Core Science Curriculum Framework – Grade 10

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) 6th Grade
   - Chemical Reactions (9.4) 9th Grade
   - Carbon Compounds (9.5) 9th Grade

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) 7th Grade
   - Energy Conservation and Transformation (9.1) 9th Grade
   - Electrical Forces (9.2) 9th Grade

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) 7th Grade

<table>
<thead>
<tr>
<th>Strand</th>
<th>Conceptual Theme</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Inquiry</td>
<td></td>
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<tr>
<td>II</td>
<td>Properties of Matter</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Energy Transfer and Transformations</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Forces and Motion</td>
<td></td>
</tr>
</tbody>
</table>
V. Matter and Energy in Ecosystems – How do matter and energy flow through ecosystems?
   - Food Chains (4.2)
   - Ecosystems (6.2) 6th Grade

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) 6th Grade
   - 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) 8th Grade
   - 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) 8th Grade

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) 6th Grade
   - The Changing Earth (7.3) 8th Grade

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) 8th Grade
   - The Solar System (8.3) 8th Grade

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) 7th Grade
Food Technology (7.4)
Building Bridges (8.4) 7th Grade
Energy and Power Technologies (9.3)
Polymers (9.6) 9th Grade
Human Environmental Impacts (9.8, 9.9)
Living with Microorganisms (10.2)
Biotechnology (10.3)
Human Population Growth (10.6)
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 10
The Standards for Scientific Inquiry, Literacy and Numeracy are integral parts of the Content Standards for each grade level in this cluster.

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

**Core Themes, Content Standards and Expected Performances**

**Strand IV: Cell Chemistry and Biotechnology**

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Expected Performances</th>
<th>Grade – Activity/Assessment</th>
<th>Timeline</th>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure and Function – How are organisms structured to ensure efficiency and survival?</strong></td>
<td><strong>10.1 - Fundamental life processes depend on the physical structure and the chemical activities of the cell.</strong></td>
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<tr>
<td>♦ Most of the chemical activities of the cell are catalyzed by enzymes that function only in a narrow range of temperature and acidity conditions.</td>
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<tr>
<td>♦ The cellular processes of photosynthesis and respiration involve transformation of matter and energy. ***</td>
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</tbody>
</table>
| **D 1.** Describe significant similarities and differences in the basic structure of plant and animal cells. | 10th Grade  
1. Animal vs. Plant Cell Lab. | September – November | Cells  
Organic Chemistry/Biochemistry | |
| **D 2.** Describe the general role of DNA and RNA in protein synthesis. | 2. Enzymes Lab | | | |
| **D 3.** Describe the general role of enzymes in metabolic cell processes. | 3. Dialysis Lab | | | |
| **D 4.** Explain the role of the cell membrane in supporting cell functions. | 4. *** Elodea Photosynthesis/Cell Respiration Lab. | November - December | Photosynthesis  
Cell Respiration | |
### Grade 10

**Core Themes, Content Standards and Expected Performances**

**Strand V: Genetics, Evolution and Biodiversity**

<table>
<thead>
<tr>
<th>Content Standards</th>
<th>Expected Performances</th>
<th>Grade – Activity/Assessment</th>
<th>Timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heredity and Evolution – What processes are responsible for life’s unity and diversity?</td>
<td>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.</td>
<td>10th Grade</td>
<td>January</td>
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<td></td>
<td>D 5. Explain how meiosis contributes to the genetic variability of organisms.</td>
<td>1. Fertilization Lab</td>
<td>Cell Division – Mitosis/Meiosis</td>
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<tr>
<td></td>
<td>D 6. Use the Punnet Square technique to predict the distribution of traits in mono- and di-hybrid crossings.</td>
<td>2. Worksheets on Punnett Squares</td>
<td>Genetics</td>
</tr>
<tr>
<td></td>
<td>D 7. Deduce the probable mode of inheritance of traits (e.g., recessive/dominant, sex-linked) from pedigree diagrams showing phenotypes.</td>
<td>3. Pedigree Worksheets</td>
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<td></td>
<td>D 8. Describe the difference between genetic disorders and infectious diseases.</td>
<td>4. Genetic Disorder Webquest</td>
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</table>

- 1. Fertilization Lab
- 2. Worksheets on Punnett Squares
- 3. Pedigree Worksheets
- 4. Genetic Disorder Webquest
### Grade 10

**Core Themes, Content Standards and Expected Performances**

**Strand IV: Cell Chemistry and Biotechnology**

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| *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 9. | Describe, in general terms, how the genetic information of organisms can be altered to make them produce new materials. | 10th Grade | March - April | DNA/Protein Synthesis |
| D 10. | Explain the risks and benefits of altering the genetic composition and cell products of existing organisms. | 1. Bio-engineered Food STS Inquiry Lab. (D34 & D35) | | |

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<th>Grade – Activity/Assessment</th>
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<tr>
<td><em>Science and Technology in Society – How do science and technology affect the quality of our lives?</em></td>
<td>D 11. Describe the similarities and differences between bacteria and viruses.</td>
<td>10th Grade</td>
<td>May - June</td>
</tr>
<tr>
<td><em>How do science and technology affect the quality of our lives?</em></td>
<td>D 12. 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.</td>
<td>1. Pathogen Wanted Poster Project</td>
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</tr>
<tr>
<td>✦ Understanding the growth and spread patterns of viruses and bacteria enables the development of methods to prevent and treat infectious diseases.</td>
<td>D 13. Explain how bacteria and yeasts are used to produce foods for human consumption.</td>
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**New Standard – Needs to be added.**
<table>
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<tr>
<td>Heredity and Evolution – What processes are responsible for life’s unity and diversity?</td>
<td>D 14. Explain how the processes of genetic mutation and natural selection are related to the evolution of species.</td>
<td>10th Grade</td>
<td>May - June</td>
</tr>
<tr>
<td>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.</td>
<td>D 15. Explain how the current theory of evolution provides a scientific explanation for fossil records of ancient life forms.</td>
<td>10th Grade</td>
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<td>D 16. Describe how structural and behavioral adaptations increase the chances for organisms to survive in their environments.</td>
<td>10th Grade</td>
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<tr>
<td><strong>Science and Technology in Society – How do science and technology affect the quality of our lives?</strong>&lt;br&gt;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.&lt;br&gt;♦️ Humans modify ecosystems as a result of rapid population growth, use of technology and consumption of resources.</td>
<td>D 17. Describe the factors that affect the carrying capacity of the environment.&lt;br&gt;D 18. 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.&lt;br&gt;D 19. Explain how technological advances have affected the size and growth rate of human populations throughout history.</td>
<td>10th Grade&lt;br&gt;1. Yeast Population Dynamics Embedded Task Inquiry Lab. To be completed by December 21st.&lt;br&gt;2. Human Population Dynamics STS Inquiry Lab. To be completed by January 31st.</td>
<td>May - June</td>
</tr>
</tbody>
</table>