California to Revise Science Standards

• SB 300, chaptered in October 2011, required the Superintendent of Public Instruction, Tom Torlakson, to submit a set of revised standards to the State Board of Education by March 2013.

• The revised standards must be based upon NGSS

• The SBE must take action on the revised standards by July 2013.
Legislative Update

• SB 1200 chaptered in October 2012, modifies the timeline that the Superintendent of Public Instruction (SSPI), Tom Torlakson, is required to submit revised California Standards in Science.
  • The revised standards must be still based upon NGSS.
  • The SSPI must submit revised standards to the SBE by July 2013, after which Board action must be taken by November 2013.
Lead Partners
California is actively participating in NGSS development.
K-12 Teachers
County Offices of Education
College and University Faculty
Practicing Scientists
Leaders in Business and Industry
Formal and Informal Science programs
California Science Teachers Association
California Mathematics and Science Projects
California Department of Education
Two-Step Process

http://www.nextgenscience.org/
A Framework for Science Education
Practices, Crosscutting Concepts, and Core Ideas

Vision
• Science for ALL Students
• Coherent Learning

Realizing the Vision
• Integrating the Three Dimensions
• Implementation
• Equity and Diversity
• Guidance for Standards Development
• Looking Toward the Future: Research to Inform K-12 Science Education Standards

Three Dimensions
• Scientific and Engineering Practices
• Crosscutting Concepts
• Core Ideas
A New Vision of Science Learning that Leads to a New Vision of Teaching

The framework is designed to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

A Framework for K-12 Science Education p. 1-2
Vision for Science Education

Builds on Existing National Science Education Efforts
The Guiding Principles of the Framework are Research-Based and Include...
Organized According to Learning Progressions

“Standards should be organized as progressions that support students’ learning over multiple grades. They should take into account how students’ command of the concepts, core ideas, and practices becomes more sophisticated over time with appropriate instructional experiences.” (NRC 2011, Rec 7)
Focus of the Framework

Three Dimensions

• Scientific and Engineering Practices
• Crosscutting Concepts
• Disciplinary Core Ideas
Dimension 1
Scientific and Engineering Practices

Inquiry = Practices

1. Asking questions (science) and defining problems (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 (science) and designing solutions (engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

For each, the Framework includes a description of the practice, the culminating 12th grade learning goals, and what we know about progression over time.
Crosscutting Concepts = Disciplinary Connective Tissue

1. Patterns
2. Cause and effect
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change
Disciplinary Core Ideas = Defines Content Knowledge

• Disciplinary Significance
  – Has broad importance across multiple science or engineering disciplines, a key organizing concept of a single discipline

• Explanatory Power
  – Can be used to explain a host of phenomena

• Generative
  – Provides a key tool for understanding or investigating more complex ideas and solving problems

• Relevant to Peoples’ Lives
  – Relates to the interests and life experiences of students, connected to societal or personal concerns

• Usable from K to 12
  – Is teachable and learnable over multiple grades at increasing levels of depth and sophistication
Fewer, clearer, higher

- “Many existing national, state, and local standards and assessments, as well as the typical curricula in use in the US, contain too many disconnected topics given equal priority.” (NRC, 2009)
- Standards and curriculum materials should be focused on a limited number of core ideas.
- Allows learners to develop understanding that can be used to solve problems and explain phenomena.
The Partnership for 21st Century Skills
Physical Sciences

• Matter and Its Interactions

• Motion and Stability

• Energy

• Waves and Their Applications
Life Sciences

- From Molecules to Organisms: Structures and Processes
- Ecosystems: Interactions, Energy, and Dynamics
- Heredity: Inheritance and Variation of Traits
- Biological Evolution: Unity and Diversity
Earth and Space Sciences

- Earth’s Place in the Universe
- Earth Systems
- Earth and Human Activity
Engineering, Technology and Applications of Sciences

- Engineering Design
- Links Among Engineering, Technology, Science and Society
Next Generation Of Science Standards Architecture

Integration of 3 Dimensions:

- Practices
- Crosscutting Concepts
- Core Ideas
What is the Value of Weaving the Three Dimensions of the Framework Together?

- Strengthening Scientific Thinking
- Lengthening Scientific Thinking
- Develop Flexible Scientific Thinking
- Making Connections within Scientific Thinking
Alignment to Common Core

• Each science standard is correlated to the cognitive demands of both English Language Arts standards and mathematics standards.

• Specific correlation of the Common Core standards are noted in the architecture of each individual science standard.
Habits of Mind

Math

M1. Make sense of problems & persevere in solving them
M2. Reason abstractly & quantitatively
M3. Construct viable arguments & critique reasoning of others
M4. Model with mathematics
M5. Use appropriate tools strategically
M6. Attend to precision
M7. Look for & make use of structure
M8. Look for & express regularity in repeated reasoning

Science

S1. Ask questions & define problems
S2. Develop and use models
S3. Plan & carry out investigations
S4. Analyze & interpret data
S5. Use mathematics & computational thinking
S6. Construct explanations & design solutions
S7. Engage in argument from evidence
S8. Obtain, evaluate & communicate information

ELA

E1. Demonstrate independence in reading complex texts, and writing and speaking about them
E2. Build a strong base of knowledge through content rich texts
E3. Obtain, synthesize, and report findings clearly and effectively in response to task and purpose
E4. Construct viable arguments & critique reasoning of others
E5. Read, write, and speak grounded in evidence
E6. Use technology & digital media strategically & capably
E7. Come to understand other perspectives & cultures through reading, listening, and collaborations
This is an example of the connection between inquiry and Habits of Mind

<table>
<thead>
<tr>
<th>ESSENTIAL FEATURE</th>
<th>VARIATIONS</th>
<th>Amount of Learner Self-Direction</th>
<th>Amount of Direction from Teacher or Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner engages in scientifically oriented questions</td>
<td>Learner poses a question</td>
<td>Learner selects among questions, poses new questions</td>
<td>Learner sharpens or clarifies question provided by teacher, materials, or other source</td>
</tr>
<tr>
<td>Learner gives priority to evidence in responding to questions</td>
<td>Learner determines what constitutes evidence and collects it</td>
<td>Learner directed to collect certain data</td>
<td>Learner given data and asked to analyze</td>
</tr>
<tr>
<td>Learner formulates explanations from evidence</td>
<td>Learner formulates explanation after summarizing evidence</td>
<td>Learner guided in process of formulating explanations from evidence</td>
<td>Learner given possible ways to use evidence to formulate explanation</td>
</tr>
<tr>
<td>Learner connects explanations to scientific knowledge</td>
<td>Learner independently examines other resources and forms the links to explanations</td>
<td>Learner directed toward areas and sources of scientific knowledge</td>
<td>Learner given possible connections</td>
</tr>
<tr>
<td>Learner communicates and justifies explanations</td>
<td>Learner forms reasonable and logical argument to communicate explanations</td>
<td>Learner coached in development of communication</td>
<td>Learner provided broad guidelines to sharpen communication</td>
</tr>
</tbody>
</table>
Shayna had a small bottle of Bromine gas. The bottle was closed with a cork. She tied a string to the cork, and then placed the bottle inside a larger bottle. She sealed the large bottle shut (Figure 1). Next, Shayna opened the small bottle by pulling the string connected to the cork. Figure 2 shows what happened after the cork of the small bottle was opened.

1. Draw a model that shows what is happening in this experiment.
2. Explain in writing what is happening in your model.
Shifts in the Teaching and Learning of Science

• Organize around limited number of core ideas. Favor depth and coherence over breadth of coverage.

• Core ideas need to be revisited in increasing depth, and sophistication across years. Focus needs to be on connections:
  – Careful construction of a storyline – helping learners build sophisticated ideas from simpler explanations, using evidence.
  – Connections between scientific disciplines, using powerful ideas (nature of matter, energy) across life, physical, and environmental sciences.
Shifts in the Teaching and Learning of Science (cont.)

- Performance expectations should bring together scientific ideas (core ideas, cross cutting ideas) with scientific and engineering practices.
  - Curriculum materials need to do more than present and assess content.
  - Curriculum materials need to involve learners in practices that develop, use, and refine the scientific ideas.
Product Not The Process

Performance expectations represent “the product” which defines what each student should know and be able to do.

It does NOT define “the process” Curriculum/instructional strategies that the teacher utilizes to achieve the outcome.
NGSS Development Timeline

Next Generation Science Standards Development Process

- July 2011: Framework for K-12 Science Education Released by National Research Council
- September 2011: California Chosen as Lead State in Development of New Science Standards, Based on Framework
- November 2011: First Meeting of State Review Team of Science Experts
- October 2012: Third Meeting of State Review Team of Science Experts
- March 2013: Final Draft of NGSS Released
- May 2012: First Public Draft of NGSS Released
- January 2013: Second Public Draft of NGSS Released
- April 2013: Two Public Meetings of Final NGSS
- Spring 2013: Two Public Meetings of Final NGSS
- July 31, 2013: SSPI Presents to California SBE Recommended Science Standards Based on the NGSS
- November 30, 2013: California SBE Adopts, Rejects, or Modifies Recommended Science Standards
- 2014*: Implementation of New Science Standards

* pending SBE action
Lots of work completed, underway, and left to do

California’s Next Steps

- SBE Adoption of NGSS
- State Framework Development
- Instruction and Assessment
- Professional Development
The structure of NGSS and pedagogical vision of the NRC Framework received high praise.

PERFORMANCE EXPECTATIONS (Standards)

• In response to a general misunderstanding of the role of NGSS, Achieve indicated that the NGSS are a set of goals, performance expectations for the end of instruction; they are NOT a curriculum. More detailed explanation of the nature of performance expectations has been included in the front matter of NGSS.
• 95% of the performance expectations have been rewritten with more specific and consistent language, relevance to student interests, and can be met in multiple ways.
• No new core ideas were added to the standards.
• More context and examples demonstrating potential connections to ocean and computer sciences were added.
PERFORMANCE EXPECTATIONS (Standards)- continued

• Standards have undergone extensive review to ensure that all content is both necessary and sufficient for student success after high school in the 21st Century, and can be supplemented with further in-depth study in particular upper-level science courses.

• Each performance expectation was reviewed for grade level appropriateness, clarity and assessability to ensure student expectations require increased proficiency in each practice over time.

• Specific expectations was added to the connections boxes to clarify the connections between standards and topics.

• The arrangement and naming of performance expectations is now provided in two different groupings: (1) by topic, and (2) by disciplinary core ideas.
SCIENCE & ENGINEERING PRACTICES (Inquiry)- Appendix F

• A full chapter explaining the inclusion of engineering in the NGSS has been included.
• The concept and practice of “inquiry” has not been omitted from NGSS—instead, it is now specified in the eight practices throughout every performance expectation.
• To help clarify the meaning of each practice, a separate chapter on “practices” was added (Appendix I).
• The writers integrated Engineering Design core ideas (ETS1) into other disciplines, resulting in the reduction of the total number of performance expectations.

  There are two different ways to view these same performance expectations:
  (1) listed within the traditional disciplines
  (2) listed in separate Engineering Design standards.
SCIENCE & ENGINEERING PRACTICES (Inquiry)- cont.

- More engineering practices (ETS2) were specified and incorporated into performance expectations at every grade level.
  - Due to their crosscutting nature, ETS2 (Links among Engineering, Technology, Science, and Society) core ideas have been integrated throughout the standards in a manner similar to that of crosscutting concepts.

CROSSCUTTING CONCEPTS- Appendix G

- A separate chapter describing the use of crosscutting concepts in each grade band has been added as an organizing framework to help students make sense of and connect to core ideas.

NATURE OF SCIENCE- Appendix H

- Nature of Science connections were made more explicit and stated in the appropriate foundation boxes. upper-level science courses.
ASSESSMENT
• The decision of what assessment to use or develop will be up to each state choosing to adopt NGSS.

NEW ADDITIONS
• A thorough discussion of equity and diversity issues has been included in NGSS (Appendix D).
• A draft of middle and high school course models has been added.
• CCSS connections underwent additional reviews by the writers of CCSS, and additional quantitative expectations were added.
• Visuals were created to show progressions of ideas through time (Appendix E).
<table>
<thead>
<tr>
<th>PS1.A</th>
<th>K-2</th>
<th>3-5</th>
<th>6-8</th>
<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure of matter (includes PS1.C Nuclear processes)</td>
<td>Matter exists as different substances as exhibited by their observable properties. Different properties are suited to different purposes.</td>
<td>Matter exists as particles that are always conserved even if they are too small to see. Measurements of a variety of observable properties can be used to identify particular substances.</td>
<td>The fact that matter is composed of atoms and molecules can be used to explain properties of substances, diversity of materials, states of matter and phase changes.</td>
<td>The sub-atomic structural model and interactions between electric charges at the atomic scale can be used to explain interactions of matter, including chemical reactions and nuclear processes. Repeating patterns of the periodic table reflect patterns of outer electrons.</td>
</tr>
<tr>
<td>PS1.B</td>
<td>Heating and cooling substances cause changes that are sometimes reversible and sometimes not.</td>
<td>Chemical reactions that occur when two or more substances are mixed can be identified by the emergence of substances with different properties; the total mass remains the same.</td>
<td>Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.</td>
<td>Chemical processes are understood in terms of collisions of molecules, rearrangement of atoms, and changes in binding energy as determined by properties of elements involved.</td>
</tr>
<tr>
<td>PS2.A</td>
<td>Pushes and pulls can have different strengths and directions, and can change the speed or direction of its motion or start or stop it.</td>
<td>The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion.</td>
<td>A frame of reference from which motion is described and the role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force.</td>
<td>Newton’s 2nd law (F=ma) and the conservation of momentum can be used to predict changes in the motion of macroscopic objects.</td>
</tr>
<tr>
<td>PS2.B</td>
<td>Types of interactions</td>
<td></td>
<td>Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object.</td>
<td>The effects of forces at a distance at macroscopic and atomic levels can be predicted and can be used to describe the relationship between electrical and magnetic fields.</td>
</tr>
<tr>
<td>PS2.C</td>
<td>Stability &amp; instability in physical systems</td>
<td>A system’s pattern of change, including how a system may appear to be unchanging, is a result of dynamic but balanced processes.</td>
<td>Stable and unstable systems as well as static and dynamic systems can be distinguished. Patterns of change and an understanding of feedback mechanisms are used to predict a system’s future.</td>
<td>A system’s behavior under a variety of conditions can be explained and predicted based on the cycles and transformations that drive it; some systems can be unpredictable given certain conditions.</td>
</tr>
<tr>
<td>PS3.A</td>
<td>Definitions of energy</td>
<td>NA</td>
<td>Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.</td>
<td>The total energy within a system is conserved. Energy transfer within and between systems can be described and predicted in terms of interactions of particles or fields.</td>
</tr>
<tr>
<td>PS3.B</td>
<td>Conservation of energy and energy transfer</td>
<td>Sunlight warms Earth’s surface.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How to Read the Standards Map
MS. LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. (Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen; NOT the chemical equation for photosynthesis.)

b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.

c. Using models to explore the transfer of energy into, out of, and within the ecosystems. (Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change)

d. Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

e. Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

f. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Use models to explore relationships between variables, especially those representing input and output. (b),(c),(d)</td>
<td>Plants, algae (including photosynthesis), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)</td>
<td>Models can be used to represent systems and their interactions—such as inputs, processes, and outcomes—and energy, matter, and information flows within systems. (b),(c),(d)</td>
</tr>
<tr>
<td>- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d)</td>
<td>Animals obtain food from eating plants or eating other animals. (a),(b)</td>
<td>Models are limited in that they only represent certain aspects of the system under study. (b),(c)</td>
</tr>
<tr>
<td>Constructing Explanations and Designing Solutions</td>
<td>- Within individual organisms, food moves through a series of chemical reactions in which a broken down and rearranged to form new molecules, to support growth or to release energy. (c)</td>
<td>Energy and Matter</td>
</tr>
<tr>
<td>- Generate and revise causal explanations from data (e.g., observations and sources of reliable information) and relate these explanations to current knowledge. (a)</td>
<td>In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to acquire energy and produce waste carbon dioxide. Aerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)</td>
<td>Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature. (b),(c)</td>
</tr>
<tr>
<td>- Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(b)</td>
<td>LS2.B: Cycle of Matter and Energy Transfer in Ecosystems</td>
<td>The transfer of energy can be tracked as energy flows through a designed or natural system. (c)</td>
</tr>
<tr>
<td>Engaging in Argument from Evidence</td>
<td>- Use arguments and evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)</td>
<td>Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a)</td>
</tr>
<tr>
<td>- Use arguments and evidence to construct an argument that supports or refutes a claim made by someone else. (f)</td>
<td><strong>Stability and Change</strong></td>
<td>Small changes in one part of a system might cause large changes in another part. (f)</td>
</tr>
</tbody>
</table>

Connections to other topics in this grade-level: MS. ES-SS-HS, MS. ES-SP, MS. PS-SPM, MS. PS-EC, MS. PS-CR

Articulation across grade-level: LS-SS, MS-SS-MEOE, HS-LS-MEOE, HS-LS-TBE

Common Core State Standards Connections:

**W.6.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

**W.7.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

**W.8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

**Mathematics**

- **MP.3** Construct viable arguments and critique the reasoning of others.
- **S.9.P** Summarize and describe distributions.
- **8.F** Use functions to model relationships between quantities.
The Essential Questions are designed to show an aspect of the world that will be explained as a student gains understanding of the disciplinary core ideas as defined by the Framework. In most cases, these questions were taken directly from the NRC Framework.
Performance Expectations = Standard

a) Stem: Each standard is written in the form of one sentence, with a stem statement describing the overall core idea that is important for student understanding of science, followed by several performance expectations that describe how students will demonstrate that understanding.

b) Component statements/Student Performance Expectations: Component statements are lettered with lowercase letters, and each combines Practices, Disciplinary Core Ideas, and Crosscutting Concepts into a performance expectation.
Orange font designates a disciplinary core idea.

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. (Assessment Boundary: Focus related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen. Not the chemical equation for photosynthesis)

b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.

c. Using models to explore the transfer of energy into, out of, and within ecosystems. (Assessment Boundary: Only light, chemical, and radiant energy need to be addressed with an emphasis that the total amount of energy does not change)

d. Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

e. Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

f. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

Science and Engineering Practices

Developing and Using Models
- Use models to explore relationships between variables, especially those representing input and output. (b), (c), (d)
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b), (c), (d)

Constructing Explanations and Designing Solutions
- Generate and revise causal explanations from data (e.g., observations and sources of reliable information) and relate these explanations to current knowledge. (a)
- Base explanations on evidence and the assumption that natural laws operate consistently as they did in the past and will continue to do so in the future. (a), (e)

Engaging in Argument from Evidence
- Use arguments and evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

Disciplinary Core Ideas

LS1.C: Structure and Function
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (b), (c), (d)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (glucose) to provide energy and produce waste carbon dioxide. Aerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that capture light energy), consumers, and decomposers at the three levels of organization for populations, communities, and ecosystems. (a), (d)
- Transfers of matter into and out of the physical environment occur at every level. For example, when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately, waste products, such as fecal matter. Decomposers recycle nutrients from dead plants or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b), (c), (d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disturbances to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

Connections to other topics in this grade level: MS-ESS-HE, MS-ESS-ESP, MS-PS-SPM, MS-PS-ECT, MS-PS-CSR

Articulation across grade levels: 5.5F, 5.MFE, HS-LS-MEOE, HS.LS-IFE

Common Core State Standards Connections:
- ELA:
  - W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
  - W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing a standard format for citations.
  - W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

- Mathematics:
  - MP.3 Construct viable arguments and critique the reasoning of others.
  - 6.S.P.6 Summarize and describe distributions.
  - 8.F.2 Use functions to model relationships between quantities.
### MS-LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

a. Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. (Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen. NOT the chemical equation for photosynthesis)

b. Developing and using models of the cycling of matter among living and nonliving parts of ecosystems. (Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change)

c. Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

d. Using evidence to explain how conserved. "As atoms in food are rearranged as they pass through different organisms in a food web, matter is conserved".

e. Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

### Crosscutting Concepts

#### Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature.
- Energy is conserved, but energy flows within systems.
- The transfer of energy can be tracked as energy flows through a designed or natural system.
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

#### Stability and Change
- Small changes in one part of a system might cause large changes in another part.

### Science and Engineering Practices

#### Developing and Using Models
- Use models to explore relationships between variables, especially those representing input and output. (b),(c),(d)
- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d)
- Constructing Explanations and Designing Solutions
  - Generate and revise causal explanations from data (e.g., observations and sources of reliable information) and relate these explanations to current knowledge. (a)
  - Use argument and evidence to construct a convincing argument that supports or refutes a claim made by someone else. (a)

### Disciplinary Core Ideas

#### LS1.C: Structure and Function
- Plants, algae (including photosynthesis), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food by eating plants or other animals. (b),(c),(d)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy. (c)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to produce energy and produce waste carbon dioxide. Aerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

#### LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- Food webs and models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers at the three groups interact—primarily, for food—within an ecosystem. (d)
- Transfers of matter into and out of the physical environment occur at every level. For example, when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately, waste products, such as fecal matter. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d)

#### LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- Ecosystems are dynamic in nature; their characteristics can vary over time. Disturbances to any physical or biological component of an ecosystem can lead to shifts in all its populations.

### Connections to other topics in this grade-level
- MS-ESS-HE, MS-ESS-ISP, MS-PS-SPM, MS-PS-ECT, MS-PS-SC

### Articulation across grade-levels
- 3.SFS, 5.MEE, HS-LS-MEOE, HS-LS-TRE

### Common Core State Standards Connections

**ELA—**

- **W.6.8** Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- **W.7.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- **W.8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

**Mathematics—**

- **MP.3** Construct viable arguments and critique the reasoning of others.
- **SP.8** Summarize and describe distributions
- **S.F** Use functions to model relationships between quantities
Assessment Boundary Statements provide further guidance or to restrict the scope of the standard at a particular grade level.

An asterisk (*) indicates an engineering connection in a practice, core idea or crosscutting concept.
Foundation Boxes

MS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students demonstrate understanding of how organisms obtain and transfer the matter and energy needed by:

- Developing an explanation for the role of photosynthesis in the cycling of matter and flow of energy on Earth. (Assessment Boundary: Limited to the explanation related to water, carbon dioxide, and light energy being used to produce sugars and release oxygen NOT the chemical equation for photosynthesis.)

- Developing and using models of the cycling of matter among living and nonliving parts of ecosystems.

- Using models to explore the transfer of energy into, out of, and within the ecosystems. (Assessment Boundary: Only light, chemical, and thermal energy need to be addressed with an emphasis that the total amount of energy does not change.)

- Constructing and communicating models of food webs that demonstrate the transfer of matter and energy among organisms (producers, consumers, and decomposers) within an ecosystem.

- Using evidence to explain that matter is conserved as atoms in food are rearranged as they pass through different organisms in a food web.

- Using evidence from credible sources to support arguments that changing a component of an ecosystem affects the species in the ecosystem.

Science and Engineering Practices

- Developing and Using Models
  - Use models to explore relationships between variables, especially those representing input and output. (b)(c)(d)
  - Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b)(c)(d)

- Constructing Explanations and Designing Solutions
  - Generate and revise causal explanations from data (e.g., observations and sources of reliable information) and relate these explanations to current knowledge. (a)
  - Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a)(e)

Engaging in Argument from Evidence

- Use argument from evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

Disciplinary Core Ideas

LS1.C: Structure and Function
- Plants, algae (including photosynthesis), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (b)(d)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (glucose) to provide energy and produce waste carbon dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems
- Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily, for food—within an ecosystem. (d)
- Transfers of matter into and out of the physical environment occur at every level. For example, when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately, some waste products, such as fecal material. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are recycled repeatedly between the living and nonliving parts of the ecosystem. (b)(c)(d)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- Ecosystems are dynamic in nature; their characteristics can vary over time. Discussions to any physical, biological, or biochemical component of an ecosystem can lead to shifts in all its populations. (f)

Crosscutting Concepts

- Systems and System Models
  - Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems. (b)(c)(d)
  - Models are limited in that they only represent certain aspects of the system under study. (a)(c)

- Energy and Matter
  - Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter. (a)(c)(d)
  - The transfer of energy can be tracked as energy flows through a designed or natural system. (c)(d)
  - Within a natural or designed system, the transfer of energy drives the motion and cycling of matter. (a)

Stability and Change
- Small changes in one part of a system might cause large changes in another part. (f)

Connections to other topics in this grade level: MS.LS-EC, MS.LS-ESP, MS.FL-SPM, MS.PS-LET, MS.PS-CR
Articulation across grade levels: 1.SFS, 5.MFE, HS.LS-MF, HS.LS-TE

Common Core State Standards Connections:
- W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing a standard format for citation.
- Mathematics –
  - MP.3 Construct viable arguments and critique the reasoning of others.
  - G.S.3 Summarize and describe distributions.
  - 8.F Use functions to model relationships between quantities.

49
Foundation boxes provide additional information that expands and explains the standards statements in relation to the three dimensions:

### Science and Engineering Practices

- Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b)(c)(d)
- Constructing Explanations and Designing Solutions
  - Generate and revise causal explanations from data (e.g., observations and sources of reliable information) and relate these explanations to current knowledge. (a)
  - Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a), (e)

### Disciplinary Core Ideas

- **Science and Engineering Practices**
  - Use arguments and evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

### Crosscutting Concepts

- Photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a)
- Animals obtain food from eating plants or eating other animals. (d)(e)
- Within individual organisms, food moves through a series of chemical reactions, which is a broken down and rearranged to form new molecules to support growth or to release energy. (e)
- In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to produce energy and produce waste carbon dioxide. Anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c)

#### Ecosystems

- **Ecosystem Dynamics, Functioning, and Resilience**
  - Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

---

**Common Core State Standards Connections:**

- W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.
- W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

**Mathematics:**

- MP.3 Construct viable arguments and critique the reasoning of others.
- 6.S.9 Summarize and describe distributions.
- 8.F Use functions to model relationships between quantities.
Science and Engineering Practices

These statements were derived from the Framework to further explain the science and engineering practices important to emphasize in each grade band. The practices are grouped by the eight categories detailed in the Framework. Most standards emphasize only a few of the practice categories. However, all practices are emphasized within a grade band.
Disciplinary Core Ideas

These statements are taken verbatim from the Framework, and detail the sub-ideas necessary for student mastery of the core idea.
Crosscutting Concept Statements

These statements were derived from the Framework to further explain the crosscutting concepts important to emphasize in each grade band. The crosscutting concepts are grouped by the seven categories detailed in the Framework. Most standards emphasize only a few of the crosscutting concept categories. However, all crosscutting concepts are emphasized within a grade band.
Lowercase letters designate which of the standard statements uses this practice, disciplinary core idea or crosscutting concepts.
Connections to the Nature of Science can be highlighted in either the practices or crosscutting concepts foundation box.
Connection Boxes provide:

a) connections to other topics in a particular grade level.

b) articulation across grade levels.

c) connections to Common Core State Standards.
*Italicics* indicates a potential connection, rather than required prerequisite knowledge.
Online Review

The draft standards and feedback survey is available on the Achieve Web site at

http://www.nextgenscience.org/

Review Period:

January 8, 2013 through January 28, 2013

Please visit Survey Monkey for an exit survey: