Washington State

K - 12 Science

Learning Standards

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SUPERINTENDENT OF PUBLIC INSTRUCTION
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Revised Washington State K-12 Science Standards

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Washington State K-12 Science Standards

Overview

Purpose

The *Washington State K-12 Science Standards* is a detailed document describing what *all students* are expected to know and be able to do at each level of our educational system in the area of science. The purpose of these standards is to provide strong support for students, parents, teachers, and the broader community by guiding the alignment of the school curriculum, instruction, and assessment at local and state levels.

To accomplish this purpose it is essential to use this document in the following ways:

> Those responsible for **curriculum alignment** should refer to this document in selecting or developing instructional materials that enable students to acquire core conceptual knowledge and abilities in science.
>
> Those responsible for **assessment alignment** at the local and state levels should refer to this document in selecting and/or developing assessment tools and rubrics that measure student achievement of the core content in these standards.
>
> Those responsible for **instructional alignment** should refer to this document in designing classroom instruction and professional development of teachers to ensure that achieving these core content standards is a priority.

It is also important to point out what the standards are not intended to provide.

> *The standards do not prescribe teaching methods.* The standards do not specify preferred teaching methods or materials. The purpose of the standards is solely to enable content alignment of curriculum, assessment, and instruction by clearly specifying what students are to understand and be able to do—not to prescribe how teachers should help students learn.
>
> *The standards are not the curriculum.* The standards specify a core of conceptual knowledge and abilities that all students should achieve by the time they leave our classrooms. Many students will be able to go well beyond the basic content described in this document, which is recommended. Curriculum developers are encouraged to create science materials that are much richer in content and deeper in conceptual understanding than is specified on these pages.
>
> *The standards are not test specifications*. The standards describe what students should know and be able to do, and they constrain the content of statewide tests. But they do not specify how knowledge or abilities are to be assessed, either at the local or state levels.
>
> *The standards are not a checklist.* Aligning curriculum content and best instructional practice is not as simple as making sure topics in the curriculum match the standards. It is also necessary for teachers to assess whether or not their students are achieving standards, and to know how to teach effectively to all students.

This document includes both *content standards* and *performance expectations*.

Content standards, which appear in the left-hand column in the body of this document, describe what students should know and be able to do in science. Agreement on content standards was the first step in developing the *Washington State K-12 Science Standards*. Recognizing that many students will have the interests and abilities to go well beyond these standards, the content standards identify the most important concepts and abilities for expanding the scope of the curriculum to meet students' needs and interests.

Performance expectations, which appear in the right-hand column, provide clear guidance about the depth of knowledge expected at each grade band, and how students are expected to demonstrate their understanding and abilities on formative and summative measures. Performance expectations specify the floor—a minimum core of concepts and abilities to be achieved by all students.

Consistent with the *Washington State K-12 Mathematics Standards*, this document supports a vision of what *all students* should learn during science instruction in grades K-8, and at least three years of high school science. But these standards should not be used to limit science programs. Young children should have many experiences to spark and nurture their interests in science and technology, and high school students should have opportunities to take science courses that go well beyond these standards and help them with the next step in their education, whether at college, technical school, an apprenticeship program, or the world of work.

Essential Academic Learning Requirements

The 2009 version of the *Washington State K-12 Science Standards* strengthens the foundations of the previous document and incorporates the latest findings of educational research. The earlier document was based on three Essential Academic Learning Requirements (EALRs). In the new standards, EALRs 1, 2, and 3 describe crosscutting concepts and abilities that characterize the nature and practice of science and technology, while EALR 4 describes what all students should know and be able to do in the domains of Life, Physical, and Earth and Space Science.

EALR 1 **Systems** thinking makes it possible to analyze and understand complex phenomena. Systems concepts begin with the idea of the part-to-whole relationship in the earliest grades, adding the ideas of systems analysis in middle school and emergent properties, unanticipated consequences, and feedback loops in high school.

EALR 2 **Inquiry** is the bedrock of science and refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how the natural world works. Students ask and answer questions that facilitate growth in their understanding of the natural world. Inquiry includes the idea that an *investigation* refers to a variety of methods that can be used to answer a scientifically oriented question, including: systematic observations, field studies, models and simulations, open-ended explorations, and controlled experiments.

EALR 3 **Application** includes the ability to use the process of technological design to solve real-world problems, to understand the relationship between science and technology and their influence on society, and to become aware of the wide variety of careers in scientific and technical fields. These abilities are needed for people to apply what they learn in school to meet challenges in their own lives, to understand and help solve societal problems involving science and technology, and contribute to the prosperity of their community, state, and nation.

EALR 4 **The Domains of Science** focus on nine Big Ideas in the domains of Physical Science, Life Science, and Earth and Space Science that all students should fully understand before they graduate from high school so that they can participate and prosper as citizens in modern society.

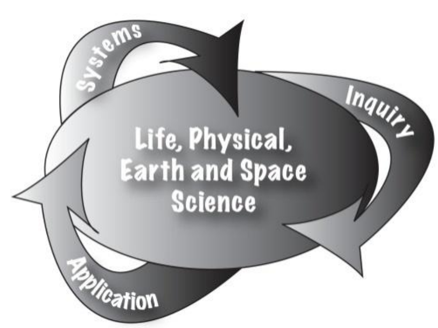
Although most state and national standards include the domains of science and scientific inquiry, and the application of science and technology to society, Washington is unique in emphasizing *systems.* ***Systems*** was chosen from among a list of unifying concepts and processes in the *National Science Education Standards* because of its growing importance in such diverse and cutting-edge fields as climate change, genetic engineering, and designing and troubleshooting complex technological systems. In addition to helping students understand and analyze scientific concepts and issues, systems thinking can help students address some of the challenges they encounter in everyday life as citizens, workers, and consumers.

Other unifying concepts and processes from the *National Science Education Standards* have also been woven into the *Washington State K-12 Science Standards*. For example, ***models*** are an important part of EALR 2 Inquiry. Students learn to design, build, and use models as well as recognize the limitations of models. The complementary processes of ***constancy*** and ***change*** are reflected throughout the standards, for example, in the conservation laws in physical science as well as the concept of dynamic equilibrium in ecosystems. Examples of ***directional, predictive***, and ***cyclic*** change are introduced and developed in the study of Earth systems, structures, and processes, and biological evolution.[i]

The EALRs of Systems, Inquiry, and Application are intended to be interwoven with core content in the science domains of Life, Physical, and Earth and Space Science. [ii] The purpose of this integration is to ensure students' long-term and conceptual understanding of the topic as well as improve their abilities to do science. For example, students might begin a field study by counting the number of organisms of two or three local species. Then they might look at a graph of owl and rodent populations in an area over a number of years, and discuss how patterns in the data might be interpreted in predator-prey relationships. The outcome of the lesson would include understanding of predator-prey relationships (Life Science) as well as the way those relationships can be investigated through field studies (Inquiry). Students might also discuss the ecosystem as a whole, and what might happen if the rodents or owls are impacted by disease (Systems), and what the trade-offs might be of different courses of action to protect the habitat (Application.)

No specific recommendations are given as to which science domains are best matched with Systems, Inquiry, and Application, and it is not expected that each science lesson would involve content from all three crosscutting areas. Decisions about how best to match the domains of science in EALR 4 with the crosscutting ideas in EALRs 1, 2, and 3 will be made at the school district level.

At the center of the Washington State science symbol are the domains of Life, Physical, and Earth and Space Science. The other three EALRs—Systems, Inquiry, and Application—are equally essential. They help students understand the science domains, and are in turn further developed as students apply them in all fields of science. The symbol emphasizes that scientific inquiry, systems thinking, and the application of science and technology should not be learned in isolation but rather in conjunction with the science domains.



Organization of the Standards

The *2009 Washington State K-12 Science Standards* differs from the previous standards document with respect to the grade bands and organization of the sciences.

Grade Bands. The most significant change is to extend standards in the domains of science from grade 10 to grade 11 in support of the recommendation[iii] that all students should take at least three years of high school science. Learning targets are specified in all science domains for a three-year science program, which could be met with a variety of different course structures and sequences. All students are encouraged to take a fourth year of science as well. Standards in Systems, Inquiry, and Application continue in grade 12 as crosscutting concepts and abilities, because they are integral to science learning and instruction.

It is essential for middle school students to have three full years of science to meet the middle school standards, to stimulate their interests in science, and to prepare them for a series of rigorous high school courses. The middle school grade band remains as a single three-year span for students in grades 6-8. A three-year grade band at the middle school level provides flexibility for school leaders to integrate the science program with other elements of the school curriculum.

The Science Standards Revision Team determined that the previous elementary grade bands were too broad because children develop rapidly in their cognitive abilities from kindergarten to 5th grade. Consequently, rather than two elementary grade bands, the new standards are presented in three grade bands at the elementary level, each spanning just two years. There is significant research to support two-year rather than three-year grade bands at the elementary level.[iv]

In summary, grade bands in the *K-12 Science Standards* are K-1, 2-3, 4-5, 6-8, and 9-12.

Big Ideas of Science. Another difference between these standards and the previous version is that content in the science disciplines is organized by nine Big Ideas in the major domains of science—three in Life Science, three in Earth and Space Science, and three in Physical Science. Each "Big Idea" is a single important concept that begins in the early grades, and builds toward an adult-level understanding.

The strategy of using Big Ideas to organize science standards arose in response to research showing that U.S. students lagged behind students in many other countries, at least in part because school curricula include far too many topics. According to the results of the Third International Mathematics and Science Study (TIMSS), "*Our curricula, textbooks, and teaching all are 'a mile wide and an inch deep.'*"[v]

A solution to this problem that has gained support from science education researchers in recent years is to organize science standards by a small number of "Big Ideas," which are essential for all people in modern society to understand.[vi] Organizing K-12 concepts and abilities by Big Ideas offers a way to decide what is and is not important for students to study, and provides a coherent vision of what students should know and be able to do that builds throughout a coherent K-12 science program.

In summary, the **content** of the *Washington State K-12 Science Standards* is organized according to twelve Big Ideas of Science: nine in the domains of Life, Physical, and Earth and Space Science, and three that cut across and unite all of the science domains: Systems, Inquiry, and Application.

Crosscutting Concepts and Abilities

Science is an active process that involves thinking in systems, asking and answering questions through *investigation*s, and applying science and technology to solve real-world problems. As illustrated in the chart below, these crosscutting concepts and abilities increase in complexity, depth, and range as students mature from one grade band to the next.

Cross-cutting	EALR 1 Systems	EALR 2 Inquiry	EALR 3 Application
The Big Ideas of Science	**…is a way of thinking that makes it possible to analyze and understand complex phenomena.**	**… is a process of asking and answering questions about the natural world that forms the bedrock of science.**	**…is about the interaction between science and technology, and how both can help solve real-world problems.**
Grades 9-12	**Predictability and Feedback**	**Conducting Analyses and Thinking Logically**	**Science, Technology, and Society**
	Create realistic models with feedback loops, and recognize that all models are limited in their predictive power.	Expand and refine skills and abilities of inquiry to gain a deeper understanding of natural phenomena.	Transfer and apply abilities in science and technological design to develop solutions to societal issues.
Grades 6-8	**Inputs, Outputs, Boundaries & Flows**	**Questioning and Investigating**	**Science, Technology, and Problem Solving**
	Look at a complex situation and see how it can be analyzed as a system with boundaries, inputs, outputs, and flows.	Investigate an answerable question through valid experimental techniques. Conclusions are based on evidence and are repeatable.	Work with other members of a team to apply the full process of technological design and relevant science concepts to solving a problem.
Grades 4-5	**Complex Systems**	**Planning *Investigation*s**	**Different Technologies**
	Analyze a system in terms of subsystems functions as well as inputs and outputs.	Plan different kinds of *investigation*s, including field studies, systematic observations, models, and controlled experiments.	Define technologies and the technological design process to understand the use of technology in different cultures and career fields.
Grades 2-3	**Role of Each Part in a System**	**Conducting *Investigation*s**	**Solving Problems**
	See how parts of objects, plants, and animals are connected and work together.	Carry out *investigation*s by using instruments, observing, recording, and drawing evidence-based conclusions.	Develop a solution to a problem by using a simplified technological design process. Investigate the use of tools.
Grades K-1	**Part-Whole Relationships**	**Making Observations**	**Tools and Materials**
	Identify parts of living and non-living systems.	Answer questions by explaining observations of the natural world.	Use simple tools and materials to solve problems in creative ways.

Big Ideas in EALR 4: The Domains of Science

The following tables summarize the nine big ideas in the science domains. Under each big idea are notes about how the learning in each of the grade level spans contributes to the development of the big idea as children advance through the grade levels. While these brief notes do not capture all of the concepts and abilities that students are expected to acquire, they do show how what students learn in any given year related to what they learned before and to what they will be expected to learn at the next grade band.[vii]

Science Domain	EALR 4 Physical Science		
The Big Ideas of Science	**Force and Motion** concerns the forces and motions that occur in our physical universe. At the highest level, students apply Newton's Laws of Motion and Gravity to explain phenomena such as the fall of a leaf and the motions of planet Earth in space.	**Matter: Properties and Change** concerns the fundamental nature of matter, including the atomic-molecular theory that explains macroscopic properties of materials and makes it possible to predict the outcomes of chemical and nuclear reactions.	**Energy: Transfer, Transformation and Conservation** concerns energy as it changes forms and moves from one place to another. Energy is never created or destroyed. These concepts are useful in explaining phenomena in all domains.
Grades 9-11	**Newton's Laws**	**Chemical Reactions**	**Transformation and Conservation of Energy**
	Multiple forces affect an objects motion in predictable ways. These affects are explained by Newton's Laws.	Atomic structure accounts for atoms ability to combine to produce compounds. These changes maybe physical, chemical or nuclear.	Energy can take many forms and be transferred and transformed. Within a closed system the total energy is conserved.
Grades 6-8	**Balanced and Unbalanced Forces**	**Atoms and Molecules**	**Interactions of Energy and Matter**
	Objects in motion are affected by balanced and unbalanced forces. Speed and direction of motion change due to these forces.	Substances have unique properties based on their atomic structure. As atoms combine in a closed system their mass is conserved.	Energy and matter interact resulting in energy transfers and transformations. There are multiple forms of energy.
Grades 4-5	**Measurement of Force and Motion**	**States of Matter**	**Heat, Light, Sound, and Electricity**
	Forces and motions can be measured.	A single kind of matter can exist as a solid, liquid, or gas. Matter is conserved.	Heat, light, sound, and electrical energy can be transferred.
Grades 2-3	**Force Makes Things Move**	**Properties of Materials**	**Forms of Energy**
	Forces on objects make them move. Changes in forces will cause changes in the motion.	The properties of an object depend on its shape and on the material it is made from.	Energy comes in different forms.
Grades K-1	**Push-Pull and Position**	**Liquids and Solids**	
	Forces are pushes and pulls. Motion is a change in position.	Different kinds of materials display different properties.	

Science Domains	EALR 4 Earth and Space Science		
The Big Ideas of Science	**Earth and Space** is the longest and most comprehensive story that can be told, beginning with the birth of the universe and our home solar system, to the dynamic Earth-Sun-Moon system that set the stage for the wide diversity of life.	**Earth Systems, Structures, and Processes** includes the big picture of Earth as an interacting and dynamic system, including weather, and climate, the oceans, and the long-term movement of crustal plates that build up mountains and cause earthquakes, tsunami, and volcanoes.	**Earth History** has been uncovered by observing processes that take place today, and projecting those processes back in time. These remnants, especially fossils, provide essential clues to understanding the evolution of our planet.
Grades 9-11	**Evolution of the Universe**	**Energy in Earth Systems**	**Evolution of the Earth**
	Physical principles apply to the origins and development of the Earth and the Universe.	Energy from the Sun drives our weather system and climate, while energy from Earth's interior drives the rock cycle and crustal plates.	Evidence provided by natural radioactive material has made it possible to determine the age of different structures and of Earth as a planet.
Grades 6-8	**The Solar System**	**Cycles in Earth Systems**	**Evidence of Change**
	Our Solar System is held together by gravity. Moon phases and eclipses are explained.	Earth is an interacting system of solids, liquids, and gases. Important Earth processes include the water cycle and the rock cycle.	Layers of rocks and different types of fossils provide clues to how conditions on Earth have changed over time.
Grades 4-5	**Earth in Space**	**Formation of Earth Materials**	**Focus on Fossils**
	Earth is spherical in shape. It spins on its axis and orbits the Sun.	Earth materials are formed by various natural processes and can be used in different ways.	Fossils provide evidence that environments of the past were quite different from what we observe today.
Grades 2-3	**The Sun's Daily Motion**	**Water and Weather**	
	The Sun and Moon have patterns of movement that can be inferred by observing and recording shadows cast by the Sun.	Water is essential in Earth systems. This is seen by observing and recording changes in weather patterns and Earth formations.	
Grades K-1	**Observing the Sun and Moon**	**Properties and Change**	
	The Sun and the Moon have patterns of movement that can be observed and recorded.	Earth materials have various properties.	

Science Domains	EALR 4 Life Science		
The Big Ideas of Science	**Structure & Function of Living Systems** includes the way living things are organized and carry on life processes, from the components of a single cell to complex multicellular organisms such as humans.	**Ecosystems** are defined as all of the plant and animal populations and nonliving resources in a given area. The relationships between organisms within an ecosystem make it possible to predict the consequences of change and provide insights into the sustainable use of natural resources.	**Biological Evolution** is the essential framework for understanding how organisms change over time, from the first single-celled bacteria on the young Earth to the amazing diversity of species that populate our planet today. Evidence and reasoning are essential to recognize the patterns and scale of past changes.
Grades 9-11	**Processes Within Cells**	**Maintenance and Stability of Populations**	**Mechanisms of Evolution**
	Cells contain the mechanisms for life functions, reproduction, and inheritance.	A variety of factors can affect the ability of an ecosystem to maintain current population levels.	The underlying mechanisms of evolution include genetic variability, population growth, resource supply, and environment.
Grades 6-8	**From Cells to Organisms**	**Flow of Energy Through Ecosystems**	**Inheritance, Variation and Adaptation**
	Cell type and organization provide living systems structure and function.	Energy flows through ecosystems from a primary source through all living organisms.	Multiple lines of evidence support biological evolution. These include genetics, reproduction, adaptation and speciation.
Grades 4-5	**Structures and Behaviors**	**Food Webs**	**Heredity and Adaptation**
	Plants and animals have different structures that meet their needs and respond to the environment.	Changes in ecosystems affect the populations that can be supported in a food web.	Ecosystems change. Organisms that can adapt to these changes will survive and reproduce in higher numbers.
Grades 2-3	**Life Cycles**	**Changes in Ecosystems**	**Variation of Inherited Characteristics**
	Plants and animals have life cycles.	Changes in ecosystems affect living populations and the non-living elements of a defined area.	Plants and animals vary from one another and their parents. These differences serve as the basis for natural selection.
Grades K-1	**Plant and Animal Parts**	**Habitats**	**Classifying Plants and Animals**
	Plants and animals meet their needs in different ways.	Habitats are places that meet the daily needs of plants and animals.	Both plants and animals have different characteristics that can be used to classify them.

Fewer Topics—Greater Depth

Because grade bands at the elementary level span two years, teachers at this level are responsible for teaching just half of the standards in the science domains (EALR 4) specified for their grade band. Because the middle school grade band spans three years, middle school teachers are responsible for teaching one-third of the standards per year at that grade band. High school teachers are also responsible for just one-third of the standards in the science domains.

The recommendation that a standard be learned in depth during one year and not repeated every year is to avoid the "mile wide and inch deep"[v] problem that characterized science education in the past. The strategy that underpins the current standards is that by focusing on just a few concepts and skills each year, teachers will have time to ensure that all of their students will achieve mastery.

This strategy involves a trade-off in "spiraling," or returning to the same core content in subsequent years. Though these standards recommend against re-teaching the same concepts year after year, they do support the need to check students' understanding and abilities learned in prior years, and the need for occasional "refresher" activities to ensure that students' knowledge and abilities continue to grow.

But with regard to Systems, Inquiry, and Application (EALRs 1, 2, and 3), this document *does* support the strategy of teaching the concepts and abilities of systems, inquiry, and application *every year K-12*, but not as isolated topics. Rather, these ideas and capabilities, which also increase in complexity and power from year to year, are to be integrated with core content in the science domains.

For this strategy to work, it has been necessary to reduce the number of standards to a manageable level. Public comment on earlier drafts and the results of research[viii] have clearly indicated that standards must be manageable if teachers and students are to be held accountable and students are to reach their highest levels of learning. Consequently, the teams developing these standards have been thoughtful in setting priorities so that *all students* can succeed.

Criteria for Development of Standards

Development of Content Standards and Performance Expectations were based on the following criteria:

Essential. To keep the number of Standards manageable, only science content that is essential for understanding the Big Ideas of science has been included. Standards in adjacent grade bands that were similar have been eliminated. It is expected that the remaining standards will be learned in depth.

Clear. The science standards should not depend on scientific vocabulary alone to convey the meaning of a statement. Where scientific vocabulary is needed to convey meaning, the term is *italicized* and defined in context. Recognizing that a common term for one person may be a "scientific term" for another, we have also included a glossary for all *italicized* terms.

Specific. It is especially important that the Science Standards specify not only the content that students are expected to study but also the depth they are expected to achieve. The new standards describe what students should *know about* science, as well as the *abilities* they should acquire.

Rigorous. The level of rigor is based on appropriate grade-level placement of standards, so that learning expectations meet the developmental readiness of the students.

Relevant. The Science Standards also include content about personal health and environmental change from the *National Science Education Standards*[ix] so that science learning is relevant not only to the domains of science, but also to the needs of individuals and society.

Anatomy of a Standard

Although most people will refer to this entire document as “The Science Standards,” it is important to recognize the function of each part of the explicit statements organized under grade-level bands. These are shown in the illustration below.

Standards for Grades K-1

EALR 4: Domains of Science (Life, Physical, or Earth and Space Science).

EALR 4: **Earth and Space Science**
Big Idea: **Earth Systems, Structures, and Processes (ES2)**
Core Content: ***Earth Materials***

This is one of nine **Big Ideas** in the science domains.

Students learn about Earth materials through their own observations. They learn to distinguish between natural materials and those processed by people. They study natural substances such as rocks and soil, and find that these Earth materials are made up of smaller parts and different kinds of materials. They learn to use common terms, such as hard, soft, dry, wet, heavy, and light, to describe what they see. These observations help students become familiar with the materials in the world around them and to begin thinking of properties of materials rather than objects.

Core Content Summary describes what students can be expected to know entering this grade band, what they will learn, and why it’s important that they meet these content standards.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
K-1 ES2A	Some objects occur in nature; others have been designed and processed by people.	Sort objects into two groups: *natural* and *human-made*.*a
K-1 ES2B	Earth materials include solid rocks, sand, and soil; and water. These materials have different observable physical *properties*.	*Describe* Earth objects using appropriate terms, such as hard, soft, dry, wet, heavy, and light, to *describe* these materials. Sort Earth objects by one observable property (e.g., rocks by size or color).*a *Compare* Earth objects by at least two properties (e.g., first *compare* rocks by size, then by color). *a
K-1 ES2C	Some Earth objects are made of more than one material.	Observe and *describe* objects made of more than one Earth material (e.g., certain rocks and soil).

Content Standards describe what students should know and be able to do.

Performance Expectations specify depth of knowledge and evidence that students have met the standard.

Mathematics Connections

*a K.3.B Sort shapes, using a sorting rule, and explain the sorting rule.

Mathematics Connections are related statements from the WA Mathematics Standards.

Mathematics Connections

Many of the standards in the *Washington State K-12 Mathematics Standards* suggest concepts, procedures, or processes that complement and support standards in science. These connections have been identified as footnotes below each set of Content Standards. The mathematics ideas will be learned as part of mathematics instruction. Because the mathematics ideas will be learned at the same grade level or an earlier grade level as the science, students can use them as tools in science. One significant difference between the Mathematics and Science Standards is that the Mathematics Standards require students to use both metric and U.S. Customary units, while students in science will be expected only to use the metric system. We encourage mathematics and science teachers to collaborate on how best to ensure that students have acquired the necessary mathematics learning before, or at the same time the associated science Performance Expectations (PEs) are learned.

As illustrated by the increased number of references to the Mathematics Standards in middle and high school, the connection between science and mathematics grows closer as students take more advanced courses. Research on the relationship between high school courses and college success indicate that those who anticipate attending college or technical schools would do well to take four full-year courses in mathematics, as well as science courses in the fields that they intend to pursue at college.[x]

Conclusion

By providing an explicit statement of what *all students* should know and be able to do in science, this document plays an essential role in our state's educational system. By making it possible to align curriculum, instruction, and assessment, the *Washington State K-12 Science Standards* provides the clarity, specificity, and priorities that educators need to help every student be successful in science.

These standards also provide a starting point for a vision of science education that goes well beyond core standards. The Big Ideas in the science domains and crosscutting concepts and skills can serve as the base for an enriched science program at all levels in elementary and middle schools, and for the design of high school courses that address these and other concepts and abilities in innovative ways.

These science education standards provide a critical foundation, but much work remains to be done. In order to create a fully aligned science education system, we will also need to:

- Identify science curricula and instructional support materials that will enable teachers to help their students meet the standards.
- Develop formative assessments and other tools that complement the curriculum materials, which teachers can use to improve their capabilities to help their students meet these standards.
- Provide systematic professional development to increase teachers' knowledge of science, their abilities to use instructional materials with formative assessments effectively, and to teach in ways that support high student achievement.
- Align the State of Washington's standardized assessments of student learning with these standards, using performance expectations as common targets for curriculum, instruction, and assessment.
- Develop online availability of standards and resources in various forms and formats, with example classroom vignettes and assessment support.

Although the organization and many of the details have been changed, the essential content and spirit of these standards are very similar to our previous science standards. Consequently, these new standards are

Science Standards
Grades 6-8

The science standards for grades 6-8 consist of nine Core Content Standards within the science domains. These standards should be learned during the three-year grade span, so that only three of them need to be learned ***in depth*** each year. Local school district curriculum teams will decide which of the areas will be learned at which grade level, depending on students' needs and interests.

As illustrated by the grid below, the three crosscutting EALRs of Systems, Inquiry, and Application are not to be learned in isolation, but rather in conjunction with content in the science domains. Not every topic needs to address all three crosscutting EALRs. But in any given year, content in Systems, Inquiry, and Application should be experienced in the context of several science lessons so that students can see the commonalities among the fields of science.

Grades 6-8 **EALR 4 Domains of Science**	**EALR 1** **Systems** **SYS**	**EALR 2** **Inquiry** **INQ**	**EALR 3** **Application** **APP**
Physical Science PS1 Balanced and Unbalanced Forces PS2 Atoms and Molecules PS3 Interactions of Energy and Matter **Earth and Space Science** ES1 The Solar System ES2 Cycles in Earth Systems ES3 Evidence of Change **Life Science** LS1 From Cells to Organisms LS2 Flow of Energy Through Ecosystems LS3 Inheritance, Variation, and Adaptation	Inputs, Outputs, Boundaries and Flows	Questioning and Investigating	Science, Technology, and Problem Solving

EALR 1: **Systems**

Big Idea: **Systems (SYS)**

Core Content: ***Inputs, Outputs, Boundaries and Flows***

In prior grades students learned about the functioning of simple systems, including inputs and outputs. In grades 6-8 students learn how to use systems thinking to simplify and analyze complex situations. Systems concepts that students learn to apply at this level include choosing system boundaries, determining if a system is open or closed, measuring the flow of matter and energy through a system, and applying systems thinking to a complex societal issue that involves science and technology. These insights and abilities can help students see the connections between and among the domains of science and among science, technology, and society.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 SYSA	Any *system* may be thought of as containing *subsystems* and as being a *subsystem* of a larger *system*.	• Given a *system*, identify *subsystems* and a larger encompassing *system* (e.g., the heart is a *system* made up of tissues and cells, and is part of the larger circulatory *system*).
6-8 SYSB	The boundaries of a *system* can be drawn differently depending on the features of the *system* being *investigated*, the size of the *system*, and the purpose of the *investigation*.	• *Explain how* the boundaries of a *system* can be drawn to fit the purpose of the study (e.g., to study how insect *populations* change, a *system* might be a forest, a meadow in the forest, or a single tree).
6-8 SYSC	The *output* of one *system* can become the *input* of another *system*.	• Give an example of how *output* of *matter* or energy from a *system* can become *input* for another *system* (e.g., household waste goes to a landfill).*a
6-8 SYSD	In an *open system*, *matter* flows into and out of the *system*. In a *closed system*, energy may flow into or out of the *system*, but *matter* stays within the *system*.	• Given a description of a *system*, analyze and defend whether it is open or closed.
6-8 SYSE	If the *input* of *matter* or energy is the same as the *output*, then the amount of *matter* or energy in the *system* won't change; but if the *input* is more or less than the *output*, then the amount of *matter* or energy in the *system* will change.	• Measure the flow of *matter* into and out of an *open system* and *predict* how the *system* is likely to change (e.g., a bottle of water with a hole in the bottom, an *ecosystem*, an *electric circuit*).*b
6-8 SYSF	The *natural* and *designed world* is complex; it is too large and complicated to *investigate* and comprehend all at once. Scientists and students learn to define small portions for the convenience of *investigation*. The units of *investigation* can be referred to as "*systems*."	• Given a complex societal issue with strong *science* and *technology* components (e.g., overfishing, global warming), *describe* the issue from a *systems* point of view, highlighting how changes in one part of the *system* are likely to influence other parts of the *system*.

Mathematics Connections

*a	6.6.D	Represent a problem situation, describe the process used to solve the problem, and verify the reasonableness of the solution.
	6.6.E	Communicate the answer(s) to the question(s) in a problem, using appropriate representations, including symbols and informal and formal mathematical language.
*b	6.6.H	Make and test conjectures based on data (or information) collected from explorations and experiments.

EALR 2: **Inquiry**

Big Idea: **Inquiry (INQ)**

Core Content: ***Questioning and Investigating***

In prior grades students learned to plan investigations to match a given research question. In grades 6-8 students learn to revise questions so they can be answered scientifically and then to design an appropriate investigation to answer the question and carry out the study. Students learn to think critically and logically to make connections between prior science knowledge and evidence produced from their investigations. Students can work well in collaborative teams and communicate the procedures and results of their investigations, and are expected to critique their own findings as well as the findings of others.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 INQA Question	Scientific *inquiry* involves asking and answering *questions* and comparing the answer with what scientists already know about the world.	• *Generate* a *question* that can be answered through scientific *investigation*. This may involve refining or refocusing a broad and ill-defined *question*.
6-8 INQB Investigate	Different kinds of *questions* suggest different kinds of scientific *investigations*.	• Plan and conduct a scientific *investigation* (e.g., *field study*, systematic *observation*, *controlled experiment*, *model*, or simulation) that is appropriate for the *question* being asked. • Propose a *hypothesis*, give a reason for the *hypothesis*, and *explain how* the planned *investigation* will test the *hypothesis*. • Work collaboratively with other students to carry out the *investigations*.
6-8 INQC Investigate	Collecting, analyzing, and displaying data are essential aspects of all *investigations*.	• *Communicate* results using pictures, tables, charts, diagrams, graphic displays, and text that are clear, accurate, and informative. *a • Recognize and interpret *patterns* – as well as *variations* from previously learned or observed *patterns* – in data, diagrams, symbols, and words.*a • Use statistical procedures (e.g., median, mean, or mode) to analyze data and make *inferences* about *relationships*.*b
6-8 INQD Investigate	For an *experiment* to be valid, all (*controlled*) *variables* must be kept the same whenever possible, except for the *manipulated* (*independent*) *variable* being tested and the *responding (dependent) variable* being measured and recorded. If a *variable* cannot be *controlled*, it must be reported and accounted for.	• Plan and conduct a *controlled experiment* to test a *hypothesis* about a *relationship* between two *variables*. *c Determine which *variables* should be kept the same (*controlled*), which (*independent*) *variable* should be systematically *manipulated*, and which *responding (dependent) variable* is to be measured and recorded. Report any *variables* not *controlled* and *explain how* they might affect results.

	Content Standards	Performance Expectations
6-8 INQE Model	*Models* are used to represent objects, events, *systems*, and processes. *Models* can be used to test *hypotheses* and better understand *phenomena*, but they have limitations.	• Create a *model* or *simulation* to represent the behavior of objects, events, *systems*, or processes. Use the *model* to explore the *relationship* between two *variables* and point out how the *model* or simulation is similar to or different from the actual phenomenon.
6-8 INQF Explain	It is important to distinguish between the results of a particular *investigation* and general conclusions drawn from these results.	• *Generate* a scientific conclusion from an *investigation* using inferential logic, and clearly distinguish between results (e.g., *evidence*) and conclusions (e.g., explanation). • *Describe* the differences between an objective summary of the findings and an *inference* made from the findings.*c
6-8 INQG Communicate Clearly	Scientific reports should enable another investigator to repeat the study to check the results.	• Prepare a written report of an *investigation* by clearly describing the *question* being *investigated*, what was done, and an objective summary of results. The report should provide *evidence* to accept or reject the *hypothesis*, *explain* the *relationship* between two or more *variables*, and identify limitations of the *investigation*.*c
6-8 INQH Intellectual Honestly	*Science* advances through openness to new *ideas*, honesty, and legitimate *skepticism*. Asking thoughtful *questions*, querying other scientists' explanations, and evaluating one's own thinking in response to the *ideas* of others are abilities of scientific *inquiry*.	• Recognize flaws in scientific *claims*, such as uncontrolled *variables*, overgeneralizations from limited data, and experimenter bias.*c • Listen actively and respectfully to research reports by other students. Critique their presentations respectfully, using *logical argument* and *evidence*. *c • Engage in reflection and self-evaluation.
6-8 INQI *Consider* Ethics	Scientists and engineers have ethical codes governing animal *experiments*, research in natural *ecosystems*, and studies that involve human subjects.	• Demonstrate ethical concerns and precautions in response to scenarios of scientific *investigations* involving animal *experiments*, research in natural *ecosystems*, and studies that involve human subjects.

Mathematics Connections

*a	7.4.D	Construct and interpret histograms, stem-and-leaf plots, and circle graphs.
*b	7.4. E	Evaluate different displays of the same data for effectiveness and bias, and *explain* reasoning.
*c	7.4.C	Describe a data set, using measures of center (median, mean, and mode) and variability (maximum, minimum, and range), and evaluate the suitability and limitations of using each measurement.

Note: Mathematics process standards (6.6-8.6) overlap the science inquiry standards.

EALR 3: **Application**

Big Idea: **Application (APP)**

Core Content: ***Science, Technology, and Problem Solving***

In prior grades students learned to work individually and collaboratively to produce a product of their own design. In grades 6-8 students work with other members of a team to apply the full process of technological design, combined with relevant science concepts, to solve problems. In doing so they learn to define a problem, conduct research on how others have solved similar problems, generate possible solutions, test the design, and communicate the results. Students also investigate professions in which science and technology are required so they can learn how the abilities they are developing in school are valued in the world of work.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 APPA	People have always used *technology* to solve problems. Advances in human civilization are linked to advances in *technology*.	• *Describe* how a *technology* has changed over time in response to societal challenges.
6-8 APPB	*Scientists* and technological designers (including *engineers*) have different goals. Scientists answer *questions* about the *natural world*; technological designers solve problems that help people reach their goals.	• *Investigate* several professions in which an understanding of *science* and *technology* is required. *Explain* why that understanding is necessary for success in each profession.
6-8 APPC	*Science* and *technology* are interdependent. *Science* drives *technology* by demanding better instruments and suggesting *ideas* for new designs. *Technology* drives *science* by providing instruments and research methods.	• Give examples to illustrate how scientists have helped solve technological problems (e.g., how the *science* of biology has helped sustain fisheries) and how engineers have aided *science* (e.g., designing telescopes to discover distant planets).
6-8 APPD	The process of *technological design* begins by defining a problem and identifying *criteria* for a successful solution, followed by research to better understand the problem and brainstorming to arrive at potential *solutions*.	• Define a problem that can be solved by *technological design* and identify *criteria* for success. • Research how others solved similar problems. • Brainstorm different *solutions*.
6-8 APPE	Scientists and engineers often work together to *generate* creative *solutions* to problems and decide which ones are most promising.	• Collaborate with other students to *generate* creative *solutions* to a problem, and *apply* methods for making trade-offs to choose the best *solution*.*a
6-8 APPF	*Solutions* must be tested to determine whether or not they will solve the problem. Results are used to modify the *design*, and the best solution must be communicated persuasively.	• Test the best *solution* by building a model or other representation and using it with the intended audience. Redesign as necessary. • Present the recommended *design* using *models* or drawings and an engaging presentation.*b
6-8 APPG	The benefits of science and technology are not available to all the people in the world.	• *Contrast* the benefits of science and technology enjoyed by people in industrialized and developing nations.
6-8 APPH	People in all *cultures* have made and continue to make contributions to society through *science* and *technology*.	• *Describe* scientific or technological contributions to society by people in various *cultures*.

Mathematics Connections

*a	6.6.D	Represent a problem situation, describe the process used to solve the problem, and verify the reasonableness of the solution.
*b	6.6.E	Communicate the answer(s) to the question(s) in a problem, using appropriate representations, including symbols and informal and formal mathematical language.

Note: This standard is closely aligned to Core Processes 6.6, 7.6 and 8.5.

EALR 4: **Physical Science**

Big Idea: **Force and Motion (PS1)**

Core Content: ***Balanced and Unbalanced Forces***

In prior grades students learned to use basic tools to measure force, time, and distance. In grades 6-8 students learn to measure, record, and calculate the average speed of objects and to tabulate and graph the results. They also develop a qualitative understanding of inertia. Students learn to predict the motion of objects subject to opposing forces along the line of travel. If the forces are balanced, the object will continue moving with the same speed and direction, but if the forces are not balanced, the object's motion will change. These concepts and principles prepare students for a more formal understanding of mechanics in high school and help them make sense of the world around them.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 PS1A	*Average speed* is defined as the distance traveled in a given period of time.	• Measure the distance an object travels in a given interval of time and calculate the object's *average speed*, using $S = d/t$. (e.g., a battery-powered toy car travels 20 meters in 5 seconds, so its *average speed* is 4 meters per second).*a • Illustrate the *motion* of an object using a graph, or *infer* the *motion* of an object from a graph of the object's position vs. time or *speed* vs. time.*b
6-8 PS1B	*Friction* is a *force* that acts to slow or stop the *motion* of objects.	• Demonstrate and explain the *frictional force* acting on an object with the use of a physical *model*.
6-8 PS1C	Unbalanced *forces* will cause changes in the speed or direction of an object's *motion*.	• Determine whether *forces* on an object are balanced or unbalanced and justify with *observational evidence*. • Given a description of *forces* on an object, *predict* the object's *motion*.*c
6-8 PS1D	The same unbalanced *force* will change the *motion* of an object with more *mass* more slowly than an object with less *mass*.	• Given two different *masses* that receive the same unbalanced *force*, *predict* which will move more quickly.

Mathematics Connections

*a	6.1.F	Fluidly and accurately multiply and divide non-negative decimals.
	6.2.E	Solve one-step equations and verify the solutions.
	6.2.F	Solve word problems using mathematical expressions and equations, and verify the solutions.
	6.3.B	Write ratios to represent a variety of rates.
	6.3.D	Solve single- and multi-step word problems involving ratios, rates, and percentages, and verify the solutions.
*b	5.5.C	Construct and interpret line graphs.
	7.5.A	Graph ordered pairs of rational numbers and determine the coordinates of a point in the coordinate plane.
*c	7.2.H	Determine whether or not a relationship is proportional and explain your reasoning.

EALR 4: **Physical Science**
Big Idea: **Matter: Properties and Change (PS2)**
Core Content: ***Atoms and Molecules***

In prior grades students learned the scientific meaning of the word *matter*, and about changes of state. In grades 6-8 students learn the basic concepts behind the atomic nature of matter. This includes the idea that elements are composed of a single kind of atom. Atoms chemically combine with each other or with atoms of other elements to form compounds. When substances are combined in physical mixtures, their chemical properties do not change; but when they combine chemically, the new product has different physical and chemical properties from any of the reacting substances. When substances interact in a closed system, the amount of mass does not change. Atomic theory also explains the ways that solids, liquids, and gases behave. These concepts about the nature of matter are fundamental to all sciences and technologies.

	Content Standards	Performance Expectations
	Students know that:	*Students are expected to:*
6-8 PS2A	Substances have *characteristic* intrinsic *properties* such as *density*, *solubility*, *boiling point*, and *melting point*, all of which are independent of the amount of the sample.	• Use *characteristic* intrinsic *properties* such as *density*, *boiling point*, and *melting point* to identify an unknown substance.
6-8 PS2B	*Mixtures* are combinations of substances whose *chemical properties* are preserved. *Compounds* are substances that are chemically formed and have different physical and *chemical properties* from the reacting substances.	• Separate a *mixture* using differences in *properties* (e.g., *solubility*, size, magnetic attraction) of the substances used to make the *mixture*. • Demonstrate that the *properties* of a *compound* are different from the *properties* of the reactants from which it was formed.
6-8 PS2C	All *matter* is made of *atoms*. *Matter* made of only one type of *atom* is called an *element*.	• *Explain that* all *matter* is made of *atoms*, and give examples of *common elements*—substances composed of just one kind of *atom*.
6-8 PS2D	*Compounds* are composed of two or more kinds of *atoms*, which are bound together in well-defined *molecules* or arrays.	• Demonstrate with a labeled diagram and explain the *relationship* among *atoms*, *molecules*, *elements*, and *compounds*.
6-8 PS2E	*Solids*, *liquids*, and *gases* differ in the *motion* of individual particles. In *solids*, particles are packed in a nearly rigid structure; in *liquids*, particles move around one another; and in *gases*, particles move almost independently.	• *Describe* how *solids*, *liquids*, and *gases* behave when put into a container (e.g., a *gas* fills the entire volume of the container). Relate these *properties* to the relative movement of the particles in the three *states* of *matter*.
6-8 PS2F	When substances within a *closed system* interact, the total *mass* of the *system* remains the same. This *concept*, called *conservation of mass*, applies to all physical and *chemical changes*.	• *Apply* the *concept* of *conservation of mass* to correctly *predict* changes in *mass* before and after *chemical reactions*, including reactions that occur in closed containers, and reactions that occur in open containers where a *gas* is given off.*a

Mathematics Connections

*a	6.1.F	Solve word problems, using mathematical expressions and equations, and verify solutions.
	7.1.E	Solve two-step linear equations.

EALR 4: **Physical Science**

Big Idea: **Energy: Transfer, Transformation and Conservation (PS3)**

Core Content: ***Interactions of Energy and Matter***

In prior grades students learned how heat, light, sound, and electrical energy are generated and can be transferred from place to place. In grades 6-8 students learn how energy and matter interact in various settings. Heat (thermal energy) always moves from a warmer to a cooler place through solids (by conduction) and through liquids and gases (mostly by convection or mechanical mixing). Light energy interacts with matter and with our eyes and allows us to see things. Electrical energy provides a convenient way to transfer energy to where and when the energy is needed. Sound is yet another form of energy produced by a vibrating object. These fundamental concepts of how matter and energy interact have broad application in all of the other sciences.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 PS3A	Energy exists in many forms: *heat*, light, chemical, electrical, *motion* of objects, and sound. Energy can be *transformed* from one *form* to another and *transferred* from one place to another.	• List different forms of energy (e.g., thermal, light, chemical, electrical, kinetic, and sound energy). • *Describe* ways in which energy is *transformed* from one *form* to another and *transferred* from one place to another (e.g., chemical to electrical energy in a battery, electrical to light energy in a bulb).
6-8 PS3B	*Heat* (thermal energy) flows from warmer to cooler objects until both reach the same temperature. *Conduction*, *radiation*, and *convection*, or *mechanical mixing*, are the means of *heat transfer*.	• Use everyday examples of *conduction*, *radiation*, and *convection*, or *mechanical mixing*, to illustrate the *transfer* of *heat* energy from warmer objects to cooler ones until the objects reach the same temperature.
6-8 PS3C	*Heat* (thermal energy) consists of random motion and the vibrations of *atoms* and *molecules*. The higher the temperature, the greater the atomic or molecular motion. *Thermal insulators* are materials that resist the flow of *heat*.	• *Explain how* various types of insulation slow *transfer* of *heat* energy based on the atomic-molecular model of *heat* (thermal energy).
6-8 PS3D	Visible light from the Sun is made up of a mixture of all colors of light. To see an object, light emitted or reflected by that object must enter the eye.	• *Describe* how to demonstrate that visible light from the Sun is made up of different colors. • Draw and label a diagram showing that for an object to be seen, light must come directly from the object or from an external source reflected from the object, and enter the eye.
6-8 PS3E	Energy from a variety of sources can be transformed into electrical energy, and then to almost any other *form* of energy. Electricity can also be distributed quickly to distant locations.	• Illustrate the *transformations* of energy in an *electric circuit* when *heat*, light, and sound are produced. *Describe* the *transformation* of energy in a battery within an *electric circuit*.

6-8 PS3F	Energy can be *transferred* from one place to another through *waves. Waves* include vibrations in materials. Sound and earthquake *waves* are examples. These and other *waves* move at different speeds in different materials.	• *Contrast* a light *wave* with a sound *wave* by identifying that both have *characteristic wavelengths,* but light *waves* can travel through a vacuum while sound *waves* cannot. • *Explain* that sound is caused by a vibrating object.

EALR 4: **Earth and Space Science**

Big Idea: **Earth in Space (ES1)**

Core Content: ***The Solar System***

In prior years, students learned the implications of the spherical-Earth concept and Earth's relationship to the Sun. In grades 6-8 students study the Moon's changing phases and learn to distinguish between phases and eclipses. They also learn about other objects in the Solar System and how they are held together by a force called "gravity." Students also learn about the Sun's position in the Milky Way, which is just one of many galaxies in the universe. This broad overview of Earth in space will provide a useful framework for students to understand new discoveries in astronomy and new milestones in the exploration of space.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 ES1A	The Moon's monthly cycle of phases can be explained by its changing relative position as it *orbits* Earth. An *eclipse* of the Moon occurs when the Moon enters Earth's shadow. An *eclipse* of the Sun occurs when the *Moon* is between the Earth and Sun, and the Moon's shadow falls on the Earth.	• Use a physical *model* or diagram to *explain how* the Moon's changing position in its *orbit* results in the changing phases of the *Moon* as observed from Earth. • *Explain how* the cause of an *eclipse* of the Moon is different from the cause of the Moon's phases.
6-8 ES1B	Earth is the third planet from the sun in a *system* that includes the Moon, the Sun, seven other major *planets* and their *moons*, and smaller objects such as *asteroids*, *plutoids*, and *comets*. These bodies differ in many *characteristics* (e.g., size, composition, relative position).	• *Compare* the relative sizes and distances of the Sun, Moon, Earth, other major *planets*, *moons*, *asteroids*, *plutoids*, and *comets*. *a
6-8 ES1C	Most objects in the *Solar System* are in regular and predictable *motion*. These *motion*s *explain* such *phenomena* as the day, the year, *phases of the moon*, and *eclipses*.	• Use a simple physical *model* or labeled drawing of the Earth-Sun-Moon *system* to *explain* day and night, *phases of the Moon*, and *eclipses* of the Moon and Sun.
6-8 ES1D	*Gravity* is the *force* that keeps planets in *orbit* around the Sun and governs the rest of the *motion* in the *Solar System*. *Gravity* alone holds us to the Earth's surface.	• *Predict* what would happen to an *orbiting* object if *gravity* were increased, decreased, or taken away.
6-8 ES1E	Our Sun is one of hundreds of billions of stars in the Milky Way galaxy. Many of these stars have planets *orbiting* around them. The Milky Way galaxy is one of hundreds of billions of galaxies in the universe.	• Construct a physical *model* or diagram showing Earth's position in the *Solar System*, the *Solar System*'s position in the Milky Way, and the Milky Way among other galaxies.

Mathematics Connections

*a 7.2.D Make scale drawings and solve problems related to scale.

EALR 4: **Earth and Space Science**

Big Idea: **Earth Systems, Structures, and Processes (ES2)**

Core Content: ***Cycles in Earth Systems***

In prior grades students learned how Earth materials change and how they can be used for various purposes. In grades 6-8 students learn about planet Earth as an interacting system of solids, liquids, and gases. Solar energy powers the water cycle and drives the weather system and ocean currents. Energy from within the planet drives the rock cycle and moves huge plates on the Earth's surface, causing earthquakes and volcanoes. The landforms we see today result from processes that build up and break down Earth structures. These fundamental ideas will enable students to understand the history of their planet, Earth processes occurring today, and future geologic events.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 ES2A	The atmosphere is a *mixture* of nitrogen, oxygen, and trace *gases* that include *water vapor*. The atmosphere has different *properties* at different elevations.	• *Describe* the composition and *properties* of the troposphere and stratosphere.
6-8 ES2B	The Sun is the major source of energy for *phenomena* on Earth's surface, such as *winds*, ocean currents, and the water cycle.	• Connect the uneven heating of Earth's surface by the Sun to global *wind* and ocean currents. • *Describe* the role of the Sun in the water cycle.
6-8 ES2C	In the *water cycle*, water *evaporates* from Earth's surface, rises and cools, condenses to form clouds and falls as rain or snow and collects in bodies of water.	• *Describe* the water cycle and give local examples of where parts of the water cycle can be seen.
6-8 ES2D	Water is a solvent. As it passes through the water cycle, it dissolves minerals and *gases* and carries them to the oceans.	• Distinguish between bodies of saltwater and fresh water and *explain how* saltwater became salty.
6-8 ES2E	The solid Earth is composed of a relatively thin *crust*, a dense metallic *core*, and a layer called the *mantle* between the *crust* and *core* that is very hot and partially melted.	• Sketch and label the major layers of Earth, showing the approximate relative thicknesses and consistency of the *crust*, *core*, and *mantle*.*a
6-8 ES2F	The *crust* is composed of huge *crustal plates* on the scale of continents and oceans which move centimeters per year, pushed by *convection* in the upper *mantle*, causing earthquakes, volcanoes, and mountains.	• Draw a labeled diagram showing how *convection* in the upper *mantle* drives movement of *crustal plates*. • *Describe* what may happen when plate boundaries meet (e.g., earthquakes, *tsunami*, *faults*, mountain building), with examples from the Pacific Northwest.
6-8 ES2G	*Landforms* are created by processes that build up structures and processes that break down and carry away material through *erosion* and *weathering*.	• *Explain how* a given landform (e.g., mountain) has been shaped by processes that build up structures (e.g., uplift) and by processes that break down and carry away material (e.g., *weathering* and *erosion*).

	Content Standards	Performance Expectations
6-8 ES2H	The *rock cycle describes* the formation of *igneous rock* from magma or lava, *sedimentary* rock from compaction of eroded particles, and *metamorphic* rock by heating and pressure.	• Identify samples of *igneous*, *sedimentary*, and *metamorphic* rock from their *properties* and *describe* how their *properties* provide *evidence* of how they were formed. • *Explain how* one kind of rock could eventually become a different kind of rock.

Mathematics Connections

*a 7.2.D Make scale drawings and solve problems related to scale.

EALR 4: **Earth and Space Science**

Big Idea: **Earth History (ES3)**

Core Content: ***Evidence of Change***

In prior grades students learned that fossils provide evidence of environmental conditions that existed long ago. In grades 6-8 students learn a few of the methods that have made it possible to uncover the history of our planet. This includes the history includes both slow, gradual changes and rapid, catastrophic events, such as an asteroid or comet striking the Earth. It is possible to read a great deal of that history from rocks, including layers of sedimentary rock, some of which contain fossils. Understanding Earth's history is a valuable complement to the study of biological evolution.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 ES3A	Our understanding of Earth history is based on the assumption that processes we see today are similar to those that occurred in the past.	• *Describe* Earth processes that we can observe and measure today (e.g., rate of *sedimentation*, movement of crustal plates, and changes in composition of the atmosphere) that provide clues to Earth's past.*a
6-8 ES3B	Thousands of layers of *sedimentary rock* provide *evidence* that allows us to determine the age of Earth's changing surface and to estimate the age of *fossils* found in the rocks.	• *Explain how* the age of landforms can be estimated by studying the number and thickness of rock layers, as well as *fossils* found within rock layers.
6-8 ES3C	In most locations *sedimentary* rocks are in horizontal formations with the oldest layers on the bottom. However, in some locations, rock layers are folded, tipped, or even inverted, providing *evidence* of geologic events in the distant past.	• *Explain why* younger layers of *sedimentary rocks* are usually on top of older layers, and *hypothesize* what geologic events could have caused huge blocks of horizontal *sedimentary* layers to be tipped or older rock layers to be on top of younger rock layers.
6-8 ES3D	Earth has been shaped by many natural catastrophes, including earthquakes, volcanic eruptions, glaciers, floods, storms, *tsunami*, and the impacts of *asteroid*s.	• *Interpret* current landforms of the Pacific Northwest as *evidence* of past geologic events (e.g., Mount St. Helens and Crater Lake provide *evidence* of volcanism, the Channeled Scablands provides *evidence* of floods that resulted from melting of glaciers).
6-8 ES3E	Living *organisms* have played several critical roles in shaping landforms that we see today.	• List several ways that living *organisms* have shaped landforms (e.g., coral islands, limestone deposits, oil and coal deposits).

Mathematics Connections

*a 6.3.B Write ratios to represent a variety of rates.

EALR 4: **Life Science**

Big Idea: **Structure and Function of Organisms (LS1)**

Core Content: ***From Cells to Organisms***

In prior grades students learned how structures in the body work together to respond to internal and external needs. In grades 6-8 students learn that all living systems are composed of cells which make up tissues, organs, and organ systems. At each level of organization, the structures enable specific functions required by the organism. Lifestyle choices and environmental conditions can affect parts of the human body, which may affect the health of the body as a whole. Understanding how organisms operate as systems helps students understand the commonalities among life forms, provides an introduction to further study of biology, and offers scientific insights into the ways that personal choices may affect health.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 LS1A	All *organisms* are composed of cells, which carry on the many *functions* needed to sustain life.	• Draw and *describe observations* made with a microscope showing that plants and animals are made of cells, and *explain that* cells are the fundamental unit of life. • *Describe* the *functions* performed by cells to sustain a living *organism* (e.g., division to produce more cells, taking in *nutrients*, releasing waste, using energy to do work, and producing materials the *organism* needs).
6-8 LS1B	One-celled *organisms* must contain parts to carry out all life *functions*.	• Draw and *describe observations* made with a microscope showing that a single-celled *organism* (e.g., paramecium) contains parts used for all life *functions*.
6-8 LS1C	*Multicellular organisms* have specialized cells that perform different *functions*. These cells join together to *form* tissues that give organs their structure and enable the organs to perform specialized *functions* within organ *systems*.	• Relate the structure of a specialized cell (e.g., nerve and muscle cells) to the *function* that the cell performs. • *Explain* the *relationship* between tissues that make up individual organs and the *functions* the organ performs (e.g., valves in the heart control blood flow, *air* sacs in the lungs maximize surface area for *transfer* of *gases*). • *Describe* the components and *functions* of the digestive, circulatory, and respiratory *systems* in humans and how these systems interact.
6-8 LS1D	Both plant and animal cells must carry on life *functions*, so they have parts in common, such as *nuclei*, *cytoplasm*, cell *membranes*, and *mitochondria*. But plants have specialized cell parts, such as *chloroplasts* and *cell walls*, because they are *producers* and do not move.	• Use labeled diagrams or *models* to illustrate similarities and differences between plant and animal cell structures and *describe* their functions (e.g., both have nuclei, cytoplasm, cell membranes, and mitochondria, while only plants have chloroplasts and cell walls).
6-8 LS1E	In classifying *organisms*, scientists consider both internal and external structures and behaviors.	• Use a classification key to identify *organisms*, noting use of both internal and external structures as well as behaviors.

	Content Standards	Performance Expectations
6-8 LS1F	Lifestyle choices and living *environments* can damage structures at any level of organization of the human body and can significantly harm the whole *organism*.	• *Evaluate* how lifestyle choices and *environments* (e.g., tobacco, drug, and alcohol use, amount of exercise, quality of *air*, and kinds of food) affect parts of the human body and the *organism* as a whole.

EALR 4: **Life Science**
Big Idea: **Ecosystems (LS2)**
Core Content: ***Flow of Energy Through Ecosystems***

In prior grades students learned how ecosystems change and how these changes affect the capacity of an ecosystem to support populations. In grades 6-8 students learn to apply key concepts about ecosystems to understand the interactions among organisms and the nonliving environment. Essential concepts include the process of photosynthesis used by plants to transform the energy of sunlight into food energy, which is used by other organisms, and possible causes of environmental change. Students also learn to investigate environmental issues and to use science to evaluate different solutions to problems. Knowledge of how energy flows through ecosystems is a critical aspect of students' understanding of how energy sustains life on the planet, including human life.

	Content Standards	**Performance Expectations**
	Students know that:	Students are expected to:
6-8 LS2A	An *ecosystem* consists of all the *populations* living within a specific area and the nonliving *factors* they interact with. One geographical area may contain many *ecosystems*.	• *Explain that* an *ecosystem* is a defined area that contains *populations* of *organisms* and nonliving *factors*. • Give examples of ecosystems (e.g., Olympic National Forest, Puget Sound, one square foot of lawn) and *describe* their boundaries and contents.
6-8 LS2B	Energy flows through an *ecosystem* from *producers* (plants) to *consumers* to *decomposers*. These *relationships* can be shown for specific *populations* in a *food web*.	• *Analyze* the flow of energy in a local *ecosystem*, and draw a labeled *food web* showing the *relationships* among all of the *ecosystem*'s plant and animal *populations*.
6-8 LS2C	The major source of energy for *ecosystems* on Earth's surface is sunlight. *Producers* transform the energy of sunlight into the chemical energy of food through *photosynthesis*. This food energy is used by plants, and all other *organisms* to carry on life processes. Nearly all *organisms* on the surface of Earth depend on this energy source.	• *Explain how* energy from the Sun is *transformed* through *photosynthesis* to produce chemical energy in food. • *Explain that* plants are the only organisms that make their own food. Animals cannot survive without plants because animals get food by eating plants or other animals that eat plants.
6-8 LS2D	*Ecosystems* are continuously changing. Causes of these changes include nonliving *factors* such as the amount of light, range of temperatures, and availability of water, as well as living *factors* such as the disappearance of different *species* through disease, *predation*, *habitat* destruction and overuse of resources or the introduction of new *species*.	• *Predict* what may happen to an *ecosystem* if nonliving *factors* change (e.g., the amount of light, range of temperatures, or availability of water or *habitat*), or if one or more *populations* are removed from or added to the *ecosystem*.
6-8 LS2E	*Investigations* of *environmental* issues should uncover *factors* causing the problem and relevant scientific *concepts* and findings that may inform an *analysis* of different ways to address the issue.	• *Investigate* a local *environmental* issue by defining the problem, researching possible causative *factors*, understanding the underlying *science*, and evaluating the benefits and risks of alternative *solutions*. • Identify resource uses that reduce the capacity of *ecosystems* to support various *populations* (e.g., use of pesticides, construction).

EALR 4: **Life Science**

Big Idea: **Biological Evolution (LS3)**

Core Content: ***Inheritance, Variation and Adaptation***

In prior years, students learned that differences in inherited characteristics might help organisms survive and reproduce. In grades 6-8 students learn how the traits of organisms are passed on through the transfer of genetic information during reproduction and how inherited variations can become adaptations to a changing environment. Sexual reproduction produces variations because genes are inherited from two parents. Variations can be either physical or behavioral, and some have adaptive value in a changing environment. In the theory of biological evolution the processes of inheritance, variation, and adaptation explain both the diversity and unity of all life.

	Content Standards	**Performance Expectations**
	Students know that:	*Students are expected to:*
6-8 LS3A	The scientific *theory* of *evolution* underlies the study of biology and explains both the *diversity* of life on Earth and similarities of all organisms at the chemical, cellular, and molecular level. *Evolution* is supported by multiple forms of scientific *evidence*.	• *Explain* and provide evidence of how biological *evolution* accounts for the *diversity* of *species* on Earth today.
6-8 LS3B	Every *organism* contains a set of *genetic information* (instructions) to specify its traits. This information is contained within *genes* in the *chromosomes* in the *nucleus* of each cell.	• *Explain that* information on how cells are to grow and *function* is contained in *genes* in the *chromosomes* of each cell *nucleus* and that during the process of reproduction the *genes* are passed from the parent cells to offspring.
6-8 LS3C	Reproduction is essential for every *species* to continue to exist. Some plants and animals reproduce sexually while others reproduce *asexually*. *Sexual reproduction* leads to greater *diversity* of *characteristics* because children inherit *genes* from both parents.	• Identify sexually and asexually reproducing plants and animals. • *Explain* why offspring that result from *sexual reproduction* are likely to have more diverse *characteristics* than offspring that result from *asexual reproduction*.
6-8 LS3D	In *sexual reproduction* the new *organism* receives half of its *genetic information* from each parent, resulting in offspring that are similar but not identical to either parent. In *asexual reproduction* just one parent is involved, and *genetic information* is passed on *nearly unchanged.*	• *Describe* that in *sexual reproduction* the offspring receive *genetic information* from both parents, and therefore differ from the parents. • *Predict* the outcome of specific genetic crosses involving one *characteristic* (using *principles* of *Mendelian* genetics). • *Explain* the survival value of *genetic variation*.
6-8 LS3E	*Adaptations* are physical or behavioral changes that are inherited and enhance the ability of an *organism* to survive and reproduce in a particular *environment*.	• Give an example of a plant or animal adaptation that would confer a survival and reproductive advantage during a given *environmental* change.
6-8 LS3F	*Extinction* occurs when the *environment* changes and the adaptive *characteristics* of a *species*, including its behaviors, are insufficient to allow its survival.	• Given an *ecosystem*, *predict* which *organisms* are most likely to disappear from that *environment* when the *environment* changes in specific ways.

	Content Standards	Performance Expectations
6-8 LS3G	*Evidence* for *evolution* includes similarities among anatomical and cell structures, and *patterns* of development make it possible to *infer* degree of relatedness among organisms.	• *Infer* the degree of relatedness of two *species*, given diagrams of *anatomical feature*s of the two *species* (e.g., chicken wing, whale flipper, human hand, bee leg).

Appendix A. Big Ideas of Science

The *Washington State K-12 Science Standards* consists of four Essential Academic Learning Requirements (EALRs). The first three are EALR 1 Systems, EALR 2 Inquiry, and EALR 3 Application. Each of these is a Big Idea consisting of concepts and abilities that cut across all domains of science. EALR 4 includes nine additional Big Ideas within the domains of Life, Physical, and Earth and Space Science. Appendix A summarizes all twelve Big Ideas, illustrating how they change over the grade bands.

Crosscutting Concepts and Abilities

Systems. The idea of systems analysis arose first in the life sciences, where the reductionist methods of physics failed to account for the many interactions among organisms and their environments. Later, Earth and Space Science adopted a view of our planet as four interacting systems—the rocky geosphere, the watery hydrosphere, the atmosphere, and the biosphere. Systems thinking also has many applications in physics. In addition to its use within domains, systems thinking provides a bridge between science domains. In elementary school students learn to think systematically about how the parts of objects, plants, and animals are connected and work together, noting that properties of a whole object or organism are different from the properties of its parts and that if one or more parts are removed, the whole system may fail. In upper elementary school, students learn that systems contain smaller (sub-) systems, and they are also parts of larger systems. In middle school the focus is on more complex ideas including systems boundaries, open and closed systems, and the flow of matter and energy through systems. In high school students learn to use the concept of feedback in developing models of systems and recognize that new and unpredictable properties may emerge in complex systems. Students can apply this more sophisticated understanding to analyzing real-world societal issues, which in turn helps them further develop their "systems thinking" abilities. The aim of this sequence of standards is for every student to be ready and able to use systems thinking whenever they encounter a complex problem with numerous factors and interconnections.

Inquiry. The bedrock of science is an understanding of the nature of science, as well as the ability to investigate the natural world. As used in this document, the term "inquiry" is not a method of teaching, but rather content that students are expected to learn. Inquiry includes an understanding of the nature of science as well as the ability to plan and conduct scientific *investigation*s and to recognize the critical importance of collaboration and intellectual honesty. In elementary school children are naturally curious about nearly everything—butterflies, clouds, and why the Moon seems to follow them at night. The essence of this standard is to channel this natural curiosity about the world so that students become better observers and logical thinkers. As children mature through the elementary grades they learn that different types of questions require different types of *investigation*s, and that answering questions often involves collecting and analyzing evidence. In middle school students learn to revise questions so they can be answered scientifically, design an appropriate *investigation* to answer the question, and carry out the study. Students are able to work well in collaborative teams and can communicate the procedures and results of their *investigation*s. High school students extend and refine their understanding of the nature of inquiry and are more competent in using mathematical tools and information technology, including computers, when available. They are also able to make closer connections between their *investigation*s and the science domains (reflecting increased knowledge), and to improve their abilities to communicate, collaborate, and participate in a community of learners.

Application. Knowledge of science, in and of itself, is not sufficient to prepare today's students for the world of tomorrow. It is important that our children learn how science and technology function together to shape our world and to become culturally sensitive and ethical problem solvers. Developing these capabilities begins in the earliest grades, when students learn to distinguish between natural materials and designed materials. Elementary students learn that tools and materials can be used to solve problems and that many problems have more than one solution. Through the elementary years students develop the ability to design a solution to a simple problem and to select the appropriate tools and materials to make something of their own design. By the time they leave elementary school, students should understand that people of many different backgrounds find satisfying work applying science and technology to real-world problems. Abilities in technological design continue to develop in middle school as students learn that teamwork is essential in solving problems and that scientists and engineers often work side by side, applying insights from nature along with mathematics and creativity. They also learn design principles, such as the use of models to identify weak points in a design, and the full engineering design process. As high school students turn their attention to local, regional, and global issues, they transfer their learning to more challenging and far-reaching problems that require both a scientific and technological lens. Students also develop a long-range perspective, taking into account possible unanticipated side effects of new technologies. Through more advanced courses in high school students realize that science and technology are not always objective, but rather that they interact with societal perspectives and concerns, and that science and technology are limited—they cannot solve all human problems or answer all questions.

Physical Science

Force and Motion. The Big Idea of Force and Motion that culminates in Newton's Laws starts in grades K-1 with the concepts of force and motion and various kinds of forces in our environment, including those that act by contact and those that act at a distance (magnetism). In upper elementary school students measure the quantities of force, time, and distance, and *compare* the speed of two objects. In middle school students calculate the average speed of objects and tabulate and graph the results. They also develop a qualitative understanding of inertia. In grades 9 through 11 students acquire a deeper understanding of the relationships among force, mass, and acceleration (F=ma) and learn that forces between two bodies are equal and opposite. They also learn that the force of gravity between two objects is proportional to their masses and inversely proportional to the square of the distance between them. Students also learn about electrical and magnetic forces and how these two forces combine in the electromagnetic force, which makes possible electric generators, motors, and other devices.

Matter: Properties and Change. Although the atomic-molecular model of matter is not introduced until middle school, students start preparing for it in the earliest grades by learning about the properties of matter and that the properties of an object depend in part on the type of material of which it is composed. In upper elementary school students learn about the different states of matter: solid, liquid, and gas. In middle school students learn that the observable properties of a substance are due to the kinds of atoms that make up the substance and how those atoms interact with other atoms. The compounds that are produced by chemical reactions often have properties that are different from the reactants. Students also learn about conservation of mass in chemical reactions. At the high school level students learn more about the structure of atoms and molecules, the various substances that they form, and how to use chemical equations to determine how atoms are rearranged during chemical reactions. They also learn about the components of the nucleus, the process of nuclear decay and formation of isotopes, and fission and fusion reactions.

Energy: Transfer, Transformation, and Conservation. Although it is difficult to define, the concept of energy is very useful in virtually all fields of science and engineering. Starting in elementary school students learn that there are different forms of energy. In upper elementary school they learn that energy can be transferred from one place to another and become more familiar with the various forms of energy. Energy topics for middle school include the idea that heat (thermal energy) always moves from a warmer place to a cooler place through solids (by conduction) and through liquids and gases (mostly by convection, or mechanical mixing). Light energy interacts with matter and our eyes, allowing us to see things. Electrical energy from a generator or battery can be transformed to a different kind of energy, providing a convenient way for us to use energy where and when we need it. Focus in high school is on the Law of Conservation of Energy—that during transfers and transformations, the total amount of energy in the universe is constant. Other high school concepts include transformation between gravitational potential and kinetic energy, the properties of waves, and the electromagnetic spectrum.

Earth and Space Science

Earth in the Universe. Observations from Earth and near-Earth orbit have revealed features of Solar System bodies, more than 300 planetary systems around other stars, the shape and dynamics of our home galaxy, and the structure and evolution of the universe as a whole. Sharing these discoveries with students and helping them develop a mental model of Earth in the Universe is an essential component of the modern worldview. In the first years of school students learn that the Sun and Moon exhibit patterns of movement if observed carefully over time. Focus in upper elementary school is on the implications of the spherical Earth concept, including its daily rotation and yearly orbit around the Sun. During middle school students build a richer mental model of Earth in space, starting with Moon phases and eclipses and moving on to other bodies in the Solar System, the Solar System's place within the Milky Way galaxy, and hundreds of billions of other galaxies. High school students learn about the life cycles of stars, the formation of elements, and the scientific theory for the beginning of time, space, and energy—the Big Bang.

Earth Systems, Structures, and Processes. There are many different Earth sciences, including geology, oceanography, climatology, and meteorology, to name a few. Two essential concepts that unify these fields are "matter," including the movement of matter through Earth systems, and the concept of "energy," including energy from the Sun and from Earth's interior. Starting in elementary school children learn about Earth materials and how they are modified for human uses. The essential role that water plays in many Earth systems is the focus for grades 2 and 3, including where it is found, solid and liquid forms, and its role in weather. In grades 4 and 5 students learn that water occurs naturally in all three states and plays an essential role in shaping landforms and creating soils. Water is essential for life, but it can also be destructive when too much is deposited too rapidly. Earth as a dynamic planet is the focus for middle school. Students learn that solar energy powers the water cycle and drives the weather system and ocean currents. Energy from deep within the planet drives the rock cycle and moves huge plates on Earth's surface, causing earthquakes, volcanoes, and mountain building. In high school, students learn about Earth processes on a global scale, including major weather systems and the essential biogeochemical cycles that continuously move elements such as carbon and nitrogen through Earth systems.

Earth History. The remarkable discoveries about the history of our planet made by Earth scientists during the 20th century illustrate the power of evidence and inference. In upper elementary school students learn that fossils not only provide evidence of organisms that lived long ago; they also make it possible to infer past climates. In middle school, students learn about the fundamental insights that led to uncovering Earth's ancient history, such as sedimentation and rock formation, and the interpretation of the evidence in various geologic formations. That history includes both slow, gradual changes such as mountain building and rapid catastrophic events, such as impacts from comets and asteroids. Students also learn about the first one-celled life forms responsible for enriching our atmosphere with oxygen. High school students learn about the use of various methods, including radioactive isotopes, to determine the age of rock formations and of the Earth itself. Evidence uncovered by these methods reveals a planet that had no oxygen in its atmosphere until the evolution of life about 3.5 billion years ago, and huge shifts in climate including the series of ice ages that began just a few million years ago.

Life Science

Structures and Functions of Living Organisms. Living organisms are complex systems that gather energy and material from the environment to carry on life processes. In the earliest grades students learn that plants and animals have body parts with different functions to meet their needs. In grades 2 and 3 students *compare* the life cycles of various plants and animals, and in grades 4 and 5 they learn about the various structures and behaviors that enable plants and animals to respond to their needs. Focus in middle school is on cells—the fundamental unit of life. Cells combine to make tissues, which make up organs that function together in organ systems that cumulatively form the whole organism. At each level of organization, structures enable functions required by the organism. The complex internal structure and functions of cells are the focus in high school. Information for producing proteins and reproduction is coded in DNA molecules, which are organized into genes and chromosomes. This elegant yet complex set of processes answers fundamental questions about how life functions and how life forms are able to replicate themselves with slight changes that make it possible for species to adapt to changing conditions.

Ecosystems. An *ecosystem* includes all of the plant and animal populations and nonliving resources in a given area. In grades 2 and 3, students learn that every organism obtains materials and energy from the environment to meet its needs. In grades 4 and 5, students learn that each organism has a different relationship to every other organism in its ecosystem. Plants have a special role as producers that make their own food and provide food for all other organisms. A food web shows how energy makes its way from organism to organism through the ecosystem. Middle school students learn that different ecosystems have similar patterns in the ways that matter and energy flow through them. High school students focus on the flow of energy through ecosystems and the factors that maintain an ecosystem's long-term stability, as well as factors that can destabilize an ecosystem, such as the introduction of new species. Students consider the effects of harvesting resources in ecosystems and the concept of sustainable development.

Biological Evolution. Evolution is the essential framework for understanding change in organisms over time. In the earliest grades children learn about the amazing diversity of Earth's organisms and their relatedness to one another. In grades 2 and 3 students observe that offspring of plants and animals closely resemble their parents, but offspring are never *exactly* the same as their parents. In grades 4 and 5 students learn that some characteristics are acquired and others are inherited. In middle school they learn that the processes of inheritance, mutation, and natural selection account for the diversity of species that exist today. High school students learn about the major factors that drive evolution and the molecular basis for inheritance and mutation. Students learn more about the processes of evolution by the classification of organisms and by tracing the evolution of a single species.