HUMAN ANATOMY AND PHYSIOLOGY

The Human Anatomy and Physiology course is designed to address the structure and function of human body systems from the cellular level to the organism level in an approach that complements the natural curiosity of high school students. The course addresses the interactions within and between systems that maintain homeostasis in an organism. It is designed for students who have an interest in learning how the human body works and for those interested in health-related science, technology, engineering, and mathematics (STEM) careers. As students engage in the study of human body systems, they are encouraged to apply the knowledge and processes of science to personally relevant issues, including how personal choices, environmental factors, and genetic factors affect the human body.

The Human Anatomy and Physiology standards provide a depth of conceptual understanding to adequately prepare students for college, career, and citizenship with an appropriate level of scientific literacy. This course encourages critical thinking, the integration of technology, and the application of knowledge and skills to solve problems. An important component of this course is a safe laboratory setting where students participate in active learning to illustrate scientific concepts that incorporate activities such as histological studies, dissections, urinalysis and blood-testing simulations, and computer-based electrocardiography. Students are expected to use clear and accurate academic language, keep detailed records, make oral and written presentations, and defend claims based on evidence from their own and others' scientific investigations.

Content standards within this course are organized according to one of the core ideas of Life Science, From Molecules to Organisms: Structures and Processes. This core idea is explored more extensively within the specific context of the anatomy and physiology of human body systems. Content standards focus on the growth and development of human body systems as well as on the structure and function of these systems from the cellular level to the organism level. Integrated within the discipline of Human Anatomy and Physiology are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Advanced Human Anatomy and Physiology will emphasize content more extensively at the cellular and chemical levels.

HUMAN ANATOMY AND PHYSIOLOGY

From Molecules to Organisms: Structures and Processes

Students will:

AL.HAP.1 - Develop and use models and appropriate terminology to identify regions, directions, planes, and cavities in the human body to locate organs and systems.

AL.HAP.2 - Analyze characteristics of tissue types (e.g., epithelial tissue) and construct an explanation of how the chemical and structural organizations of the cells that form these tissues are specialized to conduct the function of that tissue (e.g., lining, protecting).

AL.HAP.3 - Obtain and communicate information to explain the integumentary system's structure and function, including layers and accessories of skin and types of membranes.

a. Analyze the effects of pathological conditions (e.g., burns, skin cancer, bacterial and viral infections, chemical dermatitis) to determine the body's attempt to maintain homeostasis.

HUMAN ANATOMY AND PHYSIOLOGY

Structure and Function
(From Molecules to Organisms: Structures and Processes)

Students will:

AL.HAP.4 - Use models to identify the structure and function of the skeletal system (e.g., classification of bones by shape, classification of joints and the appendicular and axial skeletons).

a. Obtain and communicate information to demonstrate understanding of the growth and development of the skeletal system (e.g., bone growth and remodeling).
b. Obtain and communicate information to demonstrate understanding of the pathology of the skeletal system (e.g., types of bone fractures and their treatment, osteoporosis, rickets, other bone diseases).

AL.HAP.5 - Develop and use models to illustrate the anatomy of the muscular system, including muscle locations and groups, actions, origins and insertions.

a. Plan and conduct investigations to explain the physiology of the muscular system (e.g., muscle contraction/relaxation, muscle fatigue, muscle tone), including pathological conditions (e.g., muscular dystrophy).

AL.HAP.7 - Use models to determine the relationship between the structures in and functions of the cardiovascular system (e.g., components of blood, blood circulation through the heart and systems of the body, ABO blood groups, anatomy of the heart, types of blood vessels).

a. Design and carry out an experiment to test various conditions that affect the heart (e.g., heart rate, blood pressure, electrocardiogram [ECG] output.)

AL.HAP.8 - Communicate scientific information to explain the relationship between the structures and functions, both mechanical (e.g., chewing, churning in stomach) and chemical (e.g., enzymes, hydrochloric acid [HCl] in stomach), of the digestive system, including the accessory organs (e.g., salivary glands, pancreas).

AL.HAP.9 - Develop and use a model to explain how the organs of the respiratory system function.

a. Engage in argument from evidence describing how environmental (e.g., cigarette smoke, polluted air) and genetic factors may affect the respiratory system, possibly leading to pathological conditions (e.g., cystic fibrosis).

AL.HAP.11 - Use models to differentiate the structures of the urinary system and to describe their functions.

AL.HAP.12a -Develop and use a model to explain the body's lines of defense and immunity.

Students who demonstrate understanding can:

HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Structure and Function
(From Molecules to Organisms: Structures and Processes)

The performance expectations were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)

Planning and Carrying Out Investigations

Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Disciplinary Core Ideas

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

Connections to other DCIs in this grade-band:
HS.LS3.A (HS-LS1-1)

Articulation of DCIs across grade-bands:
MS.LS1.A (HS-LS1-1),(HS-LS1-2),(HS-LS1-3); **MS.LS3.A** (HS-LS1-1); **MS.LS3.B** (HS-LS1-1)

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-LS1-1)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS1-3)
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-LS1-3)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-LS1-2)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

HUMAN ANATOMY AND PHYSIOLOGY

Body Systems

Students will:

Central Nervous System
AL.HAP.6 - Obtain, evaluate, and communicate information regarding how the central nervous system and peripheral nervous system interrelate, including how these systems affect all other body systems to maintain homeostasis.

a. Use scientific evidence to evaluate the effects of pathology on the nervous system (e.g., Parkinson's disease, Alzheimer's disease, cerebral palsy, head trauma) and argue possible prevention and treatment options.
b. Design a medication to treat a disorder associated with neurotransmission, including mode of entry into the body, form of medication, and desired effects.*

Cardiovascular System
AL.HAP.7a - Engage in argument from evidence regarding possible prevention and treatment options related the pathology of the cardiovascular system (e.g., myocardial infarction, mitral valve prolapse, varicose veins, arteriosclerosis, anemia, high blood pressure).

Digestive System
AL.HAP.8a - Obtain and communicate information to demonstrate an understanding of the disorders of the digestive system (e.g., ulcers, Crohn's disease, diverticulitis).

Reproductive System
AL.HAP.10 - Obtain, evaluate, and communicate information to differentiate between the male and female reproductive systems, including pathological conditions that affect each.

a. Use models to demonstrate what occurs in fetal development at each stage of pregnancy.

Urinary System
AL.HAP.11a - Analyze and interpret data related to the urinary system to show the relationship between homeostatic imbalances and disease (e.g., kidney stones, effects of pH imbalances).

Lymphatic System
AL.HAP.12 - Obtain and communicate information to explain the lymphatic organs and their structure and function.

b. Obtain and communicate information to demonstrate an understanding of the disorders of the immune system (e.g., acquired immunodeficiency syndrome [AIDS], severe combined immunodeficiency [SCID]).

Endocrine System
AL.HAP.13 - Obtain, evaluate, and communicate information to support the claim that the endocrine glands secrete hormones that help the body maintain homeostasis through feedback loops.

a. Analyze the effects of pathological conditions (e.g., pituitary dwarfism, Addison's disease, diabetes mellitus) caused by imbalance of the hormones of the endocrine glands.

Engineering Design

(Engineering, technology, and science core disciplinary ideas are integrated into grade level science performance expectations.)

Students will:

AL.HAP.6b - Design a medication to treat a disorder associated with neurotransmission, including mode of entry into the body, form of medication, and desired effects.*

Students who demonstrate understanding can:

HS-ETS1-3 **Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.**

The performance expectations were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)

Crosscutting Concepts

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

Connections to HS-ETS1.A: Defining and Delimiting Engineering Problems include:
Physical Science: HS-PS2-3, HS-PS3-3
Connections to HS-ETS1.B: Developing Possible Solutions Problems include:
Earth and Space Science: HS-ESS3-2, HS-ESS3-4 **Life Science:** HS-LS2-7, HS-LS4-6
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: HS-PS1-6, HS-PS2-3

Articulation of DCIs across grade-levels:
MS.ETS1.A (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); **MS.ETS1.B** (HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4); **MS.ETS1.C** (HS-ETS1-2),(HS-ETS1-4)

Common Core State Standards Connections:

ELA/Literacy -

RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(HS-ETS1-3)
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)
MP.4	Model with mathematics. (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

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