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New York City

6-12 Science Scope & Sequence

NYC Department of Education

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The New York City Department of Education

6–12 Science Scope & Sequence

Science is everywhere and our students are naturally curious, which makes them natural scientists. A strong science program helps them make sense of the physical world around them, it can explain the how and why things work, like complex systems, from the human body to our planet Earth. In our science classrooms, students can develop an understanding of the inter-dependency of living things as well as a respect for nature.

We live in a natural learning laboratory made up of a combination of unique ecosystems in which our students can connect to the nature that is all around them in city parks, gardens, green spaces, beaches, and waterways, and the amazing environment of New York City. Through inquiry approaches and project-based learning students can potentially address real-world problems in their communities and take action. Students engaged in scientific inquiry are keen observers and active explorers who pose questions, theorize, hypothesize, predict, conduct experiments, reach conclusions, and communicate their discoveries. These skills will help them develop into scientifically literate and responsible adults.

The **Enhanced NYC Science Scope & Sequence** is a revision of an earlier Scope & Sequence published in 2008. The Enhanced NYC Science Scope & Sequence includes the current NYS MST standards that all schools should continue to follow as well as new resources. The new resources include:

- An alignment to the NGSS Science and Engineering Practices and the Cross-Cutting Concepts.
- An alignment to the Common Core Learning Standards in English Language Arts and the Common Core Learning Standards in Mathematics given the relevance between the skills needed in all three disciplines (ELA, Math, and Science).
- An alignment to the Excellence in Environmental Education: Guidelines for Learning (K–12) published by the North American Association of Environmental Education to support the environmental education of NYC students and to encourage them to find innovative solutions to environmental problems and issues in their communities.
- The New York State Education Law – Article 17, Sections 809 – Instructions for the Humane Treatment of Animals and 810 – Conservation Day
- The Reference Tables that are used most often in Regents science courses are included (in the Grades 6–12 Scope & Sequence only.

The volume of science content in each grade can present some challenges. Teachers are faced with large amounts of content to be “covered” yet want to provide their students with opportunities for in-depth scientific exploration and inquiry. This issue of “depth versus breadth” will require teachers to accept that not all content is created equal. Teachers will also need to accept that it is often not possible to cover everything. The amount of content covered rarely correlates to the amount of content that students learn because students rarely retain all of the content that is taught. The challenge teachers face is how to teach enough content yet still make time for hands-on, inquiry-driven, extended learning. Teachers will need to decide which content merits deep exploration and which content merits familiarity or exposure. Teachers will need to make these decisions based on their knowledge of the content, assessments, instructional goals and, most importantly, an understanding of students’ learning needs, readiness, and interests. Teachers may need to differentiate and provide additional scaffolding and support based on individual student needs, not limited to but especially for our English language learners, students with special needs and students who are significantly below or above grade level. The Scope & Sequence can serve as a valuable resource for teachers in planning appropriate individual, group and whole class instruction. We trust that this resource will provide teachers with useful guidance, help them make important instructional decisions, and help them develop engaging science experiences for their students.

Anna Commitante
Senior Executive Director
Curriculum, Instruction & Professional Learning

The Enhanced Science Scope & Sequence

Background

New York State Learning Standards for Mathematics, Science, and Technology (MST)

In March of 1996 the New York State Board of Regents adopted the New York State Learning Standards for Mathematics, Science, and Technology (MST). This adoption included seven standards with four of the standards comprising the process skills and three of the standards covering specific content. *Currently, all NYC schools follow the New York State Learning Standards for Mathematics, Science, and Technology (MST) and the NYS assessments in science are developed based on these standards.* The standards are as follows:

Standard 1 – Analysis, Inquiry and Design

Standard 2 – Information Systems

Standard 3 – Mathematics

Standard 4 – Science

Standard 5 – Technology Education

Standard 6 – Interconnectedness: Common Themes

Standard 7 – Interdisciplinary Problem Solving

The New York State Education Department followed with the development of Core Curriculum resource guides in Elementary level Science (Grades K–4), Intermediate level Science (Grades 5-8) and Commencement level Science (Grades 9–12) in Chemistry, Earth Science, Living Environment and Physics. The core curriculum resource guides consist of the content standards, the key ideas and the performance indicators with major understandings.

MST Process Skills Standards

The MST Standards 1, 2 and 6, 7 are considered the process standards and are shared across the three content areas of mathematics, science, and technology.

Process skills are vital in understanding the natural phenomena that is science. Scientific discovery is built on such process skills as comparing and contrasting, creating models, using measurement and interpreting data, and making predictions and informed decisions.

NOTE: MST Standard 1—Analysis, Inquiry and Design, is not listed in any of the units in this Science Scope & Sequence. This standard should be included in all of the units and therefore listing this in each of the individual units would be redundant.

Next Generation Science Standards

In 2012, the National Research Council published Frameworks for K–12 Science Education. This research-based document outlined a plan of action for science education that included the 21st Century skills needed by students. The Next Generation Science Standards were developed from the Frameworks document through the collaboration of Achieve, the National Research Council the National Science Teachers Association and the American Association for the Advancement of Science. After the release of drafts and two public feedbacks, the Next Generation Science Standards were released in April, 2013.

New York State was one of the 26 states that supported the writing of the NGSS. For the adoption of the NGSS, each state must create legislation to adopt and implement the Next Generation Science Standards with state funding. To date, 13 states have adopted the Next Generation Science Standards but New York has not done so.

In March 2014, the Board of Regents discussed the quantitative feedback that was collected from a statewide survey. Respondents rated the NGSS statistically higher in 11 out of 21 criteria and rated the current New York State Science Learning Standards (NYSSLS) statistically higher in 6 out of 21 criteria. There are four criteria where the differences between the NGSS rating and the NYSSLS rating were not statistically significant. Further analysis of the quantitative data shows that both sets of standards have strengths and weaknesses when compared to the set of criteria used in the survey. *At this time, the NYS Board of Regents has not decided to adopt the NGSS. In anticipation of a NYS adoption of the NGSS or a state version of the NGSS and to help NYC educators develop an awareness of the NGSS, this enhanced version of the Science Scope & Sequence includes an alignment to the NGSS Science and Engineering Practices and the Cross-Cutting Concepts.*

These standards, and several supporting documents explaining the structure of the NGSS and a number of appendices, are accessible online at http://www.nextgenscience.org/sites/ngss/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf

Practices in Science and Engineering

Due to the nature of science and its direct real-world applications, it is not possible to assess students' understanding of core ideas separately from their abilities to use the practices of science and engineering. Students must show that they know science concepts through their investigations of the natural world, the practices of science inquiry and by solving meaningful problems through the practices of engineering design.

The eight practices of science and engineering that the *Framework* identifies as essential for all students to learn and describe in detail are listed below:

1. Asking questions (for science) and defining problems (for engineering)

2. Developing and using models

3. Planning and carrying out investigations

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

Cross-Cutting Concepts

There are three major dimensions through which science education should be constructed: e built around three major dimensions:

a. scientific and engineering practices

b. crosscutting concepts that unify their common application across fields

c. core ideas in the major disciplines of natural science

Within these dimensions are the cross-cutting practices that connect and unite the core ideas:

1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

2. Cause and effect. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.

5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.

6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Common Core Learning Standards

National Standards in the areas of Mathematics and English Language Arts did not exist in the United States. In a joint effort, the National Governors Association and the Chief State School Officers partnered with Achieve, ACT and the College Board to begin work on the Common Core State Initiative. This state-led process that involved working with national experts developed a common core of state standards in English Language Arts and mathematics for Grades K–12.

In April 2009, New York State Governor David Paterson and former Education Commissioner Richard P. Mills, along with fifty other states and territories, agreed to participate in discussions concerning the development of these voluntary standards. The first draft of the standards was released for public feedback in 2009 and a second round of public feedback was taken in March of 2010. In June 2010, the final version of the Common Core State Standards (CCSS) for Mathematics and English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects were made accessible to the public. The Common Core State Standards were tied to *Race to the Top* funding and many states adopted them immediately. The New York State Board of Regents adopted the CCSS for Mathematics and CCSS for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects in July 2010.

The goal of the English Language Arts and Literacy Common Core State Standards is to make certain that students are college and career ready in the areas of reading, writing, speaking and listening. In science, students are expected to read the science texts at the grade appropriate level. They are also required to create logical argumentative writing based on claims, scientific reasoning and relevant evidence. Writing can also take the form of long-term, in-depth scientific research. In addition, academic discourse of formal and informal scientific presentations is envisaged at the grade appropriate level.

The goal of the Common Core Mathematics Standards is to make certain that students are college-and career-ready in the area of mathematics. Students are expected to solve problems and explain their thinking. Science is the application of the mathematical concepts and skills necessary for the real-world applications as presented in the science content.

This enhanced version of the Science Scope and Sequence includes an alignment to the Common Core Learning Standards in English Language Arts and Mathematics that are relevant in science.

Excellence in Environmental Education: Guidelines for Learning (K–12)

There is no exact date to point to when thinking about the history of environmental education. Some may argue that naturalists such as Thoreau and Emerson were the forefathers of the movement. However, a concerted effort to reach international agreement about the protection of the environment began in the years immediately after World War II. The *Conference for the Establishment of the International Union for the Protection of Nature* (IUCN) convened in France in October of 1948. The primary focus of this conference was to ensure the protection of nature and its habitats. The movement was slow to start until the publication of two books in the 1960s which rekindled international attention: Rachel Carson's *Silent Spring* and Steward Udall's *The Quiet Crisis*. These, along with the political climate of the 1960s, sparked United States legislation such as the Wilderness Act (1964), the Clean Air Act (1965), the Solid Waste Disposal Act (1965), and the Species Conservation Act (1966).

In 1970, the Environmental Education Act was passed as a direct result of the highly successful first Earth Day (April 22, 1970), and the office of Environmental Education was established within the U.S. Department of Education.

Excellence in Environmental Education

Environmental education builds from a core of key principles that inform its approach to education. Some of these important foundations are:

Systems: Systems help make sense of a large and complex world. A system is made up of parts. Each part can be understood separately. The whole, however, is understood only by understanding the relationships and interactions among the parts. The human body can be understood as a system; so can galaxies. Organizations, individual cells, communities of animals and plants, and families can all be understood as systems. And systems can be nested within other systems.

Interdependence: Human well-being is inextricably bound with environmental quality. Humans are a part of the natural order. We and the systems we create—our societies, political systems, economies, religions, cultures, technologies—impact the total environment. Since we are a part of nature rather than outside it, we are challenged to recognize the ramifications of our interdependence.

The importance of where one lives: Beginning close to home, learners forge connections with, explore, and understand their immediate surroundings. The sensitivity, knowledge, and skills needed for this local connection provides a base for moving out into larger systems, broader issues, and an expanding understanding of causes, connections, and consequences.

Integration and infusion: Disciplines from the natural sciences to the social sciences to the humanities are connected through the medium of the environment and environmental issues. Environmental education offers opportunities for integration and works best when infused across the curriculum, rather than being treated as a separate discipline or subject area.

Roots in the real world: Learners develop knowledge and skills through direct experience with the environment, environmental issues, and society. Investigation, analysis, and problem solving are essential activities and are most effective when relevant to the real world.

Lifelong learning: Critical and creative thinking, decision making, and communication, as well as collaborative learning, are emphasized. These skills are essential for active and meaningful learning, both in school and over a lifetime.

continued

Environmentally literate students possess the knowledge, intellectual skills, attitudes, experiences, and motivation to make and act upon responsible environmental decisions. Environmentally literate students understand environmental processes and systems, including human systems. They are able to analyze global, social, cultural, political, economic, and environmental relationships, and weigh various sides of environmental issues to make responsible decisions as individuals, as members of their communities, and as citizens of the world. (Adapted from *Maryland Partnership for Children in Nature*, April 2009)

In order to support the environmental education of NYC students and to encourage them to find innovative solutions to environmental problems and issues in their communities this enhanced version of the Science Scope & Sequence includes an alignment to the *Guidelines for Learning (K–12)* published by the North American Association of Environmental Education.

NYSED Mandated Instruction in Science New York State Education Law: Article 17, Sections 809–810

The New York State Legislature passes laws that are directly related to curriculum and instruction in the area of science. Article 17 of the New York State Education Law outlines instruction in certain subject areas. Two of the sections are directly related to science instruction. They are:

Article 17 – Section 809 pertains to the humane treatment of live vertebrate animals. Having live animals in the science classroom is encouraged because it sparks students' interest in the living world around them. The care and respect for animals and all living things must be promoted in the school setting. Section 809 of the New York State Education Law ensures that animals are treated ethically and humanely.

Article 17 – Section 810 pertains to Conservation Day which is celebrated on the last Friday in April. Conservation of the earth's natural resources is the focus of this designated day. School communities are encouraged to heighten awareness of the natural world through lectures, tours and plantings.

NOTE: Conservation Day should not be confused with Earth Day, which falls on April 22 each year.

Reference Tables (High School)

The Reference Tables are an invaluable tool to the high school science student. They contain important measurements, equations, maps, and identification tables. The booklets are frequently used during classes, tests, and lab assignments. The Reference Tables are also used on the New York State Regents Exams. Each of the Science Reference Tables is specific to the core science content that is taught. The most appropriate reference tables for the units in Chemistry, Earth Science and Physics have been selected.

Limitations and Expectations

In an effort to be concise and acknowledging that there are several options for the inclusion or absence of some of the supporting standards and guidelines, the most appropriate Mathematics Science and Technology (MST) Process Standards, Next Generation Science Standards (NGSS) Cross-Cutting Concept, Common Core Learning Standards (CCLS) in Mathematics and English Language Arts and Environmental Guidelines have been selected. Based on the discretion of the classroom teacher, other standards and tables may be seen as being appropriate for inclusion.

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Science Scope & Sequence Template

Grade # | **Unit** #

Unit Title

PACING RECOMMENDATION (TIMEFRAME)

Unit Overview:

A brief teacher-friendly blurb that describes the learning in the unit at a high level. (NEW)

Essential Question:

Revised essential questions for the unit. (REVISED)

Key Ideas: The key ideas addressed throughout the unit pulled from the NYSED standards. (REVISED)

NYS SCIENCE STANDARDS http://www.p12.nysed.gov/ciai/mst/pub/intersci.pdf	MST STANDARDS http://www.p12.nysed.gov/ciai/mst/pub/intersci.pdf	NGSS CROSS-CUTTING CONCEPTS http://www.nextgenscience.org/sites/ngss/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf
State standards to be covered in the unit. Re-written to include more language directly from the standards rather than abbreviated topics in order to support teachers with being able to clearly identify what student should be able to know and do when referring to the Scope & Sequence. Feedback from the field suggests that teachers use the Scope & Sequence as their primary/sole resource when planning and often do not refer to the actual standards. (REVISED) *(Note: Items with asterisks* require quantitative treatment per the Reference Table for Physics. Asterisks following individual words refer to the preceding word or phrase only; asterisks appearing after the final period of a sentence refer to all concepts or ideas presented in the sentence.)*	Identifies alignment to Standards 1, 2, 6, and 7 in order to promote consideration of the behaviors and processes students should demonstrate when engaging in scientific inquiry. (NEW)	Identified relevant cross-cutting concepts. Pulled directly from NGSS, the cross-cutting concepts help students deepen their understanding of the content and develop a coherent scientifically based view of the world. (NEW)
COMMON CORE STATE STANDARDS http://www.corestandards.org/wp-content/uploads/ELA_Standards.pdf http://www.corestandards.org/wp-content/uploads/Math_Standards.pdf	**ENVIRONMENTAL GUIDELINES FOR LEARNING** http://resources.spaces3.com/89c197bf-e630-42b0-ad9a-91f0bc55c72d.pdf	**REFERENCE TABLES FOR PHYSICAL SETTING CORE CONTENT**
Identifies pre-requisite or connected ELA & Math standards that align to content addressed in the unit. (NEW)	Makes clear connections between the content addressed in the unit and the environment. (NEW)	Identifies the tables that are pertinent for each of the units in Regents Chemistry, Regents Earth Science and Regents Physics. (NEW)

Leaf indicates a connection to Environmental Science