Biology

The Biology standards are designed to provide students with a detailed understanding of living systems. Emphasis continues to be placed on the skills necessary to examine alternative scientific explanations, actively conduct controlled experiments, analyze and communicate information, and gather and use information in scientific literature. The history of biological thought and the evidence that supports it are explored, providing the foundation for investigating biochemical life processes, cellular organization, mechanisms of inheritance, dynamic relationships among organisms, and the change in organisms through time. The importance of scientific research that validates or challenges ideas is emphasized at this level. All students are expected to achieve the content of the biology standards.

The Biology standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

BIO.1 The student will plan and conduct investigations in which
- a) observations of living organisms are recorded in the lab and in the field;
- b) hypotheses are formulated based on direct observations and information from scientific literature;
- c) variables are defined and investigations are designed to test hypotheses;
- d) graphing and arithmetic calculations are used as tools in data analysis;
- e) conclusions are formed based on recorded quantitative and qualitative data;
- f) sources of error inherent in experimental design are identified and discussed;
- g) validity of data is determined;
- h) chemicals and equipment are used in a safe manner;
- i) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results;
- j) research utilizes scientific literature;
- k) differentiation is made between a scientific hypothesis and theory;
- l) alternative scientific explanations and models are recognized and analyzed; and
- m) a scientific viewpoint is constructed and defended (the nature of science).

BIO.2 The student will investigate and understand the history of biological concepts. Key concepts include
- a) evidence supporting the cell theory;
- b) scientific explanations of the development of organisms through time (biological evolution);
- c) evidence supporting the germ theory of infectious disease;
- d) development of the structural model of DNA; and
- e) the collaborative efforts of scientists, past and present.

BIO.3 The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include
a) water chemistry and its impact on life processes;
b) the structure and function of macromolecules;
c) the nature of enzymes; and
d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration.

BIO.4 The student will investigate and understand relationships between cell structure and function. Key concepts include
a) characteristics of prokaryotic and eukaryotic cells;
b) exploring the diversity and variation of eukaryotes;
c) similarities between the activities of a single cell and a whole organism; and
d) the cell membrane model (diffusion, osmosis, and active transport).

BIO.5 The student will investigate and understand life functions of archaebacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans. Key concepts include
a) how their structures and functions vary between and within the kingdoms;
b) comparison of their metabolic activities;
c) analyses of their responses to the environment;
d) maintenance of homeostasis;
e) human health issues, human anatomy, body systems, and life functions; and
f) how viruses compare with organisms.

BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include
a) cell growth and division;
b) gamete formation;
c) cell specialization;
d) prediction of inheritance of traits based on the Mendelian laws of heredity;
e) genetic variation (mutation, recombination, deletions, additions to DNA);
f) the structure, function, and replication of nucleic acids (DNA and RNA);
g) events involved in the construction of proteins;
h) use, limitations, and misuse of genetic information; and
i) exploration of the impact of DNA technologies.

BIO.7 The student will investigate and understand bases for modern classification systems. Key concepts include
a) structural similarities among organisms;
b) fossil record interpretation;
c) comparison of developmental stages in different organisms;
d) examination of biochemical similarities and differences among organisms; and
e) systems of classification that are adaptable to new scientific discoveries.

BIO.8 The student will investigate and understand how populations change through time. Key concepts include

a) evidence found in fossil records;
b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
c) how natural selection leads to adaptations;
d) emergence of new species; and
e) scientific explanations for biological evolution.

BIO.9 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
b) nutrient cycling with energy flow through ecosystems;
c) succession patterns in ecosystems;
d) the effects of natural events and human activities on ecosystems; and
e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems including the Chesapeake Bay and its tributaries.