Crosswalk 2010 MS Science - 2018 MS CCRS for Science
Inquiry Strand Biology

2010 MS Framework Biology - Inquiry	**2018 MS CCRS for Science - all grades and courses**
Competency 1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.	All Inquiry skills will be taught in the appropriate performance objectives in the new standards. Students will use various Science and Engineering Practices (SEPs) to learn the content. All science skills should be included as needed.
1a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. • Safety rules and symbols • Proper use and care of the compound light microscope, slides, chemicals, etc. • Accuracy and precision in using graduated cylinders, balances, beakers,	
1b. Formulate questions that can be answered through research and experimental design.	
1c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development).	
1d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs).	
1e. Analyze procedures, data, and conclusions to determine the scientific validity of research.	
1f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge.	
1g. Communicate and defend a scientific argument in oral, written, and graphic form.	

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Physical Science Competency 2. Describe the biochemical basis of life and explain how energy flows within and between the living systems.	**Standard statements are in bold font below.**
2a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. • Subatomic particles and arrangement in atoms • Importance of ions in biological processes	*Covalent and ionic bonding addressed in Grade 7, Physical Science and Chemistry.* *Hydrogen bonding addressed in Marine and Aquatic Science I.*
2b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing).	*Importance of water in biological system included in Marine and Aquatic Science I.*
2c. Classify solutions as acidic, basic, or neutral and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions).	*Acid and base solutions and pH scale addressed in Grade 7 and Chemistry.*
2d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. • Basic chemical composition of each group • Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.) • Basic functions (e.g., energy, storage, cellular, heredity) of each group	**BIO.1B Students will analyze the structure and function of the macromolecules that make up cells.** BIO.1B.1 Develop and use models to compare and contrast the structure and function of carbohydrates, lipids, proteins, and nucleic acids (DNA and RNA) in organisms. BIO.1B.2 Design and conduct an experiment to determine how enzymes react given various environmental conditions (i.e., pH, temperature, and concentration). Analyze, interpret, graph, and present data to explain how those changing conditions affect the enzyme activity and the rate of the reactions that take place in biological organisms.

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2e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. • Enzyme structure • Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)	*See BIO.1B.2 above*
2f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. • ATP structure • ATP function	*See BIO.2.1 below*
2g. Analyze and explain the biochemical process of photosynthesis and cellular respiration and draw conclusions about the roles of the reactants and products in each. • Photosynthesis and respiration (reactants and products) • Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each • Aerobic and anaerobic processes in cellular respiration, including products of each and energy differences	**BIO.2 Students will explain that cells transform energy through the processes of photosynthesis and cellular respiration to drive cellular functions.** BIO.2.1 Use models to demonstrate that ATP and ADP are cycled within a cell as a means to transfer energy. BIO.2.2 Develop models of the major reactants and products of photosynthesis to demonstrate the transformation of light energy into stored chemical energy in cells. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored. BIO.2.3 Develop models of the major reactants and products of cellular respiration (aerobic and anaerobic) to demonstrate the transformation of the chemical energy stored in food to the available energy of ATP. Emphasize the chemical processes in which bonds are broken and energy is released, and new bonds are formed and energy is stored. BIO.2.4 Conduct scientific investigations or computer simulations to compare aerobic and anaerobic cellular respiration in plants and animals, using real world examples. BIO.2.5 **Enrichment**: Investigate variables (e.g., nutrient availability, temperature) that affect anaerobic respiration and current real-world applications of fermentation. BIO.2.6 **Enrichment**: Use an engineering design process to manipulate factors involved in fermentation to optimize energy production.*

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Life Science Competency 3. Investigate and evaluate the interaction between living organisms and their environment.	**Standard statements are in bold font below.**
3a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). • Plant and animal species • Climate (temperature and rainfall) • Adaptations of organisms	*Specific biome characteristics moved to Environmental Science*

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3b. Provide examples to justify the interdependence among environmental elements. • Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves) • Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers) • Roles of beneficial bacteria • Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)	**BIO.5 Students will Investigate and evaluate the interdependence of living organisms and their environment.** BIO.5.1 Illustrate levels of ecological hierarchy, including organism, population, community, ecosystem, biome, and biosphere. BIO.5.2 Analyze models of the cycling of matter (e.g., carbon, nitrogen, phosphorus, and water) between abiotic and biotic factors in an ecosystem and evaluate the ability of these cycles to maintain the health and sustainability of the ecosystem. BIO.5.3 Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases on the carbon dioxide cycle and global climate. BIO.5.4 Develop and use models to describe the flow of energy and amount of biomass through food chains, food webs, and food pyramids. BIO.5.5 Evaluate symbiotic relationships (e.g., mutualism, parasitism, and commensalism) and other co-evolutionary (e.g., predator-prey, cooperation, competition, and mimicry) relationships within specific environments. BIO.5.6 Analyze and interpret population data, both density-dependent and density-independent, to define limiting factors. Use graphical representations (growth curves) to illustrate the carrying capacity within ecosystems. BIO.5.7 Investigate and evaluate factors involved in primary and secondary ecological succession using local, real world examples. BIO.5.8 **Enrichment:** Use an engineering design process to create a solution that addresses changing ecological conditions (e.g., climate change, invasive species, loss of biodiversity, human population growth, habitat destruction, biomagnification, or natural phenomena).* BIO.5.9 **Enrichment:** Use an engineering design process to investigate and model current technological uses of biomimicry to address solutions to real-world problems.*
3c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources).	*See BIO.5.3, BIO.5.8 and BIO.5.9 above*

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Life Science Competency 4. Analyze and explain the structures and function of the levels of biological organization.	**Standard statements are in bold font below.**
4a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. •Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol) • Components of mobility (e.g., cilia, flagella, pseudopodia)	**BIO.1A Students will demonstrate an understanding of the characteristics of life and biological organization.** BIO.1A.1 Develop criteria to differentiate between living and non-living things. BIO.1A.2 Describe the tenets of cell theory and the contributions of Schwann, Hooke, Schleiden, and Virchow. BIO.1A.3 Using specific examples, explain how cells can be organized into complex tissues, organs, and organ systems in multicellular organisms. BIO.1A.4 Use evidence from current scientific literature to support whether a virus is living or non-living. **BIO.1C Students will relate the diversity of organelles to a variety of specialized cellular functions.** BIO.1C.1 Develop and use models to explore how specialized structures within cells (e.g., nucleus, cytoskeleton, endoplasmic reticulum, ribosomes, Golgi apparatus, lysosomes, mitochondria, chloroplast, centrosomes, and vacuoles) interact to carry out the functions necessary for organism survival. BIO.1C.2 Investigate to compare and contrast prokaryotic cells and eukaryotic cells, and plant, animal, and fungal cells. BIO.1C.3 Contrast the structure of viruses with that of cells, and explain why viruses must use living cells to reproduce. **BIO.1D Students will describe the structure of the cell membrane and analyze how the structure is related to its primary function of regulating transport in and out of cells to maintain homeostasis.** BIO.1D.1 Plan and conduct investigations to prove that the cell membrane is a semi-permeable, allowing it to maintain homeostasis with its environment through active and passive transport processes. BIO.1D.2 Develop and use models to explain how the cell deals with imbalances of solute concentration across the cell membrane (i.e., hypertonic, hypotonic, and isotonic conditions, sodium/potassium pump).

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4b. Differentiate between types of cellular reproduction. (DOK 1) • Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions • Binary fission (e.g., budding, vegetative propagation, etc.) Significance of meiosis in sexual reproduction • Significance of crossing over	**BIO.1E Students will develop and use models to explain the role of the cell cycle during growth, development, and maintenance in multicellular organisms.** BIO.1E.1 Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms. BIO.1E.2 Identify and describe the changes that occur in a cell during replication. Explore problems that might occur if the cell does not progress through the cycle correctly (cancer). BIO.1E.3 Relate the processes of cellular reproduction to asexual reproduction in simple organisms (i.e., budding, vegetative propagation, regeneration, binary fission). Explain why the DNA of the daughter cells is the same as the parent cell. BIO.1E.4 Enrichment: Use an engineering design process to investigate the role of stem cells in regeneration and asexual reproduction, then develop applications of stem cell research to solve human medical conditions.* **BIO.3A Students will develop and use models to explain the role of meiosis in the production of haploid gametes required for sexual reproduction.** BIO.3A.1 Model sex cell formation (meiosis) and combination (fertilization) to demonstrate the maintenance of chromosome number through each generation in sexually reproducing populations. Explain why the DNA of the daughter cells is different from the DNA of the parent cell. BIO.3A.2 Compare and contrast mitosis and meiosis in terms of reproduction. BIO.3A.3 Investigate chromosomal abnormalities (e.g., Down syndrome, Turner's syndrome, and Klinefelter syndrome) that might arise from errors in meiosis (nondisjunction) and how these abnormalities are identified (karyotypes).
4c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.)	*See BIO.1.A.3 above*
4d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction).	*Moved to Botany*

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Life Science Competency 5. Demonstrate an understanding of the molecular basis of heredity.	**Standard statements are in bold font below.**
5a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. • Structures of DNA and RNA • Processes of replication, transcription, and translation • Messenger RNA codon charts	**BIO.3C Students will construct an explanation based on evidence to describe how the structure and nucleotide base sequence of DNA determines the structure of proteins or RNA that carry out essential functions of life.** BIO.3C.1 Develop and use models to explain the relationship between DNA, genes, and chromosomes in coding the instructions for the traits transferred from parent to offspring. BIO.3C.2 Evaluate the mechanisms of transcription and translation in protein synthesis. BIO.3C.3 Use models to predict how various changes in the nucleotide sequence (e.g., point mutations, deletions, and additions) will affect the resulting protein product and the subsequent inherited trait. BIO.3C.4 Research and identify how DNA technology benefits society. Engage in scientific argument from evidence over the ethical issues surrounding the use of DNA technology (e.g., cloning, transgenic organisms, stem cell research, and the Human Genome Project, gel electrophoresis). BIO.3C.5 **Enrichment**: Investigate current biotechnological applications in the study of the genome (e.g., transcriptome, proteome, individualized sequencing, and individualized gene therapy).
5b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes.)	**BIO.3B Students will analyze and interpret data collected from probability calculations to explain the variation of expressed traits within a population.** BIO.3B.1 Demonstrate Mendel's law of dominance and segregation using mathematics to predict phenotypic and genotypic ratios by constructing Punnett squares with both homozygous and heterozygous allele pairs. BIO.3B.2 Illustrate Mendel's law of independent assortment using Punnett squares and/or the product rule of probability to analyze monohybrid crosses. BIO.3B.3 Investigate traits that follow non-Mendelian inheritance patterns (e.g., incomplete dominance, codominance, multiple alleles in human blood types, and sex-linkage). BIO.3B.4 Analyze and interpret data (e.g., pedigrees, family, and population studies) regarding Mendelian and complex genetic traits (e.g., sickle-cell anemia, cystic fibrosis, muscular dystrophy, color-blindness, and hemophilia) to determine patterns of inheritance and disease risk.

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5c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel	*See BIO 3B.4 above for pedigrees; See BIO.3A.3 above for karyotypes; See BIO.3C.4 and BIO.3C.5 for DNA technology*
5d. Discuss the characteristics and implications of both chromosomal and gene mutations. • Significance of nondisjunction, deletion, substitutions, translocation, and frame shift mutation in animals • Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Downs Syndrome, color blindness	*See BIO.3A.3 above for chromosomal mutations; See BIO.3C.3 for gene mutations; See BIO.3B.4 for disease inheritance patterns*

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Life Science Competency 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.	**Standard statements are in bold font below.**
6a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2) • Characteristics of the six kingdoms • Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species) • Body plans (symmetry) • Methods of sexual reproduction (e.g., conjugation, fertilization, pollination) • Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)	*Major kingdom characteristics moved to Grade 6; plant kingdom studies moved to Botany; Invertebrate and Vertebrate animals studied in Zoology*
6b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns.	*See BIO.4.2 below*
6c. Research and summarize the contributions of scientists, (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution.	*Moved to Foundations of Biology*

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6d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance).	**BIO.4 Students will analyze and interpret evidence to explain the unity and diversity of life.** BIO.4.1 Use models to differentiate between organic and chemical evolution, illustrating the steps leading to aerobic heterotrophs and photosynthetic autotrophs. BIO.4.2 Evaluate empirical evidence of common ancestry and biological evolution, including comparative anatomy (e.g., homologous structures and embryological similarities), fossil record, molecular/biochemical similarities (e.g., gene and protein homology), and biogeographic distribution. BIO.4.3 Construct cladograms/phylogenetic trees to illustrate relatedness between species. BIO.4.4 Design models and use simulations to investigate the interaction between changing environments and genetic variation in natural selection leading to adaptations in populations and differential success of populations. BIO.4.5 Use Darwin's Theory to explain how genetic variation, competition, overproduction, and unequal reproductive success acts as driving forces of natural selection and evolution. BIO.4.6 Construct explanations for the mechanisms of speciation (e.g., geographic and reproductive isolation). BIO.4.7 **Enrichment**: Construct explanations for how various disease agents (bacteria, viruses, chemicals) can influence natural selection.
6e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs.	*See BIO.4.1 above*