KANSAS

Science Education Standards

Approved by the Kansas State Board of Education on November 8, 2005 and February 14, 2006

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Rationale of the State Board for Adopting these Science Curriculum Standards

We believe it is in the best interest of educating Kansas students that all students have a good working knowledge of science: particularly what defines good science, how science moves forward, what holds science back, and how to critically analyze the conclusions that scientists make.

Regarding the scientific theory of biological evolution, the curriculum standards call for students to learn about the best evidence for modern evolutionary theory, but also to learn about areas where scientists are raising scientific criticisms of the theory. These curriculum standards reflect the Board's objective of: 1) to help students understand the full range of scientific views that exist on this topic, 2) to enhance critical thinking and the understanding of the scientific method by encouraging students to study different and opposing scientific evidence, and 3) to ensure that science education in our state is "secular, neutral, and non-ideological."

From the testimony and submissions we have received, we are aware that the study and discussion of the origin and development of life may raise deep personal and philosophical questions for many people on all sides of the debate. But as interesting as these personal questions may be, the personal questions are not covered by these curriculum standards nor are they the basis for the Board's actions in this area.

Evolution is accepted by many scientists but questioned by some. The Board has heard credible scientific testimony that indeed there are significant debates about the evidence for key aspects of chemical and biological evolutionary theory. All scientific theories should be approached with an open mind, studied carefully, and critically considered. We therefore think it is important and appropriate for students to know about these scientific debates and for the Science Curriculum Standards to include information about them. In choosing this approach to the science curriculum standards, we are encouraged by the similar approach taken by other states, whose new science standards incorporate scientific criticisms into the science curriculum that describes the scientific case for the theory of evolution.

We also emphasize that the Science Curriculum Standards do not include Intelligent Design, the scientific disagreement with the claim of many evolutionary biologists that the apparent design of living systems is an illusion. While the testimony presented at the science hearings included many advocates of Intelligent Design, these standards neither mandate nor prohibit teaching about this scientific disagreement.

Finally, we would like to thank the Science Standards Committee for their commitment and dedication in their work toward the standards.

INTRODUCTION

Mission Statement

Kansas science education contributes to the preparation of **all** students as lifelong learners who can use science to make informed and reasoned decisions that contribute to their local, state, national and international communities.

Vision Statement

Science education in Kansas is intended to help students develop the understandings and intellectual abilities they need to lead personal fulfilling lives, and to equip them to participate thoughtfully with fellow citizens in building and protecting a society that is open, equitable, and vital. The educational system must prepare the citizens of Kansas to meet the challenges of the 21st century. With this in mind, the intent for the *Kansas Science Education Standards (KSES)* can be expressed in a single phrase: Science standards for all students. The phrase embodies both excellence and equity. These standards apply to all students, regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science.

Inquiry is central to science learning. Science education in Kansas should strongly emphasize the skill of scientific inquiry as an essential component of scientific literacy. The National Science Education Standard on Inquiry suggests actions students should take to participate in inquiry-based science education:

> *"Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments." (National Research Council (NRC), 1996, p. 105)*

These national standards, as well as the Kansas science standards call for students to engage in inquiry science in the context of science content. In inquiry science, students describe objects and events, ask questions, construct hypotheses, test those hypotheses against current scientific knowledge and standards of evidence, and have the opportunity to devise experiments or other tests of their explanations. Finally, students will communicate their findings to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills. They also experience first-hand the thrill and excitement of science. As a result of such experiences, students will be empowered to add to the growing body of scientific knowledge. These standards rest on the premise that science is an active process. Science is something that students and adults can do, not something that is only demonstrated for them.

Purpose of this Document
These standards, benchmarks, indicators, and examples are designed to assist Kansas educators in selecting and developing local curricula, carrying out instruction, and assessing students' progress. They will also serve as the foundation for the development of state assessments in science. Finally, these standards, benchmarks, indicators, and examples represent high, yet reasonable, expectations for all students.

The *Kansas Science Education Standards*:
- Provide criteria Kansas educators and stakeholders can use to judge whether particular actions will serve the vision of a scientifically literate society.
- Bring coordination, consistency, and coherence to the improvement of science education.
- Advocate that science education must be developmentally appropriate and reflect a systemic, progressive approach throughout the elementary, middle, and high school years. (See **Implementation**, p. vii)

These standards should not be viewed as a state curriculum or instructional strategy. The content embodied in these standards can be organized and presented with many different emphases and perspectives in local district curricula. (See **Implementation**, p. vii)

Development of the *Kansas Science Education Standards*
The original *Kansas Curricular Standards for Science* was drafted in 1992, approved by the Kansas State Board of Education (KSBE) in 1993, and updated in 1995. Although all of this work occurred prior to the release of the *National Science Education Standards* in 1996, the original Kansas standards reflect early work on the national standards.

At the August 1997 meeting of the Kansas State Board of Education, the Board directed that academic standards committees composed of stakeholders from throughout Kansas should be convened in each curriculum area defined by Kansas law (reading, writing, mathematics, science, and social studies). The 1998-2001 science standards committee was able to build upon and benefited from a great deal of prior work done on a national level; the *National Science Education Standards* published by the NRC; *Benchmarks for Science Literacy* from Project 2061 of the American Association for the Advancement of Science (AAAS); and *Pathways to the Science Standards*, published by the National Science Teachers Association (NSTA). This allowed the foundation for the *Kansas Science Education Standards (2001)* to be based on research and on the work of over 18,000 scientists, science educators, teachers, school administrators and parents across the country that produced national standards as well as the school district teams and thousands of individuals who contributed to the benchmarks. *Kansas Curricular Standards for Science* was approved by the Kansas State Board of Education on February 14, 2001.

As part of the federal reauthorized 2002 Elementary and Secondary Education Act (ESEA) known as “No Child Left Behind’ (NCLB) and as part of the state’s requirement to review curriculum standards every three years, at the April 2004 meeting of the Kansas State Board of Education, the Board directed that academic standards committees should be convened and charge to:

- Review the current science standards as well as national and other state standards in light of what students should know and be able to do by each grade level assessed.
- Review the format of the curricular standards to ensure they are understandable and useable.
- Determine the level of specificity needed at each level (standards, benchmark or indicator) in terms of the content to be learned and complexity of skill assessed on the state assessments.
- Ensure standards are written in specific and measurable terms to provide greater instructional clarity for at least each grade level assessed.
- Recommend essential indicators to be assessed in the state assessment program, including additional indicators local districts may use to enrich and enhance their curriculum.
- Review the modified and extended standards to include in the revised standards document.
- Submit a first draft of the revised science standard to the State Board by December 2004.

In developing the 2005 *Kansas Science Education Standards*, permission to use portions of documents developed by NRC, AAAS, and NSTA was requested for Draft 2.

Organization of the Kansas Science Education Standards
Each standard in the main body of the document contains a series of benchmarks, which describe what students should know and be able to do at the end of a certain point in their education (i.e., grades 2, 4, 7, and 12). Each benchmark contains a series of indicators, which identify what it means for students to meet a benchmark. Indicators are frequently followed by examples, which are specific, concrete ideas or illustrations of the standards writers' intent.

Standards
There are seven standards for science. These standards are general statements of what students should know, understand, and be able to do in the natural sciences over the course of their K-12 education. The seven standards are interwoven ideas, not separate entities; thus, they should be taught as interwoven ideas, not as separate entities. These standards are clustered for grade levels K-2, 3-4, 5-7, and 8-12.

1. Science as Inquiry
2. Physical Science (Physics and Chemistry)
3. Life Science
4. Earth and Space Science
5. Science and Technology
6. Science in Personal and Environmental Perspectives
7. History and Nature of Science

Benchmarks
Benchmarks are specific statements of what students should know and be able to do at a specified point in their schooling. Benchmarks are used to measure students' progress toward meeting a standard. In these standards, benchmarks are defined for grades 2, 4, 7, and 12.

Indicators
Indicators are statements of the knowledge or skills which students demonstrate in order to meet a benchmark. Indicators are critical to understanding the standards and benchmarks and are to be met by all students. The indicators listed under each benchmark are not listed in priority order, nor do the indicators include all potential topics related to the benchmarks. Moreover, the list of examples with each indicator should be considered as representative but not as comprehensive or all-inclusive.

Instructional Examples, Teacher Notes, and Additional Specificity
To assist in the implementation of the standards, additional information is added to indicators in the form of Instructional Examples, Teacher Notes, and Additional Specificity. Instructional Examples offer an activity or a specific concrete instance of an idea of what is called for by an indicator. Teacher Notes clarify vocabulary. Information labeled Additional Specificity provide an illustration of the meaning or intent of an indicator. Like the indicators themselves, these forms of information are considered to be representative but not comprehensive or all-inclusive. Italicized words are defined in the Glossary or Teacher Notes.

Linking the Standards to the Kansas Science Assessment

Assessed indicators are marked with a delta. The delta with a numbered indicator means that the writing committee has designated this indicator for emphasis on the new Kansas Science Assessments.

- An indicator with a delta ▲ in the Grades K-4 Standards will be assessed at Grade 4.
- An indicator with a delta ▲in the Grades 5-7 Standards will be assessed at Grade 7.
- A change with the new Kansas Science Assessment will be that two assessments will be administered in Grades 9, 10 and/or 11 based on how local curriculum is best measured. One assessment will include mostly physical science (Standard 2) indicators; the other will include mostly life science (Standard 3) indicators. Both assessments will include indicators from Standards 1, 4-7.

Implementation of the *Kansas Science Education Standards*:

Actions by Kansas school districts to implement the *Kansas Science Education Standards* (KSES) should include:

1. Use the KSES as a framework for local curriculum, including Extended Standards for special needs students. The KSES provides a framework for building local curriculum. Local curriculum, developed from these standards, determines what is taught/learned in science. Local curriculum also provides local districts with a guide for selecting instructional resources.

2. Distribute complete sets of the KSES to all K-12 science teachers and K-12 administrators. Make all grade levels aware of the assessed indicators, and include all the KSES in local district K-12 science curriculum. Local districts are advised to insure that all of the KSES are included in local curriculum and that assessed indicators are not the entire focus of the use of the standards document.

3. Match each KSES indicator with the local grade level that includes the indicator in local curriculum. Determine what local district action is needed if there are KSES standards/indicators that are not addressed in local curriculum. (Note: Once approved by the KSBE, these standards will include in the Appendix a version of the standards that show a sample grade-by grade breakdown of the grade span indicators.)

4. Develop local curricula that integrates science learning with concepts and skills of other curriculum areas, especially math.

5. Classroom teachers select developmentally appropriate instructional strategies to develop the understandings and abilities described in the KSES. The importance of inquiry does not imply that all teachers should pursue a single approach to teaching science.

6. Develop local assessments that support the KSES and extend beyond learning the measured Kansas Science Assessments.

7. Provide ongoing, research-based professional development for K-12 science teachers (all grade levels, not just assessed grade levels) to assure that all students have a highly qualified science teacher. Science teachers need professional development time and support for a creative teaching and learning environment described by the KSES as lab-based, inquiry science.

8. Provide the resources needed for science learning: highly qualified science teachers, adequate class time, a rich array of learning materials, equipped and safe science classrooms, and the resources of the communities surrounding the schools.

9. Focus on K-12 student learning in science, while meeting the science learning requirements of federal "No Child Left Behind" legislation and Quality Performance Accreditation (QPA). Inform all science teachers of Kansas State Department of Education (KSDE) assessment schedules and procedures. No Child Left Behind (2002 federal legislation) requires states to assess annually in science, beginning in 2007, at designated grade levels. (See "Linking the Standards to the Kansas Science Assessment," p. vii) NCLB also requires school districts to provide highly qualified science teachers for all students by 2005. Quality Performance Accreditation is the process for accrediting Kansas schools. Each school should include science student achievement targets in the School Improvement Plan.

10. These standards provide a framework for local curricula for science knowledge and skills for all students to attain. For students going beyond the expectations of all students with their high school science education, taking advanced courses such as Anatomy and Physiology or Advanced Placement courses, these standards provide a conceptual framework upon which to build advanced curriculum.

11. Provide information about the KSES to all community members who support science learning, including parents.

12. Participate in teacher development workshops on KSES implementation provided by KSDE.

Teaching With Tolerance and Respect

Science studies natural phenomena by formulating explanations that can be tested against the natural world. Some scientific concepts and theories (e.g., blood transfusion, human sexuality, nervous system role in consciousness, cosmological and biological evolution, etc.) may differ from the teachings of a student's religious community or their cultural beliefs. Compelling student belief is inconsistent with the goal of education. Nothing in science or in any other field of knowledge shall be taught dogmatically.

A teacher is an important role model for demonstrating respect, sensitivity, and civility. Science teachers should not ridicule, belittle or embarrass a student for expressing an alternative view or belief. In doing this, teachers display and demand tolerance and respect for the diverse ideas, skills, and experiences of all students.

NATURE OF SCIENCE

Science is a systematic method of continuing investigation that uses observations, hypothesis testing, measurement, experimentation, logical argument and theory building to lead to more adequate explanations of natural phenomena. Science does so while maintaining strict empirical standards and healthy skepticism. Scientific explanations are built on observations, hypotheses, and theories. A hypothesis is a testable statement about the natural world that can be used to build more complex inferences and explanations. A theory is a well-substantiated explanation of some aspect of the natural world that can incorporate observations, inferences, and tested hypotheses.

Scientific explanations must meet certain criteria. Scientific explanations are consistent with experimental and/or observational data and testable by scientists through additional experimentation and/or observation. Scientific explanation must meet criteria that govern the repeatability of observations and experiments. The effect of these criteria is to insure that scientific explanations about the world are open to criticism and that they will be modified or abandoned in favor of new explanations if empirical evidence so warrants. Because all scientific explanations depend on observational and experimental confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available. The core theories of science have been subjected to a wide variety of confirmations and have a high degree of reliability within the limits to which they have been tested. In areas where data or understanding is incomplete, new data may lead to changes in current theories or resolve current conflicts. In situations where information is still fragmentary, it is normal for scientific ideas to be incomplete, but this is also where the opportunity for making advances may be greatest. Science has flourished in different regions during different time periods, and in history, diverse cultures have contributed scientific knowledge and technological inventions. Changes in scientific knowledge usually occur as gradual modifications, but the scientific enterprise also experiences periods of rapid advancement. The daily work of science and technology results in incremental advances in understanding the world.

UNIFYING SCIENTIFIC CONCEPTS AND PROCESSES WITHIN THE KANSAS SCIENCE EDUCATION STANDARDS (KSES)

Since early in the 20th century, science is often separated in specific disciplines for study (e.g., physics, chemistry, biology, etc). Nonetheless, students should recognize that broad, unifying concepts and processes exist which cut across traditional scientific disciplines. Five such broad, unifying concepts and processes are embedded within the seven standards. These have been selected from the *National Science Education Standards* because they;

- provide connections between and among traditional scientific disciplines,
- are fundamental and comprehensive,
- can be expressed and experienced in a developmentally appropriate manner in K-12 science education.

The five unifying concepts and processes are:

Systems, Order, and Organization

The world about us is complex; it is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions in order to investigate nature. The components of investigation can be considered a system, when a system is defined as a set of related items or parts which are organized to form a whole. Systems can include organisms, machines, fundamental particles, galaxies, ideas, etc and can be categorized as open, closed, or isolated. Other characteristics of systems include boundaries, components, resources, flow (input and output), and feedback. Statistical analysis can be used to describe order, the behavior of units of matter, objects, organisms, or events in the universe. Probability is the likelihood that a specific event will occur, expressed as the ratio of the number of actual occurrences to the number of possible occurrences in a specified space or time. Science can reduce the level of uncertainty through gaining knowledge about factors that can influence objects, organisms, systems, or events. Science can also decrease uncertainty through higher quality observations, increasing the number of observations, and using better explanatory models. Valuable ways of thinking about the world can be obtained from the various types and levels of organization. For example, the classification of organisms and placement of elements in the periodic table are two types of organization. Both physical systems and living systems can be described at different levels of organization. For example physical systems can include fundamental particles, atoms, and molecules and living systems can include cells, tissues, organs, organisms, populations, and communities.

Evidence, Models, and Explanation

Evidence includes observations and empirical data and makes up the foundation of scientific explanation. Models are representations of real objects, events, or classes of events which are used to help explain and predict. Models are used by scientists and engineers to increase their understanding of how things work. There can be many types of models including, physical objects, diagrams, mental constructs, mathematical formulas, and computer mock-ups. Scientific explanations integrate current scientific knowledge and the latest evidence from new observations, experiments, or models into logical statements which are internally consistent,

Constancy, Change, and Measurement

The speed of light, charge of an electron, and total mass plus energy in the universe are examples of properties or processes which are characteristically constant; however, most things are in the process of changing and/or becoming different. Changes may occur in a number of ways including the change in the position of objects, the properties of materials, a system's form and function, and phenomena in motion. Change is the outcome of interactions within and between systems and can occur at varying rates, scales, and patterns. Equilibrium is a physical state in which forces and changes occur in opposite and off-setting directions. For example, opposite forces are of the same magnitude, or off-setting changes occur at equal rates. Steady state, balance, and homeostasis also describe equilibrium states. Interacting units of matter tend toward equilibrium states in which the energy is distributed as randomly and uniformly as possible. The amount of change in a system can be measured quantitatively. Quantitative distinctions like measurement can be used to clarify the evidence for interactions and the ensuing change and the formulation of scientific explanations. All measurements are approximations, and the accuracy and precision of measurement depend on equipment, technology, and technique used during observations. Mathematics is crucial for accurately measuring change. There are various types of measurement systems each used for a particular purpose. The metric system is the measurement system typically used by

scientists. Knowing when to use which measurement system is very important. For example, a medical doctor studying patient weight loss may report patient weight in pounds to the individual patients but use kilograms when writing a scientific report.

Patterns of Cumulative Change

The current forms and functions of objects, organisms, and natural systems are the result of the accumulated changes over time. These changes may be gradual while other changes are sporadic. In general, it is thought that current forms and functions have arisen from previous forms or materials. An example of cumulative change is the formation of galaxies, explained by cosmological theories involving (among other theories) gravitation and the behavior of gasses, and the present diversity of living organisms, which the biological theory of evolution, or descent with modification of organisms from common ancestors, seeks to explain. The present position of the continents is explained by the theories of continental drift, which involves plate tectonic theory, fossilization, uplift and erosion. Patterns of cumulative change also help to describe the current structure of the universe. Although science proposes theories to explain changes, the actual causes of many changes are currently unknown (e.g. the origin of the universe, the origin of fundamental laws, the origin of life and the genetic code, and the origin of major body plans during the Cambrian explosion).

Form and Function

Form and function of objects, organisms, and systems are interrelated. In many cases form or shape is directly connected to how it is used, operates, or functions. Knowledge of form and function can be applied to the various levels of organization. Since function often relies on form, this relationship can be used to explain each other.

On the following page, a K-12 overview of science content is presented within the seven standards.

Overview of K-12 Kansas Science Education Standards

	Science as Inquiry	Physics & Chemistry	Life Science	Earth & Space Science	Science & Technology	Science in Personal & Environmental Perspectives	History & Nature Of Science
Grades K-4	• Skills necessary to do (full) scientific inquiry; plan and conduct a simple investigation	• Properties of objects & materials • Position & motion of objects • Forces • Electricity, & magnetism • Sound	• Compare and contrast the structure of living things • Organisms and their environments • Life cycles of organisms	• Properties of earth materials • Objects in the sky • Changes in earth & weather	• Technological design • Problem solving skills • Apply understanding of science & technology	• Personal health • Identify health risks • Changes in the environment	• People practice science
Grades 5-7	• Abilities necessary to do scientific inquiry • Designing & conducting investigations • Asking scientific questions •Understanding about scientific inquiry	• Measuring and describing properties of matter • Changes in properties of matter • Motions & forces • Transfer of energy	• Function of structures in organisms • Reproduction & heredity • Regulation & behavior • Populations & ecosystems • Diversity & adaptations of organisms	• Changes in structure of the Earth system • Past & present Earth processes • Components of the solar system • Motion & forces that affect Earth/space phenomena	• Abilities of technological design • Understanding about science & technology	• Apply scientific knowledge to personal health • The effect of human activity on resources & the environment • Risks & causes of natural hazards	• Scientific habits of mind • Contributions to science throughout history
Grades 8-12	• Abilities necessary to do scientific inquiry • Applies technology and mathematics to do scientific inquiry	<u>Chemistry</u> • Structure of atoms • Structure & properties of matter • Chemical reactions <u>Physics</u> • Motions & forces • Conservation of mass and energy; 1st and 2nd Laws of Thermodynamics • Interactions of energy & matter	• Structure and function of the cell • Molecular basis of heredity • Biological evolution • Interdependence of organisms with physical environment • Matter, energy, & organization in living systems • Behavior of animals • Diversity of structure and function in organisms	• Energy in Earth subsystems • Interactions of Earth's subsystems • Origin and development of the Earth system • Dynamics of the solar system • Organization and development of the universe	• Technology is applied science • Abilities of technological design	• Human health and nutrition • Population growth • Human populations, natural resources and environmental quality • Natural & human-induced hazards • Science, technology, and society	• Science as a human endeavor • Nature of scientific knowledge • Science from historical perspectives

SCIENCE AS INQUIRY – The student will experience science as *full inquiry*. The academic and physical skills needed for scientific inquiry begin to develop in the elementary grades.

Benchmark 1: The student will be involved in activities that develop skills necessary to conduct scientific inquiries.

Grades K-2 Indicators	Instructional Examples
The student…	The student…
1. identifies *properties* of objects.	1. states properties of objects such as leaves, shells, rocks, water, and insects.
2. *classifies* and arranges groups of objects by a variety of properties, one property at a time.	2. groups seeds by color, texture, and size; groups objects by whether they float or sink; groups rocks by texture, color, and hardness.
3. uses appropriate materials, *tools,* and safety procedures to collect information.	3. a. uses tools such as magnifiers, balances, scales, thermometers, measuring cups, and spoons when engaged in investigations. b. uses appropriate precautions, procedures, and safety equipment when doing investigations.
4. asks and answers questions about objects, organisms, and events in his/her environment.	4. observes and asks questions about a variety of objects and discusses how they are alike and different.
5. describes an observation orally or pictorially.	5. draws pictures of plant growth on a daily basis; notes color, number of leaves; labels plant parts.

Teacher Notes:
These activities entail answering simple questions through the completion of an investigation and communicating these answers to others. Not every activity will involve all of these stages nor must any particular sequence of these stages be followed.

Full inquiry - entails answering simple questions through the completion of an investigation and communicating these answers to others. The physical and academic skills needed to do scientific inquiry start to develop in the primary grades. These students have the ability to plan an investigation in order to find out what happens when they attempt various things. The students will learn the concept of a "fair" test while concentrating on concrete results. A "fair" test is one with only a single variable manipulated at a time.
Properties – a word(s) that describe(s) an object based on direct observations using touch, sight, hearing, taste, smell, and measurement.
Classify – a method of establishing order on collections of objects or events. Students use classification systems to identify objects or events, to show similarities, differences, and interrelationships. It is important to realize that all classification systems are subjective and may change

as criteria change; the test for a good classification system is whether others can use it.
Tools – object(s) used to achieve a goal, to make an observation, and extend the senses (see p. 122 in the NSES, 1996).

PHYSICAL SCIENCE - The student will use examination and manipulation of ordinary items and materials from their surroundings to investigate the world.

Benchmark 1: The student will develop skills to describe objects.

Grades K-2 Indicators	Instructional Examples
The student…	The student…
1. observes properties of objects and measures or describes those properties using age-appropriate tools and materials.	1. measures and compares size, *mass*, shape, color, texture, and temperature of objects.
2. separates or sorts a group of objects or materials by *properties*.	2. compares and sorts objects by shape, size, *mass*, and color.
3. compares solids and liquids.	3. compares the *properties* of liquid water and frozen water, or liquid (melted) chocolate chips and solid chocolate chips.
Teacher Notes: All students will have opportunities to compare, describe, and sort objects. *Properties* – a word(s) that describe(s) an object based on direct observations using touch, sight, hearing, taste, smell, and measurement. *Mass* - measure of the amount of material something contains.	

LIFE SCIENCE – The student will begin to develop an understanding of biological concepts.

Benchmark 1: The student will develop an understanding of the characteristics of living things.

Grades K-2 Indicators	Instructional Examples
The student…	The student…
1. discusses that *organisms* live only in *environments* in which their needs can be met.	1. a. learns that children need air, water, food, shelter, and care. b. learns that plants need light, air, water*. c. learns that animals need air, water, food, and shelter.
2. observes *life cycles* of different living things.	2. observes the *life cycles* of butterflies, mealworms, plants, and/or humans.
3. observes living things in various *environments*.	3. observes classroom plants; takes nature walks and field trips in his/her own area; observes terrariums and aquariums.
4. examines the *structures*/parts of living things.	4. observes that butterflies have wings, legs, and antennae; plants have roots, leaves and flowers; and people have a head, a body, skin and hair.

Teacher Notes:
Through direct experiences, students will observe living things, their *life cycles*, and their habitats.

* - like children and animals, plants also require nutrients. Children and animals obtain nutrients and energy from the food they eat. Plants obtain their nutrients from the soil/root media by way of their roots, and energy from the sun.
*Organism*s – any form of life.
Environment – all external conditions and factors, living and non-living, that affect an organism during its lifetime.
Life cycle – the process by which organisms mature, reproduce, and die.
Structures – parts of the organism that serve different functions in growth, survival, and reproduction.

EARTH AND SPACE SCIENCE – The student will observe closely the objects and materials in their *environment*.

Benchmark 1: The student will describe *properties* of *earth materials*.

Grades K-2 Indicators	Instructional Examples
The student… 1. observes, compares, and sorts *earth materials*.	The student… 1. a. describes and compares soils by color and texture; sorts pebbles and rocks by size, shape, and color. b. observes *earth materials* around the playground, on a field trip, or in his/her own yard.
Teacher Notes: Earth materials may include rocks, soils, air, and water. *Environment* - all external conditions and factors, living and non-living that affects an organism during its life time. *Properties* – word that describes an object based on direct observations using touch, sight, hearing, taste, smell, and measurements. *Earth materials* - rocks, soil, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties which make them useful in different ways.	

EARTH AND SPACE SCIENCE – The student will observe closely the objects and materials in their environment.

Benchmark 2: The student will observe and compare objects in the sky.

Grades K-2 Indicators	Instructional Examples
The student… 1. observes and recognizes the sun, moon, stars, clouds, birds, airplanes, and other objects in the sky. 2. describes that the sun provides light and warmth.	The student… 1. observes day and night sky regularly. 2 a. feels heat from the sun on the face and skin. b. observes shadows.
Teacher Notes: The sun, moon, stars, clouds, birds, and other objects, such as airplanes, have properties that can be observed and compared.	

EARTH AND SPACE SCIENCE – The student will observe closely the objects and materials in their environment.

Benchmark 3: The student will describe changes in weather.

Grades K-2 Indicators	Instructional Examples
The student… 1. observes changes in the weather from day to day. 2. records weather changes daily. 3. discusses weather safety procedures.	The student… 1. draws pictures or uses symbols to record weather observations. 2. uses weather charts, calendars, and logs to record daily weather. 3. practices tornado drill procedures; talks about the dangers of lightning and flooding.
Teacher Notes: Weather includes snow, rain, sleet, wind, and violent storms.	

SCIENCE AND TECHNOLOGY – The student will have a variety of educational experiences that involve science and *technology*.

Benchmark 1: The student will use *technology* to learn about the world around them.

Grades K-2 Indicators	Instructional Examples
The student…	The student…
1. explores the way things work.	1. observes the inner workings of age-appropriate toys, wind-up clocks, music boxes, and other mechanical devices.
2. experiences science through *technology*.	2. uses *tools* such as balances, thermometers, hand lenses, bug viewers, and science software programs.
Teacher Notes: Students will use software and other technological resources to discover the world around them. *Technology* – application of knowledge through inventions. *Tools* – object(s) used to achieve a goal, to make an observation, and extend the senses (see page 122 in the National Science Education Standards, 1996).	

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will have a variety of experiences that provide understanding for various science-related personal and environmental challenges.

Benchmark 1: The student will demonstrate responsibility for their own health.

Grades K-2 Indicators	Instructional Examples
The student…	The student…
1. engages in personal care.	1. practices washing hands, brushing teeth, and engaging in exercise; discusses appropriate types of clothing to wear; discusses personal hygiene.
2. discusses the types and benefit of healthy foods on the food pyramid.	2. explores real fruits and vegetables for textures, tastes, and health value, and/or cuts out pictures of foods and sorts into healthy and not healthy groups.
3. discuss the basic human need for safety and how to practice safety at home and school.	3. discusses the need to obey traffic signals, use crosswalks, and the danger of talking to strangers.
Teacher Notes: This standard should be integrated with physical science, life science, and earth and space science standards. Health encompasses safety, personal hygiene, exercise, and nutrition.	

HISTORY AND NATURE OF SCIENCE – The student will experience scientific inquiry and learn about people from history.

Benchmark 1: The student will know they practice science.

Grades K-2 Indicators	Instructional Examples
The student… 1. will experience explorations which provide knowledge of the scientific process. 2. uses *technology* to learn about people in science.	The student… 1. observes and tells (reports) what happens when you place a banana or an orange (with and without the skin), or a crayon in water; observes and tells (reports) what changes occur when you hold an M&M, a chocolate chip, or a raisin in your hand; observes and tells (reports) what happens when you rub your hands together very fast. 2. reads short stories and views films or videos; listens to guest speakers who are involved in science.
Teacher Notes: This standard should be integrated with physical science, life science, and earth and space science standards. *Technology* – application of knowledge through inventions.	

SCIENCE AS INQUIRY – The student will experience science as inquiry.

Benchmark 1: The student will develop the skills necessary to do full inquiry. *Full inquiry* entails answering simple questions, through completion of an *investigation*, and communicating these answers to others.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. ▲ asks questions that he/she can answer by investigating.	1. asks questions like: will the size of the opening of a container change the rate of evaporation of liquids? How much water will a sponge hold?
2. ▲ plans and conducts a simple investigation.	2. designs a test of the wet strength of paper towels; experiments with plant growth; experiments to find ways to prevent soil erosion.
3. ▲ employs appropriate equipment, *tools*, and safety procedures to gather data.	3. a. uses a balance to find the *mass* of the wet paper towel in grams; uses meter tape to measure the diameter of a rock; uses the same size containers to compare evaporation rates of different liquids. b. uses appropriate precautions, procedures, and safety equipment when conducting *investigations*.
4. ▲ demonstrates the ability to communicate, critique, analyze his/her own investigations, and interpret the work of other students.	4. describes *investigations* with pictures, graphs, written language, and oral presentations.

Teacher Notes:
Not every activity will involve all of these stages nor must any particular sequences of these stages be followed.

Full inquiry - entails answering simple questions through the completion of an investigation and communicating these answers to others. The physical and academic skills needed to do scientific inquiry start to develop in the primary grades. These students have the ability to plan an investigation in order to find out what happens when they attempt various things. The students will learn the concept of a "fair" test while concentrating on concrete results. A "fair" test is one with only a single variable manipulated at a time.
Investigation – finding the answer to a question.
Tools – object(s) used to achieve a goal, to make an observation, and extend the senses
Mass - measure of the amount of material something contains.
▲ = Recommended Grade 4 Assessed Indicator

PHYSICAL SCIENCE - The student will increase their understanding of the *properties* of objects and materials that they encounter on a daily basis. The student will compare, describe, and sort and *classify* these materials by observable properties.

Benchmark 1: The student will develop skills to describe objects.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. ▲ observes *properties* of objects and measures those *properties* using appropriate *tools*.	1. observes and records the size, *mass*, shape, volume, color, and temperature of objects using balances, thermometers, and other *metric measurement tools*.
2. ▲ describes and *classifies* objects by more than one property.	2. observes that an object could be hard, round, and rough; *classifies* objects by two or more *properties*.
3. ▲ observes and records how one object *interacts* with another object.	3. mixes baking soda and vinegar, or tea bag/food coloring and water, and records observations.
4. ▲ recognizes and describes the differences between solids, liquids, and gases.	4. observes differences between a stick of butter and the butter melted, a chocolate bar and the chocolate melted, ice, melted ice, and evaporating water; observes that a solid has a shape of its own and a liquid takes the shape of its container; observes differences between an inflated and a deflated balloon.

Teacher Notes:
Through observation, manipulation, and classification of common objects, children reflect on the similarities and differences of the objects.

Properties – word that describes an object based on direct observations using touch, sight, hearing, taste, smell, and measurements.
Classify – a method for establishing order on collections of objects or events. Students use classification systems to identify objects or events, to show similarities, differences, and interrelationships. It is important to realize that all classification systems are subjective and may change as criteria change; the test for a good classification system is whether others can use it.
Tools – object(s) used to achieve a goal, to make an observation, and extend the senses (see p.122 in the NSES, 1996).
Interact- when two or more things do something to each other.
Mass - measure of the amount of material something contains.
Metric measurements – meter, centimeter, millimeter, liter, milliliter, gram, kilogram, Celsius
▲ = Recommended Grade 4 Assessed Indicator

PHYSICAL SCIENCE – The student will increase their understanding of the properties of objects and materials that they encounter on a daily basis. The student will compare, describe, and sort and classify these materials by observable properties.

Benchmark 2: The student will describe the movement of objects.

Grades 3-4 Indicators	Instructional Examples
The student… 1. ▲ moves objects by pushing, pulling, throwing, spinning, dropping, and rolling and describes the motion. 2. describes locations of objects. 3. observes that a force (a push or a pull) is applied to make objects move or stop moving.	The student… 1. spins or rolls a variety of objects on various surfaces and explains what caused the objects to move. 2. describes the relative location of objects as up, down, in front, or behind.
Teacher Notes: Students begin to observe the position and movement of objects when they manipulate objects by pushing, pulling, throwing, dropping, and rolling them. ▲ = Recommended Grade 4 Assessed Indicator	

PHYSICAL SCIENCE – The student will increase their understanding of the properties of objects and materials that they encounter on a daily basis. The student will compare, describe, and sort and classify these materials by observable properties.

Benchmark 3: The student will recognize and demonstrate what makes sounds.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. discriminates between sounds made by different objects.	1. listens and compares the sounds made by musical instruments and other objects, such as cans, gourds, plastic spoons, pennies, and plastic disks; sorts and classifies a group of objects according to the sounds they make when they are dropped.
2. discriminates between various pitches.	2. identifies high and low pitches.
3. ▲ identifies that the source of sound is vibrations.	3. explores various vibrating objects (tuning forks, rulers, tongue depressors, musical instruments, etc.) that produce sound.

Teacher Notes:
The concept of sound is very abstract. However, by investigating a variety of sounds made by common objects, students can form a connection between sounds the objects make and the materials from which the objects are made. Plastic objects make a different sound than do wooden objects, etc.

▲ = Recommended Grade 4 Assessed Indicator

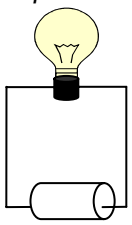
PHYSICAL SCIENCE – The student will increase their understanding of the properties of objects and materials that they encounter on a daily basis. The student will compare, describe, and sort and classify these materials by observable properties.

Benchmark 4: The student will experiment with electricity and magnetism.

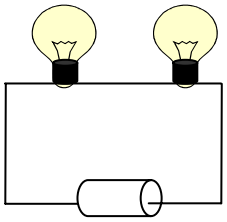
Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. ▲ demonstrates that magnets attract and repel.	1 a. explores the *interactions* between two magnets. b. designs a simple experiment with two magnets to show that they attract or repel.
2. ▲ designs a simple experiment to determine whether various objects will be attracted to magnets.	2. designs an experiment involving a group of objects to determine which are attracted to or repelled by the magnet.
3. ▲ constructs a *simple*, *parallel,* or *series circuit.*	3. a. uses a battery, bulb, and wire to light a bulb. b. uses several bulbs, batteries, and wires to make a series circuit. c. uses several bulbs, batteries, and wires to make a parallel circuit.

Teacher Notes:
Students will develop the concept that electrical circuits require a complete loop through which an electric current can pass. Magnets attract and repel each other and certain kinds of other materials.

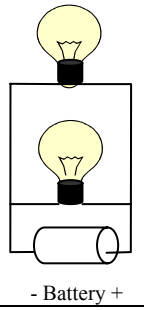
Simple circuit



Series circuit



Parallel circuit



Interact – when two or more things do something to each other.
▲ = Recommended Grade 4 Assessed Indicator

LIFE SCIENCE – The student will examine organisms, their life cycles and their surrounding in order to gain an understanding of biological concepts.

Benchmark 1: The student will develop knowledge of organisms in their environment.

Grades 3-4 Indicators	Instructional Examples
The student… 1. ▲ observes organisms and compares and contrasts different structural characteristics and the distinct functions of these structures. 2. ▲ compares basic needs of different organisms in their environment. 3. discusses ways organisms use their senses to survive in their environments.	The student… 1. compares the structures for movement of an insect to the structures for movement of a guppy; compares the leaf structures of a sprouted bean seed to the leaf structures of a corn seed. 2. compares the basic needs of an animal to the basic needs of a plant. 3. compares how organisms find food, seek shelter (bird nests, beaver dams, etc.), and defend themselves.
Teacher Notes: Each organism has different structures that function in a specific way to increase their chance for survival as an individual and as a species. For example, fish have specific structures for swimming, breathing in water, and seeing. ▲ = Recommended Grade 4 Assessed Indicator	

LIFE SCIENCE – The student will examine organisms, their life cycles, and their surrounding in order to gain an understanding biological concepts.

Benchmark 2: The student will observe and illustrate the life cycles of various organisms.

Grades 3-4 Indicators	Instructional Examples
The student… 1. ▲ compares, contrasts, and asks questions about life cycles of various organisms.	The student… 1. plants a seed; observes and records its growth; observes and records the changes of an insect as it develops from birth to adult.
Teacher Notes: The life cycles of all organisms include birth, growth or development, reproduction, and ultimately death. Organisms develop into adults that are similar to their parents. ▲ = Recommended Grade 4 Assessed Indicator	

EARTH AND SPACE SCIENCE – The student will make observations from their *environment* as to certain objects, materials, and the changes, noting their *properties*, how they differ, and then be able to explain how these things exist in their present form.

Benchmark 1: The student will develop an understanding of the properties of *earth materials*.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. ▲ collects, observes *properties*, and *classifies* a variety of *earth materials* in his/her *environment*.	1. brings in samples of *earth materials* from his/her surroundings to observe color, texture, and other physical *properties*, and observes and *classifies* rocks, soil, sand, and water.
2. investigate the properties of a variety of soils (clay, silt, sand, and loam).	2. plants seeds in a variety of soils to compare and collect data on the effect of different soils on plant growth; experiments with soil samples and observes how they react to water, wind, compaction, etc…
3. ▲ describes *properties* of many different kinds of rocks.	3. examine the properties of a variety of rocks (effect of immersion in water, color, texture, and reaction to dilute acid [vinegar]).
4. observes *fossils* and discusses how *fossil*s provide evidence of plants and animals that once lived.	4. observes a variety of *fossil*s.

Teacher Notes:
Earth materials may include rocks, soil, air, and water. Playgrounds or parks are convenient study sites to observe.

Environment - all external conditions and factors, living and non-living that affect an organism during its lifetime.
Properties – word that describes an object based on direct observations using touch, sight, hearing, taste, smell, and measurements.
Earth materials - rocks, soil, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties which make them useful in different ways.
Classify – a method of establishing order on collections of objects or events. Students use classification systems to identify objects or events, to show similarities, differences, and interrelationships. It is important to realize that all classification systems are subjective and may change as criteria change; the test for a good classification system is whether others can use it.
Fossil - part of a once-living organism or a trace of an organism preserved in rock.

▲ = Recommended Grade 4 Assessed Indicator

EARTH AND SPACE SCIENCE – The student will make observations from their *environment* as to certain objects, materials, and the changes, noting their *properties*, how they differ, and then be able to explain how these things exist in their present form.

Benchmark 2: The student will observe and describe objects in the sky.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. describes the motion of the moon and stars.	1. sketches the position of the moon in relation to a tree, rooftop, or building at two or three hourly increments on the same evening.
2. observes and compares the length of shadows.	2. observes the movement of an object's shadow during the course of a day; constructs a simple sundial.
3. ▲ discusses that the sun provides light and heat (electro-magnetic radiation) to maintain the temperature of the earth.	3. discusses why it seems cooler when the sun goes behind a cloud, and then investigates why it is cooler in the shade versus direct sunlight.
Teacher Notes: The sun, moon, stars, clouds, birds, and other objects such as airplanes have *properties* that can be observed and compared. *Properties* – word that describes an object based on direct observations using touch, sight, hearing, taste, smell, and measurements. ▲ = Recommended Grade 4 Assessed Indicator	

EARTH AND SPACE SCIENCE – The student will make observations from their *environment* as to certain objects, materials, and the changes, noting their *properties*, how they differ, and then be able to explain how these things exist in their present form.

Benchmark 3: The student will develop skills necessary to describe changes in the earth and weather.

Grades 3-4 Indicators	Instructional Examples
The student… 1. ▲ describes changes in the surface of the earth as a result of erosion. 2. ▲ observes, describes, and records daily and seasonal weather changes.	The student… 1. observes *erosion* at a study site. 2. records weather observations using simple instruments (metric rain gauge, Celsius thermometer, etc.).
Teacher Notes: If the students revisit a study site regularly, they will develop an understanding that the earth's surface and weather are constantly changing. *Erosion* – movement of earth materials from one place to another by wind, water, or force of gravity. ▲ = Recommended Grade 4 Assessed Indicator	

SCIENCE AND TECHNOLOGY – The student will have a variety of educational experiences which involve science and technology. The student will begin to understand the design process, which includes this general sequence: state the problem, the design, and the solution.

Benchmark 1: The student will work with a technology design.

Grades 3-4 Indicators	Instructional Examples
The student… 1. ▲ identifies a simple *design problem* (designs a plan, implements the plan, evaluates the results, makes changes to improve the product, and communicates the results).	The student… 1. a. tries different kinds of tools for making the biggest bubbles or the longest lasting bubbles. b. designs and flies a paper airplane that makes one loop before landing.
Teacher notes: As with the Science as Inquiry Standard, not every activity will involve all stages. Students will develop the ability to solve simple design problems that are appropriate for their developmental level. Teachers should guide students to make only one change at a time to the product as the product is being developed. *Design problem* – developing or inventing a product that accomplishes a task or challenge. ▲ = Recommended Grade 4 Assessed Indicator	

SCIENCE AND TECHNOLOGY – The student will have a variety of educational experiences which involve science and technology. They will begin to understand the design process, which includes this general sequence: state the problem, the design, and the solution.

Benchmark 2: The student will apply their understanding about science and technology.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. discusses that science is a way of investigating questions about their world.	1. discuss questions answered using science such as: Why was the zipper designed? What problem did the zipper solve? How has the zipper improved our lives? How is Velcro like a zipper? What problem was solved by Velcro? How has Velcro improved our lives?
2. invents a product to solve problems.	2. invents a new use for old products: potato masher, strainer, carrot peeler, or two- liter pop bottle; uses a juice can, two-liter pop bottle or one-half gallon milk jug to invent something useful; invents something to solve a problem.
3. works with others to solve problems.	3. solves a problem by working with others, sharing ideas, and testing the solutions.
4. understands that both genders, regardless of age, background, and/or ethnicity can work in various scientific and technological areas.	4. interviews parents and other community and school workers to determine how they use science and technology in their work.
5. investigates how scientists use *tools* to observe.	5. engages in Internet or library research; interviews or visits a school nurse's, veterinarian's, dentist's, or weatherman's office/laboratory to learn about the *tools* they use.

Teacher notes:
As with the Science as Inquiry Standard, not every activity will involve all stages. Students will develop the ability to solve simple design problems that are appropriate for their developmental level.

Children's abilities in technological problem-solving can be developed by firsthand experiences in tackling tasks with a technological purpose. They can study technological products and systems in their world: zippers, coat hooks, can openers, bridges, paper clips, etc.

Tools – object(s) used to achieve a goal, to make an observation, and extend the senses (see p. 122 in the NSES, 1996).

▲ = Recommended Grade 4 Assessed Indicator

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will demonstrate personal health and environmental practices.

Benchmark 1: The student will develop an understanding of personal health.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. discusses that safety involves freedom from danger, risk, or injury.	1. takes part in classroom discussions which could include bike safety, water safety, weather safety, sun protection, etc…
2. assumes some responsibility for his/her own health.	2. practices good dental hygiene and cleanliness; discusses healthy exercise and sleep habits.
3. ▲discusses the nutritional value of various foods and their contribution to health.	3. reads and compares nutrition information found on labels; discusses healthy foods; makes a healthy snack.

Teacher notes:
A variety of experiences will be provided to understand various science-related personal and environmental challenges. This standard should be integrated with physical science, life science, and earth & space science standards.

Personal health involves physical and mental well being, including hygienic practices, and self-respect.

As with the Science as Inquiry Standard, not every activity will involve all stages. Students will develop the ability to solve simple design problems that are appropriate for their developmental level.

Children's abilities in technological problem-solving can be developed by firsthand experiences in tackling tasks with a technological purpose. They can study technological products and systems in their world: zippers, coat hooks, can openers, bridges, paper clips, etc.

▲ = Recommended Grade 4 Assessed Indicator

STANDARD 6: SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES **GRADES 3-4**

SCIENCE IN PERSONALAND ENVIRONMENTAL PERSPECTIVES – The student will demonstrate personal health and environmental practices.

Benchmark 2: The student will demonstrate an awareness of changes in the environment.

Grades 3-4 Indicators	Instructional Examples
The student… 1. defines all types of pollution (air, water, littering, noise, etc.). 2. develops personal actions to solve pollution problems in and around the neighborhood. 3. practices reducing, reusing, and recycling.	The student… 1. takes a pollution walk, gathering examples of litter and trash. 2. after the pollution walk, works with other children to solve pollution problems observed. 3. presents the problem that paper is being wasted in the classroom; meets with other students and forms a plan to resolve this problem.
Teacher notes: A variety of experiences will be provided to understand various science-related personal and environmental challenges. This standard should be integrated with physical science, life science, and earth & space science standards. Through classroom discussions, students can begin to recognize pollution as an environmental issue, scarcity as a resource issue, and crowded classrooms or schools as a population issue. ▲ = Recommended Grade 4 Assessed Indicator	

HISTORY AND NATURE OF SCIENCE – The student will experience some things about scientific inquiry and learn about people from history.

Benchmark 1: The student will develop an awareness that people practice science.

Grades 3-4 Indicators	Instructional Examples
The student…	The student…
1. recognizes that students participate in science inquiry by asking questions.	1. asks questions such as: How are plants affected by various amounts of light? Which is the "best" paper towel (define best)? Which liquid causes substances such as a jawbreaker, chocolate candy, and Jell-O to dissolve more quickly?
2. observes, using various media, historical samples of people in science who have made contributions.	2. reads short stories; views films or videos; discusses contributions made by people in science.

Teacher notes:
Experiences of investigating and thinking about explanations, not memorization, will provide fundamental ideas about the history and nature of science. Students will observe and compare, pose questions, gather data and report findings. Posing questions and reporting findings are human activities that all students are able to understand. This standard should be integrated with physical science, life science, and earth and space science standards.

Science and technology have been practiced by people for a long time. Children and adults can derive great pleasure from doing science. They can investigate and experience science. Individuals, as well as groups of students, can conduct investigations.

Teachers need to help students understand that asking questions is the beginning of doing science.

▲ = Recommended Grade 4 Assessed Indicator

SCIENCE AS INQUIRY – The student will develop the abilities to do *scientific inquiry*, be able to demonstrate how *scientific inquiry* is applied, and develop understandings about *scientific inquiry*.

Benchmark 1: The student will demonstrate abilities necessary to do the processes of *scientific inquiry*.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ identifies questions that can be answered through scientific investigations.	1. explores properties and phenomena of various materials and generates testable questions to investigate.
2. ▲ designs and conducts *scientific investigations* safely using appropriate tools, mathematics, *technology*, and techniques to gather, analyze, and interpret data.	2 a. designs and conducts an investigation on the question, "Which paper towel absorbs the most water?" (Materials include different kinds of paper towels, water, and a graduated cylinder. Components of the investigation may include background and hypothesis, identification of independent variable, dependent variable, constants, list of materials, procedures, collection and analysis of data, and conclusions). b. given an investigative question, determines what to measure and how to measure. c. displays data collected from performing an investigation using tables, graphs, diagrams and other graphic organizers.
3. ▲ identifies the relationship between evidence and logical conclusions.	3 a. checks data to determine: Was the question addressed? Was the hypothesis supported/not supported? Did this design work? How could this experiment be improved? What other questions could be investigated? b. looks for patterns from the mean of multiple trials, such as the rate of dissolving relative to different temperatures. c. uses observations for inductive and deductive reasoning, such as explaining a person's energy level after a change in eating habits (e.g., uses Likert-type scale). d. states relationships in data, such as variables, which vary directly or inversely.

4. ▲ communicates scientific procedures, results and explanations.	4. presents a report of his/her investigation so that others understand it and can replicate the design.

TEACHER NOTES:
Given appropriate curriculum and adequate instruction, students can develop the skills of investigation and the understanding that scientific inquiry is guided by knowledge, observations, questions, and a design which identifies and controls variables to gather evidence to formulate an answer to an original question. Students are to be provided opportunities to engage in full and partial inquiries in order to develop the skills of inquiry.

Teachers can facilitate success by providing guidelines or boundaries for studying inquiry. Teachers assist students in choosing interesting questions, monitoring design plans, providing relevant examples of effective observation and organization strategies, and checking and improving skills in the use of instruments, technology, and techniques. Students at the middle level need special guidance in using evidence to build explanations, inferences, and models, guidance to think critically and logically, and to see the relationships between evidence and explanations.

Scientific inquiry – The different ways in which scientists examine the natural world and offer explanations supported by evidence resulting from their work. Inquiry also includes activities of students that help them gain knowledge and understanding of scientific ideas and how scientists study the natural world. Inquiry is a comprehensive activity which includes making observations; asking questions; researching books, journals, and other sources of information in order to determine what is presently known; design investigations; examine what has already been determined as a result of experimental evidence; use the appropriate tools to collect, evaluate, and interpret data; propose answers, provide explanations, and make predictions; and share the results through various forms of communication. The ability to identify assumptions, use critical and logical thinking, and consider alternative (scientific) explanations is important for the process of inquiry. There are various levels of inquiry (partial or guided inquiry) that students can use to learn about the natural world in a scientific way; however, students should also develop the skills needed to perform complete investigations (full inquiry).

Scientific investigation – A scientific investigation uses scientific inquiry to ask and answer a question.

Technology - Creates products to meet human needs by applying scientific principles. Science and technology are reciprocal. Science helps drive technology. Technology is essential to science, because it provides instruments and techniques that promote scientific inquiry.

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE AS INQUIRY – The student will develop the abilities to do scientific inquiry, be able to demonstrate how scientific inquiry is applied, and develop understandings about scientific inquiry.

Benchmark 2: The student will apply different kinds of investigations to different kinds of questions.

Grades 5-7 Indicators	Instructional Examples
The student….	The student…
1. develops questions and adapts (frames) the inquiry process to guide the appropriate type of investigation.	1 a. after reading a science news article, identifies variables and writes an appropriate investigative question related to the topic of the article. b. adapts an existing lab or activity to write a different question, identify another variable, and/or modify the procedure to guide a new investigation.
2. differentiates between qualitative and quantitative data in an investigation.	2. observes a decomposing compost pile, and determines how to collect quantitative (numerical, measurable) data and qualitative (descriptive) data. Identifies a question that produces quantitative data (e.g., is the temperature constant throughout the compost pile?). Identifies a question that produces qualitative data (e.g., does the color of the compost pile change over time?). With the class, analyzes all questions to classify as qualitative or quantitative.

TEACHER NOTES:
Some investigations involve observing and describing objects, organisms or events. Investigations can also involve collecting specimens, experiments, seeking more information, discovering new objects and phenomena, and creating models to explain the phenomena. Instructional activities of scientific inquiry need to engage students in identifying and shaping questions for investigations. Different kinds of questions suggest different kinds of investigations. Many processes or objects in science cannot be directly observed due to size, distance or other constraints. However, scientific evidence can be used to draw conclusions and develop a model or picture of the process or object.

To help focus, students need to frame questions such as, “What do we want to find out?” “How can we make the most accurate observations?” “If we do this, then what do we expect to happen?” Students need instruction to develop the ability to refine and refocus broad and ill-defined questions.

SCIENCE AS INQUIRY – The student will develop the abilities to do scientific inquiry, be able to demonstrate how scientific inquiry is applied, and develop understandings about scientific inquiry.

Benchmark 3: The student will analyze how science advances through the interaction of new ideas, scientific investigations, skepticism, and examinations of evidence of varied explanations.

Grades 5-7 Indicators	Instructional Examples
The student… 1. after completing an investigation, generates alternative methods of investigation and/or further questions for inquiry. 2. ▲ evaluates the work of others to determine evidence which scientifically supports or contradicts the results, identifying faulty reasoning or conclusions that go beyond evidence and/or are not supported by data.	The student… 1. asks "What would happen if…?" questions to generate new ideas for investigation. 2 a. examines and analyzes a scientific breakthrough (such as a Hubble discovery) using multiple scientific sources. b. explains how a reasonable conclusion is supported. c. analyzes evidence and data which supports or contradicts various theories (e.g., theory of continental drift, spontaneous generation, etc.).

TEACHER NOTES:
Scientific investigations often result in new ideas and phenomena for study. These generate new investigations in the scientific community. Science advances through legitimate skepticism. Asking questions and querying other scientists' explanations is part of scientific inquiry. Scientists evaluate the proposed explanations by examining and comparing evidence, identifying faulty reasoning, and suggesting other alternatives.

Much time can be spent asking students to scrutinize evidence and explanations, but to develop critical thinking skills students must be allowed this time. Data that are carefully recorded and communicated can be reviewed and revisited frequently providing insights beyond the original investigative period. This teaching and learning strategy allows students to discuss, debate, question, explain, clarify, compare, and propose new thinking through social discourse. Students will apply this strategy to their own investigations and to scientific theories.

▲ = Recommended Grade 7 Assessed Indicator

PHYSICAL SCIENCE – The student will apply process skills to develop an understanding of physical science including: properties, changes of properties of matter, motion and forces, and transfer of energy.

Benchmark 1: The student will observe, compare, and classify properties of matter.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ identifies and communicates properties of matter (including but not limited to: phases of matter, boiling point, solubility, and density).	1 a. measures and graphs the boiling point temperatures for several different liquids. b. graphs the cooling curve of a freezing ice cream mixture. c. observes substances that dissolve (sugar) and substances that do not dissolve (sand).
2. distinguishes components of various types of mixtures and categorizes chemicals.	2. a. separates sand, iron filings, and salt using a magnet and water. b. observes properties of kitchen powders (baking soda, salt, sugar, flour). Mixes in various combinations, then identifies by properties.

TEACHER NOTES:
Substances have characteristic properties. Substances often are placed in categories if they react or act in similar ways. An example of a category is metals. There are more than 100 known elements that combine in a multitude of ways to produce compounds, which account for the living and non-living substances we encounter. Middle level students have the capability of understanding relationships among properties of matter. For example, they are able to understand that density is a ratio of mass to volume, boiling point is affected by atmospheric pressure, and solubility is dependent on pressure and temperature.

These relationships are developed by concrete activities that involve hands-on manipulation of apparatus, making quantitative measurements, and interpreting data using graphs. It is important to connect characteristics of matter to common experiences so that concepts can be reconstructed. Some relevant questions are, “What happens in a pressure cooker?” “Why does adding oil to boiling rice and pasta keep it from boiling over?” “What is in antifreeze and how does it keep your radiator from freezing?” “Why do bridges have metal expansion joints?”

▲ = Recommended Grade 7 Assessed Indicator

PHYSICAL SCIENCE – The student will apply process skills to develop an understanding of physical science including: properties, changes of properties of matter, motion and forces, and transfer of energy.

Benchmark 2: The student will observe, measure, infer, and classify changes in properties of matter.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ understands the relationship of atoms to elements and elements to compounds. 2. ▲ measures and graphs the effects of temperature on matter.	The student… 1. draws a diagram to show how different compounds are composed of elements in various combinations. 2. changes water from solid to liquid to gas using heat. Measures and graphs temperature changes. Observes changes in volume occupied.

TEACHER NOTES:
Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. Middle level students have the capability of inferring characteristics that are not directly observable and stating their reasons for their inferences. Students need opportunities to form relationships between what they can see and their inferences of characteristics of matter.

We cannot always see the products of chemical reactions, so the teacher can provide opportunities for students to measure reactants and products to build the concept of conservation of mass. "Is mass lost when baking soda (solid) and vinegar (liquid) react to produce a gas?" "How could we design an experiment which would (safely) contain the reaction in a closed container in order to measure the materials before and after the reaction?" Students need to engage in activities that lead to these understandings.

▲ = Recommended Grade 7 Assessed Indicator

PHYSICAL SCIENCE – The student will apply process skills to develop an understanding of physical science including: properties, changes of properties of matter, motion and forces, and transfer of energy.

Benchmark 3: The student will investigate motion and forces.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. identifies the forces that act on an object (e.g. gravity and friction).	1. explores the variables of (wheel and ramp) surfaces that would allow a powered car to overcome the forces of gravity and friction to climb an inclined plane.
2. ▲ describes, measures, and represents data on a graph showing the motion of an object (position, direction of motion, speed).	2 a. follows the path of a toy car down a ramp that is first covered with tile and then with sandpaper. b. traces the force, direction, and speed of a baseball, from leaving the pitcher's hand and returning back to the pitcher through one of many possible paths. c. rolls a marble down a ramp. Makes adjustments to the board or to the marble's position in order to hit a target located on the floor. Measures and graphs the results.
3. ▲ recognizes and describes examples of Newton's Laws of Motion.	3 a. places a small object on a rolling toy vehicle, stops the vehicle abruptly, observes the motion of the small object. Relates to personal experience - stopping rapidly in a car. b. with a ping pong ball and two straws, investigates the effects of the force of air through two straws on the ping-pong ball with the straws at the same side of the ball, on opposite sides, and at other angles. Illustrates results with vectors (force arrows). c. researches safety equipment, such as seat belts and safety helmets, and the role they play related to inertia.
4. investigates how simple machines multiply force at the expense of distance.	4 a. investigates the load (force) that can be moved as the number of pulleys in a system is increased. b. investigates how bicycle gears work.

TEACHER NOTES: All matter is subjected to forces that affect its position and motion. Relating motions to direction, amount of force, and/or speed allows students to graphically represent data for making comparisons. A moving object that is not being subjected to a net force will continue to move in a straight line at a constant speed. The principle of inertia helps to explain many events such as sports actions, household accidents, and space walks. If more than one force acts upon an object moving along a straight line, the forces may reinforce each other or cancel each other out, depending on their direction and magnitude. Students experience forces and motions in their daily lives when kicking balls, riding in a car, and walking on ice. Teachers should provide hands-on opportunities for students to experience these physical principles. The forces acting on natural and human-made structures can be analyzed using - computer simulations, physical models, and games such as pool, soccer, bowling, and marbles. *Weight* – The response of mass to the pull of gravity. Weight is a measure of force. Note: Weight is often confused with mass. Mass is the amount of matter (stuff) an object has and is not dependent on the object's location. Weight is a measure of force and is not constant because the pull of gravity on an object's mass varies with location. An object would weigh more on Earth than on the moon because the moon has lower mass than Earth; the moon's mass would have less gravitational attraction for the object. ▲ = Recommended Grade 7 Assessed Indicator	

PHYSICAL SCIENCE – The student will apply process skills to develop an understanding of physical science including: properties, changes of properties of matter, motion and forces, and transfer of energy.

Benchmark 4: The student will understand and demonstrate the transfer of energy.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ understands that when work is done energy may transform from one form to another, including mechanical, heat, light, sound, electrical, chemical, and nuclear energy, yet is conserved.	1 a. sequences the transmission of energy through various real-life systems. b. designs an energy-transfer device using various forms of energy that will accomplish a simple task, such as popping a balloon. c. explores sound waves using a spring. d. draws a chart of energy flow through a telephone from the caller's voice to the listener's ear.
2. ▲ observes and communicates how light (electromagnetic) energy interacts with matter: transmitted, reflected, refracted, and absorbed.	2. classifies classroom objects as to how they interact with light: a window transmits; black paper absorbs; a projector lens refracts; a mirror reflects.
3. ▲ understands that heat energy can be transferred from hot to cold by radiation, convection, and conduction.	3. adds colored warm water to cool water. Observes convection. Measures and graphs temperature over time.

TEACHER NOTES:
Energy forms, such as heat, light, electricity, mechanical (motion), sound, and chemical energy are properties of substances. Energy can be transformed from one form to another. The sun is the ultimate source of energy for life systems, while heat convection currents deep within the Earth are energy sources for gradually shaping the Earth's surface. Energy cycles through physical and living systems. Energy can be measured and predictions can be made based on these measurements.

Students can explore light energy using lenses and mirrors, then connect with real-life applications such as cameras, eyeglasses, telescopes, and bar code scanners. Students connect the importance of energy transfer with sources of energy for their homes, such as chemical, nuclear, solar, and mechanical sources. Teachers provide opportunities for students to explore and experience energy forms, energy transfers, and make measurements to describe relationships.

▲ = Recommended Grade 7 Assessed Indicator

LIFE SCIENCE – The student will use process skills to investigate and gain knowledge about the structural and functional aspects of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptations of organisms.

Benchmark 1: The student will model structures of organisms and relate functions to the structures.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ understands that organisms are composed of one or more cells and compares organisms composed of single cells with organisms that are multi-cellular.	1. creates and compares two models: the major parts and their functions of a single-cell organism and the major parts and their functions of a multi-cellular organism, e.g. amoeba and hydra.
2. ▲ relates the structure of cells, organs, tissues, organ systems, and whole organisms to their functions and concludes that breakdowns in structure or function may be caused by disease, damage, heredity, or aging.	2 a. identifies human body organs and characteristics, then relates their characteristics to function. b. maps human body systems, researches their functions and shows how each supports the health of the human body. c. relates an organism's structure to how it works. d. compares lung capacity of smokers with that of non-smokers and graphs the results. e. compares and contrasts plant and animal cells.

TEACHER NOTES:
The cell theory states that organisms are made of cells, cells are the basic unit of life, and cells come from other cells. Living things at all levels of organization demonstrate the complimentary nature of structure and function. Disease is a breakdown in structure or function of an organism. It is useful for middle level students to think of life as being organized from simple to complex, such as a complex organ system includes simpler structures. Understanding the structure and function of a cell can help explain what is happening in more complex systems. Students must also understand how parts relate to the whole, such as each structure is distinct and has a set of functions that serves the whole.

Teachers can help students understand this organization of life by comparing and contrasting the levels of organization in both plants and animals. Teachers reinforce understanding of the cellular nature of life by providing opportunities to observe live cultures, such as pond water, creating models of cells, and using the Internet to observe and describe electron micrographs. Early adolescence is an ideal time to investigate the human body systems as an example of relating structure and function of parts to the whole.

▲ = Recommended Grade 7 Assessed Indicator

LIFE SCIENCE – The student will use process skills to investigate and gain knowledge about the structural and functional aspects of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptations of organisms.

Benchmark 2: The student will understand the role of reproduction and heredity for all living things.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ differentiates between asexual and sexual reproduction of organisms.	1 a. compares the regeneration of a planarian to the reproduction of an earthworm. b. compares the propagation of new plants from cuttings, which skips a portion of the life cycle, with the process of producing a new plant from fertilization of an ovum. c. observes and communicates the life cycle of an organism.
2. ▲ understands how hereditary information of each cell is passed from one generation to the next.	2 a. in a cooperative setting, traces parent characteristics with those of an offspring using Punnett squares. b. uses coin tossing to predict the probability of traits being passed on.
3. infers that the characteristics of an organism result from heredity and interactions with the environment.	3. chooses an organism; researches its characteristics; infers if these characteristics result from heredity, environment, or both.

TEACHER NOTES:
Reproduction is an activity of all living systems to ensure the continuation of every species. Organisms reproduce sexually and/or asexually. Every organism requires a set genetic information for specifying its traits. Heredity is the transmission of genetic information from parents to offspring. Students need to clarify misconceptions about reproduction, specifically the function of the sperm and egg, and how plants with flowers reproduce sexually. When examining heredity, students in middle school should primarily examine visible traits. Secondary school students should learn about how traits are coded in genetic material.

Teachers should provide opportunities for students to observe a variety of organisms and their sexual and asexual methods of reproduction by culturing bacteria, yeast cells, paramecia, hydra, mealworms, guppies, or frogs. Tracing the origin of students' own development back to sperm and egg reinforces how an organism develops from a combination of male and female sex cells. Discussions with students about traits they possess from their father and mother lead to understanding of how an organism receives genetic information from both parents and how new combinations result in the students' unique characteristics.
▲ = Recommended Grade 7 Assessed Indicator

LIFE SCIENCE – The student will use process skills to investigate and gain knowledge about the structural and functional aspects of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptations of organisms.

Benchmark 3: The student will describe homeostasis, the regulation and balance of internal conditions in response to a changing external environment.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ understands that internal and/or environmental conditions affect an organism's behavior and/or response in order to maintain and regulate stable internal conditions to survive in a continually changing environment.	The student… 1 a. selects a variable to alter the environment (e.g., temperature, light, moisture, gravity) and observes the effects on an organism (e.g., pillbug or earthworm). Thinks of his/her own behaviors and determines environmental conditions that affect behavior. b. observes the response of the body when competing in a running event. (In order to maintain body temperature, various systems begin cooling through such processes as sweating and cooling the blood at the surface of the skin). c. investigates the effects of various stimuli on plants and how they adapt their growth: phototropism, geotropism, and thermotropism are examples.

TEACHER NOTES:
All organisms perform similar processes to maintain life. They take in food and gases, eliminate wastes, grow and develop during their life cycle, produce offspring, and sustain a constant internal environment despite ongoing changes in the external environment. An organism's behavior changes as its environment changes. Students need opportunities to investigate a variety of organisms to realize that all living things have similar fundamental needs. After observing an organism's way of moving, obtaining food, and responding to danger, students can alter the environment and observe the effects on the organism.

This is an appropriate time to study the human nervous and endocrine systems. Students can compare and contrast how messages are sent through the body and how the body responds. An example is how fright causes changes within the body, preparing it for fighting or fleeing.

▲ = Recommended Grade 7 Assessed Indicator

LIFE SCIENCE – The student will use process skills to investigate and gain knowledge about the structural and functional aspects of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptations of organisms.

Benchmark 4: The student will identify and relate interactions of populations of organisms within an ecosystem.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ recognizes that all populations living together (biotic resources) and the physical factors (abiotic resources) with which they interact compose an ecosystem.	1 a. creates a classroom terrarium and identifies the interactions between the populations and physical conditions needed for survival. b. participates in a field study examining the living and non-living parts of a community. c. changes variables such as wheat crop yield, mice, or a predator, and charts the possible outcomes. (For example, how would a low population of mice affect the population of the predator over time?)
2. ▲ traces the energy flow from the sun (source of radiant energy) to producers (via photosynthesis – chemical energy) to consumers and decomposers in food webs.	2 a. explores populations at a stream, pond, field, forest floor, and/or rotting log. Identifies the various food webs and observes that organisms in a system are classified by their function. b. role-plays the interactions and energy flow of organisms in a food web, (e.g., passes a ball of string among a circle of students who represent parts of a food web such as green plants, the sun, insects, etc.). The string connecting students represents the relationships among food web components, resulting in a web-like model. c. investigates the importance of photosynthesis to all life.
3. identifies limiting factors which contribute to the growth, decline, and survival of each species.	
TEACHER NOTES:	

A population includes organisms that constitute a specific group or occur in a specified habitat at a given time and place. An ecosystem includes all organisms within a community together with the environment, functioning as a unit. Populations can be classified by the purpose they have in an ecosystem: producers (make their own food), consumers (obtain food by eating other organisms), and decomposers (use waste materials). Sunlight is the major energy source for ecosystems. This energy enters the ecosystem as sunlight and is transformed by producers into food (chemical) energy which then passes from organism to organism, which we observe as food webs. The resources of an ecosystem, biotic and abiotic, determine the number of organisms within a population that can be supported.

Having the opportunity to actively explore populations and ecosystems, helps provide better understanding for middle level students. Field studies allow students to directly observe and identify the physical conditions needed for survival as well as interactions between populations. A classroom terrarium, aquarium, or river tank can serve as an excellent model for observing ecosystems and changes and interactions that occur over time between populations of organisms and changes in physical conditions. Constructing their own food webs, given a set of organisms, helps students to see multiple relationships more clearly.

▲ = Recommended Grade 7 Assessed Indicator

LIFE SCIENCE – The student will use process skills to investigate and gain knowledge about the structural and functional aspects of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and diversity and adaptations of organisms.

Benchmark 5: The student will observe the diversity of living things and relate their adaptations to their survival or extinction.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. concludes that species of animals, plants, and microorganisms may look dissimilar on the outside but have similarities in internal structures, developmental characteristics, chemical processes, and genomes.	1 a. researches numerous organisms and creates a classification system based on observations of similarities and differences. b. uses a field guide and/or a dichotomous key to identify an organism. c. explores various ways animals take in oxygen and give off carbon dioxide.
2. ▲ understands that adaptations of organisms (changes in structure, function, or behavior that accumulate over successive generations) contribute to biological diversity.	2. compares characteristics of birds such as beaks, wings, and feet, with how a bird behaves in its environment. Then works in a cooperative group to design different parts of an imaginary bird. Relates characteristics and behaviors of that bird with its structures.
3. ▲ associates extinction of a species with environmental changes and insufficient adaptive characteristics.	3. uses various objects to model bird beaks, such as spoons, toothpicks, clothespins. Uses "beaks" to "eat" several types of food, such as cereal, raisins, noodles. (When "food" sources change, those species that have not adapted die).

TEACHER NOTES:
Millions of species of animals, plants and microorganisms are alive today. Animals and plants vary in body plans and internal structures. The theory of biological evolution is an explanation of how gradual changes of characteristics of organisms over many generations may have resulted in variations among populations and species. Therefore, a structural characteristic, process, or behavior that helps an organism survive in its environment is called an adaptation. When the environment changes and the adaptive characteristics are insufficient, the species becomes extinct.

As they investigate different types of organisms, teachers guide students toward thinking about similarities and differences. Students can compare similarities between organisms in different parts of the world, such as tigers in Asia and mountain lions in North America to explore

the concept of common ancestry. Instruction needs to be designed to uncover and correct misconceptions about natural selection. Students tend to think of all individuals in a population responding to change quickly rather than over a long period of time. Using examples such as Darwin's finches help develop understanding of natural selection over time. Providing students with fossil evidence and allowing them time to construct their own explanations is important in developing middle level students' understanding of extinction as a natural process that has affected Earth's species over time.

▲ = Recommended Grade 7 Assessed Indicator

EARTH and SPACE SCIENCE – The student will apply process skills to explore and understand the makeup of the Earth system, its history, and how it relates to the solar system.

Benchmark 1: The student will understand that the structure of the Earth system is continuously changing due to earth's physical and chemical processes.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ identifies properties of the solid earth, the oceans and fresh water, and the atmosphere.	1 a. classifies rocks, minerals, and soil by properties. b. creates a concept map of earth materials using links to show connections, such as water causing erosion of solid rock, wind evaporating water, etc… c. measures sediment load in a nearby stream. d. investigates water's major role in changing the solid surface of earth, such as the effect of oceans on climates and water as an erosion force. e. maps major climate zones and relates to ocean currents. f. compares heating and cooling over land and water. g. compares the densities of salt and fresh water.
2. ▲ models Earth's cycles, constructive and destructive processes, and weather systems.	2 a. creates rock cycle and water cycle dioramas. b. illustrates global ocean and wind currents. c. investigates weathering, erosion, and deposition.

TEACHER NOTES:
Earth has four major interacting systems: the geosphere, the atmosphere, the hydrosphere, and the biosphere. Earth (geosphere) material is constantly being reworked and changed. Physical forces, chemical reactions, heat, energy, and biological processes power the rock cycle and the water cycle. The outermost layer of the Earth is the lithosphere. Under the lithosphere is a hot, convecting mantle and a dense, metal-rich core. Massive lithospheric plates containing continents and oceans move slowly in response to movement in the mantle. These plate motions also result in earthquakes, volcanoes, and mountain building. Constructive and destructive forces change Earth's landforms. Constructive forces include crustal formation by plate movement, volcanic eruptions, earthquakes, and deposition of sediments. Destructive

forces include weathering, erosion, and glacial action.

Students learn about the major Earth systems and their relationships through direct and indirect evidence. First-hand observations of weather, rocks, soil, oceans, and gases lead students to make inferences about some of those major systems. Indirect evidence is used when determining the composition and movement in Earth's mantle and core.

▲ = Recommended Grade 7 Assessed Indicator

EARTH and SPACE SCIENCE – The student will apply process skills to explore and understand the makeup of the Earth system, its history, and how it relates to the solar system.

Benchmark 2: The student will understand past and present Earth processes and their similarity.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ understands that there are similarities between present Earth processes (including movement of lithospheric plates, constructive and destructive forces, and changes in atmospheric conditions)and historical events from the past; occasional catastrophes like a major volcanic eruptions or the impact of a large meteorite have also affected the history of the Earth.	The student… 1 a. constructs models of rock types using food. (Peanut brittle without the peanuts can illustrate a molten material crystallizing to form a solid substance similar to an igneous rock). b. takes a piece of sandstone and applies destructive forces to change it into sand. c. observes the effects of weathering on various rock types.

TEACHER NOTES:
The constructive and destructive forces we see today are similar to those that occurred in the past. Earth's history is written in the layers of the rocks, and clues in the rocks can be used to piece together a story and picture. Geologic processes that form rocks and mountains today are similar to processes that formed rocks and mountains over a long period of time in the distant past.

Teachers can provide opportunities for students to observe and research evidence of changes that can be found in Earth's crust. Sedimentary rocks, such as limestone, sandstone, and shale show deposition of sediments over time. Volcanic flows of ancient volcanoes and earthquake damage can show us what to expect from modern day catastrophes. Glacial deposits show past ice ages and global warming and cooling. Some fossil beds enable the matching of rocks from different continents, and other fossil beds show how organisms developed over a long period of time. Students will need to apply knowledge of Earth's past to make decisions relative to Earth's future.

▲ = Recommended Grade 7 Assessed Indicator

EARTH and SPACE SCIENCE – The student will apply process skills to explore and understand the makeup of the Earth system, its history, and how it relates to the solar system.

Benchmark 3: The student will identify and classify stars, planets, and other solar system components.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. ▲ compares and contrasts the characteristics of stars, planets, moons, comets, and asteroids.	1 a. identifies the Sun as a star and compares its characteristics to those of other stars. b. classifies bright stars visible from Earth by color, temperature, age, apparent brightness, and distance from earth. c. creates a graphic organizer to visualize comparisons of planets. d. identifies and classifies characteristics of asteroids and comets.
2. models spatial relationships of the earth/moon/planets/sun system to scale.	2. models the solar system to scale in a long hallway or school yard using rocks for rocky planets and balloons for gaseous planets. Designates a large object as the Sun. Models the Earth/moon/sun system to scale with the question: If Earth were the size of a tennis ball, how big would the Moon be? How big would the Sun be? How far apart would they be?
3. identifies past and present methods used to explore space.	4. researches ancient observations and explanations of the heavens and compares with today's knowledge and methods such as, how we learn about phenomena/objects we can't observe directly, (e.g., spectral analysis to determine the chemistry of stars).

TEACHER NOTES:
The solar system consists of the Sun, which is an average-sized star in the middle of its life cycle, and the nine planets and their moons, asteroids, and comets, which travel in elliptical orbits around the Sun. The Sun, the central and largest body in the system, radiates energy outward. Earth is the third of nine planets in the system, and has one moon. Other stars in our galaxy are visible from Earth, as are distant galaxies, but are so distant they appear as pinpoints of light. Scientists have discovered much about the composition and size of stars, and

how they move in space. Space and the solar system are of high interest to middle level students. Teachers can help students take advantage of the many print and on-line resources, as well as by becoming amateur sky-watchers.

▲ = Recommended Grade 7 Assessed Indicator

EARTH and SPACE SCIENCE – The student will apply process skills to explore and understand the makeup of the Earth system, its history, and how it relates to the solar system.

Benchmark 4: The student will model motions and identify forces that explain Earth phenomena.

Grades 5-7 Indicators	Instructional Examples
The student…	The student...
1. ▲ demonstrates and models object/space/time relationships that explain phenomena such as the day, the month, the year, seasons, phases of the moon, eclipses and tides.	1 a. uses an earth/moon/sun model to demonstrate a day, a month, a year, and the seasons. b. uses students to demonstrate the relative positions of the Sun, Earth, and Moon to create eclipses, phases of the moon, and tides using a circle of students representing the fluid water.
2. understands the effect of the angle of incidence of solar energy striking Earth's surface on the amount of heat energy absorbed at Earth's surface.	2. places a piece of graph paper on the surface of a globe at the equator. Holds a flashlight 10 cm from the paper perpendicular to the globe, marks the lighted area of the paper, then, places the graph paper at a high latitude. Again holds the flashlight perpendicular to the paper 10 cm from the paper. Compares the areas lit at the equator and at the high latitude, with the same amount of light energy. Identifies where each lighted square of paper receive the most energy.

TEACHER NOTES:
There are many motions and forces that affect Earth. Most objects in the solar system have regular motions, which can be tracked, measured, analyzed, and predicted. These motions can explain such phenomena as the day, year, seasons, tides, phases of the moon, and eclipses of the Sun and Moon. The force that governs the motions within the solar system, keeps the planets in orbit around the Sun, and the Moon in orbit around the Earth is gravity. Phenomena on Earth's surface, such as winds, ocean currents, the water cycle, and the growth of plants, receive their energy from the sun.

Misconceptions abound among middle level students about concepts such as the cause of the seasons and the reasons for the phases of the moon. Hands-on activities, role-playing, models, and computer simulations are helpful for understanding the relative motion of the planets and moons. Many ideas are misconceptions which could be considered in a series of "what if" questions: What if the sun's energy did not cause cloud formation and other parts of the water cycle? What if the Earth rotated once a month? What if the Earth's axis were not tilted?

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE AND TECHNOLOGY – The student will demonstrate abilities of technological design and understanding about science and technology.

Benchmark 1: The student will demonstrate abilities of technological design.

Grades 5-7 Indicators	Instructional Examples
The student… 1. evaluates problems to see if they can be properly solved using technology, devise an answer or product to solve the problem, use the answer or product, test its effectiveness, and share the answer or product using various means of communication.	The student… 1 a. designs a measurement instrument (e.g., weather instrument) for a science question that students are investigating. b. selects and researches a current technology, then projects how it might change in the next 20 years. c. designs, creates and evaluates a product that meets a need or solves a problem in a student's life. d. keeps a log of designing (and building) a technology, then uses the log to explain the process.

TEACHER NOTES:
Technological design focuses on meeting human needs, solving human problems or developing a product. Students need to develop abilities to identify specific needs and design solutions for those needs. The tasks of technological design include addressing a range of needs, materials, and aspects of science. Suitable experiences could include designing inventions that meet a need in the student's life.

Constructing a bridge of craft sticks is one way to work collaboratively in both the planning and building phase of the activity. Students need to develop criteria for evaluating their inventions/products. These questions could help develop criteria: Who will be the users of the product? Does the product meet the needs of the users? Are there any risks to the design? What is the cost? How much time will it take to build? Using their own criteria, students can design several ways of solving a problem and evaluate the best approach. Students could keep a log of their designs and evaluations to communicate the process of technological design.

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE AND TECHNOLOGY – The student will demonstrate abilities of technological design and understanding about science and technology.

Benchmark 2: The student will develop understandings of the similarities, differences, and relationships in science and technology.

Grades 5-7 Indicators	Instructional Examples
The student…	The student…
1. compares the work of research scientists with that of applied scientists and technologists.	1. reads about a scientist that studies air pressure. (A technologist designs an airplane wing.) Completes a Venn diagram to compare the processes of scientists and technologists.
2. evaluates benefits, risks, limitations and trade-offs of technological solutions.	2. selects a technology to evaluate using a graphic organizer listing uses, limitations, and possible consequences.
3. identifies contributions to science and technology by many people and many cultures.	3. using a map of the world, marks the locations for people and events that have contributed to science.

TEACHER NOTES:
When studying science and technology a distinction can be made between the two in that science uses inquiry to find answers to questions regarding the natural world while technology creates a product to meet human needs by applying scientific principles. Students in grades 5-7 have the abilities needed to assess the positive and negative effects that technology can have on society. Science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

Students may compare and contrast scientific discoveries with advances in technological design. Students may select a device they use, such as a radio, microwave, or television, and compare it to one their grandparents used.

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will apply process skills to explore and develop an understanding of issues of personal health, population, resources and environment, and natural hazards.

Benchmark 1: The student will understand scientific knowledge relative to personal health.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ identifies individual nutrition, exercise, and rest needs based on science and uses a scientific approach to thinking critically about personal health, lifestyle choices, risks and benefits.	The student… 1 a. designs, implements, and self-evaluates a personal nutrition and exercise program. b. compares and contrasts immediate benefits of eating junk food to long term benefits of a lifetime of healthy eating. c. evaluates the risks and benefits of foods, medicines, and personal products. d. evaluates and compares the nutritional and toxic properties of various natural and synthetic foods.

TEACHER NOTES:
Regular exercise, rest, and proper nutrition are important to the maintenance and improvement of human health. Injury and illness are risks to maintaining health. Middle level students need opportunities to apply scientific knowledge to their understanding of personal health and science-based decision-making related to health risks.

Teachers should understand that the decision making capacities of 10, 11, 12 and 13 year-old children are not fully developed, are subject to significant interference from hormonal changes, and otherwise lack the experience and maturity of an adult that may be necessary for wise and prudent decisions about their lives. Accordingly, teachers should work to reinforce normative parental and legal expectations designed to optimize their personal health. The challenge to teachers is to show students how science validates legal and normative parental expectations and requirements about health issues such as smoking, use of alcohol, disease, healthy eating, the wearing of seat belts and helmets, and why it is in their best personal interests to comply with these healthy expectations and requirements.

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will apply process skills to explore and develop an understanding of issues of personal health, population, resources and environment, and natural hazards.

Benchmark 2: The student will understand the impact of human activity on resources and environment.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ investigates the effects of human activities on the environment and bases decisions on knowledge of benefits and risks.	The student… 1 a. counts the number of cars that pass the school during a period of time. Investigates the effects of traffic volume on environmental quality (e.g., water and air quality, plant health). b. investigates the effects of repeatedly walking off the sidewalks. Discusses the implications for the environment. c. participates in an environmental study, such as stream monitoring. d. evaluates the benefits of burning fossil fuels to meet energy needs against the risks of increased air pollution, etc.

TEACHER NOTES:
When an area becomes overpopulated by a species, the environment will change due to the increased use of resources. Middle level students need opportunities to learn about concepts of carrying capacity. They need to gather evidence and analyze effects of human interactions with the environment.

Teachers can help their students understand these global issues by starting locally. "What changes in the atmosphere are caused by all the cars we use in our community?" Ground level ozone indicators provide an opportunity to quantify the effect. "After a heavy rain, where does the water go that runs off your lawn?" "What happens to that water source if your lawn was fertilized just before the rain?" The role of the teacher is to help students apply scientific understanding, gained through their own investigations, of environmental issues. Teachers should help students base environmental decisions on understanding, not emotion.

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will apply process skills to explore and develop an understanding of issues of personal health, population, resources and environment, and natural hazards.

Benchmark 3: The student will understand that natural hazards are dynamic examples of earth processes which cause us to evaluate risks.

Grades 5-7 Indicators	Instructional Examples
The student… 1. recognizes patterns of natural processes that may cause natural hazards and human activities that may contribute to natural hazards. 2. evaluates the risks involved with a natural hazard and identify appropriate actions in response to a natural hazard.	The student… 1 sees how channeling a stream may promote flooding downstream. Could use a county conservation commission's stream trailer to investigate the dynamics of a stream and the effects of human interaction with the stream. 2. a. finds news articles that show inadvisable risks taken in a natural hazard situation. b. investigates appropriate safety procedures for dealing with various natural hazards (e.g., tornados, floods, lightning, etc.)
TEACHER NOTES: California has earthquakes. Florida has hurricanes. Kansas has tornadoes. Natural hazards can also be caused by human interaction with the environment, such as channeling a stream. Middle level students need opportunities to identify the causes and human risks and challenges of natural hazards. Teachers can help students use data on frequency of occurrence of natural hazard events both to dispel unnatural fears for some students and overcome the common middle level student misconception of invincibility (it won't happen to me). "What would you need in a tornado survival kit to keep in the basement for your family?" This question would cause students to assess the kinds of damage caused by a tornado (need a flashlight because electrical lines may be down) and the kinds of support services available in the community.	

HISTORY AND NATURE OF SCIENCE – The student will examine and develop an understanding of science as a historical human endeavor.

Benchmark 1: The student will develop scientific habits of mind.

Grades 5-7 Indicators	Instructional Examples
The student… 1. practices intellectual honesty, demonstrates skepticism appropriately, displays open-mindedness to new ideas, and bases decisions on evidence.	The student… 1 a. analyzes news articles to determine whether data/statistics presented adequately and objectively support conclusions that are made. b. analyzes data and recognizes that a hypothesis not supported by data should be perceived as neither a right or wrong answer. c. attempts to replicate an investigation to support or refute a conclusion. d. shares interpretations that differ from currently held explanations on topics such as global warming and dietary claims. Evaluates the validity of results and accuracy of stated conclusions. e. reviews results of individual, group, or peer investigations to assess the accuracy of conclusions based upon data collection and analysis and use of evidence to reach a conclusion.

TEACHER NOTES:
Science requires varied abilities depending on the field of study, type of inquiry, and cultural context. The abilities characteristic of those engaged in scientific investigations include: reasoning, intellectual honesty, tolerance of ambiguity, appropriate skepticism, open-mindedness, and the ability to make logical conclusions based on current evidence.

Teachers can support the development of scientific habits of mind by providing students with on-going instruction using inquiry as a framework. Students can apply science concepts in investigations. They can work individually and on teams while conducting inquiry. They can share their work through varied media, and they can self-evaluate their learning. High expectations for accuracy, reliability, and openness to differing opinions should be exercised.

HISTORY AND NATURE OF SCIENCE – The student will examine and develop an understanding of science as a historical human endeavor.

Benchmark 2: The student will research contributions to science throughout history.

Grades 5-7 Indicators	Instructional Examples
The student… 1. ▲ recognizes that new knowledge leads to new questions and new discoveries, replicates historic experiments to understand principles of science, and relates contributions of men and women to the fields of science.	The student… 1 a. discusses discoveries that replaced previously held knowledge, such as safety of Freon or saccharine use, knowledge concerning the transmission of AIDS, cloning, or Pluto's status as a planet. b. rediscovers principles of electromagnetism by replicating Oersted's compass needle experiment. The compass needle deflects perpendicular to current carrying wire. c. researches the contributions of men and women of science and creates a timeline to demonstrate the ongoing contributions of dedicated scientists across ethnic, religious, and gender lines.

TEACHER NOTES:
Scientific knowledge is not static. New knowledge leads to new questions and new discoveries that may be beneficial or harmful. Contributions to scientific knowledge can be met with resistance, causing a need for replication and open sharing of ideas. Scientific contributions have been made over an expanse of time by individuals from varied cultures, ethnic backgrounds, and across gender and economic boundaries.

Students should engage in research realizing that the process may be a small portion of a larger process or of an event that takes place over a broad historical context. Teachers should focus on the contributions of scientists and how the culture of the time influenced their work. Reading biographies, interviews with scientists, and analyzing vignettes are strategies for understanding the role of scientists and the contributions of science throughout history.

▲ = Recommended Grade 7 Assessed Indicator

SCIENCE AS INQUIRY – The student will develop the abilities necessary to do scientific inquiry and develop an understanding of scientific inquiry.

Benchmark 1: The student will demonstrate the abilities necessary to do scientific inquiry.

Grades 8-12 Indicators	Additional Specificity
The student…	
1. develops and evaluates research questions.	
2. ▲ designs investigations, including developing questions, gathering and analyzing data, and designing and conducting research.	2. The scientific investigations include, when appropriate, a. formulating a testable hypothesis. b. utilizing variables, such as independent, dependent, and controls. c. using methods for gathering data that is observable, measurable, and replicable. d. analyzing and evaluating the results in order to clarify the questions and hypotheses, and to refine methods for further research.
3. ▲ correctly uses the appropriate technological tools and mathematics in their own scientific investigations.	3. a. Use various types of technology, like manually operated and electronic devices, for measurement and calculation as a vital component of scientific investigations. b. Use common mathematical functions (linear, exponential, etc.) to analyze and describe data. c. Use statistical and graphing data analysis techniques. d. Recognize that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used. e. Use equipment properly and safely.
4. ▲ actively engages in conducting an inquiry, formulating and revising his or her scientific explanations and models (physical, conceptual, or mathematical) using logic and evidence, and recognizing that potential alternative explanations and models	4. a. Engage in discussions that result in the revision of his/her explanation. b. Analyze student explanation by examining present scientific

should be considered.	knowledge, evaluating all evidence, and using logical reasoning in determining which is the best answer or model to use when searching for an explanation. c. Evaluate preconceptions and biases with respect to his/her conclusions. d. Consider modifications to student investigations based on their results.
5. communicates (reports) and defends the design, results, and conclusion of his/her investigation.	5. a. Write procedures, express concepts, review information, summarize data, and use language appropriately. b. Develop diagrams and charts to summarize and analyze data. c. Present information clearly and logically, both orally and in writing. d. Construct reasoned arguments. e. Respond appropriately to critical comments.
6. understands methods used to test hypotheses about the cause of a remote past event (historical hypothesis) that cannot be confirmed by experiment and/or direct observation by formulating competing hypotheses and then collecting the kinds of data (evidence) that would support one and refute the other	6. a. Formulate multiple hypotheses about a singular historical event and develops a ”best current explanation” of what caused the event, such as the cause of a fire or death. b. Predict the kinds of circumstantial evidence that one would observe under each hypothesis. c. Collect evidence and draw an inference as to the best explanation and whether the evidence fits either hypothesis. Explains why either explanation cannot be entirely validated by a laboratory experiment.

Teacher Notes:
Students actively involved in asking and answering their own questions, can connect the science they are learning in the classroom with real-world applications.

▲ = Recommended Sr. High Assessed Indicator

CHEMISTRY – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 1: The student will understand the structure of the atom.

Grades 8-12 Indicators	Additional Specificity
The student … 1. ▲ understands atoms, the fundamental organizational unit of matter, are composed of subatomic particles, organized in a small, dense, positively charged nucleus (containing protons and neutrons which determines the atomic mass) and surrounded by a negatively charged electron cloud (containing electrons, which determines the size of the atom). 2. understands isotopes are atoms with the same atomic number (same number of protons) but different numbers of neutrons. The nuclei of some atoms are radioactive isotopes that spontaneously decay, releasing radioactive energy.	1. These concepts may be used to predict chemical and physical properties of matter.
Teacher Notes: These concepts are basic to physics, chemistry, biology, Earth/space science. ▲ = Recommended Sr. High Assessed Indicator	

CHEMISTRY – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 2: The student will understand the states and properties of matter.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands chemists use kinetic and potential energy to explain the physical and chemical properties of matter on earth. Matter may exist in any of these three states: solids, liquids, and gases.	1. a. Elements and molecules may exist as gases, liquids or solids; ionic compounds most commonly exist as solids. b. Intermolecular attraction (attraction between molecules) determines the state of the molecule. Gases have the weakest and solids have the greatest intermolecular attraction. The hydrogen bond is an intermolecular attraction responsible for the properties of water and many biological molecules.
2. ▲ understands the periodic table lists elements according to increasing atomic number. This table organizes physical and chemical trends by groups, periods, and categories.	2. Elements in the same group share similar chemical properties because they have the same number of valence electrons. Periods indicate the energy level of the outermost (*valence*) electrons. Some categories are regions such as metals, non-metals, and transition elements.
3. ▲ understands chemical bonds result when valence electrons are transferred or shared between atoms. Ionic compounds result from atoms transferring electrons. Molecular compounds result from atoms sharing electrons.	3. a. Valence electrons (those farthest from the nucleus or highest energy electrons) determine the chemistry of the atom. b. Ionic compounds are composed of positively charged ions called cations and negatively charged ions called anions. Most cations are metals; most anions are nonmetals. c. Molecules result when two or more nonmetals form covalent bonds by sharing one or more pairs of electrons. d. Carbon atoms can bond to each other in chains, rings, and branching networks to form a variety of molecular structures including relatively large molecules essential to life.
Teacher Notes:	

▲ = Recommended Sr. High Assessed Indicator

CHEMISTRY – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 3: The student will gain a basic concept of chemical reactions.

Grades 8-12 Indicators	Additional Specificity
The student … 1. ▲ understands a chemical reaction occurs when one or more substances (reactants) react to form a different chemical substance(s) (products). 2. understands there are different types of chemical reactions all of which demonstrate the Law of Conservation of Mass (e.g., synthesis, decomposition, combustion, single and double replacement, acid/base, and oxidation/reduction).	1. Chemical reactions are written as chemical equations, which demonstrate the Law of Conservation of Mass through stoichiometric relationships. 2. a. Two or more of the following may often identify chemical reactions: physical property change, effervescence, mass change, precipitation, light emission, and heat exchange. b. Heat exchange during a chemical reaction is often easily noticed: a reaction that absorbs heat will feel colder; a reaction that releases heat will feel warmer. c. The tendency of nature to occupy the greatest number of different states, called entropy, is ultimately the driving force behind chemical reactions. d. The rate (speed) of a chemical reaction depends on such parameters as temperature, concentration, catalysts, and reaction type.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

PHYSICS – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 1: The student will understand the relationships between force and motion.

Grade 8-12 Indicators	Additional Specificity
The student …	
1. ▲understands Newton's Laws and the kinematic variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles.	1. a. The kinematic variables of position, velocity, and acceleration can most concisely be described as vectors. b. Velocity describes how position changes and acceleration describes how velocity changes. c. From the definitions of velocity and acceleration, one can derive equations that relate the kinematic variables. d. Acceleration occurs when there is either a change in speed or a change in direction. In the case of uniform circular motion, the acceleration points towards the center of the circle. The magnitude of this acceleration can be constant, and is related to the speed of the object and the radius of the circle. e. In the absence of a net force, an object's velocity will not change. f. In the presence of a net force, an object will experience an acceleration which is modeled mathematically by Newton's second law. g. The force that one object exerts on a second object has the same magnitude but opposite direction as the force that the second object exerts on the first.
2. understands physicists use conservation laws to analyze the motion of objects.	2. a. The momentum of an object is a product of its mass and velocity. Momentum is conserved when there are no external forces on the system. b. There are situations in which momentum is conserved but mechanical energy is not. Forces internal to a system can cause a loss of mechanical energy, but only external forces can change the system's momentum.

	c. Angular momentum is conserved when there are no external torques on the system.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

PHYSICS – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 2: The student will understand the conservation of mass and energy, and the First and Second Laws of Thermodynamics.

Grade 8-12 Indicators	Additional Specificity
The student …	
1. understands matter has energy. Mass and energy can be interchanged. The total energy in the universe is constant, but the type of energy may vary.	1. a. The amount of energy in a given amount of mass at rest is given by $E = mc^2$. b. The amount of energy that would be required to completely dissociate a nucleus into its constituent protons and neutrons, divided by the number of protons and neutrons, is known as the "binding energy per nucleon" of the nucleus. c. Two light nuclei that merge into a larger nucleus emit energy. This is known as fusion. d. A massive nucleus that splits apart into two medium mass nuclei emits energy. This is known as fission.
2. ▲understands the first law of thermodynamics states the total internal energy of a substance (the sum of all the kinetic and potential energies of its constituent molecules) will change only if heat is exchanged with the environment or work is done on or by the substance. In any physical interaction, the total energy in the universe is conserved.	2. a. There are different manifestations of energy. Kinetic energy is the energy an object possesses due to its motion. Gravitational potential energy is the energy due to the separation of masses. Electric potential energy is the energy due to the separation of charges. Kinetic and potential energy combined are known as mechanical energy. b. Heat is an exchange of internal (kinetic and/or potential) energy between systems due to a temperature difference. Examples of heat transport include radiation from the sun, convection of hydrosphere/atmosphere/mantle, and conduction between water/land/air. c. A force that has a component parallel to the direction of motion of an object is said to do work on that object. The work done on an object may be positive or negative. When positive work is done on an object, it increases the object's energy. Negative work decreases it.

	d. There is a relationship between energy and power. Power is the rate at which work is done, or the rate at which the energy of some system changes.
3. understands the Second Law of Thermodynamics states the entropy of a system isolated from transfer of matter and/or energy will not decrease.	3. a. Entropy is a state function that describes a system. In some cases, it can be thought of as a measure of disorder. b. A system will not spontaneously undergo a process that decreases its entropy. Heat flows spontaneously from hot objects to cooler ones. It does not flow spontaneously in the other direction. Heat can be made to flow from cooler objects to warmer ones if one does work. A heat engine can convert heat to work, but some heat will always be lost in the process.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

PHYSICS – The student will develop an understanding of the structure of atoms, compounds, chemical reactions, and the interactions of energy and matter.

Benchmark 3: The student will understand the nature of the fundamental interactions of matter and energy.

Grade 8-12 Indicators	Additional Specificity
The student …	
1. there are four fundamental forces in nature: strong nuclear force, weak nuclear force, electromagnetic force, and gravitational force.	1. a. The strong nuclear force keeps particles together in atomic nuclei. b. The weak nuclear force plays a role in the radioactive disintegration of certain nuclei. c. The strong and weak nuclear forces act on quarks and leptons, subatomic particles. d. The electromagnetic force is the force that charged particles exert on one another. The electric force between any two charged particles is given by Coulomb's law, which states that the force is inversely proportional to the square of the distance between the charges. The magnetic force occurs between any two charged particles moving relative to each other. e. The gravitational force is the attractive force that objects exert on one another due to their mass. The gravitational force between any two masses is given by Newton's law of universal gravitation, which states that the force is inversely proportional to the square of the distance between the masses. Near the surface of the Earth, the acceleration of an object due to gravity is independent of the mass of the object and therefore constant.
2. ▲understands waves have energy and can transfer energy when they interact with matter.	2. a. Waves are traveling disturbances which transport energy without the bulk motion of matter. In transverse waves, the disturbance is perpendicular to the direction of travel. In longitudinal waves, the disturbance is parallel to the direction of travel. b. There are many different types of waves. Examples are water waves, sound waves, and electromagnetic waves. Visible light, radio waves, and X-rays are all examples of electromagnetic waves. Periodic waves can also be described in terms of their wavelength, frequency, period, and amplitude. c. All waves can be described in terms of their velocities. The velocity of most types

	of waves depends on the medium in which they are traveling. There is a relationship between the speed, wavelength, and frequency of a periodic wave. The frequency of sound waves is related to the pitch we perceive. Different wavelengths of visible light correspond to different colors. d. Most common types of waves obey the principle of linear superposition. When two waves meet, they superimpose. At points where the crests (or troughs) of two waves meet there is constructive interference. At points where the crest of one wave meets the trough of another, there is destructive interference. Beats are heard when two sound waves with slightly different frequencies interfere. Two waves traveling in opposite directions can combine to produce a standing wave. e. Diffraction is the bending of a wave around an obstacle or an edge. When this happens, different intensities of the wave are observed downstream due to the wave interfering with itself. f. When light reflects from a surface, the angle of incidence is equal to the angle of reflection. When light propagates from one transparent medium to another, it bends (refracts) at the interface in a manner given by Snell's law. One can trace rays to predict the properties of images produced by mirrors. One can trace rays to predict the properties of images produced by lenses.
3. ▲ understands electromagnetic waves result when a charged particle is accelerated or decelerated.	3. a. Electromagnetic waves include radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays. The energy of electromagnetic waves is carried in packets and has a magnitude that is inversely proportional to the wavelength. b. Some particles, such as protons and electrons, have a physical property known as charge. There are two types of charge, known as positive and negative. c. Charged particles experience a force given by Coulomb's law. Coulomb's law indicates that the electric force between two charges is attractive if the charges have opposite sign, and repulsive if they have the same sign. The force between charges is inversely proportional to the square of the distance between them. d. The magnitude of the magnetic force on a particle in a magnetic field is proportional to the particle's charge and speed, and to the magnitude of the magnetic field. The direction of the force is perpendicular to both the particle's velocity and the magnetic field. If the particle's velocity is parallel to the magnetic field, the force vanishes. e. There is a potential energy associated with the electric force. This is most

	commonly dealt with in the related quantity electric potential. The electric potential energy of a particle is its charge times the electric potential at the particle's location. f. Knowledge of electric force and potential allows for the analysis of simple DC circuits. Batteries increase the electric potential energy of electrons. Although it is electrons that flow in a circuit, we analyze circuits as if positive charges are flowing in the other direction. Current is the rate at which charges are flowing in a circuit. The electric potential in a conductor has the same value everywhere in that conductor. Positive charges flowing through a resistor experience a drop in electric potential given by Ohm's law. Charges flowing through a resistor lose energy at a rate that depends on the current and on the resistance of the resistor. The resistance of resistors in series or in parallel can be computed, given the resistances of each individual resistor.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 1: The student will demonstrate an understanding of the structure and function of the cell.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands cells are composed of a variety of specialized structures that carry out specific functions.	1. a. Each cell is surrounded by a membrane that controls the flow of materials into and out of the cell. b. Proteins embedded in the membranes help carry out specific life processes such as transport and recognition. c. In eukaryotes, similar membranes compartmentalize various chemical environments of the cell into organelles such as the nucleus and mitochondria. d. Organelles carry out specific life functions for the cell such as protein synthesis, protein processing and packaging, energy transformation, communication, etc…
2. ▲ understands cell functions involve specific chemical reactions.	2. a. Food molecules taken into cells provide the chemicals needed to synthesize other molecules. b. Enzymes catalyze both breakdown and synthesis in the cell.
3. understands cells function and replicate as a result of information stored in deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) molecules.	3. a. Gene expression regulates cell functions through the synthesis of proteins. b. This regulation allows cells to respond to their environment and to control and coordinate cell division.
4. understands some plant cells contain chloroplasts, which are the sites of photosynthesis.	4. The process of photosynthesis provides a vital connection between the sun and the energy needs of living systems.
5. understands cells can differentiate, thereby enabling complex multicellular organisms to form.	5. a. In the development of most multicellular organisms, a fertilized cell forms an embryo that differentiates into an adult. b. Differentiation is regulated through expression of different genes.

	c. Differentiation leads to the formation of specialized cells, tissues, and organs which have different functions.

Teacher Notes:

The life science standards provide a framework for a variety of courses in the life sciences. All of the indicators listed for this benchmark would be appropriate for inclusion in a high school biology course. The study of microbiology (as a separate course, or within a biology course) would focus on unicellular organisms and viruses, and would generally not include indicators four and five. Even courses that focus on animals, such as such as zoology, might include indicator four, since photosynthesis provides the energy that drives most food chains. Local curriculum is based on the concepts of the Standards, but is more specific.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 2: The student will demonstrate an understanding of chromosomes, genes, and the molecular basis of heredity.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands living organisms contain DNA or RNA as their genetic material, which provides the instructions that specify the characteristics of organisms.	1. a. Nucleotides (adenine, thymine, guanine, cytosine and uracil) make up DNA and RNA molecules. b. Sequences of nucleotides that either determine or contribute to a genetic trait are called genes. c. The sequence of the nucleotide bases within genes is not dictated by any known chemical or physical law. d. DNA is replicated by using a template process that usually results in identical copies. e. DNA and associated proteins supercoil during cellular replication to become structured as chromosomes.
2. understands organisms usually have a characteristic number of chromosomes; one pair of these may determine the sex of individuals.	2. Most cells in humans contain 23 pairs of chromosomes; the 23rd pair usually contains the XX for female or XY for male.
3. ▲ understands hereditary information is contained in genes, located in the chromosomes of each cell.	3. a. An inherited trait of an individual can be determined by one gene or by many genes (a polygenic trait), and a single gene can influence more than one trait. b. The expression of traits is determined by a complex interaction of genes and the environment. c. Alleles, which are different forms of a gene, may be dominant, recessive, or co-dominant.

4. understands gametes carry the genetic information to the next generation.	4. a. Gametes usually contain only one member from each chromosome pair. b. Gametes unite to form a new individual in most organisms.
5. understands expressed mutations occur in DNA at very low rates.	5. a. Mutations are typically harmful, but they can be neutral or beneficial. b. Only mutations in gametes can be passed on to offspring and thus affect future generations. c. Mutations in somatic cells can affect the individual organism, but not its offspring.

Teacher Notes:

The life science standards provide a framework for a variety of courses in the life sciences. All of the indicators listed for this standard would be appropriate for inclusion in a high school biology course, and may be included in a botany course. The indicators provide a basis for developing local curriculum for a course focusing on genetics.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 3: The student will understand the major concepts of the theory of biological evolution.

Grades 8-12 Indicators	Additional Specificity
The student … 1 understands biological evolution, descent with modification, is a scientific explanation for the history of the diversification of organisms from common ancestors.	1. a. Biological evolution postulates an unguided natural process that has no discernable direction or goal. b. The presence of the same materials and processes of heredity (DNA, replication, transcription, translation, etc.) is used as evidence for the common ancestry of modern organisms. c. Patterns of diversification and extinction of organisms are documented in the fossil record. Evidence also indicates that simple, bacteria-like life may have existed billions of years ago. However, in many cases the fossil record is not consistent with gradual, unbroken sequences postulated by biological evolution. d. The distribution of fossil and modern organisms is related to geological and ecological changes (i.e. plate tectonics, migration). There are observable similarities and differences among fossils and living organisms. e. The frequency of heritable traits may change over a period of generations within a population of organisms, usually when resource availability and environmental conditions change as a consequence of extinctions, geologic events, and/or changes in climate. f. The view that living things in all the major kingdoms are modified descendants of a common ancestor (described in the pattern of a branching tree) has been challenged in recent years by: i. Discrepancies in the molecular evidence (e.g., differences in relatedness inferred from sequence studies of different proteins) previously thought to support that view. ii. A fossil record that shows sudden bursts of increased complexity

	(the Cambrian Explosion), long periods of stasis and the absence of abundant transitional forms rather than steady gradual increases in complexity, and iii. Studies that show animals follow different rather than identical early stages of embryological development.
2. understands populations of organisms may adapt to environmental challenges and changes as a result of natural selection, genetic drift, and various mechanisms of genetic change.	2. a. Genetic changes occur only in individual organisms. New heritable traits may result from new combinations of genes and from random mutations or changes in the reproductive cells. Except in very rare cases, mutations that may be inherited are neutral, deleterious or fatal. b. Natural selection and genetic drift occur within populations or organisms. c. Variation among individuals in a population allows individuals to respond differently to environmental challenges.
3. understands biological evolution is used to explain the earth's present day biodiversity: the number, variety and variability of organisms.	3. a. Separate populations within a species may become sufficiently different enough that new species develop. This process is called speciation. b. Changes in inherited traits accumulate in populations. c. Historically only a small percentage of species have survived to modern times. d. Whether microevolution (change within a species) can be extrapolated to explain macroevolutionary changes (such as new complex organs or body plans and new biochemical systems which appear irreducibly complex) is controversial. These kinds of macroevolutionary explanations generally are not based on direct observations and often reflect historical narratives based on inferences from indirect or circumstantial evidence.
4. ▲ understands organisms vary widely within and between populations. Variation allows for natural selection to occur.	4. a. Heritable variation exists in every species. b. New heritable traits result from new combinations of genes and from mutations or changes in the reproductive cells. c. Variation of organisms within and among species increases the likelihood that some members will survive under changing environmental conditions.

	d. Times, populations, or entire lineages become extinct. One effect of this is to increase the differences between the surviving lineages.
5. understands that the primary mechanism of evolutionary change (acting on variation) is natural selection.	5. a. Favorable heritable traits are more advantageous to reproduction and/or survival than others. b. There is a finite supply of resources available for offspring; therefore, not all survive. c. Individuals with beneficial traits generally survive to reproduce in greater numbers. d. Favorable heritable traits tend to increase in the population through time if the selective pressure is maintained.
6. understands biological evolution is used as a broad, unifying theoretical framework for biology.	6. a. Organisms are classified according to the rules of nomenclature, and are given scientific names. b. The behavioral, physical, and genetic characteristics upon which these classifications are based are used as evidence for common descent. c. Natural selection, genetic drift, genomes, and the mechanisms of genetic change provide a context in which to ask research questions and help explain observed changes in populations. However, reverse engineering and end-directed thinking are used to understand the function of bio-systems and information.
7. explains proposed scientific explanations of the origin of life as well as scientific criticisms of those explanations.	7. Some of the scientific criticisms include: a A lack of empirical evidence for a “primordial soup” or a chemically hospitable pre-biotic atmosphere; b. The lack of adequate natural explanations for the genetic code, the sequences of genetic information necessary to specify life, the biochemical machinery needed to translate genetic information into functional biosystems, and the formation of proto-cells; and c. The sudden rather than gradual emergence of organisms near the time that the Earth first became habitable.
Teacher Notes:	

The life science standards provide a framework for a variety of courses in the life sciences. Evolution is a key theoretical framework for the life sciences; these indicators should be part of any life science course curriculum, including biology, botany, zoology, and microbiology.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 4: The student will understand the interdependence of organisms and their interaction with the physical environment.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands atoms and molecules on the Earth cycle among the living and nonliving components of the biosphere.	1. The essential chemical elements for life circulate in the biosphere in characteristic paths known as biogeochemical cycles (e.g., cycles for water, nitrogen, carbon, oxygen, etc.).
2. understands energy is received, transformed and expended in ecosystems.	2. a. Radiant energy that enters the biosphere is balanced by the energy that leaves the earth into space as radiant energy, primarily heat. b. Transfer of energy through a series of organisms in an ecosystem is known as a food web. c. Organisms and ecosystems expend energy, much of which is released as heat, to maintain a high state of internal order.
3. ▲ understands the distribution and abundance of organisms and populations in ecosystems are limited by the carrying capacity.	3. a. The carrying capacity is determined by the availability of matter and energy, and the ability of the ecosystem to recycle materials. b. Living organisms produce more offspring than environmental resources can support, resulting in a competition for resources.
4. understands organisms cooperate and compete in complex, interdependent relationships	4. These relationships include; a. predator-prey relationships. b. symbiotic relationships (parasitism, mutualism, commensalism).
5. understands human beings live within and impact ecosystems.	5. a. By utilizing natural resources, increasing populations, and the use of technology; humans play a major role in altering the ecosystem. b. Habitats can be altered by human activities that affect the stability of the ecosystem including, but not limited to, changes in the atmosphere, the introduction of pollutants, and agriculture.

Teacher Notes:

The life science standards provide a framework for a variety of courses in the life sciences. Ecology concepts are key to understanding life; these indicators provide a framework for local curriculum for courses such as biology, botany, and zoology.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 5: The student will develop an understanding of matter, energy, and organization in living systems.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. recognizes that organic systems need an ongoing input of energy in order to sustain both their chemical and physical organization.	1. The input of energy is required to prevent matter from moving toward disorganized states. The rapid decay of organic systems after death results from the termination of energy input.
2. ▲ understands the Sun is the primary source of energy for life through the process of photosynthesis.	2. a. Plants and other photosynthetic organisms use energy to make organic compounds (primarily glucose) from carbon dioxide and water (CO_2 and H_2O) through a series of biochemical reactions. b. The energy in these compounds is used to assemble larger molecules with biological activity, including proteins, DNA, carbohydrates, and fats. c. These molecules serve as sources of energy for the plants themselves and for many other organisms through food webs. d. Chemosynthetic organisms, unlike photosynthetic organisms, use energy from chemical compounds to maintain life functions.
3. ▲ understands food molecules contain biochemical energy, which is then available for cellular respiration.	3. a. Energy is released when the food molecules are broken down into simpler compounds. b. Energy is transferred to adenosine triphosphate (ATP) through cellular respiration. c. Most biochemical reactions, fueled by ATP, are catalyzed by enzymes.

4. understands the structure and function of an organism serves to acquire, transform, transport, release, and eliminate the matter and energy used to sustain the organism.	

Teacher Notes:

The life science standards provide a framework for a variety of courses in the life sciences. This benchmark integrates important physical science and earth science concepts into the study of life. These indicators may be included in local curriculum in any life science course.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 6: The student will understand the behavior of animals.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands animals have behavioral responses to internal changes and to external stimuli.	1. a. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes. b. These responses can be innate and/or learned. c. The habitats in which many animals reside can be unpredictable; therefore, they need to be able to change their behavior enough to handle the uncertainties and changes they face.
2. understands most multicellular animals have nervous systems that underlie behavior.	2. a. The nervous system is made up lengthy cell extensions which contain cells that are specialized in quickly transmitting signals. b. In order to communicate with each other, nerve cells secrete molecules which can excite or inhibit the neighboring nerve cells.. c. In order to observe their surroundings, animals use sense organs that have cells dedicated for the detection of light, sound, touch and certain chemicals.
3. understands behaviors are often adaptive when viewed in terms of survival and reproductive success.	3. a. Common behaviors include seeking food, seeking mates, raising young, avoiding predators, and regulating body temperature. b. Some organisms live in groups and have social behaviors that benefit both the individual and the group.

Teacher Notes:

The life science standards provide a framework for a variety of courses in the life sciences. These indicators may be included in local curriculum for any life sciences course, and are key concepts for a course focusing on human anatomy and physiology. Human anatomy, physiology and health are vital topics for students to understand. See Kansas Health and PE Standards for additional information.

▲ = Recommended Sr. High Assessed Indicator

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 7: **The student will demonstrate an understanding of the diversity of structure and function in organisms.**

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands differences in structure and function among organisms and can identify the characteristics of relevant life forms.	1. a. Major structural differences among organisms include unicellular and multicellular, plants and animals, and invertebrates and vertebrates. b. Common functions include digestion, respiration, excretion, locomotion, communication and reproduction.
2. understands taxonomy is the systematic way in which organisms are placed into a hierarchical classification system, according to their physical and genetic characteristics and their evolutionary history.	2. a. All organisms are classified into one of a number of kingdoms, the broadest taxonomic category. b. All organisms are classified into a number of intermediate categories, of which species is the most specific.
Teacher notes: The life science standards provide a framework for a variety of courses in the life sciences. These indicators may be included in local curriculum for any life sciences course and are key concepts for a course focusing on human anatomy and physiology. Human anatomy, physiology and health are vital topics for students to understand. See Kansas Health and Physical Education (PE) Standards for additional information. ▲ = Recommended Sr. High Assessed Indicator	

LIFE SCIENCE – The student will develop an understanding of the cell, molecular basis of heredity, biological evolution, interdependence of organisms, matter, energy, and organization in living systems, and the behavior of organisms.

Benchmark 8: **The student will demonstrate an understanding of the diversity of structure and function in organisms and their human relationships and medical effects.**

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands and can identify general variations in structure, function, ecology and medical effects of microbiological agents.	1. a. Viruses are genetic material encased in a protein shell and can only reproduce in a host organism; vaccines are effective for viral infection but antibiotics are not. b. Bacteria are highly diverse prokaryotes and have important roles in the cycling of materials, the chemical industry, and as disease agents. c. Protists are unicellular eukaryotes; some are disease agents.
2. understands and can identify general variations in structure, function, ecology and medical effects of fungi.	2. Fungi are vital decomposers, plant symbionts, a source of antibiotics and food, and some can also cause diseases.
3. understands and can identify general variations in structure, function, ecology and human relationships of plants.	3. a. Variation in plant structures is important in understanding the function of plants in farming, discovering pharmaceutical products, etc. b. Photosynthesis is the basis for nearly all food chains and our food production. c. Understanding plant biology underlies a scientific understanding of ecology.

4. understands and can identify general variations in structure, function, ecology and medical effects of major animal groups.	4. a. Variation in animals is important in understanding the role of animals in farming, medical research, etc. b. Understanding animal biology underlies a scientific understanding of ecology.
5. understands and can identify the general anatomy and physiology of the human body.	5. a. Organ systems have specific structures and functions and interact with each other. b. Infections, developmental problems, trauma, and aging result in specific diseases and disorders.
Teacher Notes:	

EARTH AND SPACE SCIENCE – The student will develop an understanding of energy in the Earth system, geochemical cycles, the formation and organization of the Earth system, the dynamics of the earth/moon/sun system, and the organization and development of the universe.

Benchmark 1: The student will develop an understanding of the sources of energy that power the subsystems and cycles of the dynamic Earth: the geosphere, hydrosphere, atmosphere and biosphere.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands constructive and destructive processes dynamically reshape the surface of the Earth.	1. a. Constructive and destructive processes include erosion and deposition. b. Water, glaciers, winds, waves, and gravity are weathering and erosion agents.
2. ▲ understands the theory of plate tectonics explains that internal energy drives the Earth's ever changing structure.	2 a. Movable continental and oceanic plates make up Earth's surface; the hot, convecting mantle is the energy source for plate movement. b. Convection circulation in the mantle is driven by the outward transfer of Earth's internal heat. c. Systems on Earth's surface are powered principally by the Sun and contain an essentially fixed amount of each stable chemical atom or element. d. Rocks, water, carbon dioxide, oxygen, carbon and other nutrients cycle through different forms as a result of cycle biological and geologic processes.
3. understands that the ultimate source of atmospheric and oceanic energy comes from the Sun. Energy flow determines global climate and weather which is influenced by geographic features, cloud cover, and the Earth's rotation.	3. a. Energy from the Sun heats the oceans and the atmosphere, and drives oceanic and atmospheric circulation. b. Human activity impacts global climate. c. The composition and structure of Earth's atmosphere is a factor in the Earth's suitability to support life.

	d. Weather patterns and seasonal weather change are multi-variable phenomena. e. Biogeochemical cycles are an example of the integration of earth, physical, and biological science concepts. f. Weather in the troposphere redistributes water on the surface of the Earth through the water cycle. g. The ozone layer in the upper stratosphere filters UV radiation which is harmful to living things. h. Gamma radiation and other high energy radiation from the Sun are filtered by the upper atmosphere. i. Concepts and skills include basic weather forecasting, weather maps, fronts, pressure systems, severe storms and safety precautions.

Teacher Notes:
The concepts of energy in Earth's dynamic subsystems and cycles are concepts that integrate earth/space and physical and biological sciences. These concepts may be a part of local curriculum in courses other than earth/space science. Astronomy (space science) indicators related to light and forces can be addressed in physics and physical science courses.

▲ = Recommended Sr. High Assessed Indicator

EARTH AND SPACE SCIENCE – The student will develop an understanding of energy in the Earth system, geochemical cycles, the formation and organization of the Earth system, the dynamics of the earth/moon/sun system, and the organization and development of the universe.

Benchmark 2: The student will develop an understanding of the origin and development of the dynamic Earth system.

Grades 8-12 Indicators	Additional Specificity
The student … 1. ▲ understands geological time is used to understand the Earth's past.	1. a. Radioactive dating and relative dating (i.e., stratigraphy, fossils) are used to estimate the time rocks were formed. b. Earth changes can be short term (during a human's lifetime), such as earthquakes and volcanic eruptions, or long term (over a geological time scale), such as mountain building and plate movements. c. The Earth's atmosphere has changed over time. For example, the dramatic changes in Earth's atmosphere (i.e., introduction of O_2) which was affected by the emergence of life on Earth. d. Relates geologic evidence to a record of Earth's history. e. Matching coastlines, similarities in rock types, similarities in fossils and life forms suggest that today's continents are separated parts of what was long ago a single continent.

Teacher Notes:
The concepts of energy in Earth's dynamic subsystems and cycles are concepts that integrate earth/space, physical and biological sciences. These concepts may be a part of local curriculum in courses other than earth/space science. Astronomy (space science) indicators related to light and forces can be addressed in physics and physical science courses.

▲ = Recommended Sr. High Assessed Indicator

EARTH AND SPACE SCIENCE – The student will develop an understanding of energy in the Earth system, geochemical cycles, the formation and organization of the Earth system, the dynamics of the earth/moon/sun system, and the organization and development of the universe.

Benchmark 3: The student will develop an understanding of dynamics of our solar system.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands gravitational attraction of objects in the solar system keeps solar system objects in orbit.	1. a. Kepler's laws describe planetary motion. b. Newton's laws of inertia and gravity explain orbital motion. c. Because of the Sun's large mass, the Sun is the primary gravitational force in the solar system.
2. ▲ understands the relationship between the Earth, Moon, and Sun explains the seasons, tides and moon phases.	2. a. The angle of incidence of solar energy striking earth's surface effect the amount of heat energy absorbed at Earth's surface. b. The gravitational relationship between the Earth, Moon, and Sun causes tides.
3. understands the relative sizes and distances of objects in the solar system.	
4. understands the Sun, Earth, and other objects in the solar system formed from a nebular cloud of dust and gas.	
Teacher Notes: The concepts of energy in Earth's dynamic subsystems and cycles are concepts that integrate earth/space, physical and biological sciences. These concepts may be a part of local curriculum in courses other than earth/space science. Astronomy (space science) indicators related to light and forces can be addressed in physics and physical science courses. ▲ = Recommended Sr. High Assessed Indicator	

EARTH AND SPACE SCIENCE – The student will develop an understanding of energy in the Earth system, geochemical cycles, the formation and organization of the Earth system, the dynamics of the earth/moon/sun system, and the organization and development of the universe.

Benchmark 4: The student will develop an understanding of the organization of the universe and its development.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲understands stellar evolution.	1. a. Condensation of gases, due to gravity, is a foundation for the formation of stars. b. The life cycle of the star begins with the nebula, which contains mostly hydrogen and helium. Heavier elements were, and continue to be, made by the nuclear fusion reactions in stars. c. The Hertzsprung-Russell (H-R) diagram is used to classify stars. The Sun is a main sequence star. d. Stars are classified by their color, temperature, age, apparent brightness and distance from Earth.
2. ▲ understands the current scientific explanation of the origin and structure of the universe.	2. a. The formation of the universe began with an expansion of gases from a hot, dense state. By studying the light emitted from distant galaxies, it has been found that galaxies are moving apart from one another. b. The red shift of light, within the Doppler effect, emitted by distance galaxies supports the conclusion that the universe is expanding. c. Galaxies are a level of organization of the universe. There are at least 100 billion galaxies in the observable universe. Galaxies are organized into superclusters with large voids between them. d. The Sun is a second-generation star, which, along with our galaxy (the Milky Way which includes about 100 billion stars) formed billions of years after the Big Bang.

3. understands how the tools of astronomy have revolutionized the study of the universe.	3. a. Current telescopes can measure across the electromagnetic spectrum. b. Spectral analysis is used to determine chemical composition and energy of stars. c. Relative mass of objects can be determined by observing motion of objects in space and the effect one object's gravity has on another. d. The tools and skills of astronomers have changed through time: ancient astronomy (Stonehenge, Greeks, Chinese, Aristotle) through modern astronomy (Copernicus to present). e. Astronomical tools and skills allow astronomers to research phenomena and objects that cannot be observed and measured directly.
Teacher Notes: The concepts of energy in Earth's dynamic subsystems and cycles are concepts that integrate earth/space, physical and biological sciences. These concepts may be a part of local curriculum in courses other than earth/space science. Astronomy (space science) indicators related to light and forces can be addressed in physics and physical science courses. ▲ = Recommended Sr. High Assessed Indicator	

SCIENCE AND TECHNOLOGY – The student will develop understandings about the relationship between science and technology.

Benchmark 1: The student will develop an understanding that technology is applied science.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands technology is the application of scientific knowledge for functional purposes.	1. a. Technology is driven by the need to meet human needs and solve human problems. b. Engineering is the practical application of science to commerce or industry. c. Medicine is a practical application of science to human health. d. All technological advances contain a potential for both gains and risks for society.
2. understands creativity, imagination, and a broad scientific knowledge base are required to produce useful results.	
3. understands science advances new technologies. New technologies open new areas for scientific inquiry.	3. a. Technological knowledge may be kept confidential because of the commercial or military potential of the idea or invention. b. Invention which produces a new device, method or process is developed from study and experimentation often utilizing technology.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

STANDARD 6: SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES GRADES 8-12

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will develop an understanding of personal and community health, population growth, natural resources, environmental quality, natural hazards and hazards caused by humans , and science and technology in local, national, and global settings.

Benchmark 1: The student will develop an understanding of the overall functioning of human systems and their interaction with the environment in order to understand specific mechanisms and processes related to health issues.

Grades 8-12 Indicators	Additional Specificity
The student … 1. understands some chemical and physical hazards and accidents can be avoided through safety education. 2. ▲ understands the severity of disease symptoms is dependent on many factors. 3. understands informed personal choices concerning fitness and health involve an understanding of chemistry and biology. 4. understands selection of foods and eating patterns determine nutritional balance which affects emotional and physical well-being.	2. a. These factors include age, genetic predisposition, nutrition, and environmental factors. b. Many diseases can be prevented, controlled, or cured. Some diseases are communicable and some are not.
Teacher Notes: See Kansas Health and PE Standards for additional guidance for health education. ▲ = Recommended Sr. High Assessed Indicator	

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will develop an understanding of personal and community health, population growth, natural resources, environmental quality, natural hazards and hazards caused by humans, and science and technology in local, national, and global settings.

Benchmark 2: The student will demonstrate an understanding of population growth.

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Grades 8-12 Indicators	Additional Specificity
The student … 1. understands the rate of change in populations is determined by the combined effects of birth, death, emigration, and immigration. 2. understands a variety of factors influence birth rates and fertility rates. 3. understands populations have limits to growth.	1. Populations can increase through exponential growth. 2. Population growth changes resource availability and changes environmental conditions.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will develop an understanding of personal and community health, population growth, natural resources, environmental quality, natural hazards and hazards caused by humans, and science and technology in local, national, and global settings.

Benchmark 3: The student will understand that human populations use natural resources and influence environmental quality.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. ▲ understands natural resources from the lithosphere and ecosystems are required to sustain human populations.	1. a. These processes of ecosystems include maintenance of the atmosphere, generation of soils, control of the hydrologic cycle, and recycling of nutrients. Humans are altering many of these processes, and the changes may be detrimental, beneficial, or both to ecosystem function. b. Natural systems can reuse waste, but this capacity is limited. Recycling and environmentally sound decisions improve the quality of human life.
2. understands Earth does not have infinite resources.	2. a. Increasing human consumption places stress on most renewable resources and depletes non-renewable resources. b. Carrying capacity is the maximum number of organisms that can be sustained in a given environment. Natural resources limit the capacity of ecosystems to sustain populations.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

STANDARD 6: SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES GRADES 8-12

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will develop an understanding of personal and community health, population growth, natural resources, environmental quality, natural hazards and hazards caused by humans, and science and technology in local, national, and global settings.

Benchmark 4: The student will understand the effect of natural and human-influenced hazards.

Grades 8-12 Indicators	Additional Specificity
The student …	
1 understands that natural processes on the Earth may be hazardous for humans.	1. Humans live at the interface between two dynamically changing systems, the atmosphere and earth's crust. Human beings need to make informed choices about potential disruption by natural processes (such as volcanic activity, earthquake zones, severe weather, flood plains, etc.).
2. understands there is a need to assess potential risk and danger from natural and human-induced hazards.	2. Human-initiated changes in the environment bring benefits as well as risks to society. Various changes have costs and benefits. For example, vaccinations are a benefit for our society but can have risks for individuals.
Teacher Notes:	

SCIENCE IN PERSONAL AND ENVIRONMENTAL PERSPECTIVES – The student will develop an understanding of personal and community health, population growth, natural resources, environmental quality, natural hazards and hazards caused by humans, and science and technology in local, national, and global settings.

Benchmark 5: The student will develop an understanding of the relationship between science, technology, and society.

Grades 8-12 Indicators	Additional Specificity
The student … 1. understands how societal concerns and challenges can determine the rate of advancement in science and technology. Science and technology provides society with options of what we are capable of doing, not necessarily what we should do.	1. Increased use of antibiotics may also increase human resistance to antibiotics.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

HISTORY AND NATURE OF SCIENCE – The student will develop an understanding that science is a human endeavor and examine the characteristics and history of scientific knowledge.

Benchmark 1: The student will develop an understanding that science is a human endeavor that uses models to describe and explain the physical universe.

Grades 8-12 Indicators	Additional Specificity
The student…	
1. demonstrates an understanding of science as both vocation and avocation.	1. Science is used by researchers to develop new medicines and by parents to promote the health of their families.
2. ▲ explains how science uses peer review, replication of methods, and norms of honesty.	2. Scientific knowledge is made public through presentations at professional meetings, articles in scientific journals and other peer reviewed literature.
3. recognizes the universality of basic science concepts and the influence of personal and cultural beliefs that embed science in society.	3. Decisions the culture makes about bioethics and the use and extraction of natural resources are significantly impacted by scientific knowledge.
4. recognizes that society helps create the ways of thinking (mindsets) required for scientific advances, both toward training scientists and educating a populace to utilize benefits of science (e.g., standards of hygiene, attitudes toward forces of nature, etc.).	
5. understands there are many issues which involve morals, ethics, values or spiritual beliefs that go beyond what science can explain, but for which solid scientific literacy is useful.	5. Common examples involve bioethics, environmental issues, and military applications.
6. recognizes society's role in supporting topics of research and determining institutions where research is conducted.	

Teacher Notes:

▲ = Recommended Sr. High Assessed Indicator

HISTORY AND NATURE OF SCIENCE – The student will develop an understanding that science is a human endeavor and examine the characteristics and history of scientific knowledge.

Benchmark 2: The student will develop an understanding of the nature of scientific knowledge.

Grades 8-12 Indicators	Additional Specificity
The student …	
1. understands scientific knowledge describes and explains the natural world. Scientific knowledge is provisional and is subject to change as new evidence becomes available.	1. a. Additional evidence can lead to further confirmation, revision and refinement, or rejection of previously accepted explanations. b. Science that is truly open-ended, and that allows evidence rather than preconceptions to guide explanation is the strongest and allows for constant refining and improvement of its explanations.
2. understands scientific knowledge begins with empirical observations, which are the data (also called facts or evidence) upon which further scientific knowledge is built.	2. a. The breadth and depth of sensory observations are enhanced by technological instruments such as microscopes, telescopes, and oscilloscopes. b. Observations often include measurements, to varying degrees of accuracy and precision, so they can be described and analyzed with mathematics. c. Observational data is gathered in a number of ways, including controlled experiments, field studies, and the systematic observation of natural phenomena.
3. understands scientific knowledge consists of hypotheses, inferences, laws, and theories.	3. a. A hypothesis is a testable statement that is subject to further investigation and potential confirmation. b. An inference is a testable conclusion, based on previously established knowledge, observed evidence, and logic. c. A law is a thoroughly tested descriptive generalization of a highly regular phenomenon, usually expressed in mathematical form.

	d. A theory is a broad explanation that integrates a wide range of observations and tested hypotheses, inferences, and laws (when applicable) into a meaningful and coherent whole. e. Well established and widely accepted explanations have explanatory and predictive power and are fruitful as guides for further research.
4. understands a testable hypothesis or inference must be subject to confirmation by empirical evidence.	4. a. A valid hypothesis or inference must be potentially falsifiable. b. A hypothesis or inference is tested by making logical predictions about what observational data one would expect to exist, given the hypothesis, and then comparing actual observed data to the predicted data, which will either support or not support the hypothesis.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

HISTORY AND NATURE OF SCIENCE – The student will develop an understanding that science is a human endeavor and examine the characteristics and history of scientific knowledge.

Benchmark 3: The student will understand science from historical perspectives.

Grades 8-12 Indicators	Additional Specificity
The student… 1. demonstrates an understanding of the history of science.	1. a. Modern science has been a successful enterprise that contributes to dramatic improvements in the human condition. Science has led to significant improvements in physical health and economic growth; however, modern science can sometimes be abused by scientists and policymakers, leading to significant negative consequences for society and violations of human dignity (e.g., the eugenics movement in America and Germany; the Tuskegee syphilis experiments; and scientific justifications of eugenics and racism). b. Science progresses by incremental advances of scientists or teams of scientists. In addition, it progresses by critical analysis of: 1) properly collected data; and 2) existing theories and hypotheses, which can lead to major new scientific advances (e.g., relativity, plate tectonics, quantum theory, biological evolution). c. Some advances that are fundamental and long-lasting include: Copernican revolution, Newtonian physics, relativity, geological time scale, plate tectonics, atomic theory, nuclear physics, biological evolution, germ theory, industrial revolution, molecular biology, quantum theory, and medical and health technology.
Teacher Notes: ▲ = Recommended Sr. High Assessed Indicator	

Appendices

Appendix 1 - Glossary

Appendix 2 - Scientific Thinking Processes (need written permission from Dr. Larry Lowrey)

Appendix 3 – Example of grade-by-grade standards (to be added to KSES document after approval by KSBE).

Appendix 4 – Bibliography

GLOSSARY

This glossary in not intended as a comprehensive glossary of science terms or science education terms. Words defined here are a complied list of terms that are defined in grade level Teacher Notes within the Kansas Science Education Standards. After each term, the grade level where the definition is applied in KSES is noted.

Abiotic: nonliving materials in a biosphere such as light, air, soil, and temperature.

Adaptation: changes in structure or behavior which help a species become more suited to its environment.

Biological diversity: the variety of living organisms on Earth.

Biological evolution: a scientific theory that accounts for present day similarity and diversity among living organisms and changes in non-living entities over time. With respect to living organisms, evolution has two major perspectives: The long-term perspective focuses on the branching of lineages; the short-term perspective centers on changes within lineages. In the long term, evolution is the descent with modification of different lineages from common ancestors. In the short term, evolution is the on-going adaptation of organisms to environmental challenges and changes.

Biosphere: organisms and the environment in which they live.

Biotic: the living matter in a biosphere.

Boiling point: the temperature at which a substance begins to turn from a liquid to a gas.

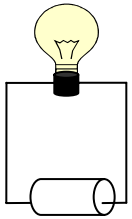
Carrying capacity: the number of individuals from a species that an environment can support.

Cell differentiation: the process by which cells specialize in order to carry out specific functions.

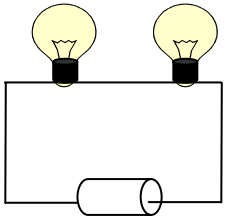
Chromosome: a strand of DNA in the nucleus of cells that carries the genes and functions in the transmission of hereditary information.

Circuits: (KSES Gr. K-4)

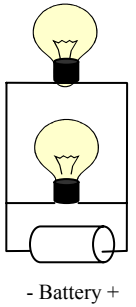
Simple circuit – include diagram



Series circuit –include diagram



Parallel circuit - - include diagram



Classify: a method of establishing order on collections of objects or events. Students use classification systems to identify objects or events, to show similarities, differences, and interrelationships. It is important to realize that all classification systems are subjective and may change as criteria change; the test for good classification system is whether others can use it. (KSES Gr. K-4)

Commensalisms: a symbiotic relationship in which one derives some benefit while the other is unaffected.

Conservation of mass: during a chemical reaction mass is neither created nor destroyed; the atoms are just rearranged.

Constructive process: the process of building new materials (e.g., rock formation)

Current: the rate at which charges are flowing in a circuit. (KSES Gr. K-4)

Density: the amount of mass per unit of volume.

Destructive process: the process of breaking down materials (e.g., weathering of rocks).

DNA (deoxyribonucleic acid): genetic information in the cell consisting of two long chains of nucleotides twisted into a double helix and joined by hydrogen bonds between the complementary bases adenine and thymine or cytosine and guanine.

Doppler effect: the shift in frequency caused by the relative motion of the sound source and the observer.

Earth materials: rocks, soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties which make them useful in different ways. (KSES Gr. K-4)

Ecosystem: a specific area where biotic and abiotic factors interact.

Electromagnetic wave: a wave consisting of oscillating electric and magnetic fields that move at the speed of light.

Empirical observation: an observation made based on experimentation.

Entropy: a measure of the extent of disorder in a system.

Environment: all external conditions and factors, living and non-living, that affect an organism during its life time. (KSES Gr. K-4)

Enzyme: proteins produced by living organisms that serve as biochemical catalysts.

Erosion: movement of earth materials from one place to another by wind, water, or force of gravity. (KSES Gr. K-4)

Eukaryotes: a single-celled or multicellular organism whose cells contain a distinct membrane-bound nucleus.

Full inquiry - entails answering simple questions through the completion of an investigation and communicating these answers to others. The physical and academic skills needed to do scientific inquiry start to develop in the primary grades. These students have the ability to plan an investigation in order to find out what happens when they attempt various things. The students will learn the concept of a "fair" test while concentrating on concrete results. A "fair" test is one with only a single variable manipulated at a time (KSES Gr. K-4).

Fossil: part of a once-living organism or a trace of an organism preserved in rock. (KSES Gr. K-4)

Gamete: a germ cell (egg or sperm) carrying half of the organism's full set of chromosomes, especially a mature germ cell capable of participating in fertilization.

Gene: a hereditary unit consisting of a sequence of DNA that occupies a specific location on a chromosome and determines a particular characteristic in an organism.

Genetic drift: changes in the gene content of a population owing to chance.

Genome: an organism's complete genetic material.

Hypothesis: a testable statement about the natural world that can be used to build more complex inferences and explanations.

Interact: when two or more things do something to each other. (KSES Gr. K-4)

Investigation: finding the answer to a question. (KSES Gr. K-4)

Lithospheric plates: plates that comprise the fractured surface of the earth; there are two types: continental plates and oceanic plates.

Lithosphere: the outer part of the earth, consisting of the crust and upper mantle, approximately 100 km (62 mi.) thick.

Life cycle: the process by which organisms mature, reproduce, and die. (KSES Gr. K-4)

Mass: measure of the amount of material something contains. (KSES Gr. K-4)

Mutualism: a symbiotic relationship between organisms of two different species in which each member benefits.

Natural selection: the process in nature by which only the organisms best adapted to their environment tend to survive and then transmit their genetic characteristics in increasing numbers to succeeding generations while those less adapted tend to be eliminated.

Organisms: any form of life. (KSES Gr. K-4)

Parasitism: a symbiotic relationship between organisms of two different species in which one member benefits and the other member is harmed.

Phases of matter: the states in which matter can exist: as a solid, liquid, or gas.

Pitch: the degree of angle.

Plate tectonics: a theory that explains the global distribution of geological phenomena such as seismicity, volcanism, continental drift, and mountain building in terms of the formation, destruction, movement, and interaction of the earth's lithospheric plates.

Properties: a word that describes an object based on direct observations using touch, sight, hearing, taste, smell, and measurement. (KSES Gr. K-4)

Reflection: the bouncing of a wave off of a surface.

Refraction: the bending of a wave as it passes through a boundary.

RNA (Ribonucleic acid): a constituent of all living cells and many viruses, consisting of a long, single-stranded chain of alternating phosphate and ribose units with the bases adenine, guanine, cytosine, and uracil bonded to the ribose.

Scientific investigation: uses scientific inquiry to ask and answer a question. (KSES Gr. 5-7)

Scientific inquiry – The different ways in which scientists examine the natural world and offer explanations supported by evidence resulting from their work. Inquiry also includes activities of students that help them gain knowledge and understanding of scientific ideas and how scientists study the natural world. Inquiry is a comprehensive activity which includes making observations; asking questions; researching books, journals, and other sources of information in order to determine what is presently known; design investigations; examine what has already been determined as a result of experimental evidence; use the appropriate tools to collect, evaluate, and interpret data; propose answers, provide explanations, and make predictions; and share the results through various forms of communication. The ability to identify assumptions, use critical and logical thinking, and consider alternative (scientific) explanations is important for the process of inquiry. There are various levels of inquiry (partial or guided inquiry) that students can use to learn about the natural world in a scientific way; however, students should also develop the skills needed to perform complete investigations (full inquiry). (KSES Gr. 5-7)

Solubility: the amount of a substance that can be dissolved in a given amount of solvent.

Structures: parts of the organism that serve different functions in growth, survival, and reproduction. (KSES Gr. K-4)

System: a naturally occurring group of objects or phenomena; a functionally related group of elements

Technological design: designs resulting from scientific and industrial progress.

Technology: Creates products to meet human needs by applying scientific principles. Science and technology are reciprocal. Science helps drive technology. Technology is essential to science, because it provides instruments and techniques that promote scientific inquiry. (KSES Grades 5-7)

Technology: application of knowledge through inventions. (KSES Gr. 8-12)

Tools: object used to achieve a goal, to make an observation, and extend the senses. (KSES Gr. K-4)

Weight: The response of mass to the pull of gravity. Weight is a measure of force. Note: Weight is often confused with mass. Mass is the amount of matter (stuff) an object has and is not dependent on the object's location. Weight is a measure of force and is not constant because the pull of gravity on an object's mass varies with location. An object would weigh more on Earth than on the moon because the moon has lower mass than Earth; the moon's mass would have less gravitational attraction for the object. (KSES Gr. 5-7)

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