# Virginia Department of Education (VDOE) Biology Instruction and Assessment Support Document February 14, 2023

This information pertains to seniors currently enrolled in Biology who need a verified credit in science.

As a reminder, the 2018 *Science Standards of Learning* and the 2018 *Science Curriculum Framework* were adopted by the Virginia Board of Education (BOE) in October 2018. These documents identify the academic content and essential components of the science curriculum at different grade levels for Virginia’s schools. Beginning in fall 2022, all school divisions were to teach and assess the 2018 *Science Standards of Learning* in their classrooms. Beginning in spring 2023, new Standards of Learning tests assessing the 2018 *Science Standards of Learning* will be administered.

Because the grade 5, grade 8, and Biology tests assessing the 2018 *Science Standards of Learning* are new assessments being administered for the first time this spring, the potential exists for delays in the return of students’ test results. A delay could be problematic for students attempting to graduate in spring 2023 who are currently enrolled in Biology to earn a verified credit in science.

With this in mind, school divisions with seniors currently enrolled in Biology who need a verified credit in science are *strongly encouraged* to administer the Biology test that assesses the 2010 *Science Standards of Learning* to those seniors. Administering the 2010 version of the Biology test to those students attempting to graduate this spring ensures that the students’ test results will be available within 24-hours of completing their test and prior to graduation. Note that students who were instructed in Biology prior to 2022-2023 and are retaking the Biology Standards of Learning test to earn a verified credit should continue to take the Biology test based on the 2010 *Science Standards of Learning*.

The VDOE recognizes that differences exist between expectations of the 2010 and 2018 *Biology Standards of Learning*. The purpose of this document is to provide support to teachers to address these differences when preparing seniors who were enrolled in Biology this year but will be taking the Biology assessment based on the 2010 *Science Standards of Learning*.

**General changes evidenced in the Virginia 2018 Science Standards of Learning:**

* The 2018 Science Standards of Learning have been restructured to support the development of concepts versus a focus on terminology. The introduction of terms as students develop conceptual understanding through engaging in science and engineering practices is a research based best practice in science instruction. The practice of introducing scientific terms and their definitions at the beginning of a unit is proven to be an ineffective instructional strategy in science education.
* The section Scientific Investigation, Reasoning, and Logic has been changed to Scientific and Engineering Practices. The expectation is that these practices are integrated to support and enhance the concepts within the standards.
* Study of the historical developments of current science concepts should emphasize the nature of science and the contributions that led to the development of the scientific concept, theory, or law versus the identification of specific scientists or events.

**Summary of changes specific to Biology:**

* The bullets were reorganized to reflect central idea of each standard stem.
* The relationship between surface area and volume and material transport was removed.
* Protein synthesis was moved to Bio.2 to reflect that it is a biochemical process.
* Bio.4 revised to emphasize bacteria and viruses.
* Human Biology was omitted in standards. Human biology should still be used to support various biological concepts.
* Synthetic biology was added to support genetics strand.

Note:

Areas highlighted in yellow are in the 2010 Standards but not the 2018 Standards.

Areas highlighted in green are in the Enduring Understanding and/or the Essential Knowledge and Practices in the indicated 2018 Science Standards.

| **2010** | **2018** |
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| BIO.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which   1. observations of living organisms are recorded in the lab and in the field; 2. hypotheses are formulated based on direct observations and information from scientific literature; 3. variables are defined and investigations are designed to test hypotheses; 4. graphing and arithmetic calculations are used as tools in data analysis; 5. conclusions are formed based on recorded quantitative and qualitative data; 6. sources of error inherent in experimental design are identified and discussed; 7. validity of data is determined; 8. chemicals and equipment are used in a safe manner; 9. appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data, communicating results, modeling concepts, and simulating experimental conditions; 10. research utilizes scientific literature; 11. differentiation is made between a scientific hypothesis, theory, and law; 12. alternative scientific explanations and models are recognized and analyzed; and 13. current applications of biological concepts are used. | BIO.1 The student will demonstrate an understanding of scientific and engineering practices by   1. 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 2. 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  1. 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  1. 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 counterarguments based on data and evidence    * differentiate between a scientific hypothesis and theory 2. 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 3. 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 the chemical and biochemical principles essential for life. Key concepts include   1. water chemistry and its impact on life processes; 2. the structure and function of macromolecules; 3. the nature of enzymes; and 4. the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration | BIO.2 The student will investigate and understand that chemical and biochemical processes are essential for life. Key ideas include   * 1. water chemistry has an influence on life processes;   2. macromolecules have roles in maintaining life processes;   3. enzymes have a role in biochemical processes;   4. protein synthesis is the process of forming proteins which influences inheritance and evolution; and   5. the processes of photosynthesis and respiration include the capture, storage, transformation, and flow of energy. |
| BIO.3 The student will investigate and understand relationships between cell structure and function. Key concepts include   1. evidence supporting the cell theory; 2. characteristics of prokaryotic and eukaryotic cells; 3. similarities between the activities of the organelles in a single cell and a whole organism; 4. the cell membrane model; and 5. the impact of surface area to volume ratio on cell division, material transport, and other life processes. | BIO.3 The student will investigate and understand that cells have structure and function. Key ideas include   1. the cell theory is supported by evidence; 2. structures in unicellular and multicellular organisms work interdependently to carry out life processes; 3. cell structures and processes are involved in cell growth and division; 4. the structure and function of the cell membrane support cell transport; and 5. specialization leads to the development of different types of cells. |
| BIO.4 The student will investigate and understand life functions of Archaea, Bacteria and Eukarya. Key concepts include   1. comparison of their metabolic activities; (built into Bio.6) 2. maintenance of homeostasis; (built into Bio.3) 3. how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans; (moved to Bio.6) 4. human health issues, human anatomy, and body systems; (not tested on 2010 SOL assessment) 5. how viruses compare with organisms; and 6. evidence supporting the germ theory of infectious disease. | BIO.4 The student will investigate and understand that bacteria and viruses have an effect on living systems. Key ideas include   1. viruses depend on a host for metabolic processes; 2. the modes of reproduction/replication can be compared; 3. the structures and functions can be compared; 4. bacteria and viruses have a role in other organisms and the environment; and 5. the germ theory of infectious disease is supported by evidence. |
| BIO.5 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include   1. cell growth and division; 2. gamete formation; 3. cell specialization; 4. prediction of inheritance of traits based on the Mendelian laws of heredity; 5. historical development of the structural model of DNA; 6. genetic variation; 7. the structure, function, and replication of nucleic acids; 8. events involved in the construction of proteins; 9. use, limitations, and misuse of genetic information; and 10. exploration of the impact of DNA technologies. | BIO.5 The student will investigate and understand that there are common mechanisms for inheritance. Key ideas include   1. 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 bases for modern classification systems. Key concepts include   1. structural similarities among organisms; 2. fossil record interpretation; 3. comparison of developmental stages in different organisms; 4. examination of biochemical similarities and differences among organisms; and 5. systems of classification that are adaptable to new scientific discoveries. | 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   1. organisms have structural and biochemical similarities and differences; 2. fossil record interpretation can be used to classify organisms; 3. developmental stages in different organisms can be used to classify organisms; 4. Archaea, Bacteria, and Eukarya are domains based on characteristics of organisms; 5. the functions and processes of protists, fungi, plants, and animals allow for comparisons and differentiation within the Eukarya kingdoms; and 6. systems of classification are adaptable to new scientific discoveries. |
| BIO.7 The student will investigate and understand how populations change through time. Key concepts include   1. evidence found in fossil records; 2. how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations; 3. how natural selection leads to adaptations; 4. emergence of new species; and   scientific evidence and explanations for biological evolution. | BIO.7 The student will investigate and understand that populations change through time. Key ideas include   1. evidence is found in fossil records and through DNA analysis; 2. genetic variation, reproductive strategies, and environmental pressures affect the survival of populations; 3. natural selection is a mechanism that leads to adaptations and may lead to the emergence of new species; and 4. biological evolution has scientific evidence and explanations. |
| BIO.8 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include   1. interactions within and among populations including carrying capacities, limiting factors, and growth curves; 2. nutrient cycling with energy flow through ecosystems; 3. succession patterns in ecosystems; 4. the effects of natural events and human activities on ecosystems; and 5. analysis of the flora, fauna, and microorganisms of Virginia ecosystems. | BIO.8 The student will investigate and understand that there are dynamic equilibria within populations, communities, and ecosystems. Key ideas include   1. interactions within and among populations include carrying capacities, limiting factors, and growth curves; 2. nutrients cycle with energy flow through ecosystems; 3. ecosystems have succession patterns; and 4. natural events and human activities influence local and global ecosystems and may affect the flora and fauna of Virginia. |