

Virginia Science Grades 9-12
Curriculum Standards Mapping

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BIOLOGY	Boardworks High School Biology Presentations
Standard BIO.2 The student will investigate and understand the history of biological concepts. Key concepts include:	
a) Evidence supporting the cell theory;	
i) The development and refinement of magnifying lenses and light microscopes made the observation and description of microscopic organisms and living cells possible.	Microscopy
ii) The development of the cell theory was accelerated by the ability to make observations on a microscopic level.	Cell Theory Microscopy
iii) The cell theory states that all living things are composed of cells and that cells come from other cells by the process of cell reproduction.	Cell Differentiation Cell Theory Cells to Organisms Mitosis
iv) Continued advances in microscopy allowed observation of cell organelles and ultrastructure. Current technology allows the observation of cellular processes underlying both cell structure and function.	Microscopy
b) Scientific explanations of the development of organisms through time (biological evolution);	
i) Scientists have developed hypotheses about conditions on early Earth that could have led to the formation of the first organic molecules, early self-replicating molecules, the source of free oxygen in Earth's atmosphere, and the appearance of prokaryotic and later eukaryotic cells.	Fossil Record
ii) Natural selection is a process by which organisms with traits well suited to an environment survive and reproduce at a greater rate than organisms less suited to that environment.	Evolution Extinction The Process of Evolution
c) Evidence supporting the germ theory of infectious disease	
<i>i) Throughout history, people have created explanations for disease.</i>	–
ii) Pasteur's and Kochs experimentation and hypotheses led to an understanding of the presence of microorganisms and their relationship to diseases.	Pasteurization
iii) The introduction of the germ theory led to the understanding that many diseases are caused by microorganisms.	Pasteurization
iv) Changes in health practices have resulted from the acceptance of the germ theory of disease.	Vaccinations
v) Modern health practices emphasize sanitation, the safe handling of food and water, aseptic techniques to keep germs out of the body, and the development of vaccinations and other chemicals and processes to destroy microorganisms.	Antibodies and Vaccinations Infectious Disease Tuberculosis Vaccinations

d) The development of the structural model of DNA.	
<i>i) Once DNA was shown to be the genetic material, a race among scientists took place to work out its structure.</i>	–
ii) Studies of the amounts of each DNA base in different organisms led to the concept of complementary base-pairing.	Nucleic Acids
iii) Interpretations of X-ray photographs of DNA were used to describe the shape and dimensions of the molecule. An analysis of this and other available data led to a structural model for the DNA double helix.	Nucleic Acids
iv) The double helix model explained how heredity information is transmitted and provided the basis for an explosion of scientific research in molecular genetics.	DNA DNA Replication 2 Nucleic Acids Transcription and Translation
e) The collaborative efforts of scientists, past and present.	
<i>i) Science depends on experimental and observational confirmation and is subject to change as new evidence becomes available.</i>	–
Standard BIO.3	
The student will investigate and understand the chemical and biochemical principles essential for life.	
Key concepts include:	
a) Water chemistry and its impact on life processes.	
i) Water molecules are both cohesive and adhesive due to the nature of bonding (polar covalent and hydrogen bonding).	Water
ii) Water is able to absorb large amounts of heat. As a result, lakes and oceans stabilize air and land temperatures.	Water
iii) Water absorbs heat when it evaporates, allowing organisms to release excess heat.	Thermoregulation Water
iv) The solid form of water, ice, floats, preventing lakes and oceans from freezing solid.	Water
v) Water is able to dissolve many substances; therefore, the water inside and outside of cells is able to carry nutrients into and around cells and wastes away from cells.	Water
<i>vi) The pH scale ranges from 0 to 14. The pH of pure water is 7. Substances added to water can lower or raise the pH. A solution with a pH below 7 is acidic. A solution with a pH above 7 is basic.</i>	–
vii) Organisms can tolerate only small changes in pH because every cell has a particular pH at which it functions best. For example, changes in pH cause changes in enzyme conformation, resulting in a change in activity.	Enzymes
b) The structure and function of macromolecules	
<i>i) The main components of a living cell are carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.</i>	–
ii) Carbon atoms can easily bond to several other carbon atoms in chains and rings to form large complex molecules.	–

iii) Cells can make a variety of macromolecules from a relatively small set of monomers.	Digestion Monosaccharides Nucleic Acids Polysaccharides Protein synthesis Proteins
iv) The primary functions of carbohydrate macromolecules are to provide and store energy. The primary functions of lipid macromolecules are to insulate, store energy, and make up cell membranes	Digestion Lipids Monosaccharides Polysaccharides
v) Nucleic acids (DNA and RNA) control cell activities by directing protein synthesis.	Controlling Protein Synthesis DNA Nucleic Acids Protein Synthesis Transcription and Translation
vi) Some proteins are structural (hair, nails). Others function in transport (hemoglobin), movement (muscle fibers and cytoskeletal elements), defense (antibodies), and regulation of cell functions (hormones and enzymes).	Antibodies and Vaccines Enzymes Immune System Proteins Types of Muscles
vii) Proteins are polymers made by linking together amino acid monomers.	Controlling Protein Synthesis Digestion Protein Synthesis Proteins
viii) A protein's structure depends on its specific conformation. The sequence of amino acids and the shape of the chain are a consequence of attractions between the chain's parts.	Controlling Protein Synthesis Enzyme Shape Proteins
c) The nature of enzymes.	
i) Each enzyme has a definite three-dimensional shape that allows it to recognize and bind with its substrate. In living cells, enzymes control the rate of metabolic reaction by acting as catalysts.	Enzymes Enzyme Shape
ii) Most cells function best within a narrow range of temperature and pH. At very low temperatures, reaction rates are too slow. High temperatures or extremes of pH can irreversibly change the structure of proteins and alter their function.	Enzymes Enzyme Shape
d) The capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration.	

i) Photosynthesis and cell respiration are complementary processes for cycling carbon dioxide and oxygen as well as transferring energy in ecosystems.	Aerobic Respiration Photosynthesis 1 Photosynthesis 2
ii) During photosynthesis, cells trap energy from sunlight with chlorophyll and use the energy, carbon dioxide and water to produce energy-rich organic molecules (glucose) and oxygen.	Photosynthesis 1 Photosynthesis 2
iii) During cell respiration, eukaryotic cells "burn" organic molecules with oxygen, which produces energy, carbon dioxide, and water.	Aerobic Respiration
iv) Light is the initial source of energy for most communities.	Food Chains Photosynthesis 1
v) Photosynthesis involves an energy conversion in which light energy is converted to chemical energy in specialized cells. These cells are found in autotrophs such as plants and some protists.	Organelles Photosynthesis 1 Photosynthesis 2
vi) <i>Cells release the chemical energy stored in the products of photosynthesis. This energy is transported within the cell in the form of ATP.</i>	-
vii) <i>When cells need energy to do work, certain enzymes release the energy stored in the chemical bonds in ATP.</i>	-
viii) Skill - Recognize the equations for photosynthesis and respiration and identify the reactants and products.	Aerobic Respiration Photosynthesis 2
Standard BIO.4	
The student will investigate and understand relationships between cell structure and function. Key concepts include:	
a) Characteristics of prokaryotic and eukaryotic cells	
i) <i>Earth's first cells were prokaryotes.</i>	-
ii) Prokaryotic cells exist in two major forms: eubacteria and archaeobacteria.	Classification Prokaryotic Cells
iii) Prokaryotes are the Earth's most abundant inhabitants. They can survive in a wide range of environments and obtain energy in a variety of ways.	Prokaryotic Cells
iv) <i>Eukaryotes arose from prokaryotes and developed into larger more complex organisms, from single-celled protists to multi-cellular fungi, plants, and animals.</i>	-
b) Explorations of the diversity and variation of eukaryotes.	
i) Several differences between eukaryotes and prokaryotes include size, genetic material surrounded by a nuclear membrane, and the addition of mitochondria and chloroplasts.	Eukaryotic Cells Prokaryotic Cells
ii) Cellular differences between plant and animal cells include the presence of a cell wall that gives the plant cell a defined shape, the presence of chloroplast, and the number of vacuoles.	Eukaryotic Cells Organelles
c) Similarities between the activities of a single cell and a whole organism; and	

<p>i) Essential cell structures and their functions include:</p> <ul style="list-style-type: none"> - the nucleus (contains DNA; site where RNA is made) - ribosome (site of protein synthesis) - mitochondria (site of cell respiration) - chloroplast (site of photosynthesis) - endoplasmic reticulum (transports materials through the cell) - Golgi (site where cell products are packaged for export) - lysosome (contains digestive enzymes) - cell membrane (controls what enters and leaves the cell) - cell wall (provides support). 	<p>Cells to Organisms Eukaryotic Cells Organelles Prokaryotic Cells</p>
<p>ii) Some organisms exist as a single cell, while others are composed of many cells, each specialized to perform distinct metabolic functions.</p>	<p>Cells to Organisms Eukaryotic Cells Organelles</p>
<p>iii) The basic processes necessary for living things to survive are the same for a single cell as they are for a more complex organism.</p>	<p>Cells to Organisms</p>
<p>iv) A single-celled organism has to conduct all life processes by itself. A multicellular organism has groups of cells that specialize to perform specific functions.</p>	<p>Cells to Organisms</p>
<p>v) Cell specialization occurs during the development of a multicellular organism. The genetic information necessary for all cellular functions remains in each cell but may not be used.</p>	<p>Cell Differentiation Specialized Plant cells</p>
<p>vi) The fluid mosaic model of a membrane emphasizes the arrangement and function of a bilayer of phospholipids, transport proteins, and cholesterol.</p>	<p>The Fluid Mosaic Model</p>
<p>d) The cell membrane model (diffusion, osmosis, and active transport)</p>	
<p>i) Diffusion occurs in cells when substances (oxygen, carbon dioxide, salts, sugars, amino acids) that are dissolved in water move from an area of higher concentration to an area of lower concentration.</p>	<p>Diffusion</p>
<p>ii) Osmosis refers to the movement of water molecules through a semi-permeable membrane from an area of greater water concentration or pressure to an area of lesser water concentration or pressure.</p>	<p>Osmosis</p>
<p>iii) Active transport refers to the movement of solid and liquid particles into and out of a cell by endocytosis and exocytosis.</p>	<p>Active Transport</p>
<p>Standard BIO.5</p>	
<p>The student will investigate and understand life functions of archaeobacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans. Key concepts include:</p>	
<p>a) How their structures and function vary between and within the kingdoms;</p>	

<p>i) Skills - Differentiate and give examples of the following from local ecosystems:</p> <ul style="list-style-type: none"> - autotrophs and heterotrophs (producers, consumers, and decomposers) - multicellular and unicellular organisms - motile and non-motile organisms - organisms with and without cell walls - sexually and asexually reproducing organisms - aquatic and terrestrial organisms - behavioral responses to the environment. 	<p>Animal Adaptations Asexual Reproduction Behavior Classification Decomposers Ecosystems Organelles Plant Adaptations</p>
b) Comparison of their metabolic activities;	-
c) Analyses of their responses to the environment;	<p>Behavior Homeostasis</p>
d) Maintenance of homeostasis;	
<p>i) For the body to use food for energy, the food must first be digested into molecules that are absorbed and transported to cells, where the food is used for energy and for repair and growth.</p>	Digestion
<p>ii) To burn food for the release of energy, oxygen must be supplied to cells and carbon dioxide removed. The respiratory system responds to changing demands by increasing or decreasing breathing rate in order to maintain homeostasis.</p>	<p>Aerobic Respiration Ventilation</p>
<p>iii) <i>The circulatory system, which moves all of these substances to or from cells, responds to changing demands by increasing or decreasing heart rate and blood flow in order to maintain homeostasis.</i></p>	-
<p>iv) The urinary system disposes of dissolved waste molecules; the intestinal tract removes solid wastes; and the skin and lungs rid the body of heat energy.</p>	<p>Homeostasis Thermoregulation The Kidneys</p>
e) Human health issues, human anatomy, body systems, and life functions.	
<p>i) Specialized cells of the immune system and the molecules they produce are designed to protect against organisms and substances that enter from outside the body and against some cancer cells that arise from within.</p>	<p>Antibodies and Vaccinations Immune System Immune Responses</p>
<p>ii) Communication between cells is required for coordination of body functions. The nerves communicate with electrochemical signals, hormones circulate through the blood, and some cells secrete substances that spread only to nearby cells.</p>	<p>Immune Responses Nerve Impulses</p>
<p>iii) Environmental factors that impact human health include diet, exercise, sleep, stress, toxic substances that enter the body, viruses, and other living organisms that infect the body.</p>	<p>Immune System Infectious Disease Nutrition Smoking</p>
<p>iv) Genetic predisposition towards diseases impacts human health. Awareness of genetic predisposition allows individuals to make lifestyle changes that can enhance quality of life.</p>	Inherited Diseases
f) How viruses compare with organisms.	

i) Viruses are not cells. Basic viral structure consists of a nucleic acid core surrounded by a protein coat.	HIV and AIDS
ii) Viruses can reproduce only inside a living cell, the host cell.	HIV and AIDS
iii) The viral reproductive process includes the following steps: - A virus must insert its genetic material into the host cell. - The viral genetic material takes control of the host cell and uses it to produce viruses. - The newly formed viruses are released from the host cell.	HIV and AIDS
Standard BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include:	
a) Cell growth and division;	
i) Mitosis produces two genetically identical cells.	Mitosis The Stages of Mitosis
ii) A typical cell goes through a process of growth, development, and reproduction called the cell cycle.	Meiosis Mitosis The Stages of Mitosis
iii) Mitosis and meiosis refer to division of the nuclear material. Cytokinesis is the division of the cytoplasm and organelles.	The Stages of Mitosis
iv) Mitosis is referred to in the following stages: prophase, metaphase, anaphase, and telophase.	The Stages of Mitosis
b) Gamete formation;	
i) Meiosis occurs in sexual reproduction when a diploid germ cell produces four haploid daughter cells that can mature to become gametes (sperm or egg).	Meiosis The Stages of Mitosis
c) Cell Specialization.	Cell Differentiation
d) Prediction of inheritance of traits based on the Mendelian laws of heredity.	
i) Mendel's laws of heredity are based on his mathematical analysis of observations of patterns of inheritance of traits.	Gregor Mendel
ii) <i>The laws of probability govern simple genetic recombinations.</i>	–
iii) Genotype describes the genetic make-up of an organism and phenotype describes the organism's appearance based on its genes.	Environmental Variation Genetic Variation
iv) Homozygous individuals have two identical alleles for a particular trait, while heterozygous individuals have contrasting alleles.	Genes and Alleles
v) When one allele masks the effect of another, that allele is called dominant and the other recessive. When an intermediate phenotype occurs and no allele dominates, incomplete dominance results.	Incomplete Dominance and Codominance
vi) Skills - Predict possible gametes in a dihybrid cross, given parental genotypes.	Gregor Mendel
vii) Skills - Use a Punnett square to show all possible combinations of gametes and the likelihood that particular combinations will occur in monohybrid crosses.	Gregor Mendel

e) Genetic variation (mutation, recombination, deletions, additions to DNA).	
i) The sorting and recombination of genes in sexual reproduction results in a great variety of gene combinations in the offspring of any two parents.	Genetic Variation The Stages of Meiosis
ii) Inserting, deleting, or substituting DNA bases can alter genes. An altered gene may be passed on to every cell that develops from it, causing an altered phenotype.	DNA Replication 2 Genetic Mutations Genetic Variation
iii) An altered phenotype may be beneficial or detrimental.	Genetic Variation
iv) Sometimes entire chromosomes can be added or deleted, resulting in a genetic disorder such as Trisomy 21 (Down syndrome).	Inherited Diseases
v) <i>Skills - Evaluate karyotype charts.</i>	—
f) The structure, function, and replication of nucleic acids (DNA and RNA);	
i) The genetic code is a sequence of DNA nucleotides in the nucleus of eukaryotic cells.	DNA Nucleic Acids
ii) DNA is a polymer consisting of nucleotides. A DNA nucleotide is identified by the base it contains: adenine (A), guanine (G), and cytosine (C) or thymine (T).	DNA Nucleic Acids Transcription and Translation
iii) DNA is a double-stranded molecule. The strands are connected by complementary nucleotide pairs (A-T and CG) like rungs on a ladder. The ladder twists to form a double helix.	DNA Nucleic Acids Transcription and Translation
iv) The genetic code is the sequence of DNA nucleotides.	DNA Nucleic Acids Transcription and Translation
v) <i>Skills - Given a DNA sequence, write a complementary mRNA strand (A-U, T-A, C-G and G-C).</i>	Controlling Protein Synthesis Transcription and Translation
g) Events involved in the construction of proteins.	
i) In order for cells to make proteins, the DNA code must be transcribed (copied) to messenger RNA (mRNA).	Controlling Protein Synthesis Transcription and Translation
ii) The mRNA carries the code from the nucleus to the ribosomes in the cytoplasm.	Controlling Protein Synthesis Transcription and Translation
iii) RNA is a single-stranded polymer of four nucleotide monomers. A RNA nucleotide is identified by the base it contains: adenine (A), guanine (G), and cytosine (C) or uracil (U).	Nucleic Acids Transcription and Translation
iv) At the ribosome, amino acids are linked together to form specific proteins. The amino acid sequence is directed by the mRNA molecule.	Controlling Protein Synthesis Transcription and Translation
v) Cells pass on their genetic code by replicating (copying) their DNA.	DNA Replication 2 Transcription and Translation

vi) During DNA replication, enzymes unwind and unzip the double helix and each strand serves as a template for building a new DNA molecule. Free nucleotides bond to the template (A-T and C-G) forming a complementary strand. The final product of replication is two identical DNA molecules.	DNA Replication 1 DNA Replication 2 Transcription and Translation
h) Use, limitations, and misuse of genetic information;	
i) Forensic identification is an example of the application of DNA technology.	Understanding Genomes
ii) There is great potential for the development of useful products through genetic engineering (e.g. human growth hormone, insulin, and pest- and disease-resistant fruits and vegetables).	Genetic Engineering Genetic Engineering for Health Care GM Organisms
iii) <i>Eugenics, a pseudo-science of selective procreation, was a movement throughout the twentieth century, worldwide as well as in Virginia, that demonstrated a misuse of the principles of heredity.</i>	–
iv) The Human Genome Project is a collaborative effort to map the entire gene sequence of organisms. This information will be useful in detection, prevention, and treatment of many genetic diseases.	Understanding Genomes
i) Exploration of the impact of DNA technologies.	
i) The potential for identifying and altering genomes raises practical and ethical questions.	Genetic Engineering GM Organisms Understanding Genomes
ii) Cloning is the production of genetically identical cells and/or organisms.	Asexual Reproduction
Standard BIO.7 The student will investigate and understand bases for modern classification systems. Key concepts include:	
a) Structural similarities among organisms.	
i) Binomial nomenclature is a standard way of identifying a species with a scientific two-word name. The first word is the genus name and the second the species name.	Classification What is a species?
ii) A species is defined as a group of organisms that has the ability to interbreed and produce fertile offspring.	Classification What is a species?
iii) Skills - Construct and utilize dichotomous keys to classify groups of objects and organisms.	Classification What is a species?
iv) Skills -Describe relationships based on homologous structures.	Classification
b) Fossil record interpretation;	
i) Compare structural characteristics of an extinct organism, as evidenced by its fossil record, with present, familiar organisms.	Fossil Record
c) Comparison of developmental stages in different organisms;	
i) <i>Recognize similarities in embryonic stages in diverse organisms in the animal kingdom, from zygote through embryo.</i>	–
d) Examination of biochemical similarities and differences among organisms;	
i) <i>Interpret a cladogram or phylogenetic tree showing evolutionary relationships among organisms.</i>	–

<i>ii) Describe relationships between organisms, given amino acid or nucleotide sequences.</i>	–
Standard BIO.8	
The student will investigate and understand how populations change through time. Key concepts include:	
a) Evidence found in fossil records.	
i) A fossil is any evidence of an organism that lived long ago.	Fossil Record
ii) Scientists have used the fossil record to construct a history of life on Earth.	Fossil Record
iii) Skills - Determine the relative age of a fossil given information about its position in the rock and absolute dating by radioactive decay.	–
<i>iv) Skills - Differentiate between relative and absolute dating based on fossils in biological evolution.</i>	–
b) How genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;	
i) Populations are groups of interbreeding individuals that live in the same place at the same time and compete with each other for food, water, shelter, and mates.	Describing Populations Ecosystems
ii) Populations are groups of interbreeding individuals that live in the same place at the same time and compete with each other for food, water, shelter, and mates.	Describing Populations
iii) Organisms with certain genetic variations will be favored to survive and pass their variations on to the next generation.	The Process of Evolution
iv) The unequal ability of individuals to survive and reproduce leads to the gradual change in a population, generation after generation over many generations.	Evolution The Process of Evolution
c) How natural selection leads to adaptations;	
i) Natural selection operates on populations over many generations.	The Process of Evolution
ii) Mutations are important in how populations change over time because they result in genetic changes to the gene pool.	Population Genetics The Process of Evolution
iii) Adaptations sometimes arise in response to environmental pressures, for example, the development of antibiotic resistance in bacterial populations, morphological changes in the peppered moth population, the development of pesticide resistance in insect populations.	Animal Adaptations Plant Adaptations Superbugs The Process of Evolution
d) Emergence of new species	
i) Natural selection is governed by the principles of genetics. The change frequency of a gene in a given population leads to a change in a population and may result in the emergence of a new species.	Evolution Population Genetics The Process of Evolution
e) Scientific explanations for biological evolution.	
i) Through his observations made in the Galapagos Islands, Charles Darwin formulated a theory of how species change over time, called natural selection.	Darwin Evolution

ii) Stephen Jay Gould's idea of punctuated equilibrium proposes that organisms may undergo rapid (in geological time) bursts of speciation followed by long periods of time unchanged. This view is in contrast to the traditional evolutionary view of gradual and continuous change.	–
Standard BIO.9 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include:	
a) Interactions within and among populations including carrying capacities, limiting factors, and growth curves.	
i) A community is a collection of interacting populations.	Introduction to Biodiversity
ii) Population growth curves exhibit many characteristics, such as initial growth stage, exponential growth, steady state, decline, and extinction.	Describing Populations Human Impact on the Environment
iii) Limiting factors are the components of the environment that restrict the growth of populations.	Ecosystems
iv) Carrying capacity is the number of organisms that can be supported by the resources in an ecosystem.	Describing Populations
v) Abiotic factors are the nonliving elements in an ecosystem, such as temperature, moisture, air, salinity, and pH. Biotic factors are all the living organisms that inhabit the environment, including predators, food sources, and competitors.	Describing Populations Ecosystems
vi) Symbiosis is a close and permanent relationship between organisms of two different species. Examples include mutualism, commensalism, and parasitism.	Host-Parasite Relationships
vii) Skills - Graph and interpret a population growth curve.	–
b) Nutrient cycling and energy flow through ecosystems;	
i) An ecosystem consists of all the interacting species and the abiotic environment in a given geographic area.	Ecosystems and Succession
ii) Nutrients cycle through an ecosystem. The most common examples of such nutrients include carbon, oxygen, nitrogen, and water.	Carbon Cycle Nitrogen Cycle Recycling Nutrients Water Cycle
iii) Flow of energy occurs between trophic levels in all ecosystems and can be depicted as follows: - food chain - food web - pyramid of energy - pyramid of biomass - pyramid of numbers.	Energy Transfer in Food Chains Food Chains Food Webs
iv) Skills - Given an illustration of a food chain and a food web, describe each organism as a producer (autotroph), consumer (primary/second order), or decomposer.	Food Chains Food Webs

c) Succession patterns in ecosystems;	
i) Ecological succession is a series of changes in a community in which new populations of organisms gradually replace existing ones.	Ecosystems and Succession
ii) A climax community occurs when succession slows down and a stable community is established. The climax community is made up of organisms that are successful at competing for resources in a given environment. The climax community in most of Virginia is a deciduous oakhickory (hardwood) forest.	Ecosystems and Succession
d) The effects of natural events and human activities on ecosystems;	
i) Human activities, such as reducing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere, and intensive farming, have changed the Earth's land, oceans, and atmosphere.	Air Pollution The Impact of Using CFCs The Atmosphere Human Impact on the Environment Sustainability Water Pollution
ii) Some of these changes have decreased the capacity of the environment to support some life forms.	Extinction Loss of Diversity
e) Analysis of the flora, fauna, and microorganisms of Virginia ecosystems including the Chesapeake Bay and its tributaries.	
<i>i) Observe and identify flora and fauna in a local community, using field guides and dichotomous keys for identifying and describing organisms that characterize the local ecosystem.</i>	-

**Virginia Science Grades 9-12
Curriculum Standards**

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LIFE SCIENCE	Boardworks High School Biology Presentations
Standard LS. 2: The student will investigate and understand that all living things are composed of cells. Key concepts include	
a) cell structure and organelles (cell membrane, cell wall, cytoplasm, vacuole, mitochondrion, endoplasmic reticulum, nucleus, and chloroplast);	
i) distinguish among the following: cell membrane, cytoplasm, nucleus, cell wall, vacuole, mitochondrion, endoplasmic reticulum, and chloroplast.	Eukaryotic Cells Organelles Prokaryotic Cells

ii) correlate the structures of cell organelles with their jobs and analyze how organelles perform particular jobs.	Eukaryotic Cells Organelles Prokaryotic Cells
b) similarities and differences between plant and animal cells;	
i) compare and contrast examples of plant and animal cells, using the light microscope and images obtained from microscopes.	Eukaryotic Cells Microscopy
c) development of cell theory;	
i) describe and sequence the major points in the development of the cell theory.	Cell Theory
ii) <i>identify the three components of the cell theory.</i>	–
d) cell division (mitosis and meiosis).	
i) differentiate between mitosis and meiosis.	Meiosis Mitosis The Stages of Meiosis The Stages of Mitosis
Standard LS. 3: The student will investigate and understand that living things show patterns of cellular organization. Key concepts include	
a) cells, tissues, organs, and systems;	
i) differentiate between unicellular organisms and multicellular organisms and name common examples of each.	Classification Eukaryotic Cells Prokaryotic Cells
ii) differentiate among cells, tissue, organs, and organ systems.	Cells to Organisms
b) life functions and processes of cells, tissues, organs, and systems (respiration, removal of wastes, growth, reproduction, digestion, and cellular transport).	
i) compare and contrast how unicellular and multicellular organisms perform various life functions. This includes the application of knowledge about systems in organisms.	Aerobic Respiration Asexual Reproduction Diffusion Prokaryotic Cells

ii) compare and contrast the various basic life functions of an organism, including respiration, waste removal, growth, irritability, and reproduction, and explain the role that each life function serves for an organism.	Aerobic Respiration Anaerobic Respiration Asexual Reproduction Blood and Blood Vessels Digestion Female Reproductive System Homeostasis Hormones Meiosis The Endocrine System The Kidneys The Respiratory System
iii) model how materials move into and out of cells in the processes of osmosis, diffusion, and active transport. This includes creating and interpreting three-dimensional models and/or illustrations demonstrating the processes involved. Students should be able to analyze the components of these models and diagrams and communicate their observations and conclusions.	Active Transport Diffusion Osmosis
Standard LS.4 The student will investigate and understand that the basic needs of organisms must be met in order to carry out life processes. Key concepts include:	
a) plant needs (light, water, gases, nutrients);	
i) distinguish between the needs of plants and animals.	Ecosystems Photosynthesis 1 Photosynthesis 2
ii) explain how organisms obtain the materials that they need.	Photosynthesis 1 Photosynthesis 2 Specialized Plant Cells
b) animal needs (food, water, gases, shelter, space);	
i) distinguish between the needs of plants and animals.	Ecosystems
ii) explain how organisms obtain the materials that they need.	Digestion Energy Transfer in Food Chains Food Chains Predator-Prey Relationships Host-Parasite Relationships
c) factors that influence life processes.	
<i>i) identify the basic needs of all living things</i>	–
ii) explain that there is a specific range or continuum of conditions that will meet the needs of organisms.	Homeostasis

Standard LS. 5: The student will investigate and understand how organisms can be classified. Key concepts include:	
a) the distinguishing characteristics of kingdoms of organisms;	
i) categorize examples of organisms as representatives of the kingdoms and recognize that the number of kingdoms is subject to change.	Classification
b) the distinguishing characteristics of major animal and plant phyla; and	
<i>ii) recognize examples of major animal phyla</i>	–
<i>iii) recognize examples of major plant phyla (divisions).</i>	–
c) the characteristics of the species.	
i) recognize scientific names as part of a binomial nomenclature.	Classification What is a species?
ii) compare and contrast key features and activities between organisms.	Classification
iii) classify organisms based on physical features.	Classification
<i>iv) arrange organisms in a hierarchy according to similarities and differences in features.</i>	–
Standard LS. 6: The student will investigate and understand the basic physical and chemical processes of photosynthesis and its importance to plant and animal life. Key concepts include	
a) energy transfer between sunlight and chlorophyll;	
i) identify and describe the organelles involved in the process of photosynthesis.	Eukaryotic Cells Photosynthesis 2
b) transformation of water and carbon dioxide into sugar and oxygen; and	
i) describe the process of photosynthesis in terms of raw materials and products generated.	Photosynthesis 1 Photosynthesis 2
c) photosynthesis as the foundation of virtually all food webs.	
i) explain how organisms utilize the energy stored from the products of photosynthesis.	Food Chains Food Webs Energy Transfer in Food Chains
ii) relate the importance of photosynthesis to the role of producers as the foundation of food webs.	Food Chains Food Webs Energy Transfer in Food Chains
Standard LS. 7: The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include:	
a) the carbon, water, and nitrogen cycles;	

i) differentiate among key processes in the water, carbon, and nitrogen cycles and analyze how organisms, from bacteria and fungi to third-order consumers, function in these cycles.	Carbon Cycle Nitrogen Cycle Water Cycle
b) interactions resulting in a flow of energy and matter throughout the system;	
<i>i) observe and identify common organisms in ecosystems and collect, record, and chart data concerning the interactions of these organisms (from observations and print and electronic resources).</i>	–
<i>ii) observe local ecosystems and identify, measure, and classify the living and nonliving components.</i>	–
iii) classify organisms found in local ecosystems as producers or first-, second-, or third-order consumers. Design and construct models of food webs with these organisms.	Food Webs
c) complex relationships within terrestrial, freshwater, and marine ecosystems; and	
i) determine the relationship between a population's position in a food web and its size.	Energy Loss in Food Chains Energy Transfer in Food Chains
ii) identify examples of interdependence in terrestrial, freshwater, and marine ecosystems.	Energy Loss in Food Chains Energy Transfer in Food Chains Food Chains Food Webs Host-Parasite Relationships Predator-Prey Relationships
d) energy flow in food webs and energy pyramids.	
i) apply the concepts of food chains, food webs, and energy pyramids to analyze how energy and matter flow through an ecosystem.	Energy Loss in Food Chains Energy Transfer in Food Chains Food Chains Food Webs
Standard LS. 8: The student will investigate and understand that interactions exist among members of a population. Key concepts include	
a) competition, cooperation, social hierarchy, territorial imperative; and	
<i>i) differentiate between the needs of the individual and the needs of a population.</i>	–
<i>ii) interpret, analyze, and evaluate data from systematic studies and experiments concerning the interactions among members of a population.</i>	–
b) influence of behavior on a population.	
<i>iii) determine the relationship between a population's position in a food web and the types of interactions seen among the individuals of the population.</i>	–
Standard LS. 9: The student will investigate and understand interactions among populations in a biological community. Key concepts include	
a) the relationships among producers, consumers, and decomposers in food webs;	

i) identify the populations of producers, consumers, and decomposers and describe the roles they play in their communities.	Decomposers Food Webs
ii) interpret, analyze, and evaluate data from systematic studies and experiments concerning the interactions of populations in an ecosystem.	Food Webs
iii) predict the effect of population changes on the food web of a community.	Food Webs
b) the relationship between predators and prey;	
i) generate predictions based on graphically represented data of predator-prey populations.	Describing Populations Predator-Prey Relationships
c) competition and cooperation;	
i) generate predictions based on graphically represented data of competition and cooperation between populations.	Describing Populations Ecosystems
d) symbiotic relationships; and	
i) differentiate between the types of symbiosis and explain examples of each.	Host-Parasite Relationships
e) niches.	
i) infer the niche of organisms from their physical characteristics.	Ecosystems and Succession
Standard LS. 10: The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include	
a) differences between ecosystems and biomes;	
i) differentiate between ecosystems and biomes.	Ecosystems and Succession
<i>ii) recognize and give examples of major biomes: desert, forest, grassland, and tundra.</i>	–
b) characteristics of land, marine, and freshwater ecosystems; and	
<i>i) compare and contrast the biotic and abiotic characteristics of land, marine, and freshwater ecosystems.</i>	–
c) adaptations that enable organisms to survive within a specific ecosystem.	
i) observe and describe examples of specific adaptations that organisms have which enable them to survive in a particular ecosystem.	Animal Adaptations Evolution Plant Adaptations The Process of Evolution
ii) analyze specific adaptations of organisms to determine how they help the species survive in its ecosystem.	Animal Adaptations Evolution Plant Adaptations The Process of Evolution
Standard LS. 11: The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time (daily, seasonal, and long term). Key concepts include	
a) phototropism, hibernation, and dormancy;	

<i>i) relate the responses of organisms to daily, seasonal, or long-term events.</i>	–
b) factors that increase or decrease population size; and	
i) differentiate between ecosystems, communities, populations, and organisms.	Describing Populations Ecosystems
ii) compare and contrast the factors that increase or decrease population size.	Describing Populations Loss of Diversity
c) eutrophication, climate changes, and catastrophic disturbances	
i) predict the effect of climate change on ecosystems, communities, populations, and organisms.	Extinction
ii) predict the effect of large scale changes on ecosystems, communities, populations, and organisms.	Describing Populations Extinction Population Genetics
iii) classify the various types of changes that occur over time in ecosystems, communities, populations, and organisms.	Describing Populations Ecosystems and Succession Extinction Population Genetics
Standard LS.12: The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include	
a) food production and harvest;	
<i>i) describe the relationship between human food harvest and the ecosystem.</i>	–
b) change in habitat size, quality, or structure;	
i) debate the pros and cons of human land use versus ecosystem stability.	Loss of Diversity Human Impact on the Environment
c) change in species competition;	
i) identify examples of ecosystem dynamics.	Ecosystems Ecosystems and Succession Energy Transfer in Food Webs
d) population disturbances and factors that threaten or enhance species survival; and	
i) compare and contrast population disturbances that threaten and those that enhance species survival.	Human Impact on the Environment
ii) observe the effect of human interaction in local ecosystems and collect, record, chart, and interpret data concerning the effect of interaction (from observations and print and electronic resources).	Air Pollution Human Impact on the Environment Water Pollution
e) environmental issues (water supply, air quality, energy production, and waste management).	

i) describe ways that human interaction has altered habitats positively and negatively.	Air Pollution Human Impact on the Environment Loss of Diversity Sustainability Water Pollution
Standard LS.13: The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include	
a) the role of DNA;	
i) recognize the appearance of DNA as double helix in shape.	DNA Nucleic Acids
ii) explain that DNA contains coded instructions that store and pass on genetic information from one generation to the next.	DNA Nucleic Acids
iii) explain the necessity of DNA replication for the continuity of life.	DNA Replication 1 Meiosis Mitosis
b) the function of genes and chromosomes;	
i) demonstrate variation within a single genetic trait	Genes and Alleles Gregor Mendel
c) genotypes and phenotypes	
i) distinguish between genotype and phenotype.	Environmental Variation
d) factors affecting the expression of traits;	
i) distinguish between dominant and recessive traits.	Genes and Alleles
ii) use Punnett squares to predict the possible combinations of inherited factors resulting from single trait crosses.	Gregor Mendel
e) characteristics that can and cannot be inherited;	
i) differentiate between characteristics that can be inherited and those that cannot be inherited.	Environmental Variation Genetic Variation
f) genetic engineering and its applications; and	
i) identify aspects of genetic engineering and supply examples of applications. Evaluate the examples for possible controversial aspects.	Genetic Engineering Genetic Engineering for Health Care GM Organisms
g) historical contributions and significance of discoveries related to genetics.	
i) describe the contributions of Mendel, Franklin, and Watson and Crick to our basic understanding of genetics.	Gregor Mendel Nucleic Acids

Standard LS.14: The student will investigate and understand that organisms change over time. Key concepts include	
a) the relationships of mutation, adaptation, natural selection, and extinction;	
i) explain how genetic variations in offspring, which lead to variations in successive generations, can result from the same two parents..	Population Genetics Genetic Mutations Genetic Variation
ii) describe how changes in the environment can bring about changes in species through natural selection, adaptation, and extinction.	Human Impact on the Environment Extinction The Process of Evolution Population Genetics
b) evidence of evolution of different species in the fossil record; and	
i) describe and explain how fossils are records of organisms and events in the Earth's history.	Fossil Record
ii) explain the evidence for evolution from a variety of sources of scientific data.	Fossil Record Darwin The Process of Evolution
c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.	
<i>i) analyze and evaluate data from investigations on variations within a local population.</i>	–
<i>ii) interpret data from simulations that demonstrate selection for a trait belonging to species in various environments.</i>	–