**
- Properties of Rocks and Minerals **(3.3)**
- Cycles of Matter in Earth's Systems **(9.7)**

IX. Energy in the Earth's Systems – How do external and internal sources of energy affect the Earth's systems?

- Weather Patterns **(K.3)**
- Land and Water Interactions **(4.3)**
- Weather and Seasons **(6.3)**
- The Changing Earth **(7.3)**

X. Earth in the Solar System – How does the position of Earth in the solar system affect conditions on our planet?

- Earth, Moon and Sun **(5.3)**
- The Solar System **(8.3)**

XI. Science and Technology in Society – How do science and technology affect the quality of our lives?

Shelters **(K.4)**
Measuring Tools **(1.4)**
Food Resources **(2.4)**
Conservation of Materials **(3.4)**
Batteries, Bulbs and Magnets **(4.4)**
Optical Technologies **(5.4)**
Water Quality **(6.4)**
Food Technology **(7.4)**
Building Bridges **(8.4)**
Energy and Power Technologies **(9.3)**
Polymers **(9.6)**
Human Environmental Impacts **(9.8, 9.9)**
Living with Microorganisms **(10.2)**
Biotechnology **(10.3)**
Human Population Growth **(10.6)**

USERS' GUIDE TO CORE SCIENCE CURRICULUM FRAMEWORK

The intent of this framework is to describe a core body of science knowledge that all students are expected to learn; knowledge that is assessed at the elementary, middle and high school levels. Although the framework introduces concepts from the life, physical and earth sciences at each grade level, schools may choose to design yearly courses that focus on one science discipline at a time, based on the needs of students and available instructional resources.

The framework is structured with the following components:

- **CONTENT STANDARDS** (the left-hand column of each page) are narrative statements of science concepts that guide the development of a rich and rigorous curriculum. They are marked with an identification code indicating the grade level and standard number (e.g., 3.2) and appear in bold type.

  Content standards include the following:
  - A **conceptual theme,** followed by an overarching **guiding question** (e.g., *Properties of Matter – How does the structure of matter affect the properties and uses of materials?*)
  - The **content standard**, a broad conceptual statement, identified with a numerical code that serves as a general learning goal for a unit of study.
  - One or two **supportive concepts**, identified with bullets, that provide more specific information about the focus of the learning unit.

- **EXPECTED PERFORMANCES** (the right-hand column of each page) identify the specific knowledge and abilities from the broader curriculum that will be assessed on the statewide tests given at Grades 5, 8 and 10.

- **SCIENTIFIC INQUIRY, LITERACY AND NUMERACY** standards, although described separately for Grades PK-2, 3-5, 6-8 and 9-10, are intended to be learned, practiced and assessed within the context of learning the science content described for each grade level.

- **UNDERSTANDING THE IDENTIFICATION CODES**

  - Each content standard is identified by a two-digit code (e.g., 2.3): The first digit refers to the grade level (second grade in the example), and the second digit identifies one of the four content standards for each grade level (standard 3 in the example).
  - Expected performances are identified by a letter (A, B, C or D) and a sequenced numeral (1 through 45) that indicates the number of expected performances within each gradespan:

  A = Grades PK-2 (includes 24 expected performances)

  B = Grades 3-5 (includes 25 expected performances)

  C = Grades 6-8 (includes 30 expected performances)

  D = Grades 9-10 (includes 45 expected performances)

Content Standards and Expected Performances

Core Science for Grades PreK-2

THE STANDARDS FOR SCIENTIFIC INQUIRY, LITERACY AND NUMERACY ARE INTEGRAL PARTS OF THE CONTENT STANDARDS FOR EACH GRADE LEVEL IN THIS CLUSTER.

Grades PreK-2 Core Scientific Inquiry, Literacy and Numeracy *How is scientific knowledge created and communicated?*	
Content Standards	**Expected Performances**
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. **SCIENTIFIC LITERACY** ♦ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. **SCIENTIFIC NUMERACY** ♦ Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.	**A INQ.1** Make observations and ask questions about objects, organisms and the environment. **A INQ.2** Use senses and simple measuring tools to collect data. **A INQ.3** Make predictions based on observed patterns. **A INQ.4** Read, write, listen and speak about observations of the natural world. **A INQ.5** Seek information in books, magazines and pictures. **A INQ.6** Present information in words and drawings. **A INQ.7** Use standard tools to measure and describe physical properties such as weight, length and temperature. **A INQ.8** Use nonstandard measures to estimate and compare the sizes of objects. **A INQ.9** Count, order and sort objects by their properties. **A INQ.10** Represent information in bar graphs.

PreK-Kindergarten Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **K.1 - Objects have properties that can be observed and used to describe similarities and differences.** ♦ Some properties can be observed with the senses, and others can be discovered by using simple tools or tests.	**A 1.** Use the senses and simple measuring tools, such as rulers and equal-arm balances, to observe common objects and sort them into groups based on size, weight, shape or color. **A 2.** Sort objects made of materials such as wood, paper and metal into groups based on properties such as flexibility, attraction to magnets, and whether they float or sink in water. **A 3.** Count objects in a group and use mathematical terms to describe quantitative relationships such as: same as, more than, less than, equal, etc.
Heredity and Evolution – What processes are responsible for life's unity and diversity? **K.2 - Many different kinds of living things inhabit the Earth.** ♦ Living things have certain characteristics that distinguish them from nonliving things, including growth, movement, reproduction and response to stimuli.	**A 4.** Describe the similarities and differences in the appearance and behaviors of plants, birds, fish, insects and mammals (including humans). **A 5.** Describe the similarities and differences in the appearance and behaviors of adults and their offspring. **A 6.** Describe characteristics that distinguish living from nonliving things.
Energy in the Earth's Systems – How do external and internal sources of energy affect the Earth's systems? **K.3 - Weather conditions vary daily and seasonally.** ♦ Daily and seasonal weather conditions affect what we do, what we wear and how we feel.	**A 7.** Describe and record daily weather conditions. **A 8.** Relate seasonal weather patterns to appropriate choices of clothing and activities.
Science and Technology in Society – How do science and technology affect the quality of our lives? **K.4 - Some objects are natural, while others have been designed and made by people to improve the quality of life.** ♦ Humans select both natural and man-made materials to build shelters based on local climate conditions, properties of the materials and their availability in the environment.	**A 9.** Describe the types of materials used by people to build houses, and the properties that make the materials useful.

Grade 1 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Forces and Motion – What makes objects move the way they do? **1.1 - The sun appears to move across the sky in the same way every day, but its path changes gradually over the seasons.** ♦ An object's position can be described by locating it relative to another object or the background. ♦ An object's motion can be described by tracing and measuring its position over time.	**A 10.** Describe how the motion of objects can be changed by pushing and pulling. **A 11.** Describe the apparent movement of the sun across the sky and the changes in the length and direction of shadows during the day.
Structure and Function – How are organisms structured to ensure efficiency and survival? **1.2 - Living things have different structures and behaviors that allow them to meet their basic needs.** ♦ Animals need air, water and food to survive. ♦ Plants need air, water and sunlight to survive.	**A 12.** Describe the different ways that animals, including humans, obtain water and food. **A 13.** Describe the different structures plants have for obtaining water and sunlight. **A 14.** Describe the structures that animals, including humans, use to move around.
Structure and Function – How are organisms structured to ensure efficiency and survival? **1.3 - Organisms change in form and behavior as part of their life cycles.** ♦ Some organisms undergo metamorphosis during their life cycles; other organisms grow and change, but their basic form stays essentially the same.	**A 15.** Describe the changes in organisms, such as frogs and butterflies, as they undergo metamorphosis. **A 16.** Describe the life cycles of organisms that grow but do not metamorphose.
Science and Technology in Society – How do science and technology affect the quality of our lives? **1.4 - The properties of materials and organisms can be described more accurately through the use of standard measuring units.** ♦ Various tools can be used to measure, describe and compare different objects and organisms.	**A 17.** Estimate, measure and compare the sizes and weights of different objects and organisms using standard and nonstandard measuring tools.

Grade 2 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **2.1 - Materials can be classified as solid, liquid or gas based on their observable properties.** ♦ Solids tend to maintain their own shapes, while liquids tend to assume the shapes of their containers, and gases fill their containers fully.	**A 18.** Describe differences in the physical properties of solids and liquids.
Structure and Function – How are organisms structured to ensure efficiency and survival? **2.2 - Plants change their forms as part of their life cycles.** ♦ The life cycles of flowering plants include seed germination, growth, flowering, pollination and seed dispersal.	**A 19.** Describe the life cycles of flowering plants as they grow from seeds, proceed through maturation and produce new seeds. **A 20.** Explore and describe the effects of light and water on seed germination and plant growth.
The Changing Earth – How do materials cycle through the Earth's systems? **2.3 - Earth materials have varied physical properties which make them useful in different ways.** ♦ Soils can be described by their color, texture and capacity to retain water. ♦ Soils support the growth of many kinds of plants, including those in our food supply.	**A 21.** Sort different soils by properties, such as particle size, color and composition. **A 22.** Relate the properties of different soils to their capacity to retain water and support the growth of certain plants.
Science and Technology in Society – How do science and technology affect the quality of our lives? **2.4 - Human beings, like all other living things, have special nutritional needs for survival.** ♦ The essential components of balanced nutrition can be obtained from plant and animal sources. ♦ People eat different foods in order to satisfy nutritional needs for carbohydrates, proteins and fats.	**A 23.** Identify the sources of common foods and classify them by their basic food groups. **A 24.** Describe how people in different cultures use different food sources to meet their nutritional needs.

Content Standards and Expected Performances

Core Science for Grades 3-5

THE STANDARDS FOR SCIENTIFIC INQUIRY, LITERACY AND NUMERACY ARE INTEGRAL PARTS OF THE CONTENT STANDARDS FOR EACH GRADE LEVEL IN THIS CLUSTER.

Grades 3-5 Core Scientific Inquiry, Literacy and Numeracy *How is scientific knowledge created and communicated?*	
Content Standards	**Expected Performances**
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. **SCIENTIFIC LITERACY** ♦ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. **SCIENTIFIC NUMERACY** ♦ Mathematics provides useful tools for the description, analysis and presentation of scientific data and ideas.	**B INQ.1** Make observations and ask questions about objects, organisms and the environment. **B INQ.2** Seek relevant information in books, magazines and electronic media. **B INQ.3** Design and conduct simple investigations. **B INQ.4** Employ simple equipment and measuring tools to gather data and extend the senses. **B INQ.5** Use data to construct reasonable explanations. **B INQ.6** Analyze, critique and communicate investigations using words, graphs and drawings. **B INQ.7** Read and write a variety of science-related fiction and nonfiction texts. **B INQ.8** Search the Web and locate relevant science information. **B INQ.9** Use measurement tools and standard units (e.g., centimeters, meters, grams, kilograms) to describe objects and materials. **B INQ.10** Use mathematics to analyze, interpret and present data.

Grade 3 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **3.1 - Materials have properties that can be identified and described through the use of simple tests.** ♦ Heating and cooling cause changes in some of the properties of materials.	**B 1.** Sort and classify materials based on properties such as dissolving in water, sinking and floating, conducting heat, and attracting to magnets. **B 2.** Describe the effect of heating on the melting, evaporation, condensation and freezing of water.
Heredity and Evolution – What processes are responsible for life's unity and diversity? **3.2 - Organisms can survive and reproduce only in environments that meet their basic needs.** ♦ Plants and animals have structures and behaviors that help them survive in different environments.	**B 3.** Describe how different plants and animals are adapted to obtain air, water, food and protection in specific land habitats. **B 4.** Describe how different plants and animals are adapted to obtain air, water, food and protection in water habitats.
The Changing Earth – How do materials cycle through the Earth's systems? **3.3 - Earth materials have different physical and chemical properties.** ♦ Rocks and minerals have properties that may be identified through observation and testing; these properties determine how earth materials are used.	**B 5.** Describe the physical properties of rocks and relate them to their potential uses. **B 6.** Relate the properties of rocks to the possible environmental conditions during their formation.
Science and Technology in Society – How do science and technology affect the quality of our lives? **3.4 - Earth materials provide resources for all living things, but these resources are limited and should be conserved.** ♦ Decisions made by individuals can impact the global supply of many resources.	**B 7.** Describe how earth materials can be conserved by reducing the quantities used, and by reusing and recycling materials rather than discarding them.

Grade 4 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Forces and Motion – What makes objects move the way they do? **4.1 - The position and motion of objects can be changed by pushing or pulling**. ♦ The size of the change in an object's motion is related to the strength of the push or pull. ♦ The more massive an object is, the less effect a given force will have on its motion.	**B 8.** Describe the effects of the strengths of pushes and pulls on the motion of objects. **B 9.** Describe the effect of the mass of an object on its motion.
Matter and Energy in Ecosystems – How do matter and energy flow through ecosystems? **4.2 - All organisms depend on the living and non-living features of the environment for survival.** ♦ When the environment changes, some organisms survive and reproduce, and others die or move to new locations.	**B 10.** Describe how animals, directly or indirectly, depend on plants to provide the food and energy they need in order to grow and survive. **B 11.** Describe how natural phenomena and some human activities may cause changes to habitats and their inhabitants.
Energy in the Earth's Systems – How do external and internal sources of energy affect the Earth's systems? **4.3 - Water has a major role in shaping the Earth's surface.** ♦ Water circulates through the Earth's crust, oceans and atmosphere.	**B 12.** Describe how the sun's energy impacts the water cycle. **B 13.** Describe the role of water in erosion and river formation.
Energy Transfer and Transformations – What is the role of energy in our world? **4.4 - Electrical and magnetic energy can be transferred and transformed.** ♦ Electricity in circuits can be transformed into light, heat, sound and magnetic effects. ♦ Magnets can make objects move without direct contact between the object and the magnet.	**B 14.** Describe how batteries and wires can transfer energy to light a light bulb. **B 15.** Explain how simple electrical circuits can be used to determine which materials conduct electricity. **B 16.** Describe the properties of magnets, and how they can be used to identify and separate mixtures of solid materials.

Grade 5 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Energy Transfer and Transformations – What is the role of energy in our world? **5.1 - Sound and light are forms of energy.** ♦ Sound is a form of energy that is produced by the vibration of objects and is transmitted by the vibration of air and objects. ♦ Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed by objects.	**B 17.** Describe the factors that affect the pitch and loudness of sound produced by vibrating objects. **B 18.** Describe how sound is transmitted, reflected and/or absorbed by different materials. **B 19.** Describe how light is absorbed and/or reflected by different surfaces.
Structure and Function – How are organisms structured to ensure efficiency and survival? **5.2 - Perceiving and responding to information about the environment is critical to the survival of organisms.** ♦ The sense organs perceive stimuli from the environment and send signals to the brain through the nervous system.	**B 20.** Describe how light absorption and reflection allow one to see the shapes and colors of objects. **B 21.** Describe the structure and function of the human senses and the signals they perceive.
Earth in the Solar System – How does the position of Earth in the solar system affect conditions on our planet? **5.3 - Most objects in the solar system are in a regular and predictable motion.** ♦ The positions of the Earth and moon relative to the sun explain the cycles of day and night, and the monthly moon phases.	**B 22.** Explain the cause of day and night based on the rotation of Earth on its axis. **B 23.** Describe the monthly changes in the appearance of the moon, based on the moon's orbit around the Earth.
Science and Technology in Society – How do science and technology affect the quality of our lives? **5.4 - Humans have the capacity to build and use tools to advance the quality of their lives.** ♦ Advances in technology allow individuals to acquire new information about the world.	**B 24.** Compare and contrast the structures of the human eye with those of the camera. **B 25.** Describe the uses of different instruments, such as eye glasses, magnifiers, periscopes and telescopes, to enhance our vision.

Content Standards and Expected Performances

Core Science for Grades 6-8

THE STANDARDS FOR SCIENTIFIC INQUIRY, LITERACY AND NUMERACY ARE INTEGRAL PARTS OF THE CONTENT STANDARDS FOR EACH GRADE LEVEL IN THIS CLUSTER.

Grades 6-8 Core Scientific Inquiry, Literacy and Numeracy *How is scientific knowledge created and communicated?*	
Content Standards	**Expected Performances**
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. ♦ Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation. ♦ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists. **SCIENTIFIC LITERACY** ♦ Scientific literacy includes speaking, listening, presenting, interpreting, reading and writing about science. ♦ Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media. **SCIENTIFIC NUMERACY** ♦ Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.	**C INQ.1** Identify questions that can be answered through scientific investigation. **C INQ.2** Read, interpret and examine the credibility of scientific claims in different sources of information. **C INQ.3** Design and conduct appropriate types of scientific investigations to answer different questions. **C INQ.4** Identify independent and dependent variables, and those variables that are kept constant, when designing an experiment. **C INQ.5** Use appropriate tools and techniques to make observations and gather data. **C INQ.6** Use mathematical operations to analyze and interpret data. **C INQ.7** Identify and present relationships between variables in appropriate graphs. **C INQ.8** Draw conclusions and identify sources of error. **C INQ.9** Provide explanations to investigated problems or questions. **C INQ.10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Grade 6 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **6.1 - Materials can be classified as pure substances or mixtures, depending on their chemical and physical properties.** ♦ Mixtures are made of combinations of elements and/or compounds, and they can be separated by using a variety of physical means. ♦ Pure substances can be either elements or compounds, and they cannot be broken down by physical means.	**C 1.** Describe the properties of common elements, such as oxygen, hydrogen, carbon, iron and aluminum. **C 2.** Describe how the properties of simple compounds, such as water and table salt, are different from the properties of the elements of which they are made. **C 3.** Explain how mixtures can be separated by using the properties of the substances from which they are made, such as particle size, density, solubility and boiling point.
Matter and Energy in Ecosystems – How do matter and energy flow through ecosystems? **6.2 - An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact.** ♦ Populations in ecosystems are affected by biotic factors, such as other populations, and abiotic factors, such as soil and water supply. ♦ Populations in ecosystems can be categorized as producers, consumers and decomposers of organic matter.	**C 4.** Describe how abiotic factors, such as temperature, water and sunlight, affect the ability of plants to create their own food through photosynthesis. **C 5.** Explain how populations are affected by predator-prey relationships. **C 6.** Describe common food webs in different Connecticut ecosystems.
Energy in the Earth's Systems – How do external and internal sources of energy affect the Earth's systems? **6.3 - Variations in the amount of the sun's energy hitting the Earth's surface affect daily and seasonal weather patterns.** ♦ Local and regional weather are affected by the amount of solar energy these areas receive and by their proximity to a large body of water.	**C 7.** Describe the effect of heating on the movement of molecules in solids, liquids and gases. **C 8.** Explain how local weather conditions are related to the temperature, pressure and water content of the atmosphere and the proximity to a large body of water. **C 9.** Explain how the uneven heating of the Earth's surface causes winds.
Science and Technology in Society – How do science and technology affect the quality of our lives? **6.4 - Water moving across and through earth materials carries with it the products of human activities.** ♦ Most precipitation that falls on Connecticut eventually reaches Long Island Sound.	**C 10.** Explain the role of septic and sewage systems on the quality of surface and ground water. **C 11.** Explain how human activity may impact water resources in Connecticut, such as ponds, rivers and the Long Island Sound ecosystem.

Grade 7 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Energy Transfer and Transformations – What is the role of energy in our world? **7.1 - Energy provides the ability to do work and can exist in many forms.** ♦ Work is the process of making objects move through the application of force. ♦ Energy can be stored in many forms and can be transformed into the energy of motion.	**C 12.** Explain the relationship among force, distance and work, and use the relationship (W=F x D) to calculate work done in lifting heavy objects. **C 13.** Explain how simple machines, such as inclined planes, pulleys and levers, are used to create mechanical advantage. **C 14.** Describe how different types of stored (potential) energy can be used to make objects move.
Structure and Function – How are organisms structured to ensure efficiency and survival? **7.2 - Many organisms, including humans, have specialized organ systems that interact with each other to maintain dynamic internal balance.** ♦ All organisms are composed of one or more cells; each cell carries on life-sustaining functions. ♦ Multicellular organisms need specialized structures and systems to perform basic life functions.	**C 15.** Describe the basic structures of an animal cell, including nucleus, cytoplasm, mitochondria and cell membrane, and how they function to support life. **C 16.** Describe the structures of the human digestive, respiratory and circulatory systems, and explain how they function to bring oxygen and nutrients to the cells and expel waste materials. **C 17.** Explain how the human musculo-skeletal system supports the body and allows movement.
Energy in the Earth's Systems – How do external and internal sources of energy affect the Earth's systems? **7.3 - Landforms are the result of the interaction of constructive and destructive forces over time.** ♦ Volcanic activity and the folding and faulting of rock layers during the shifting of the Earth's crust affect the formation of mountains, ridges and valleys. ♦ Glaciation, weathering and erosion change the Earth's surface by moving earth materials from place to place.	**C 18.** Describe how folded and faulted rock layers provide evidence of the gradual up and down motion of the Earth's crust. **C 19.** Explain how glaciation, weathering and erosion create and shape valleys and floodplains. **C 20.** Explain how the boundaries of tectonic plates can be inferred from the location of earthquakes and volcanoes.
Science and Technology in Society – How do science and technology affect the quality of our lives? **7.4 - Technology allows us to improve food production and preservation, thus improving our ability to meet the nutritional needs of growing populations.** ♦ Various microbes compete with humans for the same sources of food.	**C 21.** Describe how freezing, dehydration, pickling and irradiation prevent food spoilage caused by microbes.

Grade 8 Core Themes, Content Standards and Expected Performances	
Content Standards	**Expected Performances**
Forces and Motion – What makes objects move the way they do? **8.1 - An object's inertia causes it to continue moving the way it is moving unless it is acted upon by a force to change its motion.** ♦ The motion of an object can be described by its position, direction of motion and speed. ♦ An unbalanced force acting on an object changes its speed and/or direction of motion. ♦ Objects moving in circles must experience force acting toward the center.	**C 22.** Calculate the average speed of a moving object and illustrate the motion of objects in graphs of distance over time. **C 23.** Describe the qualitative relationships among force, mass and changes in motion. **C 24.** Describe the forces acting on an object moving in a circular path.
Heredity and Evolution – What processes are responsible for life's unity and diversity? **8.2 - Reproduction is a characteristic of living systems and it is essential for the continuation of every species.** ♦ Heredity is the passage of genetic information from one generation to another. ♦ Some of the characteristics of an organism are inherited and some result from interactions with the environment.	**C 25.** Explain the similarities and differences in cell division in somatic and germ cells. **C 26.** Describe the structure and function of the male and female human reproductive systems, including the process of egg and sperm production. **C 27.** Describe how genetic information is organized in genes on chromosomes, and explain sex determination in humans.
Earth in the Solar System – How does the position of Earth in the solar system affect conditions on our planet? **8.3 - The solar system is composed of planets and other objects that orbit the sun.** ♦ Gravity is the force that governs the motions of objects in the solar system. ♦ The motion of the Earth and moon relative to the sun causes daily, monthly and yearly cycles on Earth.	**C 28.** Explain the effect of gravity on the orbital movement of planets in the solar system. **C 29.** Explain how the regular motion and relative position of the sun, Earth and moon affect the seasons, phases of the moon and eclipses.
Science and Technology in Society – How do science and technology affect the quality of our lives? **8.4 - In the design of structures there is a need to consider factors such as function, materials, safety, cost and appearance.** ♦ Bridges can be designed in different ways to withstand certain loads and potentially destructive forces.	**C 30.** Explain how beam, truss and suspension bridges are designed to withstand the forces that act on them.

Content Standards and Expected Performances

Core Science for Grades 9-10

THE STANDARDS FOR SCIENTIFIC INQUIRY, LITERACY AND NUMERACY ARE INTEGRAL PARTS OF THE CONTENT STANDARDS FOR EACH GRADE LEVEL IN THIS CLUSTER.

Grades 9-10 Core Scientific Inquiry, Literacy and Numeracy

How is scientific knowledge created and communicated?

Content Standards	Expected Performances
SCIENTIFIC INQUIRY ♦ Scientific inquiry is a thoughtful and coordinated attempt to search out, describe, explain and predict natural phenomena. ♦ Scientific inquiry progresses through a continuous process of questioning, data collection, analysis and interpretation. ♦ Scientific inquiry requires the sharing of findings and ideas for critical review by colleagues and other scientists. **SCIENTIFIC LITERACY** ♦ Scientific literacy includes the ability to read, write, discuss and present coherent ideas about science. ♦ Scientific literacy also includes the ability to search for and assess the relevance and credibility of scientific information found in various print and electronic media. **SCIENTIFIC NUMERACY** ♦ Scientific numeracy includes the ability to use mathematical operations and procedures to calculate, analyze and present scientific data and ideas.	**D INQ.1** Identify questions that can be answered through scientific investigation. **D INQ.2** Read, interpret and examine the credibility and validity of scientific claims in different sources of information. **D INQ.3** Formulate a testable hypothesis and demonstrate logical connections between the scientific concepts guiding the hypothesis and the design of the experiment. **D INQ.4** Design and conduct appropriate types of scientific investigations to answer different questions. **D INQ.5** Identify independent and dependent variables, including those that are kept constant and those used as controls. **D INQ.6** Use appropriate tools and techniques to make observations and gather data. **D INQ.7** Assess the reliability of the data that was generated in the investigation. **D INQ.8** Use mathematical operations to analyze and interpret data, and present relationships between variables in appropriate forms. **D INQ.9** Articulate conclusions and explanations based on research data, and assess results based on the design of the investigation. **D INQ.10** Communicate about science in different formats, using relevant science vocabulary, supporting evidence and clear logic.

Grade 9

Core Themes, Content Standards and Expected Performances

Strand I: Energy Transformations

Content Standards	Expected Performances
Energy Transfer and Transformations – What is the role of energy in our world? **9.1 - Energy cannot be created or destroyed; however, energy can be converted from one form to another.** ♦ Energy enters the Earth system primarily as solar radiation, is captured by materials and photosynthetic processes, and eventually is transformed into heat.	**D 1.** Describe the effects of adding energy to matter in terms of the motion of atoms and molecules, and the resulting phase changes. **D 2.** Explain how energy is transferred by conduction, convection and radiation. **D 3.** Describe energy transformations among heat, light, electricity and motion.
Energy Transfer and Transformations – What is the role of energy in our world? **9.2 - The electrical force is a universal force that exists between any two charged objects.** ♦ Moving electrical charges produce magnetic forces, and moving magnets can produce electrical force. ♦ Electrical current can be transformed into light through the excitation of electrons.	**D 4.** Explain the relationship among voltage, current and resistance in a simple series circuit. **D 5.** Explain how electricity is used to produce heat and light in incandescent bulbs and heating elements. **D 6.** Describe the relationship between current and magnetism.
Science and Technology in Society – How do science and technology affect the quality of our lives? **9.3 - Various sources of energy are used by humans and all have advantages and disadvantages.** ♦ During the burning of fossil fuels, stored chemical energy is converted to electrical energy through heat transfer processes. ♦ In nuclear fission, matter is transformed directly into energy in a process that is several million times as energetic as chemical burning. ♦ Alternative energy sources are being explored and used to address the disadvantages of using fossil and nuclear fuels.	**D 7.** Explain how heat is used to generate electricity. **D 8.** Describe the availability, current uses and environmental issues related to the use of fossil and nuclear fuels to produce electricity. **D 9.** Describe the availability, current uses and environmental issues related to the use of hydrogen fuel cells, wind and solar energy to produce electricity.

Grade 9

Core Themes, Content Standards and Expected Performances

Strand II: Chemical Structures and Properties

Content Standards	Expected Performances
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **9.4 - Atoms react with one another to form new molecules.** ♦ Atoms have a positively charged nucleus surrounded by negatively charged electrons. ♦ The configuration of atoms and molecules determines the properties of the materials.	**D 10.** Describe the general structure of the atom, and explain how the properties of the first 20 elements in the Periodic Table are related to their atomic structures. **D 11.** Describe how atoms combine to form new substances by transferring electrons (ionic bonding) or sharing electrons (covalent bonding). **D 12.** Explain the chemical composition of acids and bases, and explain the change of pH in neutralization reactions.
Properties of Matter – How does the structure of matter affect the properties and uses of materials? **9.5 – Due to its unique chemical structure, carbon forms many organic and inorganic compounds.** ♦ Carbon atoms can bond to one another in chains, rings and branching networks to form a variety of structures, including fossil fuels, synthetic polymers and the large molecules of life.	**D 13.** Explain how the structure of the carbon atom affects the type of bonds it forms in organic and inorganic molecules. **D 14.** Describe combustion reactions of hydrocarbons and their resulting by-products. **D 15.** Explain the general formation and structure of carbon-based polymers, including synthetic polymers, such as polyethylene, and biopolymers, such as carbohydrate.
Science and Technology in Society – How do science and technology affect the quality of our lives? **9.6 - Chemical technologies present both risks and benefits to the health and well-being of humans, plants and animals.** ♦ Materials produced from the cracking of petroleum are the starting points for the production of many synthetic compounds. ♦ The products of chemical technologies include synthetic fibers, pharmaceuticals, plastics and fuels.	**D 16.** Explain how simple chemical monomers can be combined to create linear, branched and/or cross-linked polymers. **D 17.** Explain how the chemical structure of polymers affects their physical properties. **D 18.** Explain the short- and long-term impacts of landfills and incineration of waste materials on the quality of the environment.

Grade 9

Core Themes, Content Standards and Expected Performances

Strand III: Global Interdependence

Content Standards	Expected Performances
The Changing Earth – How do materials cycle through the Earth's systems? **9.7 - Elements on Earth move among reservoirs in the solid earth, oceans, atmosphere and organisms as part of biogeochemical cycles.** ♦ Elements on Earth exist in essentially fixed amounts and are located in various chemical reservoirs. ♦ The cyclical movement of matter between reservoirs is driven by the Earth's internal and external sources of energy.	**D 19.** Explain how chemical and physical processes cause carbon to cycle through the major earth reservoirs. **D 20.** Explain how solar energy causes water to cycle through the major earth reservoirs. **D 21.** Explain how internal energy of the Earth causes matter to cycle through the magma and the solid earth.
Science and Technology in Society – How do science and technology affect the quality of our lives? **9.8 - The use of resources by human populations may affect the quality of the environment.** ♦ Emission of combustion by-products, such as SO_2, CO_2 and NOx by industries and vehicles is a major source of air pollution. ♦ Accumulation of metal and non-metal ions used to increase agricultural productivity is a major source of water pollution.	**D 22.** Explain how the release of sulfur dioxide (SO_2) into the atmosphere can form acid rain, and how acid rain affects water sources, organisms and human-made structures. **D 23.** Explain how the accumulation of carbon dioxide (CO_2) in the atmosphere increases Earth's "greenhouse" effect and may cause climate changes. **D 24.** Explain how the accumulation of mercury, phosphates and nitrates affects the quality of water and the organisms that live in rivers, lakes and oceans.
Science and Technology in Society – How do science and technology affect the quality of our lives? **9.9 - Some materials can be recycled, but others accumulate in the environment and may affect the balance of the Earth systems.** ♦ New technologies and changes in lifestyle can have positive and/or negative effects on the environment.	**D 25.** Explain how land development, transportation options and consumption of resources may affect the environment. **D 26.** Describe human efforts to reduce the consumption of raw materials and improve air and water quality.

Grade 10

Core Themes, Content Standards and Expected Performances

Strand IV: Cell Chemistry and Biotechnology

Content Standards	Expected Performances
Structure and Function – How are organisms structured to ensure efficiency and survival? **10.1 - Fundamental life processes depend on the physical structure and the chemical activities of the cell.** ♦ Most of the chemical activities of the cell are catalyzed by enzymes that function only in a narrow range of temperature and acidity conditions. ♦ The cellular processes of photosynthesis and respiration involve transformation of matter and energy.	**D 27.** Describe significant similarities and differences in the basic structure of plant and animal cells. **D 28.** Describe the general role of DNA and RNA in protein synthesis. **D 29.** Describe the general role of enzymes in metabolic cell processes. **D 30.** Explain the role of the cell membrane in supporting cell functions.
Science and Technology in Society – How do science and technology affect the quality of our lives? **10.2 - Microorganisms have an essential role in life processes and cycles on Earth.** ♦ Understanding the growth and spread patterns of viruses and bacteria enables the development of methods to prevent and treat infectious diseases.	**D 31.** Describe the similarities and differences between bacteria and viruses. **D 32.** Describe how bacterial and viral infectious diseases are transmitted, and explain the roles of sanitation, vaccination and antibiotic medications in the prevention and treatment of infectious diseases. **D 33.** Explain how bacteria and yeasts are used to produce foods for human consumption.
Science and Technology in Society – How do science and technology affect the quality of our lives? **10.3 - Similarities in the chemical and structural properties of DNA in all living organisms allow the transfer of genes from one organism to another.** ♦ The principles of genetics and cellular chemistry can be used to produce new foods and medicines in biotechnological processes.	**D 34.** Describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials. **D 35.** Explain the risks and benefits of altering the genetic composition and cell products of existing organisms.

Grade 10

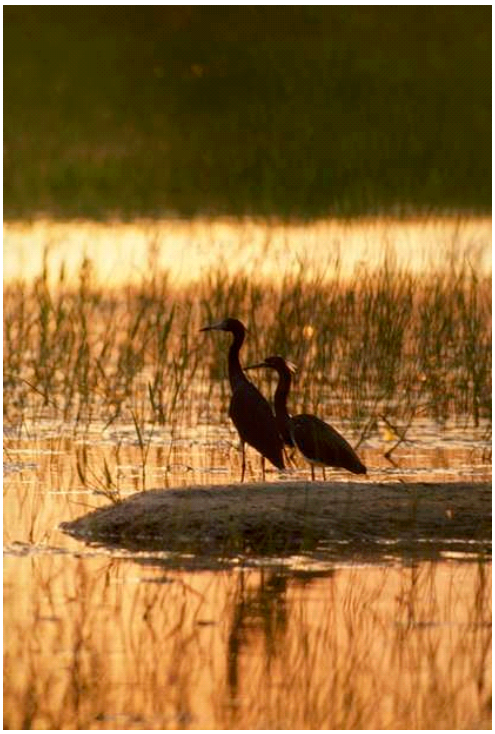
Core Themes, Content Standards and Expected Performances

Strand V: Genetics, Evolution and Biodiversity

Content Standards	Expected Performances
Heredity and Evolution – What processes are responsible for life's unity and diversity? **10.4. - In sexually reproducing organisms, each offspring contains a mix of characteristics inherited from both parents.** ♦ Genetic information is stored in genes that are located on chromosomes inside the cell nucleus. ♦ Most organisms have two genes for each trait, one on each of the homologous chromosomes in the cell nucleus.	**D 36.** Explain how meiosis contributes to the genetic variability of organisms. **D 37.** Use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings. **D 38.** Deduce the probable mode of inheritance of traits (e.g., recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes. **D 39.** Describe the difference between genetic disorders and infectious diseases.
Heredity and Evolution – What processes are responsible for life's unity and diversity? **10.5 - Evolution and biodiversity are the result of genetic changes that occur over time in constantly changing environments.** ♦ Mutations and recombination of genes create genetic variability in populations. ♦ Changes in the environment may result in the selection of organisms that are better able to survive and reproduce.	**D 40.** Explain how the processes of genetic mutation and natural selection are related to the evolution of species. **D 41.** Explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms. **D 42.** Describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.
Science and Technology in Society – How do science and technology affect the quality of our lives? **10.6 - Living organisms have the capability of producing populations of unlimited size, but the environment can support only a limited number of individuals from each species.** ♦ Human populations grow due to advances in agriculture, medicine, construction and the use of energy. ♦ Humans modify ecosystems as a result of rapid population growth, use of technology and consumption of resources.	**D 43.** Describe the factors that affect the carrying capacity of the environment. **D 44.** Explain how change in population density is affected by emigration, immigration, birth rate and death rate, and relate these factors to the exponential growth of human populations. **D 45.** Explain how technological advances have affected the size and growth rate of human populations throughout history.

APPENDIX

Enrichment Content Standards for High School Science



Adaptations of California Science Content Standards (on pages 31 – 40) permitted courtesy of California Department of Education, CDE Press, 1430 N Street, Suite 3207, Sacramento, CA 95814. Full text of California State standards available at: http://www.cde.ca.gov/re/pn/fd/sci-frame-dwnld.asp

High School Biology	
Content Standards	**Supportive Concepts**
Cell Biology The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells.	▪ Cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings. ▪ Enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions and the pH of the surroundings. ▪ Prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure. ▪ The central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm. ▪ The endoplasmic reticulum and Golgi apparatus have a role in the secretion of proteins. ▪ Usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide. ▪ The role of the mitochondria is to make stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide. ▪ Most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
Genetics Mutation and sexual reproduction lead to genetic variation in a population.	▪ Meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type. ▪ Only certain cells in a multicellular organism undergo meiosis. ▪ Random chromosome segregation explains the probability that a particular allele will be in a gamete. ▪ New combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization). ▪ Approximately half of an individual's DNA sequence comes from each parent. ▪ Genes on specific chromosomes determine an individual's sex. ▪ Possible combinations of alleles in a zygote can be predicted from the genetic makeup of the parents.

A multicellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization.	▪ The probable outcome of phenotypes in a genetic cross can be predicted from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive). ▪ Mendel's laws of segregation and independent assortment are the basis of genetics. ▪ The probable mode of inheritance can be predicted from a pedigree diagram showing phenotypes. ▪ Data on frequency of recombination at meiosis can be used to estimate genetic distances between loci and to interpret genetic maps of chromosomes.
Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism.	▪ Ribosomes synthesize proteins, using tRNAs to translate genetic information in the mRNA. ▪ The sequence of amino acids in a protein can be predicted from the sequence of codons in the RNA, by applying universal genetic coding rules. ▪ Mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein. ▪ Specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves. ▪ Proteins can differ from one another in the number and sequence of amino acids. ▪ Proteins having different amino acid sequences typically have different shapes and chemical properties.
The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells.	▪ Base-pairing rules are used to explain the precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA. ▪ Genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products. ▪ DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation and transformation) is used to construct recombinant DNA molecules. ▪ Exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

Ecology Stability in an ecosystem is a balance between competing effects.	▪ Biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats. ▪ Changes in an ecosystem can result from changes in climate, human activity, introduction of nonnative species, or changes in population size. ▪ Fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration and death. ▪ Water, carbon and nitrogen cycle between abiotic resources and organic matter in the ecosystem and oxygen cycles through photosynthesis and respiration. ▪ A vital part of an ecosystem is the stability of its producers and decomposers. ▪ At each link in a food web some energy is stored in newly made structures, but much energy is dissipated into the environment as heat. ▪ The accommodation of an individual organism to its environment is different from the gradual adaptation of a lineage of organisms through genetic change.
Evolution The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time.	▪ Natural selection acts on the phenotype rather than the genotype of an organism. ▪ Alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool. ▪ New mutations are constantly being generated in a gene pool. ▪ Variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
Evolution is the result of genetic changes that occur in constantly changing environments.	▪ Natural selection determines the differential survival of groups of organisms. ▪ A great diversity of species increases the chance that at least some organisms survive major changes in the environment. ▪ Genetic drift affects the diversity of organisms in a population. ▪ Reproductive or geographic isolation affects speciation. ▪ Fossil evidence contributes to our understanding of biological diversity, episodic speciation and mass extinction. ▪ Several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.

Physiology As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment.	▪ The complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide. ▪ The nervous system mediates communication between different parts of the body and the body's interactions with the environment. ▪ Feedback loops in the nervous and endocrine systems regulate conditions in the body. ▪ The neurons transmit electrochemical impulses. ▪ Sensory neurons, interneurons and motor neurons all have a role in sensation, thought and response. ▪ Digestion includes the secretion of stomach acid, digestive enzymes (amylases, proteases, nucleases, lipases) and bile salts into the digestion system. ▪ The kidneys have a homeostatic role in the removal of nitrogenous wastes from the blood. ▪ The liver has a homeostatic role in detoxification and keeping the blood glucose balance. ▪ Actin, myosin, Ca2 and ATP have a role in the cellular and molecular basis of muscle contraction. ▪ Hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.
Organisms have a variety of mechanisms to combat disease.	▪ The skin provides nonspecific defenses against infection. ▪ Antibodies have a role in the body's response to infection. ▪ Vaccination protects an individual from infectious diseases. ▪ There are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections. ▪ An individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign. ▪ Phagocytes, B-lymphocytes and T-lymphocytes have a role in the immune system.

High School Earth Science	
Content Standards	**Supportive Concepts**
Earth's Place in the Universe Earth-based and space-based astronomy reveal the structure, scale and changes in stars, galaxies and the universe over time.	▪ The differences and similarities among the sun, the terrestrial planets and the gas planets may have been established during the formation of the solar system. ▪ Evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago. ▪ Evidence from geological studies of Earth and other planets suggests that the early Earth was very different from Earth today. ▪ The sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium. ▪ Asteroids and meteorites had a significant role in shaping the surface of planets and their moons and in mass extinctions of life on Earth. ▪ The solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years. ▪ Galaxies are made of billions of stars and comprise most of the visible mass of the universe. ▪ Evidence indicates that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion in stars. ▪ Visual, radio and X-ray telescopes may be used to collect data that reveal those differences in the life cycles of stars. ▪ The "big bang" model suggests that the universe has been expanding for 10 to 20 billion years.
Dynamic Earth Processes Plate tectonics operating over geologic time has changed the patterns of land, sea and mountains on Earth's surface.	▪ Features of the ocean floor, as well as the shape and rock composition of the major plates, provide evidence of plate tectonics. ▪ Volcanic eruptions and earthquakes are the result of the movement of matter and energy within the Earth. ▪ The properties of rocks and minerals can be explained based on the physical and chemical conditions in which they were formed, including plate tectonic processes.
Energy in the Earth System Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.	▪ The sun is a major source of energy for Earth and other planets. ▪ Some of the solar radiation is reflected back into the atmosphere and some is absorbed by matter and photosynthetic processes. ▪ Different atmospheric gases absorb the Earth's thermal radiation. ▪ The greenhouse effect may cause climatic changes.

Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	▪ Differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat. ▪ The rotation of Earth influences the circular motions of ocean currents and air. ▪ Properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms. ▪ The interaction of wind patterns, ocean currents, and the distribution of land masses result in a global pattern of latitudinal bands of rain forests and deserts.
Climate is the long-term average of a region's weather and depends on many factors.	▪ Weather and climate involve the transfer of energy into and out of the atmosphere. ▪ Latitude, elevation, topography, proximity to large bodies of water, and cold or warm ocean currents affect the climate. ▪ Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition and other factors, such as solar radiation and plate movement.
Biogeochemical Cycles Each element on Earth moves among reservoirs which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.	▪ The movement of matter among reservoirs is driven by Earth's internal and external sources of energy. ▪ Carbon cycles through the reservoirs of the atmosphere, lithosphere, hydrosphere and biosphere.
Structure and Composition of the Atmosphere Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.	▪ The atmosphere has specific thermal structure and chemical composition. ▪ The composition of Earth's atmosphere has evolved over geologic time. ▪ The origin of atmospheric oxygen is photosynthetic processes. ▪ The ozone layer in the upper atmosphere absorbs ultraviolet radiation. This layer varies both naturally and in response to human activities.

High School Chemistry	
Content Standards	**Supportive Concepts**
Atomic and Molecular Structure The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure.	▪ The nucleus of the atom is much smaller than the atom, yet contains most of its mass. ▪ The quantum model of the atom is based on experiments and analyses by many scientists, including Dalton, Thomson, Bohr, Rutherford, Millikan and Einstein. ▪ The position of an element in the periodic table is related to its atomic number. ▪ The periodic table can be used to identify metals, semimetals, non-metals and halogens. ▪ The periodic table can be used to identify trends in ionization energy, electronegativity, the relative sizes of ions and atoms, and the number of electrons available for bonding. ▪ The electronic configuration of elements and their reactivity can be identified based on their position in the periodic table.
Chemical Bonds Biological, chemical and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules.	▪ Atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds. ▪ Chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, H_2CCH_2, N_2, Cl_2, and many large biological molecules are covalent. ▪ Salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction. ▪ The atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form. ▪ Lewis dot structures can provide models of atoms and molecules. ▪ The shape of simple molecules and their polarity can be predicted from Lewis dot structures. ▪ Electronegativity and ionization energy are related to bond formation. ▪ Solids and liquids held together by Van der Waals forces or hydrogen bonds are affected by volatility and boiling/melting point temperatures.
Conservation of Matter and Stoichiometry The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.	▪ Chemical reactions can be described by writing balanced equations. ▪ The quantity one mole is set by defining one mole of carbon; 12 atoms to have a mass of exactly 12 grams. ▪ One mole equals 6.02.x 1023 particles (atoms or molecules). ▪ The molar mass of a molecule can be determined from its chemical formula and a table of atomic masses. ▪ The mass of a molecular substance can be converted to moles, number of particles, or volume of gas at standard temperature and pressure. ▪ Hess's law is used to calculate enthalpy change in a reaction.

Reaction Rates Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.	▪ The rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time. ▪ Reaction rates depend on factors such as concentration, temperature and pressure. ▪ Equilibrium is established when forward and reverse reaction rates are equal. ▪ Catalysts play a role in increasing the reaction rate by changing the activation energy in a chemical reaction.
Organic Chemistry and Biochemistry The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes and chemical properties, and provide the biochemical basis of life.	▪ Large molecules (polymers), such as proteins, nucleic acids and starch, are formed by repetitive combinations of organic monomers. ▪ The bonding characteristics of carbon result in the formation of a large variety of structures, ranging from simple hydrocarbons to complex biological molecules and synthetic polymers. ▪ Amino acids are the building blocks of proteins.

High School Physics	
Content Standards	**Supportive Concepts**
Motion and Forces Newton's laws predict the motion of most objects.	▪ When forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest. ▪ The law $F = ma$ is used to solve motion problems that involve constant forces. ▪ When one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction. ▪ Applying a force to an object perpendicular to the direction of its motion causes the object to change direction. ▪ Circular motion requires the application of a constant force directed toward the center of the circle. ▪ Newton's laws are not exact, but provide very good approximations unless an object is small enough that quantum effects become important.
Conservation of Energy and Momentum The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	▪ Kinetic energy can be calculated by using the formula $E = (1/2)mv^2$. ▪ Changes in gravitational potential energy near Earth can be calculated by using the formula (change in potential energy) = mgh. ▪ Momentum is calculated as the product mv. ▪ Momentum is a separately conserved quantity different from energy. ▪ An unbalanced force on an object produces a change in its momentum. ▪ The principles of conservation of momentum and energy can be used to solve problems involving elastic and inelastic collisions.
Heat and Thermodynamics Energy cannot be created or destroyed although, in many processes, energy is transferred to the environment as heat.	▪ Heat flow and work are two forms of energy transfer between systems. ▪ The work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature. ▪ The internal energy of an object includes the energy of random motion of the object's atoms and molecules. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object. ▪ Most processes tend to decrease the order of a system over time, so that energy levels eventually are distributed more uniformly.

Waves Waves have characteristic properties that do not depend on the type of wave.	▪ Waves carry energy from one place to another. ▪ Transverse and longitudinal waves exist in mechanical media, such as springs and ropes, and in the Earth as seismic waves. ▪ Wavelength, frequency and wave speed are related. ▪ Sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates. ▪ Radio waves, light and X-rays are different wavelength bands in the spectrum of electromagnetic waves, the speed of which in a vacuum is approximately 3 x 10^8m/s, and less when passing through other media. ▪ Waves have characteristic behaviors, such as interference, diffraction, refraction and polarization. ▪ Beats and the Doppler Effect result from the characteristic behavior of waves.
Electric and Magnetic Phenomena Electric and magnetic phenomena are related and have many practical applications.	▪ The voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors and capacitors can be predicted using Ohm's law. ▪ Any resistive element in a DC circuit dissipates energy, which heats the resistor. ▪ The power in any resistive circuit element can be calculated by using the formula Power = I^2R. ▪ Charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges. ▪ Magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources. ▪ Changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors. ▪ Plasmas, the fourth state of matter, contain ions, or free electrons or both and conduct electricity.