

Human Anatomy and Physiology

Physiological Functions/Anatomical Structure HAP . 1

Conceptual Understanding: Anatomists have developed a universal set of reference terms that aid in the identification of body structures with a high degree of specificity. Body organization from simple to complex levels and an introduction to the organ systems forming the body lead to a higher understanding of anatomical structures in the human body.

- A** Students will demonstrate an understanding of how anatomical structures and physiological functions are organized and described using anatomical positions. HAP . 1A
- 1** Apply appropriate anatomical terminology when explaining the orientation of regions, directions, and body planes or sections. HAP . 1A . 1
 - 2** Locate organs and their applicable body cavities and systems. HAP . 1A . 2
 - 3** Investigate the interdependence of the various body systems to each other and to the body as a whole. HAP . 1A . 3

Cells and Tissues HAP . 2

Conceptual Understanding: The smallest structural and functional unit of the human body is the cell. The cell is composed of organelles that perform varied but specific functions. Cells within the human body can metabolize, digest foods, dispose of waste, reproduce, grow, move, and respond to stimuli. Groups of cells that are similar in structure and function form the four types of tissues (epithelial, connective, nervous, and muscle) found in the human body.

- A** Students will demonstrate an understanding of the relationship of cells and tissues that form complex structures of the body. HAP . 2A
- 1** Analyze the characteristics of the four main tissue types: epithelial, connective, muscle, and nervous. Examine tissues using microscopes and other various technologies. HAP . 2A . 1
 - 2** Construct a model to demonstrate how the structural organization of cells in a tissue relates to the specialized function of that tissue. HAP . 2A . 2
 - 3** Enrichment: Use an engineering design process to research and develop medications (i.e., targeted cancer therapy drugs) that target uncontrolled cancer cell reproduction. * HAP . 2A . 3

Integumentary System HAP . 3

Conceptual Understanding: The integumentary system is composed of epithelial membranes (i.e., skin epidermis, mucosae, and serosae). The connective-tissue synovial membranes cover, insulate, protect, and cushion body organs as well as

the entire body. The integumentary system is critical to maintaining homeostasis using internal and external regulators.

- A** Students will investigate the structures and functions of the integumentary system, including the cause and effect of diseases and disorders. **HAP . 3A**
- 1** Identify structures and explain the functions of the integumentary system, including layers of skin, accessory structures, and types of membranes. **HAP . 3A . 1**
 - 2** Investigate specific mechanisms (e.g., feedback and temperature regulation) through which the skin maintains homeostasis. **HAP . 3A . 2**
 - 3** Research and analyze the causes and effects of various pathological conditions (e.g., burns, skin cancer, bacterial/viral infections, and chemical dermatitis). **HAP . 3A . 3**
 - 4** Enrichment: Use an engineering design process to design and model/simulate effective treatments for skin disorders (e.g., tissue grafts). * **HAP . 3A . 4**
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Skeletal System **HAP . 4**

Conceptual Understanding: The skeletal system is composed of cartilage and bone. Together these supportive tissues form the framework for the body. The skeletal system encloses organs, attaches skeletal muscles, and connects bone, forming joints to aid in movement.

- A** Students will investigate the structures and functions of the skeletal system including the cause and effect of diseases and disorders. **HAP . 4A**
- 1** Use models to compare the structure and function of the skeletal system. **HAP . 4A . 1**
 - 2** Develop and use models to identify and classify major bones as part of the appendicular or axial skeleton. **HAP . 4A . 2**
 - 3** Identify and classify types of joints and their movement. **HAP . 4A . 3**
 - 4** Demonstrate an understanding of the growth and development of the skeletal system, differentiating between endochondral and intramembranous ossification. **HAP . 4A . 4**
 - 5** Construct explanations detailing how mechanisms (e.g., Ca^{2+} regulation) are used by the skeletal system to maintain homeostasis. **HAP . 4A . 5**
 - 6** Research and analyze various pathological conditions (e.g., bone fractures, osteoporosis, bone cancers, various types of arthritis, and carpal tunnel syndrome). **HAP . 4A . 6**
 - 7** Enrichment: Use an engineering design process to develop, model, and test effective treatments for bone disorders (i.e., prosthetics). * **HAP . 4A . 7**
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Muscular System **HAP . 5**

Conceptual Understanding: The muscular system, with the aid of three types of muscle tissue (skeletal, cardiac, and smooth), provides movement, contour and shape, joint stability, heat generation, and the transportation of materials throughout the body.

- A** Students will investigate the structures and functions of the muscular system, including the cause and effect of diseases and disorders. **HAP . 5A**
- 1** Develop and use models to illustrate muscle structure, muscle locations and groups, actions, origins, and insertions. **HAP . 5A . 1**
 - 2** Describe the structure and function of the skeletal muscle fiber and the motor unit. **HAP . 5A . 2**
 - 3** Explain the molecular mechanism of muscle contraction and relaxation. **HAP . 5A . 3**
 - 4** Use models to locate the major muscles and investigate the movements controlled by each muscle. **HAP . 5A . 4**
 - 5** Compare and contrast the anatomy and physiology of the three types of muscle tissue. **HAP . 5A . 5**
 - 6** Use technology to plan and conduct an investigation that demonstrates the physiology of muscle contraction, muscle fatigue, or muscle tone. Collect and analyze data to interpret results, then explain and communicate conclusions. **HAP . 5A . 6**
 - 7** Research and analyze the causes and effects of various pathological conditions, (e.g., fibromyalgia, muscular dystrophy, cerebral palsy, muscle cramps/strains, and tendonitis). **HAP . 5A . 7**
 - 8** Enrichment: Use an engineering design process to develop effective ergonomic devices to prevent muscle fatigue and strain (e.g., carpal tunnel, exoskeletons for paralysis, or training plans to prevent strains/sprains/cramps). * **HAP . 5A . 8**
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Nervous System **HAP . 6**

Conceptual Understanding: The nervous system is composed of the central nervous system and the peripheral nervous system. These divisions work together to create every thought, action, and sensation that occurs within the body. The exploration of the special senses will provide an understanding of sight, hearing, smell, and taste.

- A** Students will investigate the structures and functions of the nervous system, including the cause and effect of diseases and disorders. **HAP . 6A**
- 1** Describe and evaluate how the nervous system functions and interconnects with all other body systems. **HAP . 6A . 1**
 - 2** Analyze the structure and function of neurons and their supporting neuroglia cells (e.g., astrocytes, oligodendrocytes, Schwann cells, microglial). **HAP . 6A . 2**
 - 3** Discuss the structure and function of the brain and spinal cord. **HAP . 6A . 3**
 - 4** Compare and contrast the structures and functions of the central and peripheral nervous systems. Investigate how the systems interact to maintain homeostasis (e.g., reflex responses, sensory responses). **HAP . 6A . 4**
 - 5** Enrichment: Plan and conduct an experiment to test reflex response rates under varying conditions. Using technology, construct graphs in order to analyze and interpret data to explain and communicate conclusions. **HAP . 6A . 5**
 - 6** Describe the major characteristics of the autonomic nervous system. Contrast the roles of the sympathetic and parasympathetic nervous systems in maintaining homeostasis. **HAP . 6A . 6**
 - 7** Describe the structure and function of the special senses (i.e., vision, hearing, taste, and olfaction). **HAP . 6A . 7**
 - 8** Research and analyze the causes and effects of various pathological conditions (e.g., addiction, depression, schizophrenia, Alzheimer's, sports-related chronic traumatic encephalopathy [CTE], dementia, chronic migraine, stroke, and epilepsy). **HAP . 6A . 8**
 - 9** Enrichment: Use an engineering design process to develop, model, and test preventative devices for neurological injuries and/or disorders (e.g., concussion-proof helmets or medications for addiction and depression). * **HAP . 6A . 9**
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Endocrine System **HAP . 7**

Conceptual Understanding: The endocrine system, using hormones, gives instructions that control growth and development, reproductive capabilities, and the physiological homeostasis of the body systems.

- A** Students will demonstrate an understanding of the major organs of the endocrine system and the associated hormonal production and regulation. **HAP . 7A**
- 1** Obtain, evaluate, and communicate information to illustrate that the endocrine glands secrete hormones that help the body maintain homeostasis through feedback mechanisms. **HAP . 7A . 1**
 - 2** Discuss the function of each endocrine gland and the various hormones secreted. **HAP . 7A . 2**
 - 3** Model specific mechanisms through which the endocrine system maintains homeostasis (e.g., insulin/glucagon and glucose regulation; T3 / T4 and metabolic rates; calcitonin/parathyroid and calcium regulation; antidiuretic hormone and water balance; growth hormone; and cortisol and stress). **HAP . 7A . 3**
 - 4** Research and analyze the effects of various pathological conditions (e.g., diabetes mellitus, pituitary dwarfism, Graves' disease, Cushing's syndrome, hypothyroidism, and obesity). **HAP . 7A . 4**
 - 5** Enrichment: Use an engineering design process to develop effective treatments for endocrine disorders (e.g., methods to regulate hormonal imbalance).
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**Male and Female
Reproductive
Systems** **HAP . 8**

Conceptual Understanding: The reproductive system's biological function is to generate offspring for the continuance of our species. Interactions of the egg and sperm, the biological clock, and fertility play critical roles in the production of an offspring. Proper embryonic development directly depends on the health of the reproductive system.

- A** Students will investigate the structures and functions of the male and female reproductive system, including the cause and effect of diseases and disorders. **HAP . 8A**
- 1** Compare and contrast the structure and function of the male and female reproductive systems. **HAP . 8A . 1**
 - 2** Describe the male reproductive anatomy and relate structure to sperm production and release. **HAP . 8A . 2**
 - 3** Describe the female reproductive anatomy and relate structure to egg production and release. **HAP . 8A . 3**
 - 4** Construct explanations detailing the role of hormones in the regulation of sperm and egg development. Analyze the role of negative feedback in regulation of the female menstrual cycle and pregnancy. **HAP . 8A . 4**
 - 5** Evaluate and communicate information about various contraceptive methods to prevent fertilization and/or implantation. **HAP . 8A . 5**
 - 6** Describe the changes that occur during embryonic/fetal development, birth, and the growth and development from infancy, childhood, and adolescence to adulthood. **HAP . 8A . 6**
 - 7** Research and analyze the causes and effects of various pathological conditions (e.g., infertility, ovarian cysts, endometriosis, sexually transmitted diseases, and ectopic pregnancy). Research current treatments for infertility. **HAP . 8A . 7**
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Blood HAP . 9

Conceptual Understanding: Blood is the necessary fluid that transports oxygen and other elements throughout the body and removes waste products. Blood's unique composition allows for grouping into four major blood type groups (A, B, AB, and O). Blood types are based on the presence or absence of inherited antigens on the surface of the red blood cells.

- A** Students will analyze the structure and functions of blood and its role in maintaining homeostasis. HAP . 9A
- 1 Describe the structure, function, and origin of the cellular components and plasma components of blood. HAP . 9A . 1
 - 2 Distinguish the cellular difference between the ABO blood groups and investigate blood type differences utilizing antibodies to determine compatible donors and recipients. HAP . 9A . 2
 - 3 Research and analyze the causes and effects of various pathological conditions (e.g., anemia, malaria, leukemia, hemophilia, and blood doping). HAP . 9A . 3
 - 4 Enrichment: Use an engineering design process to develop effective treatments for blood disorders (e.g., methods to regulate blood cell counts or blood doping tests). * HAP . 9A . 4
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Cardiovascular System HAP . 10

Conceptual Understanding: The cardiovascular system is composed of the heart and blood vessels. The heart is the mechanism that cycles the blood throughout the body via the blood vessels. Using blood as a carrier, the system transports nutrients, gases, wastes, antibodies, electrolytes, and many other substances to and from the cells of the body. The location, size, and orientation of the heart, blood vessels, veins, arteries, and capillaries are essential in maintaining cardiovascular health. Maintenance of this system is vital.

- A** Students will investigate the structures and functions of the cardiovascular system, including the cause and effect of diseases and disorders. **HAP.10A**
- 1** Design and use models to investigate the functions of the organs of the cardiovascular system. **HAP.10A.1**
 - 2** Describe the flow of blood through the pulmonary system and systemic circulation. **HAP.10A.2**
 - 3** Investigate the structure and function of different types of blood vessels (e.g., arteries, capillaries, veins). Identify the role each plays in the transport and the exchange of materials. **HAP.10A.3**
 - 4** Demonstrate the role of valves in regulating blood flow. **HAP.10A.4**
 - 5** Plan and conduct an investigation to test the effects of various stimuli on heart rate and/or blood pressure. Construct graphs to analyze data and communicate conclusions. **HAP.10A.5**
 - 6** Research and analyze the effects of various pathological conditions (e.g., hypertension, myocardial infarction, mitral valve prolapses, varicose veins, and arrhythmia). **HAP.10A.6**
 - 7** Enrichment: Use an engineering design process to develop, model, and test effective treatments for cardiovascular diseases (e.g., methods to regulate heart rate, artificial replacement valves, open blood vessels, strengthening leaky valves). * **HAP.10A.7**
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**Lymphatic
System** **HAP.11**

Conceptual Understanding: The lymphatic system is composed of lymphoid vessels and organs. These vessels assist the cardiovascular system by maintaining blood volume. The lymphoid organs defend the body from pathogens by providing sites for development and maturation of immune system cells. There are multiple disorders of the immune system affecting the human population.

- A** Students will investigate the structures and functions of the lymphatic system, including the cause and effect of diseases and disorders. **HAP.11A**
- 1** Analyze the functions of leukocytes, lymph, and lymphatic organs in the immune system. **HAP.11A.1**
 - 2** Compare the primary functions of the lymphatic system and its relationship to the cardiovascular system. **HAP.11A.2**
 - 3** Compare and contrast the body's non-specific and specific lines of defense, including an analysis of the roles of various leukocytes: basophils, eosinophils, neutrophils, monocytes, and lymphocytes. **HAP.11A.3**
 - 4** Correlate the functions of the spleen, thymus, lymph nodes, and lymphocytes to the development of immunity. **HAP.11A.4**
 - 5** Differentiate the role of B-lymphocytes and T-lymphocytes in the development of humoral and cell-mediated immunity and primary and secondary immune responses. **HAP.11A.5**
 - 6** Investigate various forms of acquired and passive immunity (e.g., fetal immunity, breastfed babies, vaccinations, and plasma donations). **HAP.11A.6**
 - 7** Research and analyze the causes and effects of various pathological conditions (e.g., viral infections, auto-immune disorders, immunodeficiency disorders, and lymphomas). **HAP.11A.7**
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**Respiratory
System** **HAP.12**

Conceptual Understanding: The respiratory system provides the body with an abundant and continuous supply of oxygen and removes carbon dioxide from the body. The organs of this system include the nose, pharynx, larynx, trachea, bronchi and their smaller branches, and the lungs. The interaction of these organs with the cardiovascular system transports respiratory gases to the tissue cells throughout the body. Interruptions in the mechanics of this system will lead to respiratory distress.

- A** Students will investigate the structures and functions of the respiratory system, including the cause and effect of diseases and disorders. **HAP . 12A**
- 1** Design and use models to illustrate the functions of the organs of the respiratory system. **HAP . 12A . 1**
 - 2** Describe structural adaptations of the respiratory tract and relate these structural features to the function of preparing incoming air for gas exchange at the alveolus. **HAP . 12A . 2**
 - 3** Identify the five mechanics of gas exchange: pulmonary ventilation, external respiration, transport gases, internal respiration, and cellular respiration. **HAP . 12A . 3**
 - 4** Enrichment: Use an engineering design process to develop a model of the mechanisms that support breathing and illustrate the inverse relationship between volume and pressure in the thoracic cavity. * **HAP . 12A . 4**
 - 5** Research and analyze the causes and effects of various pathological conditions (e.g., asthma, bronchitis, pneumonia, and COPD). **HAP . 12A . 5**
 - 6** Research and discuss new environmental causes of respiratory distress (e.g., e-cigarettes, environmental pollutants, and changes in inhaled gas composition). **HAP . 12A . 6**
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Digestive System **HAP . 13**

Conceptual Understanding: The digestive system processes food so that it can be absorbed and used by the body's cells. The organs of the system are responsible for food ingestion, digestion, absorption, and elimination of the undigested remains from the body.

- A** Students will investigate the structures and functions of the digestive system, including the cause and effect of diseases and disorders. **HAP .13A**
- 1** Analyze the structure-function relationship in organs of the digestive system. **HAP .13A.1**
 - 2** Use models to describe structural adaptations present in each organ of the tract and correlate the structures to specific processing of food at each stage (e.g., types of teeth; muscular, elastic wall and mucous lining of the stomach; villi and microvilli of the small intestine; and sphincters along the digestive tract). **HAP .13A.2**
 - 3** Identify the accessory organs (i.e., salivary glands, liver, gallbladder, and pancreas) for digestion and describe their function. **HAP .13A.3**
 - 4** Plan and conduct an experiment to illustrate the necessity of mechanical digestion for efficient chemical digestion. **HAP .13A.4**
 - 5** Research and analyze the activity of digestive enzymes within different organs of the digestive tract, connecting enzyme function to environmental factors such as pH. **HAP .13A.5**
 - 6** Evaluate the role of hormones (i.e., gastrin, leptin, and insulin) in the regulation of hunger and satiety/fullness. **HAP .13A.6**
 - 7** Research and analyze the causes and effects of various pathological conditions (e.g., GERD/acid reflux, stomach ulcers, lactose intolerance, irritable bowel syndrome, gallstones, appendicitis, and hormonal imbalances and obesity). **HAP .13A.7**
 - 8** Enrichment: Use an engineering design process to develop effective treatments for gastrointestinal diseases (e.g., methods to regulate stomach acids or soothe ulcers, treat food intolerance, and dietary requirements/modifications).
* **HAP .13A.8**

Urinary System **HAP .14**

Conceptual Understanding: The urinary system regulates the body's homeostasis by removing nitrogenous waste while maintaining water balance, electrolytes, and the blood's acid/base balance within the body. The kidney is the primary filtration and reabsorption organ of the urinary system, controlling the composition of urine and, in turn, regulating blood composition. Improper function of the kidneys could lead to death if not corrected.

- A** Students will investigate the structures and functions of the urinary system, including the cause and effect of diseases and disorders. **HAP.14A**
- 1** Understand the structure and function of the urinary system in relation to maintenance of homeostasis. **HAP.14A.1**
 - 2** Describe the processes of filtration and selective reabsorption within the nephrons as it relates to the formation of urine and excretion of excess materials in the blood. **HAP.14A.2**
 - 3** Investigate relationship between urine composition and the maintenance of blood sugar, blood pressure, and blood volume. **HAP.14A.3**
 - 4** Enrichment: Conduct a urinalysis to compare the composition of urine from various “patients.” **HAP.14A.4**
 - 5** Develop and use models to illustrate the path of urine through the urinary tract. **HAP.14A.5**
 - 6** Research and analyze the causes and effects of various pathological conditions and other kidney abnormalities (e.g., kidney stones, urinary tract infections, gout, dialysis, and incontinence). **HAP.14A.6**