Life Science

Curriculum Guide

SY 2012-13 through SY 2018-19

Prince William County
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Introduction

The Prince William County Public Schools Science Curriculum is based on the *Science Standards of Learning for Virginia Public Schools* and is further defined by the *Science Standards of Learning* Curriculum Framework. The Science Curriculum provides guidance to teachers as they develop instruction appropriate for their students. It assists teachers as they plan their lessons by identifying essential understandings, skills, and processes students need to master. The curriculum specifically outlines the minimum content that all teachers should teach and all students should learn.

Teachers should use the science curriculum as a resource for developing instruction without limiting the scope of instruction. Additional knowledge and skills that can enrich and enhance students' understanding of the content identified in the curriculum should be included as a part of quality learning experiences.

The Prince William County Science Curriculum reflects the knowledge and skills that students are accountable for on the Science Standards of Learning assessments that are administered in the spring of each school year. Assessment items are not a verbatim reflection of the information presented in the Science Curriculum. Students are expected to continue to apply knowledge and skills from curriculum presented in previous grades as they build scientific expertise.

The design of the Science Curriculum requires that teachers prepare students to demonstrate achievement of the standards for elementary and middle school by the time they complete the grade levels tested. The high school end-of-course assessments are administered at the end of the year in which instruction takes place. (Students may earn verified units of credit upon successfully meeting expectations on the Standards of Learning assessment and course material.)

Each topic in the Science Curriculum is derived from the Science Standards of Learning. The format of the Science Curriculum facilitates teacher planning by identifying the key questions, concepts, knowledge and skills that should be the focus of instruction for each standard. The curriculum document is divided into three columns: *Curriculum Information, Essential Knowledge, Skills, and Processes/Key Vocabulary,* and *Essential Questions and Understandings*. The purpose of each column is explained below.

Curriculum Information
Each standard reflects what students know and should be able to do. In this column, the unit, SOL Reporting Category and standard is listed. Additionally, because the *Science Standard of Learning for Virginia Public Schools* is scaffolded, foundational Standards that support the SOL from previous grades are listed.

Essential Knowledge, Skills and Processes; Key Vocabulary
This section delineates the key concepts, ideas and scientific relationships that all students should grasp to demonstrate an understanding of the Standards. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. This section is helpful to teachers when planning classroom assessments as it is a guide to the knowledge and skills that define the objective. This section also identifies vocabulary that is critical to mastering the objective of that standard and many times is the first introduction for the student to new concepts and skills. The vocabulary identified is not an exhaustive list of terms that a student will encounter in addressing each standard.

Essential Questions and Understandings
This section includes background information for the teacher. It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. It may also contain definitions of key vocabulary to help facilitate student learning.

Investigate and Understand

Many of the standards in the *Science Standards of Learning* begin with the phrase "Students will investigate and understand." This phrase was chosen to communicate the range of rigorous science skills and knowledge levels embedded in each standard. Limiting a standard to one observable behavior, such as "describe" or "explain," would have narrowed the interpretation of what was intended to be a rich, highly rigorous, and inclusive content standard.

"Investigate" refers to scientific methodology and implies systematic use of the following inquiry skills:

- observing;
- classifying and sequencing;
- communicating;
- measuring;
- predicting;
- hypothesizing;
- inferring;
- defining, controlling, and manipulating variables in experimentation;
- designing, constructing, and interpreting models; and
- interpreting, analyzing, and evaluating data.

"Understand" refers to various levels of knowledge application. In the *Science Standards of Learning*, these knowledge levels include the ability to:

- recall or recognize important information, key definitions, terminology, and facts;
- explain the information in one's own words, comprehend how the information is related to other key facts, and suggest additional interpretations of its meaning or importance;
- apply the facts and principles to new problems or situations, recognizing what information is required for a particular situation, using the information to explain new phenomena, and determining when there are exceptions;
- analyze the underlying details of important facts and principles, recognizing the key relations and patterns that are not always readily visible;
- arrange and combine important facts, principles, and other information to produce a new idea, plan, procedure, or product; and
- make judgments about information in terms of its accuracy, precision, consistency, or effectiveness.

Therefore, the use of "investigate and understand" allows each content standard to become the basis for a broad range of teaching objectives, which the school division will develop and refine to meet the intent of the *Science Standards of Learning*.

Planning Guide for Life Science

VA SOL Reporting Category	Unit	Objectives	Suggested Time Allocation
Scientific Investigation, Reasoning, and Logic	**Science Process Skills**	**LS.1/ Infused** Data analysis Data collection tools Models and simulations Sources of error Variables and constants Hypotheses and repeat trails Make predications Patterns recognition Current applications of science skills	Infused throughout the year with content-specific objectives. Skills are reinforced with hands-on activities.
Life Systems	**Cell Structure and Function**	**LS.2** Plant and animal cell composition Plant and animal structure and function Compound light microscope Cell theory Cell division (cell cycle, mitosis, meiosis)	12 blocks
	Patterns of Cellular Organization	**LS.3** Cellular organization Life processes	9 blocks
	Classification	**LS.4** Domains Kingdoms Phyla Divisions Species Binomial nomenclature	10 blocks
	Photosynthesis	**LS.5** Photosynthesis Food webs	9 blocks
Ecosystems	**Interactions Among Organisms and the Environment**	**LS.6** Carbon cycle Water cycle Nitrogen cycle Organism interactions Terrestrial ecosystems Freshwater ecosystems Marine ecosystems Energy pyramid Energy flow in a food web	5 blocks

VA SOL Reporting Category	Unit	Objectives	Suggested Time Allocation
Ecosystems	**Interactions Among Organisms and the Environment**	**LS.7** Population dynamics Population behaviors	2 blocks
		LS.8 Relationships in food webs (competition, cooperation, symbiotic relationships) Predator/prey relationships	3 blocks
	Adaptations of Organisms to the Environment	**LS.9** Adaptation to abiotic and biotic factors Differences between ecosystems and biomes Land ecosystem Marine ecosystem Freshwater ecosystem	7 blocks
	Dynamics in the Environment	**LS.10** Respond to change Phototropism Environmental change factors Hibernation Dormancy Population size Eutrophication Climate change Catastrophic disturbances	5 blocks
	Influence of Humans on Ecosystems Dynamics	**LS.11** Habitat variations Species competition Population disturbances Environmental issues	5 blocks
Life Systems	**DNA and Heredity**	**LS.12** Structure of DNA Role of DNA Genes Chromosomes Inheritance factors Genetic engineering Historical contributions to the study of DNA	13 blocks
Life Systems Earth and Space Systems	**Evolution and Genetic Variation**	**LS.13** Evolution Mutations Adaptation Natural selection Environmental influences Extinction	5 blocks

Grade 8 Science: Test Blueprint Summary Table

Reporting Category	Grade 6 Standards of Learning	Life Science Standards of Learning	Physical Science Standards of Learning	Number of Items
Assessed with Other SOL	6.1j	LS.1j	PS.1n	
Scientific Investigation	6.1a-i	LS.1a-i	PS.1a-m	10
Force, Motion, Energy, and Matter	6.2a, e 6.4a-g 6.5a-b 6.6a		PS.2a-f PS.3a-b PS.4a-c PS.5a-c PS.6a-b PS.7a-d PS.8a-d PS.9a-e PS.10a-d PS.11a-d	15
Life Systems		LS.2a-d LS.3a-b LS.4a-d LS.5a-c LS.12a-f LS.13a		7
Ecosystems	6.7a-g	LS.6a-d LS.7a-b LS.8a-e LS.9a-c LS.10a-c LS.11a-e		7
Earth and Space Systems	6.2b-d 6.3a-e 6.5c-f 6.6b-f 6.8a-i 6.9a-d	LS.13b-c		11
Excluded from Testing			None	
Number of Operational Items			50	
Number of Field Test Items*			10	
Total Number of Items on Test			60	

LS. 1 Overview

In the PWCS Curriculum, all .1 standards are intended to develop investigative and inquiry skills and an understanding of the nature of science. These standards describe the range of inquiry skills and the level of proficiency in using those skills students should achieve, and the components of the nature of science that should be developed and reinforced in the context of science concepts developed in grades K - 12. **.1 standards do not require a discrete unit be taught on scientific investigation and the nature of science because the skills that make up the standard should be incorporated in all the other grade level science standards.** It is also intended that by participating in activities and experiences that develop these skills, students will achieve a preliminary understanding of scientific inquiry and the nature of science and more fully grasp the content-related concepts.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Science Process Skills (Suggested Time: Infused) **SOL Reporting Category** Scientific Investigation **Virginia SOL LS.1** The student will demonstrate and understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) data are organized into tables showings repeated trail and means; b) a classification system is developed based on multiple attributes; c) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and probeware are used to gather data; d) models and simulations are constructed and used to illustrate and explain phenomena; e) sources of experimental error are identified; f) dependent variables, independent variables, and constants are identified; g) variables are controlled to test hypotheses and trails are repeated; h) data are organized, communicated through graphical representation, interpreted and used to make predications; i) patterns are identified in data and are interpreted and evaluated; and	**The student will** • make connections between the components of the nature of science and their investigations and the greater body of scientific knowledge and research. • design a data table to organize all components of an investigation in a meaningful way. • develop and use a classification system that uses numerous attributes to organize information and discern patterns. • select and use appropriate tools and techniques for collecting qualitative and quantitative data in classroom and field investigations. • create and use mental and physical models (including simulations) as ways to visualize explanations of ideas and phenomena. • identify potential sources of error in the design of an experiment. • evaluate the design of an experiment and the events that occur during an investigation to determine which factors may affect the results of the experiment. This requires students to examine the experimental procedure and decide where or if they have made mistakes.	**Essential Questions** • What are variables and why is it important to identify, define, and control them? • How can an experimental design help us organize our investigations? • What purpose does a hypothesis serve and how should it be technically stated? • Why do scientists use models to explain data or to collect data? • How do scientist justify collecting qualitative data versus quantitative data in a scientific investigation? **Essential Understandings** • The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts a) the natural world is understandable; b) science is based on evidence - both observational and experimental; c) science is a blend of logic and innovation; d) scientific ideas are durable yet subject to change as new data are collected; e) science is a complex social endeavor; and f) scientists try to remain objective and engage in peer review to help avoid bias. • Expected results are reflected in the organization of a data table, which includes areas to record the number of repeated trials, levels of the independent variable, measured results for the dependent variable, and analysis of the results by calculation of mathematical means. • Scientists create and apply classification systems to organize information and discern patterns. • Appropriate tools and techniques are used to gather data during scientific investigations. Measurements are collected using the *International System of Units* (metric units) of measurement. • Mental and physical models, including computer and other simulations, can be helpful in explaining events or sequences of events that occur. They can be used as part of scientific explanations to support data or represent

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
j) current applications are used to reinforce life science concepts. **<u>Foundational Standards</u>** 4.1 5.1 6.1	• identify what is deliberately changed in the experiment and what is to be measured as the dependent variable. • analyze the variables in an experiment and decide which ones must be held constant (not allowed to change) in order for the investigation to represent a fair test. This requires students to comprehend what "variables" are and to apply that idea in new situations related to the *Life Science Standards of Learning* concepts. • determine the specific component of an experiment to be changed as an independent variable and control the experiment by conducting trials for the experiment in which the independent variable is not applied. This requires the student to set up a standard to which the experimental results can be compared. The student must use the results of the controlled trials to determine whether the hypothesized results were indeed due to the independent variable. • construct appropriate graphs, using data sets from investigations. This requires the student to recognize that a line graph is most appropriate for	phenomena, especially those that are not easily seen directly or must be inferred from data. • Potential sources of error in the experimental design must be identified. • To communicate the plan of an experiment accurately, the independent variable, dependent variable, and constants must be explicitly defined. • To establish that the events of an experiment are the result of manipulating the independent variable, the experiment must be controlled by observing the effects without the application of the independent variable. The results can be compared with this standard or control. Not all experiments have a control. • Multiple trials of an experiment must be conducted to verify the results. • Analysis of observed results of systematic investigations includes construction and interpretation of graphs. Such interpretation can be used to make predictions about the behavior of the dependent variable in other situations and to explore potential sources of error in the experiment. This analysis can be used to support conclusions about the results of the investigation. • Investigations can be classified as observational (descriptive) studies (intended to generate hypotheses), or experimental studies (intended to test hypotheses). • Science concepts are applied through observations and connections with everyday life and technology.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	reporting continuous or real-time data. This also requires a student to comprehend that points along the line that are not actual data points can be used to make predictions. Students should be able to interpret and analyze these graphs. • distinguish between observational and experimental investigations. • develop conclusions based on a data set and verify whether the data set truly supports the conclusion. This requires students to cite references to the data that specifically support their conclusions. **Key Vocabulary** constant control data dependent variable experiment hypothesis independent variable inference mass meniscus observations prediction qualitative data quantitative data validity volume	

LS. 2 Overview

This standard builds on the general concept in science standard 5.5 that states that living things are made of cells. The emphasis here is on the concept that cells are the unit of structure and function of living things and on the concept of subcellular components, or organelles, each with a particular structure and function. The historical contributions of many scientists to the establishment of the cell theory are also important for students to understand. This standard also introduces students to the concept of cell division. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Cell Structure, Function, and Division (Suggested Time: 12 blocks) **SOL Reporting Category** Life Systems **Virginia SOL LS.2** The student will investigate and understand that all living things are composed of cells. Key concepts include a) cell structure and organelles; b) similarities and differences between plant and animal cells; c) development of the cell theory; and d) cell division. **Foundational Standards** 5.5 The student will investigate and understand that organisms are made of one or more cells and have distinguishing characteristics that play a vital role in the organism's ability to survive and thrive in its environment.	**The student will** • distinguish among the following: cell membrane, cytoplasm, nucleus, cell wall, vacuole, mitochondrion, endoplasmic reticulum, and chloroplast. • correlate the structures of cell organelles with their functions. • compare and contrast examples of plant and animal cells, using the light microscope and images obtained from other microscopes. • describe and sequence the major points in the development of the cell theory. • identify the three components of the cell theory. • sequence the steps in the cell cycle, including the phases of mitosis. • differentiate between the purpose of mitosis and meiosis. • design an investigation from a testable question related to animal and plant cells. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. An example of such a question is: "Do onion cells vary in shape or	**Essential Questions** • What are the major parts (organelles) of a cell and what is the function of each? • How does a cell's structure relate to its function? • Who were important contributors to knowledge about cells? • Which organelles are found in plant cells but not in animal cells? • What are the three main components of the cell theory? • What are the phases of the cell cycle, including the phases of mitosis? • What is meiosis? • What is the relationship between the chromosome number of parent and daughter cells? • Why is meiosis necessary for sexual reproduction? • How does the purpose of mitosis compare to the purpose of meiosis? **Essential Understandings** • The structure of a cell organelle is suited to the function carried out by that organelle. Division of labor within a cell is essential to the overall successful function of the cell. • Similarities and differences in plants and animals are evident at the cellular level. Plant and animal cells contain some of the same organelles and some that differ. • Cell theory includes the following components: all living things are composed of cells; cells are the smallest unit (structure) of living things that can perform the processes (functions) necessary for life; and living cells come only from other living cells. • The development of cell theory can be attributed to the major discoveries of many notable scientists. The development of cell theory has been dependent upon improvements in the microscope technologies and microscopic techniques throughout the last four centuries.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	structure depending on where they are found in the plant?" **<u>Key Vocabulary</u>** anaphase cell plate cell wall cell membrane cellulose centrioles centromere chloroplast chromosome cytokinesis cytology cytoplasm daughter cells diploid endoplasmic reticulum eukaryote gametes haploid interphase meiosis metaphase mitosis mitochondria nucleus organelles parent cell prokaryote prophase somatic cell spindle fibers telophase trait vacuole	• Continuing advances in microscopes and instrumentation have increased the understanding of cell organelles and their functions. Many of these organelles can now be observed with a microscope (light, electron). • Cells go through a life cycle known as the cell cycle. The phases of the cell cycle are interphase, mitosis, and cytokinesis. (Although it is appropriate for students at this level to learn to recognize the stages of the cell cycle and mitosis, an exploration of the individual stages of meiosis may be reserved for high school Biology.) • The purpose of mitosis is to produce new cells for growth and repair that are identical to the parent cell. The purpose of meiosis is to produce reproductive (sex) cells that carry half the genetic material of the parent.

LS. 3 Overview

This standard emphasizes the fact that among living organisms, there is a universality of the functions that maintain life. This standard continues to build upon students' knowledge of these functions and introduces students to the process of cellular transport. With the exception of the structures associated with plant reproduction, which are highlighted in 4.4, this is the students' introduction to the specific structures of plants and animals that enable them to perform life functions. Students are introduced to the concepts of unicellular and multicellular organisms and division of labor. This standard is not intended to require student understanding of the details of human body systems. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Patterns of Cellular Organization (Suggested Time: 9 blocks) **SOL Reporting Category** Life Systems **Virginia SOL 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; and b) patterns of cellular organization and their relationship to life processes in living things. **Foundational Standards** 4.4 The student will investigate and understand basic plant anatomy and life processes.	**The student will** • explain the relationship among cells, tissue, organs, and organ systems. • differentiate between unicellular organisms and multicellular organisms and name common examples of each. • compare and contrast how unicellular and multicellular organisms perform various life functions. This includes the application of knowledge about systems in organisms. • explain the role that each life function serves for an organism: ingestion, digestion and removal of waste, stimulus response, growth and repair, gas exchange, and reproduction. • explain that there is a specific range or continuum of conditions that will meet the needs of organisms. • model how materials move into and out of cells in the processes of osmosis, diffusion, and selective permeability. 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	**Essential Questions** • What are the levels of cellular organization and what is the relationship among the levels? • How does the division of labor differ between unicellular organisms and multicellular organisms? • What are the processes that all living organisms need to survive? • What are essential life processes cells must carry out in order to survive? **Essential Understandings** • Cells that have the same function group together to form tissues. Tissues that have the same function group together to form organs. Organs with similar functions group to work together in an organ system. • Unicellular organisms are made of only one cell. Multicellular organisms are made of many cells. • Multicellular organisms exhibit a hierarchy of cellular organization. They are complex in that there is a division of labor among the levels of this hierarchy for carrying out necessary life processes. • Cells perform numerous functions and processes including cellular respiration, waste breakdown and removal, growth and division, and cellular transport. • Osmosis is the passive transport of water molecules across a cell membrane. Diffusion is the passive transport of substances other than water across a cell membrane. Cell membranes are selectively permeable to various substances. (A discussion of facilitated diffusion, tonicity, and active transport should be reserved for high school Biology.) • Living things carry out life processes including ingestion, digestion and removal of waste, stimulus response, growth and repair, gas exchange, and reproduction. • Numerous factors can strongly influence the life processes of organisms.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	diagrams and communicate their observations and conclusions. • create plausible hypotheses about the effects that changes in available materials might have on particular life processes in plants and in animals. • conduct basic investigations related to understanding cellular organization, with emphasis on observations of cells and tissue. This investigation should focus on the skills developed in LS.1 **Key Vocabulary** active transport cellular respiration cellular transport diffusion equilibrium excretion homeostasis metabolism multicellular organism organs organ system osmosis passive transport stimulus tissues unicellular	

LS .4 Overview

Classifying and grouping is a key inquiry skill, as described in the K–12 "Investigate and Understand" section of the Introduction to the *Science Standards of Learning.* Classifying is an important skill in the K–6 "Scientific Investigation, Reasoning and Logic" strand. The use of a classification key is introduced in 5.1.

This standard focuses on students practicing classification skills within a hierarchical biological classification system. This is accomplished by analyzing similarities and differences between the structures and functions of organisms. Students should understand that scientists use classification as a tool to organize information about organisms and to gain information about related organisms. This standard does not require a detailed survey of each domain, kingdom or phylum, but rather a general overview of how organisms are grouped and a focus on a few key groups. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Classification (Suggested Time: 10 blocks) **SOL Reporting Category** Life Systems **Virginia SOL LS.4** The student will investigate and understand how organisms can be classified. Key concepts include a) the distinguishing characteristics of domains of organisms; b) the distinguishing characteristics of kingdoms of organisms; c) the distinguishing characteristics of major animal phyla and plant divisions; and d) the characteristics that define a species. **Foundational Standards** 5.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which items such as rocks, minerals, and organisms are identified using various classification keys.	**The student will** • classify organisms based on a comparison of key physical features and activities. • arrange organisms in a hierarchy according to similarities and differences in features. • categorize examples of organisms as representative of the three domains (Archaea, Bacteria and Eukarya) and recognize that the number of domains is subject to change as new data are collected. • categorize examples of organisms as representative of the kingdoms and recognize that the number of kingdoms is subject to change as new data are collected. • recognize examples of major animal phyla. • recognize examples of major plant divisions. • recognize scientific names as part of a binomial nomenclature. **Key Vocabulary** autotroph binomial nomenclature class divisions family genus heterotroph hierarchy	**Essential Questions** • How and why do we classify organisms? • What is the hierarchy of the eight levels of classification? • What characteristics are used to organize organisms in to a domain, kingdom, phyla, and division • Which two levels of classification make up an organism's scientific name? **Essential Understandings** • Information about physical features and activities is arranged in a hierarchy of increasing specificity. The levels in the accepted hierarchy include domain, kingdom, phylum, class, order, family, genus and species. • Current classification systems now generally recognize the categorization of organisms into three domains, Archaea, Bacteria and Eukarya. • As living things are constantly being investigated, new attributes (physical and chemical) are revealed that affect how organisms are placed in a standard classification system. This system is the basis for scientific binomial nomenclature. • Any grouping of organisms into domains or kingdoms is based on several factors, including the presence or absence of cellular structures, such as the nucleus, mitochondria, or a cell wall; whether the organisms exist as single cells or are multicellular; and how the organisms get their food. For example, simple, single-celled organisms that are able to survive in extreme environments are believed to be fundamentally different from other organisms and may be classified in their own domain (Archaea). Four different kingdoms of the Eukarya domain of organisms are generally recognized by scientists today (Protista, Fungi, Plants, and Animals). • Some important animal groups (*phyla*) are the cnidarians, mollusks, annelids, arthropods, echinoderms, and chordates. • Four important plant groups (*divisions*) are the mosses, ferns, conifers, and flowering plants. • A group of similar-looking organisms that can interbreed under natural conditions and produce offspring that are capable of reproduction defines a

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	kingdom mosses offspring order phylum (phyla) species taxonomy	species.

LS.5 Overview

Students learn in 4.4 that photosynthesis is a basic life process of plants requiring chlorophyll and carbon dioxide. This standard pulls these ideas together to demonstrate the complexity and importance of photosynthesis. Energy enters food webs through photosynthesis and is then transferred throughout the food web. It is crucial that students understand the importance of plants (and other photosynthesizing organisms) in this role of providing energy to all other living things. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Photosynthesis (Suggested Time: 9 blocks) **SOL Reporting Category** Life Systems **Virginia SOL LS.5** 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; b) transformation of water and carbon dioxide into sugar and oxygen; and c) photosynthesis as the foundation of virtually all food webs. **Foundational Standards** 4.4 The student will investigate and understand basic plant anatomy and life processes.	**The student will** • describe the process of photosynthesis in terms of raw materials and products generated. • identify and describe the cellular organelles involved in the process of photosynthesis. • explain how organisms utilize the energy stored from the products of photosynthesis. • compare and contrast the processes of photosynthesis and cellular respiration. • relate the importance of photosynthesis to the role of producers as the foundation of food webs. • design an investigation from a testable question related to photosynthesis. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. **Key Vocabulary** autotroph cellular respiration chlorophyll chloroplast energy energy transfer energy transformation	**Essential Questions** • What is photosynthesis and why is it important? • What is the relationship of photosynthesis to the food web? **Essential Understandings** • Chlorophyll is a chemical in chloroplasts that can absorb or trap light energy. • Photosynthesis is the necessary life process that transforms light energy into chemical energy. It involves a series of chemical reactions in which the light energy is used to change raw materials (carbon dioxide and water) into products (sugar and oxygen). The energy is stored in the chemical bonds of the glucose (sugar) molecules. • Plants perform cellular respiration as well as photosynthesis. • Plants convert the sugars they produce into other raw materials that are used by plants and animals for growth, repair, and energy needs. • Energy is a basic need of all living things. Photosynthesizing organisms obtain their energy from the sun and are often called producers because of their ability to produce glucose (sugar). • Photosynthesizing organisms are the foundation of virtually all food webs.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	food webs heterotroph photosynthesis producer products raw materials	

LS.6 Overview

This standard explores the application of the concept of interdependence between organisms and their physical environment. This concept is covered thoroughly in the K–6 standards of the Living Systems strand. The K–6 standards include the concept of interdependence (2.5); relationships in aquatic and terrestrial food chains, trophic levels, food webs, food pyramids, and cycles (3.5 and 4.5); and interactions between the living and nonliving components of an ecosystem (4.5). Terminology used in previous standards includes producer, consumer, decomposer, herbivore, omnivore, carnivore (3.5), and niche (4.5). It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Interactions Among Organisms and the Environment (Suggested Time: 5 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.6** 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; b) interactions resulting in a flow of energy and matter throughout the system; c) complex relationships within terrestrial, freshwater, and marine ecosystems; and d) energy flow in food webs and energy pyramids. **Foundational Standards** 2.5 The student will investigate and understand that living things are part of a system. 3.5 The student will investigate and understand relationships among organisms in aquatic and terrestrial food chains.	**The student will** • differentiate among key processes in the water, carbon, and nitrogen cycles and relate how organisms, from bacteria and fungi to third-order consumers, function in these cycles. • 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). • 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. • observe local ecosystems and identify, measure, and classify the living and nonliving components. • identify examples of interdependence in terrestrial, freshwater, and marine ecosystems. • determine the relationship between a population's position in a food web and its size.	**Essential Questions** • What is an ecosystem? • How do scientists trace the pathway of important elements through the carbon, nitrogen, and water cycles? • Why are relationships between the abiotic and biotic components of an ecosystem necessary? • How is energy transferred through a community? **Essential Understandings** • Many important elements and compounds cycle through the living and nonliving components of the environment as a chain of events that continuously repeats. • Materials are recycled and made available through the action of decomposers. • In order to understand how an ecosystem functions, one must understand the concept of a system and be able to envision models of systems. • To analyze the interactions resulting in a flow of energy and matter throughout the ecosystem, one must identify the elements of the system and interpret how energy and matter are used by each organism. • Energy enters an ecosystem through the process of photosynthesis and is passed through the system as one organism eats and is, in turn, eaten. This energy flow can be modeled through relationships expressed in food webs. • The amount of energy available to each successive trophic level (producer, first-order consumer, second-order consumer, third-order consumer) decreases. This can be modeled through an energy pyramid, in which the producers provide the broad base that supports the other interactions in the system.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
4.5 The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem.	• apply the concepts of food chains, food webs, and energy pyramids to analyze how energy and matter flow through an ecosystem. • design an investigation from a testable question related to food webs. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. • analyze and critique the experimental design of basic investigations related to food webs. **Key Vocabulary** abiotic factors biotic factors carnivore community consumer decomposer ecosystem energy flow energy pyramid food chain food web herbivore omnivore producer scavenger trophic level	

LS.7 Overview

This standard applies the concept that each organism exists as a member of a population and interacts with other members of that population in a variety of ways. The term population is introduced in standard 3.6 (“Living Systems” strand). Individuals of a population demonstrate various behavioral adaptations (competition, cooperation, establishment of a social hierarchy, territorial imperative), which allow the population to survive. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Interactions Among Organisms in a Population (Suggested Time: 2 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.7** 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 b) influence of behavior on a population. **Foundational Standards** 3.6 The student will investigate and understand that ecosystems support a diversity of plants and animals that share limited resources.	**The student will** • differentiate between the needs of the individual and the needs of a population. • interpret, analyze, and evaluate data from systematic studies and experiments concerning the interactions among members of a population. • determine the relationship between a population's position in a food web and the types of interactions seen among the individuals of the population. • observe and identify populations in ecosystems and collect, record, chart, and interpret data concerning the interactions of these organisms (from observations and print and electronic resources). • categorize behaviors as examples of competition, cooperation, social hierarchy, or territorial imperative. **Key Vocabulary** competition cooperation habitat hierarchy population social order territory	**Essential Questions** • What is a population? • What do members of a population compete for in an ecosystem? • What are some examples of interactions that exist among a population? **Essential Understandings** • Individual members of a population interact with each other. These interactions include competing with each other for basic resources, mates, territory, and cooperating with each other to meet basic needs. • The establishment of a social order in a population may ensure that labor and resources are adequately shared. • The establishment of a territory ensures that members of a population have adequate habitat to provide for basic resources. • Individual behaviors and group behaviors can influence a population. • Animals exhibit needs for food, water, gases, shelter and space for which they compete. These needs may often be met in a range of conditions. Too much may be as harmful as too little (e.g., too much food or too little water).

LS.8 Overview

Life Science standard LS.8 applies the concept of interactions between populations of different species. This standard extends the concepts of prior K–6 standards, including those concerning producers, consumers, and decomposers (3.5); predator and prey (3.6); and niches (4.5). This standard introduces the concept of symbiosis and focuses on the symbiotic relationship between parasite and host. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Interactions Among Organisms in a Population (Suggested Time: 3 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.8** 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; b) the relationship between predators and prey; c) competition and cooperation; d) symbiotic relationships; and e) niches. **Foundational Standards** 3.5 The student will investigate and understand relationships among organisms in aquatic and terrestrial food chains. 3.6 The student will investigate and understand that ecosystems support a diversity of plants and animals that share limited resources. 4.5 The student will investigate and	**The student will** • identify the populations of producers, consumers, and decomposers and describe the roles they play in their communities. • interpret, analyze, and evaluate data from systematic studies and experiments concerning the interactions of populations in an ecosystem. • predict the effect of population changes on the food web of a community. • generate predictions based on graphically represented data of predator-prey populations. • generate predictions based on graphically represented data of competition and cooperation between populations. • differentiate between the types of symbiosis and explain examples of each. • infer the niche of organisms from their physical characteristics. • design an investigation from a testable question related to interactions among populations. The investigation may be a complete experimental design or may focus on systematic observation, description,	**Essential Questions** • What is a community? • What is meant by “predator-prey” relationships? • What is symbiosis? • What are the three types of symbiosis? • What is a niche? • What physical characteristics of organisms help identify their niche? **Essential Understandings** • Organisms or populations that rely on each other for basic needs form interdependent communities. • Energy resources of a community are shared through the interactions of producers, consumers, and decomposers. • The interaction between a consumer that hunts for another consumer for food is the predator-prey relationship. • In a community, populations interact with other populations by exhibiting a variety of behaviors that aid in the survival of the population. • Organisms may exist as members of a population; populations interact with other populations in a community. • Populations of one species may compete with populations of other species for resources. Populations of one species may also cooperate with populations of other species for resources. • A symbiotic relationship may exist between two or more organisms of different species when they live and work together. • Symbiotic relationships include mutualism (in which both organisms benefit), commensalism (in which one organism benefits and the other is unaffected), and parasitism (in which one organism benefits and the other is harmed). • Each organism fills a specific role or niche in its community.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
understand how plants and animals, including humans, in an ecosystem. interact with one another and with the nonliving components in the ecosystem.	measurement, and/or data collection and analysis. **Key Vocabulary** commensalism community competition host interaction interdependent mutualism niche parasite parasitism populations predator prey symbiosis/symbiotic	

LS.9 Overview

In standard LS.9, students explore the scheme of Earth as a group of living systems. Students are asked to distinguish between ecosystems and biomes. The teacher should be aware that in previous standards, students have explored environments as discrete units or have examined individual components. In standard 3.6 students are introduced to the concept of water environments (pond, marshland, swamp, stream, river, and ocean) and land environments (desert, grassland, rainforest, and forest). It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Adaptations of Organisms to the Environment (Suggested Time: 7 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.9** 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; b) characteristics of land, marine, and freshwater ecosystems; and c) adaptations that enable organisms to survive within a specific ecosystem. **Foundational Standards** 3.6 The student will investigate and understand that ecosystems support a diversity of plants and animals that share limited resources.	**The student will** • differentiate between ecosystems and biomes. • recognize and give examples of major biomes: desert, forest, grassland, and tundra. • compare and contrast the biotic and abiotic characteristics of land, marine, and freshwater ecosystems. • analyze and describe how specific adaptations enable organisms to survive in a particular ecosystem. • design an investigation from a testable question related to how specific adaptations of organisms allow them to survive in the presence of the biotic and abiotic factors in an ecosystem. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis. **Key Vocabulary** abiotic biotic adaptations aquatic biome camouflage climate	**Essential Questions** • What factors determine the characteristics of a biome? • What are the major land and aquatic biomes? • What adaptations enable organisms to survive in a specific ecosystem? **Essential Understandings** • The living organisms within a specific area and their physical environment define an ecosystem. • Characteristics of land, marine, and freshwater ecosystems vary with respect to biotic and abiotic factors. • The major terrestrial ecosystems are classified into units called biomes — large regions characterized by certain conditions, including a range of climate and ecological communities adapted to those conditions. • Organisms have specific structures, functions, and behaviors that enable them to survive the biotic and abiotic conditions of the particular ecosystem in which they live. • Organisms possess adaptations to both biotic and abiotic factors in their ecosystem that increase their chance of survival.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	community coniferous deciduous ecosystem freshwater hibernation marine migration mimicry permafrost succession terrestrial	

LS.10 Overview

In standard LS.10, students apply the concept of change over time to several specific situations. As conditions change, organisms, populations, communities, and ecosystems respond to those changes in order to survive. The key concepts are given in a sequence from responses of individual organisms (phototropism, hibernation, and dormancy) to responses of populations (factors that increase or decrease population size) to responses of communities or ecosystems (eutrophication, climate change, and catastrophic disturbances).

The concepts of standard LS.10 focus on the theme of change. Living units respond in various ways to change. A key concept is the understanding of the dynamic nature of living systems as they constantly respond to change. Change is referenced several times in the K–6 standards. In the "Earth Patterns, Cycles, and Change" strand, the following concepts are introduced: natural and human-made things may change over time (K.10); temperature, light, and precipitation bring about changes (1.7); and weather and seasonal changes affect plants, animals, and their surroundings (2.7). The "Life Processes" strand introduces the concept that plants (3.4) and animals (4.4) satisfy life needs and respond to the environment. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Dynamics in the Environment (Suggested Time: 5 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.10** The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include a) phototropism, hibernation, and dormancy; b) factors that increase or decrease population size; and c) eutrophication, climate changes, and catastrophic disturbances. **Foundational Standards** K.10 The student will investigate and understand that change occurs over time and rates may be fast or slow. 1.7 The student will investigate and understand weather and seasonal changes. 2.7 The student will investigate and understand that weather and seasonal changes affect plants,	**The student will** • relate the responses of organisms to daily, seasonal, or long-term events. • differentiate between ecosystems, communities, populations, and organisms. • predict the effect of climate change on ecosystems, communities, populations, and organisms. • predict the effect of eutrophication on ecosystems, communities, populations, and organisms. • compare and contrast the factors that increase or decrease population size. • classify the various types of changes that occur over time in ecosystems, communities, populations, and organisms, as long term, short term, or seasonal. • design an investigation from a testable question related to change over time in ecosystems, communities, populations, or organisms. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis.	**Essential Questions** • How do eutrophication, climate change, and catastrophic disturbances affect population size? • How does human activity affect population size? • What effect does climate change have on a population? • What is phototropism? **Essential Understandings** • Organisms may exist as members of a population; populations interact with other populations in a community; and communities together with the physical environment form ecosystems. • Changes that affect organisms over time may be daily, seasonal, or long term. • Plants may respond to light by growing toward it or away from it, a behavior known as phototropism. • Animals may respond to cold conditions with a period of lowered metabolism, a behavior known as hibernation. • Organisms may respond to adverse conditions with a period of lowered or suspended metabolism, a behavior known as dormancy. • A variety of environmental factors may cause the size of a population to increase or decrease. (This requires students to brainstorm examples of factors and predict the possible effects.) • Long-term changes may affect entire communities and ecosystems. Such large-scale changes include the addition of excess nutrients to the system (eutrophication), which alters environmental balance; dramatic changes in climate; and catastrophic events, such as fire, drought, flood, and earthquakes.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
animals, and their surroundings. 3.4 The student will investigate and understand that adaptations allow animals to satisfy life needs and respond to the environment. 4.4 The student will investigate and understand basic plant anatomy and life processes.	• analyze and critique the experimental design of basic investigations related to change over time in ecosystems, communities, populations, and organisms. **Key Vocabulary** catastrophic climate dormancy drought eutrophication gradual hibernation interdependent metabolism phototropism population	

LS.11 Overview

In this standard, students are called upon to apply their knowledge of human interactions to interpret how these interactions affect ecosystem dynamics. In prior standards in the "Earth Resources" strand of the K–6 standards, students explore a variety of ways in which humans interact with the environment. These include the concepts of waste management (K.11, 1.8); limitations of natural resources and factors that affect environmental quality (1.8, 3.10); Virginia's natural resources (4.8); and public policy decisions relating to the environment (6.9). In this Life Science standard, the student must interpret how human populations can change the balance of nature in ecosystems. They must use their prior knowledge of resources as well as the concepts and skills learned in Life Science standards LS.6 – LS.10. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Influence of Humans on Ecosystems Dynamics (Suggested Time: 5 blocks) **SOL Reporting Category** Ecosystems **Virginia SOL LS.11** The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include a) food production and harvest; b) change in habitat size, quality, or structure; c) change in species competition; d) population disturbances and factors that threaten or enhance species survival; and e) environmental issues. **Foundational Standards** K.11 The student will investigate and understand that materials can be reused, recycled, and conserved. 1.8 The student will investigate and understand that natural resources are limited. 3.10 The student will investigate and	**The student will** • identify examples of ecosystem dynamics. • describe the relationship between human food harvest and the ecosystem. • debate the pros and cons of human land use versus ecosystem stability. • compare and contrast population disturbances that threaten and those that enhance species survival. • describe ways that human interaction has altered habitats positively and negatively. • 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). • design an investigation from a testable question related to the relationships between ecosystem dynamics and human activity. The investigation may be a complete experimental design or may focus on systematic observation, description, measurement, and/or data collection and analysis.	**Essential Questions** • What is the relationship between human food harvest and the ecosystem? • How has human interaction positively and negatively altered habitats? **Essential Understandings** • Ecosystems are dynamic systems. Humans are a natural part of the ecosystem. Humans use the ecosystem to meet their basic needs, such as to obtain food. • Human interaction can directly alter habitat size, the quality of available resources in a habitat, and the structure of habitat components. Such interactions can be positive and/or negative. • Human input can disturb the balance of populations that occur in a stable ecosystem. These disturbances may lead to a decrease or increase in a population. Since populations in an ecosystem are interdependent, these disturbances have a ripple effect throughout the ecosystem. • The interaction of humans with the dynamic ecosystem may lead to issues of concern for continued ecosystem health in areas such as water supply, air quality, energy production, and waste management.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
understand that natural events and human influences can affect the survival of species. 4.8 The student will investigate and understand the relationships among Earth, the moon, and the sun. 6.9 The student will investigate and understand public policy decisions relating to the environment.	• analyze and critique the experimental design of basic investigations related to the relationships between ecosystem dynamics and human activity. **Key Vocabulary** compost conservation ecosystem endangered species exotic species extinction fertilizers habitat human interaction pesticides recycle ripple effect urbanization	

LS.12 Overview

In science standard 2.7, students are introduced to the general notion that plants and animals resemble their parents. This Life Science standard is the students' introduction to genetics. It is important for the teacher to understand that the intent of this standard is to provide students with a general overview of the nature of DNA, genes, and chromosomes and the important role they play in the transmission of traits from one generation to another. Students are not expected to understand the specific chemical composition of DNA or the mechanics of transcription and translation. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit DNA and Heredity (Suggested Time: 13 blocks) **SOL Reporting Category** Life Systems **Virginia SOL LS.12** The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include a) structure and role of DNA; b) the function of genes and chromosomes; c) genotypes and phenotypes; d) characteristics that can and cannot be inherited; e) genetic engineering and its applications; and f) historical contributions and significance of discoveries related to genetics. **Foundational Standards** 2.7 The student will investigate and understand that weather and seasonal changes affect plants, animals, and their surroundings.	**The student will** • recognize the appearance of DNA as double helix in shape. • explain that DNA contains coded instructions that store and pass on genetic information from one generation to the next. • explain the necessity of DNA replication for the continuity of life. • explain the relationship among genes, chromosomes, and alleles. • demonstrate variation within a single genetic trait. • distinguish between dominant and recessive traits. • distinguish between genotype and phenotype. • use Punnett squares to predict the possible combinations of inherited factors resulting from single trait crosses. • differentiate between characteristics that can be inherited and those that cannot be inherited. • identify aspects of genetic engineering and supply examples of applications. Evaluate the examples for possible controversial aspects.	**Essential Questions** • What is DNA and what is its function? • What is a gene? • What are the mechanisms involved in the inheritance of traits governed by Mendelian genetics? • How can genetic engineering techniques be applied in beneficial ways? **Essential Understandings** • DNA is a double helix molecule. • DNA is a molecule that includes different components — sugars, nitrogenous bases, and phosphates. The arrangement of the nitrogenous bases within the double helix forms a chemical code. • Chromosomes are strands of tightly wound DNA. Genes are sections of a chromosome that carry the code for a particular trait. An allele is an alternate form of a gene. • The basic laws of Mendelian genetics explain the transmission of most traits that can be inherited from generation to generation. • A Punnett Square is a model used to predict the possible combinations of inherited factors resulting from single trait crosses. (An investigation of dihybrid crosses, multiple alleles, and incomplete dominance should be reserved for high school Biology.) • Dominant traits mask the expression (phenotype) of recessive traits. Genotype is the specific combination of dominant and recessive gene forms. • Traits that are expressed through genes can be inherited. Characteristics that are acquired through environmental influences, such as injuries or practiced skills, cannot be inherited. • In genetic engineering, the genetic code is manipulated to obtain a desired product. • Genetic engineering has numerous practical applications in medicine, agriculture, and biology. • A series of contributions and discoveries led to the current level of genetic

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	• describe the contributions of Mendel, Franklin, Watson, and Crick to our basic understanding of genetics. **<u>Key Vocabulary</u>** allele chromosome DNA dominant double helix gene genetic code generation genotype heredity heterozygous homozygous hybrid inherited inheritance mutation offspring phenotype probability purebred recessive trait	science.

LS.13 Overview

Standard LS.13 explores the concept of evolution through natural selection. Species respond to changes in their environments through adaptation, which is a gradual process that occurs over long periods of time. The progression of these long-term changes is well documented in the fossil record. Evolution, as a big organizing principle of the life sciences, establishes order among the great variety of living things.

There are many misconceptions about evolution; therefore, teachers must be careful to be accurate in their presentation of this scientific theory. One common misconception among students is that they believe that environmental influences on an organism produce changes in that organism that can be passed on to offspring. However, natural selection can only work through the genetic variation that is already present in the population. It is intended that students will actively develop scientific investigation, reasoning, and logic skills, and the nature of science (LS.1) in the context of the key concepts presented in this standard.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Evolution and Genetic Variation (Suggested Time: 5 blocks) **SOL Reporting Category** Life Systems (LS.13a) Earth and Space Systems (LS.13 b-c) **Virginia SOL LS.13** The student will investigate and understand that populations of organisms change over time. Key concepts include a) the relationship of mutation, adaptation, natural selection, and extinction; b) evidence of evolution of different species in the fossil record; and c) how environmental influences, as well as genetic variation, can lead to diversity of organisms. **Foundational Standards** None	**The student will** • interpret data from simulations that demonstrate selection for a trait belonging to species in various environments. • describe how changes in the environment can bring about changes in a species (adaptation, extinction) through natural selection. • describe and explain how fossils are records of organisms and events in Earth's history. • explain the evidence for evolution from a variety of sources of scientific data. • explain how genetic variations in offspring, which lead to variations in successive generations, can result from the same two parents. • analyze and evaluate data from investigations on variations within a local population. • explain how environmental influences, as well as genetic variation, can lead to diversity of organisms. **Key Vocabulary** adaptation diversity extinction evolution	**Essential Questions** • What is evolution and what evidence do scientists have to support it? • What are the mechanisms through which evolution takes place? • How do environmental influences, as well as genetic variations, lead to diversity of organisms? **Essential Understandings** • The mechanisms through which evolution takes place are a related set of processes that include mutation, adaptation, natural selection, and extinction. This results in changes in populations of organisms over time. • Mutations are inheritable changes because a mutation is a change in the DNA code. • Adaptations are structures, functions, or behaviors that enable a species to survive. • Natural selection is the survival and reproduction of the individuals in a population that exhibit the traits that best enable them to survive in their environment. • A mutation may result in a favorable change or adaptation in genetic information that improves a species' ability to exist in its environment, or a mutation may result in an unfavorable change that does not improve or impedes a species' ability to exist in its environment. • The evidence for evolution is drawn from a variety of sources of data, including the fossil record, radiometric dating, genetic information, the distribution of organisms, and anatomical and developmental similarities across species. • Individuals of a population each exhibit a range of variations in a trait as a result of the variations in their genetic codes. These variations may or may not help them survive and reproduce in their environment. • If a species does not include traits that enable it to survive in its environment or to survive changes in the environment, then the species may become extinct.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	fossil mutation natural selection radioactive	