

**STANDARD 1: SCIENCE AS INQUIRY**

**Grades 8-12**

**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
<p>The student...</p> <ol style="list-style-type: none"> <li>1. actively engages in asking and evaluating research questions.</li> <li>2. ▲ actively engages in investigations, including developing questions, gathering and analyzing data, and designing and conducting research</li> <li>3. ▲ actively engages in using technological tools and mathematics in their own scientific investigations.</li> </ol>	<ol style="list-style-type: none"> <li>1. Well-formed research questions drive scientific inquiry.</li> <li>2. The scientific investigations includes, when appropriate,               <ol style="list-style-type: none"> <li>a. formulating a testable hypothesis.</li> <li>b. identify and test variables (independent, dependent, and variables to be kept constant).</li> <li>c. using methods for gathering data that is observable, measurable, and replicable.</li> <li>d. analyzing and evaluating the results in order to clarify the questions and hypotheses, and to refine methods for further research.</li> </ol> </li> <li>3.               <ol style="list-style-type: none"> <li>a. using a variety of technologies, such as hand tools, measuring instruments, calculators, and computers as an integral component of scientific investigations.</li> <li>b. using common mathematical functions to analyze and describe data.</li> <li>c. uses statistical and graphing data analysis techniques.</li> <li>d. recognizes that the accuracy and precision of the data, and therefore the quality of the investigation, depends on the instruments used.</li> </ol> <ol style="list-style-type: none"> <li>a. using equipment properly and safely.</li> </ol> </li> </ol>

<p>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 should be considered.</p> <p>5. actively engages in communicating and defending the design, results, and conclusion of his/her investigation.</p>	<p>4. a. engages in discussions that result in the revision of his/her explanation.</p> <p>b. analyzes their explanation by reviewing current scientific understanding, weighing the evidence, and examining the logic so as to decide which explanations and models have the greatest explanatory power.</p> <p>c. evaluates personal preconceptions and biases with respect to his/her conclusions.</p> <p>d. based on their results, students consider modifications to their investigations.</p> <p>5. a. writes procedures, expresses concepts, reviews information, summarizes data, and uses language appropriately.</p> <p>b. develops diagrams and charts to summarize and analyze data.</p> <p>c. presents information clearly and logically, both orally and in writing.</p> <p>d. constructs reasoned arguments.</p> <p>e. responds appropriately to critical comments.</p>
<p>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.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 2A: CHEMISTRY**

Grades 8-12

**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
<p>The student ...</p> <p>1. ▲ understands atoms, the fundamental organizational unit of matter, are composed of subatomic particles. Chemists are primarily interested in the protons, electrons, and neutrons found in the atom.</p> <p>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.</p>	<p>1 a. All atoms are identified by the number of protons in the nucleus, i.e. the atomic number. The protons have a positive charge and a mass of 1 amu. Protons and neutrons are found in the small, dense, nucleus.</p> <p>b. Neutrons have a neutral charge and a mass of 1 amu.</p> <p>c. The electrons have a negative charge and are found outside the nucleus in an electron cloud. The mass of an electron is approximately 2,000 times smaller than a proton. The electrons determine the size and chemical properties of the atom.</p> <p>a. The number of electrons is equal to the number of protons in a neutral atom. Ions have a different number of electrons than protons.</p> <p>b.</p> <p>2 a. The periodic table reflects the average mass of the isotopes.</p> <p>b. Examples of released radioactivity are alpha, beta, and gamma radiation.</p> <p>c. Some isotopes spontaneously decay at a first order rate. There is a negative linear relationship between the log of the sample isotope concentration vs. time,</p>

	d. To balance a nuclear equation, the sum of the atomic numbers and the sum of the mass numbers must be equal on both sides of the equation.
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Teacher Notes:

These concepts are basic to physics, chemistry, biology, earth/space science.

▲ = High School Assessed Indicator

**STANDARD 2A: CHEMISTRY**

Grades 8-12

**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 students will understand the states and properties of matter.**

Grades 8-12 Indicators	Additional Specificity
<p>The student ...</p> <p>1. ▲ understands chemists use kinetic and potential energy to explain the physical and chemical properties of matter on earth that may exist in any of these three states: solids, liquids, and gases.</p> <p>2. ▲ understands the periodic table lists elements according to increasing atomic number. This table organizes physical and chemical trends by groups, periods, and sub-categories.</p>	<p>1a. Elements and molecules may exist as gases, liquids or solids. Ionic compounds most commonly exist as solids.</p> <p>b. Intermolecular attraction (attraction between molecules) determines the state of the molecule. Examples of intermolecular attraction include hydrogen bonding, permanent dipole interaction, and induced dipole interaction. 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.</p> <p>2a. Elements in the same group have the same number of valence electrons and can be used to predict similar physical and chemical properties. Elements are grouped by similar ground state valence electron configurations.</p> <p>b. As periods increase, the principle energy levels of the outermost (<i>valence</i>) electrons increase. Electrons changing from one energy level to another may result in the emission or absorption of various forms of electromagnetic radiation, including the range of colors that form visible light. When there is color, there are electrons changing energy levels.</p> <p>c. Sub-categories are regions such as metals, non-metals, and transition elements. Nonmetals have different physical and chemical properties than metals. For example, nonmetals have lower melting points, lower density, and are poorer conductors of electricity and heat. Chemical properties depend on the subshell of the valence electrons which are different for metals and non-metals.</p>

3. ▲ understands chemical bonds result when valence electrons are transferred or shared between atoms. Breaking a chemical bond requires energy. Formation of a chemical bond releases energy. Ionic compounds result from atoms transferring electrons. Molecular compounds result from atoms sharing electrons.  
For example, carbon atoms can bond to each other in chains, rings, and branching networks. Branched network and metallic solids also result from bonding.

3 a. Valence electron configurations determine whether an atom gains, loses, or shares electrons to achieve a more stable electron configuration similar to the noble gases.

b. Positively charged ions are called cations, and negatively charged ions are called anions. Cations are attracted to anions (opposite charges attract). Most cations are metals; most anions are nonmetals. In stable ionic compounds, the sum of the charges is zero.

c. Covalent bonds form when two or more atoms share one or more pairs of electrons to achieve a more stable electron configuration. The two classifications of covalent bonds are nonpolar and polar. The greater the electronegativity difference between atoms involved in the bond, the more polar the bond.

d. The energy required to break ionic bonds is greater than the energy required to break covalent bonds. 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.

e. 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. Diamonds, a 3-dimensional branching of carbon atoms and quartz, a repeated 3-dimensional branching of silicon dioxide molecules, are further examples of network solids. Unique properties of network solids include hardness, high melting points, poor conductors - indicative of covalent bonding and stable geometry.

f. Metallic bonding is defined as free roaming electrons forming a negative sea of electrons surrounding the positive metal ions.

Teacher Notes:

The states and classes of matter are introduced in Grade 3-4 and further developed in the Grades 5-7. Grades 8-12 students should be able to explain these concepts at an advanced molecular level.

▲ = High School Assessed Indicator

**STANDARD 2A: CHEMISTRY**

Grades 8-12

**CHEMISTRY – The students 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
<p>The student ...</p> <p>1. ▲ understands a chemical reaction occurs when one or more substances (reactants) react to form a different chemical substance(s) (products). There are different types of chemical reactions all of which demonstrate the Law of Conservation of Matter and Energy.</p> <p>2. understands how to perform mathematical calculations regarding the Law of Conservation of Matter, i.e., through stoichiometric relationships.</p> <p>3. understands the differences and reactions between acids, bases, and salts. Perform calculations to determine the concentration of ions in solutions.</p>	<p>1a. Chemical reactions are written as balanced chemical equations. In ordinary chemical reactions, the number and kind of atoms must be conserved.</p> <p>b. Examples of chemical reactions are synthesis, decomposition, combustion, single and double replacement, acid/base, and oxidation/reduction.</p> <p>c. Two or more of the following may often identify chemical reactions: physical property change, effervescence, mass change, precipitation, light emission, and heat exchange.</p> <p>d. The rate (speed) of a chemical reaction depends on such parameters as temperature, concentration, catalysts, inhibitors, surface area, and reaction type.</p> <p>2a..Reaction stoichiometry involves understanding the use of coefficients (moles) to balance equations and solve for a variety of relationships using the molar mass of the substances. Examples of these types of relationships include mole/mole, mole/mass, mole/volume, mass/volume, mass/mass, etc.</p> <p>3a. Acids react with bases to produce water and salt.</p> <p>b. pH is a logarithmic function of hydronium ion concentration. pH decreases as the hydronium ion concentration increases. pOH and hydroxide concentrations are found in a similar way.</p>

	<p>c. Determination of an unknown base may be determined by experimental titration and use of <math>M_a \times V_a = M_b \times V_b</math>.</p> <p>d. Dilution formulas (<math>M_1 \times V_1 = M_2 \times V_2</math>) can be used to determine the concentration of a solution after diluting it with water.</p>
Teacher Notes:	
▲ = High School Assessed Indicator	

**STANDARD 2B: PHYSICS**

**Grades 8-12**

**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
<p>The student ...</p> <p>1. ▲ understands Newton’s Laws and the variables of time, position, velocity, and acceleration can be used to describe the position and motion of particles.</p> <p>2. understands physicists use conservation laws to analyze the motion of objects.</p>	<p>1. a. The kinematic (motion) variables: position, velocity, and acceleration can most concisely be described as vectors.</p> <p>b. Velocity describes how position changes and acceleration describes how velocity changes.</p> <p>c. From the definitions of velocity and acceleration, one can derive equations that relate the kinematic variables.</p> <p>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 is constant, and is related to the speed of the object and the radius of the circle.</p> <p>e. In the absence of a net force, an object’s velocity will not change.</p> <p>f. In the presence of a net force, an object will experience an acceleration which is modeled mathematically by Newton’s second law.</p> <p>c. 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.</p> <p>2. a. Mechanical energy is conserved when no non-conservative forces (such as friction) do work.</p> <p>b. 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.</p>

c. 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.

d. Angular momentum is conserved when there is no external torques on the system.

Teacher Notes:

▲ = High School Assessed Indicator

**STANDARD 2B: PHYSICS**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>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.</li>   <li>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.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. The amount of energy in a given amount of mass at rest is given by <math>E = mc^2</math>.</li>   <li>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.</li>   <li>c. Two light nuclei that merge into a larger nucleus emit energy. This is known as fusion.</li>   <li>d. A massive nucleus that splits apart into two medium mass nuclei emit energy. This is known as fission.</li> </ol> </li>   <li>2.               <ol style="list-style-type: none"> <li>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.</li>   <li>b. Heat is an exchange of internal (kinetic and/or potential) energy between systems due to a temperature difference. 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. Examples of heat transport include radiation from the sun, convection of hydrosphere/atmosphere/mantle, and conduction between water/land/air.</li> </ol> </li> </ol>

<p>3. understands the second law of thermodynamics that states the entropy of the universe is increasing.</p>	<p>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.</p> <p>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.</p> <p>3. a. Entropy is a state function that describes a system. In some cases, it can be thought of as a measure of disorder. A system will not spontaneously undergo a process that decreases its entropy.</p> <p>b. A discretely defined system; a collection of objects or particles interacting via forces or processes that are internal to the system, remains the same or become more disordered ( i.e. losing heat across the boundary of the system) over time.</p>
<p>Teacher Notes:</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 2B: PHYSICS**

**Grades 8-12**

**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
<p>The student ...</p> <p>1. There are four fundamental forces in nature: strong nuclear force, weak nuclear force, electromagnetic force, and gravitational force.</p> <p>2. ▲ understands waves have energy and can transfer energy when they interact with matter.</p>	<p>1. a. The strong nuclear force keeps particles together in atomic nuclei.</p> <p>b. The weak nuclear force plays a role in the radioactive disintegration of certain nuclei.</p> <p>c. The strong and weak nuclear forces act on quarks and leptons, subatomic particles.</p> <p>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 state 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.</p> <p>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. This explains the motion of planets. 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.</p> <p>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.</p> <p>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.</p>

<p>3. The student understand interference – how waves interact with other waves</p> <p>4. The student will understand the principles of reflection and refraction.</p> <p>5. ▲ understands electromagnetic waves result when a charged particle is accelerated or decelerated.</p>	<p>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. Difference wavelengths of visible light correspond to different colors.</p> <p>3. a. 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 through 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.</p> <p>b. 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.</p> <p>4. a. 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.</p> <p>5. 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.**</p> <p>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.</p> <p>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.</p> <p>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.</p>
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<p>6. The student understands basic electrostatics and circuits.</p>	<p>6. a. 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.</p> <p>b. 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.</p>
<p>Teacher Notes:</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 3: LIFE SCIENCE****Grades 8-12****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
<p>The student ...</p> <ol style="list-style-type: none"><li>1. understands cells are composed of a variety of specialized structures that carry out specific functions.</li><li>2. ▲ understands cell functions involve specific chemical reactions.</li><li>3. understands cells function and replicate as a result of information stored in DNA and RNA molecules.</li><li>4. understands some plant cells contain chloroplasts, which are the sites of photosynthesis.</li><li>5. understands cells can differentiate, thereby enabling complex multicellular organisms to form.</li></ol>	<ol style="list-style-type: none"><li>1. <ol style="list-style-type: none"><li>a. Each cell is surrounded by a membrane that controls the flow of materials into and out of the cell.</li><li>b. Proteins embedded in the membranes help carry out specific life processes such as transport and recognition.</li><li>c. In eukaryotes, similar membranes compartmentalize various chemical environments of the cell into organelles such as the nucleus and mitochondria.</li><li>d. Organelles carry out specific life functions for the cell such as protein synthesis, protein processing and packaging, energy transformation, communication, etc...</li></ol></li><li>2. <ol style="list-style-type: none"><li>a. Food molecules taken into cells provide the chemicals needed to synthesize other molecules.</li><li>b. Enzymes catalyze both breakdown and synthesis in the cell.</li></ol></li><li>3. <ol style="list-style-type: none"><li>a. Gene expression regulates cell functions through the synthesis of proteins.</li><li>b. This regulation allows cells to respond to their environment and to control and coordinate cell division.</li></ol></li><li>4. The process of photosynthesis provides a vital connection between the sun and the energy needs of living systems.</li><li>5. <ol style="list-style-type: none"><li>a. In the development of most multicellular organisms, a fertilized cell forms an embryo that differentiates into an adult.</li></ol></li></ol>

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 4 and 5. Even courses that focus on animals, such as zoology, might include indicator 4, since photosynthesis provides the energy that drives most food chains. Local curriculum is based on the concepts of the Standards, but is more specific.

▲ = High School Assessed Indicator

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. ▲ understands living organisms contain DNA or RNA as their genetic material, which provides the instructions that specify the characteristics of organisms.</li>   <li>2. understands organisms usually have a characteristic number of chromosomes; one pair of these may determine the sex of individuals.</li>   <li>3. ▲ understands hereditary information is contained in genes, located in the chromosomes of each cell.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. Nucleotides (adenine, thymine, guanine, cytosine and uracil) make up DNA and RNA molecules.</li>   <li>b. Sequences of nucleotides that either determine or contribute to a genetic trait are called genes.</li>   <li>c. DNA is replicated by using a template process that usually results in identical copies.</li>   <li>d. DNA and associated proteins supercoil during cellular replication to become structured as chromosomes.</li> </ol> </li>   <li>6. Most cells in humans contain 23 pairs of chromosomes; the 23rd pair usually contains the XX for female or XY for male.</li>   <li>3.               <ol style="list-style-type: none"> <li>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.</li>   <li>b. The expression of traits is determined by a complex interaction of genes and the environment.</li>   <li>c. Alleles, which are different forms of a gene, may be dominant, recessive, or co-dominant.</li> </ol> </li> </ol>

<p>4. understands gametes carry the genetic information to the next generation.</p> <p>5. understands expressed mutations occur in DNA at very low rates.</p>	<p>4. a. Gametes usually contain only one member from each chromosome pair.</p> <p>b. Gametes unite to form a new individual in most organisms.</p> <p>5. a. Mutations are genetic changes and can be beneficial, neutral, or deleterious. Many mutations have deleterious effect on the organism's survival and/or reproduction.</p> <p>b. Only mutations in gametes can be passed on to offspring and thus affect future generations.</p> <p>c. Mutations in somatic cells can affect the individual organism, but not its offspring.</p>
<p>Teacher Notes:</p> <p>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 any organismal biology class. The indicators provide a basis for developing local curriculum for a course focusing on genetics.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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 biological evolution.**

Grades 8-12 Indicators	Additional Specificity
<p>The student ...</p> <p>1 ▲ understands biological evolution, descent with modification, is a scientific explanation for the history of the diversification of organisms from common ancestors</p> <p>2. understands populations of organisms adapt to environmental challenges and changes as a result of natural selection, genetic drift, and various mechanisms of genetic change.</p>	<p>1. a. 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.</p> <p>b. Patterns of diversification and extinction of organisms are documented in the fossil record. Evidence indicates that simple, bacteria-like life may have existed billions of years ago.</p> <p>c. 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.</p> <p>d. 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.</p> <p>2. a. Genetic changes occur only in individual organisms.</p> <p>b. Natural selection and genetic drift occur within populations or organisms.</p> <p>c. Variation among individuals in a population allows individuals to respond differently to environmental challenges.</p>

<p>3. ▲ understands biological evolution is used to explain the earth's present day biodiversity: the number, variety and variability of organisms.</p> <p>4. ▲ understands organisms vary widely within and between populations. Variation allows for natural selection to occur.</p> <p>5. understands the primary mechanism acting on variation is natural selection.</p>	<p>3. a. Separate populations within a species may become sufficiently different enough that new species develop. This process is called speciation.</p> <p>b. Changes in inherited traits accumulate in populations.</p> <p>c. Historically only a small percentage of species have survived to modern times.</p> <p>4. a. Heritable variation exists in every species.</p> <p>b. New heritable traits result from new combinations of genes and from mutations or changes in the reproductive cells.</p> <p>c. Variation of organisms within and among species increases the likelihood that some members will survive under changing environmental conditions.</p> <p>d. Times, populations, or entire lineages become extinct. One effect of this is to increase the differences between the surviving lineages.</p> <p>5. a. Favorable heritable traits are more advantageous to reproduction and/or survival than others.</p> <p>b. There is a finite supply of resources available for offspring; therefore not all survive.</p> <p>c. Individuals with beneficial traits generally survive to reproduce in greater numbers.</p> <p>d. Favorable heritable traits tend to increase in the population through time if the selective pressure is maintained.</p>
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<p>6. understands biological evolution is used as a broad, unifying theoretical framework for biology.</p>	<p>6. a. Organisms are classified and according to the rules of nomenclature, and are given scientific names.</p> <p>b. The behavioral, physical, and genetic characteristics upon which these classifications are based are used as evidence for common descent.</p> <p>d. 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.</p>
<p>Teacher Notes:</p> <p>See introduction pages x – xiii for more information on the Nature of Science. 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.</p> <p>These indicators should be part of any life science course curriculum, including biology, botany, zoology and microbiology.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. ▲ understands atoms and molecules on the earth cycle among the living and nonliving components of the biosphere.</li> <li>2. understands energy is received, transformed and expended in ecosystems.</li> <li>3. ▲ understands the distribution and abundance of organisms and populations in ecosystems are limited by the carrying capacity.</li> <li>4. understands organisms cooperate and compete in complex, interdependent relationships</li> <li>5. understands human beings live within and impact ecosystems.</li> </ol>	<ol style="list-style-type: none"> <li>1. The essential chemical elements for life circulate in the <i>biosphere</i> in characteristic paths known as biogeochemical cycles (e.g., cycles for water, nitrogen, carbon, oxygen, etc)</li> <li>2.             <ol style="list-style-type: none"> <li>a. Radiant energy that enters the biosphere is balanced by the energy that leaves the earth into space as radiant energy, primarily heat.</li> <li>b. Transfer of energy through a series of organisms in an ecosystem is known as a food web.</li> <li>c. Organisms and ecosystems expend energy, much of which is released as heat, to maintain a high state of internal order.</li> </ol> </li> <li>3.             <ol style="list-style-type: none"> <li>a. The carrying capacity is determined by the availability of matter and energy, and the ability of the ecosystem to recycle materials.</li> <li>b. Living organisms produce more offspring than environmental resources can support, resulting in a competition for resources</li> </ol> </li> <li>4. These relationships include;             <ol style="list-style-type: none"> <li>a. predator-prey relationships</li> <li>b. symbiotic relationships (parasitism, mutualism, commensalisms).</li> </ol> </li> <li>5.             <ol style="list-style-type: none"> <li>a. Humans modify ecosystems as a result of population growth, technology, and consumption.</li> <li>b. Human modifications of habitats through direct harvesting, pollution, atmospheric changes, and other factors affect ecosystem stability.</li> </ol> </li> </ol>

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.

Learning Science in the Outdoors: Varied experiences in the outdoors make natural processes less abstract and are critical to developing scientific literacy. Teachers are encouraged to create outdoor learning experiences for their students.

▲ = High School Assessed Indicator

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"><li>1. understands living systems require a continuous input of energy to maintain their chemical and physical organization.</li><li>2. ▲ understands the sun is the primary source of energy for life through the process of photosynthesis.</li></ol>	<ol style="list-style-type: none"><li>1. Without the input of energy, all matter tends toward more disorganized states. With death and the cessation of energy intake, living systems rapidly disintegrate.</li><li>2. <ol style="list-style-type: none"><li>a. Plants and other photosynthetic organisms use energy to make organic compounds (primarily glucose) from carbon dioxide and water (CO<sub>2</sub> and H<sub>2</sub>O) through a series of biochemical reactions.</li><li>b. The energy in these compounds is used to assemble larger molecules with biological activity, including proteins, DNA, carbohydrates, and fats.</li><li>c. These molecules serve as sources of energy for the plants themselves and for many other organisms through food webs.</li><li>d. Chemosynthetic organisms, unlike photosynthetic organisms, use energy from chemical compounds to maintain life functions.</li></ol></li></ol>

<p>3. ▲ understands food molecules contain biochemical energy, which is then available for cellular respiration.</p> <p>4. understands the structure and function of an organism serve to acquire, transform, transport, release, and eliminate the matter and energy used to sustain the organism.</p>	<p>3. a. Energy is released when the food molecules are broken down into simpler compounds</p> <p>b. Energy is transferred to ATP through cellular respiration</p> <p>c. Most biochemical reactions, fueled by ATP, are catalyzed by enzymes.</p>
<p>Teacher Notes:</p> <p>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.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. ▲ understands animals have behavioral responses to internal changes and to external stimuli.</li>   <li>2. understands most multicellular animals have nervous systems that underlie behavior.</li>   <li>3. understands behaviors are often adaptive when viewed in terms of survival and reproductive success.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes.</li>   <li>b. These responses can be innate and/or learned.</li>   <li>c. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change.</li> </ol> </li>   <li>2.               <ol style="list-style-type: none"> <li>a. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves.</li>   <li>b. The nerve cells communicate with each other by secreting specific excitatory and inhibitory molecules.</li>   <li>c. Sense organs, specialized cells that detect light, sound, touch and specific chemicals, enable animals to monitor what is going on in the world around them.</li> </ol> </li>   <li>3.               <ol style="list-style-type: none"> <li>a. Common behaviors include seeking food, seeking mates, raising young, avoiding predators, and regulating body temperature.</li>   <li>b. Some organisms live in groups and have social behaviors that benefit both the individual and the group.</li> </ol> </li> </ol>

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.

▲ = High School Assessed Indicator

**STANDARD 3: LIFE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"><li>1. understands differences in structure and function among organisms and can identify the characteristics of relevant life forms.</li><li>2. ▲ understands that homeostasis is the dynamic regulation and balance of an organisms internal environment to maintain conditions suitable for survival.</li><li>3. ▲ understands that living things change following a specific pattern of developmental stages called life cycles.</li><li>4. understands that in complex organisms there is a division of labor into specific body systems i.e., respiration, digestion, nervous, endocrine, excretion, circulatory, reproductive, immune, skeletal and muscle.</li></ol>	<ol style="list-style-type: none"><li>1. <ol style="list-style-type: none"><li>a. Major structural differences among organisms include unicellular and multicellular, plants and animals, and invertebrates and vertebrates</li><li>b. Common functions include digestion, respiration, excretion, locomotion, communication and reproduction</li></ol></li><li>4. <ol style="list-style-type: none"><li>a. These systems interact with one another to maintain homeostasis.</li><li>b. Relate the organs and their functions to the body system.</li></ol></li></ol>

5. understands taxonomy is the systematic way in which organism are placed into a hierarchical classification system, according to their physical and genetic characteristics and their evolutionary history.

- 5. 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 PE Standards for additional information.

▲ = High School Assessed Indicator

**STANDARD 4: EARTH AND SPACE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. understands constructive and destructive processes, including weathering, erosion and deposition, dynamically reshape the surface of the earth.</li>   <li>2. ▲ understands the theory of Plate Tectonics explains that internal energy drives the earth’s ever changing structure.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. The rock cycle describes constructive and destructive processes that change the forms of rocks and soil (solid earth).</li>   <li>b. Water, glaciers, winds, waves, and gravity are weathering and erosion agents.</li> </ol> </li>   <li>2.               <ol style="list-style-type: none"> <li>a. Movable continental and oceanic plates make up earth's surface; the hot, convecting mantle is the energy source for plate movement.</li>   <li>b. Essentially all energy on earth originates with the sun, is generated by radioactive decay in earth’s interior, or is left over from earth’s formation.</li>   <li>c. Convection circulation in the mantle is driven by the outward transfer of earth's internal heat.</li>   <li>d. Systems on earth's surface are powered principally by the sun and contain an essentially fixed amount of each stable chemical atom or element.</li>   <li>e. Rocks, water, CO<sub>2</sub>/ O<sub>2</sub>, carbon and other nutrients cycle through different forms as a result of cycle biological and geologic processes.</li> </ol> </li> </ol>

3. The ultimate source of atmospheric and oceanic energy comes from the sun. Energy flow drives global climate and weather. Climate and weather are 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. Example: Burning of fossil fuels produces ground level ozone that hinders plant growth.
  - 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 is filtered by the upper atmosphere.
  - i. Concepts and skills include basic weather forecasting, weather maps, fronts, pressure systems, severe storms and safety precautions.

<p>4. Understands the processes of water cycling through surface water (oceans, lakes, streams, glaciers), ground water (aquifers), and the atmosphere. (hydrological cycle)</p>	<p>4. a. Processes of evaporation, condensation, precipitation, transpiration, runoff, and filtration move water through the water cycle.</p> <p>b. Weather in the troposphere redistributes water on the surface of the earth through the water cycle.</p> <p>c. Ground water is stored in aquifers and moved through underground streams.</p> <p>d. Water in the atmosphere is in the form of water vapor and clouds.</p>
<p>Teacher Notes:</p> <p>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.</p> <p>Learning Science in the Outdoors: Varied experiences in the outdoors make natural processes less abstract and are critical to developing scientific literacy. Teachers are encouraged to create outdoor learning experiences for their students.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 4: EARTH AND SPACE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <p>1. ▲ understands geological time is used to understand the earth's past.</p>	<p>1. a. Radioactive dating and relative dating (i.e. stratigraphy, fossils) are used to estimate the time rocks were formed.</p> <p>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.</p> <p>c. The earth's atmosphere has changed over time. For example: The dramatic changes in earth's atmosphere (i.e. introduction of O<sub>2</sub>) which were affected by the emergence of life on earth.</p> <p>d. Relates geologic evidence to a record of earth's history</p> <p>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.</p>
<p>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.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 4: EARTH AND SPACE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. understands gravitational attraction of objects in the solar system keeps solar system objects in orbit.</li>   <li>2. ▲ understands the relationship between the earth, moon, and sun explains the seasons, tides and moon phases.</li>   <li>3. understands the relative sizes and distances of objects in the solar system.</li>   <li>4. understands the sun, earth, and other objects in the solar system formed from a nebular cloud of dust and gas.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. Kepler’s laws describe planetary motion.</li> <li>b. Newton’s laws of inertia and gravity explain orbital motion.</li> <li>c. Because of the sun’s large mass, the sun is the primary gravitational force in the solar system.</li> </ol> </li>   <li>2.               <ol style="list-style-type: none"> <li>a. The angle of incidence of solar energy striking earth’s surface effect the amount of heat energy absorbed at earth’s surface.</li> <li>b. The gravitational relationship between the earth, moon, and sun causes tides.</li> </ol> </li> </ol>
<p><b>Teacher Notes:</b>            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.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 4: EARTH AND SPACE SCIENCE**

**Grades 8-12**

**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
<p>The student ...</p> <p>1. ▲ understands stellar evolution.</p> <p>2. understands the current scientific explanation of the origin and structure of the universe.</p>	<p>1. a. Condensation of gases, due to gravity, is a foundation for the formation of stars</p> <p>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.</p> <p>c. The Hertzsprung-Russell (H-R) diagram is used to classify stars. The sun is a main sequence star.</p> <p>d. Stars are classified by their color, temperature, age, apparent brightness and distance from earth.</p> <p>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.</p> <p>b. The red shift of light, within the Doppler effect, emitted by distance galaxies supports the conclusion that the universe is expanding.</p>
<p>3. understand how the tools of astronomy have revolutionized the study of the universe.</p>	<p>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.</p> <p>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.</p>

	<p>3.</p> <ul style="list-style-type: none"> <li>a. Current telescopes can measure across the Electromagnetic-Spectrum.</li> <li>b. Spectral analysis is used to determine chemical composition and energy of stars.</li> <li>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.</li> <li>d. The tools and skills of astronomers have changed through time: ancient astronomy (Stonehenge, Greeks, Chinese, Aristotle) through modern astronomy (Copernicus to present).</li> <li>e. Astronomical tools and skills allow astronomers to research phenomena and objects that cannot be observed and measured directly.</li> </ul>
<p>Teacher Notes:</p> <p>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.</p> <p>▲ = High School Assessed Indicator</p>	

**STANDARD 5: SCIENCE AND TECHNOLOGY**

**Grades 8-12**

**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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. ▲ understands technology is the application of scientific knowledge for functional purposes.</li>   <li>2. understands creativity, imagination, and a broad scientific knowledge base are required to produce useful results.</li>   <li>3. understands science advances new technologies. New technologies open new areas for scientific inquiry.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>a. Technology is driven by the need to meet human needs and solve human problems.</li>   <li>b. Engineering is the practical application of science to commerce or industry.</li>   <li>c. Medicine is a practical application of science to human health.</li>   <li>d. All technological advances contain a potential for both gains and risks for society.</li> </ol> </li>   <li>3.               <ol style="list-style-type: none"> <li>a. Technological knowledge may be kept confidential because of the commercial or military potential of the idea or invention.</li>   <li>b. Invention which produces a new device, method or process is developed from study and experimentation often utilizing technology.</li> </ol> </li> </ol>
<p>Teacher Notes:</p>	
<p>▲ = High School Assessed Indicator</p>	

**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 and human-induced hazards, 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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. understands some chemical and physical hazards and accidents can be avoided through safety education</li> <li>2. understands the severity of disease symptoms is dependent on many factors,</li> <li>3. understands informed personal choices concerning fitness and health involve an understanding of chemistry and biology.</li> <li>4. understands selection of foods and eating patterns determine nutritional balance which affects emotional and physical well-being.</li> </ol>	<ol style="list-style-type: none"> <li>2.               <ol style="list-style-type: none"> <li>a. These factors include age, genetic predisposition, nutrition, and environmental factors.</li> <li>b. Many diseases can be prevented, controlled, or cured. Some diseases are communicable and some are not.</li> </ol> </li> </ol>
<p>Teacher Notes:</p> <p>See Kansas Health and PE Standards for additional guidance for health education.</p> <p>▲ = High School Assessed Indicator</p>	

**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 and human-induced hazards, and science and technology in local, national, and global settings.

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

Grades 8-12 Indicators	Additional Specificity
<p>The student ...</p> <ol style="list-style-type: none"><li>1. understands the rate of change in populations is determined by the combined effects of birth, death, emigration, and immigration.</li><li>2. understands a variety of factors influence birth rates and fertility rates.</li><li>3. understands populations have limits to growth.</li></ol>	<ol style="list-style-type: none"><li>1. Populations can increase through exponential growth.</li><li>2. Population growth changes resource availability and changes environmental conditions.</li></ol>
<p>Teacher Notes:</p> <p>▲ = High School Assessed Indicator</p>	

**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 and human-induced hazards, 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
<p>The student ...</p> <ol style="list-style-type: none"> <li>1. ▲ understands natural resources from the lithosphere and ecosystems are required to sustain human populations.</li>   <li>2. understands earth does not have infinite resources.</li> </ol>	<ol style="list-style-type: none"> <li>1.               <ol style="list-style-type: none"> <li>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.</li>   <li>b. Natural systems can reuse waste, but this capacity is limited. Recycling and environmentally sound decisions improve the quality of human life.</li> </ol> </li>   <li>2.               <ol style="list-style-type: none"> <li>a. Increasing human consumption places stress on most renewable resources and depletes non-renewable resources.</li>   <li>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.</li> </ol> </li> </ol>
<p>Teacher Notes:            Learning Science in the Outdoors: Varied experiences in the outdoors make natural processes less abstract and are critical to developing scientific literacy. Teachers are encouraged to create outdoor learning experiences for their students.</p> <p>▲ = High School Assessed Indicator</p>	

**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 and human-induced hazards, 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
<p>The student ...</p> <ol style="list-style-type: none"><li>1 understands natural processes of earth may be hazardous for humans.</li><li>2. understands there is a need to assess potential risk and danger from natural and human-induced hazards.</li></ol>	<p>The student ...</p> <ol style="list-style-type: none"><li>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, ...)</li><li>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.</li></ol>
Teacher Notes:	

**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 and human-induced hazards, 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 progress in science and technology can be affected by social issues and challenges. Science and technology indicate what can happen, not what should happen.	1. Increased use of antibiotics may also increase human resistance to antibiotics.
Teacher Notes: ▲ = High School Assessed Indicator	

**STANDARD 7: HISTORY AND NATURE OF SCIENCE**

**Grades 8-12**

**HISTORY AND NATURE OF SCIENCE – The student will develop understanding of science as a human endeavor, the nature of scientific knowledge, and historical perspectives.**

**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 Details
<p>The student...</p> <ol style="list-style-type: none"> <li>1. demonstrates an understanding of science as both vocation and avocation.</li> <li>2. explains how science uses peer review, replication of methods, and norms of honesty.</li> <li>3. recognizes the universality of basic science concepts and the influence of personal and cultural beliefs that embed science in society.</li> <li>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.).</li> <li>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.</li> <li>6. recognizes society’s role in supporting topics of research and determining institutions where research is conducted.</li> </ol>	<ol style="list-style-type: none"> <li>2. Scientific knowledge is made public through presentations at professional meetings and publications in scientific journals.</li> <li>5. Common examples involve bioethics, environmental issues, and military applications.</li> </ol>
<p>Teacher Notes:                  ▲ = High School Assessed Indicator</p>	

**STANDARD 7: HISTORY AND NATURE OF SCIENCE**

**Grades 8-12**

**HISTORY AND NATURE OF SCIENCE – The student will develop understanding of science as a human endeavor, the nature of scientific knowledge, and historical perspectives.**

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

Grades 8-12 Indicators	Additional Specificity
<p>The student ...</p> <ol style="list-style-type: none"><li>1. understands scientific knowledge describes and explains the physical world in terms of matter, energy, and forces. Scientific knowledge is provisional and is subject to change as new evidence becomes available.</li> <li>2. understands scientific knowledge begins with empirical observations, which are the data (also called facts or evidence) upon which further scientific knowledge is built.</li></ol>	<ol style="list-style-type: none"><li>1.<ol style="list-style-type: none"><li>a. Additional evidence can lead to further confirmation, revision and refinement, or rejection of previously accepted explanations.</li> <li>b. The core theories of science have a high degree of reliability within the limits to which they have been tested and their scope of applicability.</li> <li>c. The open-endedness of science is its greatest strength and allows for constant refining and improvement of our explanations.</li></ol></li> <li>2.<ol style="list-style-type: none"><li>a. The breadth and depth of sensory observations are enhanced by technological instruments such as microscopes, telescopes, and oscilloscopes.</li> <li>b. Observations often include measurements, to varying degrees of accuracy and precision, so they can be described and analyzed with mathematics.</li> <li>c. Observational data is gathered in a number of ways, including controlled experiments, field studies, and the systematic observation of natural phenomena.</li></ol></li></ol>

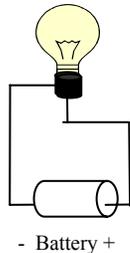




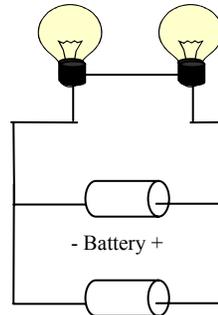
This glossary is not intended as a comprehensive glossary of science terms or science education terms. Words defined here are a compiled list of terms that are defined in grade level Teacher Notes within the Kansas Science Education Standards. After each term, the grade level where the definition is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

Circuits (KSES Gr. K-4)

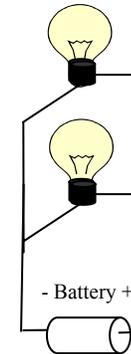
Simple circuit – include diagram



Series circuit –include diagram



Parallel circuit - - include diagram



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 good classification system is whether others can use it. (KSES Gr. K-4)

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

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

Full inquiry – involves asking a simple question, completing an investigation, answering the question, and presenting the results to others. In elementary grades, students begin to develop the physical and intellectual abilities of scientific inquiry. They can design investigations to try things to see what happens – they tend to focus on concrete results of tests and will entertain the idea of a “fair” test (a test in which only one variable at a time is changed) (see page 122 in the National Science Education Standards, 1996). (KSES Gr. K-4)

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)

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

Erosion – movement of earth materials from one place to another. (KSES Gr. K-4)

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)

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)

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

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

Scientific investigation – A scientific investigation uses scientific inquiry to ask an answer a question. (KSES Grades 5-7)

Scientific inquiry – The diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world. Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative (scientific) explanations. Students will engage in selected aspects of inquiry (partial or guided inquiry) as they learn the scientific way of knowing the natural world, but they also should develop the capacity to conduct complete investigations (full inquiry). (From the National Education Standards, p. 23) (KSES Gr. 5-7)

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)

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

Technology – application of knowledge through inventions. (see 8-12 Standard 5 document)

Tools – object used to achieve a goal, to make an observation, and extend the senses (see page 122 in the National Science Education Standards, 1996). (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 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 weight less on Earth than on Jupiter because Jupiter has greater mass than Earth; Jupiter's mass would have a greater gravitational attraction for the object. (KSES Gr. 5-7)