Virginia Science Content Guidelines: Biology II: Advanced Survey of Biology Topics (3052)

SCED Description: Usually taken after a comprehensive initial study of biology, Biology—Advanced Studies courses cover biological systems in more detail. Topics that may be explored include cell organization, function, and reproduction; energy transformation; human anatomy and physiology; and the evolution and adaptation of organisms.

Prerequisite: Biology I (3051)

The purpose of the Biology II is to provide students an in depth exploration of Biology I concepts. The content guidelines were developed to reflect the advanced nature of the course yet allow flexibility for division to choose topics that relate to student interest, make content relevant to the student population, and to connect with current issues or needs in the community.

# Scientific and Engineering Practices

**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**

# Biology II Content

Bio II.2 The student will investigate and understand that living things are composed of cells; these cells serve as a foundation to more complex systems in multicellular organisms. Key ideas include

* organelles interact to contribute to the function of the cell;
* cells and organisms have different strategies to obtain nutrients and eliminate wastes;
* cells communicate by generating, transmitting, receiving, and responding to chemical signals;
* systems of specialized cells within organisms help them perform essential life processes; and
* many biomechanical feedback mechanisms of organisms are responses to environmental cues.

Bio II.3 The students will investigate and understand that the highly complex organization of living systems requires energy transformations and exchange of matter. Key ideas include

* organisms must exchange matter with the environment and use energy to grow, reproduce, and maintain organization;
* the composition and structure of macromolecules determine their function;
* systems are dynamic and change in response to inputs and outflows of energy and matter;
* photosynthetic processes allow organisms to capture and store energy in the form of macromolecules; and
* the processes of cellular respiration allow organisms to use stored energy in the form of macromolecules.

Bio II.4 The student will investigate and understand that transfer of inheritable information leads to the continuity of life. Key ideas include

* chromosomal inheritance provides an understanding for the patterns of transmission of genes from parents to offspring;
* patterns of inheritance of many traits does not follow the ratios predicted by Mendelian genetics;
* epigenetic changes can affect gene expression through reversible modifications of DNA or histones;
* gene regulation results in differential gene expression and influences cell products and function; and
* random mutations due to errors in DNA replication, DNA mechanisms, and environmental factors can lead to random mutations in DNA.

Bio.II.5 The student will investigate and understand that evolution is characterized by a change in the genetic makeup of a population over time. Key ideas include

* natural selection acts on phenotypic variations in a population and is a major mechanism of evolution;
* evolutionary fitness is measured by reproductive success;
* evolutions is driven by random occurrences such as mutation, genetic drift, and migration;
* Hardy-Weinberg is a model for describing and predicting allele frequencies in non-evolving populations; and
* phylogenetic trees and cladograms show evolutionary relationships among lineages.

Bio.II.6 The student will investigate and understand that ecosystems have a hierarchal structure and are composed of complex, interactive systems. Key ideas include

* ecosystems and communities change on the basis of interactions among populations and disruptions to the environment;
* the structure of a community or ecosystem is measured in terms of species composition and species diversity;
* keystone species, producers, and essential biotic and abiotic factors contribute to maintaining the diversity of an ecosystem;
* relationships within and among populations within a community or ecosystem can drive population dynamics and can result in enhanced movement of, or access to, matter and energy;
* the availability of resource can result in uncontrolled population growth and ecological changes; and
* the introduction of an invasive species can allow the species to exploit a new niche.

Bio.II 7 The student will investigate and understand concepts from different fields in biology. Topics may include but are not limited to:

1. biochemistry (to include an examination of macromolecule monomers and polymers, their structure and function in the human body, and reactions needed to sustain life processes)
2. comparative anatomy (to include anatomical terminology and an exploration of functional systems such as skeletal, muscular, circulatory, digestive, reproductive, and nervous systems)
3. climate change (to include the synthesis of evidence to determine impacts on Earth systems and predict impacts as variable change)
4. genetics and synthetic biology (to include genetic engineering techniques that are used to analyze and manipulate DNA and RNA)