BIOLOGY - Updated Version 11/24/08

The Science Course Level Expectations document is an **updated** version to the April, 2005 K-12 Science Grade Level Expectations.
The original 9-12 document was organized by grade span; whereas, the attached draft document is organized by Course Level Expectations (CLEs) for high school.
The CLEs will provide the framework for instruction and assessment for high school science courses.

Science Course Level Expectations:

A Framework for Instruction and Assessment

The *Science Course Level Expectations* outline related ideas, concepts, skills and processes that form the foundation for understanding and learning science. It includes updates to the April, 2005 K-12 *Science Grade Level Expectations*. In addition, it provides a framework to bring focus to teaching, learning, and assessing science. The Course Level Expectations (CLEs) for Physical Science, Physics I, Chemistry I, Biology I, and Earth & Space Sciences outline rigorous science expectations for students enrolled in **traditional** or **integrated** courses that will prepare them for success in college, the workplace, and effective participation in civic life.

Since the Outstanding Schools Act of 1993, several documents have been developed prior to the 2005 K-12 *Grade Level Expectations* to aid Missouri school districts in creating curriculum that will enable all students to achieve their maximum potential. Those include: \

- The *Show-Me Standards* which identify broad content knowledge and process skills for all students to be successful as they continue their education, enter the workforce, and assume civic responsibilities
    - The *Framework for Curriculum Development* which provides districts with a "frame" for building curricula using the *Show-Me Standards* as a foundation
- The *Assessment Annotations for the Curriculum Frameworks* which identify content and processes that should be assessed at the local and state level in grades 4, 8, and 10 mathematics

Essential content, aligned to state and national documents that support inquiry-based instruction, included in the Grade and Course Level Expectations should be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations. Each Grade and Course Level Expectation is aligned to the Show-Me Content and Process Standards (1996). A Depth-of-Knowledge level will be assigned to each grade or course level expectation before formal adoption of this document. The Depth of Knowledge identifies the highest level at which the expectation will be assessed, based upon the demand of the GLE/CLE. Depth-of-Knowledge levels include: Level 1-recall; Level 2-skill/concept; Level 3-strategic thinking; and Level 4-extended thinking.

* Indicates that an item is essential to the curricula of the Course but will not be assessed at the State level. The indicated expectations should be taught and assessed locally.

Sources: National Science Education Standards (NRC); Project 2061 (AAAS) Benchmarks for Science Literacy and Atlas: Research related to science education (e.g., Driver's work re: misconceptions); Show Me Standards, Framework for Curriculum Development in Science, and MAP documents; National Assessment of Education Progress (NAEP) Science Framework; Curriculum documents from school districts and other states.

Important resources for districts' use as they develop curriculum and assessments and plan instruction include: the Project 2061 (AAAS) Benchmarks (online at http://www.project2061.org/tools/benchol/bolintro.htm) and ATLAS (a compendium of concept maps showing grade-level appropriateness, sequencing of expectations in order to build conceptual understanding, and connections across science strands); Young People's Images of Science and Making Sense of Secondary Science by Rosalind Driver et al. (both present research related to student misconceptions K-12); The National Science Education Standards (online at http://www.nap.edu/readingroom/books/nses/html/); How Students Learn Science (available from the National Research Council (The National Academies Press)

SCOPE AND SEQUENCE

This is one model of a curriculum scope and sequence. Grade level expectations for grades K-8 are clustered into suggested units and arranged to support development of conceptual understanding. School district personnel are encouraged to adapt this model as necessary in order to better meet the needs of their students. The Expectations described in Strand 7: Inquiry and Strand 8: Science/Technology/Human Activity should be made a priority and integrated throughout every teaching unit in each of the other strands. Beginning no later than Fall 2008, students completing Biology I (or its equivalent) will be administered the Biology I end-of-course assessment. The development and administration of future end-of-course assessments is dependent upon decisions of the State Board of Education and state funding.

	Kindergarten	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	9 - 12
Strand 1 Matter & Energy	Properties of Matter Investigating Sound	Properties of Matter: Mass and Temperature	Properties of Rocks and Soil Forms of Energy: Sound	Investigating States of Matter Earth, Sun and Moon	Mixtures and Solutions Forms of Energy: Electrical Circuits		Properties of and Changes in Matter Forms of Energy: Light and Sound	Forms of Energy: Heat, Electricity, and Magnetism Energy Transformations	Physical and Chemical Properties and Changes of Matter	Atomic Theory and Changes in Matter Energy Forms and Transfer
Strand 2 Force & Motion	Change in Position	Investigating Motion	Forces and Motion		Laws of Motion	Work and Simple Machines		Force, Motion, and Work		Interactions between Energy, Force, and Motion
Strand 3 Living Organisms	Plants and Animals Parent-Offspring Relationships	Characteristics of Plants and Animals	Life Cycles of Animals	Plants		Classification of Plants and Animals	Characteristics of Living Organisms		Cells and Body Systems Disease Reproduction and Heredity	Diversity and Unity Among Organisms Cellular Processes Genetics and Heredity
Strand 4 Ecology	Weather and Seasons			Food Chains	Interactions among Organisms and their Environments		Ecosystems and Populations			Interdependence of Organisms and their Environment Matter and Energy in the Ecosystem Biological Evolution
Strand 5 Earth Systems	Weather and Seasons	Observing Water and Weather	Earth Materials: Rocks and Soil	Investigating States of Matter	Changes in the Earth's Surface	Water Cycle and Weather	Internal Processes and External Events Earth's Resources	Weather and Climate	Rock Cycle and Plate Tectonics	Components and Structure of Earth's Systems Interactions among Earth's Systems and Processes of Change Effect of Human Activity on Earth's Resources
Strand 6 Universe	Objects in the Sky			Earth, Sun, and Moon		Solar System		Objects and Their Motion in the Solar System		Objects in the Universe and Their Motion
Strand 7 Scientific Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry	Inquiry
Strand 8 Science, Technology, & Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity	Science, Technology, and Human Activity

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter	
	Biology
A	
Objects, and the materials they are made of, have properties that can be used to describe and classify them	
DOK	
B	
Properties of mixtures depend upon the concentrations, properties, and interactions of particles	
DOK	
C	
Properties of matter can be explained in terms of moving particles too small to be seen without tremendous magnification	
DOK	
D	
Physical changes in states of matter due to thermal changes in materials can be explained by the Kinetic Theory of Matter	
DOK	
E	
The atomic model describes the electrically neutral atom	
DOK	

Strand 1: Properties and Principles of Matter and Energy

1. Changes in properties and states of matter provide evidence of the atomic theory of matter -- Continued	
	Biology
F **The periodic table organizes the elements according to their atomic structure and chemical reactivity**	
DOK	
G **Properties of objects and states of matter can change chemically and/or physically**	
DOK	
H **Chemical bonding is the combining of different pure substances (elements, compounds) to form new substances with different properties**	
DOK	
I **Mass is conserved during any physical or chemical change**	a. * Compare the mass of the reactants to the mass of the products in a chemical reaction or physical change (e.g., biochemical processes, carbon dioxide-oxygen cycle, nitrogen cycle, decomposition and synthesis reactions involved in a food web) as support for the Law of Conservation of Mass
DOK	**a – 2**

Strand 1: Properties and Principles of Matter and Energy

2. Energy has a source, can be stored, and can be transferred but is conserved within a system	
	Biology
A	
Forms of energy have a source, a means of transfer (work and heat), and a receiver	
DOK	
B	
Mechanical energy comes from the motion (kinetic energy) and/or relative position (potential energy) of an object	
DOK	
C	
Electromagnetic energy from the Sun (solar radiation) is a major source of energy on Earth	
DOK	
D	
Chemical reactions involve changes in the bonding of atoms with the release or absorption of energy	
DOK	
E	
Nuclear energy is a major source of energy throughout the universe	
DOK	

Strand 1: Properties and Principles of Matter and Energy

2. Energy has a source, can be stored, and can be transferred but is conserved within a system -- Continued	
	Biology
F **Energy can be transferred within a system as the total amount of energy remains constant (i.e., Law of Conservation of Energy)**	a. * Classify the different ways to store energy (i.e., chemical, nuclear, thermal, mechanical, electromagnetic) and describe the transfer of energy as it changes from kinetic to potential, while the total amount of energy remains constant, within a system (e.g., biochemical processes, carbon dioxide-oxygen cycle, nitrogen cycle, food web)
DOK	**a – 2**

Strand 2: Properties and Principles of Force and Motion

1. The motion of an object is described by its change in position relative to another object or point	
	Biology
A	
The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference)	
DOK	
B	
An object that is accelerating is speeding up, slowing down, or changing direction	
DOK	
C	
Momentum depends on the mass of the object and the velocity with which it is traveling	
DOK	

Strand 2: Properties and Principles of Force and Motion

2. Forces affect motion	
	Biology
A	
Forces are classified as either contact forces (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism), that can be described in terms of direction and magnitude	
DOK	
B	
Every object exerts a gravitational force on every other object	
DOK	
C	
Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force	
DOK	
D	
Newton's Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion	
DOK	
E	
Perpendicular forces act independently of each other	
DOK	

Strand 2: Properties and Principles of Force and Motion

2. Forces affect motion -- Continued	
	Biology
F	
Work transfers energy into and out of a mechanical system	
DOK	

Strand 3: Characteristics and Interactions of Living Organisms

1. There is a fundamental unity underlying the diversity of all living organisms	
	Biology
A **Organisms have basic needs for survival**	Not assessed at this level (Prior knowledge)
DOK	
B **Organisms progress through life cycles unique to different types of organisms**	a. Recognize cells both increase in number and differentiate, becoming specialized in structure and function, during and after embryonic development b. * Identify factors (e.g., biochemical, temperature) that may affect the differentiation of cells and the development of an organism
DOK	**a – 1, b – 1**
C **Cells are the fundamental units of structure and function of all living things**	a. * Recognize all organisms are composed of cells, the fundamental units of structure and function b. Describe the structure of cell parts (e.g., cell wall, cell membrane, cytoplasm, nucleus, chloroplast, mitochondrion, ribosome, vacuole) found in different types of cells (e.g., bacterial, plant, skin, nerve, blood, muscle) and the functions they perform (e.g., structural support, transport of materials, storage of genetic information, photosynthesis and respiration, synthesis of new molecules, waste disposal) that are necessary to the survival of the cell and organism
DOK	**a – 1, b – 2**
D **Plants and animals have different structures that serve similar functions necessary for the survival of the organism**	Not assessed at this level (Prior knowledge)
DOK	
E **Biological classifications are based on how organisms are related**	a. * Explain how similarities used to group taxa might reflect evolutionary relationships (e.g., similarities in DNA and protein structures, internal anatomical features, patterns of development) b. * Explain how and why the classification of any taxon might change as more is learned about the organisms assigned to that taxon
DOK	**a – 2, b – 2**

Strand 3: Characteristics and Interactions of Living Organisms

2. Living organisms carry out life processes in order to survive	
	Biology
A **The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means**	a. *Compare and contrast the structure and function of mitochondria and chloroplasts b. *Compare and contrast the structure and function of cell wall and cell membranes c. Explain physical and chemical interactions that occur between organelles (e.g. nucleus, cell membrane, chloroplast, mitochondrion, ribosome) as they carry out life processes
DOK	**a – 2, b – 2, c – 2**
B **Photosynthesis and cellular respiration are complementary processes necessary to the survival of most organisms on Earth**	a. Explain the interrelationship between the processes of photosynthesis and cellular respiration (e.g., recycling of oxygen and carbon dioxide), comparing and contrasting photosynthesis and cellular respiration reactions (Do NOT assess intermediate reactions) b. Determine what factors affect the processes of photosynthesis and cellular respiration (i.e., light intensity, availability of reactants, temperature)
DOK	**a – 2, b – 2**
C **Complex multicellular organisms have systems that interact to carry out life processes through physical and chemical means**	
DOK	
D **Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds**	a. Summarize how energy transfer occurs during photosynthesis and cellular respiration as energy is stored in and released from the bonds of chemical compounds (i.e. ATP) b. * Relate the structure of organic compounds (e.g., proteins, nucleic acids, lipids, carbohydrates) to their role in living systems c. * Recognize energy is absorbed or released in the breakdown and/or synthesis of organic compounds d. * Explain how protein enzymes affect chemical reactions (e.g., the breakdown of food molecules, growth and repair, regulation) e. * Interpret a data table showing the effects of an enzyme on a biochemical reaction
DOK	**a – 2, b – 2, c – 1, d – 2, e – 2**

Strand 3: Characteristics and Interactions of Living Organisms

2. Living organisms carry out life processes in order to survive -- Continued	
	Biology
E **Protein structure and function are coded by the DNA (Deoxyribonucleic acid) molecule**	a. Explain how the DNA code determines the sequence of amino acids necessary for protein synthesis b. * Recognize the function of protein in cell structure and function (i.e., enzyme action, growth and repair of body parts, regulation of cell division and differentiation)
DOK	**a – 2, b – 1**
F **Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis)**	a. Explain the significance of the selectively permeable membrane to the transport of molecules b. Predict the movement of molecules across a selectively permeable membrane (i.e., diffusion, osmosis, active transport) needed for a cell to maintain homeostasis given concentration gradients and different sizes of molecules c. Explain how water is important to cells (e.g., is a buffer for body temperature, provides soluble environment for chemical reactions, serves as a reactant in chemical reactions, provides hydration that maintains cell turgidity, maintains protein shape)
DOK	**a – 2, b – 2, c – 2**
G **Life processes can be disrupted by disease (intrinsic failures of the organ systems or by infection due to other organisms)**	
DOK	

Strand 3: Characteristics and Interactions of Living Organisms

3. There is a genetic basis for the transfer of biological characteristics from one generation to the next through reproductive processes	
	Biology
A **Reproduction can occur asexually or sexually**	a. * Distinguish between asexual (i.e., binary fission, budding, cloning) and sexual reproduction
DOK	**a – 1**
B **All living organisms have genetic material (DNA) that carries hereditary information**	a. Describe the chemical and structural properties of DNA (e.g., DNA is a large polymer formed from linked subunits of four kinds of nitrogen bases; genetic information is encoded in genes based on the sequence of subunits; each DNA molecule in a cell forms a single chromosome) (Assess the concepts – NOT memorization of nitrogen base pairs) b. Recognize that DNA codes for proteins, which are expressed as the heritable characteristics of an organism c. * Recognize that degree of relatedness can be determined by comparing DNA sequences d. * Explain how an error in the DNA molecule (mutation) can be transferred during replication e. Identify possible external causes (e.g., heat, radiation, certain chemicals) and effects of DNA mutations (e.g., altered proteins which may affect chemical reactions and structural development)
DOK	**a – 1, b – 1, c – 1, d – 2, e – 2**
C **Chromosomes are components of cells that occur in pairs and carry hereditary information from one cell to daughter cells and from parent to offspring during reproduction**	a. Recognize the chromosomes of daughter cells, formed through the processes of asexual reproduction and mitosis, the formation of somatic (body) cells in multicellular organisms, are identical to the chromosomes of the parent cell b. Recognize that during meiosis, the formation of sex cells, chromosomes are reduced to half the number present in the parent cell c. Explain how fertilization restores the diploid number of chromosomes d. *Identify the implications of human sex chromosomes for sex determination
DOK	**a – 1, b – 1, c – 2, d – 1**
D **There is heritable variation within every species of organism**	a. Describe the advantages and disadvantages of asexual and sexual reproduction with regard to variation within a population b. * Describe how genes can be altered and combined to create genetic variation within a species (e.g., mutation, recombination of genes) c. * Recognize that new heritable characteristics can only result from new combinations of existing genes or from mutations of genes in an organism's sex cells
DOK	**a – 2, b – 2, c – 1**
E **The pattern of inheritance for many traits can be predicted by using the principles of Mendelian genetics**	a. Explain how genotypes (heterozygous and homozygous) contribute to phenotypic variation within a species b. Predict the probability of the occurrence of specific traits, including sex-linked traits, in an offspring by using a monohybrid cross c. *Explain how sex-linked traits may or may not result in the expression of a genetic disorder (e.g., hemophilia, muscular dystrophy, color blindness) depending on gender
DOK	**a – 2, b – 2, c – 2**

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

1. Organisms are interdependent with one another and with their environment	
	Biology
A **All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem**	a. Explain the nature of interactions between organisms in predator/prey relationships and different symbiotic relationships (i.e., mutualism, commensalisms, parasitism) b. Explain how cooperative (e.g., symbiotic) and competitive (e.g., predator/prey) relationships help maintain balance within an ecosystem c. * Explain why no two species can occupy the same niche in a community (The functional role of a species is not limited to its placement along a food pyramid; it also includes the interactions of a species with other organisms while obtaining food. For example, the methods used to tolerate the physical factors of its environment, such as climate, water, nutrients, soils, and parasites, are all part of its functional role. In other words, the ecological niche of an organism is its natural history: all the interactions and interrelationships of the species with other organisms and the environment.)
DOK	**a – 1, b – 2, c – 2**
B **Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite**	a. Identify and explain the limiting factors (biotic and abiotic) that may affect the carrying capacity of a population within an ecosystem b. *Predict how populations within an ecosystem may change in number and/or structure in response to hypothesized changes in biotic and/or abiotic factors
DOK	**a – 2, b – 2**
C **All organisms, including humans, and their activities cause changes in their environment that affect the ecosystem**	a. *Devise a multi-step plan to restore the stability and/or biodiversity of an ecosystem when given a scenario describing the possible adverse effects of human interactions with that ecosystem (e.g., destruction caused by direct harvesting, pollution, atmospheric changes) b. *Predict and explain how natural or human caused changes (biological, chemical and/or physical) in one ecosystem may affect other ecosystems due to natural mechanisms (e.g., global wind patterns, water cycle, ocean currents)
DOK	**a – 3, b – 2**
D **The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes**	a. Predict the impact (beneficial or harmful) a natural or human caused environmental event (e.g., forest fire, flood, volcanic eruption, avalanche, acid rain, global warming, pollution, deforestation, introduction of an exotic species) may have on the diversity of different species in an ecosystem b. *Describe possible causes of extinction of a population
DOK	**a – 2, b – 1**

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

2. Matter and energy flow through the ecosystem	
	Biology
A **As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use**	a. *Illustrate and describe the flow of energy within a food web b. *Explain why there are generally more producers than consumers in an energy pyramid c. Predict how the use and flow of energy will be altered due to changes in a food web
DOK	**a – 2, b – 2, c – 2**
B **Matter is recycled through an ecosystem**	a. *Explain the processes involved in the recycling of nitrogen, oxygen, and carbon through an ecosystem b. * Explain the importance of the recycling of nitrogen, oxygen, and carbon within an eco
DOK	**a – 2, b – 1**

Strand 4: Changes in Ecosystems and Interactions of Organisms with their Environments

3. Genetic variation sorted by the natural selection process explains evidence of biological evolution	
	Biology
A **Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record**	a. *Interpret fossil evidence to explain the relatedness of organisms using the principles of superposition and fossil correlation b. *Evaluate the evidence that supports the theory of biological evolution (e.g., fossil records, similarities between DNA and protein structures, similarities between developmental stages of organisms, homologous and vestigial structures)
DOK	**a – 2, b – 3**
B **Reproduction is essential to the continuation of every species**	a. *Define a species in terms of the ability to mate and produce fertile offspring b. Explain the importance of reproduction to the survival of a species (i.e., the failure of a species to reproduce will lead to extinction of that species)
DOK	**a – 1, b – 2**
C **Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem**	a. Identify examples of adaptations that may have resulted from variations favored by natural selection (e.g., long-necked giraffes, long-eared jack rabbits) and describe how that variation may have provided populations an advantage for survival b. *Explain how genetic homogeneity may cause a population to be more susceptible to extinction (e.g., succumbing to a disease for which there is no natural resistance) c. Explain how environmental factors (e.g., habitat loss, climate change, pollution, introduction of non-native species) can be agents of natural selection d. *Given a scenario describing an environmental change, hypothesize why a given species was unable to survive
DOK	**a – 2, b – 2, c – 2, d – 2**

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

1. Earth's Systems (geosphere, atmosphere, and hydrosphere) have common components and unique structures	
	Biology
A	
The Earth's crust is composed of various materials, including soil, minerals, and rocks, with characteristic properties	
DOK	
B	
The hydrosphere is composed of water (a material with unique properties) and other materials	
DOK	
C	
The atmosphere (air) is composed of a mixture of gases, including water vapor, and minute particles	
DOK	

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes	
	Biology
A	
The Earth's materials and surface features are changed through a variety of external processes	
DOK	
B	
There are internal processes and sources of energy within the geosphere that cause changes in Earth's crustal plates	
DOK	
C	
Continual changes in Earth's materials and surface that result from internal and external processes is described by the rock cycle	
DOK	
D	
Changes in the Earth over time can be inferred through rock and fossil evidence	
DOK	

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

2. Earth's Systems (geosphere, atmosphere, and hydrosphere) interact with one another as they undergo change by common processes -- Continued	
	Biology
E	
Changes in the form of water as it moves through Earth's systems are described as the water cycle	
DOK	
F	
Climate is a description of average weather conditions in a given area due to the transfer of energy and matter through Earth's systems	
DOK	

Strand 5: Processes and Interactions of the Earth's Systems (Geosphere, Atmosphere, and Hydrosphere)

3. Human activity is dependent upon and affects Earth's resources and systems	
	Biology
A **Earth's materials are limited natural resources affected by human activity**	a. *Predict local and/or global effects of environmental changes when given a scenario describing how the composition of the geosphere, hydrosphere, or atmosphere is altered by natural phenomena or human activities b. *Recognize how the geomorphology of Missouri (i.e., different types of Missouri soil and rock materials such as limestone, granite, clay, loam; land formations such as Karst (cave) formations, glaciated plains, river channels) affects the survival of organisms
DOK	**a – 2, b – 3**

Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

1. The universe has observable properties and structure	
	Biology
A **The Earth, Sun, and moon are part of a larger system that includes other planets and smaller celestial bodies**	
DOK	
B **The Earth has a composition and location suitable to sustain life**	a. * Explain how Earth's environmental characteristics and location in the universe (e.g., atmosphere, temperature, orbital path, magnetic field, mass-gravity, location in solar system) provide a life-supporting environment
DOK	**a – 2**
C **Most of the information we know about the universe comes from the electromagnetic spectrum**	
DOK	

Strand 6: Composition and Structure of the Universe and the Motion of the Objects Within It

2. Regular and predictable motions of objects in the universe can be described and explained as the result of gravitational forces	
	Biology
A	
The apparent position of the Sun and other stars, as seen from Earth, changes in observable patterns	
DOK	
B	
The apparent position of the moon, as seen from Earth, and its actual position relative to Earth changes in observable patterns	
DOK	
C	
The regular and predictable motions of a planet and moon relative to the Sun explain natural phenomena, such as day, month, year, shadows, moon phases, eclipses, tides, and seasons	
DOK	
D	
Gravity is a force of attraction between objects in the solar system that governs their motion	
DOK	

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking	
	Biology
A **Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation**	a. Formulate testable questions and hypotheses b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment c. Design and conduct a valid experiment d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature) e. *Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using a controlled laboratory experiment, but instead by using a model, due to the limits of the laboratory environment, resources, and/or technologies f. *Acknowledge there is no fixed procedure called "the scientific method", but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations g. Evaluate the design of an experiment and make suggestions for reasonable improvements
DOK	**a – 3, b – 3, c – 4, d – 2, e – 1, f – 2, g – 3**
B **Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations**	a. *Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data (e.g., microscopes, thermometers, analog and digital meters, computers, spring scales, balances, metric rulers, graduated cylinders) b. Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second c. Determine the appropriate tools and techniques to collect, analyze, and interpret data d. Judge whether measurements and computation of quantities are reasonable e. Calculate the range, average/mean, percent, and ratios for sets of data f. *Recognize observation is biased by the experiences and knowledge of the observer (e.g., strong beliefs about what should happen in particular circumstances can prevent the detection of other results)
DOK	**a – 2, b – 1, c – 2, d – 2, e – 1, f – 2**
C **Scientific inquiry includes evaluation of explanations (laws/principles, theories/models) in light of evidence (data) and scientific principles (understandings)**	a. Use quantitative and qualitative data as support for reasonable explanations (conclusions) b. Analyze experimental data to determine patterns, relationships, perspectives, and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable) c. Identify the possible effects of errors in observations, measurements, and calculations, on the validity and reliability of data and resultant explanations (conclusions) d. Analyze whether evidence (data) and scientific principles support proposed explanations (laws/principles, theories/models)
DOK	**a – 3, b – 3, c – 3, d – 3**

Strand 7: Scientific Inquiry

1. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking -- Continued	
	Biology
D **The nature of science relies upon communication of results and justification of explanations**	a. Communicate the procedures and results of investigations and explanations through: ♦ oral presentations ♦ drawings and maps ♦ data tables (allowing for the recording and analysis of data relevant to the experiment such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) ♦ graphs (bar, single, and multiple line) ♦ equations and writings b. * Communicate and defend a scientific argument c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed, and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)
DOK	**a – 3, b – 3, c – 2**

Strand 8: Impact of Science, Technology and Human Activity

1. The nature of technology can advance, and is advanced by, science as it seeks to apply scientific knowledge in ways that meet human needs	
	Biology
A **Designed objects are used to do things better or more easily and to do some things that could not otherwise be done at all**	
DOK	
B **Advances in technology often result in improved data collection and an increase in scientific information**	a. * Recognize the relationships linking technology and science (e.g., how technological problems may create a demand for new science knowledge, how new technologies make it possible for scientists to extend research and advance science)
DOK	**a – 2**

Strand 8: Impact of Science, Technology and Human Activity

2. Historical and cultural perspectives of scientific explanations help to improve understanding of the nature of science and how science knowledge and technology evolve over time	
	Biology
A **People of different gender and ethnicity have contributed to scientific discoveries and the invention of technological innovations**	a. *Recognize contributions to science are not limited to the work of one particular group, but are made by a diverse group of scientists representing various ethnic and gender groups b. *Recognize gender and ethnicity of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology
DOK	**a – 1, b – 1**
B **Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity**	a. *Identify and describe how explanations (laws/principles, theories/models) of scientific phenomena have changed over time as a result of new evidence (e.g., cell theory, theories of spontaneous generation and biogenesis, theories of extinction, evolution theory, structure of the cell membrane, genetic theory of inheritance) b. *Identify and analyze current theories that are being questioned, and compare them to new theories that have emerged to challenge older ones (e.g., theories of evolution, extinction, global warming)
DOK	**a – 2, b – 3**

Strand 8: Impact of Science, Technology and Human Activity

3. Science and technology affect, and are affected by, society	
	Biology
A **People, alone or in groups, are always making discoveries about nature and inventing new ways to solve problems and get work done**	
DOK	
B **Social, political, economic, ethical and environmental factors strongly influence, and are influenced by, the direction of progress of science and technology**	a. *Analyze the roles of science and society as they interact to determine the direction of scientific and technological progress (e.g., prioritization of and funding for new scientific research and technological development is determined on the basis of individual, political and social values and needs; understanding basic concepts and principles of science and technology influences debate about the economics, policies, politics, and ethics of various scientific and technological challenges) b. *Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research) c. *Analyze and evaluate the drawbacks (e.g., design constraints, unintended consequences, risks), benefits, and factors (i.e., social, political, economic, ethical, and environmental) affecting progress toward meeting major scientific and technological challenges (e.g., limitations placed on stem-cell research or genetic engineering, introduction of alien species, deforestation, bioterrorism, nuclear energy, genetic counseling, use of alternative energies for carbon fuels, use of pesticides
DOK	**a – 3, b – 3, c – 3**
C **Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent**	a. *Identify and evaluate the need for informed consent in experimentation b. *Identify the ethical issues involved in experimentation (i.e., risks to organisms or environment) c. *Identify and evaluate the role of models as an ethical alternative to direct experimentation (e.g., using a model for a stream rather than pouring oil in an existing stream when studying the effects of oil pollution on aquatic plants)
DOK	**a – 1, b – 1, c – 1**
D **Scientific information is presented through a number of credible sources, but is at times influenced in such a way to become non-credible**	a. *Evaluate a given source for its scientific credibility (e.g., articles in a new periodical quoting an "eye witness", a scientist speaking within or outside his/her area of expertise) b. * Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society
DOK	**a – 3, b – 1**

Notes