GRADES 9-12

Overview

While the high school curriculum is essential preparation for postsecondary study for many students, it is the last formal instructional experience for others. To enable all students to become scientifically literate, the science curriculum in Grades 9-12 provides students with the knowledge and skills necessary for the twenty-first century. Therefore, the *Alabama Course of Study: Science* offers the following cores: Physical Science, Biology, Chemistry, and Physics. It also defines ten elective cores in the more specialized areas of Aquascience, Botany, Earth and Space Science, Environmental Science, Forensic Science, Genetics, Geology, Human Anatomy and Physiology, Marine Science, and Zoology. Each core specifies the minimum required content students must achieve in order to receive credit toward graduation. The scientific process and application skills located on page 10 of this document should be incorporated into the teaching of the core content standards.

In compliance with state and national laws and regulations, the *Alabama Course of Study: Science* specifies required science content in a manner intended to balance a need for rigor in course offerings and consistency statewide with the need for local flexibility in designing local course offerings. Options to satisfy current graduation requirements for students seeking the Alabama High School Diploma and the Alabama High School Diploma with Advanced Academic Endorsement are shown below.

Minimum Number of Science Credits
Required for Graduation

	Biology	**A Physical Science***	**Elective****	**Total**
Alabama High School Diploma	1	1	2	4
Alabama High School Diploma with Advanced Academic Endorsement***	1	1	2***	4

* Requirements fulfilled only by courses incorporating the Physical Science Core, Chemistry Core, or Physics Core

** Two additional courses designed from the elective cores in this document or rigorous courses designed locally and approved by the Alabama Department of Education

***Advanced-level courses required for the Alabama High School Diploma with Advanced Academic Endorsement

The *Alabama Course of Study: Science* provides content standards within fourteen core areas. The content described in these cores represents fundamental concepts and skills that all Alabama students should know and be able to do to become scientifically literate. Local school systems may develop courses expanding the core content to address specific needs of the local student population or to utilize local resources while retaining the identified core as the foundation. The presentation of the minimum required content in the *Alabama Course of Study*: *Science* is not intended to restrict local school systems from designing course offerings or a multiple-year sequence of course offerings of a more integrated nature. The classroom instructional sequence need not follow the order in which content standards are presented in this document within any course.

In designing instructional units and strategies, teachers are encouraged to integrate scientific processes, applications, and knowledge within lessons. As advocated by the *National Science Education Standards* produced by the NRC, the emphasis is on acquiring understanding and developing a foundation for using scientific knowledge and processes. All science courses in Grades 9-12 are laboratory-based courses and address the scientific process and application skills identified on page 10 of this document. Instruction should ensure the ability of students to apply data analysis techniques, including identifying significant digits, calculating quantities involving significant figures, writing numbers in ordinary and scientific notation, identifying SI units, and performing scientific conversions.

The increasing demand for technological proficiency makes the use of technology essential in all science classrooms and laboratories. Students are encouraged to conduct research in particular science areas and relate it to the community in the form of service projects. Student achievement in these areas should be measured with a variety of assessment tools.

The cognitive level of students in Grades 9-12 must be considered when planning for instruction. Many students are still making the transition from concrete thinking to formal operational reasoning. Field and laboratory experiences help bridge this transition. Misconceptions concerning many scientific phenomena are also abundant at this age level. Teachers should work diligently to uncover these misconceptions and help students to recognize them as such. This can be done through the use of discrepant events and demonstrations that cause students to ask “why” their logic or experiences do not always agree with scientific explanations. Small- and large-group discussions, essay questions, and laboratory reports all help reveal students’ understandings and misconceptions to the teacher, and student verbalizations — written and oral — help students realize whether or not they clearly understand a concept.

PHYSICAL SCIENCE CORE

The Physical Science Core, as presented in this document, is an inquiry-based core that includes basic concepts and skills in chemistry and physics that are considered foundational in those disciplines. Core content focuses on scientific facts, concepts, principles, theories, and models that are important for scientific literacy. While this core contains the minimum required content, teachers are encouraged to expand the physical science content as needed. The scientific process and application skills located on page 10 of this document should be taught in conjunction with scientific knowledge standards in this laboratory-based course. Inquiry skills should be incorporated into as many content standards as possible.

The Physical Science Core emphasizes firsthand observation through laboratory investigations, practical problem solving, and the use of technology. Content within this core provides students with a firm laboratory-based foundation for scientific literacy and for the pursuit of subsequent science courses. Special attention is given to scientific application of knowledge and processes to practical real-world questions. This core will vary from the Chemistry and Physics Cores in content and rigor, amount and types of experimentation, technical application, and instrumentation.

Students should be presented with related technology and, when practicable, should experiment with instrumentation. The required technology for the Physical Science Core consists of basic instruments that, in some cases, students can construct. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction.

Students will:

1. Recognize periodic trends of elements, including the number of valence electrons, atomic size, and reactivity.
    - Categorizing elements as metals, nonmetals, metalloids, and noble gases
    - Differentiating between families and periods
    - Using atomic number and mass number to identify isotopes

2. Identify solutions in terms of components, solubility, concentration, and conductivity.
    - Comparing saturated, unsaturated, and supersaturated solutions
    - Comparing characteristics of electrolytes and nonelectrolytes
    - Describing factors that affect solubility and rate of solution, including nature of solute and solvent, temperature, agitation, surface area, and pressure on gases

3. Contrast the formation of ionic and covalent bonds based on the transfer or sharing of valence electrons.
    - Demonstrating the formation of positive and negative monatomic ions by using electron dot diagrams

4. Use nomenclature and chemical formulas to write balanced chemical equations.
    - Explaining the law of conservation of matter
    - Identifying chemical reactions as composition, decomposition, single replacement, or double replacement
    - Defining the role of electrons in chemical reactions

5. Describe physical and chemical changes in terms of endothermic and exothermic processes.

6. Identify characteristics of gravitational, electromagnetic, and nuclear forces.

7. Relate velocity, acceleration, and kinetic energy to mass, distance, force, and time.
    - Interpreting graphic representations of velocity versus time and distance versus time
    - Solving problems for velocity, acceleration, force, work, and power
    - Describing action and reaction forces, inertia, acceleration, momentum, and friction in terms of Newton's three laws of motion
    - Determining the resultant of collinear forces acting on a body
        Example: solving problems involving the effect of a tailwind or headwind on an airplane
    - Solving problems for efficiency and mechanical advantage of simple machines

8. Relate the law of conservation of energy to transformations of potential energy, kinetic energy, and thermal energy.
    - Identifying the relationship between thermal energy and the temperature of a sample of matter
    - Describing the flow of thermal energy between two samples of matter
    - Explaining how thermal energy is transferred by radiation, conduction, and convection
    - Relating simple formulas to the calculation of potential energy, kinetic energy, and work

9. Compare methods of energy transfer by mechanical and electromagnetic waves.
    - Distinguishing between transverse and longitudinal mechanical waves
    - Relating physical properties of sound and light to wave characteristics
        Examples: loudness to amplitude, pitch to frequency, color to wavelength and frequency

10. Explain the relationship between electricity and magnetism.
    Example: using a moving charge to create a magnetic field and using a moving magnetic field to induce a current in a closed wire loop

    - Differentiating between induction and conduction
    - Identifying mechanical, magnetic, and chemical methods used to create an electrical charge
        Examples: mechanical—rubbing materials together,
        magnetic—moving a closed loop of wire across a magnetic field,
        chemical—using batteries
    - Describing electrical circuits in terms of Ohm's law

11. Describe the nuclear composition of unstable isotopes and the resulting changes to their nuclear composition.
    - Identifying types of nuclear emissions, including alpha particles, beta particles, and gamma radiation
    - Differentiating between fission and fusion
    - Identifying uses and possible negative side effects of nuclear technology
      Examples: uses—nuclear power generation, medical applications, space travel; negative effects—radioactive contamination, nuclear fuel waste and waste storage

12. Identify metric units for mass, distance, time, temperature, velocity, acceleration, density, force, energy, and power.

BIOLOGY CORE

Content standards within the Biology Core must be included in all high school biology courses. This core is not intended to serve as the entire curriculum for any course. Teachers are encouraged to expand the biology curriculum beyond the minimum content of this core. It is also important to note that depth of understanding, not breadth of content, is the goal of the biology curriculum. Content standards require emphasis on open-ended laboratory exploration, active investigation, and analysis of ideas. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. While important to the study of biology, vocabulary should be a means to understanding and communicating rather than an end unto itself.

Instructional techniques that include technology should be utilized to explore DNA, amino acids, and proteins in the laboratory. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and support inquiry-based instruction. With the advent of anticipated breakthroughs in science and the personal, environmental, and societal issues that will accompany them, biological literacy for all Alabama citizens is essential.

Students will:

1. Select appropriate laboratory glassware, balances, time measuring equipment, and optical instruments to conduct an experiment.
    - Describing the steps of the scientific method
    - Comparing controls, dependent variables, and independent variables
    - Identifying safe laboratory procedures when handling chemicals and using Bunsen burners and laboratory glassware
    - Using appropriate SI units for measuring length, volume, and mass

2. Describe cell processes necessary for achieving homeostasis, including active and passive transport, osmosis, diffusion, exocytosis, and endocytosis.
    - Identifying functions of carbohydrates, lipids, proteins, and nucleic acids in cellular activities
    - Comparing the reaction of plant and animal cells in isotonic, hypotonic, and hypertonic solutions
    - Explaining how surface area, cell size, temperature, light, and pH affect cellular activities
    - Applying the concept of fluid pressure to biological systems
        Examples: blood pressure, turgor pressure, bends, strokes

3. Identify reactants and products associated with photosynthesis and cellular respiration and the purposes of these two processes.

4. Describe similarities and differences of cell organelles, using diagrams and tables.
    - Identifying scientists who contributed to the cell theory
      Examples: Hooke, Schleiden, Schwann, Virchow, van Leeuwenhoek
    - Distinguishing between prokaryotic and eukaryotic cells
    - Identifying various technologies used to observe cells
      Examples: light microscope, scanning electron microscope, transmission electron microscope

5. Identify cells, tissues, organs, organ systems, organisms, populations, communities, and ecosystems as levels of organization in the biosphere.
    - Recognizing that cells differentiate to perform specific functions
      Examples: ciliated cells to produce movement, nerve cells to conduct electrical charges

6. Describe the roles of mitotic and meiotic divisions during reproduction, growth, and repair of cells.
    - Comparing sperm and egg formation in terms of ploidy
      Example: ploidy—haploid, diploid
    - Comparing sexual and asexual reproduction

7. Apply Mendel's law to determine phenotypic and genotypic probabilities of offspring.
    - Defining important genetic terms, including dihybrid cross, monohybrid cross, phenotype, genotype, homozygous, heterozygous, dominant trait, recessive trait, incomplete dominance, codominance, and allele
    - Interpreting inheritance patterns shown in graphs and charts
    - Calculating genotypic and phenotypic percentages and ratios using a Punnett square

8. Identify the structure and function of DNA, RNA, and protein.
    - Explaining relationships among DNA, genes, and chromosomes
    - Listing significant contributions of biotechnology to society, including agricultural and medical practices
      Examples: DNA fingerprinting, insulin, growth hormone
    - Relating normal patterns of genetic inheritance to genetic variation
      Example: crossing-over
    - Relating ways chance, mutagens, and genetic engineering increase diversity
      Examples: insertion, deletion, translocation, inversion, recombinant DNA
    - Relating genetic disorders and disease to patterns of genetic inheritance
      Examples: hemophilia, sickle cell anemia, Down's syndrome, Tay-Sachs disease, cystic fibrosis, color blindness, phenylketonuria (PKU)

9. Differentiate between the previous five-kingdom and current six-kingdom classification systems.
    - Sequencing taxa from most inclusive to least inclusive in the classification of living things
    - Identifying organisms using a dichotomous key
    - Identifying ways in which organisms from the Monera, Protista, and Fungi kingdoms are beneficial and harmful
      Examples: beneficial—decomposers,
      harmful—diseases
    - Justifying the grouping of viruses in a category separate from living things
    - Writing scientific names accurately by using binomial nomenclature

10. Distinguish between monocots and dicots, angiosperms and gymnosperms, and vascular and nonvascular plants.
    - Describing the histology of roots, stems, leaves, and flowers
    - Recognizing chemical and physical adaptations of plants

      Examples: chemical—foul odor, bitter taste, toxicity;
      physical—spines, needles, broad leaves

11. Classify animals according to type of skeletal structure, method of fertilization and reproduction, body symmetry, body coverings, and locomotion.

    Examples: skeletal structure—vertebrates, invertebrates;
    fertilization—external, internal;
    reproduction—sexual, asexual;
    body symmetry—bilateral, radial, asymmetrical;
    body coverings—feathers, scales, fur;
    locomotion—cilia, flagella, pseudopodia

12. Describe protective adaptations of animals, including mimicry, camouflage, beak type, migration, and hibernation.
    - Identifying ways in which the theory of evolution explains the nature and diversity of organisms
    - Describing natural selection, survival of the fittest, geographic isolation, and fossil record

13. Trace the flow of energy as it decreases through the trophic levels from producers to the quaternary level in food chains, food webs, and energy pyramids.
    - Describing the interdependence of biotic and abiotic factors in an ecosystem

      Examples: effects of humidity on stomata size, effects of dissolved oxygen on fish respiration
    - Contrasting autotrophs and heterotrophs
    - Describing the niche of decomposers
    - Using the ten percent law to explain the decreasing availability of energy through the trophic levels

14. Trace biogeochemical cycles through the environment, including water, carbon, oxygen, and nitrogen.
    - Relating natural disasters, climate changes, nonnative species, and human activity to the dynamic equilibrium of ecosystems

      Examples: natural disasters—habitat destruction resulting from tornadoes;
      climate changes—changes in migratory patterns of birds;
      nonnative species—exponential growth of kudzu and Zebra mussels due to absence of natural controls;
      human activity—habitat destruction resulting in reduction of biodiversity, conservation resulting in preservation of biodiversity
    - Describing the process of ecological succession

15. Identify biomes based on environmental factors and native organisms.

    Example: tundra—permafrost, low humidity, lichens, polar bears

16. Identify density-dependent and density-independent limiting factors that affect populations in an ecosystem.

    Examples: density-dependent—disease, predator-prey relationships, availability of food and water;
    density-independent—natural disasters, climate

    - Discriminating among symbiotic relationships, including mutualism, commensalism, and parasitism

CHEMISTRY CORE

The Chemistry Core provides the basis for students to address consumer, health, safety, environmental, technological, societal, and scientific issues on a daily basis. Its content defines the fundamental knowledge and skills necessary for students to develop an understanding of the most basic chemistry concepts associated with structure, form, change, availability, and use of matter and energy.

The Chemistry Core content standards are appropriate for high school students and comprise the basic content to be incorporated into all first-year chemistry courses. Emphasis is placed on the Physical Science domain, but many possible connections to the Earth and Space Science domain as well as to the Life Science domain should be made. The core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the chemistry curriculum beyond the minimum content of this core. Chemistry courses developed from the Chemistry Core will vary in the amount and kind of experimentation, technical applications, and instrumentation, as well as in the level of difficulty and abstractness. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. All chemistry courses developed from this core should be laboratory-based and should encourage critical thinking and the use of basic chemical concepts and scientific strategies by students as they learn to make intelligent decisions and solve practical problems.

Technology is important to the Chemistry Core and is used for measuring, probing, and analyzing matter and energy. Chemistry-related technology includes probeware and devices such as spectroscopes that can be interfaced with computer- or calculator-based programs in order for data to be acquired directly during investigations both within and beyond the school laboratory. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite mathematics course for the Chemistry Core is Algebra I. The Physical Science Core is recommended for students who have not mastered the physical science curriculum in the middle school grades.

Students will:

1. Differentiate among pure substances, mixtures, elements, and compounds.
    - Distinguishing between intensive and extensive properties of matter
    - Contrasting properties of metals, nonmetals, and metalloids
    - Distinguishing between homogeneous and heterogeneous forms of matter

2. Describe the structure of carbon chains, branched chains, and rings.

3. Use the periodic table to identify periodic trends, including atomic radii, ionization energy, electronegativity, and energy levels.
    - Utilizing electron configurations, Lewis dot structures, and orbital notations to write chemical formulas
    - Calculating the number of protons, neutrons, and electrons in an isotope
    - Utilizing benchmark discoveries to describe the historical development of atomic structure, including photoelectric effect, absorption, and emission spectra of elements

      Example: Thomson's cathode ray, Rutherford's gold foil, Millikan's oil drop, and Bohr's bright line spectra experiments

4. Describe solubility in terms of energy changes associated with the solution process.
    - Using solubility curves to interpret saturation levels
    - Explaining the conductivity of electrolytic solutions
    - Describing acids and bases in terms of strength, concentration, pH, and neutralization reactions
    - Describing factors that affect the rate of solution
    - Solving problems involving molarity, including solution preparation and dilution

5. Use the kinetic theory to explain states of matter, phase changes, solubility, and chemical reactions.

   Example: water at 25 degrees Celsius remains in the liquid state because of the strong attraction between water molecules while kinetic energy allows the sliding of molecules past one another

6. Solve stoichiometric problems involving relationships among the number of particles, moles, and masses of reactants and products in a chemical reaction.
    - Predicting ionic and covalent bond types and products given known reactants
    - Assigning oxidation numbers for individual atoms of monatomic and polyatomic ions
    - Identifying the nomenclature of ionic compounds, binary compounds, and acids
    - Classifying chemical reactions as composition, decomposition, single replacement, or double replacement
    - Determining the empirical or molecular formula for a compound using percent composition data

7. Explain the behavior of ideal gases in terms of pressure, volume, temperature, and number of particles using Charles's law, Boyle's law, Gay-Lussac's law, the combined gas law, and the ideal gas law.

8. Distinguish among endothermic and exothermic physical and chemical changes.

   Examples: endothermic physical—phase change from ice to water,
   endothermic chemical—reaction between citric acid solution and baking soda,
   exothermic physical—phase change from water vapor to water,
   exothermic chemical—formation of water from combustion of hydrogen and oxygen

    - Calculating temperature change by using specific heat
    - Using Le Châtelier's principle to explain changes in physical and chemical equilibrium

9. Distinguish between chemical and nuclear reactions.
    - Identifying atomic and subatomic particles, including mesons, quarks, tachyons, and baryons
    - Calculating the half-life of selective radioactive isotopes
    - Identifying types of radiation and their properties
    - Contrasting fission and fusion
    - Describing carbon-14 decay as a dating method

PHYSICS CORE

Physics is the branch of science that addresses the properties of physical matter, physical quantities, and their relationships. It consists of studies of mechanics, heat, light, sound, electricity, and magnetism.

Content standards contained in the Physics Core must be incorporated into all first-year physics courses. Emphasis is placed on the Physical Science domain, but many possible connections to the Earth and Space Science domain should be made. The core itself is not intended to serve as the entire curriculum of any course but as a basis upon which to build the content of a high school physics course. Teachers are encouraged to expand the physics curriculum beyond the minimum content of this core. Differences among physics courses developed using this core will be in the extent and sophistication of experimentation, content, technical applications, and instrumentation as well as in the level of difficulty and abstractness. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. All physics courses developed from the core content should be laboratory-based.

Content standards in the Physics Core not only require the use of algorithmic problem solving, but also the understanding and ability to describe and interpret quantitative relationships in physics. The core provides an opportunity for students to expand their knowledge of physical phenomena, develop the ability to think critically, and solve practical problems related to matter and energy.

Computer-centered technology is an important component of any physics course developed from this core. The use of probeware such as photogates, pressure sensors, and nuclear scalers is encouraged. Probeware can be interfaced with calculator-based or computer-based programs so that data can be acquired directly during investigations and later manipulated and analyzed. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite mathematics course for the Physics Core is Algebra II with Trigonometry. The Physical Science Core is recommended as a prerequisite for students who have not mastered the physical science curriculum in the middle school grades.

Students will:

1. Explain linear, uniform circular, and projectile motions using one- and two-dimensional vectors.
    - Explaining the significance of slope and area under a curve when graphing distance-time or velocity-time data
        Example: slope and area of a velocity-time curve giving acceleration and distance traveled
    - Describing forces that act on an object
        Example: drawing a free-body diagram showing all forces acting on an object and resultant effects of friction, gravity, and normal force on an object sliding down an inclined plane

2. Define the law of conservation of momentum.
    - Calculating the momentum of a single object
    - Calculating momenta of two objects before and after collision in one-dimensional motion

3. Explain planetary motion and navigation in space in terms of Kepler's and Newton's laws.

4. Describe quantitative relationships for velocity, acceleration, force, work, power, potential energy, and kinetic energy.

5. Explain the concept of entropy as it relates to heating and cooling, using the laws of thermodynamics.
    - Using qualitative and quantitative methods to show the relationship between changes in heat energy and changes in temperature

6. Describe wave behavior in terms of reflection, refraction, diffraction, constructive and destructive wave interference, and the Doppler effect.
    - Explaining reasons for differences in speed, frequency, and wavelength of a propagating wave in varying materials
    - Describing uses of different components of the electromagnetic spectrum, including radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X rays, and gamma radiation
    - Demonstrating particle and wave duality
    - Describing the change of wave speed in different media

7. Describe properties of reflection, refraction, and diffraction.

    Examples: tracing the path of a reflected light ray, predicting the formation of reflected images through tracing of rays

    - Demonstrating the path of light through mirrors, lenses, and prisms

        Example: tracing the path of a refracted light ray through prisms using Snell's law
    - Describing the effect of filters and polarization on the transmission of light

8. Summarize similarities in the calculation of electrical, magnetic, and gravitational forces between objects.
    - Determining the force on charged particles using Coulomb's law

9. Describe quantitative relationships among charge, current, electrical potential energy, potential difference, resistance, and electrical power for simple series, parallel, or combination direct current (DC) circuits.

AQUASCIENCE ELECTIVE CORE

Aquascience introduces students to practical applications of both physical and biological concepts and skills. While aquaculture is the cornerstone of the course, the program places heavy emphasis on integration of knowledge to solve problems and broaden depth of understanding about such topics as selective breeding; marine geology, hydrology, and fluid dynamics; biogeochemical cycles; and regulation of management of water resources.

The core itself is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the aquascience curriculum beyond the minimum core content**,** accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should also be used in instruction to the maximum extent possible to illustrate scientific concepts and principles. Recommended prerequisite science courses for the Aquascience Elective Core are the required Biology Core and a physical science course.

Students will:

1. Differentiate among freshwater, brackish water, and saltwater ecosystems.
   - Identifying chemical, geological, and physical features of aquatic ecosystems

2. Relate geological and hydrological phenomena and fluid dynamics to aquatic systems.

3. Explain the importance of biogeochemical cycles in an aquatic environment.

4. Determine important properties and content of water as related to aquaculture.
   Examples: turbidity, pH, pollutants, dissolved oxygen, high specific heat, density, temperature

   - Describing the influence of water quality on aquaculture
     Examples: aquatic plant control, water quality management, recognition and correction of oxygen deficiency, pH control
   - Identifying sources of aquatic pollution
     Examples: point and nonpoint pollution, volcanic ash, waste disposal
   - Describing methods of reclaiming waste water and polluted water
     Examples: settling ponds; hydroponics; irrigation water; chemical additives; mechanical, biological, and chemical filtering systems

5. Identify the genotype and phenotype for specific characteristics in aquatic animals resulting from selective breeding.
   Examples: disease-resistant fish, rapid maturation rates

   - Explaining the importance of anatomy and physiology in aquaculture
     Examples: body systems, internal and external anatomy of a fish, basic structure of an oyster

6. Describe adaptations that allow organisms to exist in specific aquatic environments.

7. Describe processes and environmental characteristics that affect growth rates of aquatic animals.
   Examples: reproductive habits, feeding habits, interdependence of organisms, overcrowding, seasonal changes

8. Determine effects of the fishing industry on the aquatic environment.
   Examples: aquaculture, overfishing

   - Describing basic principles involved in fish production
   - Explaining various methods of pond preparation, predator control, and species management
   - Explaining harvesting techniques and methods of transporting fish to market

9. Describe various structures and equipment used in growing aquacrops.
   Examples: open ponds, cages, raceways, tanks, silos

   - Determining the suitability of habitat construction for aquaculture
   - Identifying biological concerns in a recirculating or closed system

10. Describe the control of disease and pests in aquatic environments.
    Examples: pathogenic microspecies, parasites, predators, trash fish

BOTANY ELECTIVE CORE

Botany is a laboratory-based elective core focusing on advanced biological concepts addressed in the Biology Core. The Botany Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite science course for the Botany Elective Core is the Biology Core.

Students will:

1. Identify the twelve plant kingdom divisions.
   - Classifying native Alabama plants using dichotomous keys

2. Describe phylogenetic relationships between plants and other organisms.
   - Classifying plants as vascular or nonvascular
   - Classifying seed-bearing and spore-bearing plants
   - Classifying plants as gymnosperms or angiosperms
   - Contrasting monocots and dicots
   - Describing mutualism among algae and fungi in lichens

3. List plant adaptations required for life on land.
   - Describing the alternation of generations in plants
   - Comparing characteristics of algae and plants

4. Identify major types of plant tissues found in roots, stems, and leaves.
   Examples: parenchyma, sclerenchyma, collenchyma

5. Identify types of roots, stems, and leaves.
   Examples: roots—tap, fibrous;
   stems—herbaceous, woody;
   leaves—simple, compound

6. Explain the importance of soil type, texture, and nutrients to plant growth.
   - Describing water and mineral absorption in plants
   - Analyzing the roles of capillarity and turgor pressure

7. Explain plant cell processes, including light dependent and light independent reactions of photosynthesis, glycolysis, aerobic and anaerobic respiration, and transport.

8. Describe plant responses to various stimuli.
   - Identifying effects of hormones on plant growth
     Examples: gibberellin, cytokinin, auxin
   - Differentiating among phototropism, gravitropism, and thigmotropism

9. Identify life cycles of mosses, ferns, gymnosperms, and angiosperms.

10. Describe the structure and function of flower parts.
    - Describing seed germination, development, and dispersal

11. Describe various natural and artificial methods of vegetative propagation.
    Examples: natural—stem runners, rhizomes, bulbs, tubers;
    artificial—cutting, grafting, layering

12. Describe the ecological and economic importance of plants.
    Examples: ecological—algae-producing oxygen, bioremediation, soil preservation;
    economic—food, medication, timber, fossil fuels, clothing

    - Analyzing effects of human activity on the plant world

13. Identify viral, fungal, and bacterial plant diseases and their effects.
    Examples: viral—tobacco mosaic, Rembrandt tulips;
    fungal—mildew, rust;
    bacterial—black rot

EARTH AND SPACE SCIENCE ELECTIVE CORE

The Earth and Space Science Elective Core introduces students to an advanced study of Earth and perspectives of the universe from Earth as well as future challenges and technologies required for space exploration. This core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core encourage students to make informed decisions using critical-thinking and problem-solving skills, perform investigations using the scientific method, utilize appropriate technology, and apply knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite science course for the Earth and Space Science Elective Core is the Physical Science Core, the Chemistry Core, or the Physics Core.

Students will:

1. Describe sources of energy, including solar, gravitational, geothermal, and nuclear.

2. Describe effects on weather of energy transfer within and among the atmosphere, hydrosphere, biosphere, and lithosphere.
    - Describing the energy transfer related to condensation in clouds, precipitation, winds, and ocean currents
    - Describing characteristics of the El Niño and La Niña phenomena
    - Using data to analyze global weather patterns
      Examples: temperature, barometric pressure, wind speed and direction

3. Explain how weather patterns affect climate.
    - Explaining characteristics of various weather systems, including high and low pressure areas or fronts
    - Interpreting weather maps and symbols to predict changing weather conditions
    - Identifying technologies used to obtain meteorological data

4. Describe the production and transfer of stellar energies.
    - Describing the relationship between life cycles and nuclear reactions of stars
    - Describing how the reception of solar radiation is affected by atmospheric and lithospheric conditions
      Example: volcanic eruptions and greenhouse gases affecting reflection and absorption of solar radiation

5. Discuss various theories for the origin, formation, and changing nature of the universe and our solar system.
    - Explaining the nebular hypothesis for formation of planets, the big bang theory, and the steady state theory
    - Relating Hubble's law to the concept of an ever-expanding universe
    - Describing the impact of meteor, asteroid, and comet bombardment on planetary and lunar development

6. Explain the length of a day and of a year in terms of the motion of Earth.
    - Explaining the relationship of the seasons to the tilt of Earth's axis and its revolution about the sun

7. Explain techniques for determining the age and composition of Earth and the universe.
    - Using radiometric age methods to compute the age of Earth
    - Using expanding universe measurements to determine the age of the universe
    - Identifying techniques for evaluating the composition of objects in space

8. Explain the terms astronomical unit and light year.

9. Relate the life cycle of stars to the H-R diagram.
    - Explaining indicators of motion by the stars and sun in terms of the Doppler effect and red and blue shifts
    - Describing the relationship of star color, brightness, and evolution to the balance between gravitational collapse and nuclear fusion

10. Identify scientists and their findings relative to Earth and space, including Copernicus, Galileo, Kepler, Newton, and Einstein.
    - Identifying classical instruments used to extend the senses and increase knowledge of the universe, including optical telescopes, radio telescopes, spectroscopes, and cameras

11. Describe pulsars, quasars, black holes, and galaxies.

12. Describe challenges and required technologies for space exploration.
    - Identifying long-term human space travel needs, including life support
    - Identifying applications of propulsion technologies for space travel
    - Identifying new instrumentation and communication technologies needed for space information gathering

        Examples: Mars Exploration Rover, Cassini spacecraft and Huygens probe, Gravity Probe B
    - Identifying benefits to the quality of life that have been achieved through space advances

        Examples: cellular telephone, GPS
    - Identifying new technology used to gather information, including spacecraft, observatories, space-based telescopes, and probes

ENVIRONMENTAL SCIENCE ELECTIVE CORE

The Environmental Science Elective Core introduces students to a broad view of the biosphere and the physical parameters that affect it. Students study a variety of topics including energy resources, environmental quality, and human practices and their effect on the environment. The Environmental Science Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. Recommended prerequisite science courses for the Environmental Science Elective Core are the Biology and Physical Science Cores or the Biology and Chemistry Cores.

Students will:

1. Identify the influence of human population, technology, and cultural and industrial changes on the environment.
    - Describing the relationship between carrying capacity and population size

2. Evaluate various fossil fuels for their effectiveness as energy resources.
    - Describing the formation and use of nonrenewable fossil fuels
    - Identifying by-products of the combustion of fossil fuels, including particulates, mercury, sulfur dioxide, nitrogen dioxide, and carbon dioxide
    - Identifying chemical equations associated with the combustion of fossil fuels
    - Describing benefits of abundant, affordable energy to mankind
    - Identifying effects of fossil fuel by-products on the environment, including ozone depletion; formation of acid rain, brown haze, and greenhouse gases; and concentration of particulates and heavy metals

3. Evaluate other sources of energy for their effectiveness as alternatives to fossil fuels.
    - Comparing nuclear fission and nuclear fusion reactions in the production of energy
    - Comparing energy production and waste output in generating nuclear energy
    - Differentiating between renewable and nonrenewable energy resources
    - Identifying local energy sources
        Examples: landfill gas, wind, water, sun
    - Identifying ways the law of conservation of energy relates to fuel consumption
        Examples: development of hybrid cars, construction of energy-efficient homes

4. Identify the impact of pollutants on the atmosphere.
   - Identifying layers of the atmosphere and the composition of air
   - Describing the formation of primary, secondary, and indoor air pollutants
   - Relating pollutants to smog and thermal inversions
   - Investigating the impact of air quality on the environment
   - Interpreting social, political, and economic influences on air quality

5. Describe properties of water that make it a universal solvent.

6. Identify sources of local drinking water.
   - Determining the quality of fresh water using chemical testing and bioassessment
   - Describing the use of chemicals and microorganisms in water treatment
   - Describing water conservation methods
   - Describing the process of underground water accumulation, including the formation of aquifers
   - Identifying major residential, industrial, and agricultural water consumers
   - Identifying principal uses of water

7. Identify reasons coastal waters serve as an important resource.
   Examples: economic stability, biodiversity, recreation

   - Classifying biota of estuaries, marshes, tidal pools, wetlands, beaches, and inlets
   - Comparing components of marine water to components of inland bodies of water

8. Identify major contaminants in water resulting from natural phenomena, homes, industry, and agriculture.
   - Describing the eutrophication of water by industrial effluents and agricultural runoffs
   - Classifying sources of water pollution as point and nonpoint

9. Describe land-use practices that promote sustainability and economic growth.
   Examples: no-till planting, crop rotation

   - Defining various types and sources of waste and their impact on the soil
     Examples: types—biodegradeable, nonbiodegradeable, organic, radioactive, nonradioactive;
     sources—pesticides, herbicides
   - Identifying ways to manage waste, including composting, recycling, reusing, and reclaiming

10. Describe the composition of soil profiles and soil samples of varying climates.
    - Identifying various processes and activities that promote soil formation
      Examples: weathering, decomposition, deposition
    - Relating particle size to soil texture and type of sand, silt, or clay

11. Describe agents of erosion, including moving water, gravity, glaciers, and wind.
    - Describing methods for preventing soil erosion
      Examples: planting vegetation, constructing terraces, providing barriers

12. Identify positive and negative effects of human activities on biodiversity.
    - Identifying endangered and extinct species locally, regionally, and worldwide
    - Identifying causes for species extinction locally, regionally, and worldwide

FORENSIC SCIENCE ELECTIVE CORE

The Forensic Science Elective Core focuses on the analysis of evidence collection, the decomposition process, crime scenes, skeletal remains, toxicology, and document validity. Case studies and crime scenarios help students understand the implications and complicated issues that are emerging as the science of forensics continues to develop.

The Forensic Science Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to the solving of practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite science course for the Forensic Science Elective Core is the Biology Core.

Students will:

1. Describe responsibilities of various personnel involved in crime scene investigations.
   Examples: police, detectives, laboratory specialists, medical examiners

   - Explaining how to search, sketch, and record data from a crime scene

2. Explain ways to collect and preserve evidence from a crime scene.
   - Distinguishing between physical evidence and witness evidence
   - Comparing the three main pattern types that combine to form an individual's unique fingerprint
   - Explaining different methods of latent fingerprint development
   - Identifying origins of impressions, including footwear and tire treads
   - Describing ways to identify hair, fiber, and blood evidence

3. Distinguish between class and individual characteristics of firearms.
   Examples: toolmark, caliber, scatter pattern

4. Describe presumptive and confirmatory tests.
   Examples: blood type comparison, DNA testing

5. Describe the importance of genetic information to forensics.
   - Using the process of gel electrophoresis to identify patterns in DNA

6. Describe the decomposition process.
    - Using rigor mortis to determine corpse position
    - Identifying decomposition by-products to determine cause of death
    - Using entomological life cycles to determine time of death

7. Identify the importance of skeletal remains in forensics.
    - Comparing bones and skulls based on age, sex, and race
    - Using forensic dentistry to establish identity

8. Describe general categories of drugs and poisons and their effects on humans.
    - Explaining ways poisons are detected at autopsy

9. Use laws of physics to explain forensic evidence.
    - Analyzing blood splatter patterns in relation to speed, height, and direction
    - Tracking trajectories of collected evidence

10. Describe techniques used to determine the validity of documents.
    Examples: fiber and handwriting analyses, ink chromatography

GENETICS ELECTIVE CORE

The Genetics Elective Core focuses on Mendelian genetics, gene structure and function, inheritance patterns, genetic abnormalities, biotechnology, and the Human Genome Project. Case studies in biotechnology and scenarios in bioethics help students understand the implications and complicated issues that are emerging as the science of genetics continues to develop. The Genetics Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. Recommended prerequisite science courses for the Genetics Elective Core are Algebra I and the Biology and Physical Science Cores or the Biology and Chemistry Cores.

Students will:

1. Explain how the Hardy-Weinberg principle provides a baseline for recognizing evolutionary changes in gene frequency due to genetic drift, gene flow, nonrandom mating, mutation, and natural selection.

2. Describe factors such as radiation, chemicals, and chance that cause mutations in populations.
   - Describing effects of genetic variability on adaptations

3. Describe the significance of Mendel's work to the development of the modern science of genetics, including the laws of segregation and independent assortment.

4. Describe the process of meiosis and the cell cycle, including the hereditary significance of each.
   - Comparing spermatogenesis and oogenesis using charts

5. Describe inheritance patterns based on gene interactions.
   - Predicting patterns of heredity using pedigree analysis
   - Identifying incomplete dominance, codominance, and multiple allelism

6. Describe occurrences and effects of sex linkage, autosomal linkage, crossover, multiple alleles, and polygenes.

7. Describe the structure and function of DNA, including replication, translation, and transcription.
   - Applying the genetic code to predict amino acid sequence
   - Describing methods cells use to regulate gene expression
   - Defining the role of RNA in protein synthesis

8. Explain the structure of eukaryotic chromosomes, including transposons, introns, and exons.

9. Differentiate among major areas in modern biotechnology, including plant, animal, microbial, forensic, and marine.
   Examples: hybridization, cloning, insulin production, DNA profiling, bioremediation

   - Describing techniques used with recombinant DNA
     Examples: DNA sequencing, isolation of DNA segments, polymerase chain reaction, gel electrophoresis

10. Explain the development and purpose of the Human Genome Project.
    - Analyzing results of the Human Genome Project to predict ethical, social, and legal implications
    - Describing medical uses of gene therapy, including vaccines and tissue and antibody engineering

11. Describe the replication of DNA and RNA viruses, including lytic and lysogenic cycles, using diagrams.

GEOLOGY ELECTIVE CORE

The study of geology helps students clarify their understanding of the structure of Earth and the dynamic processes that have shaped and continue to shape it. In the Geology Elective Core, students conduct field and laboratory investigations, use scientific methods during investigations, and make informed decisions based on critical thinking and problem solving. Topics emphasized include plate tectonics, Earth's materials, geologic dating, internal and external geological processes, hydrology, and geology as it relates to the state of Alabama.

The Geology Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite science course for the Geology Elective Core is the Physical Science Core or the Chemistry Core.

Students will:

1. Describe Earth's layers, including the lithosphere, asthenosphere, outer core, and inner core.
   - Identifying methods for determining the composition of Earth's lithosphere
     Example: collection and analysis of rocks and minerals
   - Describing the composition of Earth's lithosphere
     Example: granitic and basaltic rocks
   - Relating the types of lithosphere to tectonic plates
     Examples: granitic lithosphere with continental plates, basaltic lithosphere with oceanic plates
   - Comparing the temperature, density, and composition of Earth's crust to that of the mantle and outer and inner cores

2. Relate the concept of equilibrium to geological processes, including plate tectonics and stream flow.
   Examples: stream channel on a slope, movement of tectonic plates, convection within Earth

3. Explain natural phenomena that shape the surface of Earth, including rock cycles, plate motions and interactions, erosion and deposition, volcanism, earthquakes, weathering, and tides.

4. Describe the topography of the sea floor and the continents.
   - Describing the formation of continental shelves
   - Explaining changes of continental topography caused by erosion and uplift
     Example: formation of southern Appalachian Mountains in Alabama

5. Classify rocks as sedimentary, igneous, and metamorphic.
   - Identifying characteristics of extrusive and intrusive igneous rocks
   - Describing mineral composition and chemical elements of rocks
   - Describing characteristics of clastic, organic, and chemical sedimentary rocks
   - Explaining texture and composition of rocks

6. Explain the concept of geological time within the framework of the geologic time scale.
   - Describing how sedimentary rocks provide a record of evolutionary change
   - Describing the role of fossils in determining the age of strata
   - Identifying geological time scales, including eon, era, period, and epoch
   - Identifying relative and absolute dating methods

7. Describe processes of rock formation.
   Examples: cooling, deposition

   - Explaining factors that control texture and composition of rocks
     Examples: formation depth, formation size, chemical composition
   - Describing processes of fossil formation

8. Explain interactions among topography, climate, organic activity, time, and parent material through which soils are created.

9. Describe the movement and storage of water in terms of watersheds, rainfall, surface runoff, aquifers, and surface water reservoirs.
   - Identifying major regional and national watersheds

10. Explain the mechanism of plate tectonics.
    - Explaining processes that cause earthquakes and volcanic eruptions
    - Identifying Earth's main tectonic plates
    - Describing faults and folds and their relationships to tectonic forces
    - Describing technologies used to measure and forecast earthquakes and volcanic eruptions

11. Identify mass movements, including topples, slides, spreads, and flows.

12. Identify natural subsurface openings, including lava tubes, solution cavities, and caves.
    - Explaining the process that leads to sinkholes in karst development

13. Describe the formation and characteristics of river systems.
    - Explaining the formation of alluvial fans
    - Identifying natural events and man-made structures that affect rivers
      Examples: natural events—weather, construction of dams by beavers;
      man-made structures—levees, dams

14. Explain the interaction of the continuous processes of waves, tides, and winds with the coastal environment.
    - Identifying the impact of periodic weather phenomena on coastal regions
      Examples: hurricanes destroying sand dunes, El Niño or La Niña redefining shorelines
    - Identifying the positive and negative impact of humans on coastal regions
      Examples: positive—shoreline protection,
      negative—buildings replacing protective dunes and barriers

15. Identify geological regions in Alabama and the southeastern United States.
    - Identifying geological ages of Alabama rocks
    - Describing characteristics of geological regions within Alabama
    - Identifying earthquake zones in Alabama
    - Identifying types of rocks in Alabama
    - Identifying areas of Alabama that have sinkholes and caves
    - Identifying varying seasonal rainfall patterns throughout Alabama

HUMAN ANATOMY AND PHYSIOLOGY ELECTIVE CORE

The Human Anatomy and Physiology Elective Core contains content standards relating to the structure and function of the components of the human body. It is designed specifically for students who are interested in pursuing careers in the medical and allied-health fields. Core content emphasizes the structure and function of cells, tissues, and organs; organization of the human body; biochemistry; and the skeletal, muscular, nervous, endocrine, digestive, respiratory, cardiovascular, integumentary, immune, urinary, and reproductive systems. An important component of this course is the laboratory setting in which students are encouraged to apply the knowledge and processes of science while independently seeking answers to questions of personal interest and importance.

The Human Anatomy and Physiology Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. Safe laboratory exercises, such as histological studies, dissections, urinalysis and blood testing simulations, and computer-based electrocardiography laboratories, should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. Utilization of the ASIM program, where applicable, is highly recommended. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. The recommended prerequisite science course for the Human Anatomy and Physiology Elective Core is the Biology Core.

Students will:

1. Use appropriate anatomical terminology.
   Examples: proximal, superficial, medial, supine, superior, inferior, anterior, posterior

2. Identify anatomical body planes, body cavities, and abdominopelvic regions of the human body.

3. Classify major types of cells, including squamous, cuboidal, columnar, simple, and stratified.

4. Classify tissues as connective, muscular, nervous, or epithelial.

5. Identify anatomical structures and functions of the integumentary system.
   - Identifying accessory organs
   - Recognizing diseases and disorders of the integumentary system
     Examples: decubitus ulcer, melanoma, psoriasis

6. Identify bones that compose the skeletal system.
    - Identifying functions of the skeletal system
    - Identifying subdivisions of the skeleton as axial and appendicular skeletons
    - Classifying types of joints according to their movement
    - Identifying the four bone types
    - Identifying various types of skeletal system disorders
      Examples: fractures, arthritis

7. Identify major muscles, including origins, insertions, and actions.
    - Describing common types of body movements, including flexion, extension, abduction, and adduction
    - Classifying muscles based on functions in the body, including prime movers, antagonists, synergists, and fixators
    - Comparing skeletal, smooth, and cardiac muscles based on their microscopic anatomy
    - Identifying diseases and disorders of the muscular system
      Examples: muscular dystrophy, multiple sclerosis, strain

8. Identify structures of the nervous system.
    - Explaining differences in the function of the peripheral nervous system and the central nervous system
    - Labeling parts of sensory organs, including the eye, ear, tongue, and skin receptors
    - Recognizing diseases and disorders of the nervous system
      Examples: Parkinson’s disease, meningitis

9. Identify structures and functions of the cardiovascular system.
    - Tracing the flow of blood through the body
    - Identifying components of blood
    - Describing blood cell formation
    - Distinguishing among human blood groups
    - Describing common cardiovascular diseases and disorders
      Examples: myocardial infarction, mitral valve prolapse, varicose veins, arteriosclerosis

10. Identify structures and functions of the digestive system.
    - Tracing the pathway of digestion from the mouth to the anus using diagrams
    - Identifying disorders affecting the digestive system
      Examples: ulcers, Crohn’s disease, diverticulitis

11. Identify structures and functions of the respiratory system.
    - Tracing the pathway of the oxygen and carbon dioxide exchange
    - Recognizing common disorders of the respiratory system
      Examples: asthma, bronchitis, cystic fibrosis

12. Identify structures and functions of the reproductive system.
    - Differentiating between male and female reproductive systems
    - Recognizing stages of pregnancy and fetal development
    - Identifying disorders of the reproductive system
      Examples: endometriosis, sexually transmitted diseases, prostate cancer

13. Identify structures and functions of the urinary system.
    - Tracing the filtration of blood from the kidneys to the urethra
    - Recognizing diseases and disorders of the urinary system
      Examples: kidney stones, urinary tract infections

14. Identify the endocrine glands and their functions.
    - Describing effects of hormones produced by the endocrine glands
    - Identifying common disorders of the endocrine system
      Examples: diabetes, goiter, hyperthyroidism

15. Identify physiological effects and components of the immune system.
    - Contrasting active and passive immunity
    - Evaluating the importance of vaccines
    - Recognizing disorders and diseases of the immune system
      Examples: acquired immunodeficiency syndrome (AIDS), acute lymphocytic leukemia

MARINE SCIENCE ELECTIVE CORE

The Marine Science Elective Core is intended to provide students with advanced studies of science within the context of the marine environment. While emphasis is placed primarily on living organisms, oceanography and aspects of marine water chemistry are important components of the core. Also studied are anatomy and physiology of saltwater organisms, classification, biodiversity, interdependence of organisms within marine biomes, and human and natural impact on marine systems.

The Marine Science Elective Core includes minimum core content and is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the marine science curriculum beyond the minimum content, accommodating specific community interests and utilizing local resources. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. Courses developed from this core should encourage critical thinking, use of the scientific method, and the integration of technology. Investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Recommended prerequisite science courses for the Marine Science Elective Core are the Biology Core and a physical science course.

Students will:

1. Select appropriate equipment for scientific field investigations in marine environments.
    - Identifying patterns and relationships determined from collected data
    - Solving for unknown quantities by manipulating variables

2. Differentiate among freshwater, brackish water, and saltwater.

3. Describe physical characteristics of oceans, including topography of the ocean floor, plate tectonics, wave motion, depth, and pressure.

4. Recognize interactions between the atmosphere and the ocean.
    - Describing how waves, ocean currents, and tides are generated

5. Discuss physical and chemical properties of saltwater.
    Examples: physical—turbidity, temperature, density;
    chemical—salinity, pH, dissolved gases

6. Describe components of major marine ecosystems, including estuaries, coral reefs, benthic communities, and open-ocean communities.

7. Identify patterns and interrelationships among producers, consumers, scavengers, and decomposers in a marine ecosystem.

8. Describe characteristics of marine plant and algae divisions.
    - Describing commercial, economical, and medicinal values of marine plants and algae

9. Arrange various forms of marine life from most simple to most complex.
    - Classifying marine organisms using binomial nomenclature
    - Identifying characteristics of ocean-drifting organisms
      Examples: phytoplankton, zooplankton
    - Identifying characteristics of marine invertebrates
      Examples: Protozoa, Porifera, Coelenterata, Arthropoda
    - Identifying characteristics of marine vertebrates
      Examples: fishes, reptiles, birds, mammals
    - Identifying characteristics of marine plants
      Examples: algae, seaweed
    - Describing adaptations in the marine environment

10. Describe the anatomy and physiology of representative aquatic organisms.
    - Identifying different aquatic species using dichotomous keys

11. Describe positive and negative effects of human influence on marine environments.
    Examples: positive—reef restoration, protection of endangered species;
    negative—pollution, overfishing

12. Identify various careers related to marine science.

ZOOLOGY ELECTIVE CORE

The Zoology Elective Core builds on the Biology Core with added emphasis on animal taxa, basic body plans, symmetry, and behavior. The emerging field of bioethics provides information on the proper care and ethical treatment of laboratory animals. Laboratory investigations, including dissection as well as computer simulations, provide students with adequate exposure to the comparative anatomy of representative animal species. Field studies encourage student interest and provide a means to study animals in their natural surroundings.

The Zoology Elective Core is not intended to serve as the entire curriculum of any course. Teachers are encouraged to expand the curriculum beyond the minimum content of this core, accommodating specific community interests and utilizing unique local resources. Courses developed from this core should encourage critical thinking, use of the scientific method, integration of technology, and application of knowledge and skills learned to practical questions and problems. The scientific process and application skills located on page 10 of this document should be incorporated into as many course standards as possible. It is also essential that students place theories and discoveries of significant persons into a historical perspective. Students should use clear and accurate language, keep accurate records, make reports, present oral and written projects, and participate in discussions regarding the results and conclusions of scientific investigations. Safe field and laboratory investigations should be used in instruction to the maximum extent possible to illustrate scientific concepts and principles and to support inquiry-based instruction. The recommended prerequisite science course for the Zoology Elective Core is the Biology Core.

Students will:

1. Define basic anatomical terminology associated with the study of animals.
   Examples: dorsal, superior, plantar, caudal, aboral

2. Distinguish among the acoelomate, pseudocoelomate, and coelomate body plans.

3. Identify the body symmetry of animals as radial, bilateral, or asymmetrical.

4. Use taxonomic groupings to differentiate the structure and physiology of invertebrates with dichotomous keys.
   - Identifying examples and characteristics of Porifera
   - Identifying examples and characteristics of Cnidaria
   - Identifying examples and characteristics of Mollusca
   - Identifying examples and characteristics of worms, including Platyhelminthes, Nematoda, and Annelida
   - Identifying examples, characteristics, and life cycles of Arthropoda
   - Identifying examples and characteristics of Echinodermata

5. Use taxonomic groupings to differentiate structure and physiology of vertebrates with dichotomous keys.
    - Identifying examples and characteristics of the three classes of fish
    - Identifying examples and characteristics of Amphibia
    - Identifying examples and characteristics of Reptilia
    - Identifying examples and characteristics of Aves
    - Identifying examples and characteristics of Mammalia

6. Identify factors used to distinguish species, including behavioral differences and reproductive isolation.

7. Explain how species adapt to changing environments to enhance survival and reproductive success, including changes in structure, behavior, or physiology.
    Examples: aestivation, thicker fur, diurnal activity

8. Differentiate among organisms that are threatened, endangered, and extinct.
    Examples: threatened—bald eagle,
    endangered—California condor,
    extinct—dodo

    - Identifying causative factors of decreasing population size
        Examples: overcrowding resulting in greater incidence of disease, fire destroying habitat and food sources

9. Analyze a field study of animal behavior patterns to determine the relationship of these patterns to an animal's niche.