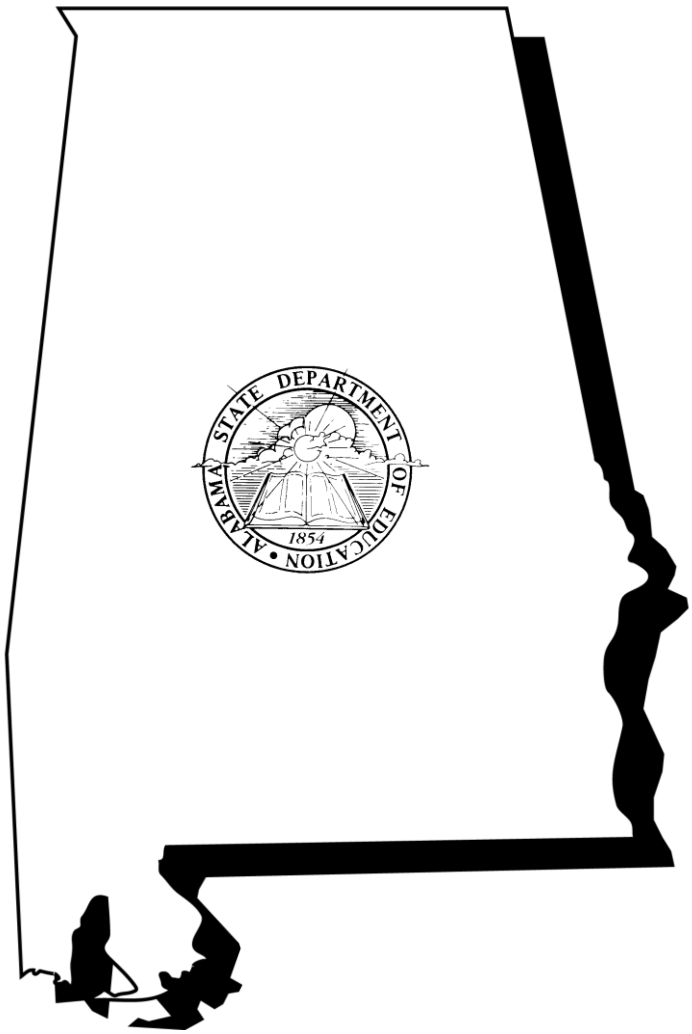
Alabama Course of Study
Science



Joseph B. Morton
State Superintendent of Education
ALABAMA DEPARTMENT OF EDUCATION
Bulletin 2005, No. 20

STATE SUPERINTENDENT OF EDUCATION'S MESSAGE

Dear Educator:

Scientific literacy for all Alabama students is the goal of Alabama's K-12 science program. This is a lofty objective and one that is not easily or quickly attained. Its accomplishment, however, is essential if Alabama students are to meet the daily challenges of the twenty-first century. Recognizing this, the new *Alabama Course of Study: Science* (Bulletin 2005, No. 20) focuses on scientific literacy and provides rigorous content standards delineating expected achievement by all students in Alabama.

The new Science Course of Study incorporates national standards and reform efforts in science education. It also presents a more rigorous, "hands-on," "minds-on" approach to teaching fundamental science concepts. As our state and nation depend more and more on science and technology, scientific literacy is increasingly becoming the benchmark for the success of our children. Their success is in our hands.

The Science State Course of Study Committee and Task Force (composed of educators and business and community leaders), the State Board of Education, and I believe a sound program of instruction has been developed to guide local school systems in the implementation of their science curricula. Using this new course of study as the foundation, let us work together to prepare every student for a bright and promising future.

JOSEPH B. MORTON
State Superintendent of Education

Alabama Course of Study: Science

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PREFACE

The *Alabama Course of Study: Science* (Bulletin 2005, No. 20) provides the framework for the K-12 science education program in Alabama's public schools. Content standards in this document are minimum and required (*Code of Alabama*, 1975, §16-35-4). They are fundamental and specific but not exhaustive. When developing a local curriculum, each school system may include additional content standards to address specific local needs or focus on local resources. Implementation guidelines, resources, and activities may also be added.

The 2004-2005 Science State Course of Study Committee and Task Force made use of the following documents in developing the minimum required content: *Alabama Course of Study: Science* (Bulletin 2001, No. 20); *National Science Education Standards* produced by the National Research Council; Project 2061's *Science for All Americans*; *Benchmarks for Science Literacy* published by the American Association for the Advancement of Science; and *Pathways to the Science Standards* published by the National Science Teachers Association.

In addition, Committee members read articles in professional journals and magazines, reviewed similar documents from other states, and examined national evaluations of state standards. Members attended state and national conferences, listened to and read suggestions from interested individuals and groups throughout Alabama, and discussed each issue and standard among themselves.

The following position statement regarding scientific theories is included in this document. The word "theory" has many meanings. Theories are defined as systematically organized knowledge, abstract reasoning, speculative ideas or plans, or systematic statements of principles. Scientific theories are based on both observations of and assumptions about the natural world. They are always subject to change in view of new and confirmed observations.

Many scientific theories have been developed over time. The value of scientific work, however, is not only the development of theories but also what is learned from the development process. The *Alabama Course of Study: Science* was developed within the context of trying to establish scientific literacy, not to question or diminish one's beliefs or faith. To that end, this document includes many theories and studies of scientists' works for examination by students. The works of Copernicus, Newton, and Einstein, to name a few, have provided a basis for much of our knowledge of the world today.

The theory of evolution by natural selection, a theory included in this document, states that natural selection provides the basis for the modern scientific explanation for the diversity of living things. Since natural selection has been observed to play a role in influencing small changes in a population, it is assumed, based on the study of artifacts, that it produces large changes, even though this has not been directly observed. Because of its importance and implications, students should understand the nature of evolutionary theories. They should learn to make distinctions among the multiple meanings of evolution, to distinguish between observations and assumptions used to draw conclusions, and to wrestle with the unanswered questions and unresolved problems still faced by evolutionary theory.

There are many unanswered questions about the origin of life. With the explosion of new scientific knowledge in biochemical and molecular biology and exciting new fossil discoveries, Alabama students may be among those who use their understanding and skills to contribute to knowledge and to answer many unanswered questions. Instructional materials chosen to implement the content standards within this course of study should be approached with an open mind, studied carefully, and critically considered.

ACKNOWLEDGMENTS

This document was developed by the 2004-2005 Science State Course of Study Committee and Task Force composed of early childhood, intermediate, middle school, high school, and college educators appointed by the State Board of Education and business and professional persons appointed by the Governor (*Code of Alabama*, 1975, §16-35-1). The Committee and Task Force began work in March 2004 and submitted the document to the State Board of Education for adoption at the February 2005 meeting.

Science State Course of Study Committee and Task Force

Wayne T. Ray, Ed.D., Superintendent, Russellville City Board of Education, 2004-2005 Science State Course of Study Committee Chairperson

Sonya Adams, Teacher, Forest Hills Middle School, Fairfield City Board of Education

Marsha Hardy Boswell, Teacher, Ragland High School, St. Clair County Board of Education

James R. Bounds, Program Manager, Colsa Corporation, Huntsville

A. E. Carden, Ph.D., Professor Emeritus, The University of Alabama

Tonya Coker, Teacher, Fort Deposit Elementary School, Lowndes County Board of Education

Donny Davis, Assistant Principal, Russellville High School, Russellville City Board of Education

Kathryn Eddy, Teacher, Greenwood Elementary School, Bessemer City Board of Education

Erin Glover, Teacher, Inverness Elementary School, Shelby County Board of Education

Francis H. Hare, Jr., Attorney, Birmingham

Barbara J. Harris, Teacher, Collins Elementary School, Scottsboro City Board of Education

Jo McGill Hellmich, Teacher, Silverhill Elementary School, Baldwin County Board of Education

Rhonda White Jett, Teacher, J. B. Pennington High School, Blount County Board of Education

Patti Johnson, Principal, Ashville Elementary School, St. Clair County Board of Education

Ben Johnston, Teacher, Liberty Middle School, Madison City Board of Education

DeeDee M. Jones, M.D., Teacher, Russell County High School, Russell County Board of Education

Sonja B. Jones, Teacher, Brownwood Elementary School, Scottsboro City Board of Education

Laura Kennedy, Teacher, Maddox Middle School, Jasper City Board of Education

Elizabeth Kennedy Lawlor, Chief of Staff, Office of House Majority Leader, Montgomery

Richard Quinn Lee, Teacher, Oxford High School, Oxford City Board of Education

Jane Latimer Little, Teacher, Carlisle Park Middle School, Guntersville City Board of Education

Kenya Martin, Teacher, South Highlands Elementary School, Opp City Board of Education

June Mays, Teacher, Winfield Elementary School, Winfield City Board of Education

John Mincy, (retired) Executive, Novartis Corporation, Mobile

James W. Nabers, Jr., M.D., Physician, Red Bay

Cinda Young Preuit, Teacher, Speake School, Lawrence County Board of Education

Melanie Maddox Sessions, Teacher, Charles Henderson High School, Troy City Board of Education

Edward L. Shaw, Jr., Ed.D., Professor, University of South Alabama

Penelope Dawn Smith, Teacher, Zion Chapel High School, Coffee County Board of Education

Jo A. Stafford, Teacher, Hampton Cove Middle School, Huntsville City Board of Education

Angie Stapler, Teacher, Douglas Elementary School, Marshall County Board of Education

Phyllis Taylor, Instructor, Jacksonville State University

Gloria J. Thomas, Teacher, Lakewood Elementary School, Phenix City Board of Education

Beth Bowers Vaughan, Project Manager, CH2M Hill, Auburn

Tillie Valdivia Warmack, Teacher, Elizabeth S. Chastang Middle School, Mobile County Board of Education

Anita H. Watts, Teacher, Lincoln High School, Talladega County Board of Education

Appreciation is extended to **Scott Brande, Ph.D.,** University of Alabama at Birmingham; **John Christy, Ph.D.,** University of Alabama at Huntsville; **Tom Denton, Ph.D.,** Auburn University Montgomery; **Marion J. Goldston, Ph.D.,** The University of Alabama; **Paul Helminger, Ph.D.,** University of South Alabama; **Raymond Henry, Ph.D.,** Auburn University; **Steve Kempf, Ph.D.,** Auburn University; **Jason Linville, Ph.D.,** University of Alabama at Birmingham; **Joe March, Ph.D.,** University of Alabama at Birmingham; **Nathan Okia, Ph.D.,** Auburn University Montgomery; **Velma Richardson, Ph.D.,** Tuskegee University; **Gena Riley, Ph.D.,** Jacksonville State University; and **M. E. Spencer,** University of Montevallo, who served as content reviewers of this document.

State Department of Education personnel who managed the development process were:

Ruth C. Ash, Ed.D., Deputy State Superintendent of Education;
Feagin Johnson, Jr., Assistant State Superintendent of Education;
Anita Buckley Commander, Ed.D., Director, Classroom Improvement;
Cynthia C. Brown, Coordinator, Curriculum and Programs, Classroom Improvement; and
Martha B. Donaldson, Executive Secretary, State Courses of Study Committees, Curriculum and Programs, Classroom Improvement.

State Department of Education program specialists who assisted the Committee and Task Force in developing the document were:

Ginger Montgomery, Science Specialist, Curriculum and Programs, Classroom Improvement;
John Halbrooks, Science in Motion Specialist, Curriculum and Programs, Classroom Improvement;
Robin Nelson, Science Specialist; Alabama Math, Science, and Technology Initiative; and
Kay A. Warfield, Ed.D., Elementary Science Specialist, Field Services, Classroom Improvement.

State Department of Education process specialists who assisted the Committee and Task Force in developing the document were:

DaLee Chambers, Ph.D., Education Specialist, Special Education Services;
Susan DuBose, Social Studies Specialist, Field Services, Classroom Improvement;
Julia E. Felder, Counseling and Guidance Specialist, Curriculum and Programs, Classroom Improvement;
Charlie Jackson, Education Specialist, Special Education Services;
Sarah F. Mason, Ed.D., Mathematics Specialist, Curriculum and Programs, Classroom Improvement;
J. Steve McAliley, Language Arts Specialist, Curriculum and Programs, Classroom Improvement;
Dan Roth, Education Specialist, Special Education Services;
Mark Ward, Assessment Specialist, Assessment;
Debra Webster, Health and Physical Education Specialist, Field Services, Classroom Improvement; and
Sara Wright, Arts Specialist, Curriculum and Programs, Classroom Improvement.

Leigh Ann Kyser, Administrative Assistant to the Deputy State Superintendent, assisted with the preparation of the document.

Rosetta Ball, clerical support staff, Curriculum and Programs, Classroom Improvement, assisted with the preparation of the document.

Mary Nell Shaw, Graphic Arts Specialist, Communication Section, assisted in the development of the graphic design.

Susan J. Blankenship, (retired) Education Specialist, State Department of Education, edited and proofread the document.

ALABAMA'S K-12 SCIENCE CURRICULUM

General Introduction

Scientific Literacy: A Goal for Alabama's K-12 Science Education Program

The *National Science Education Standards* document produced by the National Research Council (NRC) has established scientific literacy as a national goal of science education. Scientific literacy for all Alabama students also continues to be the goal of Alabama's K-12 science education program. The *Alabama Course of Study: Science* (Bulletin 2005, No. 20) defines the minimum required content that students should master to achieve this goal.

Scientific literacy enables students to use scientific principles and processes in everyday life to make informed decisions. A solid foundation in science helps develop and strengthen many skills that students use daily such as solving problems creatively, thinking critically, working cooperatively in teams, practicing stewardship of natural resources, and using technology effectively. The goal of scientific literacy is best achieved through an inquiry-based K-12 science program that incorporates scientific knowledge and skills with opportunities to apply both in practical ways.

In order to empower students to achieve scientific literacy and to make sound decisions, Alabama's K-12 science program places a renewed emphasis on the importance of **teaching science every day to every student in every grade.** A young student's sense of wonder is strongly encouraged by teachers who stimulate and nurture young children's interests, senses, curiosities, and impressions concerning the world around them. As these students grow into preadolescence, exposure to concrete facts, scientific generalizations, theories, principles, and laws becomes increasingly important. Conceptual understanding gradually expands from the concrete to the abstract as students mature and acquire the ability to master complex applications. Instruction is focused on providing experiences, knowledge, and skills that allow students to build understanding of both the content of science and the nature of the scientific enterprise.

Effective implementation of the *Alabama Course of Study: Science* encourages the development of scientifically literate students. Such individuals are more likely to face with confidence the challenges of an ever-changing world as well as enhance the economic productivity of Alabama, which is directly linked to the scientific and technological skills of its workforce. Student achievement of the goal of scientific literacy requires an investment in students' education that is well worth the efforts and resources expended.

ALABAMA'S K-12 SCIENCE CURRICULUM

Conceptual Framework

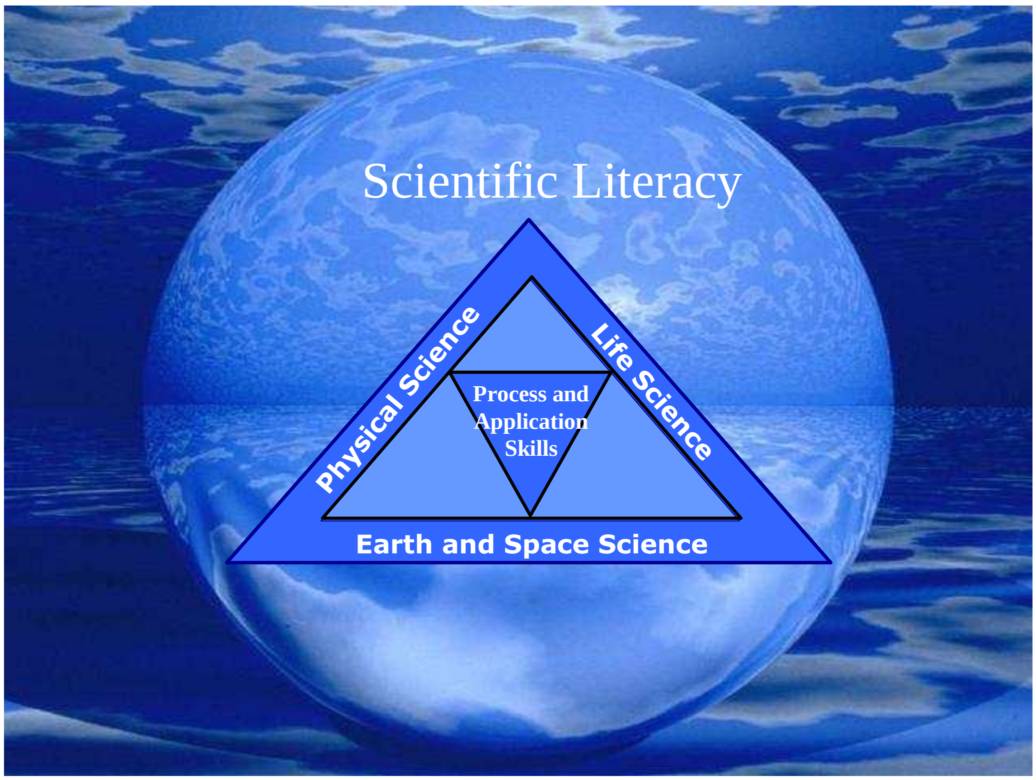
The goal of Alabama's K-12 science curriculum is the achievement of scientific literacy by all Alabama students. A scientifically literate person is one who has a sound basis in scientific knowledge, the ability to use scientific processes and technology to understand science-related decisions and problems, and the ability to apply science to the increasing challenges of an ever-changing world. The relationship among these aspects of scientific literacy is depicted in the conceptual framework graphic, which provides a blueprint for scientific literacy for all Alabama students. This framework illustrates the two basic components for establishing scientific literacy — the minimum required content that students should master and the process and application skills that are the mechanisms for structuring, integrating, and teaching the content standards.

To face the many challenges of a mobile society, Alabama students must be given every opportunity to become scientifically literate from a worldwide perspective. The need for international scientific literacy is represented by the global impression on the graphic representation of the conceptual framework. The content that is the basis for Alabama's science curriculum in Grades K-12 is represented by the outside triangle of the graphic. Like the triangle, which is the most stable of shapes, this content represents a firm and steady foundation upon which school systems can develop curricula that satisfy the needs of all students. The three domains of scientific knowledge — Physical Science, Life Science, and Earth and Space Science — are represented by the three sides of the outside triangle. These domains continue from kindergarten through the high school courses, with concepts increasing in rigor through the grades. Content standards build on each succeeding grade level, eliminating repetition from one grade or course to another. For example, the concept of matter in the Physical Science domain progresses from identifying matter as solid or liquid in kindergarten and describing states of matter based on the kinetic energy of its particles in Grade 8 to describing the momentum of objects in motion, including the calculation of momenta of objects, in the high school Physics Core. Similar progressions are found in the other two domains. The concept of the structure of living things in the Life Science domain ranges from comparing size, shape, structure, and basic needs of living things in kindergarten to justifying the grouping of viruses in a category separate from living things in the high school Biology Core. In the Earth and Space Science domain, concepts progress from identifying objects observed in the day sky in kindergarten to identifying moon phases in Grade 6 and relating the life cycle of stars to the Hertzprung-Russell (H-R) diagram in the high school Earth and Space Science Elective Core. While students achieve scientific literacy at varying degrees throughout the grades, the content standards establish the minimum content that all students should master.

Scientific process skills are defined as critical and logical methods or skills used for searching for and evaluating knowledge. Represented by the inside triangular region, these skills are embedded within the three domains of science. The scientific application skills, which incorporate technology, enable students to use and enhance scientific knowledge. The process skills, along with the application skills, address how science consists of both "hands-on" and "minds-on" experiences for students, including observing, inferring, experimenting, and using inquiry-based learning.

Scientific literacy is the mastery of the science content standards that leads one to exhibit the use of scientific processes, understand the fundamental principles of science, and utilize acquired knowledge in making science-related decisions and solving problems. Scientific literacy is the ultimate goal of the K-12 science curriculum as reflected by its position in the conceptual framework illustration on page 3. This goal serves as the apex from which all content standards are derived and is the key element in the design of Alabama's K-12 science curriculum.

CONCEPTUAL FRAMEWORK



POSITION STATEMENTS

CLASSROOM ENVIRONMENT

Effective science classroom environments are those in which teachers and students work collaboratively in the teaching and learning of science. These effective environments are designed by teachers who continually seek to enhance knowledge regarding the field of science as well as seek professional growth regarding classroom instruction and student learning. The classroom environment provides developmentally appropriate opportunities for students to "do science." "Inquiry-based learning"; "hands-on, minds-on learning"; and "active learning" are integral to this environment. This kind of classroom reflects the following features.

- Student interaction and active engagement with objects and other students or adults provide for maximum understanding.
- Student learning styles and interests are integral parts of planned and spontaneous activities that allow the flexibility to take advantage of "teachable moments."
- Student inventions and discoveries are the intended, encouraged, and valued elements of instructional design.
- Student understanding is facilitated, guided, and constantly assessed.

LABORATORY EMPHASIS

Effective science instruction emphasizes critical thinking and investigative processes that reveal consistencies, relationships, and patterns. The science laboratory, therefore, should be thought of as any place where scientific inquiry occurs, whether it be the traditional laboratory, classroom, playground, science museum, amusement park, or beach. Laboratories are most effectively used when students manipulate variables, make observations, and use prior knowledge to construct reasonable explanations when solving problems. Teachers guide and facilitate investigations by instructing students in scientific methods of inquiry, in correct and appropriate manipulative techniques, and in safe and humane laboratory practices.

SCIENTIFIC WRITING

Written communication is essential. Writing, therefore, should be emphasized across the curriculum. Students should be given opportunities to demonstrate writing skills to explain and document inquiries of scientific phenomena and concepts. Writing activities, such as scientific journals and laboratory reports, should be introduced in the primary grades. During the middle and high school years, students should expand writing skills to complete more detailed laboratory reports using appropriate terminology, available technology, and suitable units of measurement. In addition, open-ended essays are an excellent way to assess students' understanding of scientific concepts, principles, and laws.

SAFETY

Active hands-on learning increases the potential for injuries or accidents. Safety is a primary concern for everyone in kindergarten through Grade 12, including students, teachers, support personnel, and administrators. For this reason, the National Science Teachers Association (NSTA) and the Science State Course of Study Committee and Task Force recommend that all science teachers be certified in first aid by the American Red Cross. Before allowing students to participate in scientific investigations, teachers should recognize any potential for harm in order to prevent possible injuries or accidents or to minimize the impact of injuries or accidents if prevention is not successful.

Safety must be given priority in the storage, use, and care of equipment, specimens, and materials within the realm of the scientific process. In addition, all equipment should be maintained in good working condition for its intended purpose. Science teachers should adhere to national regulatory agencies such as the American Chemical Society (ACS) and the Occupational Safety and Health Administration (OSHA) as well as local and state regulatory agencies that have established safety guidelines. In addition, teachers must work with the local school and local school system to be certain that the science safety guidelines for which they are responsible are implemented. Teachers must also be certain that students receive adequate instruction for participating safely in all science investigations, no matter the location. As part of the safety guidelines, consideration must be given to adequate and safe space for scientific collaboration and investigation. To address this safety issue, professional organizations of science teachers recommend that science laboratory classes not exceed 24 students.

A written science safety plan is an essential part of the school science program. It is suggested that the science safety plan be developed by a team that includes the principal, teachers, school nurse, a fire fighter, and a representative from an insurance agency. Suggestions for developing science safety policies for school systems and school science safety plans are available on the compact disk (CD) issued by the Alabama Department of Education to schools in Alabama. These publications are entitled *The Total Science Safety System: Elementary* (Bulletin 2001, No. 35) and *The Total Science Safety System: Secondary* (Bulletin 2001, No. 28). After initial development, an annual review and assessment of the plan should be made to ensure its effectiveness.

Teachers should also be aware of the state safety goggle law found in the *Code of Alabama*, 1975, §16-1-7. This law requires local boards of education to provide ANSI Z87 or Z87.1 safety goggles to every student engaged in science experiments. Teachers are further encouraged to obtain and keep readily available the safety references, *Science and Safety—Making the Connection* (secondary) and the *Science and Safety: It's Elementary!* calendar and flip chart. These publications are available to download free of charge from the Council of State Science Supervisors (CSSS) at http://csss.enc.org/safety.htm.

CONNECTIONS

The useful knowledge that people possess is richly interconnected. The traditional delivery system of teaching science has been the separate and distinct offerings of each domain of science — Physical Science, Life Science, and Earth and Space Science — and each discipline — Biology, Chemistry, or Physics. As the distinctions among the traditional disciplines of science have become less apparent, curriculum planners recommend that domain-based and discipline-based content be taught each year in several grade levels (Hurd, 1992). Emphasis should be placed on the similarities of the domains of science rather than on the differences.

Similarly, when students use the knowledge and skills learned in other fields of study such as mathematics, social studies, English language arts, and arts education, scientific learning is enhanced. Also, knowledge and skills learned in other fields provide students with a repertoire of approaches for directing experiments, presenting findings, and defending conclusions. Such interdisciplinary connections benefit students in the following ways.

- Previous learning is reinforced through application to real-world conditions rather than to abstract situations.
- Learning is viewed as an integrated, ongoing process rather than as isolated fragments of knowledge to be remembered for a test.

INTEGRATION OF TECHNOLOGY

Effective science programs incorporate the use of technology. By integrating technology into the teaching of science, students are able to form a more accurate view of the nature of science and also gain a better understanding of the interrelationship of science and technology. Technology may be in the form of tools that help scientists make better observations and measurements as well as perform and analyze investigations better. Three state programs that facilitate the use of technology in the classroom are the Alabama Science in Motion (ASIM) program, the Alabama Technology in Motion (ATIM) program, and the Alabama Math, Science, and Technology Initiative (AMSTI).

Whenever feasible, teachers should involve students in technology-enhanced activities to meet needs, solve problems, or evaluate data. Students should also be engaged in considering positive and negative consequences of the design and use of technology.

INSTRUCTIONAL MODEL

Effective instructional strategies ensure that students are actively engaged in the learning process, have opportunities for interaction with the environment, and have time for reflection upon learning. The instructional setting must allow students time for developing the reasoning and critical-thinking skills necessary for constructing meaning and thus building upon scientific knowledge. In this setting, teachers guide students, provide students with a focus, challenge students to excel, and encourage and support student learning at all levels of inquiry. Members of the Science State Course of Study Committee and Task Force support the use of inquiry-based instructional models such as the Five E Instructional Model shown below.*

Five E Instructional Model

ENGAGE

Providing students with activities such as brainstorming; Know, Want to Know, Learned (KWL); and making simple observations to stimulate interest, evaluate and make connections between past and present learning, and identify prior misconceptions

EXPLORE

Allowing students to build upon prior knowledge through new experiences that incorporate active participation in a range of activities, including analysis, reflection, and data collection

EXPLAIN

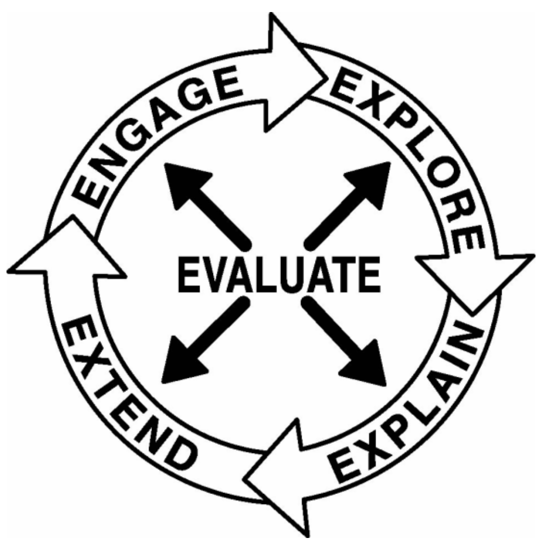
Providing students with opportunities to construct meaning by verbalizing understanding of activities, making explanations, addressing questions, correcting misunderstandings, and introducing new science vocabulary

EXTEND

Offering students challenging opportunities to practice skills and extend understanding through research, projects, and presentations

EVALUATE

Having students reflect on their own learning in conjunction with teacher evaluations and self-assessment of understanding



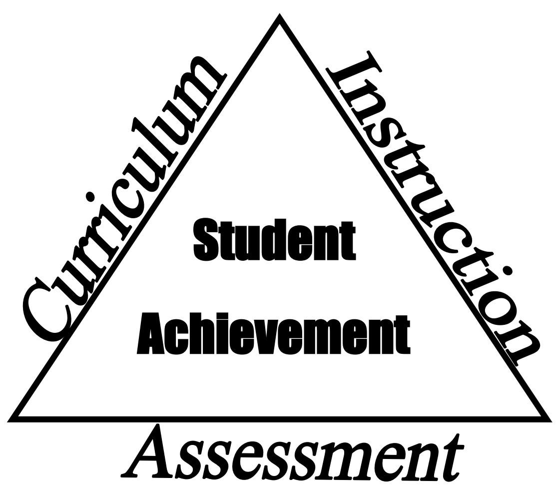
*Adapted from Rodger W. Bybee, *Achieving Scientific Literacy: From Purposes to Practices.* Portsmouth, New Hampshire: Heinemann Publishers, 1997.

ASSESSMENT

The content standards contained in this document have an impact on the assessment of science instruction as well as on the assessment of student learning. Classroom and state assessments should inform science teachers not only of student performance but also of the adequacy of various instructional strategies.

Teachers use assessment data to plan instruction. During instruction, teachers collect additional data on student learning that allows for revision of instructional strategies and better guidance of student learning. Assessment techniques reflect learning that occurs at the cognitive, affective, and psychomotor levels. Consequently, the content standards in this document intertwine the knowledge, processes, and applications of science. This intertwining of standards necessitates a variety of assessment methods to ensure that all students, including students with disabilities, acquire not only knowledge of science but also skills of science. Classroom assessments should go beyond simple paper-and-pencil tests to include performance-based assessments and the use of a variety of assessment techniques. These could include the use of multiple-choice items, pre- and post-examinations of performance, checklists, open-ended essay items, journals, laboratory reports, verbal explanations, portfolios, and projects.

The model shown below is a graphic representation of the components necessary for student achievement. While curriculum and instruction are important components of student learning, assessment must reflect what is taught and how it is taught to complete the process. Assessment instruments and procedures that include meaningful ways of determining student acquisition of knowledge, skills, and processes are consistent with Alabama's goal of educating students to become scientifically literate.



CULTURAL DIVERSITY IN SCIENCE

Persons representative of diverse cultures and races have made significant contributions to the body of knowledge of science as well as to the methodologies and applications of science throughout the history of the scientific enterprise. These persons continue to play instrumental roles in the progress of many scientific disciplines. As Alabama and the nation experience the need for increasing the number of scientists and engineers into the twenty-first century, more cultures and races will be called upon to share their knowledge and expertise. The history of science and people responsible for scientific advances contribute invaluable knowledge from which future generations can continue scientific inquiry. Alabama's education program must encourage all students to recognize the role of science in future careers and to consider science and science-related professions.

Cultural diversity is an asset in the classroom. A student's interest is significantly enhanced by relating familiar cultural perspectives to the study of science-related topics by identifying contributions to science made by diverse cultural and racial groups and by providing role models throughout the study of science. Participation in meaningful cooperative activities and investigations in which students are encouraged to share opinions and cultural perspectives often positively impacts student confidence, perception of ability, and persistence in working on complex problems. Such strategies foster inclusion and help ease the stressful competition that has discouraged many students in the past from continuing studies in science or pursuing careers in science.

Regardless of gender, culture, or ethnic background, all students should have the opportunity to become scientifically literate citizens. In addition to the use of local resources and facilities, integration of culturally relevant biographical sketches of male and female scientists from a variety of ethnic backgrounds, including persons from Alabama's rich repertoire of scientists, should be incorporated into scientific topics.

SCIENTIFIC PROCESS AND APPLICATION SKILLS

Scientific processes are defined as ways in which scientists gather, sort, organize, analyze, and make sense of information about the world. Basic process and application skills include observing, communicating, classifying, measuring, predicting, and inferring. Advanced process and application skills include controlling variables, defining operationally, formulating hypotheses, experimenting in a controlled environment, and analyzing data. In order to reach the goal of scientific literacy for all Alabama students, it is crucial that the process and application skills be embedded throughout the content areas and applied through the use of inquiry. Because inquiry and process skills allow students to participate in and take ownership of science content through investigations, teachers must provide students at all grade levels and in every domain of science with opportunities to safely apply these skills.

Basic and advanced scientific process and application skills are located on the chart on the following page. This chart provides a more detailed explanation of each of the skill areas.

SCIENTIFIC PROCESS AND APPLICATION SKILLS

Observing	Using one or more of the senses to gather information about one's environment	**BASIC**
Communicating	Conveying oral or written information verbally as well as visually through models, tables, charts, and graphs	
Classifying	Utilizing simple groupings of objects or events based on common properties	
Measuring	Using appropriate metric units for measuring length, volume, and mass	
Predicting	Proposing possible results or outcomes of future events based on observations and inferences drawn from previous events	
Inferring	Constructing an interpretation or explanation based on information gathered	
Controlling Variables	Recognizing the many factors that affect the outcome of events and understanding their relationships to each other whereby one factor (variable) can be manipulated while others are controlled	**ADVANCED**
Defining Operationally	Stating definitions of objects or events based on observable characteristics	
Formulating Hypotheses	Making predictions of future events based on manipulation of variables	
Experimenting (Controlled)	Conducting scientific investigations systematically, including identifying and framing the **question** carefully, forming a **hypothesis**, managing **variables** effectively, developing a logical experimental **procedure**, recording and analyzing **data**, and presenting **conclusions** based on investigation and previous research	
Analyzing Data	Using collected data to accept or reject hypotheses	

DIRECTIONS FOR INTERPRETING THE MINIMUM REQUIRED CONTENT

1. **CONTENT STANDARDS** are statements that define what students should know and be able to do at the conclusion of a course or grade. Content standards in this document contain minimum required content. The order in which standards are listed within a course or grade is not intended to convey a sequence for instruction. Each content standard completes the phrase "*Students will*."

> *Students will:*
>
> Describe effects of forces on objects, including change of speed, direction, and position.
>
> (First Grade – Content Standard 3)

2. **BULLETS** denote content that is related to the standards and required for instruction. Bulleted content is listed under a standard and identifies additional minimum required content.

> *Students will:*
>
> Define solution in terms of solute and solvent.
> - Defining diffusion and osmosis
> - Defining isotonic, hypertonic, and hypotonic solutions
> - Describing acids and bases based on their hydrogen ion concentration
>
> (Eighth Grade: Physical Science – Content Standard 6)

3. **EXAMPLES** clarify certain components of content standards or bullets. They are illustrative but not exhaustive.

> *Students will:*
>
> 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
>
> (Biology Core – Content Standard 10)

GRADES K-2

Overview

Science education in Grades K-2 sets the stage for lifelong learning in science. Young children entering school are energetic, eager to learn, and possess a natural curiosity about their world. They construct knowledge of their world through the use of the five senses. These young students process information through a variety of learning styles and demonstrate ownership through self-expression and excitement regarding their newly acquired science concepts.

An effective science classroom capitalizes on the young learner's energy and curiosity. Students model what scientists do rather than simply reading or hearing about science. The classroom becomes an inquiry-based environment that incorporates technology and extends learning beyond the printed page and classroom walls. This dynamic classroom provides experiences and interactions with animate and inanimate objects that stimulate the learner and make science real.

Instruction that includes developmentally appropriate content, integration of scientific process and application skills, and utilization of technology is necessary for the success of students in Grades K-2. Mastery of the content included in this document also requires active participation by all students. Effective instructional strategies that include the use of peer learning techniques, the application of technology to write and retell science stories, and the incorporation of investigations to enhance student vocabulary and comprehension are valuable components of the Grades K-2 science program. Appropriate science content, combined with creative instructional strategies that provide an extension of classroom learning, provides students with a solid foundation for lifelong learning of science.

KINDERGARTEN

Kindergartners enter the school community with an eagerness and curiosity to discover their environments. Although their experiences and background knowledge are limited, science enables them to answer questions about themselves and the world around them. The everyday experiences of students in their daily environments provide them with a foundation that helps them make sense of their world.

Activities that stimulate kindergartners' interest in science investigations encourage them to develop a lifelong pursuit for scientific information and exploration. This can best be accomplished through implementation of a challenging curriculum, inquiry-based learning, and a nurturing classroom atmosphere. The classroom should be flexible, child-friendly, comfortable, stimulating, intellectually challenging, and adaptable to a variety of learning styles.

The kindergarten curriculum incorporates developmentally appropriate content, process and application skills, and technology. Content includes concepts such as relating a variety of sounds to their sources; describing seasonal changes in weather; and comparing the size, shape, structure, and basic needs of living things. Students also classify objects using the five senses and use process skills to construct knowledge of their surroundings. Student application of technology includes the use of tools such as hand lenses, computers, different types of media, and the investigation of various scientific concepts. The utilization of process skills to engage learners, explore new ideas, explain findings, extend understanding, and evaluate one's own learning during inquiry-based investigations provides kindergarten students with the necessary foundation for scientific literacy.

Physical Science

Students will:

1. Classify objects as solids or liquids.

2. Identify the sun as Earth's source of light and heat.
    - Predicting the effect of the sun on living and nonliving things
    - Identifying relationships between light and shadows
    - Predicting the occurrence of shadows

3. Relate a variety of sounds to their sources, including weather, animal, and transportation sounds.
    Examples: weather—thunder,
    animal—dog bark,
    transportation—truck horn

4. Identify properties of motion, including change of position and change of speed.

5. Predict whether an object will be attracted by a magnet.

Life Science

6. Compare size, shape, structure, and basic needs of living things.
    - Identifying similarities of offspring and their parents

7. Classify objects using the five senses.
    - Grouping objects according to color, shape, size, sound, taste, smell, texture, and temperature

Earth and Space Science

8. Identify features of Earth as landmasses or bodies of water.

9. Identify seasons of the year.
    - Describing seasonal changes in the weather

10. Identify objects observed in the day sky with the unaided eye, including the sun, clouds, moon, and rainbows.

FIRST GRADE

First-grade students enter the classroom with a natural curiosity about their environment. Their inquisitive nature leads them to wonder about the world around them and to ask a variety of science-related questions. Students in Grade 1 are beginning to develop social skills that enable them to interact in inquiry-based and cooperative learning opportunities. A stimulating classroom environment with a meaningful curriculum allows them to begin to take ownership of their own learning experiences.

In Grade 1, content increases both in depth and in breadth. Topics include properties of various objects and effects of forces acting upon them, awareness of the structure of the body, and comparison of the day sky to the night sky. Content also includes the concepts of recognizing changes in weather, identifying components of Earth's surface, and identifying ways to conserve Earth's resources. The process skills and technology utilized in kindergarten increase in complexity due to the more rigorous content of Grade 1. The classroom environment allows students to engage in a hands-on approach to learning that facilitates acquisition of science knowledge, utilization of process skills, and application of technology.

Physical Science

Students will:

1. Select appropriate tools and technological resources needed to gather, analyze, and interpret data.
   Examples: platform balances, hand lenses, computers, maps, graphs, journals

2. Identify basic properties of objects.
   Examples: size, shape, color, texture

3. Describe effects of forces on objects, including change of speed, direction, and position.

Life Science

4. Describe survival traits of living things, including color, shape, size, texture, and covering.
   - Classifying plants and animals according to physical traits
     Examples: animals—six legs on insects,
     plants—green leaves on evergreen trees
   - Identifying developmental stages of plants and animals
     Examples: plants—seed developing into seedling, seedling developing into tree;
     animals—piglet developing into pig, kid developing into goat
   - Describing a variety of habitats and natural homes of animals

5. Identify parts of the human body, including the head, neck, shoulders, arms, spine, and legs.
   - Recognizing the importance of a balanced diet for healthy bones
   - Discussing the relationship of muscles and bones to locomotion
   - Discussing the relationship of bones to protection of vital organs
     Example: protection of brain by skull
   - Identifying technology used by scientists to study the human body
     Examples: X-ray images, magnetic resonance imaging (MRI)

6. Recognize evidence of animals that no longer exist.

Earth and Space Science

7. Identify components of Earth's surface, including soil, rocks, and water.

8. Recognize daily changes in weather, including clouds, precipitation, and temperature.
   - Recognizing instruments used to observe weather
     Examples: thermometer, rain gauge, wind sock, weather vane
   - Recording weather data using weather journals, charts, and maps

9. Identify ways to conserve Earth's resources.
   Example: turning off lights and water when not in use

10. Describe uses of recycled materials.
    Examples: manufacture of paper products from old newspapers, production of mulch from trees

11. Compare the day sky to the night sky as observed with the unaided eye.

SECOND GRADE

Second-grade students begin the school year equipped with prior knowledge and skills that enhance their awareness of scientific concepts and serve as a foundation for continued exploration of the world around them. These young scientists engage in science-related challenges that encourage various levels of inquiry. They are actively involved in hands-on science investigations that are teacher-selected but often self-guided.

The classroom environment stimulates the natural curiosity of students. Investigating materials and situations, asking questions, communicating findings, and seeking meaning from everyday activities and experiences are vital instructional components for all students in Grade 2.

The second-grade curriculum provides opportunities for students to develop awareness of simple machines and changes in the states of matter. Students identify characteristics of plants and animals and become aware of the impact of weather on society. The curriculum integrates scientific processes with technology as a basis for inquiry. It pairs a dynamic classroom environment with a challenging curriculum designed to extend the natural curiosity of students and encourage the development of scientific knowledge and skills.

Physical Science

Students will:

1. Identify states of matter as solids, liquids, and gases.
    - Describing objects according to physical properties, including hardness, color, and flexibility
    - Describing changes between states of matter

        Examples: solid to liquid—melting,
        gas to liquid—condensing,
        liquid to gas—evaporating,
        liquid to solid—freezing
    - Measuring quantities of solids and liquids

2. Identify vibration as the source of sound.
    - Identifying pitch and volume as properties of sound
    - Distinguishing between pitch and volume of sound

3. Recognize that light travels in a straight line until it strikes an object.
    - Recognizing that light can be reflected

4. Describe observable effects of forces, including buoyancy, gravity, and magnetism.

    Examples: buoyancy—boat floating on water,
    gravity—apple falling from tree,
    magnetism—magnets adhering to metal

    - Identifying simple machines, including the inclined plane, lever, pulley, wedge, screw, and wheel and axle

Life Science

5. Identify the relationship of structure to function in plants, including roots, stems, leaves, and flowers.

6. Identify characteristics of animals, including behavior, size, and body covering.
   - Comparing existing animals to extinct animals
     Examples: iguana to stegosaurus, elephant to wooly mammoth
   - Identifying migration and hibernation as survival strategies

Earth and Space Science

7. Identify geological features as mountains, valleys, plains, deserts, lakes, rivers, and oceans.
   - Identifying local landforms and bodies of water
   - Identifying components of soil, including sand, clay, and silt

8. Identify evidence of erosion and weathering of rocks.

9. Describe evaporation, condensation, and precipitation in the water cycle.

10. Identify the impact of weather on agriculture, recreation, the economy, and society.
    - Recognizing the importance of science and technology to weather predictions

11. Identify basic components of our solar system, including the sun, planets, and Earth's moon.

GRADES 3-5

Overview

In Grades 3-5, students are introduced to the full range of scientific knowledge in the domains of Physical Science, Life Science, and Earth and Space Science through content, processes, and application skills. Many content standards build upon prior knowledge while others introduce new concepts and skills. Concrete experiences remain important as students develop abstract-thinking abilities and extend their scientific knowledge. Manipulative skills become more refined, making possible more sophisticated measurement techniques and an expanded use of scientific equipment and technology. Teachers guide students to recognize the important role science plays in society and in the development of technology.

Students in Grades 3-5 are engaged in a learning environment that encourages exploration, inquiry, formulation of models, and application of results based on experiences. As in Grades K-2, such an environment increases opportunities to provide a solid foundation of scientific knowledge and experiences upon which understanding is built. Maintaining a scientific journal of investigations helps students organize experimental information, enhances their reading and writing skills, and allows time for reflection on scientific information and processes.

Students in these grades begin simple independent studies involving variables and increase their abilities to conduct group investigations and work as a team. Effective science instruction inspires their curiosity and encourages independent investigations and discoveries through student-generated questions. As the teacher plans for instruction, attention is given to identifying clear learning goals and providing developmentally appropriate activities that assist students in achieving these goals.

THIRD GRADE

Students in Grade 3 are becoming more aware of scientific concepts. They are active, inquisitive, and have a greater interest in their environment and an increased capacity for intellectual growth. Through varied and appropriate activities, third-grade students begin to develop a sense of where they are in their world. Teachers extend the natural inclinations of students to ask questions and investigate their world through an inquiry-based classroom environment. In this learning environment, students apply process skills, engage in hands-on activities, and participate in cooperative groups to conduct investigations that begin with questions and progress toward the communication of answers.

The development of critical-thinking and problem-solving skills is a major goal of the third-grade science program. In Grade 3, the study of science includes planning and implementing simple classroom and field investigations. Students describe the layers of Earth, including the inner and outer cores, mantle, and crust. They observe the force and motion of objects, identify weather phenomena, organize weather data into tables or charts, describe the life cycle of plants, and determine the effect of environmental conditions on plant growth and survival.

Physical Science

Students will:

1. Classify substances as soluble or insoluble.
   Examples: soluble—sugar in water, powdered drink in water;
   insoluble—sand in water, oil in water

2. Identify physical and chemical changes of matter.
   Examples: physical—chopping wood,
   chemical—burning wood

3. Describe ways energy from the sun is used.
   Examples: plant growth, light, heat

   - Identifying fossil fuels as a source of energy

4. Define force and motion.
   - Identifying forces that change an object's position or motion
     Examples: lifting, pushing, pulling
   - Identifying sources of friction
     Examples: rubbing hands together, applying sandpaper to wood
   - Describing the force of gravity

5. Identify the relationship of simple machines to compound machines.
   Example: pencil sharpener composed of a wheel and axle, inclined plane, and wedge

Life Science

6. Identify structures and functions of the muscular and skeletal systems of the human body.

7. Describe the life cycle of plants, including seed, seed germination, growth, and reproduction.
   - Describing the role of plants in a food chain
   - Identifying plant and animal cells
   - Describing how plants occupy space and use light, nutrients, water, and air
   - Classifying plants according to their features
     Examples: evergreen or deciduous, flowering or nonflowering
   - Identifying helpful and harmful effects of plants
     Examples: helpful—provide food, control erosion;
     harmful—cause allergic reactions, produce poisons
   - Identifying how bees pollinate flowers
   - Identifying photosynthesis as the method used by plants to produce food

8. Identify how organisms are classified in the Animalia and Plantae kingdoms.

9. Describe how fossils provide evidence of prehistoric plant life.
   Example: plant fossils in coal or shale providing evidence of existence of prehistoric ferns

10. Determine habitat conditions that support plant growth and survival.
    Examples: deserts support cacti, wetlands support ferns and mosses

Earth and Space Science

11. Describe Earth's layers, including inner and outer cores, mantle, and crust.
    - Classifying rocks and minerals by characteristics, including streak, color, hardness, magnetism, luster, and texture

12. Identify conditions that result in specific weather phenomena, including thunderstorms, tornadoes, and hurricanes.
    - Identifying cloud types associated with specific weather patterns
    - Identifying positive and negative effects of weather phenomena
      Examples: positive—flooding deposits good soil when waters recede,
      negative—flooding kills crops
    - Identifying technology used to record and predict weather, including thermometers, barometers, rain gauges, anemometers, and satellites
    - Explaining symbols shown on a weather map
    - Organizing weather data into tables or charts

13. Describe ways to sustain natural resources, including recycling, reusing, conserving, and protecting the environment.
    - Recognizing the impact of society on human health and environmental conditions

14. Describe the position of Earth, the moon, and the sun during the course of a day or month.
    - Describing various forms of technology used in observing Earth and its moon

FOURTH GRADE

Students in Grade 4 are often intrigued with science. They are able to use critical-thinking and problem-solving skills as well as scientific methods to plan and implement field and laboratory investigations. These students need to be involved in an active learning process that extends beyond the memorization of concepts to include application of knowledge and skills. Concrete experiences are important to students at this stage of development. Such experiences allow students to continue to build upon and strengthen skills learned in earlier grades as they progress to higher levels of cognitive reasoning.

The fourth-grade classroom includes an active learning environment that provides intellectually stimulating instruction and developmentally appropriate activities. Teachers incorporate activities that foster exploration and investigation, thus enabling students to communicate valid conclusions about their world.

As students in Grade 4 expand their conceptual understanding of science, they identify components and processes of the natural world. These include functions and uses of electricity; how light interacts with transparent, translucent, and opaque materials; the effects of friction; ways in which organisms grow and develop; and the appearance and movement of Earth and its moon.

Physical Science

Students will:

1. Describe how electrical circuits can be used to produce light, heat, sound, and magnetic fields.
    - Identifying ways to use and conserve electrical energy
    - Identifying characteristics of parallel and series circuits
    - Classifying materials as conductors, nonconductors, and insulators of electricity and heat
    - Identifying relationships among charge, current, and potential energy
    - Identifying components of a circuit

2. Compare different pitches of sound produced by changing the size, tension, amount, or type of vibrating material.
    - Describing the relationship between the structure of the ear and hearing

3. Recognize how light interacts with transparent, translucent, and opaque materials.
    Examples: transparent—most light passes through,
    translucent—some light passes through,
    opaque—no light passes through

    - Predicting the reflection or absorption of light by various objects

4. Describe effects of friction on moving objects.
    - Identifying momentum and inertia as properties of moving objects
    - Identifying ways to increase or decrease friction

Life Science

5. Describe the interdependence of plants and animals.
   - Describing behaviors and body structures that help animals survive in particular habitats
     Examples: behaviors—migration, hibernation, mimicry;
     body structures—quills, fangs, stingers, webbed feet
   - Describing life cycles of various animals to include incomplete and complete metamorphosis
     Examples: damsel fly, mealworms
   - Tracing the flow of energy through a food chain
     Example: producer, first-level consumer, second-level consumer, and third-level consumer
   - Identifying characteristics of organisms, including growth and development, reproduction, acquisition and use of energy, and response to the environment

6. Classify animals as vertebrates or invertebrates and as endotherms or ectotherms.
   - Describing the organization of cells into tissues, organs, and organ systems
   - Describing the grouping of organisms into populations, communities, and ecosystems
   - Classifying common organisms into kingdoms, including Animalia, Plantae, Protista, Fungi, Archaebacteria, and Eubacteria

Earth and Space Science

7. Describe geological features of Earth, including bodies of water, beaches, ocean ridges, continental shelves, plateaus, faults, canyons, sand dunes, and ice caps.

8. Identify technological advances and other benefits of space exploration.
   Examples: laser, pacemaker, dehydrated food, flame-retardant clothing, global positioning system (GPS), satellite imagery, global weather information, diagnostic imagery

   - Listing highlights of space exploration, including satellites, manned moon missions, the unmanned Mars mission, and an inhabited space station
   - Identifying Alabama's contribution to the space industry

9. Describe the appearance and movement of Earth and its moon.
   - Identifying the waxing and waning of the moon in the night sky
   - Identifying lunar and solar eclipses

10. Describe components of our solar system.
    - Defining comets, asteroids, and meteors

FIFTH GRADE

In Grade 5, concrete experiences remain important to students as they conduct scientific inquiries and include evidence of abstract ideas in their explorations. Students refine their abilities to identify variables and increase the accuracy of their predictions based on prior experiences and explanations based on information gathered.

Fifth-grade students need a positive learning environment that encourages and challenges their efforts and progress toward learning science. This environment is supported through active learning opportunities and content-related questions that foster science communication.

As fifth-grade students continue to explore the physical world, they develop detailed comparisons through investigations and hands-on experiences. Students form an understanding of the relationship between food chains and food webs, compare plant and animal cells, and become more knowledgeable about the forms and transfer of energy. They also begin to compare Earth to other planets in our solar system.

Physical Science

Students will:

1. Identify evidence of chemical changes through color, gas formation, solid formation, and temperature change.
   Example: combining vinegar and baking soda to produce a gas

2. Define mass, volume, and density.
   - Identifying the atom as the basic building block of matter
   - Relating temperature changes to particle motion
     Example: movement of colored dye in hot and cold water
   - Relating density to the sinking or floating of an object in a liquid

3. Use everyday indicators to identify common acids and bases.
   Examples: using grape juice to determine that vinegar is an acid, using juice from boiled red cabbage to determine that baking soda is a base

4. Describe forms of energy, including chemical, heat, light, and mechanical.
   - Identifying types of potential and kinetic energy
     Examples: potential—water behind a dam, battery;
     kinetic—water moving across turbine blades
   - Describing alternatives to the use of fossil fuels
     Examples: solar energy, geothermal energy, windmill, hydroelectric power, biomass
   - Identifying the transfer of energy by conduction, convection, and radiation
     Examples: conduction—hot plate heating a pan,
     convection—space heater heating air,
     radiation—sun heating Earth's surface

5. Contrast ways in which light rays are bent by concave and convex lenses.
    - Describing how a prism forms a visible spectrum
    - Explaining why different objects have different colors
    - Describing how mirrors reflect light
      Example: discussing differences in the reflection of light by convex and concave mirrors
    - Describing the relationship between the structure of the eye and sight
    - Identifying types of corrective lenses used to correct different sight problems
      Examples: convex—farsightedness,
      concave—nearsightedness
    - Identifying the contribution of van Leeuwenhoek to the development of the microscope

6. Compare effects of gravitational force on Earth, on the moon, and within space.
    - Identifying contributions of Newton to the study of gravity
    - Describing how a spring scale is used to measure weight
    - Explaining how air resistance affects falling objects

Life Science

7. Identify common parts of plant and animal cells, including the nucleus, cytoplasm, and cell membrane.
    - Comparing unicellular and multicellular organisms
    - Comparing plant and animal cells

8. Identify major body systems and their functions, including the circulatory system, respiratory system, excretory system, and reproductive system.

9. Describe the relationship of populations within a habitat to various communities and ecosystems.
    - Describing the relationship between food chains and food webs
    - Describing symbiotic relationships

Earth and Space Science

10. Identify spheres of Earth, including the geosphere, atmosphere, and hydrosphere.
    - Describing technology used to investigate Earth
      Examples: sonar, radar, seismograph, weather balloons, satellites
    - Describing the rock cycle

11. Compare distances from the sun to planets in our solar system.
    - Relating the size of Earth to the size of other planets in our solar system
    - Identifying technology used to study planets
      Examples: Hubble telescope, space probes, Mars Exploration Rover

GRADES 6-8

Overview

Middle school students can be characterized as curious, energetic, and enthusiastic. These students are moving from childhood to adolescence at various rates. They possess multiple learning styles, varied intellectual abilities, and are sensitive to peer perception. Teachers are challenged to incorporate effective classroom strategies that meet students' growing needs as individual learners while helping students make the transition from learning concrete facts to making scientific applications. With a foundation based on inquiry, the middle school science curriculum affords students opportunities for exploration and an in-depth study of science concepts. The scientific process and application skills located on page 10 of this document should be integrated into the teaching of the required science content.

Earth and Space Science, Life Science, and Physical Science content and skills are best taught through a "hands-on," "minds-on" approach to learning. In order to facilitate this process, the science classroom must extend beyond traditional boundaries while maintaining a primary focus on student safety. Students learn the "what" while being encouraged to seek the "why" and "how" behind natural phenomena. By designing a challenging curriculum, creating a supportive environment, stimulating student imagination, and providing opportunities for investigation, science teachers enable students to become actively involved in their own learning.

Success in science translates into the creation of productive, lifelong learners capable of meeting the needs and challenges of the twenty-first century. The goals of the middle school science program, therefore, are to meet the needs of the individual learner, to challenge all students to excel, and to provide students with the resources necessary to acquire science content and skills applicable both within and beyond the educational setting.

SIXTH GRADE

Earth and Space Science

Sixth-grade students are energetic and curious. They are maturing at a rapid rate and are in a transitional stage characterized by physical, social, and cognitive changes. The sixth-grade classroom environment addresses these changes by providing balance between elementary and middle school practices. While these changes lead students toward emotional and academic independence, sixth-graders continue to need guidance. They also need an environment that both supports and challenges them as they become more responsible individuals.

The curriculum for Grade 6 focuses on Earth and Space Science. As sixth-grade students become more aware of their environment, their natural curiosity about this important field of study is easily stimulated. Content standards challenge students to discover their world, their planet, and Earth's place in the universe. Students are provided opportunities to learn important scientific facts and to build conceptual understanding of scientific principles, laws, and theories. Their study is inquiry-based, allowing them to develop critical-thinking skills and problem-solving abilities needed for future studies in the field of science.

Students will:

1. Identify global patterns of atmospheric movement, including El Niño, the Gulf Stream, the jet stream, the Coriolis effect, and global winds that influence local weather.
   - Predicting local weather and weather patterns
     Examples: cold and warm fronts, high and low pressure areas
   - Describing the function of instruments and technology used to investigate Earth's weather, including barometers, thermometers, wind socks, weather vanes, satellites, radar, weather balloons, and rain gauges
   - Using lines of latitude and longitude to locate areas of specific weather events
   - Interpreting weather data through observations collected over time
     Example: calculating annual precipitation and average temperature

2. Describe factors that cause changes to Earth's surface over time.
   Examples: earthquakes, volcanoes, weathering, erosion, glacial erosion or scouring, deposition, water flow, tornadoes, hurricanes, farming and conservation, mining and reclamation, deforestation and reforestation, waste disposal, global climate changes, greenhouse gases

   - Comparing constructive and destructive natural processes and their effects on land formations
     Examples: constructive—volcanic and mountain-building processes; destructive—erosion by wind, water, and ice
   - Distinguishing rock strata by geologic composition
     Examples: predicting relative age of strata by fossil depth, predicting occurrence of natural events by rock composition in a particular strata

3. Describe water and carbon biogeochemical cycles and their effects on Earth.

4. Explain the plate tectonic theory.
   Example: using terminology such as *continental drift, seafloor spreading, lava, magma, eruption, epicenter, focus, seismic wave*, and *subduction zone*

   - Describing types of volcanoes and faults
   - Determining energy release through seismographic data
     Example: using data from the Mercalli scale and the Richter scale

5. Describe layers of the oceanic hydrosphere, including the pelagic zone, benthic zone, abyssal zone, and intertidal zone.

6. Describe regions of the oceanic lithosphere, including the continental shelf, continental slope, and abyssal plain.

7. Describe Earth's biomes.
   Examples: aquatic biomes, grasslands, deserts, chaparrals, taigas, tundras

   - Identifying geographic factors that cause diversity in flora and fauna, including elevation, location, and climate

8. Describe how Earth's rotation, Earth's axial tilt, and distance from the equator cause variations in the heating and cooling of various locations on Earth.

9. Identify the moon's phases.
   - Describing lunar and solar eclipses
   - Relating effects of the moon's positions on oceanic tides

10. Describe components of the universe and their relationships to each other, including stars, planets and their moons, solar systems, and galaxies.
    - Identifying the impact of space exploration on innovations in technology
      Examples: MRI, microwave, satellite imagery, GPS
    - Mapping seasonal changes in locations of constellations in the night sky
    - Describing the life cycle of a star
      Example: H-R diagram

11. Describe units used to measure distance in space, including astronomical units and light years.

SEVENTH GRADE

Life Science

Seventh-grade students experience a wide range of physical and psychological changes during this stage of development where peer perception and social interaction play major roles. As students seek to distance themselves from younger students, they must be encouraged to preserve the excitement of discovery while developing the self-discipline necessary for mastery of concepts at a higher level.

A variety of instructional strategies and techniques is essential for guiding students in Grade 7. Teachers must capitalize on the need for students to communicate and interact with classmates while harnessing their energy and enthusiasm for constructive learning activities. "Hands-on," "minds-on" learning by doing provides an excellent method of instruction for students at this stage as learning progresses from the concrete to the abstract and from knowledge to application in science.

The focus of the Life Science course allows seventh-grade students to connect the dynamics of the sixth-grade Earth and Space Science course with the rules that govern the known universe in the eighth-grade Physical Science course. As students' lives are affected daily by growth and experience, the curriculum for this age group provides the means for understanding the mechanisms behind maturity and development. Seventh-grade learners are ready to explore and question new ideas and theories. To preserve their natural curiosity and channel their focus on content, students in Grade 7 are encouraged to develop an appreciation for the importance of diversity of life while simultaneously understanding the impact their roles as individuals play in the community of life.

Students will:

1. Describe characteristics common to living things, including growth and development, reproduction, cellular organization, use of energy, exchange of gases, and response to the environment.
    - Identifying homeostasis as the process by which an organism responds to its internal or external environment
    - Predicting how an organism's behavior impacts the environment
    - Identifying unicellular organisms, including bacteria and protists, by their methods of locomotion, reproduction, ingestion, excretion, and effects on other organisms
    - Identifying the structure of a virus

2. Identify functions of organelles found in eukaryotic cells, including the nucleus, cell membrane, cell wall, mitochondria, chloroplasts, and vacuoles.

    Example: mitochondria releasing energy for use in cellular respiration

    - Identifying components of the cell theory
    - Identifying cells as prokaryotic or eukaryotic
    - Listing the sequence of the mitotic cell cycle

3. Relate major tissues and organs of the skeletal, circulatory, reproductive, muscular, respiratory, nervous, and digestive systems to their functions.
    - Arranging in order the organizational levels of the human body from the cell through organ systems

4. Describe organisms in the six-kingdom classification system by their characteristics.
    - Recognizing genus and species as components of a scientific name
    - Identifying contributions of Aristotle and Linnaeus to the early history of taxonomy

5. Identify major differences between plants and animals, including internal structures, external structures, methods of locomotion, methods of reproduction, and stages of development.
    - Describing the processes of photosynthesis and cellular respiration

6. Describe evidence of species variation due to climate, changing landforms, interspecies interaction, and genetic mutation.
    Examples: fossil records over geologic time, rapid bacterial mutations due to environmental pressures

7. Describe biotic and abiotic factors in the environment.
    Examples: biotic—plants, animals;
    abiotic—climate, water, soil

    - Classifying organisms as autotrophs or heterotrophs
    - Arranging the sequence of energy flow in an ecosystem through food webs, food chains, and energy pyramids

8. Describe the function of chromosomes.
    - Identifying genes as parts of chromosomes that carry genetic traits

9. Identify the process of chromosome reduction in the production of sperm and egg cells during meiosis.

10. Identify differences between deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
    Examples: DNA—double helix, contains thymine;
    RNA—single stranded, contains uracil

    - Identifying Watson and Crick as scientists who discovered the shape of the DNA molecule

11. Identify Mendel's laws of genetics.
    - Recognizing Down's syndrome and sickle cell anemia as inherited genetic disorders
    - Using a monohybrid Punnett square to predict the probability of traits passed from parents to offspring

EIGHTH GRADE

Physical Science

Eighth-grade students exhibit a wide range of learning styles and intellectual abilities. This diverse range of development requires the implementation of a science curriculum that is designed to engage students in multiple types of scientific inquiry. The classroom environment must provide opportunities for questioning, exploration, and an in-depth study of important concepts. Curiosity and creativity flourish as teachers develop activities that encourage students to use their imaginations for solving problems and designing investigations. As in other disciplines, students engage in higher, more abstract thinking processes as they become well-grounded in experimental, manipulative, and laboratory-oriented processes. They also work in a variety of groups to foster collaboration among their peers.

Content standards in Grade 8 are inquiry-based and include concepts and skills in chemistry and physics that are considered foundational. This focus is designed to prepare students for the physics and chemistry courses that are often taken in high school. The scientific process and application skills should be integrated into the teaching of the required science content to allow students to combine reasoning and thinking skills with scientific knowledge. This Physical Science course provides eighth-grade students with a firm foundation for scientific literacy and for the pursuit of subsequent science courses.

Students will:

1. Identify steps within the scientific process.
   - Applying process skills to interpret data from graphs, tables, and charts
   - Identifying controls and variables in a scientific investigation
   - Measuring dimension, volume, and mass using *Système International d'Unités* (SI units)
   - Identifying examples of hypotheses
   - Identifying appropriate laboratory glassware, balances, time measuring equipment, and optical instruments used to conduct an investigation

2. Describe the structure of atoms, including the location of protons, neutrons, and electrons.
   - Identifying the charge of each subatomic particle
   - Identifying Democritus and Dalton as contributors to the atomic theory

3. Determine the number of protons, neutrons, and electrons, and the mass of an element using the periodic table.
   - Locating metals, nonmetals, metalloids, and noble gases on the periodic table
   - Using data about the number of electrons in the outer shell of an atom to determine its reactivity

4. State the law of conservation of matter.
   - Balancing chemical equations by adjusting coefficients

5. Differentiate between ionic and covalent bonds.
    - Illustrating the transfer or sharing of electrons using electron dot diagrams

6. Define solution in terms of solute and solvent.
    - Defining diffusion and osmosis
    - Defining isotonic, hypertonic, and hypotonic solutions
    - Describing acids and bases based on their hydrogen ion concentration

7. Describe states of matter based on kinetic energy of particles in matter.
    - Explaining effects of temperature, concentration, surface area, and catalysts on the rate of chemical reactions

8. Identify Newton's three laws of motion.
    - Defining terminology such as *action and reaction forces, inertia, acceleration, momentum,* and *friction*
    - Interpreting distance−time graphs

9. Describe how mechanical advantages of simple machines reduce the amount of force needed for work.
    - Describing the effect of force on pressure in fluids

      Example: increasing force on fluid leading to increase of pressure within a hydraulic cylinder

10. Differentiate between potential and kinetic energy.

    Examples: potential—rock resting at the top of a hill,
    kinetic—rock rolling down a hill

11. Explain the law of conservation of energy and its relationship to energy transformation, including chemical to electrical, chemical to heat, electrical to light, electrical to mechanical, and electrical to sound.

12. Classify waves as mechanical or electromagnetic.

    Examples: mechanical—earthquake waves;
    electromagnetic—ultraviolet light waves, visible light waves

    - Describing how earthquake waves, sound waves, water waves, and electromagnetic waves can be destructive or beneficial due to the transfer of energy
    - Describing longitudinal and transverse waves
    - Describing how waves travel through different media
    - Relating wavelength, frequency, and amplitude to energy
    - Describing the electromagnetic spectrum in terms of frequencies

      Example: electromagnetic spectrum in increasing frequencies—microwaves, infrared light, visible light, ultraviolet light, X rays

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.

ALABAMA HIGH SCHOOL GRADUATION REQUIREMENTS

(Alabama Administrative Code 290-3-1-02(8)(a) (b) and (c))

1. COURSE REQUIREMENTS

The Alabama courses of study shall be followed in determining minimum required content in each discipline. Students seeking the Alabama High School Diploma with Advanced Academic Endorsement shall complete advanced level work in the core curriculum. Students seeking the Alternate Adult High School Diploma shall complete the prescribed credits for the Alabama High School Diploma and pass the test of General Education Development (GED).

COURSE REQUIREMENTS	Alabama High School Diploma Credits	Alabama High School Diploma with Advanced Academic Endorsement Credits	Alternate Adult High School Diploma Credits
ENGLISH LANGUAGE ARTS	**4**	**4**	**4**
Four credits to include the equivalent of:			
English 9	1	1	1
English 10	1	1	1
English 11	1	1	1
English 12	1	1	1
MATHEMATICS	**4**	**4**	**4**
Four credits to include the equivalent of:			
Algebra I	1	1	1
Geometry	1	1	1
Algebra II with Trigonometry		1	
Mathematics Elective(s)	2	1	2
SCIENCE	**4**	**4**	**4**
Four credits to include the equivalent of:			
Biology	1	1	1
A physical science	1	1	1
Science Electives	2	2	2
SOCIAL STUDIES*	**4**	**4**	**4**
Four credits to include the equivalent of:			
Grade 9 Social Studies	1	1	1
Grade 10 Social Studies	1	1	1
Grade 11 Social Studies	1	1	1
Grade 12 Social Studies	1	1	1
PHYSICAL EDUCATION	**1**	**1**	**1**
HEALTH EDUCATION	**0.5**	**0.5**	**0.5**
ARTS EDUCATION	**0.5**	**0.5**	**0.5**
COMPUTER APPLICATIONS**	**0.5**	**0.5**	**0.5**
FOREIGN LANGUAGE***		**2**	
ELECTIVES	**5.5**	**3.5**	**5.5**
Local boards shall offer foreign languages, fine arts, physical education, wellness education, career/technical education, and driver education as electives.			
TOTAL CREDITS	**24**	**24**	**24**

* All four required credits in Social Studies shall comply with the current *Alabama Course of Study.*

** May be waived if competencies outlined in the computer applications course are demonstrated to qualified staff in the local school system. The designated one-half credit shall then be added to the electives credits, making a total of six electives credits for the Alabama High School Diploma and the Alternate Adult High School Diploma or four electives credits for the Alabama High School Diploma with Advanced Academic Endorsement.

*** Students earning the diploma with the advanced academic endorsement shall successfully complete two credits in the same foreign language.

2. ASSESSMENT REQUIREMENTS

Pass the required statewide assessment for graduation.

Alabama High School Graduation Requirements (continued)

(Alabama Administrative Code 290-3-1-.02(8)(g)1.)

1. COURSE REQUIREMENTS

Effective for students with disabilities as defined by the *Individuals with Disabilities Education Act*, students must earn the course credits outlined in Ala. Admin. Code r. 290-3-1-.02(8)(g)1. and take the *Alabama High School Graduation Exam* at least once (spring of the 11th grade), in order to be awarded the Alabama Occupational Diploma.

COURSE REQUIREMENTS	Alabama Occupational Diploma Credits
ENGLISH LANGUAGE ARTS	**4**
Four credits to include the equivalent of:	
Employment English I	1
Employment English II	1
Employment English III	1
Employment English IV	1
MATHEMATICS	**4**
Four credits to include the equivalent of:	
Essential Mathematics I	1
Essential Mathematics II	1
Algebraic Explorations I	1
Algebraic Explorations II	1
SCIENCE	**4**
Four credits to include the equivalent of:	
Life Skills Science I: Physical Science	1
Life Skills Science II: Biology	1
Life Skills Science III: Earth and Space Science	1
Science Connections IV	1
SOCIAL STUDIES	**4**
Four credits to include the equivalent of:	
Career Preparation I	1
Career Preparation II	1
Career Preparation III	1
American Government/Economics IV	1
CAREER/TECHNICAL EDUCATION	**2**
COORDINATED STUDIES	**1**
COOPERATIVE CAREER/TECHNICAL EDUCATION	**1**
HEALTH EDUCATION	**0.5**
PHYSICAL EDUCATION	**1**
ARTS EDUCATION	**0.5**
ELECTIVES	**2**
Existing laws require LEAs to offer arts education, physical education, wellness education, career/technical education, and driver education as electives.	
TOTAL CREDITS	**24**

2. ASSESSMENT REQUIREMENTS

Take the required statewide assessment for graduation at least once (during the spring of the eleventh-grade year).

GUIDELINES AND SUGGESTIONS FOR LOCAL TIME REQUIREMENTS AND HOMEWORK

Total Instructional Time

The total instructional time of each school day in all schools and at all grade levels shall be not less than 6 hours or 360 minutes, exclusive of lunch periods, recess, or time used for changing classes (*Code of Alabama*, 1975, §16-1-1).

Suggested Time Allotments for Grades 1 - 6

The allocations below are based on considerations of a balanced educational program for Grades 1-6. Local school systems are encouraged to develop a general plan for scheduling that supports interdisciplinary instruction. Remedial and/or enrichment activities should be a part of the time schedule for the specific subject area.

Subject Area	Grades 1-3	Grades 4-6
Language Arts	150 minutes daily	120 minutes daily
Mathematics	60 minutes daily	60 minutes daily
Science	30 minutes daily	45 minutes daily
Social Studies	30 minutes daily	45 minutes daily
Physical Education	30 minutes daily*	30 minutes daily*
Health	60 minutes weekly	60 minutes weekly
Technology Education (Computer Applications)	60 minutes weekly	60 minutes weekly
Character Education	10 minutes daily**	10 minutes daily**
Arts Education		

Dance
Music
Theatre
Visual Arts

Daily instruction with Arts specialists in each of the Arts disciplines is the most desirable schedule. However, schools unable to provide daily Arts instruction in each discipline are encouraged to schedule in Grades 1 through 3 two 30- to 45-minute Arts instruction sessions per week and in Grades 4 through 6 a minimum of 60 minutes of instruction per week. Interdisciplinary instruction within the regular classroom setting is encouraged as an alternative approach for scheduling time for Arts instruction when Arts specialists are not available.

*Established by the State Department of Education in accordance with *Code of Alabama*, 1975, §16-40-1

**Established by the State Department of Education in accordance with *Code of Alabama*, 1975, §16-6B-2(h)

Kindergarten

In accordance with *Alabama Administrative Code* r. 290-5-1-.01(5) Minimum Standards for Organizing Kindergarten Programs in Alabama Schools, the daily time schedule of the kindergartens shall be the same as the schedule of the elementary schools in the systems of which they are a part since kindergartens in Alabama operate as full-day programs. There are no established time guidelines for individual subject areas for the kindergarten classroom. The emphasis is on large blocks of time that allow children the opportunity to explore all areas of the curriculum in an unhurried manner.

It is suggested that the full-day kindergarten program be organized utilizing large blocks of time for large group, small groups, center time, lunch, outdoor activities, snacks, transitions, routines, and afternoon review. Individual exploration, small-group interest activities, interaction with peers and teachers, manipulation of concrete materials, and involvement in many other real-world experiences are needed to provide a balance in the kindergarten classroom.

Grades 7-12

A minimum of 140 clock hours of instruction is required for one unit of credit and a minimum of 70 clock hours of instruction is required for one-half unit of credit.

In those schools where Grades 7 and 8 are housed with other elementary grades, the school may choose the time requirements listed for Grades 4-6 or those listed for Grades 7-12.

Character Education

For all grades, not less than 10 minutes instruction per day shall focus upon the students' development of the following character traits: courage, patriotism, citizenship, honesty, fairness, respect for others, kindness, cooperation, self-respect, self-control, courtesy, compassion, tolerance, diligence, generosity, punctuality, cleanliness, cheerfulness, school pride, respect of the environment, patience, creativity, sportsmanship, loyalty, and perseverance.

Homework

Homework is an important component of every student's instructional program. Students, teachers, and parents should have a clear understanding of the objectives to be accomplished through homework and the role it plays in meeting curriculum requirements. Homework reflects practices that have been taught in the classroom and provides reinforcement and/or remediation for students. It should be student-managed, and the amount should be age-appropriate, encouraging learning through problem solving and practice.

At every grade level, homework should be meaning-centered and mirror classroom activities and experiences. Independent and collaborative projects that foster creativity, problem-solving abilities, and student responsibility are appropriate. Parental support and supervision reinforce the quality of practice or product as well as skill development.

Each local board of education shall establish a policy on homework consistent with the State Board of Education resolution adopted February 23, 1984. (Action Item #F-2)

BIBLIOGRAPHY

Alabama Course of Study: Science (Bulletin 2001, No. 20). Montgomery, Alabama: Alabama Department of Education, 1998.

Alabama Course of Study: Technology Education (Bulletin 2002, No. 21). Montgomery, Alabama: Alabama Department of Education, 2002.

Benchmarks for Science Literacy. New York, New York: Oxford University Press, Inc., 1993.

Bybee, Rodger W. *Achieving Scientific Literacy: From Purpose to Practices*. Portsmouth, New Hampshire: Heinemann Publishers, 1997.

Hurd, Paul DeHart. "*Transforming Science Education*." ASCD Curriculum Handbook. Alexandria, Virginia: Association for Supervision and Curriculum Development, 1992.

National Science Education Standards. Washington, D.C.: National Academy Press, 1996.

Rutherford, F. James. *Science for All Americans.* New York, New York: Oxford University Press, Inc., 1990.

Science Framework for the 2005 National Assessment of Educational Progress. Washington, D.C.: National Assessment Governing Board, September 2004.

The Handy Science Answer Book. Pittsburgh, Pennsylvania: Department of Science and Technology, Carnegie Library, 1994.

The Total Science Safety System: Elementary (Bulletin 2001, No. 35). Montgomery, Alabama: Alabama Department of Education, 2001.

The Total Science Safety System: Secondary (Bulletin 2001, No. 28). Montgomery, Alabama: Alabama Department of Education, 2001.

Third International Mathematics and Science Study. Washington, D.C.: Office of Educational Research and Improvement, United States Department of Education, June 1997.

Webster's II New College Dictionary. Boston, Massachusetts: Houghton Mifflin Company, 1999.