First Grade Standards

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The First Grade Georgia Standards of Excellence for science engage students in raising questions about the world around them and seeking answers by making observations. First graders use whole numbers to analyze scientific data. They identify how magnets pull on all things made of iron and either attract or repel other magnets. First graders create drawings that correctly depict something being described. The students are asked to plan and carry out simple investigations to understand patterns (shadows, sound, weather, and daily needs of plants and animals) observed in the world around them and make predictions based on these investigations. They follow safety rules.

Earth and Space Science

S1E1. Obtain, evaluate, and communicate weather data to identify weather patterns.

a. Represent data in tables and/or graphs to identify and describe different types of weather and the characteristics of each type.
b. Ask questions to identify forms of precipitation such as rain, snow, sleet, and hailstones as either solid (ice) or liquid (water).
c. Plan and carry out investigations on current weather conditions by observing, measuring with simple weather instruments (thermometer, wind vane, rain gauge), and recording weather data (temperature, precipitation, sky conditions, and weather events) in a periodic journal, on a calendar, and graphically.
d. Analyze data to identify seasonal patterns of change.
(*Clarification statement:* Examples could include temperature, rainfall/snowfall, and changes to the environment.)

Physical Science

S1P1. Obtain, evaluate, and communicate information to investigate light and sound.

a. Use observations to construct an explanation of how light is required to make objects visible.
b. Ask questions to identify and compare sources of light.
c. Plan and carry out an investigation of shadows by placing objects at various points from a source of light.
d. Construct an explanation supported by evidence that vibrating materials can make sound and that sound can make materials vibrate.
e. Design a signal that can serve as an emergency alert using light and/or sound to communicate over a distance.

S1P2. Obtain, evaluate, and communicate information to demonstrate the effects of magnets on other magnets and other objects.

a. Construct an explanation of how magnets are used in everyday life.
(*Clarification statement:* Everyday life uses could include refrigerator magnets, toys, magnetic latches, and name tags.)
b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other and the effect of magnets on common objects.

Life Science

S1L1. Obtain, evaluate, and communicate information about the basic needs of plants and animals.

a. Develop models to identify the parts of a plant—root, stem, leaf, and flower.
b. Ask questions to compare and contrast the basic needs of plants (air, water, light, and nutrients) and animals (air, water, food, and shelter).
c. Design a solution to ensure that a plant or animal has all of its needs met.

Physical Science Standards

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The Physical Science Georgia Standards of Excellence are designed to continue student investigations of the physical sciences that began in grades K-8, and provide students the necessary skills to have a richer knowledge base in physical science. The standards in this course are designed as a survey of the core ideas in the physical sciences. Those core ideas will be studied in more depth during in the chemistry and physics courses. The physical science standards include abstract concepts such as the conceptualization of the structure of atoms and the role they play in determining the properties of materials, motion and forces, the conservation of energy and matter, wave behavior, electricity, and the relationship between electricity and magnetism. The idea of radioactive decay is limited to the understanding of whole half-lives and how a constant proportional rate of decay is consistent with declining measures that only gradually approach to zero. Students investigate physical science concepts through the study of phenomena, experiences in laboratory settings, and field work.

Physical Science

SPS1. Obtain, evaluate, and communicate information from the Periodic Table to explain the relative properties of elements based on patterns of atomic structure.

a. Develop and use models to compare and contrast the structure of atoms, ions and isotopes. (*Clarification statement:* Properties include atomic number, atomic mass and the location and charge of subatomic particles.)
b. Analyze and interpret data to determine trends of the following:
   - Number of valence electrons
   - Types of ions formed by main group elements
   - Location and properties of metals, nonmetals, and metalloids
   - Phases at room temperature
c. Use the Periodic Table as a model to predict the above properties of main group elements.

SPS2. Obtain, evaluate, and communicate information to explain how atoms bond to form stable compounds.

a. Analyze and interpret data to predict properties of ionic and covalent compounds. (*Clarification statement:* Properties are limited to types of bonds formed, elemental composition, melting point, boiling point, and conductivity.)
b. Develop and use models to predict formulas for stable, binary ionic compounds based on balance of charges.
c. Use the International Union of Pure and Applied Chemistry (IUPAC) nomenclature for translating between chemical names and chemical formulas. (*Clarification statement:* Limited to binary covalent and binary ionic, containing main group elements, compounds but excludes polyatomic ions.)

SPS3. Obtain, evaluate, and communicate information to support the Law of Conservation of Matter.

a. Plan and carry out investigations to generate evidence supporting the claim that mass is conserved during a chemical reaction. (*Clarification statement:* Limited to synthesis, decomposition, single replacement, and double replacement reactions.)
b. Develop and use a model of a chemical equation to illustrate how the total number of atoms is conserved during a chemical reaction. (*Clarification statement:* Limited to chemical equations that include binary ionic and covalent compounds and will not include equations containing polyatomic ions.)

SPS4. Obtain, evaluate, and communicate information to explain the changes in nuclear structure as a result of fission, fusion and radioactive decay.

a. Develop a model that illustrates how the nucleus changes as a result of fission and fusion.
b. Use mathematics and computational thinking to explain the process of half-life as it relates to radioactive decay.
   (*Clarification statement:* Limited to calculations that include whole half-lives.)
c. Construct arguments based on evidence about the applications, benefits, and problems of nuclear energy as an alternative energy source.

SPS5. Obtain, evaluate, and communicate information to compare and contrast the phases of matter as they relate to atomic and molecular motion.

a. Ask questions to compare and contrast models depicting the particle arrangement and motion in solids, liquids, gases, and plasmas.
b. Plan and carry out investigations to identify the relationships among temperature, pressure, volume, and density of gases in closed systems.
   (*Clarification statement:* Using specific Gas laws to perform calculations is beyond the scope of this standard; emphasis should focus on the conceptual understanding of the behavior of gases rather than calculations.)

SPS6. Obtain, evaluate, and communicate information to explain the properties of solutions.

a. Develop and use models to explain the properties (solute/solvent, conductivity, and concentration) of solutions.
b. Plan and carry out investigations to determine how temperature, surface area, and agitation affect the rate solutes dissolve in a specific solvent.
c. Analyze and interpret data from a solubility curve to determine the effect of temperature on solubility.
d. Obtain and communicate information to explain the relationship between the structure and properties (e.g., pH, and color change in the presence of an indicator) of acids and bases.
   (*Clarification statement:* Limited to only the structure of simple acids and bases (e.g., HCl and NaOH) that demonstrates the presence of an H+ or OH-.
e. Plan and carry out investigations to detect patterns in order to classify common household substances as acidic, basic, or neutral.

SPS7. Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.

a. Construct explanations for energy transformations within a system.
   (*Clarification statement:* Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.)

b. Plan and carry out investigations to describe how molecular motion relates to thermal energy changes in terms of conduction, convection, and radiation.
c. Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels).
d. Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves.

SPS8. Obtain, evaluate, and communicate information to explain the relationships among force, mass, and motion.

a. Plan and carry out an investigation to analyze the motion of an object using mathematical and graphical models.
(*Clarification statement:* Mathematical and graphical models could include distance, displacement, speed, velocity, time and acceleration.)
b. Construct an explanation based on experimental evidence to support the claims presented in Newton's three laws of motion.
(*Clarification statement:* Evidence could demonstrate relationships among force, mass, velocity, and acceleration.)
c. Analyze and interpret data to identify the relationship between mass and gravitational force for falling objects.
d. Use mathematics and computational thinking to identify the relationships between work, mechanical advantage, and simple machines.

SPS9. Obtain, evaluate, and communicate information to explain the properties of waves.

a. Analyze and interpret data to identify the relationships among wavelength, frequency, and energy in electromagnetic waves and amplitude and energy in mechanical waves.
b. Ask questions to compare and contrast the characteristics of electromagnetic and mechanical waves.
c. Develop models based on experimental evidence that illustrate the phenomena of reflection, refraction, interference, and diffraction.
d. Analyze and interpret data to explain how different media affect the speed of sound and light waves.
e. Develop and use models to explain the changes in sound waves associated with the Doppler Effect.

SPS10. Obtain, evaluate, and communicate information to explain the properties of and relationships between electricity and magnetism.

a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.

b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits.
(*Clarification statement:* Advantages and disadvantages of series and parallel circuits should be addressed.)
c. Plan and carry out investigations to determine the relationship between magnetism and the movement of electrical charge.
(*Clarification statement:* Investigations could include electromagnets, simple motors, and generators.)

Science Georgia Standards of Excellence

SCIENCE - Zoology

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In this course, students will recognize key features of the major body plans that have evolved in animals and how those body plans have changed over time resulting in the diversity of animals that are evident today.

In addition to classification and recognition, this course teaches students about the anatomical and physiological characteristics of animals. These characteristics relate to how an animal functions and can help students see the connections uniting particular animal groups. An understanding of form and function allows students to study how animals have evolved over time and to relate animals to their particular role in an ecosystem.

Finally, students will develop an understanding that all living things are interconnected. Students should realize that the worldwide activities of humans can contribute to animal diversity both positively and negatively. It should also be understood that humans are dependent on animal species for advances in medicine, ecosystem maintenance, and food supply.

SCIENCE - Zoology

SZ1. Obtain, evaluate, and communicate information to derive the phylogeny of animal taxa using informative characteristics.

a. Construct an explanation of the relationships among animal taxa using evidence from morphology, embryology, and biochemistry.
b. Analyze and interpret data to explain patterns in structure and function and construct a classification of representative animal taxa including: Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda, Echinodermata, and Chordata.
c. Develop a model (i.e. cladogram, phylogenetic tree) using data to place taxa in a phylogenetic (evolutionary) context to support hypotheses of relationships

SZ2. Obtain, evaluate, and communicate information to explain the evolutionary history of animals over the geological history of Earth.

a. Construct an explanation of the geological history of earth and the effects of major environmental changes.
(*Clarification statement:* Explanations should be based on evidence from the fossil and geologic record. Major events include Cambrian Explosion and the causes of mass extinction events.)
b. Construct an explanation of how evolution allows species to adapt to environmental changes.
(*Clarification statement:* Explanations should address the mechanisms that drive evolution like adaptation, natural selection, convergence, and speciation.)

SZ3.Obtain, evaluate, and communicate information to compare and contrast structure and function of morphological and genetic characteristics across representative taxa.

a. Plan and carry out investigations to determine patterns in morphology (including organ systems, symmetry and body cavities) of representative animal taxa.
b. Construct an explanation of life functions (i.e., reproduction, respiration, digestion) at appropriate level of organization for representative taxa.
c. Construct an explanation based on evidence to relate important structural changes across evolutionary history to key functional transitions.

SZ4. Obtain, evaluate, and communicate information to assess how animals interact with their environment and one another.

a. Construct explanations to relate structure and function of animals to ecological roles, including morphological, physiological, and behavioral adaptations
b. Develop a model to explain patterns in various life cycles found among animals (e.g., polyp and medusa in cnidarians; multiple hosts and stages in the platyhelminthes or nematode life cycle; arthropod metamorphosis; egg, tadpole, adult stages in the amphibian life cycle).
c. Construct an explanation based on evidence of the effects of symbiotic relationships between animals (i.e., parasites and disease vectors) and between animals and other organisms (i.e., algae in coral; protists in termites; parasites).

SZ5. Obtain, evaluate, and communicate information to analyze the relationship between humans and animals within various phyla.

a. Ask questions and define problems identifying the cause and effect of human activities on the biodiversity of organisms (including habitat destruction, overharvesting, water consumption, and pollution).
b. Design a solution to preserve species diversity in natural and captive environments with regard to conservation, habitat restoration, breeding programs and management of genetic diversity at local and global levels.
c. Construct an argument based on evidence of the short-term and long-term impacts of legal, societal, political, ethical, and economic decisions on animal diversity. (*Clarification statement:* Arguments should include, but are not limited to medical, research, and agricultural use of animals.)

Science Georgia Standards of Excellence

SCIENCE - Oceanography

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The oceanography course is designed to emphasize the interconnectedness of multiple science disciplines. Students will recognize that the ocean is a dynamic system reflecting interactions among organisms, ecosystems, chemical cycles, and physical and geological processes, on land, in air, and in the oceans. Students will investigate oceanography concepts through experience in laboratories and fieldwork using the processes of inquiry.

SCIENCE - Oceanography

SO1. Obtain, evaluate, and communicate information about how and why humans explore our ocean.

a. Obtain, evaluate, and communicate information that compares historical and modern motivations for ocean exploration and methods of exploration.
b. Define problems and challenges associated with oceanographic research and exploration. (*Clarification statement*: Emphasis should be on using technology to address issues such as seawater corrosiveness, deep sea temperatures and pressure, water depth, distance from land, and wave action.)

SO2. Obtain, evaluate, and communicate information about the characteristics, physical features, and boundaries of the oceans.

a. Analyze and interpret geologic data to describe how the Earth's ocean basins, ocean and atmosphere were formed.
b. Construct an argument from evidence to support the role of plate tectonics in shaping the physical features of the ocean and continents.
c. Analyze and interpret data to understand how the dynamic events at plate boundaries influence the physical features of oceans and continents.
(*Clarification statement*: Events such as tsunamis and earthquakes should be included in this element.)
d. Develop and use models to investigate geological features from the continental margins to the deep ocean basins.
(Clarification statement: Models should provide scale information about the features being represented.)
e. Ask questions to classify the sources of different types of marine sediments.

SO3. Obtain, evaluate, and communicate information to model the flow of energy in the ocean.

a. Construct an explanation to support the claim that some of the earliest life forms originated in the ocean.
b. Ask questions to compare and contrast the relative role of photosynthesis and chemosynthesis in oceanic biologic productivity and describe the oceanic realms in which each mode of primary production occurs.
(*Clarification statement*: Distinguish between photosynthesis and chemosynthesis in ocean organisms.)
c. Develop and use models to analyze the flow of energy and cycling of matter in marine ecosystems.
(*Clarification statement*: This includes food webs and trophic levels.)
d. Ask questions to investigate relationships between biotic and abiotic factors in marine ecosystems including estuaries, coral reefs, kelp forests, the open ocean, and the deep ocean.

SO4. Obtain, evaluate, and communicate information that describes the complex relationships between weather, climate and the oceans.

a. Develop a model to explain the effects of tilt of the earth, solar energy inputs, and heat capacity of land and oceans on the resulting patterns of weather and climate.
b. Ask questions to investigate and provide explanations about the influence of the Coriolis Effect on winds, ocean currents, and climate.
c. Analyze and interpret data to develop models for global patterns of atmospheric and oceanic circulation.
(*Clarification statement:* Include the role of deep water currents in oceanic circulation.)
d. Construct an explanation for variations in global weather patterns such as El Nino, hurricanes, and monsoons and design solutions to minimize the impact of these systems on human populations.
e. Use mathematics and computational thinking to explain how climate change influences the ocean.
(*Clarification statement*: Emphasis is on sea level rise and ocean acidification.)

SO5. Obtain, evaluate, and communicate information on how waves and tides are created and their influence on coastal processes.

a. Develop and use models to demonstrate how ocean waves are generated.
(*Clarification statement:* Consideration should be given to the type of waves formed by wind, atmospheric pressure gradients, gravitation, earthquakes, storms, and surface tension forces.)
b. Use mathematics and computational thinking to analyze the properties of ocean waves and how they change as they interact with the seafloor.
c. Construct an argument based on evidence from tide tables and lunar calendars to explain the role of the moon and sun in the formation of tides and tidal patterns.
d. Construct an explanation for the effects of waves and tides on coastlines, including how they interact with sandy shorelines to transport sediments, influence barrier islands, and affect the marine organisms that live there.

SO6. Obtain, evaluate, and communicate information on the physical and chemical properties of seawater and how they influence the structure of the ocean.

a. Develop and use a model to demonstrate how the ocean and land are connected by the hydrologic and other biogeochemical cycles.
b. Plan and carry out an investigation to discover the unique properties of seawater when compared to fresh water.
(*Clarification statement*: Water quality monitoring could be used to address this element.)
c. Ask questions to investigate how the water column is structured based upon the physical properties of seawater (temperature, salinity, density).
d. Develop an argument based on evidence to support the claim that the physical properties of sea water influence the evolution, adaptations and distributions of marine organisms.
(*Clarification statement:* This should include addressing how invertebrate and vertebrate organisms are differently impacted by sea water properties.)

SO7. Obtain, evaluate, and communicate information about how humans use the ocean as a resource and the need for responsible stewardship.

a. Construct an argument based on evidence about the impact that extraction of physical, geological, chemical, and biological resources from the oceans has on marine ecosystems.
b. Design, evaluate, and refine solutions on how to use the ocean as a source of alternative energy.
c. Construct an explanation based on evidence on how recreation and transportation impact marine ecosystems.
d. Analyze and interpret data to investigate the causes of ocean acidification, biomagnification of pollutants, ocean deoxygenation, and eutrophication.
e. Construct an argument based on evidence to examine policies and laws related to responsible stewardship of the oceans.
f. Design and evaluate a sustainability plan that includes conservation efforts to reduce human impact on the ocean.
(*Clarification statement:* Human impact should include the role of individuals living inland.)

Physics Standards

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The Physics Georgia Standards of Excellence are designed to continue the student investigations of the physical sciences that began in grades K-8, and provide students the necessary skills to be proficient in physics. These standards include more abstract concepts such as nuclear decay processes, interactions of matter and energy, velocity, acceleration, force, energy, momentum, properties and interactions of matter, electromagnetic and mechanical waves, and electricity, magnetism and their interactions. Students investigate physics concepts through experiences in laboratories and field work using the science and engineering practices of asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information.

Physics

SP1. Obtain, evaluate, and communicate information about the relationship between distance, displacement, speed, velocity, and acceleration as functions of time.

a. Plan and carry out an investigation of one-dimensional motion to calculate average and instantaneous speed and velocity.
   - Analyze one-dimensional problems involving changes of direction, using algebraic signs to represent vector direction.
   - Apply one-dimensional kinematic equations to situations with no acceleration, and positive, or negative constant acceleration.

b. Analyze and interpret data using created or obtained motion graphs to illustrate the relationships among position, velocity, and acceleration, as functions of time.

c. Ask questions to compare and contrast scalar and vector quantities.

d. Analyze and interpret data of two-dimensional motion with constant acceleration.
   - Resolve position, velocity, or acceleration vectors into components (x and y, horizontal and vertical).
   - Add vectors graphically and mathematically by adding components.
   - Interpret problems to show that objects moving in two dimensions have independent motions along each coordinate axis.
   - Design an experiment to investigate the projectile motion of an object by collecting and analyzing data using kinematic equations.
   - Predict and describe how changes to initial conditions affect the resulting motion.
   - Calculate range and time in the air for a horizontally launched projectile.

SP2. Obtain, evaluate, and communicate information about how forces affect the motion of objects.

a. Construct an explanation based on evidence using Newton's Laws of how forces affect the acceleration of a body.
   - Explain and predict the motion of a body in absence of a force and when forces are applied using Newton's 1st Law (principle of inertia).
   - Calculate the acceleration for an object using Newton's 2nd Law, including situations where multiple forces act together.
   - Identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's 3rd Law.

b. Develop and use a model of a Free Body Diagram to represent the forces acting on an object (both equilibrium and non-equilibrium).

c. Use mathematical representations to calculate magnitudes and vector components for typical forces including gravitational force, normal force, friction forces, tension forces, and spring forces.

d. Plan and carry out an investigation to gather evidence to identify the force or force component responsible for causing an object to move along a circular path.
   • Calculate the magnitude of a centripetal acceleration.
e. Develop and use a model to describe the mathematical relationship between mass, distance, and force as expressed by Newton's Universal Law of Gravitation.

SP3. Obtain, evaluate, and communicate information about the importance of conservation laws for mechanical energy and linear momentum in predicting the behavior of physical systems.

a. Ask questions to compare and contrast open and closed systems.
b. Use mathematics and computational thinking to analyze, evaluate, and apply the principle of conservation of energy and the Work-Kinetic Energy Theorem.
   • Calculate the kinetic energy of an object.
   • Calculate the amount of work performed by a force on an object.
c. Plan and carry out an investigation demonstrating conservation and rate of transfer of energy (power) to solve problems involving closed systems.
d. Construct an argument supported by evidence of the use of the principle of conservation of momentum to
   • explain how the brief application of a force creates an impulse.
   • describe and perform calculations involving one dimensional momentum.
   • connect the concepts of Newton's 3rd law and impulse.
   • experimentally compare and contrast inelastic and elastic collisions.

SP4. Obtain, evaluate, and communicate information about the properties and applications of waves.

a. Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy.
   (*Clarification statement:* Mathematically describe how the velocity, frequency, and wavelength of a propagating wave are related.)
b. Develop and use models to describe and calculate characteristics related to the interference and diffraction of waves (single and double slits).
c. Construct an argument that analyzes the production and characteristics of sounds waves.
   (*Clarification statement:* Includes, but not limited to, Doppler Effect, standing waves, wavelength, the relationship between amplitude and the energy of the wave, and the relationship between frequency and pitch.)
d. Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves.
   (*Clarification statement:* Properties of waves include, but not limited to, amplitude, frequency, wavelength, and the relationship between frequency or wavelength and the energy of the wave.)

e. Plan and carry out investigations to describe common features of light in terms of color, polarization, spectral composition, and wave speed in transparent media.
   - Analyze experimentally and mathematically aspects of reflection and refraction of light waves and describe the results using optical ray diagrams.
   - Perform calculations related to reflections from plane surfaces and focusing using thin lenses.

f. Plan and carry out investigations to identify the behavior of light using lenses.
(*Clarification statement:* Investigations concerning Snell's Law, optical ray diagrams, and thin lens equation should be conducted.)

g. Plan and carry out investigations to describe changes in diffraction patterns associated with geometry and wavelength for mechanical and electromagnetic waves.

SP5. Obtain, evaluate, and communicate information about electrical and magnetic force interactions.

a. Develop and use mathematical models and generate diagrams to compare and contrast the electric and gravitational forces between two charged objects.

b. Plan and carry out investigations to demonstrate and qualitatively explain charge transfer by conduction, friction, and induction.

c. Construct an explanation based on evidence of the behavior of charges in terms of electric potential energy.

d. Plan and carry out an investigation of the relationship between voltage, current, and power for direct current circuits.
(*Clarification statement:* Application of Ohm's Law to different circuit configurations, not limited to parallel and series, and calculations of equivalent resistance are expected.)

e. Plan and carry out investigations to clarify the relationship between electric currents and magnetic fields.
(*Clarification statement:* This includes coils and their importance in the design of motors and generators.)

SP6. Obtain, evaluate, and communicate information about nuclear changes of matter and related technological applications.

a. Develop and use models to explain, compare, and contrast nuclear processes including radioactive decay, fission, and fusion.

b. Construct an argument to compare and contrast mechanisms and characteristics of radioactive decay.
(*Clarification statement:* Include alpha, beta, and gamma decays and their effects.)

c. Develop and use mathematical models and representations to calculate the amount of substance present after a given amount of time based on its half-life and relate this to the law of conservation of mass and energy.

Science Georgia Standards of Excellence

SCIENCE - Microbiology

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The microbiology course is designed to continue student investigations that began in grades K-8 and high school biology and chemistry. This curriculum is extensively performance and laboratory based. It integrates the study of microbial physiology, ecology, and genetics with instruction focusing on the impact microorganisms have on health, agriculture, biotechnology and the environment. Careers related to medicine, healthcare, research, food science and biotechnology should be emphasized throughout the course. Real-life applications should be emphasized through case studies concerning diseases; epidemiology; food preparation and safety; and use of microbes in industry, agriculture, biotechnology and the environment.

SCIENCE - Microbiology

SMI1. Obtain, evaluate, and communicate information regarding the historical progression of the core ideas of microbiology.

a. Obtain, evaluate, and communicate information relating the importance of microscopy to the origins of microbiology.
b. Ask questions to obtain information regarding the use of Koch's postulates to identify pathogens and other microorganisms.
(*Clarification statement*: Address the premise of Koch's work and include why Koch's Postulates do not apply to all pathogens.)
c. Construct explanations to illustrate how advances in technological developments have driven major innovations in microbiology (e.g. biotechnology, microbial ecology, medical microbiology, etc.)

SMI2. Obtain, evaluate, and communicate information to differentiate among types of microorganisms based on defining characteristics.

a. Develop and use models to distinguish between different kinds of microorganisms (Prokaryotes and Eukaryotes) based on cellular structure (including but not limited to, cell wall, cell membrane, organelles, cilia, and flagella), molecular biology (plasmids, DNA, RNA and proteins), and biochemical composition (lipids, proteins, and carbohydrates).
b. Construct explanations of how viruses differ from other cellular parasites.
c. Construct explanations for the relative sizes and different types of cell shapes of microorganisms.
d. Plan and carry out investigations to explore various methods used to visualize microorganisms.

SMI3. Obtain, evaluate, and communicate information to examine the structural components of prokaryotic and eukaryotic microorganisms and their functions.

a. Use models to investigate and compare structural properties of prokaryotic and eukaryotic membranes and the functions associated with these membranes.
b. Construct an argument based on evidence on how prokaryotic cell walls differ from eukaryotic cell walls, and how these differences contribute to their function.
c. Develop and use models to demonstrate how internal organization differs between prokaryotes and eukaryotes and explain the functions of internal structures.
d. Construct an explanation of the endosymbiotic theory and its evolutionary relevance.

SMI4. Obtain, evaluate, and communicate information on how microorganisms generate energy for cellular functions.

a. Construct an explanation of how microorganisms use photosynthesis, cellular respiration, and/or chemosynthesis to generate energy as ATP to drive cell function.

SMI5. Obtain, evaluate, and communicate information regarding the molecular mechanisms underlying DNA replication, gene expression (transcription and translation), and genetic variation, in microbes.

a. Develop and use models to investigate and compare the molecular mechanisms involved in DNA replication in prokaryotes and eukaryotes.
b. Develop and use models to demonstrate the molecular basis of gene expression (transcription) in microbes.
c. Construct explanations on how genetic variations in microbes arise due to mutations and gene transfer (via transformation, transduction, and/or conjugation) and how these genetic variations affect survival and functioning of prokaryotes.
d. Obtain, evaluate, and communicate information to compare and contrast sexual and asexual reproduction of eukaryotes, asexual reproduction of prokaryotes, and replication of viruses.
e. Construct an explanation of how genetic variation can lead to microbial evolution and ultimately how this information impacts modern biotechnological applications.

SMI6. Obtain, evaluate, and communicate information to determine parameters affecting prokaryotic microbial growth, ways of controlling microbial growth and how microorganisms respond to control mechanisms.

a. Use mathematics and computational thinking to predict and model the growth phases of microbial populations and the factors that influence these phases.
b. Construct an argument based on evidence on how nutritional requirements and environmental factors can influence microbial growth.
c. Analyze and interpret data to compare various physical and chemical methods used to control microbial growth.
   (*Clarification statement:* "Control" should include increasing, decreasing, and/or preventing the growth of microorganisms.)
d. Construct an argument using multiple forms of evidence regarding the modes of actions of antimicrobials (antibiotics, antifungals, and other pharmaceuticals) in preventing the growth of microorganisms.
e. Ask questions and define problems related to how the use of antimicrobials influences the evolution of resistant pathogens via genetic changes in the population (e.g., the evolution of multi-drug resistant bacteria, treatment resistant HIV, or viral recombination).

SMI7. Obtain, evaluate, and communicate information to analyze the impact of microorganisms in the environment and their uses in biotechnology, agriculture, and industry.

a. Construct an explanation for the prevalence and diversity of microorganisms in various environments.
b. Ask questions to investigate the roles of microorganisms in global nutrient cycling and primary production in soil, fresh water, and marine ecosystems.
c. Analyze and interpret data to determine the impact of microorganisms on water and soil quality.
d. Construct an argument from evidence to justify the use of microorganisms in industry, agriculture, and biotechnology.
    - Relate the use of microbes to their rapid growth, ease of genetic manipulation, and accessibility.
    - Consider bioethical implications of using genetically modified organisms (GMOs) in biotechnology.

SMI8. Obtain, evaluate, and communicate information to examine relationships among microbes and other organisms.

a. Construct an argument to support the variety of relationships (symbiotic and pathogenic) between humans and microbes.
b. Construct an argument to support the mutualistic relationship between microbes and other organisms (plants, animals & fungi).
c. Ask questions to gather and communicate information about how pathogenic microbes cause disease in humans and other organisms.
d. Obtain, evaluate, and communicate information to demonstrate how higher organisms defend against pathogenic microbes.

Seventh Grade Standards

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The Seventh Grade Georgia Standards of Excellence for science are designed to give all students the necessary skills for a smooth transition from elementary life science standards to high school biology standards. The purpose is to give all students an overview of common strands in life science including, but not limited to, diversity of living organisms, structure and function of cells, heredity, ecosystems, and biological evolution.

Seventh grade students keep records of their observations, use those records to analyze the data they collect, recognize patterns in the data, use simple charts and graphs to represent the relationships they see, and find more than one way to interpret their findings. They make and use observations to explain the diversity of living organisms and how the organisms are classified, how they reproduce and how genetic information is passed from parents to their offspring. They use different models to represent systems such as cells, tissues, and organs. They use what they know about ecosystems to explain how matter cycles and energy flows through the ecosystem. They use the concepts of natural selection and fossil evidence to construct explanations about the diversity of life that they see. Seventh graders plan and carry out investigations, describe observations, and show information in graphical form. The students replicate investigations and compare results to find similarities and differences.

Life Science

S7L1. Obtain, evaluate, and communicate information to investigate the diversity of living organisms and how they can be compared scientifically.

a. Develop and defend a model that categorizes organisms based on common characteristics.
b. Evaluate historical models of how organisms were classified based on physical characteristics and how that led to the six kingdom system (currently archaea, bacteria, protists, fungi, plants, and animals).
(*Clarification statement:* This includes common examples and characteristics such as, but not limited to, prokaryotic, eukaryotic, unicellular, multicellular, asexual reproduction, sexual reproduction, autotroph, heterotroph, and unique cell structures. Modern classification will be addressed in high school.)

S7L2. Obtain, evaluate, and communicate information to describe how cell structures, cells, tissues, organs, and organ systems interact to maintain the basic needs of organisms.

a. Develop a model and construct an explanation of how cell structures (specifically the nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, and mitochondria) contribute to the function of the cell as a system in obtaining nutrients in order to grow, reproduce, make needed materials, and process waste.
(*Clarification statement:* The intent is for students to demonstrate how the component structures of the cell interact and work together to allow the cell as a whole to carry out various processes. Additional structures, beyond those listed, will be addressed in high school Biology.)
b. Develop and use a conceptual model of how cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms.
c. Construct an argument that systems of the body (Cardiovascular, Excretory, Digestive, Respiratory, Muscular, Nervous, and Immune) interact with one another to carry out life processes.
(*Clarification statement:* The emphasis is not on learning individual structures and functions associated with each system, but on how systems interact to support life processes.)

S7L3. Obtain, evaluate, and communicate information to explain how organisms reproduce either sexually or asexually and transfer genetic information to determine the traits of their offspring.

a. Construct an explanation supported with scientific evidence of the role of genes and chromosomes in the process of inheriting a specific trait.

b. Develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation.
(*Clarification statement:* Models could include, but are not limited to, the use of monohybrid Punnett squares to demonstrate the heritability of genes and the resulting genetic variation, identification of heterozygous and homozygous, and comparison of genotype vs. phenotype.)
c. Ask questions to gather and synthesize information about the ways humans influence the inheritance of desired traits in organisms through selective breeding.
(*Clarification statement:* The element specifically addresses artificial selection and the ways in which it is fundamentally different from natural selection.)

S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.

a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem.
(*Clarification statement:* The interactions include, but are not limited to, predator-prey relationships, competition, mutualism, parasitism, and commensalism.)
b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem.
(*Clarification statement:* Emphasis is on tracing movement of matter and flow of energy, not the biochemical mechanisms of photosynthesis and cellular respiration.)
c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems.
d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth's major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, and tundra) and aquatic ecosystems (i.e., freshwater, estuaries, and marine).
(*Clarification statement:* Emphasis is on the factors that influence patterns across biomes such as the climate, availability of food and water, and location.)

S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.

a. Use mathematical representations to evaluate explanations of how natural selection leads to changes in specific traits of populations over successive generations.
(*Clarification statement:* Referencing data should be obtained from multiple sources including, but not limited to, existing research and simulations. Students should be able to calculate means, represent this data in a table or graph, and reference it when explaining the principles of natural selection.)

b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.
c. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, and extinction of organisms and their relationships to modern organisms. (*Clarification statement:* Evidence of evolution found in comparisons of current/modern organisms such as homologous structures, DNA, and fetal development will be addressed in high school.)

Eighth Grade Standards

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The Eighth Grade Georgia Standards of Excellence for science are designed to give all students the necessary skills for a smooth transition from elementary physical science standards to high school physical science standards. The purpose is to give all students an overview of common strands in physical science including, but not limited to, the nature of matter, conservation of energy, energy transformations, conservation of matter, kinematics, and dynamics. These standards are not intended in any way to take the place of the high school physical science standards.

Eighth grade students keep records of their observations, use those records to analyze the data they collect, recognize patterns in the data, use simple charts and graphs to represent the relationships they see, and find more than one way to interpret their findings. They develop conceptual understanding of the laws of conservation of matter and conservation of energy, are able to explain the characteristics of the motion of an object (speed, acceleration) and the way that forces may change the state of motion of an object. They use what they observe to explain the difference between physical and chemical changes and cause and effect relationships between force, mass, and the motion of objects. Students in eighth grade construct explanations based on evidence on the difference and similarities between electromagnetic and mechanical waves. Eighth graders plan and carry out investigations, describe observations, and show information in graphical form. The students replicate investigations and compare results to find similarities and differences.

Physical Science

S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.

a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures.
(*Clarification statement:* Include heterogeneous and homogeneous mixtures. Types of bonds and compounds will be addressed in high school physical science.)
b. Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed.
c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical (i.e., density, melting point, boiling point) properties of matter.
d. Construct an argument based on observational evidence to support the claim that when a change in a substance occurs, it can be classified as either chemical or physical.
(*Clarification statement:* Evidence could include ability to separate mixtures, development of a gas, formation of a precipitate, change in energy, color, and/or form.)
e. Develop models (e.g., atomic-level models, including drawings, and computer representations) by analyzing patterns within the periodic table that illustrate the structure, composition, and characteristics of atoms (protons, neutrons, and electrons) and simple molecules.
f. Construct an explanation based on evidence to describe conservation of matter in a chemical reaction including the resulting differences between products and reactants.
(*Clarification statement:* Evidence could include models such as balanced chemical equations.)

S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system.

a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed, and potential energy to mass and height of an object.
b. Plan and carry out an investigation to explain the transformation between kinetic and potential energy within a system (e.g., roller coasters, pendulums, rubber bands, etc.).
c. Construct an argument to support a claim about the type of energy transformations within a system [e.g., lighting a match (light to heat), turning on a light (electrical to light)].
d. Plan and carry out investigations on the effects of heat transfer on molecular motion as it relates to the collision of atoms (conduction), through space (radiation), or in currents in a liquid or a gas (convection).

S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.

a. Analyze and interpret data to identify patterns in the relationships between speed and distance, and velocity and acceleration.
(*Clarification statement:* Students should be able to analyze motion graphs, but students should not be expected to calculate velocity or acceleration.)
b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object.
c. Construct an argument from evidence to support the claim that the amount of force needed to accelerate an object is proportional to its mass (inertia).

S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves.

a. Ask questions to develop explanations about the similarities and differences between electromagnetic and mechanical waves.
(*Clarification statement:* Include transverse and longitudinal waves and wave parts such as crest, trough, compressions, and rarefactions.)
b. Construct an explanation using data to illustrate the relationship between the electromagnetic spectrum and energy.
c. Design a device to illustrate practical applications of the electromagnetic spectrum (e.g., communication, medical, military).
d. Develop and use a model to compare and contrast how light and sound waves are reflected, refracted, absorbed, diffracted or transmitted through various materials.
(*Clarification statement:* Include echo and how color is seen but do not cover interference and scattering.)
e. Analyze and interpret data to predict patterns in the relationship between density of media and wave behavior (i.e., speed).
f. Develop and use a model (e.g., simulations, graphs, illustrations) to predict and describe the relationships between wave properties (e.g., frequency, amplitude, and wavelength) and energy.
g. Develop and use models to demonstrate the effects that lenses have on light (i.e., formation an image) and their possible technological applications.

S8P5. Obtain, evaluate, and communicate information about gravity, electricity, and magnetism as major forces acting in nature.

a. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact.

b. Plan and carry out investigations to demonstrate the distribution of charge in conductors and insulators.
(*Clarification statement:* Include conduction, induction, and friction.)
c. Plan and carry out investigations to identify the factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) that affect the strength of electric and magnetic forces.
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Science Georgia Standards of Excellence

SCIENCE - Astronomy

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This course will provide the student with an introduction to the concepts of modern astronomy, the origin and history of the Universe, and the formation of the Earth and the solar system. Students will compare the Earth's properties with those of the other planets and explore how the heavens have influenced human thought and action. The course gives a description of astronomical phenomena using the laws of physics. The course treats many standard topics including planets, stars, the Milky Way and other galaxies, and black holes. Laboratory exercises include experiments in light properties, measurement of radiation from celestial sources, and observations at local observatories and/or planetariums.

SCIENCE - Astronomy

SAST1. Obtain, evaluate, and communicate information to assess the validity of historical theories of astronomy.

a. Ask questions to investigate the daily/seasonal motions of the sky and communicate the significance of constellations, for navigation and time-keeping.
(*Clarification statement*: Compare and contrast astronomy and astrology and describe how the zodiac relates to the motions of solar system objects.)

b. Obtain, evaluate and communicate information about how ancient structures, instruments, philosophies and civilizations influenced ancient astronomy.
(*Clarification statement:* Philosophies include but are not limited to geocentric theory, Aristotelian physics, and the Ptolemaic model with epicycles.)

c. Construct an argument based on evidence to support the scientific claims made by the heliocentric model.
(*Clarification statement*: Include observational evidence from Galileo's work, and the ideas of Copernicus, Kepler, and Newton.)

d. Use mathematics and computational thinking to relate Kepler's Laws to Newton's Law of Gravitation.

e. Construct an explanation for how technological advances in the design of reflecting and refracting telescopes have improved our ability to study the universe.
(*Clarification statement*: The focus is on the historical use of optical telescopes utilizing only the visible light spectrum.

SAST2. Obtain, evaluate, and communicate information to explain astronomical observations made from the point of reference of Earth.

a. Develop and use models to evaluate the relationship between the relative positions of the Earth, Moon and Sun and observable phenomena.
(*Clarification statement:* This includes moon phases, eclipses, tides, and seasons.)

b. Plan and carry out an investigation using the celestial sphere to explain how latitude and time of year affect visibility of constellations and other celestial objects.

c. Develop and use models of relative orbital motion of planets within our solar system to explain retrograde motion.

d. Use mathematics and computational thinking to explain the relationship between the properties of light and the vast distances in the cosmos.
(*Clarification statement*: This includes but is not limited to the Doppler Effect, cosmological red shifts, parsecs, light years, and astronomical units.)

e. Plan and carry out an investigation to analyze the electromagnetic spectrum and spectroscopic data to obtain information about the inherent properties and motions of objects.
(*Clarification statement*: Consider the use of diffraction gratings to analyze spectroscopic wavelength data along with other quantitative telescopic data.)

SAST3. Obtain, evaluate, and communicate information to illustrate the formation of the solar system and the properties of celestial objects within it.

a. Develop and use models to explain the formation of the solar system.
(*Clarification statement*: This includes the nebular theory.)

b. Develop and use models to explain the chemical composition and characteristics of the Sun and other solar system objects.
(*Clarification statement*: This should include addressing the role of nuclear fusion in the formation of elements in the sun and the role that hydrostatic equilibrium plays in the formation of different objects in the solar system.)

c. Ask questions to investigate and communicate major properties of our solar system bodies and the zones they inhabit.
(*Clarification statement*: This includes planets, dwarf planets, major moons, asteroid belt, comets, Kuiper belt, and the Öort cloud.)

SAST4. Obtain, evaluate, and communicate information to describe the scientific view of the origin of the universe, the evolution of matter, and the development of galaxies.

a. Construct an argument from evidence in support of the Big Bang theory.
(*Clarification statement*: This includes but is not limited to the cosmological principle, cosmic microwave background radiation, and space-time expansion.)

b. Use models to describe the conditions of the early universe that led to the formation and evolution of matter as well as the birth of the first stars and galaxies.

c. Construct an explanation using indirect evidence to support the existence of dark matter and dark energy.

d. Develop and use models to relate how galactic evolution occurs through mergers and collisions.

SAST5. Obtain, evaluate, and communicate information about the connections between mass, gravity and fusion with respect to the life cycle of stars.

a. Develop and use models to explain the process of stellar evolution from star birth to star death, including binary systems.

b. Construct an argument based on evidence from the Hertzsprung-Russell diagram to assess the properties of stars, including density, luminosity, temperature, rates of fusion, and spectral class.

c. Ask questions to evaluate evidence that predicts the lifespan and final stage of stellar evolution based on mass.
(*Clarification statement*: Include stellar remnants and events such as neutron stars, pulsars, black holes, supernovae.)

d. Construct an argument based on evidence that explores the connections among various cosmic phenomena and leading theories.

SAST6. Obtain, evaluate, and communicate information to discuss how the past, current, and future explorations of space impact our investigations of the connections between cosmic phenomena and conditions necessary for life.

a. Construct an argument based on evidence of the significance of historical and future space exploration as they relate to leaps in technology, cultural cooperation, knowledge, and inspiration.
(*Clarification statement*: Historical space exploration begins with Sputnik and continues to the present day, including possible future extrasolar exploration, space stations, and colonization.)

b. Analyze and interpret telescopic data of various electromagnetic spectra in order to evaluate the uses and advantages of the data from each.
(*Clarification statement*: This includes but is not limited to atmospheric analysis, solar monitoring, and exoplanet detection.)

c. Construct an explanation for the existence and importance of habitable zones, habitable planetary bodies, and possible signatures of life in our own and in other solar systems.

d. Construct an explanation of how astronomical and planetary hazards and global atmospheric changes have impacted the evolution of life on Earth.
(*Clarification statement*: This includes but is not limited to asteroid impacts, changes in solar radiation, and gamma ray bursts.)

Science Georgia Standards of Excellence

SCIENCE - Astronomy

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This course will provide the student with an introduction to the concepts of modern astronomy, the origin and history of the Universe, and the formation of the Earth and the solar system. Students will compare the Earth's properties with those of the other planets and explore how the heavens have influenced human thought and action. The course gives a description of astronomical phenomena using the laws of physics. The course treats many standard topics including planets, stars, the Milky Way and other galaxies, and black holes. Laboratory exercises include experiments in light properties, measurement of radiation from celestial sources, and observations at local observatories and/or planetariums.

SCIENCE - Astronomy

SAST1. Obtain, evaluate, and communicate information to assess the validity of historical theories of astronomy.

a. Ask questions to investigate the daily/seasonal motions of the sky and communicate the significance of constellations, for navigation and time-keeping.
(*Clarification statement*: Compare and contrast astronomy and astrology and describe how the zodiac relates to the motions of solar system objects.)

b. Obtain, evaluate and communicate information about how ancient structures, instruments, philosophies and civilizations influenced ancient astronomy.
(*Clarification statement:* Philosophies include but are not limited to geocentric theory, Aristotelian physics, and the Ptolemaic model with epicycles.)

c. Construct an argument based on evidence to support the scientific claims made by the heliocentric model.
(*Clarification statement*: Include observational evidence from Galileo's work, and the ideas of Copernicus, Kepler, and Newton.)

d. Use mathematics and computational thinking to relate Kepler's Laws to Newton's Law of Gravitation.

e. Construct an explanation for how technological advances in the design of reflecting and refracting telescopes have improved our ability to study the universe.
(*Clarification statement*: The focus is on the historical use of optical telescopes utilizing only the visible light spectrum.

SAST2. Obtain, evaluate, and communicate information to explain astronomical observations made from the point of reference of Earth.

a. Develop and use models to evaluate the relationship between the relative positions of the Earth, Moon and Sun and observable phenomena.
(*Clarification statement:* This includes moon phases, eclipses, tides, and seasons.)

b. Plan and carry out an investigation using the celestial sphere to explain how latitude and time of year affect visibility of constellations and other celestial objects.

c. Develop and use models of relative orbital motion of planets within our solar system to explain retrograde motion.

d. Use mathematics and computational thinking to explain the relationship between the properties of light and the vast distances in the cosmos.
(*Clarification statement*: This includes but is not limited to the Doppler Effect, cosmological red shifts, parsecs, light years, and astronomical units.)

e. Plan and carry out an investigation to analyze the electromagnetic spectrum and spectroscopic data to obtain information about the inherent properties and motions of objects.
(*Clarification statement*: Consider the use of diffraction gratings to analyze spectroscopic wavelength data along with other quantitative telescopic data.)

SAST3. Obtain, evaluate, and communicate information to illustrate the formation of the solar system and the properties of celestial objects within it.

a. Develop and use models to explain the formation of the solar system.
(*Clarification statement*: This includes the nebular theory.)

b. Develop and use models to explain the chemical composition and characteristics of the Sun and other solar system objects.
(*Clarification statement*: This should include addressing the role of nuclear fusion in the formation of elements in the sun and the role that hydrostatic equilibrium plays in the formation of different objects in the solar system.)

c. Ask questions to investigate and communicate major properties of our solar system bodies and the zones they inhabit.
(*Clarification statement*: This includes planets, dwarf planets, major moons, asteroid belt, comets, Kuiper belt, and the Öort cloud.)

SAST4. Obtain, evaluate, and communicate information to describe the scientific view of the origin of the universe, the evolution of matter, and the development of galaxies.

a. Construct an argument from evidence in support of the Big Bang theory.
(*Clarification statement*: This includes but is not limited to the cosmological principle, cosmic microwave background radiation, and space-time expansion.)

b. Use models to describe the conditions of the early universe that led to the formation and evolution of matter as well as the birth of the first stars and galaxies.

c. Construct an explanation using indirect evidence to support the existence of dark matter and dark energy.

d. Develop and use models to relate how galactic evolution occurs through mergers and collisions.

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b. Construct an argument based on evidence from the Hertzsprung-Russell diagram to assess the properties of stars, including density, luminosity, temperature, rates of fusion, and spectral class.

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SCIENCE - Botany

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SCIENCE - Botany

SBO1. Obtain, evaluate, and communicate information to analyze the nature of the relationships between plant morphological structures and anatomical structures, functions, and processes.

a. Ask questions to investigate and provide explanations about the basic plant structures (i.e., major organs, tissues, and cells) in relation to their functions.
(*Clarification statement:* Instruction for plant structures and functions should address how plastic or rigid these can be in plants.)

b. Construct an explanation supported by evidence relating plant structures to plant processes (photosynthesis, respiration, transport, growth, reproduction, and dispersal).
(*Clarification statement:* Instruction should focus on understanding major processes such as light and dark reactions of photosynthesis, Glycolysis, Krebs Cycle, Electron Transport Chain, upward movement of water and nutrients (ascent of sap), movement of food, growth forms, vegetative and sexual reproduction, seed dispersal mechanisms, and how morphological and anatomical structures support these processes.)

c. Develop and use a model to trace the origin of changes of major plant structures and organs through geological time, in response to major changes in the environment (i.e., development of vascular tissues, change from spores to seed formers).

d. Construct an explanation about the coevolution of plant morphological and anatomical structures with animals (i.e., pollination), *Rhizobium* (i.e., nitrogen fixation), and Mycorrhiza (i.e., fungi in rhizosphere).
(*Clarification statement*: In addressing pollination, be aware that students may have a misconception that insects are the sole source of pollination. Vertebrates, wind, fire and water also play a part. While not all are examples of coevolution, they represent reproductive/dispersal strategies and advancements by some plant groups.)

e. Use mathematical models to predict the effect of hormones on structural growth of a plant in response to an external stimulus. (Focus on phototropism, geotropism, and thigmotropism).

SBO2. Obtain, evaluate, and communicate information to delineate the plant divisions based on current plant phylogenetic and taxonomic principles.

a. Construct an explanation based on evidence to compare nonvascular to vascular plants and seedless to seed plants.

b. Construct an argument based on evidence from traditional methods and emerging technologies (i.e., using physical characteristics and molecular evidences) to classify plants into major plant divisions.

c. Analyze and interpret data to develop models (i.e., cladograms and phylogenetic trees) based on patterns of common ancestry or convergence.

SBO3. Obtain, evaluate, and communicate information to describe Georgia's major physiographic ecoregions, their representative natural plant communities, and their conservation.

a. Analyze and interpret data using taxonomic keys to identify and compare the major plant forms that dominate natural plant communities growing in aquatic and terrestrial habitats and the ecosystems they support in Georgia.
b. Construct an argument based on evidence of the impact of non-native invasive plants on Georgia's natural communities.
c. Construct explanations of the factors that cause plants to become endangered and design solutions to prevent extinction.
d. Design a solution to create sustainable plant communities within Georgia's ecoregions and reduce negative human impact.
(*Clarification statement:* Solutions to creating sustainable plant communities include, but are not limited to, restoration and reintroduction science, propagation methods, and habitat management.)

SBO4. Obtain, evaluate, and communicate information to analyze the impact of plant diseases and pests on plant defense systems and agriculture.

a. Ask questions based on observational, investigative or research evidence to develop sustainable management strategies for common plant diseases.
(*Clarification statement:* Management strategies and practices could focus on agricultural and landscaping plants.)
b. Construct an explanation based on research (i.e., case studies) to evaluate how plant diseases affect humans, animals, and the economy.
c. Plan and carry out an investigation to determine how plants respond to insect pests and pathogens, and note the plant defense mechanism.
(*Clarification statement:* Instruction should include diseases caused by common bacteria, viruses, fungi and vectored by insects.)

SBO5. Obtain, evaluate, and communicate information to analyze the diversity of plant adaptations and responses to changing environmental conditions.

a. Construct an explanation to describe the diversity of plants and their adaptations in relation to differing ecosystems and changing environments, both long term (climate) and short term (seasonal and diurnal).
(*Clarification statement:* Instruction should focus on climatic, seasonal, and diurnal changes.)
b. Construct an argument based on evidence to predict which plant adaptions increase survival in different stressful environments (i.e., water extremes, saline environment, and extreme temperature).
c. Develop and use models to analyze how change and disruptions in major nutrient cycles (i.e., C, H, O, N, P) might affect plant responses.

SBO6. Obtain, evaluate, and communicate information to analyze the economic and ecological importance of plants in human society.

a. Construct an explanation of how plants are used in different societies (agriculture, horticulture, industry, medicine, biotechnology).
b. Develop a model to explain how plants impact the environment by providing diverse habitats for birds, insects, and other wildlife in ecosystems.
(*Clarification statement*: Include urban environments and how plants mitigate flooding and heat island effects and create cleaner air and water.)
c. Construct an argument based on evidence to explain the use and potential benefits of genetically modified plants through traditional and modern molecular techniques and investigate the bio-ethical issues related to genetic engineering of plants.

Science Georgia Standards of Excellence

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Chemistry Standards

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The Chemistry Georgia Standards of Excellence are designed to continue student investigations of the physical sciences that began in grades K-8 and provide students the necessary skills to be proficient in chemistry. These standards include more abstract concepts such as the structure of atoms, structure and properties of matter, the conservation and interaction of energy and matter, and the use of Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes. Students investigate chemistry concepts through experiences in laboratories and field work using the process of inquiry.

Chemistry students use the periodic table to help with the identification of elements with particular properties, recognize patterns that lead to explain chemical reactivity and bond formation. They use the IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds, and conduct experiments to manipulate factors that affect chemical reactions.

Chemistry

SC1. Obtain, evaluate, and communicate information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements.

a. Evaluate merits and limitations of different models of the atom in relation to relative size, charge, and position of protons, neutrons, and electrons in the atom.
b. Construct an argument to support the claim that the proton (and not the neutron or electron) defines the element's identity.
c. Construct an explanation based on scientific evidence of the production of elements heavier than hydrogen by nuclear fusion.
d. Construct an explanation that relates the relative abundance of isotopes of a particular element to the atomic mass of the element.
e. Construct an explanation of light emission and the movement of electrons to identify elements.
f. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (i.e. including atomic radii, ionization energy, and electronegativity).
g. Develop and use models, including electron configuration of atoms and ions, to predict an element's chemical properties.

SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.

a. Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces.
b. Construct an argument by applying principles of inter- and intra- molecular forces to identify substances based on chemical and physical properties.
c. Construct an explanation about the importance of molecular-level structure in the functioning of designed materials.
   (*Clarification statement:* Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.)
d. Develop and use models to evaluate bonding configurations from nonpolar covalent to ionic bonding.
   (*Clarification statement:* VSEPR theory is not addressed in this element.)
e. Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds.
f. Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds.

g. Develop a model to illustrate the release or absorption of energy (endothermic or exothermic) from a chemical reaction system depends upon the changes in total bond energy.

SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

a. Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
b. Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g., precipitate formation, gas evolution, color change, water production, and changes in energy to the system).
c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate
   - percent composition
   - empirical/molecular formulas
   - mass, moles, and molecules relationships
   - molar volumes of gases
d. Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures.
   (*Clarification statement:* For elements c and d emphasis is on use of mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.)
e. Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.

SC4. Obtain, evaluate, and communicate information about how to refine the design of a chemical system by applying engineering principles to manipulate the factors that affect a chemical reaction.

a. Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions.
   (*Clarification statement:* Pressure should not be tested experimentally.)
b. Construct an argument using collision theory and transition state theory to explain the role of activation energy in chemical reactions.
   (*Clarification statement:* Reaction coordinate diagrams could be used to visualize graphically changes in energy (direction flow and quantity) during the progress of a chemical reaction.)
c. Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples.

d. Refine the design of a chemical system by altering the conditions that would change forward and reverse reaction rates and the amount of products at equilibrium.
(*Clarification statement:* Emphasis is on the application of LeChatelier's principle.)

SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.

a. Plan and carry out an investigation to calculate the amount of heat absorbed or released by chemical or physical processes.
(*Clarification statement:* Calculation of the enthalpy, heat change, and Hess's Law are addressed in this element.)
b. Construct an explanation using a heating curve as evidence of the effects of energy and intermolecular forces on phase changes.
c. Develop and use models to quantitatively, conceptually, and graphically represent the relationships between pressure, volume, temperature, and number of moles of a gas.

SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases.

a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation.
b. Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent.
c. Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e., molarity and percent by mass).
d. Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration.
e. Develop and use a model to explain the effects of a solute on boiling point and freezing point.
f. Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH.
(*Clarification statement:* Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.)
g. Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases.
h. Plan and carry out an investigation to explore acid-base neutralization.

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Chemistry

SC1. Obtain, evaluate, and communicate information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements.

a. Evaluate merits and limitations of different models of the atom in relation to relative size, charge, and position of protons, neutrons, and electrons in the atom.
b. Construct an argument to support the claim that the proton (and not the neutron or electron) defines the element's identity.
c. Construct an explanation based on scientific evidence of the production of elements heavier than hydrogen by nuclear fusion.
d. Construct an explanation that relates the relative abundance of isotopes of a particular element to the atomic mass of the element.
e. Construct an explanation of light emission and the movement of electrons to identify elements.
f. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (i.e. including atomic radii, ionization energy, and electronegativity).
g. Develop and use models, including electron configuration of atoms and ions, to predict an element's chemical properties.

SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.

a. Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces.
b. Construct an argument by applying principles of inter- and intra- molecular forces to identify substances based on chemical and physical properties.
c. Construct an explanation about the importance of molecular-level structure in the functioning of designed materials.
   (*Clarification statement:* Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.)
d. Develop and use models to evaluate bonding configurations from nonpolar covalent to ionic bonding.
   (*Clarification statement:* VSEPR theory is not addressed in this element.)
e. Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds.
f. Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds.

g. Develop a model to illustrate the release or absorption of energy (endothermic or exothermic) from a chemical reaction system depends upon the changes in total bond energy.

SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

a. Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
b. Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g., precipitate formation, gas evolution, color change, water production, and changes in energy to the system).
c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate
   - percent composition
   - empirical/molecular formulas
   - mass, moles, and molecules relationships
   - molar volumes of gases
d. Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures.
   (*Clarification statement:* For elements c and d emphasis is on use of mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.)
e. Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.

SC4. Obtain, evaluate, and communicate information about how to refine the design of a chemical system by applying engineering principles to manipulate the factors that affect a chemical reaction.

a. Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions.
   (*Clarification statement:* Pressure should not be tested experimentally.)
b. Construct an argument using collision theory and transition state theory to explain the role of activation energy in chemical reactions.
   (*Clarification statement:* Reaction coordinate diagrams could be used to visualize graphically changes in energy (direction flow and quantity) during the progress of a chemical reaction.)
c. Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples.

d. Refine the design of a chemical system by altering the conditions that would change forward and reverse reaction rates and the amount of products at equilibrium.
(*Clarification statement:* Emphasis is on the application of LeChatelier's principle.)

SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.

a. Plan and carry out an investigation to calculate the amount of heat absorbed or released by chemical or physical processes.
(*Clarification statement:* Calculation of the enthalpy, heat change, and Hess's Law are addressed in this element.)
b. Construct an explanation using a heating curve as evidence of the effects of energy and intermolecular forces on phase changes.
c. Develop and use models to quantitatively, conceptually, and graphically represent the relationships between pressure, volume, temperature, and number of moles of a gas.

SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases.

a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation.
b. Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent.
c. Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e., molarity and percent by mass).
d. Communicate scientific and technical information on how to prepare and properly label solutions of specified molar concentration.
e. Develop and use a model to explain the effects of a solute on boiling point and freezing point.
f. Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH.
(*Clarification statement:* Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.)
g. Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted-Lowry models of acid and bases.
h. Plan and carry out an investigation to explore acid-base neutralization.

Science Georgia Standards of Excellence

SCIENCE - Ecology

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Science consists of a way of thinking and investigating, as well a growing body of knowledge about the natural world. To become literate in science, students need to possess sufficient understanding of fundamental science content knowledge, the ability to engage in the science and engineering practices, and to use scientific and technological information correctly. Technology should be infused into the curriculum and the safety of the student should always be foremost in instruction.

Ecology is the study of the distribution and abundance of life and interactions between and among organisms and their environment, including the impact of human activities on the natural world. It draws on elements from biology, chemistry, physics, mathematics, and the social sciences. This curriculum is lab and field based. Whenever possible careers related to ecology and relevant case studies should be emphasized.

SCIENCE - Ecology

SEC1. Obtain, evaluate, and communicate information on how biotic and abiotic factors interact to influence the distribution of species and the diversity of life on Earth.

a. Develop a model describing the organizational structure of a habitat within an ecosystem.
(Clarification statement: Includes biotic and abiotic factors and the organizational structure; organism, population, community, ecosystems.)
b. Ask questions to predict the cause and effect of varying levels of abiotic and biotic factors on a habitat in Georgia.
(*Clarification statement:* Focus on specific habitat types, not biomes.)
c. Construct an argument based on evidence to explain factors that lead to sustainability of biodiversity in an ecosystem.

SEC2. Obtain, evaluate, and communicate information to analyze factors influencing population growth, density, and dispersion.

a. Construct an explanation of factors that regulate population density and growth within communities.
(*Clarification statement*: This includes both density dependent and density independent limiting factors and their relationship to carrying capacity.)
b. Develop and use models to predict population dispersion as a result of population growth and resource availability.
c. Construct an explanation to describe how population growth and dispersion are influenced by natural selection.
(*Clarification statement:* This includes reproductive strategies, adaptations, and competition for resources.)

SEC3. Obtain, evaluate, and communicate information to construct explanations of community interactions.

a. Construct an argument based on evidence to support how species interactions (e.g., predation, parasitism, mutualism, commensalism, and competition) and adaptations are a response to selective pressures.
b. Obtain, evaluate, and communicate information about various ecological niches within habitats and determine how interactions between species lead to resource partitioning.
c. Construct an explanation based on evidence that describes the impact of keystone, invasive, native, indicator, and rare species in Georgia ecosystems.
d. Construct an explanation about species diversity and how it relates to the stability of ecosystems and communities.
e. Develop a model to explain ecological succession in terms of changes in communities over time and the impact of disturbance on community composition.

SEC4. Obtain, evaluate, and communicate information about biogeochemical cycles and how the flow of energy influences ecosystems.

a. Plan and carry out an investigation of the movement of nitrogen and phosphorus through an ecosystem as a limiting factor in plant communities related to aquatic system succession. (*Clarification statement*: Field experience or scientific research study should be included.)
b. Construct an explanation of the movement of carbon through an ecosystem. (*Clarification statement:* Focus is on ecological processes in terrestrial and aquatic ecosystems, not on anthropogenic influences.)
c. Develop a model utilizing the first and second laws of thermodynamics and the law of conservation of matter to explain and illustrate the flow of energy and matter in ecosystems.
d. Construct an argument based on evidence to explain the relationship between net primary productivity and biodiversity.

SEC5. Obtain, evaluate, and communicate information on the impact of natural and anthropogenic activities on ecological systems.

a. Analyze and interpret data on the ecological impacts of sustainable and non-sustainable use of natural resources and predict the cause and effect of unsustainable use of natural resources on ecosystems.
b. Construct an argument based on evidence to predict the impact of climate change on an ecosystem.
c. Construct an argument based on evidence of the consequences of habitat fragmentation and habitat loss on biodiversity in relation to island biogeography.
d. Obtain, evaluate, and communicate mitigation strategies to reduce the impacts of non-sustainable activities on Georgia ecosystems.

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The Entomology Georgia Standards of Excellence are designed to continue student investigations that began in grades K-8 and high school biology. To achieve the goal of entomological literacy these standards provide students with basic understanding of insect biology as it relates to agriculture, animal and human health, ecosystem functioning and monitoring, and insect products. Students will investigate these entomological concepts through laboratory and field experience using the processes of inquiry.

SCIENCE - Entomology

SEN1. Obtain, evaluate, and communicate information about the roles of insects in ecosystems.

a. Construct an explanation for the role(s) of insects in diverse terrestrial and freshwater food webs (i.e., as herbivores, predators, and scavengers) and the need for conservation.
b. Ask questions to compare and contrast the prevalence of specific insect species in local Georgia regions.
c. Use mathematics and computational thinking to compare species diversity and biomass in different terrestrial habitats and evaluate why insects dominate both measures in most regions (e.g., field plot population sampling).
d. Construct an explanation of the importance of insects in ecosystem sustainability (e.g., plant pollination, decomposers/recyclers of organic matter).
e. Plan and carry out an investigation to demonstrate how some groups of insects are used as bio-indicators because they are sensitive or tolerant to habitat change conditions.
f. Construct an argument based on evidence to demonstrate co-evolution/co-adaptation relationships between various insects and plants (e.g. pollination syndrome).

SEN2. Obtain, evaluate, and communicate information about how insect morphology and adaptation is related to insect success.

a**.** Plan and carry out an investigation to compare and contrast the insect body plan to other arthropods (e.g., Chelicerates, Myriapods, and Crustaceans).
b. Construct arguments based on evidence to explain how different insect life cycles impact insect survival and success (e.g., complete vs. incomplete).
c. Develop and use a model to identify insects based on the morphological characteristics of the ten largest insect orders (e.g., Odonata, Lepidoptera, Homoptera, Hemiptera, Orthoptera, Coleoptera, Hymenoptera, Diptera, Blattodea, Siphonaptera).
(*Clarification statement:* This could include how some insects have evolved to control reproduction favoring female or "queen" survival.)
d. Analyze and interpret data on how insect structure and function are integrated and reflect evolved adaptations to different environments. (e.g., mimicry, camouflage.)
e. Ask questions and define problems related to the impact of non-native species on local ecosystems (e.g., the effect of bark beetles or wooly adelgids on local forests).

SEN3. Obtain, evaluate, and communicate information about the impact of insects on the production of food and other products and in popular culture and commerce.

a. Construct explanations of the contributions of insects to human culture and commerce (e.g., music, art, silk, honey, lacquer, and dyes).
b. Construct an argument based on evidence to demonstrate the importance of an insect's ecological niche in food production and food sources (e.g., pollinators of agricultural crops, human protein source, biomass pyramid).
c. Analyze and interpret data about the economic impact of insects as pests in agriculture, stored food, buildings, and domesticated animals (e.g., spotted-wing drosophila, sawtooth grain beetle, termites, fleas, flies).

SEN4. Obtain, evaluate, and communicate information about the impact of insects on human and other animal health, medicine, and biotechnology.

a. Develop and use a model to illustrate the impact of disease-transmitting insects (e.g., malaria, yellow fever, plague, dengue fever, and West Nile virus) on public health and human history (e.g., the Black Plague during the Middle Ages, and malaria in world history including Georgia).
   (*Clarification statement:* Demonstrate that the spread of diseases is based on species survivability in certain habitats, e.g. – Zika, because of the carrying species inability to survive in colder climates.)
b. Ask questions to investigate how insects can affect human and other animal health through allergic reactions (e.g., wasp stings, cockroach droppings).
c. Plan and carry out an investigation to demonstrate the application of forensic entomology and biotechnology in the area of crime scene analysis, insect toxins and pharmaceuticals, and neurological research.

SEN5. Obtain, evaluate, and communicate information about the relationship between human activity and insect populations.

a. Use mathematics and computational thinking to determine the significance of human behavior on insect populations (e.g., intended and unintended results of habitat destruction by human activity – pest control, industrialization, deforestation, global warming).
b. Ask questions to determine the impact of controlling insect populations (e.g., intended and unintended results from pest management alternatives).
c. Construct an explanation based on evidence of how conventional pesticide application has impacted various ecological niches (e.g. insect resistance, human health, and beneficial insect populations).
d. Construct an argument based on evidence about the use of beneficial insects as a method of biological control of both agricultural crop and domesticated animal pests (e.g., insect parasitoids, predators, and herbivores).
(*Clarification statement:* Instruction should include both the biocontrol efforts that have worked as well as those that have failed or had unintended consequences (e.g., insect biocontrol agents preying on beneficial insects instead of the target insect)).
e. Plan and carry out an investigation of the benefits and risks of using genetically modified crops to manage insect pests.
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Science Georgia Standards of Excellence

SCIENCE - Epidemiology

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The Epidemiology Georgia Standards of Excellence are designed to extend student investigations that begin in biology. This curriculum is performance-based. It integrates scientific investigations using real world situations to find patterns and determine causation of pathological conditions. Instruction should focus on the design, implementation, and evaluation of studies to increase students' media literacy and their understanding of public health.

SCIENCE - Epidemiology

SEPI1. Obtain, evaluate, and communicate information to understand and analyze the disease process.

a. Obtain, evaluate and communicate information about the history and uses of epidemiology. (*Clarification statement*: This element is intended to include scientists, public health organizations and scientific breakthroughs.)
b. Ask questions about diseases and pathogens that cause them.
c. Construct an explanation of the body's defense mechanisms and how illness results when the mechanisms fail to maintain homeostasis.
d. Construct an argument from evidence to explain how the rapid evolution of pathogens results in diseases that will continue to be a public health concern.
(*Clarification statement:* Instruction should include an emphasis on the importance of antibiotic resistance from both domestic and global perspectives).
e. Develop and use models to explain the different modes of disease transmission and how timing of exposure during the disease process affects spread of disease.

SEPI2. Obtain, evaluate, and communicate information to identify and formulate hypotheses about patterns of health and disease.

a. Analyze and interpret data focusing on the amount, distribution and patterns of disease within a population by person, place and time.
(*Clarification statement*: Instruction should focus on the amounts, distributions and patterns from local and global perspectives).
b. Use models that are based on empirical evidence to identify patterns of health and disease to characterize a public health problem.
c. Analyze and interpret data about the patterns of illness, including at least one chronic disease.
(*Clarification statement*: This element should include research on the top three epidemics in Georgia.)

SEPI3. Obtain, evaluate, and communicate information about the type and use of analytical epidemiology and study designs and associations.

a. Develop and use models to explain basic epidemiologic study designs (e.g., cross-sectional, case-control, cohort, and randomized controlled trial).
(*Clarification statement:* Students should be able to compare and contrast various models and study designs. Each model has strengths and appropriate applications, but not every model is appropriate for each situation.)
b. Plan and carryout investigations to determine if exposure and disease are associated and communicate the information, including the limits of the investigation.
c. Ask questions to assess ethical issues in epidemiology and human trials.

SEPI4. Obtain, evaluate, and communicate information to analyze associations and causations of health and disease.

a. Use mathematical models to predict and explain the relationship between variables and the presence, nature, and impact of any confounding factors.
b. Analyze and interpret epidemiological data as well as evidence from other scientific disciplines to determine if exposure to a variable causes a disease.
(*Clarification statement*: Students should understand the differences between confounding and associated variables when analyzing data.)

SEPI5. Obtain, evaluate, and communicate information about health-related messages in the media to make informed public health decisions and life goals.

a. Construct an argument based on evidence to assess the impact of emergent technologies on health and disease.
(*Clarification statement*: Instruction should address the advantages and disadvantages of current technological advances such as gene therapy, etc.)
b. Construct an argument based on evidence to assess the strengths and limitations of epidemiological reports.
c. Develop and use models to analyze strategies that promote a healthy lifestyle in relation to eating habits and exercise.
(*Clarification statement*: Instruction can include various modes of exercise, nutrition and the elimination of certain life-style habits.)
d. Obtain, evaluate, and communicate information about various career paths in public health as well as the applications and benefits of public health for a healthy society.

Science Georgia Standards of Excellence

SCIENCE - Epidemiology

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The Epidemiology Georgia Standards of Excellence are designed to extend student investigations that begin in biology. This curriculum is performance-based. It integrates scientific investigations using real world situations to find patterns and determine causation of pathological conditions. Instruction should focus on the design, implementation, and evaluation of studies to increase students' media literacy and their understanding of public health.

SCIENCE - Epidemiology

SEPI1. Obtain, evaluate, and communicate information to understand and analyze the disease process.

a. Obtain, evaluate and communicate information about the history and uses of epidemiology. (*Clarification statement*: This element is intended to include scientists, public health organizations and scientific breakthroughs.)
b. Ask questions about diseases and pathogens that cause them.
c. Construct an explanation of the body's defense mechanisms and how illness results when the mechanisms fail to maintain homeostasis.
d. Construct an argument from evidence to explain how the rapid evolution of pathogens results in diseases that will continue to be a public health concern.
(*Clarification statement:* Instruction should include an emphasis on the importance of antibiotic resistance from both domestic and global perspectives).
e. Develop and use models to explain the different modes of disease transmission and how timing of exposure during the disease process affects spread of disease.

SEPI2. Obtain, evaluate, and communicate information to identify and formulate hypotheses about patterns of health and disease.

a. Analyze and interpret data focusing on the amount, distribution and patterns of disease within a population by person, place and time.
(*Clarification statement*: Instruction should focus on the amounts, distributions and patterns from local and global perspectives).
b. Use models that are based on empirical evidence to identify patterns of health and disease to characterize a public health problem.
c. Analyze and interpret data about the patterns of illness, including at least one chronic disease.
(*Clarification statement*: This element should include research on the top three epidemics in Georgia.)

SEPI3. Obtain, evaluate, and communicate information about the type and use of analytical epidemiology and study designs and associations.

a. Develop and use models to explain basic epidemiologic study designs (e.g., cross-sectional, case-control, cohort, and randomized controlled trial).
(*Clarification statement:* Students should be able to compare and contrast various models and study designs. Each model has strengths and appropriate applications, but not every model is appropriate for each situation.)
b. Plan and carryout investigations to determine if exposure and disease are associated and communicate the information, including the limits of the investigation.
c. Ask questions to assess ethical issues in epidemiology and human trials.

SEPI4. Obtain, evaluate, and communicate information to analyze associations and causations of health and disease.

a. Use mathematical models to predict and explain the relationship between variables and the presence, nature, and impact of any confounding factors.
b. Analyze and interpret epidemiological data as well as evidence from other scientific disciplines to determine if exposure to a variable causes a disease.
(*Clarification statement*: Students should understand the differences between confounding and associated variables when analyzing data.)

SEPI5. Obtain, evaluate, and communicate information about health-related messages in the media to make informed public health decisions and life goals.

a. Construct an argument based on evidence to assess the impact of emergent technologies on health and disease.
(*Clarification statement*: Instruction should address the advantages and disadvantages of current technological advances such as gene therapy, etc.)
b. Construct an argument based on evidence to assess the strengths and limitations of epidemiological reports.
c. Develop and use models to analyze strategies that promote a healthy lifestyle in relation to eating habits and exercise.
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Earth Systems Standards

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The Earth Systems Georgia Standards of Excellence are designed to continue student investigations that began in K-8 Earth Science and Life Science curricula on the connections among Earth's systems through Earth history. These systems – the atmosphere, hydrosphere, geosphere, and biosphere – interact through time to produce the Earth's landscapes, ecology, and resources. These standards engage the students in constructing explanations of phenomena fundamental to the sciences of geology and physical geography, including the early history of the Earth, plate tectonics, landform evolution, the Earth's geologic record, weather and climate, and the history of life on Earth. Instruction should focus on development of scientific explanations, rather than mere descriptions of phenomena. Case studies, laboratory exercises, maps, and data analysis should be integrated into units. Special attention should be paid to topics of current interest (e.g., recent earthquakes, tsunamis, global warming, price of resources) and to potential careers in the geosciences.

Earth Systems

SES1. Obtain, evaluate, and communicate information to investigate the composition and formation of Earth systems, including the Earth's place in the solar system.

a. Construct an explanation of the origins of the solar system from scientific evidence including the composition, distribution and motion of solar system objects.
(*Clarification statement:* The nebular hypothesis should be included in this element.)
b. Ask questions to evaluate evidence for the development and composition of Earth's early systems, including the geosphere (crust, mantle and core), hydrosphere and atmosphere.
(*Clarification statement:* The differentiation by density of Earth into crust, mantle and core should be included in this element.)
c. Develop a model of the physical composition of Earth's layers using multiple types of evidence (e.g., Earth's magnetic field, composition of meteorites and seismic waves).
(*Clarification statement:* Earth's layers should include crust, mantle, inner core and outer core.)

SES2. Obtain, evaluate, and communicate information to understand how plate tectonics creates certain geologic features, landforms, Earth materials, and geologic hazards.

a. Construct an explanation based on evidence that describes the mechanisms causing plate tectonic motion.
(*Clarification statement:* The role of radioactive decay as the source of energy that drives the process of convection should be studied as part of this element).
b. Develop and use models for the different types of plate tectonic settings (convergent, divergent and transform boundaries).
(*Clarification statement:* Subduction zones, continental collisions, rift zones, and ocean basins should be included.)
c. Construct an explanation that communicates the relationship of geologic features, landforms, Earth materials and geologic hazards to each plate tectonic setting.
d. Ask questions to compare and contrast the relationship between transformation processes of all rock types (sedimentary, igneous, and metamorphic) and specific plate tectonic settings.
(*Clarification statement:* The plate tectonic settings to be considered here are continental collision, subduction zone, mid-ocean ridge, transformation fault, hot spot, and passive zone.)
e. Construct an argument using multiple forms of evidence that supports the theory of plate tectonics (e.g., fossils, paleomagnetism, seafloor age, etc.).

SES3. Obtain, evaluate, and communicate information to explore the actions of water, wind, ice, and gravity as they relate to landscape change.

a. Plan and carry out an investigation that demonstrates how surface water and groundwater act as the major agents of physical and chemical weathering.
b. Develop a model of the processes and geologic hazards that result from both sudden and gradual mass wasting.

c. Construct an explanation that relates the past and present actions of ice, wind, and water to landform distribution and landscape change.
d. Construct an argument based on evidence that relates the characteristics of the sedimentary materials to the energy by which they were transported and deposited.

SES4. Obtain, evaluate, and communicate information to understand how rock relationships and fossils are used to reconstruct the Earth's past.

a. Use mathematics and computational thinking to calculate the absolute age of rocks using a variety of methods (e.g., radiometric dating, rates of erosion, rates of deposition, and varve count).
b. Construct an argument applying principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) to interpret a geologic cross-section and describe how unconformities form.
c. Analyze and interpret data from rock and fossil succession in a rock sequence to interpret major events in Earth's history such as mass extinction, major climatic change, and tectonic events.
d. Construct an explanation applying the principle of uniformitarianism to show the relationship between sedimentary rocks and their fossils to the environments in which they were formed.
e. Construct an argument using spatial representations of Earth data that interprets major transitions in Earth's history from the fossil and rock record of geologically defined areas. (*Clarification statement:* Students should use maps and cross-sections with a focus on Georgia.)

SES5. Obtain, evaluate, and communicate information to investigate the interaction of solar energy and Earth's systems to produce weather and climate.

a. Develop and use models to explain how latitudinal variations in solar heating create differences in air pressure, global wind patterns, and ocean currents that redistribute heat globally.
b. Analyze and interpret data (e.g., maps, meteograms, and weather apps) that demonstrate how the interaction and movement of air masses creates weather.
c. Construct an argument that predicts weather patterns based on interactions among ocean currents, air masses, and topography.
d. Analyze and interpret data to show how temperature and precipitation produce the pattern of climate regions (zones) on Earth.
e. Construct an explanation that describes the conditions that generate extreme weather events (e.g., hurricanes, tornadoes, and thunderstorms) and the hazards associated with these events.
f. Construct an argument relating changes in global climate to variation to Earth/sun relationships and atmospheric composition.

SES6. Obtain, evaluate, and communicate information about how life on Earth responds to and shapes Earth's systems.

a. Construct an argument from evidence that describes how life has responded to major events in Earth's history (e.g., major climatic change, tectonic events) through extinction, migration, and/or adaptation.
b. Construct an explanation that describes how biological processes have caused major changes in Earth's systems through geologic time (e.g., nutrient cycling, atmospheric composition, and soil formation).
c. Ask questions to investigate and communicate how humans depend on Earth's land and water resources, which are distributed unevenly around the planet as a result of past geological and environmental processes.
d. Analyze and interpret data that relates changes in global climate to natural and anthropogenic modification of Earth's atmosphere and oceans.

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Environmental Science Standards

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The Environmental Science Georgia Standards of Excellence are designed to continue the student investigations that began in grades K-8. These standards integrate the study of many components of our environment, including the human impact on our planet. Students investigate the flow of energy and cycling of matter within ecosystems, and evaluate types, availability, allocation, and sustainability of energy resources. Instruction should focus on student data collection and analysis from field and laboratory experiences. Some concepts are global; in those cases, interpretation of global data sets from scientific sources is strongly recommended. Chemistry, physics, mathematical, and technological concepts should be integrated throughout the course. Whenever possible, careers related to environmental science should be emphasized.

Environmental Science

SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.

a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere.
b. Develop and use a model based on the Laws of Thermodynamics to predict energy transfers throughout an ecosystem (food chains, food webs, and trophic levels).
(*Clarification statement:* The first and second law of thermodynamics should be used to support the model.)
c. Analyze and interpret data to construct an argument of the necessity of biogeochemical cycles (hydrologic, nitrogen, phosphorus, oxygen, and carbon) to support a sustainable ecosystem.
d. Evaluate claims, evidence, and reasoning of the relationship between the physical factors (e.g., insolation, proximity to coastline, topography) and organismal adaptations within terrestrial biomes.
e. Plan and carry out an investigation of how chemical and physical properties impact aquatic biomes in Georgia.
(*Clarification statement:* Consider the diverse aquatic ecosystems across the state such as streams, ponds, coastline, estuaries, and lakes.)

SEV2. Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth's ecosystems.

a. Analyze and interpret data related to short-term and long-term natural cyclic fluctuations associated with climate change.
(*Clarification statement:* Short-term examples include but are not limited to El Niño and volcanism. Long-term examples include but are not limited to variations in Earth's orbit such as Milankovitch cycles.)
b. Analyze and interpret data to determine how changes in atmospheric chemistry (carbon dioxide and methane) impact the greenhouse effect.
c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession.
d. Construct an argument to support a claim about the value of biodiversity in ecosystem resilience including keystone, invasive, native, endemic, indicator, and endangered species.

SEV3. Obtain, evaluate, and communicate information to evaluate types, availability, allocation, and sustainability of energy resources.

a. Analyze and interpret data to communicate information on the origin and consumption of renewable forms of energy (wind, solar, geothermal, biofuel, and tidal) and non-renewable energy sources (fossil fuels and nuclear energy).

b. Construct an argument based on data about the risks and benefits of renewable and nonrenewable energy sources.
(*Clarification statement:* This may include, but is not limited to, the environmental, social, and economic risks and benefits.)
c. Obtain, evaluate, and communicate data to predict the sustainability potential of renewable and non-renewable energy resources.
d. Design and defend a sustainable energy plan based on scientific principles for your location.

SEV4. Obtain, evaluate, and communicate information to analyze human impact on natural resources.

a. Construct and revise a claim based on evidence on the effects of human activities on natural resources.

Human Activities	Natural Resources
Agriculture	Land
Forestry	Water
Ranching	Air
Mining	Organisms
Urbanization	
Fishing	
Water use	
Pollution	
Desalination	
Waste water treatment	

b. Design, evaluate, and refine solutions to reduce human impact on the environment including, but not limited to, smog, ozone depletion, urbanization, and ocean acidification.
c. Construct an argument to evaluate how human population growth affects food demand and food supply (GMOs, monocultures, desertification, Green Revolution).

SEV5. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems.

a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product.
b. Analyze and interpret data on global patterns of population growth (fertility and mortality rates) and demographic transitions in developing and developed countries.
c. Construct an argument from evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems.
d. Design and defend a sustainability plan to reduce your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.

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c. Analyze and interpret data to construct an argument of the necessity of biogeochemical cycles (hydrologic, nitrogen, phosphorus, oxygen, and carbon) to support a sustainable ecosystem.
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Water use	
Pollution	
Desalination	
Waste water treatment	

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SEV5. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems.

a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product.
b. Analyze and interpret data on global patterns of population growth (fertility and mortality rates) and demographic transitions in developing and developed countries.
c. Construct an argument from evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems.
d. Design and defend a sustainability plan to reduce your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.

Science Georgia Standards of Excellence

SCIENCE – Forensic Science

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The Forensic Science Georgia Standards of Excellence are designed to build upon science concepts from previous courses and apply science to the investigation of crime scenes. Students will learn the scientific protocols for analyzing a crime scene, chemical and physical separation methods to isolate and identify materials, how to analyze biological evidence, and the criminal use of tools, including impressions from firearms, tool marks, arson, and explosive evidence.

SCIENCE – Forensic Science

SFS1. Obtain, evaluate, and communicate information to properly conduct a forensic investigation of a crime scene.

a. Construct an explanation of how scientific forensic techniques used in collecting and submitting evidence for admissibility in court have evolved over time.
(*Clarification statement:* Emphasis is on Locard's Exchange Principle, Frye standard, Daubert ruling)
b. Plan and carry out investigations using the scientific protocols for analyzing a crime scene (e.g., search, isolate, collect, and record).
c. Construct an argument from evidence explaining the relevance of possible evidence at the site of an investigation.
d. Develop models to analyze and communicate information obtained from the crime scene.
(*Clarification statement*: Properly document and sketch a crime scene.)

SFS2. Obtain, evaluate, and communicate information on various scientific techniques to analyze physical, trace, and digital evidence.

a. Plan and carryout an investigation to determine the value of physical and trace evidence.
b. Plan and carryout an investigation to analyze the morphology and types of hair, fibers, soil and glass evidence in order to make a physical match examination.
c. Use models for the evaluation of handwriting and document evidence.
d. Analyze and interpret data to evaluate digital sources of evidence.
e. Ask questions to determine the appropriate uses of chromatography and spectroscopy in evidence analysis.
(*Clarification statement:* Addressing spectroscopy at an analytical chemistry level is not required.)

SFS3. Obtain, evaluate, and communicate information relating to biological evidence in forensic investigations.

a. Ask questions to investigate types of toxins, poisons, and drugs and their effects on the body.
b. Analyze and interpret data to investigate the effects of blood alcohol content on the body.
c. Construct an explanation to distinguish the difference between human and animal blood.
d. Plan and carry out an investigation to analyze the physics of bloodstain patterns.
e. Plan and carry out an investigation involving DNA processing and analysis.

SFS4. **Obtain, evaluate, and communicate information to analyze the role of impression evidence in order to make a physical match examination.**

a. Construct an explanation for utilizing the appropriate technique to lift and evaluate identifiable, latent, plastic and patent fingerprints.
(*Clarification statement*: Classifying print and minutiae patterns are addressed in this element. Students should be able to explain why they are using a specific technique.)
b. Analyze and interpret data regarding impression evidence.
(*Clarification statement:* Impression evidence could include ballistics, tool marks, footwear, tire impressions, etc.).
c. Construct an explanation to support the significance of impression evidence in an investigation.

SFS5. Obtain, evaluate, and communicate information to Medicolegal Death Investigations.

a. Ask questions to identify various causes and mechanisms of death (blunt force trauma, heart attack, bleeding, etc.).
b. Construct an argument based on evidence that pertains to the manner of death (natural, homicide, suicide, accidental, or undetermined).
c. Use mathematics and computational thinking to explain post-mortem changes used to determine post-mortem interval (PMI):
    - Rigor mortis
    - Livor mortis
    - Algor mortis
    - Gastric contents

    (*Clarification statement:* Instruction should include the historical use of Algor Mortis as it is often not used by practicing forensic specialists.)
d. Analyze and interpret entomological data to evaluate the role insects play in decomposition and determining PMI.
e. Plan and carry out an investigation to analyze height, sex, age, and race to develop an anthropological profile of the victim and potential perpetrator.

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Science Georgia Standards of Excellence

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The geology course is designed to lead the student toward a successful understanding of introductory geologic science. The goal of this course is to provide students with a basic understanding of geology, geologic processes, and how geology impacts our society. The curriculum investigates the Earth's formation, Earth materials and processes, available and important resources, changing landscapes and climate, catastrophic events, and society's attempt to deal with our ever-changing world. Students can make real-world connections by examining our role in the solar system, man's effect upon our mineral and rock resources, seismic events, landforms and how a changing climate has the ability to alter life as we know it, thus applying their knowledge to these real-world situations.

SCIENCE - Geology

SG1. Obtain, evaluate, and communicate information to understand the formation of Earth and the evolution of its component systems.

a. Construct an explanation based on evidence for the formation of the Earth.
(*Clarification statement*: The mechanisms of accretion and differentiation should be addressed here. Include an understanding of Earth's elemental composition, the Nebular Theory and the Iron Catastrophe Theory.)

b. Develop a model of the Earth's internal structures including both physical (i.e., lithosphere, asthenosphere, mesosphere, outer core and inner core) and chemical (crust, mantle, core) layers.
(*Clarification statement:* Include how data, computer technology, and computational thinking are used to determine thicknesses and chemical composition of the layers.)

c. Construct an explanation based on evidence for the origin and evolution of Earth's hydrosphere and atmosphere.
(*Clarification statement:* Include the ideas of outgassing, photochemical dissociation, photosynthesis and comet delivery.)

SG2. Obtain, evaluate, and communicate information about the geologic conditions and processes that form different rocks and minerals through the rock cycle.

a. Plan and carry out investigations to explore how chemical variation and geological processes result in the formation of different rock forming minerals.
(*Clarification statement:* This could include the formation of quartz, K-feldspar, plagioclase, muscovite, biotite, amphibole, pyroxene, olivine, kaolinite, calcite, halite, gypsum, chlorite, garnet and staurolite.)

b. Develop and use models to demonstrate the processes that form plutonic (intrusive) and volcanic (extrusive) igneous rocks of differing compositions, and textures.

c. Ask questions to differentiate between processes that form various types of sedimentary rocks (i.e., weathering, erosion, deposition, burial, compaction and cementation).

d. Construct an explanation for how igneous and sedimentary rocks transform to different types of metamorphic rocks.
(*Clarification statement:* Explain how different conditions of metamorphism and starting (parent) rock compositions determine metamorphic rock type.)

SG3. Obtain, evaluate, and communicate information to explore geologic time.

a. Analyze data to interpret sequences of events in Earth's history.
(*Clarification statement:* Include relative vs. absolute dating techniques, principles of stratigraphy (e.g. Superposition and cross-cutting relationships), radiometric dating, and the fossil record.*)*

b. Construct an argument based on evidence about how catastrophic and long-term events have impacted the evolution of life on Earth, including mass extinctions (e.g., asteroid/comet impact, plate tectonics and climate change).

c. Obtain, evaluate, and communicate information that documents important tectonic events and sea level/climatic changes in Georgia over geologic time.
(*Clarification statement:* Include a description and origin of the Valley and Ridge, Piedmont, Blue Ridge Mountains, and the Coastal Plain physiographic provinces.)

SG4. Obtain, evaluate, and communicate information about the evidence for plate tectonics; investigate the roles of Earth's internal processes as a mechanism of plate motion; and assess the relationship between plate tectonic boundary type and geologic hazards.

a. Construct an explanation based on evidence that describes the mechanisms causing tectonic plate movement, the different types of plate boundaries, and how boundary type relates to mountain building, earthquakes, volcanism, and features such as volcanic arcs, hot spots, and mid ocean ridges.
(*Clarification statement:* Include the role of radioactive decay as a source of heat energy driving the process of convection, as well as the physical processes of slab pull and ridge push.)

b. Construct an explanation based on evidence that describes the mechanisms that create melt in the lithosphere in relationship to plate tectonics.
(*Clarification statement:* The role of pressure release, added heat, and added water content should be studied relative to the plate tectonic locations where this melting occurs.)

c. Use models to predict and differentiate between the various types of folds and faults.
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d. Use models to communicate the differences between folded, fault-block, dome, plateau**,** and volcanic mountains to investigate their relationship to tectonic setting.

e. Analyze and interpret data to classify volcanoes using their interior/exterior features, magma composition, lithology, and plate tectonic setting

f. Analyze and interpret seismic data and assess risk of volcanic eruptions and earthquakes in Georgia and other areas in the United States.
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SG5. Obtain, evaluate, and communicate information to explain the effects of Earth's surface processes.

a. Ask questions to understand the effects of regional climate on weathering processes and soil formation.

b. Construct an argument from evidence to explain how sedimentary rock formation and chemical weathering changes greenhouse gas concentrations in Earth's atmosphere.

c. Obtain, evaluate, and communicate information to characterize the formation of landforms in desert and glacial environments.
(*Clarification statement:* Information sources should include, geologic maps, topographic maps, cross-sectional maps, and remote sensing data.)

d. Develop and use models to examine the erosional and depositional features of various coastal systems.

e. Plan and carry out an investigation to analyze how surface water and groundwater act as major agents of change in fluvial systems.
(*Clarification statement*: Include surface reservoirs, groundwater reservoirs, and fluvial systems, as well as the processes of infiltration, runoff, evaporation, and precipitation.)

SG6. Obtain, evaluate, and communicate information to investigate the distribution, extraction, and use of resources on the Earth and other bodies in the Solar System.

a. Ask questions to investigate the origin, distribution, and economic importance of geologic resources, including those mined in Georgia.
(*Clarification statement:* Include kaolin, marble, gold, dimension stone and crushed stone aggregate, sand and gravel as major parts of the state economy.)

b. Construct an argument from evidence to support a claim about the impact of extraction and use of geological resources in the environment and human life.
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c. Analyze and interpret data to predict and develop evidence for the occurrence and distribution of geologic resources on the Moon, other planets, and extraterrestrial bodies (asteroids, meteors, and comets).

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Science Georgia Standards of Excellence

SCIENCE - Human Anatomy & Physiology

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Human anatomy and physiology is designed to continue student investigations that began in grades K-8 and high school biology. This curriculum is extensively performance and laboratory based. It integrates the study of the structures and functions of the human body, however rather than focusing on distinct anatomical and physiological systems (respiratory, nervous, etc.) instruction should focus on the essential requirements for life. Areas of study include organization of the body; protection, support and movement; providing internal coordination and regulation; processing and transporting; and reproduction, growth and development. Whenever possible, careers related to medicine, research, healthcare and modern medical technology should be emphasized throughout the curriculum. Case studies concerning diseases, disorders and ailments (i.e. real-life applications) should be emphasized.

SCIENCE - Human Anatomy & Physiology

SAP1. Obtain, evaluate, and communicate information to analyze anatomical structures of the human body.

a. Develop and use models to demonstrate the orientation of structures and regions of the human body.

b. Construct an explanation about the relationship between a body structure (i.e., cells, tissues, organs, and organ systems) and its function within the human body.

SAP2. Obtain, evaluate, and communicate information to analyze the structure and function of the integumentary, skeletal, and muscular systems.

a. Construct an explanation about the relationship between the structures of the integumentary system and their role in protection, eliminating waste products, and regulating body temperature.

b. Develop and use models to relate the structure of the skeletal system to its functional role in movement, protection, and support.

c. Develop and use models to determine the relationship between structures of the muscular system and their role in movement and support.

d. Ask questions about how the interdependence of the integumentary, skeletal, and muscular systems makes support, protection, and movement possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP3. Obtain, evaluate, and communicate information to explain the coordination of information processing in the endocrine and nervous systems.

a. Ask questions to investigate how the structures of the nervous system support the function of information processing (detection, interpretation, and response).

b. Analyze and interpret data to explain how the hormones of the endocrine system regulate physical and chemical processes to maintain a stable internal environment.
(*Clarification statement:* This should include positive and negative feedback mechanisms, e.g. heart rate, blood sugar, childbirth, temperature, growth, etc.)

c. Ask questions about how the interdependence of the endocrine and nervous systems makes information processing (detection, interpretation and response) possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP4. Obtain, evaluate, and communicate information to analyze the processing of matter and energy in the cardiovascular, respiratory, digestive and urinary systems.

a. Plan and carry out an investigation to explore the structures and role of the cardiovascular and respiratory systems in obtaining oxygen, transporting nutrients, and removing waste.
b. Develop and use models to explain the relationship between the structure and function of the digestive and urinary systems as they utilize matter to derive energy and eliminate waste.
c. Ask questions about the interdependence of the cardiovascular, respiratory, urinary and digestive systems.
(*Clarification statement:* Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP5. Obtain, evaluate, and communicate information to analyze the role of the reproductive system as it pertains to the growth and development of humans.

a. Ask questions to gather and communicate information about how the structures of the reproductive system allow for production of egg and sperm, fertilization, and the development of offspring.
(*Clarification statement:* Regulation of the functions by hormones should be addressed in this standard.)
b. Develop and use models to describe the stages of human embryology and gestation.
c. Ask questions about how the reproductive system makes growth and development possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

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SAP2. Obtain, evaluate, and communicate information to analyze the structure and function of the integumentary, skeletal, and muscular systems.

a. Construct an explanation about the relationship between the structures of the integumentary system and their role in protection, eliminating waste products, and regulating body temperature.

b. Develop and use models to relate the structure of the skeletal system to its functional role in movement, protection, and support.

c. Develop and use models to determine the relationship between structures of the muscular system and their role in movement and support.

d. Ask questions about how the interdependence of the integumentary, skeletal, and muscular systems makes support, protection, and movement possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP3. Obtain, evaluate, and communicate information to explain the coordination of information processing in the endocrine and nervous systems.

a. Ask questions to investigate how the structures of the nervous system support the function of information processing (detection, interpretation, and response).

b. Analyze and interpret data to explain how the hormones of the endocrine system regulate physical and chemical processes to maintain a stable internal environment.
(*Clarification statement:* This should include positive and negative feedback mechanisms, e.g. heart rate, blood sugar, childbirth, temperature, growth, etc.)

c. Ask questions about how the interdependence of the endocrine and nervous systems makes information processing (detection, interpretation and response) possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP4. Obtain, evaluate, and communicate information to analyze the processing of matter and energy in the cardiovascular, respiratory, digestive and urinary systems.

a. Plan and carry out an investigation to explore the structures and role of the cardiovascular and respiratory systems in obtaining oxygen, transporting nutrients, and removing waste.
b. Develop and use models to explain the relationship between the structure and function of the digestive and urinary systems as they utilize matter to derive energy and eliminate waste.
c. Ask questions about the interdependence of the cardiovascular, respiratory, urinary and digestive systems.
(*Clarification statement:* Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

SAP5. Obtain, evaluate, and communicate information to analyze the role of the reproductive system as it pertains to the growth and development of humans.

a. Ask questions to gather and communicate information about how the structures of the reproductive system allow for production of egg and sperm, fertilization, and the development of offspring.
(*Clarification statement:* Regulation of the functions by hormones should be addressed in this standard.)
b. Develop and use models to describe the stages of human embryology and gestation.
c. Ask questions about how the reproductive system makes growth and development possible.
(*Clarification statement*: Questions should address the homeostatic mechanisms, as well as the effects of and responses to aging, diseases, and disorders).

Kindergarten Standards

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The Kindergarten Georgia Standards of Excellence for science engage students in raising questions about the world around them. Though not developmentally ready for in-depth explanations, kindergarten students wonder why things move and note the various patterns in their movement (e.g., the sun and the moon appear and disappear in the sky). Students learn to use whole numbers to describe scientific data and how to identify parts of things (i.e. tools and toys). Kindergarteners use their senses (sight, smell, taste, touch, and sound) to group objects and to make observations about the physical world by describing, comparing, and sorting items according to physical attributes (i.e. number, shape, texture, size, weight, color, and motion). They learn to follow rules to stay safe.

Earth and Space Science

SKE1. Obtain, evaluate, and communicate observations about time patterns (day to night and night to day) and objects (sun, moon, stars) in the day and night sky.

a. Ask questions to classify objects according to those seen in the day sky, the night sky, and both.
b. Develop a model to communicate the changes that occur in the sky during the day, as day turns into night, during the night, and as night turns into day using pictures and words. (*Clarification statement:* Students are not expected to understand tilt of the Earth, rotation, or revolution.)

SKE2. Obtain, evaluate, and communicate information to describe the physical attributes of earth materials (soil, rocks, water, and air).

a. Ask questions to identify and describe earth materials—soil, rocks, water, and air.
b. Construct an argument supported by evidence for how rocks can be grouped by physical attributes (size, weight, texture, color).
c. Use tools to observe and record physical attributes of soil such as texture and color.

Physical Science

SKP1. Obtain, evaluate, and communicate information to describe objects in terms of the materials they are made of and their physical attributes.

a. Ask questions to compare and sort objects made of different materials. (Common materials include clay, cloth, plastic, wood, paper, and metal.)
b. Use senses and science tools to classify common objects, such as buttons or swatches of cloth, according to their physical attributes (color, size, shape, weight, and texture).
c. Plan and carry out an investigation to predict and observe whether objects, based on their physical attributes, will sink or float.

SKP2. Obtain, evaluate, and communicate information to compare and describe different types of motion.

a. Plan and carry out an investigation to determine the relationship between an object's physical attributes and its resulting motion (straight, circular, back and forth, fast and slow, and motionless) when a force is applied. (Examples could include toss, drop, push, and pull.)
b. Construct an argument as to the best way to move an object based on its physical attributes.

Life Science

SKL1. Obtain, evaluate, and communicate information about how organisms (alive and not alive) and non-living objects are grouped.

a. Construct an explanation based on observations to recognize the differences between organisms and nonliving objects.
b. Develop a model to represent how a set of organisms and nonliving objects are sorted into groups based on their attributes.

SKL2. Obtain, evaluate, and communicate information to compare the similarities and differences in groups of organisms.

a. Construct an argument supported by evidence for how animals can be grouped according to their features.
b. Construct an argument supported by evidence for how plants can be grouped according to their features.
c. Ask questions and make observations to identify the similarities and differences of offspring to their parents and to other members of the same species.

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Science Georgia Standards of Excellence

SCIENCE - Meteorology

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The meteorology course is designed to build on the foundation laid by the Earth systems and Earth science courses. Students will learn that Earth is a dynamic system and Earth's atmosphere is a result of processes that took millions of years. The learner then takes this knowledge of the composition and characteristics of Earth's atmosphere and transfers it to delve into the factors that can cause short term and long term changes in Earth's atmospheric conditions. Students will learn that the Earth is an interacting system of both energy and matter. To understand the interaction, students must build on prior knowledge of matter and the factors the affect its behavior. In addition, throughout this course students will use science inquiry skills, manipulation of appropriate lab equipment and demonstration of appropriate safety practices.

SCIENCE - Meteorology

SM1. Obtain, evaluate, and communicate information about the structure and composition of Earth's atmosphere and the processes that cause weather.

a. Construct an explanation for how atmospheric properties (i.e., temperature, density, chemical composition, pressure and moisture) influence its structure.
b. Develop a model that explains seasonal variations in insolation including length of daylight hours, angle of midday sun, and Earth's axial tilt.
c. Plan and carry out an investigation to explain how albedo and specific heat (land versus water surfaces) create differences in surface heating.

SM2. Obtain, evaluate, and communicate information about energy transfer and its role in precipitation, cloud formation, and air mass formation.

a. Ask questions to compare and contrast the relationships between air masses, source regions, fronts, and the changes associated with frontal passage (e.g., air density, temperature, dew point, wind direction, cloud types, precipitation.)
b. Ask questions to identify major types of clouds and weather associated with each type. (*Clarification statement:* Cloud types should go beyond cirrus, stratus, and cumulus and may also include cirrostratus, altocumulus, cumulonimbus, etc.)
c. Construct an explanation of how clouds and different types of precipitation develop. (*Clarification statement*: The convective loop processes should be addressed here.)
d. Develop and use models to construct an explanation of the role that pressure differences have on energy transfer and the development of wind systems (e.g., sea breeze, land breeze, Hadley cells, Ferrel cells, prevailing winds, jet stream, ENSO, global scale winds). (*Clarification statement:* Inclusion of the Coriolis effect is appropriate at the global scale).

SM3. Obtain, evaluate, and communicate information about the science of weather forecasting.

a. Analyze and interpret data to create a surface map that includes, but is not limited to, high- and low-pressure systems, isobars, wind barbs, and fronts.
b. Construct an argument supported by evidence for the type of weather expected for a specific location using weather maps and knowledge of the movement of air masses, fronts, and weather systems.
c. Ask questions to develop predictions about the formation of meteorological events including severe thunderstorms, hurricanes, tornadoes, floods, droughts, and winter storms.
d. Ask questions to investigate and communicate the role of technology and public awareness on weather forecasting (e.g., NOAA/NWS observation data network, instrumentation, satellites, radar, weather balloons, models, watch/warning criteria).
e. Construct an argument supported by observations to verify the forecast contained in a weather briefing for a specific location.

SM4. Obtain, evaluate, and communicate information about the relationship between weather and society.

a. Obtain and communicate information to relate the personal, local, national, and global implications of severe weather events.
b. Ask questions to identify the relationships between weather and society (e.g., urban heat island, smog formation, air quality, stratospheric ozone).
c. Obtain, evaluate, and communicate information about the potential individual and societal impacts of changing weather and climate conditions.
(*Clarification statement*: Impacts such as economic, social, health (physical and emotional), political, ecological, etc. should be addressed.)
d. Design and defend a safety plan based on common weather events for your geographic location.
(*Clarification statement:* Safety plans should address hazardous weather alerts and include protocols for a variety of weather events.)

SM5. Obtain, evaluate, and communicate information about climate and climate change.

a. Analyze and interpret data to construct explanations for various global climate types based upon climatic characteristics such as latitudinal variations in insolation, distribution of land and water, prevailing winds, average temperature and precipitation, atmospheric circulation, physical geography, altitude, and ocean currents.
b. Ask questions and communicate information about factors impacting global climate change (e.g., Milankovitch and ENSO cycles, greenhouse gases, changes in physical geography).
c. Construct an argument from evidence about the potential implications of global climate change on weather.

Science Georgia Standards of Excellence

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Science Georgia Standards of Excellence

SCIENCE - Microbiology

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The microbiology course is designed to continue student investigations that began in grades K-8 and high school biology and chemistry. This curriculum is extensively performance and laboratory based. It integrates the study of microbial physiology, ecology, and genetics with instruction focusing on the impact microorganisms have on health, agriculture, biotechnology and the environment. Careers related to medicine, healthcare, research, food science and biotechnology should be emphasized throughout the course. Real-life applications should be emphasized through case studies concerning diseases; epidemiology; food preparation and safety; and use of microbes in industry, agriculture, biotechnology and the environment.

SCIENCE - Microbiology

SMI1. Obtain, evaluate, and communicate information regarding the historical progression of the core ideas of microbiology.

a. Obtain, evaluate, and communicate information relating the importance of microscopy to the origins of microbiology.
b. Ask questions to obtain information regarding the use of Koch's postulates to identify pathogens and other microorganisms.
(*Clarification statement*: Address the premise of Koch's work and include why Koch's Postulates do not apply to all pathogens.)
c. Construct explanations to illustrate how advances in technological developments have driven major innovations in microbiology (e.g. biotechnology, microbial ecology, medical microbiology, etc.)

SMI2. Obtain, evaluate, and communicate information to differentiate among types of microorganisms based on defining characteristics.

a. Develop and use models to distinguish between different kinds of microorganisms (Prokaryotes and Eukaryotes) based on cellular structure (including but not limited to, cell wall, cell membrane, organelles, cilia, and flagella), molecular biology (plasmids, DNA, RNA and proteins), and biochemical composition (lipids, proteins, and carbohydrates).
b. Construct explanations of how viruses differ from other cellular parasites.
c. Construct explanations for the relative sizes and different types of cell shapes of microorganisms.
d. Plan and carry out investigations to explore various methods used to visualize microorganisms.

SMI3. Obtain, evaluate, and communicate information to examine the structural components of prokaryotic and eukaryotic microorganisms and their functions.

a. Use models to investigate and compare structural properties of prokaryotic and eukaryotic membranes and the functions associated with these membranes.
b. Construct an argument based on evidence on how prokaryotic cell walls differ from eukaryotic cell walls, and how these differences contribute to their function.
c. Develop and use models to demonstrate how internal organization differs between prokaryotes and eukaryotes and explain the functions of internal structures.
d. Construct an explanation of the endosymbiotic theory and its evolutionary relevance.

SMI4. Obtain, evaluate, and communicate information on how microorganisms generate energy for cellular functions.

a. Construct an explanation of how microorganisms use photosynthesis, cellular respiration, and/or chemosynthesis to generate energy as ATP to drive cell function.

SMI5. Obtain, evaluate, and communicate information regarding the molecular mechanisms underlying DNA replication, gene expression (transcription and translation), and genetic variation, in microbes.

a. Develop and use models to investigate and compare the molecular mechanisms involved in DNA replication in prokaryotes and eukaryotes.
b. Develop and use models to demonstrate the molecular basis of gene expression (transcription) in microbes.
c. Construct explanations on how genetic variations in microbes arise due to mutations and gene transfer (via transformation, transduction, and/or conjugation) and how these genetic variations affect survival and functioning of prokaryotes.
d. Obtain, evaluate, and communicate information to compare and contrast sexual and asexual reproduction of eukaryotes, asexual reproduction of prokaryotes, and replication of viruses.
e. Construct an explanation of how genetic variation can lead to microbial evolution and ultimately how this information impacts modern biotechnological applications.

SMI6. Obtain, evaluate, and communicate information to determine parameters affecting prokaryotic microbial growth, ways of controlling microbial growth and how microorganisms respond to control mechanisms.

a. Use mathematics and computational thinking to predict and model the growth phases of microbial populations and the factors that influence these phases.
b. Construct an argument based on evidence on how nutritional requirements and environmental factors can influence microbial growth.
c. Analyze and interpret data to compare various physical and chemical methods used to control microbial growth.
   (*Clarification statement:* "Control" should include increasing, decreasing, and/or preventing the growth of microorganisms.)
d. Construct an argument using multiple forms of evidence regarding the modes of actions of antimicrobials (antibiotics, antifungals, and other pharmaceuticals) in preventing the growth of microorganisms.
e. Ask questions and define problems related to how the use of antimicrobials influences the evolution of resistant pathogens via genetic changes in the population (e.g., the evolution of multi-drug resistant bacteria, treatment resistant HIV, or viral recombination).

SMI7. Obtain, evaluate, and communicate information to analyze the impact of microorganisms in the environment and their uses in biotechnology, agriculture, and industry.

a. Construct an explanation for the prevalence and diversity of microorganisms in various environments.
b. Ask questions to investigate the roles of microorganisms in global nutrient cycling and primary production in soil, fresh water, and marine ecosystems.
c. Analyze and interpret data to determine the impact of microorganisms on water and soil quality.
d. Construct an argument from evidence to justify the use of microorganisms in industry, agriculture, and biotechnology.
    - Relate the use of microbes to their rapid growth, ease of genetic manipulation, and accessibility.
    - Consider bioethical implications of using genetically modified organisms (GMOs) in biotechnology.

SMI8. Obtain, evaluate, and communicate information to examine relationships among microbes and other organisms.

a. Construct an argument to support the variety of relationships (symbiotic and pathogenic) between humans and microbes.
b. Construct an argument to support the mutualistic relationship between microbes and other organisms (plants, animals & fungi).
c. Ask questions to gather and communicate information about how pathogenic microbes cause disease in humans and other organisms.
d. Obtain, evaluate, and communicate information to demonstrate how higher organisms defend against pathogenic microbes.

First Grade Standards

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The First Grade Georgia Standards of Excellence for science engage students in raising questions about the world around them and seeking answers by making observations. First graders use whole numbers to analyze scientific data. They identify how magnets pull on all things made of iron and either attract or repel other magnets. First graders create drawings that correctly depict something being described. The students are asked to plan and carry out simple investigations to understand patterns (shadows, sound, weather, and daily needs of plants and animals) observed in the world around them and make predictions based on these investigations. They follow safety rules.

Earth and Space Science

S1E1. Obtain, evaluate, and communicate weather data to identify weather patterns.

a. Represent data in tables and/or graphs to identify and describe different types of weather and the characteristics of each type.
b. Ask questions to identify forms of precipitation such as rain, snow, sleet, and hailstones as either solid (ice) or liquid (water).
c. Plan and carry out investigations on current weather conditions by observing, measuring with simple weather instruments (thermometer, wind vane, rain gauge), and recording weather data (temperature, precipitation, sky conditions, and weather events) in a periodic journal, on a calendar, and graphically.
d. Analyze data to identify seasonal patterns of change.
(*Clarification statement:* Examples could include temperature, rainfall/snowfall, and changes to the environment.)

Physical Science

S1P1. Obtain, evaluate, and communicate information to investigate light and sound.

a. Use observations to construct an explanation of how light is required to make objects visible.
b. Ask questions to identify and compare sources of light.
c. Plan and carry out an investigation of shadows by placing objects at various points from a source of light.
d. Construct an explanation supported by evidence that vibrating materials can make sound and that sound can make materials vibrate.
e. Design a signal that can serve as an emergency alert using light and/or sound to communicate over a distance.

S1P2. Obtain, evaluate, and communicate information to demonstrate the effects of magnets on other magnets and other objects.

a. Construct an explanation of how magnets are used in everyday life.
(*Clarification statement:* Everyday life uses could include refrigerator magnets, toys, magnetic latches, and name tags.)
b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other and the effect of magnets on common objects.

Life Science

S1L1. Obtain, evaluate, and communicate information about the basic needs of plants and animals.

a. Develop models to identify the parts of a plant—root, stem, leaf, and flower.
b. Ask questions to compare and contrast the basic needs of plants (air, water, light, and nutrients) and animals (air, water, food, and shelter).
c. Design a solution to ensure that a plant or animal has all of its needs met.

Second Grade Standards

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The Second Grade Georgia Standards of Excellence for science engage students in raising questions and seeking answers about the world around them by making observations and exploring phenomena. At the appropriate times, students will ask, "How do you know?" and will attempt to answer the question. They will use whole numbers as well as basic fractions (such as one-half and one-fourth) to identify and analyze scientific data. Second graders will find sums and differences of single digit numbers and then justify the answer. They will give rough estimates to problems and estimate lengths, weights, and time intervals. They will explain to others how to solve numerical problems related to a science activity.

Second grade students push, pull, and manipulate things to see what will happen. They study the changing patterns of the moon and the sun and its effects on Earth. Second graders conduct simple investigations to understand that no matter how parts of an object are assembled their overall weight is the same as the total weight of the parts. They understand that heating and cooling cause changes in the properties of the materials. They observe changes caused by weather, plants, animals, and humans to the environment and study the life cycle of different organisms.

Earth and Space Science

S2E1. Obtain, evaluate, and communicate information about stars having different sizes and brightness.

a. Ask questions to describe the physical attributes (size and brightness) of stars.
b. Construct an argument to support the claim that although the sun appears to be the brightest and largest star, it is actually medium in size and brightness.

S2E2. Obtain, evaluate, and communicate information to develop an understanding of the patterns of the sun and the moon and the sun's effect on Earth.

a. Plan and carry out an investigation to determine the effect of the position of the sun in relation to a fixed object on Earth at various times of the day.
b. Design and build a structure that demonstrates how shadows change throughout the day.
c. Represent data in tables and/or graphs of the length of the day and night to recognize the change in seasons.
d. Use data from personal observations to describe, illustrate, and predict how the appearance of the moon changes over time in a pattern.
(*Clarification statement:* Students are not required to know the names of the phases of the moon or understand the tilt of the Earth.)

S2E3. Obtain, evaluate, and communicate information about how weather, plants, animals, and humans cause changes to the environment.

(*Clarification statement:* Changes should be easily observable and could be seen on school grounds or at home.)

a. Ask questions to obtain information about major changes to the environment in your community.
b. Construct an explanation of the causes and effects of a change to the environment in your community.

Physical Science

S2P1. Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects.

a. Ask questions to describe and classify different objects according to their physical properties. (*Clarification statement:* Examples of physical properties could include color, mass, length, texture, hardness, strength, absorbency, and flexibility.)
b. Construct an explanation for how structures made from small pieces (linking cubes, building blocks) can be disassembled and then rearranged to make new and different structures.
c. Provide evidence from observations to construct an explanation that some changes in matter caused by heating or cooling can be reversed and some changes are irreversible.
(*Clarification statement:* Changes in matter could include heating or freezing of water, baking a cake, boiling an egg.)

S2P2. Obtain, evaluate, and communicate information to explain the effect of a force (a push or a pull) in the movement of an object (changes in speed and direction).

a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object.
b. Design a device to change the speed or direction of an object.
c. Record and analyze data to decide if a design solution works as intended to change the speed or direction of an object with a force (a push or a pull).

Life Science

S2L1. Obtain, evaluate, and communicate information about the life cycles of different living organisms.

a. Ask questions to determine the sequence of the life cycle of common animals in your area: a mammal such as a cat, dog or classroom pet, a bird such as a chicken, an amphibian such as a frog, and an insect such as a butterfly.
b. Plan and carry out an investigation of the life cycle of a plant by growing a plant from a seed and by recording changes over a period of time.
c. Construct an explanation of an animal's role in dispersing seeds or in the pollination of plants.
d. Develop models to illustrate the unique and diverse life cycles of organisms other than humans.

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Earth and Space Science

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a. Ask questions to describe the physical attributes (size and brightness) of stars.
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S2E2. Obtain, evaluate, and communicate information to develop an understanding of the patterns of the sun and the moon and the sun's effect on Earth.

a. Plan and carry out an investigation to determine the effect of the position of the sun in relation to a fixed object on Earth at various times of the day.
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c. Represent data in tables and/or graphs of the length of the day and night to recognize the change in seasons.
d. Use data from personal observations to describe, illustrate, and predict how the appearance of the moon changes over time in a pattern.
(*Clarification statement:* Students are not required to know the names of the phases of the moon or understand the tilt of the Earth.)

S2E3. Obtain, evaluate, and communicate information about how weather, plants, animals, and humans cause changes to the environment.

(*Clarification statement:* Changes should be easily observable and could be seen on school grounds or at home.)

a. Ask questions to obtain information about major changes to the environment in your community.
b. Construct an explanation of the causes and effects of a change to the environment in your community.

Physical Science

S2P1. Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects.

a. Ask questions to describe and classify different objects according to their physical properties. (*Clarification statement:* Examples of physical properties could include color, mass, length, texture, hardness, strength, absorbency, and flexibility.)
b. Construct an explanation for how structures made from small pieces (linking cubes, building blocks) can be disassembled and then rearranged to make new and different structures.
c. Provide evidence from observations to construct an explanation that some changes in matter caused by heating or cooling can be reversed and some changes are irreversible.
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S2P2. Obtain, evaluate, and communicate information to explain the effect of a force (a push or a pull) in the movement of an object (changes in speed and direction).

a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object.
b. Design a device to change the speed or direction of an object.
c. Record and analyze data to decide if a design solution works as intended to change the speed or direction of an object with a force (a push or a pull).

Life Science

S2L1. Obtain, evaluate, and communicate information about the life cycles of different living organisms.

a. Ask questions to determine the sequence of the life cycle of common animals in your area: a mammal such as a cat, dog or classroom pet, a bird such as a chicken, an amphibian such as a frog, and an insect such as a butterfly.
b. Plan and carry out an investigation of the life cycle of a plant by growing a plant from a seed and by recording changes over a period of time.
c. Construct an explanation of an animal's role in dispersing seeds or in the pollination of plants.
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Third Grade Standards

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The Third Grade Georgia Standards of Excellence for science engage students in making observations and using information they obtained to answer questions. Their communication skills allow them to record findings, analyze data, and recognize the importance of keeping records of observations without making alterations. Third graders add and subtract whole numbers mentally, on paper, and with a calculator. They observe, construct, and measure objects using ordinary hand tools. They observe things with many parts and describe the ways in which the parts influence or interact with one another. They represent objects in the real world with geometric figures, number sequences, graphs, diagrams, maps, and stories. The students will use this information to explain physical attributes of rocks and soils, understand how fossils provide evidence of organisms that lived long ago, describe ways in which heat energy is transferred and measured, identify features of plants and animals within the geographical regions of Georgia, and recognize the effects of pollution on the environment.

Earth and Space Science

S3E1. Obtain, evaluate, and communicate information about the physical attributes of rocks and soils.

a. Ask questions and analyze data to classify rocks by their physical attributes (color, texture, luster, and hardness) using simple tests.
(*Clarification statement*: Mohs scale should be studied at this level. Cleavage, streak and the classification of rocks as sedimentary, igneous, and metamorphic are studied in sixth grade.)
b. Plan and carry out investigations to describe properties (color, texture, capacity to retain water, and ability to support growth of plants) of soils and soil types (sand, clay, loam).
c. Make observations of the local environment to construct an explanation of how water and/or wind have made changes to soil and/or rocks over time.
(*Clarification statement:* Examples could include ripples in dirt on a playground and a hole formed under gutters.)

S3E2. Obtain, evaluate, and communicate information on how fossils provide evidence of past organisms.

a. Construct an argument from observations of fossils (authentic or reproductions) to communicate how they serve as evidence of past organisms and the environments in which they lived.
b. Develop a model to describe the sequence and conditions required for an organism to become fossilized.
(*Clarification statement:* Types of fossils (cast, mold, trace, and true) are not addressed in this standard.)

Physical Science

S3P1. Obtain, evaluate, and communicate information about the ways heat energy is transferred and measured.

a. Ask questions to identify sources of heat energy.
(*Clarification statement:* Examples could include sunlight, friction, and burning.)
b. Plan and carry out an investigation to gather data using thermometers to produce tables and charts that illustrate the effect of sunlight on various objects.
(*Clarification statement:* The use of both Fahrenheit and Celsius temperature scales is expected.)
c. Use tools and every day materials to design and construct a device/structure that will increase/decrease the warming effects of sunlight on various materials.
(*Clarification statement:* Conduction, convection, and radiation are taught in upper grades.)

Life Science

S3L1. Obtain, evaluate, and communicate information about the similarities and differences between plants, animals, and habitats found within geographic regions (Blue Ridge Mountains, Piedmont, Coastal Plains, Valley and Ridge, and Appalachian Plateau) of Georgia.

a. Ask questions to differentiate between plants, animals, and habitats found within Georgia's geographic regions.
b. Construct an explanation of how external features and adaptations (camouflage, hibernation, migration, mimicry) of animals allow them to survive in their habitat.
c. Use evidence to construct an explanation of why some organisms can thrive in one habitat and not in another.

S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.

a. Ask questions to collect information and create records of sources and effects of pollution on the plants and animals.
b. Explore, research, and communicate solutions, such as conservation of resources and recycling of materials, to protect plants and animals.

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The Science Georgia Standards of Excellence are designed to provide foundational knowledge and skills for all students to develop proficiency in science. The Project 2061's *Benchmarks for Science Literacy* and the follow up work, *A Framework for K-12 Science Education* were used as the core of the standards to determine appropriate content and process skills for students. The Science Georgia Standards of Excellence focus on a limited number of core disciplinary ideas and crosscutting concepts which build from Kindergarten to high school. The standards are written with the core knowledge to be mastered integrated with the science and engineering practices needed to engage in scientific inquiry and engineering design. Crosscutting concepts are used to make connections across different science disciplines.

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S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.

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Fourth Grade Standards

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Earth and Space Science

S4E1. Obtain, evaluate, and communicate information to compare and contrast the physical attributes of stars and planets.

a. Ask questions to compare and contrast technological advances that have changed the amount and type of information on distant objects in the sky.
b. Construct an argument on why some stars (including the Earth's sun) appear to be larger or brighter than others.
(*Clarification statement:* Differences are limited to distance and size, not age or stage of evolution.)
c. Construct an explanation of the differences between stars and planets.
d. Evaluate strengths and limitations of models of our solar system in describing relative size, order, appearance and composition of planets and the sun.
(*Clarification statement:* Composition of planets is limited to rocky vs. gaseous.)

S4E2. Obtain, evaluate, and communicate information to model the effects of the position and motion of the Earth and the moon in relation to the sun as observed from the Earth.

a. Develop a model to support an explanation of why the length of day and night change throughout the year.
b. Develop a model based on observations to describe the repeating pattern of the phases of the moon (new, crescent, quarter, gibbous, and full).
c. Construct an explanation of how the Earth's orbit, with its consistent tilt, affects seasonal changes.

S4E3. Obtain, evaluate, and communicate information to demonstrate the water cycle.

a. Plan and carry out investigations to observe the flow of energy in water as it changes states from solid (ice) to liquid (water) to gas (water vapor) and changes from gas to liquid to solid.
b. Develop models to illustrate multiple pathways water may take during the water cycle (evaporation, condensation, and precipitation).
(*Clarification statement:* Students should understand that the water cycle does not follow a single pathway.)

S4E4. Obtain, evaluate, and communicate information to predict weather events and infer weather patterns using weather charts/maps and collected weather data.

a. Construct an explanation of how weather instruments (thermometer, rain gauge, barometer, wind vane, and anemometer) are used in gathering weather data and making forecasts.
b. Interpret data from weather maps, including fronts (warm, cold, and stationary), temperature, pressure, and precipitation to make an informed prediction about tomorrow's weather.
c. Ask questions and use observations of cloud types (cirrus, stratus, and cumulus) and data of weather conditions to predict weather events.
d. Construct an explanation based on research to communicate the difference between weather and climate.

Physical Science

S4P1. Obtain, evaluate, and communicate information about the nature of light and how light interacts with objects.

a. Plan and carry out investigations to observe and record how light interacts with various materials to classify them as opaque, transparent, or translucent.
b. Plan and carry out investigations to describe the path light travels from a light source to a mirror and how it is reflected by the mirror using different angles.
c. Plan and carry out an investigation utilizing everyday materials to explore examples of when light is refracted.
(*Clarification statement:* Everyday materials could include prisms, eyeglasses, and a glass of water.)

S4P2. Obtain, evaluate, and communicate information about how sound is produced and changed and how sound and/or light can be used to communicate.

a. Plan and carry out an investigation utilizing everyday objects to produce sound and predict the effects of changing the strength or speed of vibrations.
b. Design and construct a device to communicate across a distance using light and/or sound.

S4P3. Obtain, evaluate, and communicate information about the relationship between balanced and unbalanced forces.

a. Plan and carry out an investigation on the effects of balanced and unbalanced forces on an object and communicate the results.
b. Construct an argument to support the claim that gravitational force affects the motion of an object.
c. Ask questions to identify and explain the uses of simple machines (lever, pulley, wedge, inclined plane, wheel and axle, and screw) and how forces are changed when simple machines are used to complete tasks.
(*Clarification statement:* The use of mathematical formulas is not expected.)

Life Science

S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem.

a. Develop a model to describe the roles of producers, consumers, and decomposers in a community.
(*Clarification statement:* Students are not expected to identify the different types of consumers – herbivores, carnivores, omnivores and scavengers.)
b. Develop simple models to illustrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers.

c. Design a scenario to demonstrate the effect of a change on an ecosystem. (*Clarification statement:* Include living and non-living factors in the scenario.)
d. Use printed and digital data to develop a model illustrating and describing changes to the flow of energy in an ecosystem when plants or animals become scarce, extinct or over-abundant.

Fourth Grade Standards

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d. Evaluate strengths and limitations of models of our solar system in describing relative size, order, appearance and composition of planets and the sun.
(*Clarification statement:* Composition of planets is limited to rocky vs. gaseous.)

S4E2. Obtain, evaluate, and communicate information to model the effects of the position and motion of the Earth and the moon in relation to the sun as observed from the Earth.

a. Develop a model to support an explanation of why the length of day and night change throughout the year.
b. Develop a model based on observations to describe the repeating pattern of the phases of the moon (new, crescent, quarter, gibbous, and full).
c. Construct an explanation of how the Earth's orbit, with its consistent tilt, affects seasonal changes.

S4E3. Obtain, evaluate, and communicate information to demonstrate the water cycle.

a. Plan and carry out investigations to observe the flow of energy in water as it changes states from solid (ice) to liquid (water) to gas (water vapor) and changes from gas to liquid to solid.
b. Develop models to illustrate multiple pathways water may take during the water cycle (evaporation, condensation, and precipitation).
(*Clarification statement:* Students should understand that the water cycle does not follow a single pathway.)

S4E4. Obtain, evaluate, and communicate information to predict weather events and infer weather patterns using weather charts/maps and collected weather data.

a. Construct an explanation of how weather instruments (thermometer, rain gauge, barometer, wind vane, and anemometer) are used in gathering weather data and making forecasts.
b. Interpret data from weather maps, including fronts (warm, cold, and stationary), temperature, pressure, and precipitation to make an informed prediction about tomorrow's weather.
c. Ask questions and use observations of cloud types (cirrus, stratus, and cumulus) and data of weather conditions to predict weather events.
d. Construct an explanation based on research to communicate the difference between weather and climate.

Physical Science

S4P1. Obtain, evaluate, and communicate information about the nature of light and how light interacts with objects.

a. Plan and carry out investigations to observe and record how light interacts with various materials to classify them as opaque, transparent, or translucent.
b. Plan and carry out investigations to describe the path light travels from a light source to a mirror and how it is reflected by the mirror using different angles.
c. Plan and carry out an investigation utilizing everyday materials to explore examples of when light is refracted.
(*Clarification statement:* Everyday materials could include prisms, eyeglasses, and a glass of water.)

S4P2. Obtain, evaluate, and communicate information about how sound is produced and changed and how sound and/or light can be used to communicate.

a. Plan and carry out an investigation utilizing everyday objects to produce sound and predict the effects of changing the strength or speed of vibrations.
b. Design and construct a device to communicate across a distance using light and/or sound.

S4P3. Obtain, evaluate, and communicate information about the relationship between balanced and unbalanced forces.

a. Plan and carry out an investigation on the effects of balanced and unbalanced forces on an object and communicate the results.
b. Construct an argument to support the claim that gravitational force affects the motion of an object.
c. Ask questions to identify and explain the uses of simple machines (lever, pulley, wedge, inclined plane, wheel and axle, and screw) and how forces are changed when simple machines are used to complete tasks.
(*Clarification statement:* The use of mathematical formulas is not expected.)

Life Science

S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem.

a. Develop a model to describe the roles of producers, consumers, and decomposers in a community.
(*Clarification statement:* Students are not expected to identify the different types of consumers – herbivores, carnivores, omnivores and scavengers.)
b. Develop simple models to illustrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers.

c. Design a scenario to demonstrate the effect of a change on an ecosystem. (*Clarification statement:* Include living and non-living factors in the scenario.)
d. Use printed and digital data to develop a model illustrating and describing changes to the flow of energy in an ecosystem when plants or animals become scarce, extinct or over-abundant.

Fifth Grade Standards

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The Science Georgia Standards of Excellence drive instruction. Hands-on, student-centered, and inquiry-based approaches should be the emphasis of instruction. The standards are a required minimum set of expectations that show proficiency in science. However, instruction can extend beyond these minimum expectations to meet student needs. At the same time, these standards set a maximum expectation on what will be assessed by the Georgia Milestones Assessment System.

Science consists of a way of thinking and investigating, as well a growing body of knowledge about the natural world. To become literate in science, students need to possess sufficient understanding of fundamental science content knowledge, the ability to engage in the science and engineering practices, and to use scientific and technological information correctly. Technology should be infused into the curriculum and the safety of the student should always be foremost in instruction.

The Fifth Grade Georgia Standards of Excellence for science engage students in investigations of scientific concepts. Students are active learners and use hands-on activities to discover and explain phenomena. They understand that science is a process for gaining knowledge about the natural world and are able to conduct experiments and report their findings in the form of written reports, charts, and various other presentations including multi-media projects. Their scientific explanations emphasize evidence and begin to use scientific principles, models, and theories.

Fifth graders keep records of investigations and observations and understand why they should not alter records. They use numerical data to describe and compare objects, convert the fractions to decimals in scientific calculations, and identify the largest and smallest possible value of something. They use reference books, magazines or newspapers, and computer databases to locate scientific information.

Students at this grade level are able to identify the causes of some of Earth's surface features, explain the difference between a physical and a chemical change, investigate electricity and magnetism and the relationship between them, use scientific procedures to classify organisms, understand the difference between behaviors and traits, contrast the parts of animal and plant cells, and argue from evidence on how microorganisms can be beneficial or harmful to other organisms.

Earth and Space Science

S5E1. Obtain, evaluate, and communicate information to identify surface features on the Earth caused by constructive and/or destructive processes.

a. Construct an argument supported by scientific evidence to identify surface features (examples could include deltas, sand dunes, mountains, volcanoes) as being caused by constructive and/or destructive processes (examples could include deposition, weathering, erosion, and impact of organisms).
b. Develop simple interactive models to collect data that illustrate how changes in surface features are/were caused by constructive and/or destructive processes.
c. Ask questions to obtain information on how technology is used to limit and/or predict the impact of constructive and destructive processes.
(*Clarification statement:* Examples could include seismological studies, flood forecasting (GIS maps), engineering/construction methods and materials, and infrared/satellite imagery.)

Physical Science

S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.

a. Plan and carry out investigations of physical changes by manipulating, separating and mixing dry and liquid materials.
b. Construct an argument based on observations to support a claim that the physical changes in the state of water are due to temperature changes, which cause small particles that cannot be seen to move differently.
c. Plan and carry out an investigation to determine if a chemical change occurred based on observable evidence (color, gas, temperature change, odor, new substance produced).

S5P2. Obtain, evaluate, and communicate information to investigate electricity.

a. Obtain and combine information from multiple sources to explain the difference between naturally occurring electricity (static) and human-harnessed electricity.
b. Design a complete, simple electric circuit, and explain all necessary components.
c. Plan and carry out investigations on common materials to determine if they are insulators or conductors of electricity.

S5P3. Obtain, evaluate, and communicate information about magnetism and its relationship to electricity.

a. Construct an argument based on experimental evidence to communicate the differences in function and purpose of an electromagnet and a magnet.
(*Clarification statement:* Function is limited to understanding temporary and permanent magnetism.)

b. Plan and carry out an investigation to observe the interaction between a magnetic field and a magnetic object.
(*Clarification statement:* The interaction should include placing materials of various types (wood, paper, glass, metal, and rocks) and thickness between the magnet and the magnetic object.)

Life Science

S5L1. Obtain, evaluate, and communicate information to group organisms using scientific classification procedures.

a. Develop a model that illustrates how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibian, reptile, bird, and mammal) using data from multiple sources.
b. Develop a model that illustrates how plants are sorted into groups (seed producers, non-seed producers) using data from multiple sources.

S5L2. Obtain, evaluate, and communicate information showing that some characteristics of organisms are inherited and other characteristics are acquired.

a. Ask questions to compare and contrast instincts and learned behaviors.
b. Ask questions to compare and contrast inherited and acquired physical traits.
(*Clarification statement:* Punnett squares and genetics are taught in future grades.)

S5L3. Obtain, evaluate, and communicate information to compare and contrast the parts of plant and animal cells.

a. Gather evidence by utilizing technology tools to support a claim that plants and animals are comprised of cells too small to be seen without magnification.
b. Develop a model to identify and label parts of a plant cell (membrane, wall, cytoplasm, nucleus, chloroplasts) and of an animal cell (membrane, cytoplasm, and nucleus).
c. Construct an explanation that differentiates between the structure of plant and animal cells.

S5L4. Obtain, evaluate, and communicate information about how microorganisms benefit or harm larger organisms.

(*Clarification statement:* Possible microorganisms could include Tardigrades, Lactobacillus, Probiotics, Rotifers, Salmonella, Clostridium botulinum (Botox), E-coli, Algae, etc. Students are not expected to know these specific microorganisms. The list is provided to give teachers examples.)

a. Construct an argument using scientific evidence to support a claim that some microorganisms are beneficial.
b. Construct an argument using scientific evidence to support a claim that some microorganisms are harmful.

Fifth Grade Standards

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Fifth graders keep records of investigations and observations and understand why they should not alter records. They use numerical data to describe and compare objects, convert the fractions to decimals in scientific calculations, and identify the largest and smallest possible value of something. They use reference books, magazines or newspapers, and computer databases to locate scientific information.

Students at this grade level are able to identify the causes of some of Earth's surface features, explain the difference between a physical and a chemical change, investigate electricity and magnetism and the relationship between them, use scientific procedures to classify organisms, understand the difference between behaviors and traits, contrast the parts of animal and plant cells, and argue from evidence on how microorganisms can be beneficial or harmful to other organisms.

Earth and Space Science

S5E1. Obtain, evaluate, and communicate information to identify surface features on the Earth caused by constructive and/or destructive processes.

a. Construct an argument supported by scientific evidence to identify surface features (examples could include deltas, sand dunes, mountains, volcanoes) as being caused by constructive and/or destructive processes (examples could include deposition, weathering, erosion, and impact of organisms).
b. Develop simple interactive models to collect data that illustrate how changes in surface features are/were caused by constructive and/or destructive processes.
c. Ask questions to obtain information on how technology is used to limit and/or predict the impact of constructive and destructive processes.
(*Clarification statement:* Examples could include seismological studies, flood forecasting (GIS maps), engineering/construction methods and materials, and infrared/satellite imagery.)

Physical Science

S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.

a. Plan and carry out investigations of physical changes by manipulating, separating and mixing dry and liquid materials.
b. Construct an argument based on observations to support a claim that the physical changes in the state of water are due to temperature changes, which cause small particles that cannot be seen to move differently.
c. Plan and carry out an investigation to determine if a chemical change occurred based on observable evidence (color, gas, temperature change, odor, new substance produced).

S5P2. Obtain, evaluate, and communicate information to investigate electricity.

a. Obtain and combine information from multiple sources to explain the difference between naturally occurring electricity (static) and human-harnessed electricity.
b. Design a complete, simple electric circuit, and explain all necessary components.
c. Plan and carry out investigations on common materials to determine if they are insulators or conductors of electricity.

S5P3. Obtain, evaluate, and communicate information about magnetism and its relationship to electricity.

a. Construct an argument based on experimental evidence to communicate the differences in function and purpose of an electromagnet and a magnet.
(*Clarification statement:* Function is limited to understanding temporary and permanent magnetism.)

b. Plan and carry out an investigation to observe the interaction between a magnetic field and a magnetic object.
(*Clarification statement:* The interaction should include placing materials of various types (wood, paper, glass, metal, and rocks) and thickness between the magnet and the magnetic object.)

Life Science

S5L1. Obtain, evaluate, and communicate information to group organisms using scientific classification procedures.

a. Develop a model that illustrates how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibian, reptile, bird, and mammal) using data from multiple sources.
b. Develop a model that illustrates how plants are sorted into groups (seed producers, non-seed producers) using data from multiple sources.

S5L2. Obtain, evaluate, and communicate information showing that some characteristics of organisms are inherited and other characteristics are acquired.

a. Ask questions to compare and contrast instincts and learned behaviors.
b. Ask questions to compare and contrast inherited and acquired physical traits.
(*Clarification statement:* Punnett squares and genetics are taught in future grades.)

S5L3. Obtain, evaluate, and communicate information to compare and contrast the parts of plant and animal cells.

a. Gather evidence by utilizing technology tools to support a claim that plants and animals are comprised of cells too small to be seen without magnification.
b. Develop a model to identify and label parts of a plant cell (membrane, wall, cytoplasm, nucleus, chloroplasts) and of an animal cell (membrane, cytoplasm, and nucleus).
c. Construct an explanation that differentiates between the structure of plant and animal cells.

S5L4. Obtain, evaluate, and communicate information about how microorganisms benefit or harm larger organisms.

(*Clarification statement:* Possible microorganisms could include Tardigrades, Lactobacillus, Probiotics, Rotifers, Salmonella, Clostridium botulinum (Botox), E-coli, Algae, etc. Students are not expected to know these specific microorganisms. The list is provided to give teachers examples.)

a. Construct an argument using scientific evidence to support a claim that some microorganisms are beneficial.
b. Construct an argument using scientific evidence to support a claim that some microorganisms are harmful.

Sixth Grade Standards

The Science Georgia Standards of Excellence are designed to provide foundational knowledge and skills for all students to develop proficiency in science. The Project 2061's *Benchmarks for Science Literacy* and the follow up work, *A Framework for K-12 Science Education* were used as the core of the standards to determine appropriate content and process skills for students. The Science Georgia Standards of Excellence focus on a limited number of core disciplinary ideas and crosscutting concepts which build from Kindergarten to high school. The standards are written with the core knowledge to be mastered integrated with the science and engineering practices needed to engage in scientific inquiry and engineering design. Crosscutting concepts are used to make connections across different science disciplines.

The Science Georgia Standards of Excellence drive instruction. Hands-on, student-centered, and inquiry-based approaches should be the emphasis of instruction. The standards are a required minimum set of expectations that show proficiency in science. However, instruction can extend beyond these minimum expectations to meet student needs. At the same time, these standards set a maximum expectation on what will be assessed by the Georgia Milestones Assessment System.

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The Sixth Grade Georgia Standards of Excellence for science are designed to give all students an overview of common strands in earth science including, but not limited to, meteorology, geology, astronomy, and oceanography.

Sixth grade students use records they keep and analyze the data they collect, plan and carry out investigations, describe observations, and show information in different forms. They are able to recognize relationships in simple charts and graphs and find more than one way to interpret their findings. They replicate investigations and compare results to find similarities and differences. Sixth graders study weather patterns and systems by observing and explaining how an aspect of weather can affect a weather system. They are able to construct explanations based on evidence of the role of water in Earth processes, recognize how the presence of land and water in combination with the energy from the sun affect the climate and weather of a region. They use different models to represent systems such as the solar system and the sun/moon/Earth system. They study uses and conservation of Earth's natural resources and use what they observe about the Earth's materials to infer the processes and timelines that formed them.

Earth and Space Science

S6E1. Obtain, evaluate, and communicate information about current scientific views of the universe and how those views evolved.

a. Ask questions to determine changes in models of Earth's position in the solar system, and origins of the universe as evidence that scientific theories change with the addition of new information.
(*Clarification statement:* Students should consider Earth's position in geocentric and heliocentric models and the Big Bang as it describes the formation of the universe.)
b. Develop a model to represent the position of the solar system in the Milky Way galaxy and in the known universe.
c. Analyze and interpret data to compare and contrast the planets in our solar system in terms of:
   - size relative to Earth,
   - surface and atmospheric features,
   - relative distance from the sun, and
   - ability to support life.
d. Develop and use a model to explain the interaction of gravity and inertia that governs the motion of objects in the solar system.
e. Ask questions to compare and contrast the characteristics, composition, and location of comets, asteroids, and meteoroids.

S6E2. Obtain, evaluate, and communicate information about the effects of the relative positions of the sun, Earth, and moon.

a. Develop and use a model to demonstrate the phases of the moon by showing the relative positions of the sun, Earth, and moon.
b. Construct an explanation of the cause of solar and lunar eclipses.
c. Analyze and interpret data to relate the tilt of the Earth to the distribution of sunlight throughout the year and its effect on seasons.

S6E3. Obtain, evaluate, and communicate information to recognize the significant role of water in Earth processes.

a. Ask questions to determine where water is located on Earth's surface (oceans, rivers, lakes, swamps, groundwater, aquifers, and ice) and communicate the relative proportion of water at each location.
b. Plan and carry out an investigation to illustrate the role of the sun's energy in atmospheric conditions that lead to the cycling of water.
(*Clarification statement:* The water cycle should include evaporation, condensation, precipitation, transpiration, infiltration, groundwater, and runoff.)

c. Ask questions to identify and communicate, using graphs and maps, the composition, location, and subsurface topography of the world's oceans.
d. Analyze and interpret data to create graphic representations of the causes and effects of waves, currents, and tides in Earth's systems.

S6E4. Obtain, evaluate, and communicate information about how the sun, land, and water affect climate and weather.

a. Analyze and interpret data to compare and contrast the composition of Earth's atmospheric layers (including the ozone layer) and greenhouse gases.
(*Clarification statement:* Earth's atmospheric layers include the troposphere, stratosphere, mesosphere, and thermosphere.)
b. Plan and carry out an investigation to demonstrate how energy from the sun transfers heat to air, land and water at different rates.
(*Clarification statement:* Heat transfer should include the processes of conduction, convection, and radiation.)
c. Develop a model demonstrating the interaction between unequal heating and the rotation of the Earth that causes local and global wind systems.
d. Construct an explanation of the relationship between air pressure, weather fronts, and air masses and meteorological events such as tornados and thunderstorms.
e. Analyze and interpret weather data to explain the effects of moisture evaporating from the ocean on weather patterns and weather events such as hurricanes.

S6E5. Obtain, evaluate, and communicate information to show how Earth's surface is formed.

a. Ask questions to compare and contrast the Earth's crust, mantle, inner and outer core, including temperature, density, thickness, and composition.
b. Plan and carry out an investigation of the characteristics of minerals and how minerals contribute to rock composition.
c. Construct an explanation of how to classify rocks by their formation and how rocks change through geologic processes in the rock cycle.
d. Ask questions to identify types of weathering, agents of erosion and transportation, and environments of deposition.
(*Clarification statement:* Environments of deposition include deltas, barrier islands, beaches, marshes, and rivers.)
e. Develop a model to demonstrate how natural processes (weathering, erosion, and deposition) and human activity change rocks and the surface of the Earth.
f. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.
(*Clarification statement:* Include convergent, divergent, and transform boundaries.)

g. Construct an argument using maps and data collected to support a claim of how fossils show evidence of the changing surface and climate of the Earth.
h. Plan and carry out an investigation to provide evidence that soil is composed of layers of weathered rocks and decomposed organic material.

S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.

a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.
b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.
c. Construct an argument evaluating contributions to the rise in global temperatures over the past century.
(*Clarification statement:* Tables, graphs, and maps of global and regional temperatures, and atmospheric levels of greenhouse gases such as carbon dioxide and methane, should be used as sources of evidence.)

Sixth Grade Standards

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Sixth grade students use records they keep and analyze the data they collect, plan and carry out investigations, describe observations, and show information in different forms. They are able to recognize relationships in simple charts and graphs and find more than one way to interpret their findings. They replicate investigations and compare results to find similarities and differences. Sixth graders study weather patterns and systems by observing and explaining how an aspect of weather can affect a weather system. They are able to construct explanations based on evidence of the role of water in Earth processes, recognize how the presence of land and water in combination with the energy from the sun affect the climate and weather of a region. They use different models to represent systems such as the solar system and the sun/moon/Earth system. They study uses and conservation of Earth's natural resources and use what they observe about the Earth's materials to infer the processes and timelines that formed them.

Earth and Space Science

S6E1. Obtain, evaluate, and communicate information about current scientific views of the universe and how those views evolved.

a. Ask questions to determine changes in models of Earth's position in the solar system, and origins of the universe as evidence that scientific theories change with the addition of new information.
(*Clarification statement:* Students should consider Earth's position in geocentric and heliocentric models and the Big Bang as it describes the formation of the universe.)
b. Develop a model to represent the position of the solar system in the Milky Way galaxy and in the known universe.
c. Analyze and interpret data to compare and contrast the planets in our solar system in terms of:
   - size relative to Earth,
   - surface and atmospheric features,
   - relative distance from the sun, and
   - ability to support life.
d. Develop and use a model to explain the interaction of gravity and inertia that governs the motion of objects in the solar system.
e. Ask questions to compare and contrast the characteristics, composition, and location of comets, asteroids, and meteoroids.

S6E2. Obtain, evaluate, and communicate information about the effects of the relative positions of the sun, Earth, and moon.

a. Develop and use a model to demonstrate the phases of the moon by showing the relative positions of the sun, Earth, and moon.
b. Construct an explanation of the cause of solar and lunar eclipses.
c. Analyze and interpret data to relate the tilt of the Earth to the distribution of sunlight throughout the year and its effect on seasons.

S6E3. Obtain, evaluate, and communicate information to recognize the significant role of water in Earth processes.

a. Ask questions to determine where water is located on Earth's surface (oceans, rivers, lakes, swamps, groundwater, aquifers, and ice) and communicate the relative proportion of water at each location.
b. Plan and carry out an investigation to illustrate the role of the sun's energy in atmospheric conditions that lead to the cycling of water.
(*Clarification statement:* The water cycle should include evaporation, condensation, precipitation, transpiration, infiltration, groundwater, and runoff.)

c. Ask questions to identify and communicate, using graphs and maps, the composition, location, and subsurface topography of the world's oceans.
d. Analyze and interpret data to create graphic representations of the causes and effects of waves, currents, and tides in Earth's systems.

S6E4. Obtain, evaluate, and communicate information about how the sun, land, and water affect climate and weather.

a. Analyze and interpret data to compare and contrast the composition of Earth's atmospheric layers (including the ozone layer) and greenhouse gases.
(*Clarification statement:* Earth's atmospheric layers include the troposphere, stratosphere, mesosphere, and thermosphere.)
b. Plan and carry out an investigation to demonstrate how energy from the sun transfers heat to air, land and water at different rates.
(*Clarification statement:* Heat transfer should include the processes of conduction, convection, and radiation.)
c. Develop a model demonstrating the interaction between unequal heating and the rotation of the Earth that causes local and global wind systems.
d. Construct an explanation of the relationship between air pressure, weather fronts, and air masses and meteorological events such as tornados and thunderstorms.
e. Analyze and interpret weather data to explain the effects of moisture evaporating from the ocean on weather patterns and weather events such as hurricanes.

S6E5. Obtain, evaluate, and communicate information to show how Earth's surface is formed.

a. Ask questions to compare and contrast the Earth's crust, mantle, inner and outer core, including temperature, density, thickness, and composition.
b. Plan and carry out an investigation of the characteristics of minerals and how minerals contribute to rock composition.
c. Construct an explanation of how to classify rocks by their formation and how rocks change through geologic processes in the rock cycle.
d. Ask questions to identify types of weathering, agents of erosion and transportation, and environments of deposition.
(*Clarification statement:* Environments of deposition include deltas, barrier islands, beaches, marshes, and rivers.)
e. Develop a model to demonstrate how natural processes (weathering, erosion, and deposition) and human activity change rocks and the surface of the Earth.
f. Construct an explanation of how the movement of lithospheric plates, called plate tectonics, can cause major geologic events such as earthquakes and volcanic eruptions.
(*Clarification statement:* Include convergent, divergent, and transform boundaries.)

g. Construct an argument using maps and data collected to support a claim of how fossils show evidence of the changing surface and climate of the Earth.
h. Plan and carry out an investigation to provide evidence that soil is composed of layers of weathered rocks and decomposed organic material.

S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.

a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.
b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.
c. Construct an argument evaluating contributions to the rise in global temperatures over the past century.
(*Clarification statement:* Tables, graphs, and maps of global and regional temperatures, and atmospheric levels of greenhouse gases such as carbon dioxide and methane, should be used as sources of evidence.)

Seventh Grade Standards

The Science Georgia Standards of Excellence are designed to provide foundational knowledge and skills for all students to develop proficiency in science. The Project 2061's *Benchmarks for Science Literacy* and the follow up work, *A Framework for K-12 Science Education* were used as the core of the standards to determine appropriate content and process skills for students. The Science Georgia Standards of Excellence focus on a limited number of core disciplinary ideas and crosscutting concepts which build from Kindergarten to high school. The standards are written with the core knowledge to be mastered integrated with the science and engineering practices needed to engage in scientific inquiry and engineering design. Crosscutting concepts are used to make connections across different science disciplines.

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The Seventh Grade Georgia Standards of Excellence for science are designed to give all students the necessary skills for a smooth transition from elementary life science standards to high school biology standards. The purpose is to give all students an overview of common strands in life science including, but not limited to, diversity of living organisms, structure and function of cells, heredity, ecosystems, and biological evolution.

Seventh grade students keep records of their observations, use those records to analyze the data they collect, recognize patterns in the data, use simple charts and graphs to represent the relationships they see, and find more than one way to interpret their findings. They make and use observations to explain the diversity of living organisms and how the organisms are classified, how they reproduce and how genetic information is passed from parents to their offspring. They use different models to represent systems such as cells, tissues, and organs. They use what they know about ecosystems to explain how matter cycles and energy flows through the ecosystem. They use the concepts of natural selection and fossil evidence to construct explanations about the diversity of life that they see. Seventh graders plan and carry out investigations, describe observations, and show information in graphical form. The students replicate investigations and compare results to find similarities and differences.

Life Science

S7L1. Obtain, evaluate, and communicate information to investigate the diversity of living organisms and how they can be compared scientifically.

a. Develop and defend a model that categorizes organisms based on common characteristics.
b. Evaluate historical models of how organisms were classified based on physical characteristics and how that led to the six kingdom system (currently archaea, bacteria, protists, fungi, plants, and animals).
(*Clarification statement:* This includes common examples and characteristics such as, but not limited to, prokaryotic, eukaryotic, unicellular, multicellular, asexual reproduction, sexual reproduction, autotroph, heterotroph, and unique cell structures. Modern classification will be addressed in high school.)

S7L2. Obtain, evaluate, and communicate information to describe how cell structures, cells, tissues, organs, and organ systems interact to maintain the basic needs of organisms.

a. Develop a model and construct an explanation of how cell structures (specifically the nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, and mitochondria) contribute to the function of the cell as a system in obtaining nutrients in order to grow, reproduce, make needed materials, and process waste.
(*Clarification statement:* The intent is for students to demonstrate how the component structures of the cell interact and work together to allow the cell as a whole to carry out various processes. Additional structures, beyond those listed, will be addressed in high school Biology.)
b. Develop and use a conceptual model of how cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms.
c. Construct an argument that systems of the body (Cardiovascular, Excretory, Digestive, Respiratory, Muscular, Nervous, and Immune) interact with one another to carry out life processes.
(*Clarification statement:* The emphasis is not on learning individual structures and functions associated with each system, but on how systems interact to support life processes.)

S7L3. Obtain, evaluate, and communicate information to explain how organisms reproduce either sexually or asexually and transfer genetic information to determine the traits of their offspring.

a. Construct an explanation supported with scientific evidence of the role of genes and chromosomes in the process of inheriting a specific trait.

b. Develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation.
(*Clarification statement:* Models could include, but are not limited to, the use of monohybrid Punnett squares to demonstrate the heritability of genes and the resulting genetic variation, identification of heterozygous and homozygous, and comparison of genotype vs. phenotype.)
c. Ask questions to gather and synthesize information about the ways humans influence the inheritance of desired traits in organisms through selective breeding.
(*Clarification statement:* The element specifically addresses artificial selection and the ways in which it is fundamentally different from natural selection.)

S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments.

a. Construct an explanation for the patterns of interactions observed in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem.
(*Clarification statement:* The interactions include, but are not limited to, predator-prey relationships, competition, mutualism, parasitism, and commensalism.)
b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem.
(*Clarification statement:* Emphasis is on tracing movement of matter and flow of energy, not the biochemical mechanisms of photosynthesis and cellular respiration.)
c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems.
d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth's major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, and tundra) and aquatic ecosystems (i.e., freshwater, estuaries, and marine).
(*Clarification statement:* Emphasis is on the factors that influence patterns across biomes such as the climate, availability of food and water, and location.)

S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of evolution of living organisms through inherited characteristics.

a. Use mathematical representations to evaluate explanations of how natural selection leads to changes in specific traits of populations over successive generations.
(*Clarification statement:* Referencing data should be obtained from multiple sources including, but not limited to, existing research and simulations. Students should be able to calculate means, represent this data in a table or graph, and reference it when explaining the principles of natural selection.)

b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species.
c. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, and extinction of organisms and their relationships to modern organisms. (*Clarification statement:* Evidence of evolution found in comparisons of current/modern organisms such as homologous structures, DNA, and fetal development will be addressed in high school.)