# Virginia Science Content Guidelines

# Biology II: Anatomy and Physiology (03053)

## Science and Engineering Practices

AP.1 Using the content in the Anatomy and Physiology Content Guidelines, students 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 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
   * construct arguments concerning ethical issues in the medical field based on evidence and discuss these issues from multiple viewpoints;
   * 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

## Body Organization and Cellular Processes

AP.2 The student will investigate and understand that there is an organization of the human body. Key content includes

* relationships exist between the different levels of organization of the human body;
* homeostatic imbalance may have significant effects on organisms;
* negative and positive feedback mechanisms play roles in maintaining homeostasis;
* directional terms and body planes are used to indicate areas of the body; and
* the body is composed of major cavities with different internal structures.

AP.3 The student will investigate and understand that chemical and biochemical processes are essential for human life. Key content includes

* macromolecules have roles in maintaining life processes;
* enzymes have a role in biochemical reactions;
* several factors adversely affect enzymatic activity and the rate of biochemical reactions;
* cellular respiration is responsible for the transformation and flow of energy in organisms;
* the process of protein synthesis leads to the development of proteins specific to body functions;
* protein shape varies and is related to its functions:
* metabolism and its anabolic and catabolic processes regulate energy use; and
* problems with chemical and biochemical processes may lead to health problems.

AP.4 The students will investigate and understand that cell histology leads to specific functions. Key content includes

* eukaryotic organelles work interdependently to carry out life processes;
* cytoskeletal and extracellular structures play a role in cell size and function;
* different types of cells and tissues have different role in the human body;
* passive and active cell transport are mechanisms for transferring nutrients, water, and waste; and
* cellular division leads to new somatic and sex cells.

## Body System Structures and Functions

AP.5 The students will understand that the anatomical features of the integumentary systems allow for multiple purposes in the human body. Key content includes

* the functions of the integumentary system play roles in maintaining the homeostasis of an individual;
* structure and function of skin, hair, and nails differ to accommodate different roles in organisms;
* the structures of sudoriferous and sebaceous glands lead to different functions in humans;
* physiological processes are necessary for tissue injury and tissue repair; and
* irregularities of the integumentary system may impact an individual’s health.

AP.6 The students will understand that the anatomical features of the skeletal system lead it to have multiple purposes in the human body. Key content includes

* the skeletal system has several functions in the human body;
* the formation and maintenance of bones occurs throughout a person’s lifetime;
* there are four types of bones (long, short, flat, irregular, sesmoid) that serve different functions;
* the skeletal system is divided into axial and appendicular skeletons;
* joints are classified according to their degree and type of movement; and
* skeletal diseases and bone breaks impact human mobility and health.

AP.7 The students will understand that the anatomical features of the muscle cell and muscular system lead to multiple purposes in the human body. Key content includes

* the muscular system is responsible for both voluntary and involuntary movement in the human body;
* muscle cells engage in a process during muscle contraction;
* muscles have different roles in movement and are grouped as agonists, antagonists, synergists, and fixators;
* the location and size of major skeletal muscles is critical to different types of human movements; and
* muscular diseases impact human mobility and health.

AP.8 The students will understand that both the anatomical and functional divisions of the nervous system allow for sensation, integration, and response. Key content includes

* the anatomical features of nervous system is composed of the central nervous system (CNS) and the peripheral nervous system (PNS) each having their own components and functions;
* the functional divisions of the nervous system include the sympathetic division and parasympathetic division;
* the neuron is the basic unit of the nervous system;
* reflex arcs are the nerve pathways in a reflex action; and
* aging may have adverse effects on the nervous system.

AP.9 The students will understand that the senses provide input to the nervous system. Key content includes

* each sensory organ has unique anatomical features that allow for the detection and transmission of stimulus; and
* aging results in distinct changes to each of special senses.

AP.10 The students will understand that the endocrine system is responsible for regulating a range of bodily functions through the release of hormones. Key content includes

* the endocrine system is made up of glands that produce and secrete hormones that regulate the body’s growth, metabolism, and sexual development and function.
* hormones are chemical messengers created in the body;
* hormones are classified by their structure, mechanisms of action, nature of action and their effects and simulation of endocrine glands; and
* glandular disorders impact human health.

AP.11 The students will understand that the circulatory system transports nutrients, oxygen, and hormones to cells throughout the body and removes metabolic wastes. Key content includes

* blood is composed of different types of cells suspended in plasma;
* the structure of the heart provides a mechanism to transport blood to the lungs and to the rest of the body;
* cardiac output, stroke volume, and regulation of heart rate are affected by different factors;
* the structure of arteries, arterioles, capillaries, venules, and veins allow for different functions within the cardiovascular system;
* blood pressure is regulated by the nervous system, endocrine system, and autoregulatory functions; and
* diseases and age related changes impact the circulatory system.

AP.12 The students will understand that the lymphatic system supports the cardiovascular system and immunity. Key content includes

* the lymphatic system is a network of tissues and organs that help rid the body of toxins, wastes, and unwanted materials;
* lymph a fluid transported by the lymphatic system;
* there are multiple steps involved in cell-mediated and antibody mediated immune response; and
* vaccines and antibiotics play a role in disease prevention.

AP.13 The students will understand the respiratory system allows for gas exchange with the environment. Key content includes

* the respiratory system consists of organs and structures that take in oxygen and expel carbon dioxide;
* the process of inspiration and expiration includes multiple body systems;
* anaerobic vs aerobic respiration both effect the respiratory system; and
* aging may impact the function of the respiratory system.

AP.14 The students will understand that the function of the digestive system is digestion and absorption of nutrients. Key content includes

* the digestive system is a complex system with multiple organs that have different functions;
* gastrointestinal tract is composed of four layers;
* there are both mechanical and chemical processes in the process of digestion;
* the small and large intestines are responsible for nutrient and water absorption; and
* disorders and aging may affect the digestive system.

AP.15 The students will understand that the urinary system is composed of osmoregulatory organs. Key content includes

* the urinary system primary role is the elimination of wastes from metabolic processes in the form of urea;
* the urinary system also has roles in maintaining blood volume and pressure as well as controlling electrolytes, metabolites and pH;
* the nephron is the functional unit of the kidney;
* the three physiological processes and structures involved in urine foundation-filtration, reabsorption, and secretion; and
* disorders and of aging effect the function of the urinary system.

AP.16 The students will understand the function of the reproductive system is to ensure survival of the species. Key content includes

* the structure and function of the reproductive system differs in males and females;
* gametes are formed during the process of spermatogenesis and oogenesis;
* reproductive hormones play critical roles in the functioning of the reproductive system;
* the menstrual cycle describes the processes and hormones in the development and release of the egg; and
* human fetal development includes the development of the zygote into a blastocyst, implantation, gastrulation, embryo, and the fetus.