Human Anatomy and Physiology

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Human Anatomy and Physiology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three units of science. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Human Anatomy and Physiology comprises a systematic study in which students will examine human anatomy and physical functions. They will analyze descriptive results of abnormal physiology and evaluate clinical consequences. A workable knowledge of medical terminology will be demonstrated.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

AP.LO: LEVELS OF ORGANIZATION

AP.LO.1: Hierarchy of Organization
AP.LO.2: Types of Tissues
AP.LO.3: Homeostasis
AP.LO.4: Anatomical Terminology

AP.SM: SUPPORT AND MOTION

AP.SM.1: Integumentary System
AP.SM.2: Skeletal System
AP.SM.3: Muscular System

AP.IC: INTEGRATION AND COORDINATION

AP.IC.1: Nervous System
AP.IC.2: Special Senses
- Sense of Sight
- Senses of Hearing and Balance
- Senses of Taste and Smell

AP.IC.3: Endocrine System

AP.T: TRANSPORT

AP.T.1: Blood
AP.T.2: Cardiovascular System
AP.T.3: Lymphatic and Immune Systems

AP.AE: ABSORPTION AND EXCRETION

AP.AE.1: Digestive System
AP.AE.2: Respiratory System
AP.AE.3: Urinary System

AP.R: REPRODUCTION

AP.R.1: Reproductive System

NATURE OF SCIENCE HIGH SCHOOL

Nature of Science
One goal of science education is to help students become scientifically literate citizens able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.

Categories	High School
Scientific Inquiry, Practice and Applications All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.	• Identify questions and concepts that guide scientific investigations. • Design and conduct scientific investigations using a variety of methods and tools to collect empirical evidence, observing appropriate safety techniques. • Use technology and mathematics to improve investigations and communications. • Formulate and revise explanations and models using logic and scientific evidence (critical thinking). • Recognize and analyze explanations and models. • Communicate and support scientific arguments.

Science is a Way of Knowing
Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.
	• Various science disciplines use diverse methods to obtain evidence and do not always use the same set of procedures to obtain and analyze data (i.e., there is no one scientific method).
	  ○ Make observations and look for patterns.
	  ○ Determine relevant independent variables affecting observed patterns.
	  ○ Manipulate an independent variable to affect a dependent variable.
	  ○ Conduct an experiment with controlled variables based on a question or hypothesis.
	  ○ Analyze data graphically and mathematically.
	• Science disciplines share common rules of evidence used to evaluate explanations about natural phenomenon by using empirical standards, logical arguments and peer reviews.
	  ○ Empirical standards include objectivity, reproducibility, and honest and ethical reporting of findings.
	  ○ Logical arguments should be evaluated with open-mindedness, objectivity and skepticism.
	• Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
	• The various scientific disciplines have practices, methods, and modes of thinking that are used in the process of developing new science knowledge and critiquing existing knowledge.

Science is a Human Endeavor Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, abilities, family backgrounds and incomes.	• Science depends on curiosity, imagination, creativity and persistence. • Individuals from different social, cultural, and ethnic backgrounds work as scientists and engineers. • Science and engineering are influenced by technological advances and society; technological advances and society are influenced by science and engineering. • Science and technology might raise ethical, social and cultural issues for which science, by itself, does not provide answers and solutions.
Scientific Knowledge is Open to Revision in Light of New Evidence Science is not static. Science is constantly changing as we acquire more knowledge.	• Science can advance through critical thinking about existing evidence. • Science includes the process of comparing patterns of evidence with current theory. • Some science knowledge pertains to probabilities or tendencies. • Science should carefully consider and evaluate anomalies (persistent outliers) in data and evidence. • Improvements in technology allow us to gather new scientific evidence.

*Adapted from Appendix H – Understanding the Scientific Enterprise: The Nature of Science in the Next Generation Science Standards

Human Anatomy and Physiology continued

AP.LO: LEVELS OF ORGANIZATION
AP.LO.1: Hierarchy of organization
AP.LO.2: Types of tissues
AP.LO.3: Homeostasis
AP.LO.4: Anatomical terminology

CONTENT ELABORATION: LEVELS OF ORGANIZATION

AP.LO.1: Hierarchy of organization
Building on knowledge about cell structures and processes from middle school and Biology, this topic focuses on the increasing complexity of cells as they are organized into tissues. Several tissue types make up an organ. Several organs working together make up an organ system. All the organ systems interact and form the human body.

AP.LO.2: Types of tissues
The human body is comprised of four types of tissues: epithelial, connective, muscle and nervous. This topic includes a broad overview of the structure, function and location of each tissue type. Tissues can be studied as an independent unit or as they are encountered within each organ system. Investigations are used to understand and explain types of tissues in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.LO.3: Homeostasis
Homeostasis is a theme that is explored throughout the course. Homeostasis involves positive and negative feedback mechanisms that continuously monitor and adjust the body's internal conditions (e.g., temperature regulation, pH, hormone regulation, blood pressure, hemostasis). At times, there can be a disruption (or disruptions) in the feedback loops, creating an imbalance. This homeostatic imbalance can result in a variety of conditions.

AP.LO.4: Anatomical terminology
Standard anatomical position is to be used as a reference point. Each area of the human body is identified by region. The features and structures of the body, relative to each other, are described by directional terms. The body and its organs can be divided by planes. The organs are located in cavities.

EXPECTATIONS FOR LEARNING

The content in the standards needs to be taught in ways that incorporate the nature of science and engage students in scientific thought processes. Where possible, real-world data and problem- and project-based experiences should be utilized. *Ohio's Cognitive Demands* relate to current understanding and research about the ways people learn and are important aspects to the overall understanding of science concepts. Care should be taken to provide students opportunities to engage in all four types of thinking. Additionally, lessons need to be designed so that they incorporate the concepts described in the *Nature of Science*.

VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

This section provides guidance for developing classroom tasks that go beyond traditional approaches to instruction. It is a springboard for generating innovative ideas to address the cognitive demands. A variety of activities are presented so that teachers can select those that best meet the needs of their students. This is not an all-inclusive checklist and is not intended to cover every aspect of the standards. **These activities are suggestions and are not mandatory.**

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.LO.1: Hierarchy of organization			
	Research various species of organisms that have been studied in order to understand fundamental physiological processes in humans. Explain the considerations in determining what species is the best to study for a particular process.	Analyze data about various human cell types and hypothesize the relationships between structure and function.	Identify the levels of organization from cellular to organism.
AP.LO.2: Types of tissues			
Simulate tissue engineering using a variety of materials (e.g., gelatin, agar, yeast). Critique the characteristics of each tissue simulation to rate its possible use in tissue grafting.		Use microscopes or virtual images to examine various tissues. Compare a range of epithelial (e.g., squamous, columnar, cuboidal), connective (e.g., cartilage, bone, blood), muscular (e.g., skeletal, cardiac, smooth) and nervous tissues. Interpret how the function of each tissue type relates to its structure.	Create labeled illustrations or models of the four types of human tissues.
AP.LO.3: Homeostasis			
Design or critique a device used to maintain or monitor homeostasis for a human body process (e.g., heart rate, glucose, oxygen level).	Investigate homeostasis by measuring changes in heart rate. Compare resting heart rate to the rate after changing a variable. Present data and hypothesize ways to improve heart rates in stressed individuals (e.g., yoga, deep breathing).	After using a simulation or another data source, discuss how the data are similar to and different from the self-regulation that goes on in an actual human body. Research the chronic changes in the muscular, circulatory, and respiratory systems in response to starting an exercise program. Distinguish which kinds of changes result from which kinds of exercise (e.g., aerobic, anaerobic). Investigate ways that prions, viruses, bacteria, protozoans and multicellular parasites disturb homeostasis. Give examples of diseases caused by each category.	Identify examples of how the body uses homeostasis to maintain balance. Differentiate between positive and negative feedback mechanisms.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.LO.4: Anatomical terminology			
		Demonstrate knowledge of anatomical directional terminology through the dissection of a three-dimensional object, such as a clay model, doll or gummy bear.	Label a diagram of a human body with directional terms, planes and cavities.

Human Anatomy and Physiology continued

AP.SM: SUPPORT AND MOTION
AP.SM.1: Integumentary system
AP.SM.2: Skeletal system
AP.SM.3: Muscular system

CONTENT ELABORATION: SUPPORT AND MOTION

AP.SM.1: Integumentary system
The integumentary system consists of skin and accessory structures. The skin is composed of three layers: the epidermis, the dermis and the hypodermis (subcutaneous layer). The accessory structures can include sweat glands, sebaceous glands, arrector pili muscles, hair follicles and nails. Skin functions include protection, temperature regulation, excretion and sensory perception. These occur through the processes of perspiration, skin production and shedding, vitamin D synthesis and repair. Homeostatic imbalances are explored. These include, but are not limited to, burns, skin cancer, anhidrosis, acne, eczema or scleroderma. Investigations are used to understand and explain the integumentary system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.SM.2: Skeletal system
The skeletal system is composed of bones, cartilage, joints and ligaments. Bones make up most of the skeleton. There are four main cell types that compose bone tissue, each with a specific function: osteogenic cells, osteocytes, osteoblasts and osteoclasts. The microscopic anatomy of compact bone includes osteons. Bones are classified by their shape. The structure of a typical long bone can be explored. Specific bones of the skeleton can be studied by their subdivisions: the axial skeleton and the appendicular skeleton. Cartilage is found in areas of the nose, ears, ribs and joints. Joints can be classified by structure or by function. The general structure of synovial joints may be explored. Ligaments connect bone to bone, stabilizing joints.

The skeletal system provides support for the human body, protects soft organs, allows for movement due to attachment of muscles, stores minerals and fat and forms blood cells. Processes of the skeletal system include hematopoiesis, ossification and bone growth and remodeling. A comparison of male to female, juvenile to adult or human to other vertebrate skeletons may be explored. Homeostatic imbalances are explored. These include, but are not limited to, osteoporosis, malnutrition, fractures, anterior cruciate ligament (ACL) injuries and arthritis. Investigations are used to understand and explain the skeletal system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.SM.3: Muscular system
The muscular system consists of three types of muscle cells: skeletal, smooth and cardiac. The primary function of the muscular system is to contract, thereby, moving the body and internal fluids, maintaining posture, generating heat and stabilizing joints. Muscles are controlled voluntarily and/or involuntarily.

Heart muscle cells are mononucleated, branched and striated. Intercalated disks are characteristic of cardiac muscle and aid in communication between cardiac muscle cells. Smooth muscle cells, found in the hollow organs and blood vessels, are mononucleated, spindle-shaped and nonstriated. Skeletal muscle cells, found attached to bones and skin, are multinucleated, cylindrical and striated. The muscles of the body can be studied by group, which include the muscles of the head, face and neck, the trunk and the upper and lower limbs.

Processes of the muscular system include gross body movements produced by skeletal muscles as they interact with the skeletal system, and muscle contraction. The connection between the nervous system and the skeletal system should be explored through the study of action potentials and the resulting contraction of sarcomeres, as described by the sliding filament theory. Energy processing and muscle responses to stimuli can be studied along with building muscle tissue through exercise. The effects of steroids can also be investigated. Homeostatic imbalances are explored. These include, but are not limited to, muscular dystrophy and atrophy. Investigations are used to understand and explain the muscular system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

EXPECTATIONS FOR LEARNING

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VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

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Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.SM.1: Integumentary system			
Skin cells and accessory structures			
		Create labeled illustrations or models of skin cells and accessory structures. Compare the structure and function of the integument of the major classes of vertebrates. Explore the connection between types of cells, accessory structures, and the ability to sense temperature and pressure.	Use microscopes, micrographs, models or illustrations to identify types of skin cells and accessory structures. Describe the process of tissue engineering and tissue donation. Describe what attributes need to be considered in order to be a tissue donor. List sensory structures in the integumentary system.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Skin cancer-UV connection			
Design a sunscreen that does not kill aquatic wildlife (e.g. corals).	Design an investigation to compare various sunscreens and homeopathic methods using UV sensitive paper or UV sensitive yeast strains.	Investigate and present data on the connection between UV/sun exposure and increased incidence of skin cancer. Create a presentation or infographic to inform an audience about the risks of, and dispel common myths about, UV exposure. Propose a plan to lower the incidence of skin cancer. Explore the safety of tanning salons and alternative tanning methods (e.g., spray tanning).	Explain how UV light from sun or tanning salon exposure increases the risks of skin cancer.
Homeostatic imbalances			
		Dispel myths about acne with knowledge about homeostatic imbalances in the integumentary system.	Explain the cause of homeostatic imbalances (e.g., burns, skin cancers, anhidrosis, acne, eczema, scleroderma).
AP.SM.2: Skeletal system			
Structure			
Design and create a model of a prosthetic limb that can a perform a task (e.g., lift or carry an object). Design a bone model with cardstock and tape to meet specific parameters (e.g., strength). Test how well the model meets the parameters.		Compare bone structures in various vertebrates. Associate the structure of bones with their function (e.g., hollow bones in birds, fused radioulna in frogs). Dissection (e.g., chicken legs, pigs, cats) can be used as a point of comparison. Measure femur length and perform associated calculations to find height. Graph results to compare genders and ages.	Create an illustration of a long bone and label all structures. Use models or illustrations to identify and name bones and important bony features of the human skeleton.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Bones			
Design a better cast for fractures, identifying the materials, type of fixation, etc.		Create a model of each type of bone and identify features. Research gender and age data for common fractures. Discuss patterns that emerge. Develop explanations for common injuries for given age/gender classifications. Develop an action plan to help the elderly prevent bone density loss.	Identify, label and describe the types of bones using graphics, images, X-ray images or lab bone specimens. Create an illustration of different stages of bone development and destruction, including fracture repair. List and describe factors that affect bone density.
Anatomical movement			
Design a system to analyze movement/joint stability in specified movements.		Record (e.g., drawings, video) common athletic movements and identify bones and joints involved and anatomical movement represented.	Identify the movement involved in moving specified joints.
AP.SM.3: Muscular system			
Muscle fatigue			
	Design, plan, and conduct an investigation on muscle fatigue using basic exercise equipment (e.g., tennis ball, clothespin, textbook). Collect data and analyze.	Explore muscle fatigue in relationship to handedness, gender, height and other factors.	Provide an example of muscle fatigue and describe the physiology behind it.
Muscles			
Design and construct an artificial hand from common household items where the fingers flex and extend to perform a task.	Choose opposing major muscle groups and design an investigation to compare contraction length and/or force.	Create a presentation describing and differentiating between muscle tissue types. Build a model using household items to demonstrate the steps of the sliding filament theory.	Use microscopes, micrographs, models or illustrations to identify muscle tissue types. Define and describe the types of connective tissue.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Steroids - effects and risks			
		Research and present findings over the uses for steroids, risks of use and alternative treatment options. Create a presentation to inform the public about the risks of anabolic steroid abuse.	Research anabolic steroids, their effects on the body, medical applications and risk factors of their use.
Homeostatic imbalances in muscles			
		Create a product which describes symptoms, treatments and prognosis for varying muscle disorders. Develop a plan to reduce risks and prevent muscle atrophy associated with the disorder.	Identify common muscle disorders and give common symptoms and treatments.

Human Anatomy and Physiology continued

AP.IC: INTEGRATION AND COORDINATION
AP.IC.1: Nervous system
AP.IC.2: Special senses
- Sense of sight
- Senses of hearing and balance
- Senses of taste and smell

AP.IC.3: Endocrine system

CONTENT ELABORATION: INTEGRATION AND COORDINATION

AP.IC.1: Nervous system
The nervous system consists of neurons and supporting cells that combine to form nerves, the spinal cord and the brain. The primary functions of the nervous system are sensation, integration and response. A comparison of the structures and functions of the central and peripheral nervous systems should be explored. The central nervous system is composed of the brain and spinal cord. The peripheral nervous system includes the remaining nervous tissue.

A neuron consists of dendrites, a cell body and an axon. Neurons conduct electrical impulses along their membranes and at synapses. Brain cells can detect and sometimes respond to these impulses. Neuroglial cells help to support neural function.

The brain consists of three major parts: the cerebrum, cerebellum and brainstem. The cerebrum is divided into lobes and hemispheres. Functions of the cerebrum that may be explored include voluntary muscle control, memory, sensory perception, emotions and speech. The cerebellum is primarily responsible for balance and coordination. The brainstem, a part of the autonomic nervous system, includes structural divisions that perform basic life functions such as breathing and heart rate.

The spinal cord is a continuation of the brainstem. The spinal cord is a bundle of nerve tracts that transmits nerve signals between the brain and the body through electrical impulses.

Nerves are bundles of neurons that transmit impulses between the peripheral and central nervous systems. The study of nerves can include sciatic, cranial and spinal nerves. Supporting structures of the central nervous system include the meninges and cerebrospinal fluid which protect the central nervous system.

Processes of the nervous system are action potential propagation, simple nerve pathways (reflex arc) and neurotransmitter function. Homeostatic imbalances are explored. These include, but are not limited to, the effects of drugs, mental illnesses, spinal injuries, concussions, meningitis and multiple sclerosis (MS). Investigations are used to understand and explain the nervous system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.IC.2: Special senses

- Sense of sight
- Senses of hearing and balance
- Senses of taste and smell

The special senses consist of sight, hearing, balance, smell and taste. Each sense involves a network of feedback processes and consists of distinct structures.

Sense of sight

The eye provides visual environmental feedback and includes primary and accessory structures. Light enters through the pupil and is then focused by the lens onto the retina at the visual axis. The optic nerve transmits the electrical impulses to the brain where they are translated. The accessory structures provide lubrication, protection and support to the eye.

Processes include stimulation of the photoreceptors (rods and cones) by light. Homeostatic imbalances are explored. These include, but are not limited to, certain types of blindness, conjunctivitis, glaucoma, astigmatism, hyperopia, myopia and cataracts. Investigations are used to understand and explain the sense of sight in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis (e.g., squid, falcon, hawks) communication skills and real-world applications.

Senses of hearing and balance

The ears respond to a range of sounds and provide a sense of equilibrium. The structures include those of the outer, middle and inner ear. Processes of hearing and balance should be explored including the perception of sound and spatial awareness. Homeostatic imbalances are explored. These include, but are not limited to, certain types of hearing loss, otitis media, lack of balance (e.g., vertigo), tinnitus, auditory processing, motion sickness and Meniere's syndrome. Investigations are used to understand and explain the senses of hearing and balance in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

Senses of taste and smell

The senses of taste and smell occur primarily in the oral and nasal cavities. The structure of taste buds and olfactory cells are the foundation of taste and smell. The location, structure and afferent pathways of taste and smell receptors should be addressed.

Processes include activation of chemoreceptors and transmission of electrical impulses to the brain, where they are integrated. Homeostatic imbalances are explored. These include, but are not limited to, age-related sensitivities, taste preferences, anosmia and olfactory auras. Investigations are used to understand and explain the senses of taste and smell in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.IC.3: Endocrine system

The endocrine system is comprised of glands that secrete hormones resulting in a response in target cells or organs. Glands with their associated hormones may include pituitary, hypothalamus, thyroid, thymus, parathyroid, pineal, pancreas, adrenal, ovaries and testes. The endocrine system results in regulating metabolism, maintaining homeostasis, regulating growth and development, and controlling reproduction through hormonal release.

The processes involved in the endocrine system should include a comparison of negative and positive feedback systems. Negative feedback examples can include regulation of blood glucose levels, calcium levels, blood pressure and temperature. Positive feedback examples can include oxytocin in childbirth and hemostasis.

Homeostatic imbalances are explored. These include, but are not limited to, hyper- and hypo- functions of glands, diabetes (type I and type II), gigantism and dwarfism. Investigations are used to understand and explain the endocrine system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

EXPECTATIONS FOR LEARNING

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Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.IC.1: Nervous system			
Central nervous system/peripheral nervous system			
Examine the basic design of artificial limbs that integrate with the nervous system to provide the recipient control of the device.	Design and implement an investigation to measure muscular response to stimuli.	Compare the structures and functions of the central nervous system with the structures and functions of the peripheral nervous system. Evaluate scientific claims for and against the use of environmental toxins/neurotoxins (e.g., lead, mercury, radon). Provide peer-reviewed scientific evidence to support your claims.	Identify the main structures and functions of the central nervous system and the peripheral nervous system.
Neurons			
		Construct a 3D model of a neuron that can be used to illustrate anatomy, action potential propagation, simple nerve pathways (reflex arc) and neurotransmitter function. Critique the current treatment(s) available for a neurological disease (e.g., Parkinson's, MS, Huntington's).	Using microscopes, micrographs, models or illustrations, identify the cells of the nervous tissue.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Brain structure/function			
High school athletes are reported to be more susceptible to brain damage than their peers. Use scientific evidence to support or refute this claim. If this claim is accurate, suggest a possible way to reduce Chronic Traumatic Encephalopathy (CTE) injuries in high school athletes. Use correlations of symptoms caused by brain injuries to critique personal protective equipment (e.g., bicycle helmet, hard hats) and suggest modifications to improve their design.	Explore some of the difficulties of investigating brain function and critique the limitations in treating damage and disease in the brain and other parts of the nervous system.	Predict the outcome of tumor growth in different regions of the brain. Relate the development of the brain to decision-making skills. Correlate the relationship between a brain injury occurring in a specific region and the expressed symptoms. Determine the validity of left brain/right brain dominance. Determine if the structure and function of the nervous system are similar to the operating system of a computer. Compare the structure of another vertebrate brain (e.g., sheep) to the human brain.	Use microscopes, micrographs, models or illustrations to identify the main structures of the brain. List the functions of the cerebrum, cerebellum and brainstem. Create labeled illustrations or models of the human brain that include structure and function.
Spinal cord			
	Design an investigation to compare reaction times and reflex times.	Measure reaction and reflex times and explain the differences in your recorded data.	Use microscopes, micrographs, models or illustrations to identify the main structures of the spinal cord.
Nerves			
		Differentiate between spinal and cranial nerves Explain how the density of nerve endings in different body areas and the ability of nerves to adapt to stimuli relate to human physiology.	Use microscopes, micrographs, models or illustrations to identify the main structures of a nerve.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Processes			
Design a prototype of a new medical device for an amputee, including the transfer of electrical impulses to neurons.	Design and implement an investigation to measure the effect of a depressant or stimulant on a model organism's nervous system (e.g., *C. elegans,* Daphnia*)*.	Explain the symptoms of a chosen neurologic disorder based upon the physiology of the disorder. Describe how opioids interfere with chemical communication in the brain. Predict how a change in membrane potential would impact action potential propagation in an axon. Create a model of action potential propagation and/or neurotransmitter function.	Use graphs of membrane potential vs. time; distinguish between depolarization, repolarization and hyperpolarization.
AP.IC.2: Special senses			
Sight			
Choose a disease causing a homeostatic imbalance to vision. Use a picture as a control, and modify the picture to show how the picture would be seen by an individual with the chosen visual disease. Design a possible medical device that could alleviate the symptom.	Propose hypotheses for how the vertebrate eye first appeared in a common ancestor as a simple organ or clump of cells that detected light and the direction from which it came. Explain the possible adaptive significance of this photosensitivity. Propose one or more evolutionary hypotheses to explain the differences and similarities in the structure and function of vertebrate eyes and molluscan eyes.	Examine binocular vision by performing various eye tests. Identify common defects of the eye (e.g., astigmatism, color blindness) and their common treatments. Investigate a specific neurological effect of aging and explain how this leads to a homeostatic imbalance (e.g., glaucoma, hyperopic). Compare the structure of the vertebrate eye and the molluscan eye. Design a poster using physiological differences between the vertebrate eye and the molluscan eye to explain why mollusks will never suffer the homeostatic imbalance of detached retina.	Trace the pathway of light through the eye. Use microscopes, micrographs, models or illustrations to identify the main structures of the eye, and their functions.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Hearing/balance			
Choose a disease causing a homeostatic imbalance to the sense of hearing. Modify a sound file to illustrate the effects of the damage and suggest possible medical devices that could alleviate the symptoms. Design a device to direct whales from areas of danger (e.g. the site of a major underwater oil well failure). Use the mechanism by which bats capture prey in darkness to design an assistive technology for visual impairment.	Examine the evolutionary origin of the bones involved in hearing in mammals from the earliest chordates.	Explain how the inner ear maintains equilibrium and balance. Investigate a specific neurological effect of aging and explain how this leads to a homeostatic imbalance (e.g., tinnitus).	Use models or illustrations to identify the main structures in the inner, outer, and middle ear. Listen to different tones and identify patterns of hearing ability. Describe sensorineural and conductive hearing pathways.
Taste/smell			
	Design and carry out an investigation to determine how smell and taste are related in the body and how sensory messages to the brain contribute to flavor perception. Propose one or more hypotheses to explain why a dog's sense of smell is much more sensitive than a human's.	Explain how chemoreceptor function is blocked by a chemical such as miraculin or by *Gymnema sylvestre* tea.	Use models, illustrations or slides to identify the anatomical structures related to taste and smell (e.g., taste buds, gustatory cells, papillae, cilia).
AP.IC.3: Endocrine system			
Glands/structures			
		Examine endocrine system stress responses. Analyze the physiological reactions that were experienced during a situation of threat or stress. Identify which aspects of the endocrine system created those reactions.	Use models and/or illustrations to identify the main structures associated with glands and their associated target cells/organs.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Processes			
Critique the medical devices used by diabetics to monitor and treat blood sugar and propose solutions to address any identified flaws.		Analyze patient data to diagnose a hormone imbalance and provide suggestions for treatment.	Draw examples of negative and positive feedback loops. Predict the effect of changes in hormone levels.
Environmental impacts			
Propose one or more technological or engineering solution(s) to control broad-leafed "weeds" without using potential environmental endocrine disruptors.	Explain how environmental endocrine disruptors can lead to an increase in the incidence rate of breast cancer in women in developed but not in developing countries.	Research and prepare a poster for peers identifying where they are exposed to environmental endocrine disruptors in their daily lives.	

Human Anatomy and Physiology continued

AP.T: TRANSPORT
AP.T.1: Blood
AP.T.2: Cardiovascular system
AP.T.3: Lymphatic and immune systems

CONTENT ELABORATION: TRANSPORT

AP.T.1: Blood
Blood is composed of plasma and the formed elements: red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes). The primary functions of blood are transportation, protection and regulation. Plasma, the most abundant component of blood, is the liquid portion that transports dissolved nutrients, waste, hormones, antibodies and proteins throughout the body. Red blood cells carry oxygen used during cellular processes throughout the body. White blood cells identify and protect the body against infectious disease and foreign cells. Platelets bind together when a blood vessel is damaged resulting in blood clot formation.

The major ABO blood types, A, B, AB and O, are determined by the presence or absence of antigens on the surface of red blood cells. An additional antigen is present or absent on the surface of red blood cells determining Rh factor. Blood type antibodies are found in plasma. Processes related to blood include the production of blood cells and platelets, and hemostasis. Homeostatic imbalances are explored. These include, but are not limited to, sickle cell anemia, hemophilia, deep vein thrombosis, leukemia and lymphoma. Investigations are used to understand and explain blood in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.T.2: Cardiovascular system
The cardiovascular system consists of the heart and blood vessels. The heart is mostly comprised of cardiac muscle which is supplied with oxygenated blood by coronary arteries.

The structure of the heart includes four chambers, four valves and major vessels leading to and from the heart. The flow of blood through the heart, pulmonary and systemic circuits should be explored. Blood flows from arteries, to arterioles, to capillaries, to venules, then to veins. In the capillaries, oxygen, nutrients, and chemical messengers diffuse out (leave) and carbon dioxide and other waste products diffuse in (enter). Veins have valves that keep the blood flowing toward the heart.

The primary function of the cardiovascular system is the transport of oxygen, carbon dioxide, hormones, nutrients, waste products and chemical messengers.

Processes involved in the cardiovascular system include the cardiac cycle and cardiac and conductive pathway which is measured by electrocardiograms and blood pressure.

Homeostatic imbalances are explored. These include, but are not limited to, a variety of cardiovascular diseases and structural imperfections of the heart, valves and vessels. Examples include, but are not limited to, myocardial infarction, aneurysm, atherosclerosis, hypertrophic cardiomyopathy, hypo/hypertension and arrhythmias. Investigations are used to understand and explain the cardiovascular system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.T.3: Lymphatic and immune system
The lymphatic system includes lymph, lymphatic vessels, lymph nodes and the immune system. The lymphatic system has multiple, interrelated functions. They include the removal of fluid from tissues, absorption of large fatty acids in small intestines and transport of white blood cells to the lymph nodes. The immune system consists of white blood cells that destroy foreign antigens. Tissue fluid that has entered into lymphatic capillaries becomes lymph. Multiple lymphatic capillaries form lymphatic vessels. As lymph circulates through the body, it passes through multiple lymph nodes. These lymph nodes contain lymphocytes which destroy foreign antigens.

Processes of the lymphatic system include defense through nonspecific and specific resistance. Examples of nonspecific resistance include mechanical barriers such as the skin, enzymes, species resistance and mucous membranes. In specific resistance, antibodies are produced that defend the body against foreign antigens. Memory cells are produced following an infection that allow for possible immunity against a specific antigen upon re-exposure. A comparison of primary versus secondary immune responses can be explored. Homeostatic imbalances are explored. These include, but are not limited to, autoimmune disorders, parasitic diseases, allergies, bacterial versus viral infections and ringworm. Vaccinations provide the body with either long-term protection or short-term protection against many pathogens. Investigations are used to understand and explain the lymphatic system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

EXPECTATIONS FOR LEARNING

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VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

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Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.T.1: Blood			
		Create a graphic organizer to illustrate the differentiation of stem cells into white blood cells, red blood cells and lymphocytes. Compare and contrast the genes that code for hemoglobin in humans and mice.	Create labeled illustrations or models of the components of whole blood. Identify the structure and function of red blood cells (erythrocytes). Describe the process of hemostasis. Explain the function of blood and each of the components of whole blood.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Blood typing			
Critique available artificial blood products. Design artificial blood products.	Design a process to identify unknown blood types to determine transfusion compatibility or paternity. Propose one or more hypotheses to explain the global distribution of the ABO blood groups in humans.	Investigate the process of agglutination and describe its consequences. Create a global distribution map of the frequency of the ABO blood groups among native, human populations. Prepare blood transfusion guidelines that a medical assistant can use to understand which patients can receive which type(s) of blood and why blood typing is important for blood transfusions. Include the concepts of "universal donor" and "universal recipient".	Identify ABO phenotypes and genotypes. Identify Rh phenotypes and genotypes. Use Punnett squares to explain the inheritance of blood types. Create a labeled illustration or model of blood to explain the relationship between antigens, antibodies and blood type (e.g., ABO/Rh).
Homeostatic imbalances			
	Compare the original distribution of sickle-cell anemia in human populations with the global distribution of malaria. Propose one or more hypotheses to explain the distributions and make predictions based on your hypotheses. **Note:** *Sickle-cell anemia is a disease found among the descendants of people originally from areas where malaria is or has been common. Avoid the misconception that sickle-cell anemia is linked to one particular race.*	Diagnose homeostatic imbalances (e.g., anemia, sickle-cell anemia, leukemia, sepsis) by analyzing laboratory data (e.g., blood sample, patient symptoms, family history). Construct a pedigree of a family history and create a genetic counseling plan to advise the patient and family.	Explain the role of hemoglobin.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.T.2: Cardiovascular system			
Gross anatomy			
Critique available artificial heart and valve products.	Investigate the structures and function of the human heart by dissecting a sheep heart, which is similar in structure and function. Trace the flow of blood through the vessels, valves, and chambers of the heart and explore the role the organ plays in the propulsion of blood through the pulmonary and systemic circuits. Dissect various vertebrate hearts to compare mammalian hearts with those of birds (4-chambered), amphibians (3-chambered) and fish (2-chambered). Trace the flow of blood through the vessels, valves, and chambers of the heart and explore the role the organ plays in the propulsion of blood through the pulmonary and systemic circuits. Use findings to develop an understanding of the function of the 4-chambered heart to support endothermic organisms.	Based on labeled illustrations, explain the components needed for an artificial heart and/or its components.	Create labeled illustrations or models to describe the pathway of blood through the valves, chambers and major vessels of the heart. Create labeled illustrations or models to describe the pathway of blood through the pulmonary and systemic circuits. Identify the functions of the cardiovascular system.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Cardiac histology			
		Describe the relationship between the structure and specialized function of cardiac muscle cells. Create labeled illustrations, models, or written descriptions to differentiate between arteries, arterioles, capillaries, venules and veins in terms of structure and function.	Identify the cells and tissues of the cardiovascular system.
Cardiac output and imbalances			
Analyze data to explain why long-term exposure to microgravity can be dangerous to the cardiovascular system. Propose counter-measures to minimize effects of microgravity. Design a device to clear an occluded artery.	Manipulate and measure cardiac output to investigate the relationship between heart rate, volume and cardiac output. Diagnose homeostatic imbalances by analyzing signs and symptoms, laboratory data, ECG/EKGs and imaging studies. Create an evidence-based treatment plan.	Describe how microgravity can be applied on Earth to treat or prevent circulatory diseases. Diagnose an individual by analyzing an electrocardiogram. Create labeled illustrations or models of congenital cardiovascular defects and explain how they disrupt normal cardiac function.	Identify the components of cardiac output. Explain the relationship between heart rate, volume and cardiac output. Match electrocardiogram (ECG/EKG) waves to events in the cardiac cycle. Describe the features of an electrocardiogram (ECG/EKG) used to identify homeostatic imbalances. Identify homeostatic imbalances of the cardiovascular system.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.T.3: Lymphatic and immune systems			
Immune system			
	Explain how antibiotic resistance arises in a microbial population using insights from an understanding of evolution through natural selection.	Create a public service announcement highlighting the benefits of vaccinations for children, including risks to the population at large. Compare the treatment of bacterial and viral infections. Include concepts of nonspecific and specific resistance.	Create labeled illustrations or models of the cells of the immune system. Explain how the immune system works. Describe the uses for Enzyme-Linked Immunosorbent Assay (ELISA). Identify and describe the structures and functions of the lymphatic system. Create a flowchart to demonstrate the circulation of lymph throughout the body.
Homeostatic imbalances			
	Design an experiment to test the effectiveness of antibacterial products.	Create a community education campaign to increase awareness about the transmission of insect-transmitted diseases, their causes and prevention. Critique the effectiveness of tonsil removal on infection rates. Design a model to demonstrate the spread of a pathogen throughout a population.	Describe the mechanisms of autoimmune responses.

Human Anatomy and Physiology continued

AP.AE: ABSORPTION AND EXCRETION
AP.AE.1: Digestive system
AP.AE.2: Respiratory system
AP.AE.3: Urinary system

CONTENT ELABORATION: ABSORPTION AND EXCRETION

AP.AE.1: Digestive system
The digestive system consists of the gastrointestinal tract (alimentary canal) as well as various accessory organs including the teeth, tongue, salivary glands, liver, gallbladder and pancreas.

The digestive system processes and supplies the molecules needed to sustain the living tissues within the body through the absorption of nutrients. Six major functions of the digestive system include secretion, ingestion, mechanical processing, enzymatic digestion, absorption and excretion. The lining of the digestive system protects surrounding tissues from the mechanical and enzymatic stresses of the digestive process.

Processes of the digestive system include the mechanical and chemical breakdown of food into small molecules which are then absorbed by the digestive tract. Specific actions within the digestive system include mastication, peristalsis, segmentation and the release of hormones and enzymes necessary for digestion. The metabolic functions of the accessory organs play strategic roles in the breakdown of food products, the maintenance of glucose levels within the blood and the regulation of homeostasis in the body. Indigestible material is excreted as waste. Homeostatic imbalances are explored. These include, but are not limited to, conditions such as gallstones, heartburn, ulcers, dehydration, diarrhea, cirrhosis and cancers of the digestive system. Investigations are used to understand and explain the digestive system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.AE.2: Respiratory system
The respiratory system is comprised of the airways, lungs and diaphragm. The airways include the nasal and oral cavities, pharynx, larynx, trachea, bronchi, bronchioles and alveoli. The respiratory system transports and exchanges gases including oxygen and carbon dioxide.

Processes involved in the respiratory system include respiration mechanics and gas exchange. Respiration mechanics is the process by which humans breathe and includes the movement of the diaphragm and pressure-volume relationships. Gas exchange refers to the diffusion of gas across the alveolar epithelium in the respiratory system and capillary endothelium of the cardiovascular system. Lung volumes and capacities can be measured using spirometry. Homeostatic imbalances are explored. These include, but are not limited to, asthma, chronic obstructive pulmonary disease (COPD), tuberculosis, cystic fibrosis and the effects of smoking and pollution. Investigations are used to understand and explain the respiratory system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

AP.AE.3: Urinary system
The urinary system is a regulatory system that helps maintain homeostasis. The structures of the urinary system include the kidneys, ureters, bladder and urethra. Each kidney consists of the renal cortex, medulla and renal pyramids. The functional unit of the kidney is the nephron. The renal pelvis is a funnel-shaped chamber that is connected to the ureter.

The primary functions of the urinary system are excretion, elimination and regulation of blood volume and pressure. Processes of the urinary system include filtration, reabsorption and secretion, which occurs in the nephrons. Urine is normally a clear, yellow, sterile solution but the composition can vary slightly between individuals. Urinalysis is a diagnostic tool for detecting substances and conditions in the body. Antidiuretic hormone (ADH) and aldosterone hormones influence the volume and concentration of urine. Caffeine and alcohol act as diuretics and can lead to short or long-term kidney issues. Homeostatic imbalances are explored. These include, but are not limited to, urinary tract infections, kidney stones, nephritis and acute and chronic kidney disease. Investigations are used to understand and explain the urinary system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

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Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.AE.1: Digestive system			
Propose a redesign of an alimentary canal segment and/or accessory digestive organ. Propose a procedure as a potential cure for cirrhosis or ulcers using tissue engineering techniques. Explore the types of bariatric surgeries and compare their safety and effectiveness to determine whether this is an effective weight-loss solution. Explain the advantages and disadvantages. Research global geographic variation in the prevalence of lactase persistence. Relate this geographic variation in the ability to chemically digest milk sugar to the cultural history of dairy livestock domestication. Consider the timeframe of microevolutionary changes between human populations.	Investigate the relative lengths of the alimentary canal of various vertebrates with differing diets. Propose hypotheses to explain the relationship between relative length and diet. Design models of mechanical and chemical digestion using varied materials. Compare the efficiency of human digestion and ruminant digestion. Assess the claim that probiotic foods are healthy. Provide evidence to support or refute this claim.	Journal daily food choices and relate it to the current USDA Choose My Plate recommendations. Explain how bariatric surgery impacts the digestive system. Explain how hydrochloric acid (HCl) in the stomach aids in digestion and provides protection from pathogens. Prepare a presentation on the importance of symbiotic colonic bacteria.	Trace food from the mouth to the anus and describe what happens in each region. Describe the structure and function of accessory digestive organs. Explain the role of a specific enzyme in the digestive process. Include where it is produced, where it enters the alimentary canal, the pH range in which it works best, the types of molecules it chemically digests and what products the chemical breakdown forms. Distinguish mechanical from chemical digestion. Identify the regions of the stomach and their functions. Identify tissue and cell types in digestive and accessory organs using microscopes, slides, micrographs, models or illustrations.
AP.AE.2: Respiratory system			
	Design a model to show how cold/flu impacts respiratory function. Use the model to investigate how various remedies alleviate symptoms.	Explain mammalian (including human) respiration by comparing it to the respiratory anatomy and physiology of the other major vertebrate groups (e.g., cephalochordates/urochordates, fish, amphibians, amniotes).	Identify sections of the respiratory tree by histological slides/images. Explain how the structure in each portion of the respiratory tree supports its function. List the normal respiratory volumes. Explain what factors alter respiratory volumes. Name muscles used for inspiration and expiration.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
Obstructive vs. restrictive disease			
	Investigate factors which alter respiratory volumes. Compare breathing in obstructive and restrictive diseases (e.g., simulate obstructive disease by wrapping a belt around the chest and tightening appropriately, simulate restrictive disease by pursing lips around a straw). Collect data on respiratory volumes during obstructive and restrictive respiratory disorders (e.g., use a tape measure to measure the thoracic cavity as an estimate of volume).	Interpret spirometry data and match it to the appropriate "patients"; normal, asthmatic, smoker, athlete. Provide evidence to support your claim.	
Respiratory health and the environment			
Design an action plan to improve the air quality in an area with low air quality (e.g., construction dust in a building). Determine the design specifications of a face mask to filter fine particulate matter (PM 2.5 particles) resulting from the combustion of fossil fuels.	Investigate local air quality and asthma or other pulmonary disease rates. Formulate an argument for how the air quality in an area impacts local respiratory health.	Explore asthma rates, pollution levels and ozone levels, globally. Create a poster or other graphic comparing the size of PM 2.5 particles generated by combustion of fossil fuels to the size of particles that can be diffused by the surfaces of the respiratory system (including the size of red blood cells).	Explain the physiological effects and damages caused by PM 2.5 particles generated by the combustion of fossil fuels.
Exercise and respiration			
Design a device to improve the respiratory function in athletes.	Perform an investigation to compare pre- and post- exercise data (e.g., breathing rate, depth, tidal volume).		Differentiate between tidal volume and breathing rate. Explain how to determine breathing rate and depth.

Designing technological/engineering solutions using science concepts	Demonstrating science knowledge	Interpreting and communicating science concepts	Recalling accurate science
AP.AE.3: Urinary system			
Design a device that serves as a "mini dialysis" machine to be used in patients with renal failure. List and discuss the limitations.	Design a model using dialysis tubing and some common solute to demonstrate the movement of wastes from interstitial fluid to the renal tube. Match representative urine lab values (concentrations) with mock patient scenarios for a condition (e.g., high ADH, dehydration, excess coffee, urinary tract infection, diuretics). Create a treatment plan for the patient.	Illustrate filtration, secretion and reabsorption of ions/molecules in the kidney. Explain the relationship between the renal system and other organ systems (e.g., vascular). Include complications of renal failure. Interpret lab values to determine what ions/proteins need to be altered during dialysis. Create a pamphlet that explains the impact of diet on blood chemistry and how that affects kidney function, especially in those on dialysis. Compare the functions of current hemodialysis machines with the actual kidneys. Illustrate or describe the roles of osmosis and diffusion in the process of urine formation. Explain what lab values you would expect in various patient scenarios (e.g., infection, dehydration). Kangaroo rats live in the Mojave Desert of the U.S. Predict how the relative dimensions of their nephrons compare with those of humans. Justify the prediction.	Trace the formation of urine through the processes of osmosis and diffusion. Describe the basic physiological processes accomplished by the nephron (filtration, reabsorption, secretion). Describe the process by which the body eliminates excess fluids. Identify normal urine concentrations. Illustrate or describe the roles of osmosis and diffusion in the process of urine formation. Explain how molecules/hormones influence the body's hydration status. Identify the impacts of drinking too much water (i.e., hyperhydration). Describe the gross and histological structure of the urinary bladder. Relate the structure of the urinary bladder to its function.

Human Anatomy and Physiology continued

AP.R: REPRODUCTION
AP.R.1: Reproductive system

CONTENT ELABORATION: REPRODUCTION

AP.R.1: Reproductive system
The reproductive system is comprised of internal and external organs and hormones. The ovaries and testes produce gametes that fuse to form a zygote, a single cell that develops into an embryo and eventually an adult. A comparison of male and female anatomy should be explored. The female body has the function of providing protection and nourishment for the developing fetus until birth. If all is successful, a new generation of offspring will occur.

The processes of the reproductive system include oogenesis, spermatogenesis and fertilization. Additional processes can include lactation and menstruation. Homeostatic imbalances are explored. These include, but are not limited to, infertility, chromosomal disorders, endometriosis, cancer, Human Papillomavirus (HPV), and sexually transmitted diseases (STD's). Investigations are used to understand and explain the reproductive system in a variety of inquiry and design scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

Note: *At this level, a detailed description of embryological development is not required. The focus is on the structure and function of the reproductive organs.*

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AP.R.1: Reproductive system			
Design an artificial womb (ectogenesis) that could support embryonic life.	Examine how environmental variables can impact sea urchin fertilization.	Develop a visual graphic with a timeline indicating the evolution of reproductive physiology in mammals from egg laying monotremes, marsupials and then placental mammals. Display the current global distribution of monotreme, marsupial and placental mammals. Propose one or more hypotheses to explain these observed distribution patterns. Interpret information from a case study to discuss the misconception that all menstrual cycles last 28 days. Design a poster or similar graphic to inform peers of the global, human population over the last 5,000 years.	Identify the structures of the male reproductive system and the functions of each structure. Identify the structures of the female reproductive system and the functions of each structure. Explain the pathway of a gamete through each reproductive system. Compare the processes of oogenesis and spermatogenesis.