Introduction to the Next Generation Science Standards (NGSS) First Public Draft

Presented by: Dr. Gerry Wheeler and Dr. Stephen Pruitt

May 15, 2012
NGSS First Public *Draft* Released Friday, May 11

Unprecedented to have such widespread involvement of so many states and stakeholders—including classroom teachers—involved in science standards development.

NGSS will have a profound influence on curriculum, assessment, and teacher professional development in the years ahead.

NSTA encourages all teachers to review the NGSS draft and provide feedback to Achieve by June 1.
NSTA role with the NGSS

- One of four partners in a state-led process, including
  - The National Academies of Science (the NRC)
  - Achieve Inc.
  - National Science Teachers Association
  - American Association for the Advancement of Science

- Provided guidance and reviews directly to the National Research Council and Achieve

- Provided names of teachers for writers on the writing teams
NSTA Outreach

- Inform science education community about the NGSS draft
- Encourage science educators to have a voice by engaging in the review process
- Help educators study and learn more about the document
NSTA Resources on NGSS

www.nsta.org
NSTA Resources on NGSS

www.nsta.org
NSTA Resources on NGSS

www.nsta.org/ngss
Web Seminar: How to Lead a Study Group on NGSS

Web Seminar Tomorrow Night

Wednesday, May 16
6:30-8 pm (Eastern)

Gerry Wheeler, Harold Pratt, & Ted Willard

www.learningcenter.nsta.org
Discussion Forums about NGSS in the NSTA Learning Center

Visit NSTA’s Next Generation Science Standards Forums in the NSTA Learning Center where you can share your thoughts with other teachers and ask questions about the standards.

Forums are organized by grade level and topic to facilitate focused discussion about the standards.

http://learningcenter.nsta.org/discuss/#5
NSELA/ NSTA 2012 Professional Development
Summer Leadership Institute

June 24- 28, 2012
Austin, Texas

This immersive experience will bring together scores of individual science educators, teams (leaders and teachers), and administrators to explore the K–12 Framework and draft Next Generation Science Standards.

Register at: www.nsta.org/pd/nsela/
NSTA Print Resources

NSTA Reader’s Guide to the *Framework*

NSTA Journal Articles about the *Framework* and the *Standards*
COMPASS

Classroom Opportunities Multiply Practices and the Application of Science Standards
COMPASS

- Will support educators in the implementation of NGSS
- Will allow educators to access teaching and learning resources seamlessly from standards pages on nextgenscience.org
- Funded by the Carnegie Corporation, which also funded development of the *Framework* and *NGSS*
What is your level of familiarity with the Next Generation Science Standards?

A. Tonight is my first exposure to it.
B. I’ve heard it mentioned, but don’t know many details.
C. I’ve attended one or more presentations about it and/or read about it in detail.
D. I participated in a lead state review or critical stakeholder review of one of the earlier drafts.
For More Information from NSTA

- [www.nsta.org/ngss](http://www.nsta.org/ngss)

- Email: ngss@nsta.org
Next Generation Science Standards
First Point

It’s a DRAFT!
Details about the Public Release

**Goal:** To distribute and receive feedback from interested stakeholders; to create a transparent process

- The standards opened for review May 11, 2012.
- The standards and the survey can be accessed at [www.nextgenscience.org](http://www.nextgenscience.org)
- The review period ends on June 1, 2012.
Process for Development of Next Generation Science Standards

States and other key stakeholders are engaged in the development and review of the new college and career ready science standards

- State Led Process
- Writing Teams
- Critical Stakeholder Team
- Achieve is managing the development process

NRC Study Committee members to check the fidelity of standards based on framework
What is your level of familiarity with the K-12 Framework for Science Education?

A. I’ve never heard of it.

B. I’ve heard of it, but have never looked at it.

C. I’ve heard a bit about it and/or skimmed its contents.

D. I’ve read through it.

E. I’ve studied it in detail.
Next Generation Science Standards…

<table>
<thead>
<tr>
<th>Are:</th>
<th>Are NOT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Performance Expectations focused on the nexus of the three dimensions of science learning</td>
<td>➢ Separate sets of isolated inquiry and content standards</td>
</tr>
<tr>
<td>➢ Performance Expectations that require students demonstrate proficiency</td>
<td>➢ Curriculum or instructional tasks, courses, experiences or materials</td>
</tr>
<tr>
<td>➢ Designed to lead to a coherent understanding of the Practices, CCC, and DCIs</td>
<td>➢ Meant to limit the use of Practices or Crosscutting Concepts in instruction</td>
</tr>
<tr>
<td></td>
<td>➢ Designed to be separate or isolated experiences</td>
</tr>
</tbody>
</table>
**Performance Expectations**

**MS.PS-SPM  Structure and Properties of Matter**

Students who demonstrate understanding can:

a. **Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.** [Clarification Statement: Examples of atoms combining can include Hydrogen (H₂) and Oxygen (O₂) combining to form hydrogen peroxide (H₂O₂) or water (H₂O).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]
Language was based on Framework and expanded into Matrices

NRC Framework language from Grade Band Endpoints

Language was based on Framework and expanded into Matrices
Structure and Properties of Matter

Students who demonstrate understanding can:

a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits. [Clarification Statement: Examples of atoms combining can include Hydrogen \((H_2)\) and Oxygen \((O_2)\) combining to form hydrogen peroxide \((H_2O_2)\) or water \((H_2O)\).] [Assessment Boundary: Valence electrons and bonding energy are not addressed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

**Science and Engineering Practices**

**Developing and Using Models**

- Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to explain, predict, and predict more abstract phenomena and design systems.
  - Use and/or construct models to predict, explain, and/or collect data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs. (a)

**Disciplinary Core Ideas**

**PS1.A: Structure and Properties of Matter**

- All substances are made from some 100 different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (a)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (a)

**Crosscutting Concepts**

**Patterns**

- Macroscopic patterns are related to the nature of microscopic and atomic-level structure. Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems. Patterns can be used to identify cause and effect relationships. Graphs and charts can be used to identify patterns in data. (a)

Connections to other DCIs in this grade-level: MS-ESS-ESP, MS-ESS-SS, MS-LS-MEOE

Articulation of DCIs across grade-levels: 3.LF, 5.SPM, HS-PS-SPM, HS-PS-NP, HS-PS-E

Common Core State Standards Connections: [Note: these connections will be made more explicit and complete in future draft releases]

**ELA**

- **W.5.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
- **W.7.1** Write arguments to support claims with clear reasons and relevant evidence.
- **SL.5.4** Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
- **SL.6.4** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
- **SL.7.4** Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- **WHST.6–8.1** Write arguments focused on discipline-specific content.
- **RST.6–8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

**Mathematics**

- **MP.4** Model with mathematics.
- **MP.8** Look for and express regularity in repeated reasoning.
- **6.SP** Develop understanding of statistical variability. Summarize and describe distributions.
## Science and Engineering Practices Matrix

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Constructing Explanations and Designing Solutions</strong></td>
<td>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence in constructing explanations and designing solutions.</td>
<td>Constructing explanations and designing solutions in 3–5 builds on prior experiences in K–2 and progresses to the use of evidence in constructing multiple explanations and designing multiple solutions.</td>
<td>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.</td>
<td>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent sources of evidence consistent with scientific knowledge, principles, and theories.</td>
</tr>
<tr>
<td>The products of science are explanations and the products of engineering are solutions.</td>
<td>Use information from observations to construct explanations about investigations.</td>
<td>Use qualitative and quantitative relationships to construct explanations for phenomena.</td>
<td>Use quantitative claims regarding the relationship between dependent and independent variables.</td>
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</tr>
<tr>
<td>The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.</td>
<td>Use tools and materials provided to design a solution to a specific problem.</td>
<td>Apply scientific reasoning to link evidence to claims and show why the data is adequate for the explanation or conclusion.</td>
<td>Apply scientific reasoning, theory, and models to link evidence to claims and show why the data is adequate for the explanation or conclusion.</td>
<td>Apply scientific reasoning, theory, and models to link evidence to claims and show why the data is adequate for the explanation or conclusion.</td>
</tr>
<tr>
<td>The goal of engineering design is a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements.</td>
<td>The optimal choice depends on how well the proposed solutions meet criteria and constraints.</td>
<td>Generate and revise causal explanations from data (e.g., observations, sources of reliable information) and relate these explanations to current knowledge.</td>
<td>Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review.</td>
<td>Base causal explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.</td>
</tr>
</tbody>
</table>

**Next Generation Science Standards**

[Image of Next Generation Science Standards logo]
### Crosscutting Concepts Matrix

#### 2. Cause and Effect: Mechanism and Prediction
Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

<table>
<thead>
<tr>
<th>K-2 Crosscutting Statements</th>
<th>3-5 Crosscutting Statements</th>
<th>6-8 Crosscutting Statements</th>
<th>9-12 Crosscutting Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Events have causes that generate observable patterns. Simple tests can be designed to gather evidence to support or refute student ideas about causes.</td>
<td>Cause and effect relationships are routinely identified, tested, and used to explain change. Events that occur together with regularity might or might not be a cause and effect relationship.</td>
<td>Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems. Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.</td>
<td>Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.</td>
</tr>
</tbody>
</table>

#### 3. Scale, Proportion, and Quantity
In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

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<tbody>
<tr>
<td>Relative scales allow objects to be compared and described (e.g. bigger and smaller; hotter and colder; faster and slower). Standard units are used to measure length.</td>
<td>Natural objects and observable phenomena exist from the very small to the immensely large. Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.</td>
<td>Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. The observed function of natural and designed systems may change with scale. Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. Scientific relationships can be represented through the use of algebraic expressions and equations.</td>
<td>The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. Patterns observable at one scale may not be observable or exist at other scales. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g. linear growth vs. exponential growth).</td>
</tr>
</tbody>
</table>
Connections to Engineering, Technology, and Applications of Science Matrix

### 1. Interdependence of Science, Engineering, and Technology

<table>
<thead>
<tr>
<th>K-2 Crosscutting Statements</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Science and engineering involve the use of tools to observe and measure things.</td>
<td>Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.</td>
<td>Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward.</td>
<td>Science and engineering complement each other in the cycle known as research and development (R&amp;D). Many R&amp;D projects may involve scientists, engineers, and others with wide ranges of expertise.</td>
</tr>
</tbody>
</table>

### 2. Influence of Engineering, Technology, and Science on Society and the Natural World

<table>
<thead>
<tr>
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<th>3-5 Crosscutting Statements</th>
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<th>9-12 Crosscutting Statements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. Taking natural materials to make things impacts the environment.</td>
<td>People's needs and wants change over time, as do their demands for new and improved technologies. Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. When new technologies become available, they can bring about changes in the way people live and interact with one another.</td>
<td>All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies are driven by people's needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Technology use varies over time and from region to region.</td>
<td>Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications. Engineers continuously modify these systems to increase benefits while decreasing costs and risks. New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.</td>
</tr>
</tbody>
</table>
Conceptual Shifts in the NGSS

1. K–12 science education should reflect the real world interconnections in science
2. Science and Engineering Practices and Crosscutting Concepts should not be taught in a vacuum; they should always be integrated with multiple core concepts throughout the year
3. Science concepts build coherently across K-12
4. The NGSS focus on deeper understanding and application of content
5. Integration of science and engineering
6. Coordination with Common Core State Standards
Standards Comparison: Structure and Properties of Matter

**Current State Middle School Science Standard**

a. Distinguish between atoms and molecules.
b. Describe the difference between pure substances (elements and compounds) and mixtures.
c. Describe the movement of particles in solids, liquids, gases, and plasmas states.
d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility).
e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color).
f. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements.
g. Identify and demonstrate the Law of Conservation of Matter.

**NGSS Middle School Sample**

a. Construct and use models to explain that atoms combine to form new substances of varying complexity in terms of the number of atoms and repeating subunits.
b. Plan investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.
c. Use a simulation or mechanical model to determine the effect on the temperature and motion of atoms and molecules of different substances when thermal energy is added to or removed from the substance.
d. Construct an argument that explains the effect of adding or removing thermal energy to a pure substance in different phases and during a phase change in terms of atomic and molecular motion.
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Organization of the NGSS

Organized by Disciplinary Content
- Physical Science
- Life Science
- Earth-Space Science
- Engineering

K-5
- Grade By Grade
- Engineering concepts are integrated into performance expectations

6-8
- Grade Banded
- Model Pathways to follow the second public draft

9-12
- Grade Banded
- Model Pathways to follow the second public draft
Second Point

It’s a DRAFT!
Review the Draft Standards

The draft standards are ready for public review

Click here to review the NGSS draft and provide feedback

About NGSS

Next Generation Science Standards for Today’s Students and Tomorrow’s Workforce: Through a collaborative, state-led process managed by Achieve, new K–12 science standards are being developed that will be rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education. The NGSS will be based on the Framework for K–12 Science Education developed by the National Research Council.

Latest News

The First Public Draft of the NGSS is Ready for Your Review
May 11, 2012

New Poll Shows Strong Support for Improving Science Education
March 30, 2012

Final Print Version of A Framework for K–12 Science Education is Now Available
March 07, 2012

Resources

Watch a webinar about the NGSS
The first public draft of the Next Generation Science Standards is available from May 11 to June 1. We welcome and appreciate your feedback.

The NGSS have been written as student performance expectations grouped by topics, and can be viewed in the topical groupings or individually. The draft performance expectations are composed of the three dimensions from the NRC Framework. These draft performance expectations describe how students will demonstrate their understanding. Click on the links to the left to learn more about the standards, and choose one of the buttons below to explore and provide comments on the standards.

Feedback collected during the comment period will be organized and shared with the leading states and writing team members. After the feedback is considered, a feedback report will be issued that will explain how feedback was handled and why.
Search by Topics

You can also search for individual performance expectations.

Download a PDF of all performance expectations grouped by topic, or select criteria below to search for individual topic groupings. You can Ctrl+click (cmd+click on Macs) to select or de-select multiple criteria. Note that adding criteria from both categories narrows your results.

<table>
<thead>
<tr>
<th>Grades</th>
<th>Discipline</th>
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<td>K-2</td>
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</tr>
<tr>
<td>K</td>
<td>Engineering, Technology, and Applications of Science</td>
</tr>
<tr>
<td>1</td>
<td>Life Sciences</td>
</tr>
<tr>
<td>2</td>
<td>Physical Sciences</td>
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<td>3-5</td>
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<td>5</td>
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<tr>
<td>Middle School (6-8)</td>
<td></td>
</tr>
</tbody>
</table>

[Search]

Performance Expectations by Topic
Click on a topic to view associated performance expectations.

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<thead>
<tr>
<th>Elementary</th>
<th>K-5 Storylines: K-2 3-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.OTE</td>
<td>Organisms and Their Environments</td>
</tr>
<tr>
<td>K.SPM</td>
<td>Structure and Properties of Matter</td>
</tr>
<tr>
<td>K.WEA</td>
<td>Weather</td>
</tr>
<tr>
<td>1.SF</td>
<td>Structure and Function</td>
</tr>
<tr>
<td>1.LS</td>
<td>Light and Sound</td>
</tr>
<tr>
<td>1.PC</td>
<td>Patterns and Cycles</td>
</tr>
<tr>
<td>2.ECS</td>
<td>Earth's Changing Surface</td>
</tr>
<tr>
<td>2.SPM</td>
<td>Structure, Properties, and Interactions of Matter</td>
</tr>
<tr>
<td>2.IOS</td>
<td>Interdependence of Organisms and their Surroundings</td>
</tr>
<tr>
<td>2.PP</td>
<td>Pushes and Pulls</td>
</tr>
<tr>
<td>3.WCI</td>
<td>Weather, Climate, and Impacts</td>
</tr>
<tr>
<td>3.IOE</td>
<td>Environmental Impacts on Organisms</td>
</tr>
<tr>
<td>3.PSF</td>
<td>Structure, Function, and Stimuli</td>
</tr>
<tr>
<td>3.IFS</td>
<td>Interactions of Forces</td>
</tr>
<tr>
<td>4.LCT</td>
<td>Life Cycles and Traits</td>
</tr>
<tr>
<td>4.PSE</td>
<td>Processes that Shape the Earth</td>
</tr>
<tr>
<td>4.E</td>
<td>Energy</td>
</tr>
<tr>
<td>4.WAV</td>
<td>Waves</td>
</tr>
<tr>
<td>5.SPM</td>
<td>Structure, Properties, and Interactions of Matter</td>
</tr>
<tr>
<td>5.MEE</td>
<td>Matter and Energy in Ecosystems</td>
</tr>
<tr>
<td>5.ESI</td>
<td>Earth Systems and Their Interactions</td>
</tr>
<tr>
<td>5.SSS</td>
<td>Stars and the Solar System</td>
</tr>
</tbody>
</table>
Search Performance Expectations

You can also search by topics.

All performance expectations are listed below. To narrow the list displayed, select search criteria. You can Ctrl+click (cmd+click on Macs) to select or de-select multiple criteria. Note that adding criteria from multiple categories narrows your results.

Views: Black and white / Practices and Core Ideas / Practices and Crosscutting Concepts / Print this page

- Grade Band/Level
- Practices
- Cross Cutting Concepts
- Disciplinary Core Ideas

Search  Reset criteria

How to read the standards »
Related Content »

Go to the NGSS Survey
Views: PDF
HS.LS-MEOE Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

a. **Construct a model to support explanations of the process of photosynthesis by which light energy is converted to stored chemical energy.** [Clarification Statement: Models may include diagrams and chemical equations. The focus should be on the flow of matter and energy through plants.][Assessment Boundary: Limited to the inputs and outputs of photosynthesis and chemosynthesis, not the specific biochemical steps involved.]

b. **Construct an explanation of how sugar molecules that contain carbon, hydrogen, and oxygen are combined with other elements to form amino acids and other large carbon-based molecules.** [Clarification Statement: Explanations should include descriptions of how the cycling of these elements provide evidence of matter conservation.][Assessment Boundary: Focus is on conceptual understanding of the cycling of matter and the basic building blocks of organic compounds, not the actual process.]

c. **Use a model to explain cellular respiration as a chemical process whereby the bonds of food molecules and oxygen molecules are broken and bonds in new compounds are formed that result in a net transfer of energy.** [Assessment Boundary: Limited to the conceptual understanding of the inputs and outputs of metabolism, not the specific steps.]

d. **Evaluate data to compare the energy efficiency of aerobic and anaerobic respiration within organisms.** [Assessment Boundary: Limited to a comparison of ATP input and output.]

e. **Use data to develop mathematical models to describe the flow of matter and energy between organisms and the ecosystem.** [Assessment Boundary: Use data on energy stored in biomass that is transferred from one trophic level to another.]

f. **Communicate descriptions of the roles of photosynthesis and cellular respiration in the carbon cycle specific to the carbon exchanges among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.**

g. **Provide evidence to support explanations of how elements and energy are conserved as they cycle through ecosystems and how organisms compete for matter and energy.** [Clarification Statement: Elements included can include carbon, oxygen, hydrogen, and nitrogen.]
Developing and Using Models

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world.
- Use multiple types of models to represent and explain phenomena and move flexibly between model types based on merits and limitations.
- Construct, revise, and use models to predict and explain relationships between systems and their components.
- Examine merits and limitations of various models in order to select or revise a model that best fits the evidence or the design criteria.

a. **Construct a model to support explanations** of the process of photosynthesis by which light energy is converted to stored chemical energy. [Clarification Statement: Models may include diagrams and chemical equations. The focus should be on the flow of matter and energy through plants.] [Assessment Boundary: Limited to the inputs and outputs of photosynthesis and chemosynthesis, not the specific biochemical steps involved.]

b. **Construct an explanation of** how sugar molecules that contain carbon, hydrogen, and oxygen are combined with other elements to form amino acids and other large-carbon-based molecules. [Clarification Statement: Explanations should include descriptions of how the cycling of these elements provide evidence of matter conservation.] [Assessment Boundary: Focus is on conceptual understanding of the cycling of matter and the basic building blocks of organic compounds, not the actual process.]

c. **Use a model to explain** cellular respiration as a chemical process whereby the bonds of food molecules and oxygen molecules are broken and bonds in new compounds are formed that result in a net transfer of energy. [Assessment Boundary: Limited to the conceptual understanding of the inputs and outputs of metabolism, not the specific steps.]

d. **Evaluate data to compare the energy efficiency** of aerobic and anaerobic respiration within organisms. [Assessment Boundary: Limited to a comparison of ATP input and output.]

e. **Use data to develop mathematical models** to describe the flow of matter and energy between organisms and the ecosystem. [Assessment Boundary: Use data on energy stored in biomass that is transferred from one trophic level to another.]

f. **Communicate descriptions** of the roles of photosynthesis and cellular respiration in the carbon cycle specific to the carbon exchanges among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

g. **Provide evidence to support explanations** of how elements and energy are conserved as they cycle through ecosystems and how organisms compete for matter and energy [Clarification Statement: Elements included can include carbon, oxygen, hydrogen, and nitrogen.]
- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. The sugar molecules thus formed contain carbon, hydrogen, and oxygen; their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.

Students who demonstrate understanding:

a. **Construct a model to support explanations of the process of photosynthesis by which light energy is converted to stored chemical energy.** [Clarification Statement: Models may include diagrams and chemical equations. The focus should be on the flow of matter and energy through plants.] [Assessment Boundary: Limited to the inputs and outputs of photosynthesis and chemosynthesis, not the specific biochemical steps involved.]

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f. **Communicate descriptions of the roles of photosynthesis and cellular respiration in the carbon cycle specific to the carbon exchanges among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.**

g. **Provide evidence to support explanations of how elements and energy are conserved as they cycle through ecosystems and how organisms compete for matter and energy.** [Clarification Statement: Elements included can include carbon, oxygen, hydrogen, and nitrogen.]
Energy and Matter

The total amount of energy and matter in closed systems is conserved. Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Students who demonstrate understanding:

a. Construct a model to support explanations of the process of photosynthesis by which light energy is converted to stored chemical energy. [Clarification Statement: Models may include diagrams and chemical equations. The focus should be on the flow of matter and energy through plants.][Assessment Boundary: Limited to the inputs and outputs of photosynthesis and chemosynthesis, not the specific biochemical steps involved.]

b. Construct an explanation of how sugar molecules that contain carbon, hydrogen, and oxygen are combined with other elements to form amino acids and other large carbon-based molecules. [Clarification Statement: Explanations should include descriptions of how the cycling of these elements provide evidence of matter conservation.][Assessment Boundary: Focus is on conceptual understanding of the cycling of matter and the basic building blocks of organic compounds, not the actual process.]

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g. Provide evidence to support explanations of how elements and energy are conserved as they cycle through ecosystems and how organisms compete for matter and energy. [Clarification Statement: Elements included can include carbon, oxygen, hydrogen, and nitrogen.]
### Science and Engineering Practices

**Developing and Using Models**
- Modeling in 9-12 builds on K-8 and progresses to using, synthesizing, and constructing models to explain phenomena or predict and explain relationships between systems and their components in the natural and designed world.
- Construct, revise, and use models to predict and explain relationships between systems and their components.

**Planning and Carrying Out Investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in 9-12 builds on K-8 experiences and progresses to including investigations that build, test, and revise conceptual, mathematical, physical, and empirical models.
- Plan and carry out investigations individually and collaboratively as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects and ensure that the investigation’s design has controlled for them.

**Using Mathematics and Computational Thinking**
- Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponential and logarithmic functions, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
- Use mathematical expressions to represent phenomena or design solutions in order to solve algebraically for desired quantities.

**Obtaining, Evaluating, and Communicating Information**
- Obtaining, evaluating, and communicating information in 9-12 builds on 6-8 and progresses to evaluate the validity and reliability of the claims, methods, and designs.
- Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports.

### Disciplinary Core Ideas

**PS2.B: Types of Interactions**
- Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.
- Forces at a distance are explained by fields permeating space that can transfer energy through space. Magnets or changing electric fields cause magnetic fields; electric charges or changing magnetic fields cause electric fields.
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
- The strong and weak nuclear interactions are important inside atomic nuclei—for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones.

### Crosscutting Concepts

**Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect. Changes in systems may have various causes that may not have equal effects.

#### Connections to Engineering, Technology, and Applications of Science

**Interdependence of Science, Engineering, and Technology**
- Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

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**Common Core State Standards Connections**
- [Note: these connections will be made more explicit and complete in future draft releases]

**ELA**
- **RST.9-10.7** Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- **RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

**WHST.9**
- Draw evidence from informational texts to support analysis, reflection, and research.
Survey Considerations

- Items in the Table of Contents are separate surveys
- Users may access all surveys, single surveys, or partial surveys
- To access each survey
  - Register your email address and create a password
  - Re-enter your email and password to enter each survey
- Users may save each entry by clicking “Next” button
- Do NOT “Submit” the survey until your feedback is complete for that survey
Welcome to the
Next Generation Science Standards (NGSS)
Survey Website

About This Survey
This survey is designed so respondents can provide general feedback as well as specific feedback on the different science standards of the NGSS, where the science standards are arranged by topic name. The survey is organized in sections. Each section is a unique web-based survey. Once you register, you will be provided a link to the Main Survey where you will be asked to enter information about yourself and will be provided a link to the Table of Contents for the different survey sections. Each entry in this Table of Contents is a link to one of the survey sections. [NOTE: You will be asked to verify your registration information when you open a new feedback section.]

This survey will be open through June 1, 2012.
NGSS Survey Table of Contents

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Directions for Navigating Between The NGSS Survey and External Websites

The NGSS survey contains links to external websites with relevant information (i.e., the NRC A Framework for K - 12 Science Education and the NGSS website). Keep the webpage for the survey open while you are actively providing feedback. To return to the survey after viewing other websites, click the tab at the top of the browser for the survey webpage, or close the pages to the other websites.

Saving Your Work and Continuing Later

To save your survey feedback and continue later, just click the "NEXT" button on the bottom right of the active survey window. This will save the data on all preceding pages. You may then safely exit the survey by closing your browser window. When you wish to continue later, you may access the survey using the "Go to the Survey" button on the NGSS website or, if you have been sent a link, by clicking on that survey link and using the Survey Table of Contents to navigate to the particular survey you want to work on.
Submission screen for each survey

End of Survey on Individual Elementary School Standards

Would you like to submit your responses to the Survey on Individual Elementary School Standards? [WARNING: Once you submit this survey you will not be able to access it.]

Close Window [NOTE: Clicking "Close Window" will close the window and save your work without submitting.]

Type "submit" here if you wish to submit your responses then click "NEXT" below
- Engaging K-12 and higher education
- New definition required
- Evidence gathering

- State Coalitions
- Engaging the business community
- Communications strategy

- Policies to support quality implementation (e.g., graduation requirements)
- Effects on K-12, higher education, and workforce

- Supporting states in planning for adoption
- Supporting states in planning for implementation

- College and Career Readiness
- NGSS Support
- Science Education Policies
- Adoption and Implementation Planning
It’s a DRAFT!
Stephen Pruitt, Ph.D.
Vice President, Content, Research and Development
spruiitt@achieve.org

www.nextgenscience.org
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Welcome to Your Personalized Learning Web Space!

Paul, you've already earned 1335 Activity Points!

You've recently earned:
- Ruby Aggregator
- Add Personal Resources

You're close to earning:
- Ruby Commenter
- Post 9 more comments/questions

With these resources you can build your professional development plan, track your activities and assess your progress. You can start at “Explore Learning Opportunities” below or by creating your game plan with the PD Plan and Portfolio tool. You may also review an archived Web Seminar or a multimedia overview of the Learning Center.
National Science Teachers Association
Dr. Gerry Wheeler, Interim Executive Director
Zipporah Miller, Associate Executive Director
Conferences and Programs
Al Byers, Assistant Executive Director e-Learning

NSTA Web Seminars
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