

Biology

The Biology standards are designed to provide students with a detailed understanding of living systems. Students investigate biochemical life processes, cellular organization, mechanisms of inheritance, dynamic relationships among organisms, and the changes in organisms through time. Skills necessary to examine scientific explanations, conduct experiments, analyze and communicate information, and gather and use information in scientific literature continues to be important. The importance of scientific research that validates or challenges ideas is emphasized at this level. Tools and technology, including calculators, computers, probeware, and microscopes are used when feasible. Students will use chemicals and equipment safely. Mathematics, computational thinking, and experience in the engineering design process are important as students advance in their scientific thinking.

BIO.1 The student will demonstrate an understanding of scientific and engineering practices by

a) asking questions and defining problems

- ask questions that arise from careful observation of phenomena and/or organisms, from examining models and theories, and/or to seek additional information
- determine which questions can be investigated within the scope of the school laboratory or field to determine relationships between independent and dependent variables
- generate hypotheses based on research and scientific principles
- make hypotheses that specify what happens to a dependent variable when an independent variable is manipulated

b) planning and carrying out investigations

- individually and collaboratively plan and conduct observational and experimental investigations
- plan and conduct investigations or test design solutions in a safe and ethical manner including considerations of environmental, social, and personal effects
- determine appropriate sample size and techniques
- select and use appropriate tools and technology to collect, record, analyze, and evaluate data

c) interpreting, analyzing, and evaluating data

- construct and interpret data tables showing independent and dependent variables, repeated trials, and means
- construct, analyze, and interpret graphical displays of data
- use data in building and revising models, supporting an explanation for phenomena, or testing solutions to problems
- analyze data using tools, technologies, and/or models to make valid and reliable scientific claims or determine an optimal design solution

d) constructing and critiquing conclusions and explanations

- make quantitative and/or qualitative claims regarding the relationship between dependent and independent variables
- construct and revise explanations based on valid and reliable evidence obtained from a variety of sources including students' own investigations, models, theories, simulations, and peer review
- apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and design solutions
- compare and evaluate competing arguments or design solutions in light of currently accepted explanations and new scientific evidence
- construct arguments or counter-arguments based on data and evidence
- differentiate between a scientific hypothesis and theory

e) *developing and using models*

- evaluate the merits and limitations of models
- develop, revise, and/or use models based on evidence to illustrate or predict relationships
- develop and/or use models to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems

f) *obtaining, evaluating, and communicating information*

- compare, integrate, and evaluate sources of information presented in different media or formats to address a scientific question or solve a problem
 - gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and credibility of each source
- communicate scientific and/or technical information about phenomena in multiple formats

BIO.2 The student will investigate and understand that chemical and biochemical processes are essential for life. Key ideas include

- a) water chemistry has an influence on life processes;
- b) macromolecules have roles in maintaining life processes;
- c) enzymes have a role in biochemical processes;
- d) protein synthesis is the process of forming proteins which influences inheritance and evolution; and
- e) the processes of photosynthesis and respiration include the capture, storage, transformation, and flow of energy.

BIO.3 The student will investigate and understand that cells have structure and function. Key ideas include

- a) the cell theory is supported by evidence;
- b) structures in unicellular and multicellular organisms work interdependently to carry out life processes;
- c) cell structures and processes are involved in cell growth and division;
- d) the structure and function of the cell membrane support cell transport; and
- e) specialization leads to the development of different types of cells.

BIO.4 The student will investigate and understand that bacteria and viruses have an effect on living systems. Key ideas include

- a) viruses depend on a host for metabolic processes;
- b) the modes of reproduction/replication can be compared;
- c) the structures and functions can be compared;
- d) bacteria and viruses have a role in other organisms and the environment; and
- e) the germ theory of infectious disease is supported by evidence.

BIO.5 The student will investigate and understand that there are common mechanisms for inheritance. Key ideas include

- a) DNA has structure and is the foundation for protein synthesis;
- b) the structural model of DNA has developed over time;
- c) the variety of traits in an organism are the result of the expression of various combinations of alleles;
- d) meiosis has a role in genetic variation between generations; and
- e) synthetic biology has biological and ethical implications.

BIO.6 The student will investigate and understand that modern classification systems can be used as organizational tools for scientists in the study of organisms. Key ideas include

- a) organisms have structural and biochemical similarities and differences;
- b) fossil record interpretation can be used to classify organisms;
- c) developmental stages in different organisms can be used to classify organisms;
- d) Archaea, Bacteria, and Eukarya are domains based on characteristics of organisms;
- e) the functions and processes of protists, fungi, plants, and animals allow for comparisons and differentiation within the Eukarya kingdoms; and
- f) systems of classification are adaptable to new scientific discoveries.

BIO.7 The student will investigate and understand that populations change through time. Key ideas include

- a) evidence is found in fossil records and through DNA analysis;
- b) genetic variation, reproductive strategies, and environmental pressures affect the survival of populations;
- c) natural selection is a mechanism that leads to adaptations and may lead to the emergence of new species; and
- d) biological evolution has scientific evidence and explanations.

BIO.8 The student will investigate and understand that there are dynamic equilibria within populations, communities, and ecosystems. Key ideas include

- a) interactions within and among populations include carrying capacities, limiting factors, and growth curves;
- b) nutrients cycle with energy flow through ecosystems;
- c) ecosystems have succession patterns; and
- d) natural events and human activities influence local and global ecosystems and may affect the flora and fauna of Virginia.