BIOLOGY 1 OVERVIEW

The academic standards and performance indicators establish the practices and core content for all Biology courses in South Carolina high schools. The core ideas within the standards are not meant to represent an equal division of material and concepts. Therefore, the number of indicators per core idea should not be expected to be equal, nor should equal numbers of performance indicators within each standard be expected.

The five core areas of the Biology 1 course standards include:

- Cells as a System
- Energy Transfer
- Heredity – Inheritance and Variation of Traits
- Biological Evolution – Unity and Diversity
- Ecosystem Dynamics

The eight science and engineering practices describe how students should learn and demonstrate knowledge of the content outlined in the content standards. Engaging in these practices will help students become scientifically literate and astute consumers of scientific information. The seven core concepts (patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function; and stability and change) are reinforced in the appropriate context of the core science content through hands-on instruction in the classroom.

Students should engage in scientific and engineering practices as a means to learn about the specific topics identified for the course. It is critical that educators understand the Science and Engineering Practices are *not* to be taught in isolation. There should *not* be a distinct "Inquiry" unit at the beginning of each school year. Rather, the practices need to be employed *within the content* for each grade level.

Teachers, schools, and districts should use these standards and indicators to make decisions concerning the structure and content of Biology 1 courses. All biology courses must include instruction in the practices of science and engineering, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. All biology courses are laboratory courses requiring a minimum of 30% hands-on investigation. Biology laboratories will need to be stocked with the materials and equipment necessary to complete investigations.

The academic standards and performance indicators for Biology 1 should be the basis for the development of classroom and course-level assessments. In addition, the academic standards and performance indicators for Biology 1 will be the basis for the development of the items on the state-required End-of-Course Examination Program (EOCEP) for Biology 1.

BIOLOGY 1
SCIENCE AND ENGINEERING PRACTICES

NOTE: Scientific investigations should always be done in the context of content knowledge expected in this course. The standard describes how students should learn and demonstrate knowledge of the content outlined in the other standards.

Standard H.B.1: The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understandings of science content.

H.B.1A. Conceptual Understanding: The practices of science and engineering support the development of science concepts, develop the habits of mind that are necessary for scientific thinking, and allow students to engage in science in ways that are similar to those used by scientists and engineers.

Performance Indicators: Students who demonstrate this understanding can:

H.B.1A.1 Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims.

H.B.1A.2 Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

H.B.1A.3 Plan and conduct controlled scientific investigations to answer questions, test hypotheses, and develop explanations: (1) formulate scientific questions and testable hypotheses based on credible scientific information, (2) identify materials, procedures, and variables, (3) use appropriate laboratory equipment, technology, and techniques to collect qualitative and quantitative data, and (4) record and represent data in an appropriate form. Use appropriate safety procedures.

H.B.1A.4 Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions.

H.B.1A.5 Use mathematical and computational thinking to (1) use and manipulate appropriate metric units, (2) express relationships between variables for models and investigations, and (3) use grade-level appropriate statistics to analyze data.

H.B.1A.6 Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams.

H.B.1A.7 Construct and analyze scientific arguments to support claims, explanations, or designs using evidence and valid reasoning from observations, data, or informational texts.

H.B.1A.8 Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations.

H.B.1B. Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.

Performance Indicators: Students who demonstrate this understanding can:

H.B.1B.1 Construct devices or design solutions using scientific knowledge to solve specific problems or needs: (1) ask questions to identify problems or needs, (2) ask questions about the criteria and constraints of the device or solutions, (3) generate and communicate ideas for possible devices or solutions, (4) build and test devices or solutions, (5) determine if the devices or solutions solved the problem and refine the design if needed, and (6) communicate the results.

BIOLOGY 1
CELLS AS A SYSTEM

Standard H.B.2: The student will demonstrate the understanding that the essential functions of life take place within cells or systems of cells.

H.B.2A. Conceptual Understanding: The essential functions of a cell involve chemical reactions that take place between many different types of molecules (including carbohydrates, lipids, proteins and nucleic acids) and are catalyzed by enzymes.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2A.1 Construct explanations of how the structures of carbohydrates, lipids, proteins, and nucleic acids (including DNA and RNA) are related to their functions in organisms.

H.B.2A.2 Plan and conduct investigations to determine how various environmental factors (including temperature and pH) affect enzyme activity and the rate of biochemical reactions.

H.B.2B. Conceptual Understanding: Organisms and their parts are made of cells. Cells are the structural units of life and have specialized substructures that carry out the essential functions of life. Viruses lack cellular organization and therefore cannot independently carry out all of the essential functions of life.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2B.1 Develop and use models to explain how specialized structures within cells (including the nucleus, chromosomes, cytoskeleton, endoplasmic reticulum, ribosomes and Golgi complex) interact to produce, modify, and transport proteins. Models should compare and contrast how prokaryotic cells meet the same life needs as eukaryotic cells without similar structures.

H.B.2B.2 Collect and interpret descriptive data on cell structure to compare and contrast different types of cells (including prokaryotic versus eukaryotic, and animal versus plant versus fungal).

H.B.2B.3 Obtain information to contrast the structure of viruses with that of cells and to explain, in general, why viruses must use living cells to reproduce.

H.B.2C. Conceptual Understanding: Transport processes which move materials into and out of the cell serve to maintain the homeostasis of the cell.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2C.1 Develop and use models to exemplify how the cell membrane serves to maintain homeostasis of the cell through both active and passive transport processes.

H.B.2C.2 Ask scientific questions to define the problems that organisms face in maintaining homeostasis within different environments (including water of varying solute concentrations).

H.B.2C.3 Analyze and interpret data to explain the movement of molecules (including water) across a membrane.

H.B.2D. Conceptual Understanding: The cells of multicellular organisms repeatedly divide to make more cells for growth and repair. During embryonic development, a single cell gives rise to a complex, multicellular organism through the processes of both cell division and differentiation.

Performance Indicators: Students who demonstrate this understanding can:

H.B.2D.1 Construct models to explain how the processes of cell division and cell differentiation produce and maintain complex multicellular organisms.

H.B.2D.2 Develop and use models to exemplify the changes that occur in a cell during the cell cycle (including changes in cell size, chromosomes, cell membrane/cell wall, and the number of cells produced) and predict, based on the models, what might happen to a cell that does not progress through the cycle correctly.

H.B.2D.3 Construct explanations for how the cell cycle is monitored by check point systems and communicate possible consequences of the continued cycling of abnormal cells.

H.B.2D.4 Construct scientific arguments to support the pros and cons of biotechnological applications of stem cells using examples from both plants and animals.

BIOLOGY 1
ENERGY TRANSFER

Standard H.B.3: The student will demonstrate the understanding that all essential processes within organisms require energy which in most ecosystems is ultimately derived from the Sun and transferred into chemical energy by the photosynthetic organisms of that ecosystem.

H.B.3A. Conceptual Understanding: Cells transform energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another.

Performance Indicators: Students who demonstrate this understanding can:

H.B.3A.1 Develop and use models to explain how chemical reactions among ATP, ADP, and inorganic phosphate act to transfer chemical energy within cells.

H.B.3A.2 Develop and revise models to describe how photosynthesis transforms light energy into stored chemical energy.

H.B.3A.3 Construct scientific arguments to support claims that chemical elements in the sugar molecules produced by photosynthesis may interact with other elements to form amino acids, lipids, nucleic acids or other large organic molecules.

H.B.3A.4 Develop models of the major inputs and outputs of cellular respiration (aerobic and anaerobic) to exemplify the chemical process in which the bonds of molecules are broken, the bonds of new compounds are formed and a net transfer of energy results.

H.B.3A.5 Plan and conduct scientific investigations or computer simulations to determine the relationship between variables that affect the processes of fermentation and/or cellular respiration in living organisms and interpret the data in terms of real-world phenomena.

BIOLOGY 1

HEREDITY – INHERITANCE AND VARIATION OF TRAITS

Standard H.B.4: The student will demonstrate an understanding of the specific mechanisms by which characteristics or traits are transferred from one generation to the next via genes.

H.B.4A. Conceptual Understanding: Each chromosome consists of a single DNA molecule. Each gene on the chromosome is a particular segment of DNA. The chemical structure of DNA provides a mechanism that ensures that information is preserved and transferred to subsequent generations.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4A.1 Develop and use models at different scales to explain the relationship between DNA, genes, and chromosomes in coding the instructions for characteristic traits transferred from parent to offspring.

H.B.4A.2 Develop and use models to explain how genetic information (DNA) is copied for transmission to subsequent generations of cells (mitosis).

H.B.4B. Conceptual Understanding: In order for information stored in DNA to direct cellular processes, a gene needs to be transcribed from DNA to RNA and then must be translated by the cellular machinery into a protein or an RNA molecule. The protein and RNA products from these processes determine cellular activities and the unique characteristics of an individual. Modern techniques in biotechnology can manipulate DNA to solve human problems.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4B.1 Develop and use models to describe how the structure of DNA determines the structure of resulting proteins or RNA molecules that carry out the essential functions of life.

H.B.4B.2 Obtain, evaluate and communicate information on how biotechnology (including gel electrophoresis, plasmid-based transformation and DNA fingerprinting) may be used in the fields of medicine, agriculture, and forensic science.

H.B.4C. Conceptual Understanding: Sex cells are formed by a process of cell division in which the number of chromosomes per cell is halved after replication. With the exception of sex chromosomes, for each chromosome in the body cells of a multicellular organism, there is a second similar, but not identical, chromosome. Although these pairs of similar chromosomes can carry the same genes, they may have slightly different alleles. During meiosis the pairs of similar chromosomes may cross and trade pieces. One chromosome from each pair is randomly passed on to form sex cells resulting in a multitude of possible genetic combinations. The cell produced during fertilization has one set of chromosomes from each parent.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4C.1 Develop and use models of sex cell formation (meiosis) to explain why the DNA of the daughter cells is different from the DNA of the parent cell.

H.B.4C.2 Analyze data on the variation of traits among individual organisms within a population to explain patterns in the data in the context of transmission of genetic information.

H.B.4C.3 Construct explanations for how meiosis followed by fertilization ensures genetic variation among offspring within the same family and genetic diversity within populations of sexually reproducing organisms.

H.B.4D. Conceptual Understanding: Imperfect transmission of genetic information may have positive, negative, or no consequences to the organism. DNA replication is tightly regulated and remarkably accurate, but errors do occur and result in mutations which (rarely) are a source of genetic variation.

Performance Indicators: Students who demonstrate this understanding can:

H.B.4D.1 Develop and use models to explain how mutations in DNA that occur during replication (1) can affect the proteins that are produced or the traits that result and (2) may or may not be inherited.

BIOLOGY 1
ECOSYSTEM DYNAMICS

Standard H.B.6: The student will demonstrate an understanding that ecosystems are complex, interactive systems that include both biological communities and physical components of the environment.

H.B.6A. Conceptual Understanding: Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. Limiting factors include the availability of biotic and abiotic resources and challenges such as predation, competition, and disease.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6A.1 Analyze and interpret data that depict changes in the abiotic and biotic components of an ecosystem over time or space (such as percent change, average change, correlation and proportionality) and propose hypotheses about possible relationships between the changes in the abiotic components and the biotic components of the environment.

H.B.6A.2 Use mathematical and computational thinking to support claims that limiting factors affect the number of individuals that an ecosystem can support.

H.B.6B. Conceptual Understanding: Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6B.1 Develop and use models of the carbon cycle, which include the interactions between photosynthesis, cellular respiration and other processes that release carbon dioxide, to evaluate the effects of increasing atmospheric carbon dioxide on natural and agricultural ecosystems.

H.B.6B.1 Analyze and interpret quantitative data to construct an explanation for the effects of greenhouse gases (such as carbon dioxide and methane) on the carbon cycle and global climate.

H.B.6C. Conceptual Understanding: A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively stable over long periods of time. Fluctuations in conditions can challenge the functioning of ecosystems in terms of resource and habitat availability.

Performance Indicators: Students who demonstrate this understanding can:

H.B.6C.1 Construct scientific arguments to support claims that the changes in the biotic and abiotic components of various ecosystems over time affect the ability of an ecosystem to maintain homeostasis.