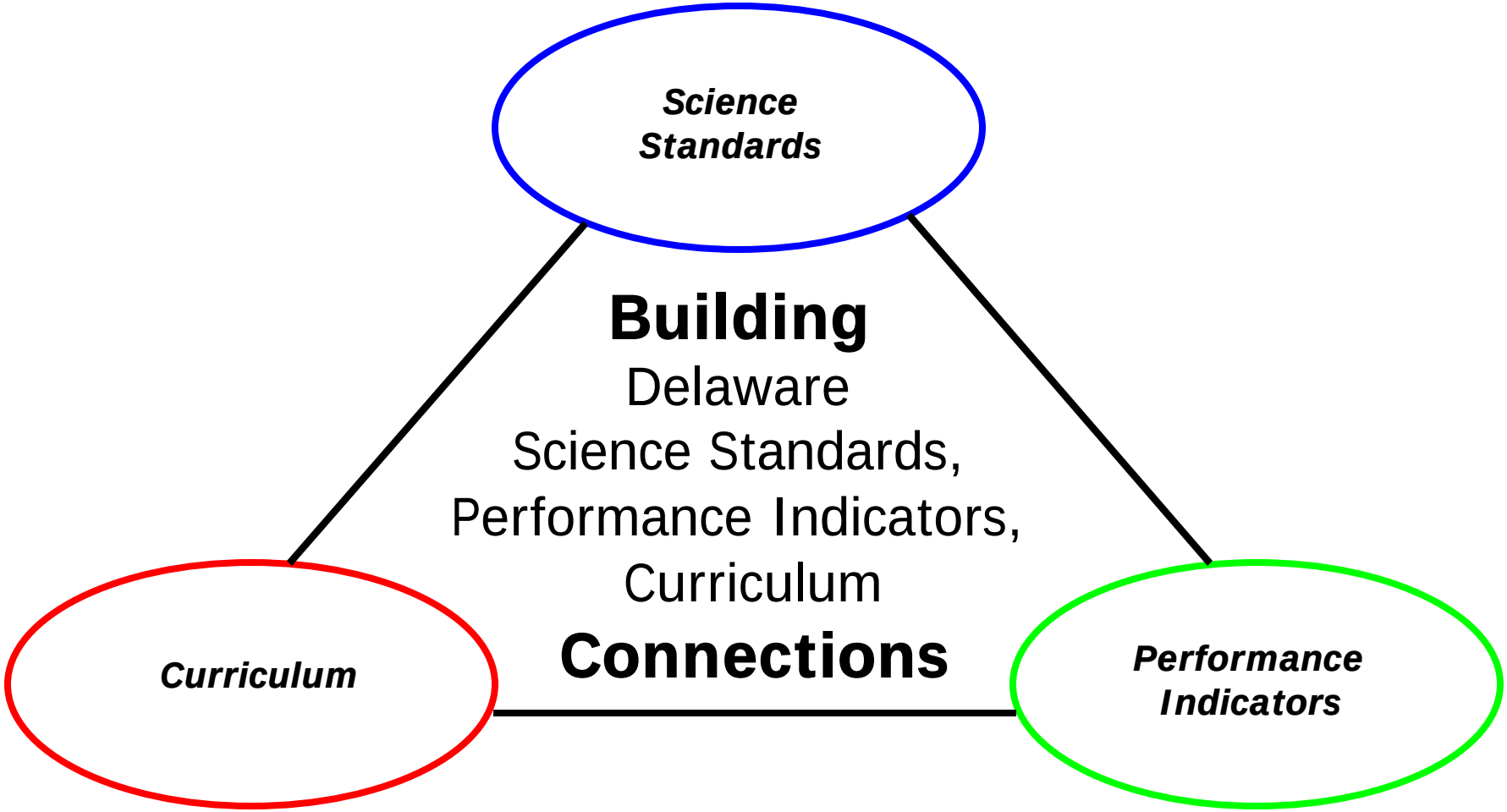

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Grade 10 Science Standards and Performance Indicators

12/07/00

Standard 1 – Nature and Application of Science and Technology

Science Standard	Performance Indicator	Concept	Unit
Science as Inquiry 1.11 The identification and formulation of appropriate questions guide the design and breadth of a scientific investigation. Based on the type of question(s) proposed, investigations explore new phenomena, solve science and technology related problems, compare different theories, resolve conflicts concerning societal issues, determine reasons for discrepancies in previous experimental results, or test the practicality of a consumer product.	All	Experimental Design Scope of Science	Transmission of Genetic Information
1.12 Scientific investigations in many cases follow no fixed set of steps. However, there are certain features of a valid scientific investigation that are essential and result in evidence that can be used to construct explanations.	All	Experimental Design	
1.13 Tools and technologies extend human capabilities to perform investigations in more detail and with greater accuracy and improved precision.	All	Technology and Science	Transmission of genetic information
1.14 The close examination of evidence is necessary to construct logical scientific explanations and present arguments which defend proposed explanations. Such critical analyses of supporting evidence are not only important to scientific investigations but help in judging the validity of claims made in advertisements or concluded from investigative reports.	All	Analysis of Evidence Evidence and Scientific Explanation	Transmission of genetic information
1.15 Publication and presentation of scientific work with supporting evidence is part of the critique, review, and validation process conducted by the scientific community. The presentation of such work in accessible journals and reviews adds to the body of scientific knowledge and serves as background for subsequent investigations in similar areas.	All	Importance of Communication	

Science, Technology & Society 1.21 The practice of science and technology is not a linear process. In many cases, the desire of scientists to find what is real in nature creates opportunities for technology development. At the same time, technology provides scientists with tools and techniques that allow expansion of their capabilities and effectiveness.	All	Science and Technology Relationship	Transmission of genetic information
1.22 The social, economic, and political forces of a society have a significant influence on what science and technology programs are pursued, invested in, and used.	All	Science, Technology, and Society	Transmission of genetic information
History & Context of Science 1.31 Science is an international activity in which significant inventions and innovations have come from around the world. Even though scientists live and work in different cultures and come from different backgrounds, many of their activities are part of international collaborative efforts, and the knowledge created is shared in order to maximize the benefits to society.	All	Collaboration, Communication, and Science	Transmission of genetic information
1.32. Science is divided into many disciplines such as astrophysics, biochemistry, and geophysics. Each discipline is a field of endeavor in itself and requires specialized training. Many of the tools, techniques, methods, and much of the knowledge created in one discipline are shared across disciplines in order maximize the impact of the work.	All	Scientific Disciplines Integration of Knowledge	

Standard 2 – Materials and Their Properties

Science Standards	Performance Indicator	Content	Unit
Properties & Structure of Matter 2.13 (1) Substances are formed by atoms interacting with one another and transferring or sharing electrons. These interactions generally involve the electrons farthest from the nucleus, and result in the formation of chemical bonds and molecules, the building blocks of compounds.	10.25 Manipulate molecular models to demonstrate that carbon is neither a strong electron acceptor nor a strong electron donor and is thus able to form covalent bonds with many elements. Use the molecular models to explain how carbon atoms uniquely bond to one another to form a large variety of molecules including those necessary for life.	Atoms, Molecules and Chemical Bonds	
2.14 (2) The properties of compounds depend on the properties and interactions of their molecules. These molecular properties and interactions depend on the kinds of atoms in the molecule, molecular shape and motion, and the electrical forces that exist between molecules. An enormous variety of biological, chemical, and physical phenomena can be explained by these properties and interactions. Bonding diagrams and three-dimensional models can be used to represent and visualize atoms, molecules, and interactions.	10.25 Manipulate molecular models to demonstrate that carbon is neither a strong electron acceptor nor a strong electron donor and is thus able to form covalent bonds with many elements. Use the molecular models to explain how carbon atoms uniquely bond to one another to form a large variety of molecules including those necessary for life. 10.26 Use molecular models or visual representations to explain why complex carbohydrates are polymers. Describe the process by which water is removed from sugar molecules (dehydration synthesis) to form carbohydrates and is added to break them down (hydrolysis).	Properties of Compounds Molecular Properties and Interactions	Transmission of genetic information
2.15 (2) Elements and compounds exist as solids, liquids, and gases. In solids, the atomic and molecular structures are orderly and nearly rigid and the vibration of atoms and molecules is constrained to a fixed site. In liquids, atoms and molecules move more freely and randomly, and this movement is insufficient to overcome the attractive forces that exits between atoms and molecules. In gases, molecular motion is rapid and random and overcomes the attractive forces that exist between molecules.	10.19 Use demonstrations to explain the process of Brownian motion. Describe how the process of diffusion or the movement of molecules from an area of high concentration to an area of low concentration (down the concentration gradient) occurs because of molecular collisions. 10.33 Reanalyze data obtained from the cellular model investigations that determined the relationship among cell size, surface area to volume ratio and the rate of diffusion into and out of the cell. Relate the results of the investigation to the need for cells to divide in order to function efficiently.	Physical States of Matter	

Transformation & Conservation of Matter 2.21 (4) Chemical reactions which take place between the atoms and molecules of elements and compounds occur all around us, for example, combustion, rusting of iron, growing of plants, and cooking of foods. Complex chemical reactions take place constantly in every cell of the human body. A chemical equation represents, with symbols and formulas, the reactions and products in a chemical reaction.	10.01 Conduct experimental observations and cite evidence (e.g., formation of a precipitate, evolution of gas, change of color, release/absorption of energy in the form of heat, light or sound) as to whether or not a chemical reaction has occurred. 10.02 Analyze chemical equations for a variety of common types of reactions (e.g., synthesis, decomposition, replacement and combustion) and identify the reactants and products in 6the equation. 10.03 Identify the number of atoms on each side of a chemical equation to determine if the equation is balanced. Recognize that balanced chemical equations illustrate that the mass of the product is equal to the mass of the reactants. 10.32 Analyze the equation for cellular respiration along with the equation for photosynthesis. Use the formulas to identify the reactants and products in each process and to explain the complimentary nature of the processes.	Chemical Reactions Chemical Equations	
2.22 (7) Virtually all chemical reactions release or absorb energy. During chemical reactions, energy in the form of heat, light, or electricity is absorbed in the breaking of bonds or released when new bonds are formed. The rate of a chemical reaction depends on the properties and concentration of the reactants, temperature, and the presence or absence of a catalyst. A catalyst changes the rate of a chemical reaction by interacting with the reacting species but is not consumed in the overall reaction.	10.01 Conduct experimental observations and cite evidence (e.g., formation of a precipitate, evolution of gas, change of color, release/absorption of energy in the form of heat, light or sound) as to whether or not a chemical reaction has occurred. 10.02 Analyze chemical equations for a variety of common types of reactions (e.g., synthesis, decomposition, replacement and combustion) and identify the reactants and products in 6the equation. 10.04 Investigate factors (e.g., presence of a catalyst, temperature, concentration) that influence the rate at which reactions occur. Construct simple diagrams to demonstrate and to explain that activation energy is required for the reaction to reach the transition state (the point at which the system has the highest potential energy) and that there is an energy difference between reactants and products. 10.05 Analyze reaction diagrams for some common chemical reactions to compare the amount of heat energy absorbed by the reaction to the amount of heat energy released. Explain using the diagrams that if the products of the reactions are at a higher energy level than the reactants, then the reaction has absorbed heat energy (endothermic), but if the products of the reaction are at a lower energy level than the reactants, then heat energy has been released (exothermic). 10.27 Recognize that when chemical bonds between sugar molecules are broken (hydrolysis) energy is released and that heterotrophs must break chemical bonds in food	Chemical Reactions and Transfer of Energy Reaction Rates Catalysts	

	molecules during cellular respiration to obtain the energy needed for life processes. 10.29 Refer to the results of previous rate of reaction investigations and reaction diagrams to explain how enzymes lower the energy of activation and permit low temperature chemical reactions to occur in cells. 10.30 Select an enzyme substrate system (e.m., amylase/starch, protease/gelatin, catalase/hydrogen peroxide) and investigate factors that affect the rate of enzyme catalyzed reactions (e.g., temperature, light pH, enzyme/substrate concentration).		
2.23 (1) A large number of reactions, usually in solution, that are important in non-living and living systems, involve the transfer of either electrons (oxidation/reduction) or hydrogen ions (acid/base reactions).	10.01 Conduct experimental observations and cite evidence (e.g., formation of a precipitate, evolution of gas, change of color, release/absorption of energy in the form of heat, light or sound) as to whether or not a chemical reaction has occurred.	Oxidation/Reduction Reactions Acid/Base Reactions	
2.24 (1) Regardless of how atoms and molecules in a closed system interact with one another, or how they combine or break apart, the total weight of the system remains the same.	10.03 Identify the number of atoms on each side of a chemical equation to determine if the equation is balanced. Recognize that balanced chemical equations illustrate that the mass of the product is equal to the mass of the reactants.	Conservation of Mass	
2.25 (3) Certain small molecules (monomers) react with one another in repetitive fashion (polymerization) to form long chain macromolecules (polymers). The properties of the macromolecules depend on the properties of the molecules used in their formation and on the lengths and structure of the polymer chain.	10.26 Use molecular models or visual representations to explain why complex carbohydrates are polymers. Describe the process by which water is removed from sugars molecules (dehydration synthesis) to form carbohydrates and is added to break them down (hydrolysis). 10.27 Recognize that when chemical bonds between sugar molecules are broken (hydrolysis) energy is released and that heterotrophs must break chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes. 10.37 Construct models (pop beads, pipe cleaners) to demonstrate that DNA is a long twisted, double stranded polymer composed of small sub-units. Explain how the order of the sub-units on one strand of KNA provides a template that determines the order of the sub-units on the other strand of DNA.	Macromolecules and Polymers	Transmission of genetic information

Standard 3 - Energy and Its Effects

Science Standard	Performance Indicator	Concept	Unit
Forms/Sources of Energy 3.15 (4) Chemical energy is derived from the gain or loss of electrons between atoms during the making and breaking of chemical bonds. The energy released or absorbed in a chemical reaction can be predicted and measured. The rate of many chemical reactions can be increased by raising the temperature or by adding catalysts in order to reduce the activation energy.	10.05 Analyze reaction diagrams for some common chemical reactions to compare the amount of heat energy absorbed by the reaction to the amount of heat energy released. Explain using the diagrams that if the products of the reactions are at a higher energy level than the reactants, then the reaction has absorbed heat energy (endothermic), but if the products of the reaction are at a lower energy level than the reactants, then heat energy has been released (exothermic). 10.06 Recognize that in general, synthesis reactions require energy while decomposition reactions usually release energy. 10.07 Use data obtained from investigations to explain the processes used by autotrophs to capture light energy and produce molecules such as simple sugars and starch. Measure the rate of photosynthesis and recognize that photosynthesis is an endothermic reaction in which sunlight is continually needed if carbohydrates are to be synthesized. 10.09 Calculate the relative amount of chemical potential energy stored in chemical bonds of a variety of foods. Recognize that all matter does not contain the same amount of energy.	Transfer of Energy and Chemical Reactions	
Transformation & Conservation of Energy 3.31 (3) Energy can be transformed from one form into another, but the total energy is constant in a closed system. The amount of energy involved in any process, and the rate at which it is generated or consumed can be discussed qualitatively and measured. Some energy is released or absorbed in most energy transformations.	10.07 Use data obtained from investigations to explain the processes used by autotrophs to capture light energy and produce molecules such as simple sugars and starch. Measure the rate of photosynthesis and recognize that photosynthesis is an endothermic reaction in which sunlight is continually needed if carbohydrates are to be synthesized. 10.10 Explain that as organisms break down the high energy compounds in foods, some of the energy escapes as heat. Construct diagrams to illustrate this point. 10.12 Investigate where humans position themselves on the food chain. Describe individual and global benefits that could be realized from humans eating at a lower trophic level.	Conservation of Energy Energy Transformation	

Standard 4 – Earth in Space

Science Standard	Performance Indicator	Concept	Unit
Solar System Models 4.14 (1) The tilt of the Earth's axis relative to its orbital plane does not change as the Earth orbits the Sun during a year. Seasonal variations of the apparent path of the Sun through the sky determine how directly the Sun's rays strike and warm different areas of the Earth.	10.13 Investigate how seasonal variations in solar energy in an ecosystem affects the biomass of producers. Relate this variation to the total number of consumers the system supports and identify ways in which ecosystems reduce energy demands during times of decreased solar energy input (e.g., leaves falling, estivation, migration).	Earth in Space Generation of Seasons	

Standard 6 – Life Processes

Science Standard	Performance Indicator	Concept	Unit
Structure/Function Relationship 6.11 (1) Cells are the fundamental structural and functional units of all living organisms. Cells take highly varied forms in different plants, animals, and microorganisms. Structural variations among cells determine the function each cell performs.	10.15 Use microscopes to observe a variety of cells from each of the kingdoms. Identify similarities and differences among the cells and explain how structural variations determine the function that each of the cells perform.	Cells and Living Organisms	
6.12 (4) Cells have distinct and separate structures (organelles) which perform and monitor processes essential for survival of the cell (e.g., energy production, waste disposal, synthesis of new molecules, storage of genetic material). The highly specific function of each organelle is directly related to its structure.	10.15 Use microscopes to observe a variety of cells from each of the kingdoms. Identify similarities and differences among the cells and explain how structural variations determine the function that each of the cells perform. 10.16 Describe the difference in complexity of cells. Distinguish between cells (prokaryotes) that are relatively simple with no true nucleus from cells (eukaryotes) that have more complex organization with a true nucleus and membrane bound organelles. 10.17 observe cellular models to identify major organelles. Select several of the cellular organelles and explain how the highly specialized functions of each is directly related to its structure. 10.18 Use microscopes to observe the chloroplast of a plant cell. Recognize that these organelles specialize in the process of photosynthesis. Relate the structure of the chloroplast tot he process of photosynthesis.	Cellular Organelles Subcellular Specialization	
6.13 (7) The cell membrane defines the boundary of the cell and regulates the passage of materials into and out of the cell. Transport mechanisms across the membrane are dependent on membrane structure and concentration gradients.	10.16 Describe the difference in complexity of cells. Distinguish between cells (prokaryotes) that are relatively simple with no true nucleus from cells (eukaryotes) that have more complex organization with a true nucleus and membrane bound organelles. 10.17 observe cellular models to identify major organelles. Select several of the cellular organelles and explain how the highly specialized functions of each is directly related to its structure. 10.20 Recognize that the movement of water into and out of living cells is vital to life processes and that the diffusion of water through a semi-permeable membrane is referred to as osmosis. 10.21 Distinguish between active and passive transport. Recognize that active transport requires energy in order to move molecules from an area of low concentration to an area of high concentration (against the concentration	Cell Membrane Transport into and out of Cell	

	gradient). 10.22 Use fluid mosaic models of the plasma membrane to explain how its structure regulates the movement of materials across the membrane. 10.23 Design a controlled experiment to investigate the capacity of the cell membrane to regulate what enters and leaves the cell. Expose cells (e.g., chicken egg, plant cells) to solutions of different concentrations and explain the relationship between the solutions and the internal environment of the cell (hypotonic, isotonice, hypertonice). Relate the results of the investigation to every day examples of this phenomenon (e.g., food preservation using salt and sugar, dehydration from drinking seawater, rehydration of produce on grocery shelves by spraying with water. 10.24 Construct cell models)e.g., phenolphthalein-agar cubes, potato-iodine cubes) to investigate the relationship among cell size, surface area to volume ratio and the rates of diffusion into and out of the cell. Speculate why large organisms have developed from many cells rather than one large cell.		
Matter & Energy Transformations 6.21 (2) Cells carry out a variety of chemical transformations which allow conversion of energy from one form to another, the breakdown of molecules into smaller units, and the building of larger molecules from smaller ones. Most of these transformations are made possible by protein catalysts called enzymes.	10.18 Use microscopes to observe the chloroplast of a plant cell. Recognize that these organelles specialize in the process of photosynthesis. Relate the structure of the chloroplast to the process of photosynthesis. 10.29 Refer to the results of previous rate of reaction investigations and reaction diagrams to explain how enzymes lower the energy of activation and permit low temperature chemical reactions to occur in cells.	Energy and Chemical Reactions Enzymes are Protein Catalysts	
6.22 (3) Plant cells contain plastids, which convert light energy into chemical energy through the process of photosynthesis. This chemical energy is used by the plants to convert carbon dioxide and water into high-energy food molecules such as lipids and carbohydrates. Photosynthesis adds oxygen to the atmosphere and removes CO2.	10.07 Use data obtained from investigations to explain the processes used by autotrophs to capture light energy and produce molecules such as simple sugars and starch. Measure the rate of photosynthesis and recognize that photosynthesis is an endothermic reaction in which sunlight is continually needed if carbohydrates are to be synthesized. 10.08 Identify the reactants and the products in an equation that represent photosynthesis. Explain how the equation demonstrates the Law of Conservation of Matter. 10.18 Use microscopes to observe the chloroplast of a plant cell. Recognize that these organelles specialize in the process of photosynthesis. Relate the structure of the chloroplast tot he process of photosynthesis.	Conversion of Energy By Photosynthesis Consumption of CO_2 & Production of O_2	
6.23 (6) All organisms including plants use the process of cellular respiration to transform high-energy food molecules produced during photosynthesis into energy. The energy produced is stored in the phosphate linkages of ATP and is used by organisms to conduct their life processes. Cellular	10.08 Identify the reactants and the products in an equation that represent photosynthesis. Explain how the equation demonstrates the Law of Conservation of Matter. 10.09 Calculate the relative amount of chemical potential energy stored in chemical bonds of a variety of foods.	Cellular Respiration & Energy Transformation	

respiration may require oxygen and adds carbon dioxide to the atmosphere.	Recognize that all matter does not contain the same amount of energy. 10.27 Recognize that when chemical bonds between sugar molecules are broken (hydrolysis) energy is released and that heterotrophs must break chemical bonds in food molecules during cellular respiration to obtain the energy needed for life processes. 10.28 Recognize that during cellular respiration, carbohydrates and other food molecules are broken down and transformed into chemical energy, ATP, and that in this form, energy can then be used to do cell work. (e.g., transporting materials across the cell membrane, conducting nerve impulses, contracting muscle fibers). 10.31 Design investigations to develop reasonable explanations concerning the complimentary relationship (cycling of matter and the flow energy) between photosynthesis and cellular respiration. For example, a small snail, a water plant, a light source, and a pH indicator can be sued as part of an experimental design to explain the relationship. 10.32 Analyze theequation for cellular respiration along with the equation for photosynthesis. Use the formulas to identify the reactants and products in each process and to explain the complimentary nature of the processes.	Consumption of O_2 & Production of CO_2	
6.24 (3) Photosynthesis and cellular respiration are complimentary processes to the flow of energy and the cycling of matter in ecosystems.	10.08 Identify the reactants and the products in an equation that represent photosynthesis. Explain how the equation demonstrates the Law of Conservation of Matter. 10.31 Design investigations to develop reasonable explanations concerning the complimentary relationship (cycling of matter and the flow energy) between photosynthesis and cellular respiration. For example, a small snail, a water plant, a light source, and a pH indicator can be sued as part of an experimental design to explain the relationship. 10.32 Analyze theequation for cellular respiration along with the equation for photosynthesis. Use the formulas to identify the reactants and products in each process and to explain the complimentary nature of the processes.	Photosynthesis, Respiration and Energy Cycling	

Standard 7 – Diversity and Continuity of Living Things

Science Standard	Performance Indicator	Concept	Unit
Heredity 7.11 (5) Heredity/genetic information in chromosomes is contained in molecules of DNA that consist of various combinations of four different subunits (nucleotides) that encode this information. Genes are sections of DNA that direct synthesis of specific proteins associated with traits in organisms.	10.34 Manipulate simple chromosomal models (e.g., 3-4 sets of chromosomes) to demonstrate that as a diploid cell replicates, it forms two new sets of identical chromosomes. 10.36 Recognize that genes are subunits of chromosomes and are composed of DNA molecules which transmit genetic information from cell to cell during mitosis. 10.37 Construct models (pop beads, pipe cleaners) to demonstrate that DNA is a long twisted, double stranded polymer composed of small sub-units. Explain how the order of the sub-units on one strand of KNA provides a template that determines the order of the sub-units on the other st4rand of DNA. 10.38 Use DNA models to demonstrate that during mitosis when the KNA (chromosome) replicates the strands separate and the old starnd serves as the template for the new complementary strand. Recognize that through this replication process, two identical strands of DNA are formed exactly like the original double stranded molecule. 10.39 Use models of DNA, RNA, and amino acids to demonstrate the mechanism by which DNA directs the synthesis of proteins. Explain that gene is a section DNA that directs the synthesis of a specific protein associated with a specific trait in an organism. Recognize that a gene mutation (change in the order of DNA subunits) can cause a structural change in a protein which can result in the alteration of a trait.	Chromosomes & DNA DNA and Genes Genes and Proteins Genes and Traits	Transmission of genetic information
7.12 (4) Principles of Mendelian genetics are useful in determining the pattern of inheritance for many traits.	10.47 Conduct simulation activities (e.g., use beans, kernels of corn, pop beads to represent alleles for a specific trait) to demonstrate how genetic information is passed from one generation to the next. Based on the results of the simulation, explain the basic principles of Mendelian genetics: inherited characteristics are controlled by genes occurring in pairs, a dominant gene can mask the effect of a recessive gene, a pair of genes separate during the formation of sex cells. 10.48 Use Punnett squares and pedigree charts to determine probabilities and patterns of inheritance such as dominant/recessive, codominance, sex-linkage, multi-allele inheritance. 10.49 Investigate patterns of inheritance for several well	Mendelian Genetics	Transmission of genetic information

	known human genetic disorders (e.g., autosomal recessive/cystic fibrosis, autosomal dominant/Huntington's Disease, sex linked/hemophilia). Explain the probability of offspring inheriting the disorder and the advances medical research has made in treating the disorder. 10.50 Perform probability activities (using pennies, candies, etc.) to simulate gender determination or the inheritance of a particular trait. Based on results of the activities explain the effect sample size has on the match between probable outcomes and predicted results.		
7.13 (3) Gene mutations are alterations in normal DNA structure, which can be used by coding error in DNA synthesis, heat, radiation and certain chemicals. Mutations may be beneficial, harmful, or neutral to cell function and can be passed to an organism's offspring. Somatic mutations are not heritable.	10.39 Use models of DNA, RNA, and amino acids to demonstrate the mechanism by which DNA directs the synthesis of proteins. Explain that a gene is a section of DNA that directs the synthesis of a specific protein associated with a specific trait in an organism. Recognize that a gene mutation (change in the order of DNA subunits) can cause a structural change in a protein which can result in the alteration of a trait. 10.43 Demonstrate through the use of diagrams or models that meiosis promotes genetic diversity via crossing over, genetic recombination, mutations. 10.51 Recognize mutation (changes in DAN) and recombination as the sources of heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species. Describe how a variety of influences may cause gene mutations.	Gene Mutations	Transmission of genetic information

Reproduction & Development 7.21 (5) During the cell cycle, DNA of the parent cell replicates to form identical chromosomes and genes and the cell divides into two identical offspring cells.	10.34 Manipulate simple chromosomal models (e.g., 3-4 sets of chromosomes) to demonstrate that as a diploid cell replicates, it forms two new sets of identical chromosomes during the stages. 10.35 Observe a series of pictures, slides or models that illustrate the stages of mitosis. Sequence the stages and describe distinctive differences observed in the chromosomes during the stages. 10.36 Recognize that genes are subunits of chromosomes and are composed of DNA molecules which transmit genetic information from cell to cell during mitosis. 10.37 Construct models (pop beads, pipe cleaners) to demonstrate that DNA is a long twisted, double stranded polymer composed of small sub-units. Explain how the order of the sub-units on one strand of DNA provides a template that determines the order of the sub-units on the other strand of DNA. 10.38 Use DNA models to demonstrate that during mitosis when the DNA (chromosome) replicates the strands separate and the old strand serves as the template for the new complementary strand. Recognize that through this replication process, two identical strands of DNA are formed exactly like the original double stranded molecule.	DNA Replication and Cell Cycle	Transmission of genetic information
7.22 (5) During the cell division process that forms gametes (meiosis), the number of chromosomes is reduced by one-half and genes are shuffled and recombined. The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations in the offspring.	10.41 Recognize that during the formation of gametes or sex cells (meiosis) the number of chromosomes is reduced by one half and genes are shuffled and recombined. 10.42 Construct cellular models (e.g., modeling clay, pop beads) to represent a male or female diploid animal that has a limited number of sets of chromosomes (e.g., 2-3). Track how meiosis affects the distribution of chromosomes and the shuffling of genes. 10.43 Demonstrate through the use of diagrams or models that meiosis promotes genetic diversity via crossing over, genetic recombination, mutations. 10.45 Use models to demonstrate that during meiosis, the gametes receive a single sex chromosome. Explain that during fertilization, a sex chromosome contributed by the mother and one contributed by the father determines the sex of the offspring. 10.46 Use models or diagrams to demonstrate that the diploid chromosome number is restored during fertilization.	Chromosome Number and Gamete Production Source of Genetic Variation	Transmission of genetic information

Evolution 7.31 (9) The process of natural selection occurs when some heritable variations that arise from mutation and recombination give individuals within a species some survival advantages over others. These advantaged offspring are more likely to survive and reproduce, thus increasing the proportion of individuals with advantageous characteristics. New species may form when populations become isolated from each other.	10.41 Recognize that during the formation of gametes or sex cells (meiosis) the number of chromosomes is reduced by one half and genes are shuffled and recombined. 10.43 Demonstrate through the use of diagrams or models that meiosis promotes genetic diversity via crossing over, genetic recombination, mutations. 10.45 Use models to demonstrate that during meiosis, the gametes receive a single sex chromosome. Explain that during fertilization, a sex chromosome contributed by the mother and on contributed by the father determines the sex of the offspring. 10.49 Investigate patterns of inheritance for several well known human genetic disorders (e.g., autosomal recessive/cystic fibrosis, autosomal dominant/Huntington's Disease, sex linked/hemophilia). Explain the probability of offspring inheriting the disorder and the advances medical research has made in treating the disorder. 10.50 Perform probability activities (using pennies, candies, etc.) to simulate gender determination or the inheritance of a particular trait. Based on results of the activities explain the effect sample size has on the match between probable outcomes and predicted results. 10.51 Recognize mutation (changes in DNA) and recombination as the sources of heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species. Describe how a variety of influences may cause gene mutations. 10.52 Conduct a natural selection simulation and use data generated from it to describe how environmentally favored traits are perpetuated over generations while less favorable traits decrease in frequency. 10.53 Cite evidence (Darwin's finches, fossils, melanin in peppered moths, anatomical or biochemical comparisons) from a variety of extinct and present day species to support evolution and natural selection. Draw reasonable conclusions regarding evolutionary change over time. 10.54 Recognize that evolution involves changes in the genetic make-up of whole populations over time, not changes in genes of an individual organism. Distinguish between short term physiological adaptations in an organism (e.g., skin tanning and muscular development) and long term evolutionary changes in a population (e.g., cranial capacity and curvature of the spine). 10.55 Trace the history and context of the development of the theory of natural selection. Use natural selection as an	Natural Selection Origin of Species	Transmission of genetic information

	example to explain how science advances knowledge through careful observation, rigorous testing of hypotheses, and formation of theories.		
7.32 (5) Evolution does not proceed at the same rate in all organisms; nor does it progress in some set direction. Some organisms have remained relatively unchanged for millions of years while others have died out altogether. In addition, some complex organisms have evolved from simple unspecialized forms of life, while other species are the result of complex life forms evolving to simple forms.	10.51 Recognize mutation (changes in DNA) and recombination as the sources of heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species. Describe how a variety of influences may cause gene mutation. 10.52 Conduct a natural selection simulation and use data generated from it to describe how environmentally favored traits are perpetuated over generations while less favorable traits decrease in frequency. 10.53 Cite evidence (Darwin's finches, fossils, melanin in peppered moths, anatomical or biochemical comparisons) from a variety of extinct and present day species to support evolution and natural selection. Draw reasonable conclusions regarding evolutionary change over time. 10.54 Recognize that evolution involves changes in the genetic make-up of whole populations ;over time, not changes in the genes of an individual organism. Distinguish between short term physiological adaptations in an organism (e.g., skin tanning and muscular development) and long term evolutionary changes in a population (e.g., cranial capacity and curvature of the spine). 10.55 Trace the history and context of the development of the theory of natural selection. Use natural selection as an example to explain how science advances knowledge through careful observation rigorous testing of hypotheses, and formation of theories.	Rates and Direction of Evolution	Transmission of genetic information

Diversity 7.43 (5) Variations of organisms within a species and diversity among species increase the likelihood that at least some organisms will survive major changes in the environment.	10.51 Recognize mutation (changes in DNA) and recombination as the sources of heritable variations that give individuals within a species survival and reproductive advantage or disadvantage over others in the species. Describe how a variety of influences may cause gene mutations. 10.52 Conduct a natural selection simulation and use data generated from it to describe how environmentally favored traits are perpetuated over generations while less favorable traits decrease in frequency. 10.53 Cite evidence (Darwin's finches, fossils, melanin in peppered moths, anatomical or biochemical comparison) from a variety of extinct and present day species to support evolution and natural selection. Draw reasonable conclusions regarding evolutionary change over time. 10.54 Recognize that evolution involves changes in the genetic make-up of whole populations over time, not changes in the genes of an individual organism. Distinguish between short term physiological adaptations in an organism (e.g., skin tanning and muscular development) and long term evolutionary changes in a population (e.g., cranial capacity and curvature of the spine). 10.55 Trace the history and context of the development of the theory of natural selection. Use natural selection as an example to explain ;how science advances knowledge through careful observation, rigorous testing of hypotheses, and formation of theories.	Importance of Diversity Sources of Diversity	Transmission of genetic information
Health & Technology Applications 7.51 (2) The expanding ability to manipulate genetic material, reproductive processes, and embryological development are being used to diagnose and treat human abnormalities as well as manufacture new consumer products. These applications raise many ethical, legal, social, and public policy questions.	10.40 Investigate how the human ability to manipulate genetic material can be applied to many areas of medicine, biology, and agriculture. Discuss the ethical, legal, social, and public policy implications that these applications raise. 10.49 Investigate patterns of inheritance for several well known human genetic disorders (e.g., autosomal recessive/cystic fibrosis, autosomal dominant/Huntington's Disease, sex linked/hemophilia). Explain the probability of offspring inheriting the disorder and the advances medical research has made in treating the disorder.	Importance of Genetic Technologies Technology and Society Issues	Transmission of genetic information
7.52 (2) Recombinant DNA technology, which is a form of genetic engineering, involves the insertion of DNA from one cell into another cell where the inserted DNA is expressed. Genetic engineering is being applied in many areas of biology, agriculture, and medicine.	10.40 Investigate how the human ability to manipulate genetic material can be applied to many areas of medicine, biology, and agriculture. Discuss the ethical, legal, social, and public policy implications that these applications raise. 10.49 Investigate patterns of inheritance for several well known human genetic disorders (e.g., autosomal recessive/cystic fibrosis, autosomal dominant/Huntington's Disease, sex linked/hemophilia). Explain the probability of offspring inheriting the disorder and the advances medical	Recombinant DNA Technology Importance of Genetic Technology	Transmission of genetic information

	research has made in treating the disorder.		
7.53 (2) DNA is analyzed to study populations, identify individuals, and diagnose genetic disorders.	10.44 Observe karyotypes of human chromosomes (paired and sequenced) and differentiate between the autosomes and the sex chromosomes. 10.49 Investigate patterns of inheritance for several well known human genetic disorders (e.g., autosomal recessive/cystic fibrosis, autosomal dominant/Huntington's Disease, sex linked/hemophilia). Explain the probability of offspring inheriting the disorder and the advances medical research has made in treating the disorder.	Population Biology Uniqueness of Individual's Genetic Constitution	Transmission of genetic information

Standard 8 - Ecology

Science Standard	Performance Indicators	Concept	Unit
Flow of Matter & Energy in Ecosystems 8.11 (4) The supply of nutrients and the efficiency of the solar energy transformations are two major factors which ultimately determine the number of organisms and species in an ecosystem.	10.07 Use data obtained from investigations to explain the processes used by autotrophs to capture light energy and produce molecules such as simple sugars and starch. Measure the rate of photosynthesis and recognize that photosynthesis is an endothermic reaction in which sunlight is continually needed if carbohydrates are to be synthesized. 10.11 Analyze a variety of graphs or pyramids (e.g., pyramids of numbers, pyramid of biomass, pyramid of energy) that represent energy flow in food chains and food webs. Explain why in general, fewer organisms can be supported at each trophic level of the pyramid and why sunlight needs to be continually fed into the system. 10.12 Investigate where humans position themselves on the food chain. Describe individual and global benefits that could be realized from humans eating at a lower trophic level. 10.13 Investigate how seasonal variations in solar energy in an ecosystem affects the biomass of producers. Relate this variation to the total number of consumers they system supports and identify ways in which ecosystems reduce energy demands during times of decreased solar energy input (e.g., leaves falling, estivation, migration).	Nutrient Supply and Energy Determine the Parameters of the Ecosystem	
8.12 (2) The law of conservation of matter applies to ecosystems. Matter needed to sustain life in ecosystems is continually recycled among organisms and between organisms and the environment.	10.31 Design investigations to develop reasonable explanations concerning the complimentary relationship (cycling of matter and the flow of energy) between photosynthesis and cellular respiration. For example, a small snail, a water plant, a light source, and pH indicator can be used as part of an experimental design to explain the relationship. 10.32 Analyze the equation for cellular respiration along with the equation for photosynthesis. Use the formulas to identify the reactants and products in each process and to explain the complimentary nature of the processes.	Conservation of Matter within Ecosystems	
8.13 (6) The law of conservation of energy applies to ecosystems. All energy is conserved as it passes from the Sun through an ecosystem. During energy transformations some energy is converted to biologically unusable waste heat which is eventually lost and replenished by a continual input of solar energy.	10.11 Analyze a variety of graphs or pyramids (e.g., pyramids of numbers, pyramid of biomass, pyramid of energy) that represent energy flow in food chains and food webs. Explain why in general, fewer organisms can be supported at each trophic level of the pyramid and shy sunlight needs to be continually fed into the system.	Conservation of Energy with Ecosystems	

	10.12 Investigate where humans position themselves on the food chain. Describe individual and global benefits that could be realized from humans eating at a lower trophic level. 10.13 Investigate how seasonal variations in solar energy in an ecosystem affects the biomass of producers. Relate this variation to the total number of consumers the system supports and identify ways in which ecosystems reduce energy demands during times of decreased solar energy input (e.g., leaves falling, estivation, migration). 10.14 Investigate the effect of human induced changes on the population size and the diversity of organisms found in an ecosystem. Explain the effect of the changes on the amount of energy available at each trophic level of the ecosystem. 10.31 Design investigations to develop reasonable explanations concerning the complimentary relationship (cycling of matter and the flow of energy) between photosynthesis and cellular respiration. For example, a small snail, a water plant, a light source, and a pH indicator can be used as part of an experimental design to explain the relationship. 10.32 Analyze the equation for cellular respiration along with the equation for photosynthesis. Use the formulas to identify the reactants and products in each process and to explain the complimentary nature of the processes.		
Interaction of Humans Within Ecosystems 8.31 (1) All organisms are dependent upon the Earth's finite supply of material resources to sustain life. Human decision concerning the use of resources alters the stability and the biodiversity of ecosystems and adversely affect the natural recycling processes which maintain the quality of air, water and land.	10.14 Investigate the effect of human induced changes on the population size and the diversity of organisms found in an ecosystem. Explain the effect of the changes on the amount of energy available at each trophic level of the ecosystem.	Limits of Earth's Resources	
8.32 (1) The availability of and access to natural resources shape the economic policies of society and form a basis for international trade agreements. Unequal distribution of resources and increase demand for natural resources require global cooperation and long-term planning to satisfy the resource needs of successive generations.	10.14 Investigate the effect of human induced changes on the population size and the diversity of organisms found in an ecosystem. Explain the effect of the changes on the amount of energy available at each trophic level of the ecosystem.	Natural Resources and Human Society	
8.33 (1) People manage the Earth and its resources by preservation, conservation, appropriate utilization, and restoration. There is a wide variety of national laws (e.g., Clean Air Act, Clean Water Act, Endangered Species Act) and state laws (e.g., Coastal Zone Act) that exist to protect the environment.	10.14 Investigate the effect of human induced changes on the population size and the diversity of organisms found in an ecosystem. Explain the effect of the changes on the amount of energy available at each trophic level of the ecosystem.	Ecosystems and Legal Protections	