

**Massachusetts Science Grades 9-12  
Learning Standards Mapping**

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<b>BIOLOGY</b>	<b>Boardworks High School Biology Presentations</b>
<b>1. The Chemistry of Life</b> <b>Central Concept: Chemical elements form organic molecules that interact to perform the basic functions of life.</b>	
1.1 Recognize that biological organisms are composed primarily of very few elements. The six most common are C, H, N, O, P, and S.	-
1.2 Describe the basic molecular structures and primary functions of the four major categories of organic molecules (carbohydrates, lipids, proteins, nucleic acids).	Digestion Lipids Monosaccharides Nucleic Acids Polysaccharides Proteins
1.3 Explain the role of enzymes as catalysts that lower the activation energy of biochemical reactions. Identify factors, such as pH and temperature, that have an effect on enzymes.	Enzymes Enzyme Shape
<b>2. Cell Biology</b> <b>Central Concepts: Cells have specific structures and functions that make them distinctive. Processes in a cell can be classified broadly as growth, maintenance, and reproduction.</b>	
2.1 Relate cell parts/organelles (plasma membrane, nuclear envelope, nucleus, nucleolus, cytoplasm, mitochondrion, endoplasmic reticulum, Golgi apparatus, lysosome, ribosome, vacuole, cell wall, chloroplast, cytoskeleton, centriole, cilium, flagellum, pseudopod) to their functions. Explain the role of cell membranes as a highly selective barrier (diffusion, osmosis, facilitated diffusion, active transport).	Active Transport Diffusion Eukaryotic Cells Organelles Osmosis Prokaryotic Cells
2.2 Compare and contrast, at the cellular level, the general structures and degrees of complexity of prokaryotes and eukaryotes.	Prokaryotic Cells Eukaryotic Cells
2.3 Use cellular evidence (e.g. cell structure, cell number, cell reproduction) and modes of nutrition to describe the six kingdoms (Archaeobacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).	Classification Organelles
2.4 Identify the reactants, products, and basic purposes of photosynthesis and cellular respiration. Explain the interrelated nature of photosynthesis and cellular respiration in the cells of photosynthetic organisms.	Aerobic Respiration Photosynthesis1 Photosynthesis2
2.5 Explain the important role that ATP serves in metabolism.	Aerobic Respiration Cell Theory

2.6 Describe the cell cycle and the process of mitosis. Explain the role of mitosis in the formation of new cells, and its importance in maintaining chromosome number during asexual reproduction.	Asexual Reproduction Mitosis The Stages of Mitosis
2.7 Describe how the process of meiosis results in the formation of haploid cells. Explain the importance of this process in sexual reproduction, and how gametes form diploid zygotes in the process of fertilization.	Genetic Variation Meiosis The Stages of Meiosis
2.8 <i>Compare and contrast a virus and a cell in terms of genetic material and reproduction.</i>	—
<b>3. Genetics</b> <b>Central Concepts: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.</b>	
3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.	DNA Genetic Variation Nucleic Acids Protein Synthesis Transcription and Translation
3.2 Describe the basic process of DNA replication and how it relates to the transmission and conservation of the genetic code. Explain the basic processes of transcription and translation, and how they result in the expression of genes. Distinguish among the end products of replication, transcription, and translation.	Controlling Protein Synthesis DNA Replication 1 DNA Replication 2 Protein Synthesis Transcription and Translation
3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.	DNA Replication 2 Genetic Mutations Genetic Variation
3.4 Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles).	Genes and Alleles Gregor Mendel Incomplete Dominance and Codominance Inherited Diseases Patterns of Inheritance
3.5 Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance (e.g. dihybrid crosses).	Gregor Mendel Patterns of Inheritance
3.6 Use a Punnett Square to determine the probabilities for genotype and phenotype combinations in monohybrid crosses.	Gregor Mendel

<p><b>4. Anatomy and Physiology</b>  <b>Central Concepts: There is a relationship between the organization of cells into tissues and the organization of tissues into organs. The structures and functions of organs determine their relationships within body systems of an organism. Homeostasis allows the body to perform its normal functions.</b></p>	
<p>4.1 Explain generally how the digestive system (mouth, pharynx, esophagus, stomach, small and large intestines, rectum) converts macromolecules from food into smaller molecules that can be used by cells for energy and for repair and growth.</p>	<p>Digestion Diffusion</p>
<p>4.2 Explain how the circulatory system (heart, arteries, veins, capillaries, red blood cells) transports nutrients and oxygen to cells and removes cell wastes. Describe how the kidneys and the liver are closely associated with the circulatory system as they perform the excretory function of removing waste from the blood. Recognize that kidneys remove nitrogenous wastes, and the liver removes many toxic compounds from blood.</p>	<p>Blood and Blood Vessels Diffusion The Kidneys</p>
<p>4.3 Explain how the respiratory system (nose, pharynx, larynx, trachea, lungs, alveoli) provides an exchange of oxygen and carbon dioxide.</p>	<p>Diffusion The Respiratory System Ventilation</p>
<p>4.4 Explain how the nervous system (brain, spinal cord, sensory neurons, motor neurons) mediates communication among different parts of the body and mediates the body's interactions with the environment. Identify the basic unit of the nervous system, the neuron, and explain generally how it works.</p>	<p>Nerve Impulses Reflexes The Brain The Nervous System</p>
<p>4.5 Explain how the muscular/skeletal system (skeletal, smooth and cardiac muscles, bones, cartilage, ligaments, tendons) works with other systems to support the body and allow for movement. Recognize that bones produce blood cells.</p>	<p>Controlling Movement The Skeleton Types of Muscle</p>
<p>4.6 Recognize that the sexual reproductive system allows organisms to produce offspring that receive half of their genetic information from their mother and half from their father, and that sexually produced offspring resemble, but are not identical to, either of their parents.</p>	<p>Female Reproductive System Genetic Variation Meiosis The Stages of Meiosis</p>
<p>4.7 Recognize that communication among cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells produce signals to communicate only with nearby cells.</p>	<p>Female Reproductive System Hormones Nerve Impules The Endocrine System</p>
<p>4.8 Recognize that the body's systems interact to maintain homeostasis. Describe the basic function of a physiological feedback loop.</p>	<p>Homeostasis</p>

<p><b>5. Evolution and Biodiversity</b>  <b>Central Concepts: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction.</b></p>	
<p>5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.</p>	<p>Darwin  Evolution  Fossil Record  The Process of Evolution</p>
<p>5.2 Describe species as reproductively distinct groups of organisms. Recognize that species are further classified into a hierarchical taxonomic system (kingdom, phylum, class, order, family, genus, species) based on morphological, behavioral, and molecular similarities. Describe the role that geographic isolation can play in speciation.</p>	<p>Classification  Population Genetics  What is a Species?</p>
<p>5.3 Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.</p>	<p>Evolution  Extinction  The Process of Evolution</p>
<p><b>6. Ecology</b>  <b>Central Concept: Ecology is the interaction among organisms and between organisms and their environment.</b></p>	
<p>6.1 Explain how birth, death, immigration, and emigration influence population size.</p>	<p>Describing Populations</p>
<p>6.2 Analyze changes in population size and biodiversity (speciation and extinction) that result from the following: natural causes, changes in climate, human activity, and the introduction of invasive, non-native species.</p>	<p>Describing Populations  Extinction  Loss of Diversity</p>
<p>6.3 Use a food web to identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through trophic levels. Describe how relationships among organisms (predation, parasitism, competition, commensalism, mutualism) add to the complexity of biological communities.</p>	<p>Ecosystems  Energy Loss in Food Chains  Energy Transfer in Food Chains  Food Webs  Food Chains  Host-Parasite Relationships  Predator-Prey Relationships</p>
<p>6.4 Explain how water, carbon, and nitrogen cycle between abiotic resources and organic matter in an ecosystem, and how oxygen cycles through photosynthesis and respiration.</p>	<p>Aerobic Respiration  Carbon Cycle  Nitrogen Cycle  Photosynthesis 1  Photosynthesis 2  Recycling Nutrients  Water Cycle</p>