What Is Science? Any study of science includes the search for understanding the natural world and facts, principles, theories and laws that have been verified by the scientific community and are used to explain and predict natural phenomena and events.

Acquiring scientific knowledge involves constructing hypotheses using observation and knowledge in the content area in order to formulate useful questions that provoke scientific inquiry. As a result of repeated, rigorous testing over time and applying multiple perspectives to a problem, consistent information emerges. A theory describes this verifiable event or phenomena. Theories are powerful elements in science and are used to predict other events. As theories lose their ability to predict, they are modified, expanded or generalized or incorporated into a broader theory.

Knowledge of what science is incorporates carefully developed and integrated components:

- Nature of science -- the ways in which scientists search for answers to questions and explanations of observations about the natural world; includes process knowledge of observing, classifying, inferring, predicting, measuring, hypothesizing, experimenting and interpreting data
- Unifying themes of science -- concepts, generalizations and principles that result from and lead to inquiry
- Knowledge -- facts, principles, theories and laws verifiable through scientific inquiry by the world community of scientists; includes physics, chemistry, earth science and biological sciences
- Inquiry -- an intellectual process of logic that includes verification of answers to questions about and explanations for natural objects, events and phenomena
- Process skills -- Recognition by students how knowledge is acquired and applied in science by observing, classifying, inferring, predicting, measuring, computing, estimating, communicating, using space/time relationships, defining operationally, formulating hypotheses, testing and experimenting, designing controlled experiments, recognizing variables, manipulating variables, interpreting data, formulating models, designing models and producing solutions.
- Problem solving -- application of concepts to problems of human adaptation to the environment that often leads to recognition of new problems; has social implications and leads to personal decision-making and action; a process which forms the link for interactions between scientific and technological results or findings; involves operational definitions, recognizing variables, formulating models and asking questions
- Scientific thinking -- the disposition to suspend judgment, not make decisions and not take action until results, explanations or answers have been tested and verified with information.

Academic Standards for Biological Sciences (Final Draft January 2010)

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3.1. Biological Sciences Biology of organisms and cells concerns living things, their appearance, different types of life, the scope of their similarities and differences, where they live and how they live. Living things are made of the same components as all other matter, involve the same kinds of transformations of energy and move using the same basic kinds of forces as described in chemistry and physics standards. Through the study of the diversity of life, students learn how life has evolved. This great variety of life forms continues to change even today as genetic instructions within cells are passed from generation to generation, yet the amazing integrity of most species remain.

A. Organisms and Cells

1. Common Characteristics of Life (3.1.B.A1.)

- Describe the common characteristics of life.
- Compare and contrast the cellular structures and degrees of complexity of prokaryotic and eukaryotic organisms.
- Explain that some structures in eukaryotic cells developed from early prokaryotic cells (e.g., mitochondria, chloroplasts)

2. Energy Flow (3.1.B.A2.)

- Identify the initial reactants, final products, and general purposes of photosynthesis and cellular respiration. Explain the important role of ATP in cell metabolism.
- Describe the relationship between photosynthesis and cellular respiration in photosynthetic organisms.
- Explain why many biological macromolecules such as ATP and lipids contain high energy bonds.
- Explain the importance of enzymes as catalysts in cell reactions.
- Identify how factors such as pH and temperature may affect enzyme function.

3. Life Cycles (3.1.B.A3.)

- Explain how all organisms begin their life cycles as a single cell and that in multicellular organisms, successive generations of embryonic cells form by cell division.

4. Cell Cycles (3.1.B.A4.)

- Summarize the stages of the **cell cycle**.
- Examine how interactions among the different molecules in the cell cause the distinct stages of the cell cycle which can also be influenced by other signaling molecules.
- Explain the role of **mitosis** in the formation of new cells and its importance in maintaining chromosome number during asexual reproduction.
- Compare and contrast a virus and a cell. Relate the stages of viral cycles to the cell cycle.

5. Form and Function (3.1.B.A5.)

- Relate the structure of cell organelles to their function (energy capture and release, transport, waste removal, protein synthesis, movement, etc).
- Explain the role of water in cell metabolism.
- Explain how the cell membrane functions as a regulatory structure and protective barrier for the cell.
- Describe transport mechanisms across the plasma membrane.

6. Organization (3.1.B.A6.)

- Explain how cells differentiate in multicellular organisms.

7. Molecular Basis of Life (3.1.B.A7.)

- Analyze the importance of carbon to the structure of biological macromolecules.
- Compare and contrast the functions and structures of proteins, lipids, carbohydrates, and nucleic acids.
- Explain the consequences of extreme changes in pH and temperature on cell proteins.

8. Unifying Themes (3.1.B.A8.)

- CHANGE AND CONSTANCY:
  Recognize that systems within cells and multicellular organisms interact to maintain homeostasis.
- PATTERNS:
  Demonstrate the repeating patterns that occur in biological polymers.
- SYSTEMS:
  Describe how the unique properties of water support life.

9. Science as Inquiry

- Examine the status of existing theories.
- Evaluate experimental information for relevance and adherence to science processes.
- Judge that conclusions are consistent and logical with experimental conditions.
- Interpret results of experimental research to predict new information, propose additional investigable questions, or advance a solution.
- Communicate and defend a scientific argument.

B. Genetics

1. Heredity (3.1.B.B1.)

- Explain that the information passed from parents to offspring is transmitted by means of genes which are coded in **DNA** molecules.
- Explain the basic process of **DNA** replication.
- Describe the basic processes of transcription and translation.
- Explain how crossing over, jumping genes, and deletion and duplication of genes results in genetic variation.
- Explain how **mutations** can alter genetic information and the possible consequences on resultant cells.

2. Reproduction (3.1.B.B2.)

- Describe how the process of **meiosis** results in the formation of haploid gametes and analyze the importance of **meiosis** in sexual reproduction.
- Compare and contrast the function of **mitosis** and **meiosis**.
- Illustrate that the sorting and recombining of genes in sexual reproduction results in a great variety of possible gene combinations in offspring.

3. Molecular Basis of Life (3.1.B.B3.)

- Describe the basic structure of **DNA**, including the role of hydrogen bonding.
- Explain how the process of **DNA** replication results in the transmission and conservation of the genetic code.
- Describe how transcription and translation result in gene expression.
- Differentiate among the end products of replication, transcription, and translation.
- Cite evidence to support that the genetic code is universal.

4. Biotechnology (3.1.B.B4.)

- Explain how **genetic technologies** have impacted the fields of medicine, **forensics,** and agriculture

5. Unifying Themes (3.1.B.B5.)

- PATTERNS:
  Describe how Mendel's laws of segregation and independent assortment can be observed through patterns of inheritance.
  Distinguish among observed inheritance patterns caused by several types of genetic traits (dominant, recessive, codominant, sex-linked, polygenic, incomplete dominance, multiple alleles)
- CONSTANCY AND CHANGE:
  Explain how the processes of replication, transcription, and translation are similar in all organisms.
  Explain how gene actions, patterns of heredity, and reproduction of cells and organisms account for the continuity of life.
- SCALE:
  Demonstrate how inherited characteristics can be observed at the molecular, cellular, and organism levels.

6. Science as Inquiry

- Examine the status of existing theories.
- Evaluate experimental information for relevance and adherence to science processes.
- Judge that conclusions are consistent and logical with experimental conditions.
- Interpret results of experimental research to predict new information, propose additional investigable questions, or advance a solution.
- Communicate and defend a scientific argument.

C. Evolution

1. Natural Selection (3.1.B.C1.)

- Describe species as reproductively distinct groups of organisms.
- Analyze the role that geographic isolation can play in speciation.
- Explain how evolution through natural selection can result in changes in biodiversity through the increase or decrease of genetic diversity within a population.
- Describe how the degree of kinship between species can be inferred from the similarity in their **DNA** sequences.

2. Adaptation (3.1.B.C2.)

- Describe the theory suggesting that life on Earth arose as a single, primitive prokaryote about 4 billion years ago and that for the next 2 billion years, a huge diversity of single-celled **organisms** evolved.
- Analyze how increasingly complex, multicellular organisms evolved once cells with nuclei developed.
- Describe how mutations in sex cells may be passed on to successive generations and that the resulting **phenotype** may help, harm, or have little or no effect on the offspring's success in its environment.
- Describe the relationship between environmental changes and changes in the gene pool of a population.

3. Unifying Themes (3.1.B.C3.)

- CONSTANCY AND CHANGE:
  Compare and contrast various theories of evolution.
  Interpret data from fossil records, anatomy and **physiology**, and **DNA** studies relevant to the **theory of evolution**.
- PATTERNS:
  Discuss the implications of a universal genetic code for evolution.

4. Science as Inquiry

- Examine the status of existing theories.
- Evaluate experimental information for relevance and adherence to science processes.
- Judge that conclusions are consistent and logical with experimental conditions.
- Interpret results of experimental research to predict new information, propose additional investigable questions, or advance a solution.
- Communicate and defend a scientific argument.