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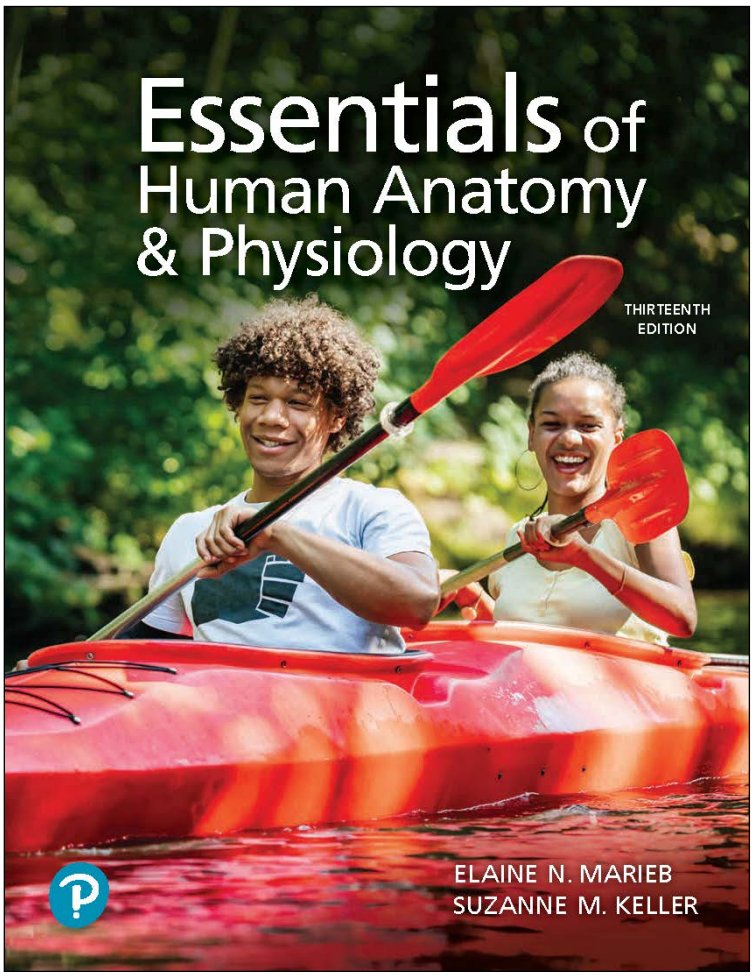

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To the

Arkansas
Science Standards 2016
Human Anatomy & Physiology

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A Correlation of Essentials of Human Anatomy & Physiology, 13th Edition, ©2022
to the Arkansas Science Standards 2016
Human Anatomy & Physiology

Introduction

This document demonstrates how ***Essentials of Human Anatomy & Physiology, 13th Edition, ©2022*** supports the Arkansas Science Standards for Human Anatomy & Physiology. Citations include both the print Student Edition and online Mastering® digital resources.

The Pearson Advantage

Introducing the 13th Edition of ***Essentials of Human Anatomy & Physiology,*** the #1 high school A&P textbook for a general audience! A friendly, down-to-earth writing style presents anatomy and physiology as a "story" that is easily understood and remembered. Highlighting clinical applications, this program prepares students for both college and careers. Features include:

• Strong art and text integration including 3-D anatomy drawings, visual process diagrams, and realistic bone-and-muscle art.

• What, How & Why chapter previews introduce key examples of A&P concepts that will be covered in the chapter helping learners hone in on what they are studying, how it functions, and why it is important for them to learn.

• New! Study Tips plus figures, tables, or graphs questions have been added to each of the End-of-Chapter review sections.

• Effective pedagogical tools throughout include integrated learning outcomes, Did You Get It? concept check questions, figure questions that accompany selected artwork and quickly engage visual learners, chapter summaries with integrated references to *Essentials of Interactive Physiology*, and end-of-chapter review questions that help students study and test their comprehension of chapter material.

Mastering® A&P

The Mastering® platform delivers engaging, dynamic learning opportunities—focused on course objectives and responsive to reach student's progress—that are proven to help students absorb course material and understand difficult concepts. Interactive learning tools include:

• Self-paced tutorials integrate hints and immediate wrong-answer feedback to emulate the office hour experience and help students grasp key course concepts.

• Book-specific Coaching Activities are assignable activities that bring interactivity to key physiological processes using art from the book.

• New! Hide and reveal answer keys for all end-of-chapter review questions.

• New! Interactive eText allows students to watch videos and animations at point of use.

• A&P Flix™ movie-quality animations provide carefully developed, step-by-step explanations with dramatic 3-D representations of structures that show action and movement of processes to bring difficult-to-teach A&P concepts to life. Each animation includes practice quizzes.

SE = Student Edition (print version)
Digital Resources: The symbol > indicates a click to reach each digital asset on the Realize platform.

A Correlation of Essentials of Human Anatomy & Physiology, 13th Edition, ©2022
to the Arkansas Science Standards 2016
Human Anatomy & Physiology

Table of Contents

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Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Topic 1: Patterns	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS1-1AR Construct an explanation based on evidence obtained from a variety of sources for the pattern of hierarchical organization of each body system: • Integumentary System • Skeletal System • Muscular System • Respiratory System • Circulatory System • Digestive System • Nervous System • Endocrine System • Lymphatic System • Urinary System • Reproductive Systems	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Did You Get It?, 7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #16, 105 4.2b Structure of the Skin, 110-115 5.1c Structure of Bone, 132-135 6.2 Microscopic Anatomy of Skeletal Muscle, 181-183 7.1a Structural Classification, 222 9.2 The Major Endocrine Organs, 306-307 11.1a Anatomy of the Heart, 352-353 11.2a Microscopic Anatomy of Blood Vessels, 366-368 12.1 Lymphatic Vessels, 393-394 13.1 Functional Anatomy of the Respiratory System, 432-433 14.1a Organs of the Alimentary Canal, 461-474 15.1a Location and Structure, 512-513 16.3a Ovaries, 549 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life.	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
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. (Performance Expectation HAP-LS1-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #10
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. (Performance Expectation HAP-LS1-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS1-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
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.	
Use a model based on evidence to illustrate the relationships between systems or between components of a system. (Performance Expectation HAP-LS1-1AR)	**SE:** Figure 1.1 Levels of structural organization, 3 Figure 1.2 The body's organ systems, 5-6 Figure 3.19 Connective tissues and their common body locations, 93-95 Figure 3.20 Types of muscle tissue and their common locations in the body, 97 Figure 3.21 Nervous tissue, 98 Figure 4.3 Skin structure, 111 Figure 4.4 The main structural features of the epidermis, 112 Figure 5.4 Microscopic structure of bone, 136 Figure 6.3 Anatomy of a skeletal muscle fiber (cell), 182 Figure 7.3 Supporting cells (neuroglia) of nervous tissue, 223 Figure 9.6 The thyroid gland, 311 Figure 11.10 Structure of blood vessels, 366 Figure 12.2 Special structural features of lymphatic capillaries, 394 Figure 13.6 Functional anatomy of the respiratory membrane (air-blood barrier), 440 Figure 14.4 Anatomy of the stomach, 465 Figure 15.3 Structure of the nephron, 515 Figure 16.8 The human female reproductive organs, 551 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (Performance Expectation HAP-LS1-1AR)	**SE:** Figure 1.1 Levels of structural organization, 3 Figure 1.2 The body's organ systems, 5-6 Figure 3.19 Connective tissues and their common body locations, 93-95 Figure 3.20 Types of muscle tissue and their common locations in the body, 97 Figure 3.21 Nervous tissue, 98 Figure 4.3 Skin structure, 111 Figure 4.4 The main structural features of the epidermis, 112 Figure 5.4 Microscopic structure of bone, 136 Figure 6.3 Anatomy of a skeletal muscle fiber (cell), 182 Figure 7.3 Supporting cells (neuroglia) of nervous tissue, 223 Figure 9.6 The thyroid gland, 311 Figure 11.10 Structure of blood vessels, 366 Figure 12.2 Special structural features of lymphatic capillaries, 394 Figure 13.6 Functional anatomy of the respiratory membrane (air-blood barrier), 440 Figure 14.4 Anatomy of the stomach, 465 Figure 15.3 Structure of the nephron, 515 Figure 16.8 The human female reproductive organs, 551 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology
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 and revise 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. (Performance Expectation HAP-LS1-1AR)	**SE:** Did You Get It?, 7 Did You Get It?, 20 Short Answer Essay, #10, 22 Short Answer Essay, #18, 105

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Planning and Carrying Out Investigations	
Planning and carrying out investigations 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. (Performance Expectation HAP-LS1-1AR)	For supporting content, please see: **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology
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. (Performance Expectation HAP-LS1-1AR)	**SE:** Figure 1.1 Levels of structural organization, 3 Figure 1.2 The body's organ systems, 5-6 Figure 3.19 Connective tissues and their common body locations, 93-95 Figure 3.20 Types of muscle tissue and their common locations in the body, 97 Figure 3.21 Nervous tissue, 98 Figure 4.3 Skin structure, 111 Figure 4.4 The main structural features of the epidermis, 112 Figure 5.4 Microscopic structure of bone, 136 Figure 6.3 Anatomy of a skeletal muscle fiber (cell), 182 Figure 7.3 Supporting cells (neuroglia) of nervous tissue, 223 Figure 9.6 The thyroid gland, 311 Figure 11.10 Structure of blood vessels, 366 Figure 12.2 Special structural features of lymphatic capillaries, 394 Figure 13.6 Functional anatomy of the respiratory membrane (air-blood barrier), 440 Figure 14.4 Anatomy of the stomach, 465 Figure 15.3 Structure of the nephron, 515 Figure 16.2 Male reproductive organs, 542 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
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. (Performance Expectation HAP-LS1-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.5c Types of Connective Tissue, 92-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 4.2b Structure of the Skin, 110-115 5.1c Structure of Bone, 132-135 6.1a Muscle Types, 177-181 7.2a Supporting Cells, 223-224 7.2b Neurons, 225-229 9.2g Pancreatic Islets, 318-319 11.1a Anatomy of the Heart, 352-353 11.2a Microscopic Anatomy of Blood Vessels, 366-368 12.1 Lymphatic Vessels, 393-394 13.1a The Nose, 433-434 14.1a Organs of the Alimentary Canal, 461-470 15.1a Location and Structure, 512-513 16.1b Duct System, 541-543 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS1-1AR)	**SE:** Did You Get It?, 20 Short Answer Essay, #14, 22
Patterns	
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (Performance Expectation HAP-LS1-1AR)	**SE:** Figure 1.1 Levels of structural organization, 3 Figure 1.2 The body's organ systems, 5-6 Did You Get It?, 7 Short Answer Essay, #10, 22 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Practice Anatomy Lab (PAL)>Histology

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Topic 2: Structure and Function	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS2-1AR Develop and use a model to identify and describe the relationship between the structures and physiological processes of each body system: • Integumentary System • Skeletal System • Muscular System • Respiratory System • Circulatory System • Digestive System • Nervous System • Endocrine System • Lymphatic System • Urinary System • Reproductive Systems	**SE:** 4.2a Functions of the Integumentary System, 109 4.2b Structure of the Skin, 110-115 5.1a Functions of the Bones, 131 5.1c Structure of Bone, 132-135 6.1a Muscle Types, 177-181 6.1b Muscle Functions, 181 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 9.1c Stimuli for Control of Hormone Release, 305-306 11.1a Anatomy of the Heart, 352-353 11.1d Physiology of the Heart, 359-365 11.2c Physiology of Circulation, 374-383 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 12.5d Cellular (Cell-Mediated) Immune Response, 414-416 13.2a Mechanics of Breathing, 441-444 13.2c External Respiration, Gas Transport, and Internal Respiration, 445-448 14.2c Activities of the Stomach, 478-480 15.1a Location and Structure, 512-513 15.1c Urine Formation and Characteristics, 516-519 16.6b Events of Embryonic and Fetal Development, 561-563 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Anatomy Review Animation: Endocrine; IP Anatomy Review Animation: Immune; IP Anatomy Review Animation: Respiratory; IP Anatomy Review Animation: Digestive; IP Anatomy Review Animation: Urinary >Launch the Study Area>Practice Anatomy Lab (PAL)>Anatomical Models

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life. (Performance Expectation HAP-LS2-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549
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. (Performance Expectation HAP-LS2-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #10
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. (Performance Expectation HAP-LS2-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues

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Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS2-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis
LS1.B: Growth and Development of Organisms	
In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (Performance Expectation HAP-LS2-1AR)	**SE:** 3.3b Cell Division, 80-83 16.6a Accomplishing Fertilization, 560-561 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Mitosis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #12

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
LS1.C: Organization for Matter and Energy Flow in Organisms	
The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (Performance Expectation HAP-LS2-1AR)	This objective falls outside the scope of this program. For supporting content only, please see: **SE:** 2.1b Energy, 24-25
The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (Performance Expectation HAP-LS2-1AR)	**SE:** Carbohydrates, 42-43 Lipids, 43-45 Proteins, 47-51 Nucleic Acids, 51-54 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration; Protein Synthesis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (Performance Expectation HAP-LS2-1AR)	**SE:** 2.1a Matter, 23-24 2.1b Energy, 24-25 2.4b Patterns of Chemical Reactions, 35-37 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (Performance Expectation HAP-LS2-1AR)	**SE:** Carbohydrate Metabolism, 488-490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
LS1.D: Information Processing	
Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (Performance Expectation HAP-LS2-1AR)	**SE:** 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Short Answer Essay, #16, 271 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>Propagation of an Action Potential

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
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. (Performance Expectation HAP-LS2-1AR)	**SE:** Figure 4.5 Skin structure, 111 Figure 5.6 Growth and remodeling of long bones, 137 Table 6.1 Comparison of Skeletal, Cardiac, and Smooth Muscles, 178 Figure 6.5 Events at the neuromuscular junction, 185 Figure 7.10 How neurons communicate at chemical synapses, 232 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.7 The intrinsic conduction system of the heart, 359 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 11.22 Capillary transport mechanisms, 382 Figure 12.17 T cell activation and interactions with other cells of the immune response, 415 Figure 12.18 A proposed mechanism by which cytotoxic T cells kill target cells, 416 Figure 13.7 Rib cage and diaphragm positions during breathing, 442 Figure 13.11 The loading and unloading of oxygen (O_2) and carbon dioxide (CO_2) in the body, 447 Figure 14.15 Peristaltic waves in the stomach, 480 Figure 15.5 Sites of filtration, reabsorption, and secretion in a nephron, 518 Figure 16.17 From fertilization and cleavage to implantation, 562 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle >Launch the Study Area>Interactive Physiology (IP)>IP2: Cardiac Output; IP2: Tubular Reabsorption and Secretion >Launch the Study Area>Practice Anatomy Lab (PAL)>Anatomical Models

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
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. (Performance Expectation HAP-LS2-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Investigating the Refractory Period of Cardiac Muscle; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation
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.	
Ask questions that arise from examining models or a theory to clarify relationships. (Performance Expectation HAP-LS2-1AR)	For related content, please see: **SE:** Figure 4.3 Skin structure, 111 Figure 5.6 Growth and remodeling of long bones, 137 Table 6.1 Comparison of Skeletal, Cardiac, and Smooth Muscles, 178 Figure 6.5 Events at the neuromuscular junction, 185 Figure 7.10 How neurons communicate at chemical synapses, 232 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.7 The intrinsic conduction system of the heart, 359 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 11.22 Capillary transport mechanisms, 382 Figure 12.17 T cell activation and interactions with other cells of the immune response, 415 Figure 12.18 A proposed mechanism by which cytotoxic T cells kill target cells, 416 Figure 13.7 Rib cage and diaphragm positions during breathing, 442 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Figure 14.15 Peristaltic waves in the stomach, 480 Figure 15.5 Sites of filtration, reabsorption, and secretion in a nephron, 518 Figure 16.17 From fertilization and cleavage to implantation, 562

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Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS2-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Investigating the Refractory Period of Cardiac Muscle; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation
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. (Performance Expectation HAP-LS2-1AR)	**SE:** Figure 5.6 Growth and remodeling of long bones, 137 Figure 6.5 Events at the neuromuscular junction, 185 Figure 6.14 Muscle action, 197 Figure 7.10 How neurons communicate at chemical synapses, 232 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.7 The intrinsic conduction system of the heart, 359 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 11.22 Capillary transport mechanisms, 382 Figure 12.17 T cell activation and interactions with other cells of the immune response, 415 Figure 12.18 A proposed mechanism by which cytotoxic T cells kill target cells, 416 Figure 13.7 Rib cage and diaphragm positions during breathing, 442 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Figure 14.15 Peristaltic waves in the stomach, 480 Figure 15.5 Sites of filtration, reabsorption, and secretion in a nephron, 518 Figure 16.17 From fertilization and cleavage to implantation, 562 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle >Launch the Study Area>Interactive Physiology (IP)>IP2: Cardiac Output; IP Animation: Pathway of Blood through the Heart; IP2: Tubular Reabsorption and Secretion

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS2-1AR)	**SE:** 4.2a Functions of the Integumentary System, 109 4.2b Structure of the Skin, 110-115 5.1a Functions of the Bones, 131 5.1c Structure of Bone, 132-135 6.1b Muscle Functions, 181 6.2 Microscopic Anatomy of Skeletal Muscle, 181-183 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Short Answer Essay, #13, 271 11.1a Anatomy of the Heart, 352-353 11.1d Physiology of the Heart, 359-365 11.2b Gross Anatomy of Blood Vessels, 369-373 11.2c Physiology of Circulation, 374-383 Short Answer Essay, #25, 391 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 12.5d Cellular (Cell-Mediated) Immune Response, 414-416 13.1f The Lungs, 437-440 13.2a Mechanics of Breathing, 441-444 Short Answer Essay, #12, 459 14.2c Activities of the Stomach, 478-480 15.1b Nephrons, 513-516 15.1c Urine Formation and Characteristics, 516-519 16.6b Events of Embryonic and Fetal Development, 561-563 Short Answer Essay, #15, #21, #23, #23, 578 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Anatomy Review Animation: Endocrine; IP Anatomy Review Animation: Immune; IP Anatomy Review Animation: Respiratory; IP Anatomy Review Animation: Digestive; IP Anatomy Review Animation: Urinary >Launch the Study Area>Practice Anatomy Lab (PAL)>Anatomical Models

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS2-1AR)	**SE:** Short Answer Essay, #13, #15, 129 Did You Get It?, 138 Did You Get It?, 187 Short Answer Essay, #16, 271 Short Answer Essay, #14, #18, 330 Did You Get It?, 362 Did You Get It?, 380 Short Answer Essay, #16, 430 Short Answer Essay, #16, 459 Did You Get It?, 531 Short Answer Essay, #18, 578
Patterns	
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (Performance Expectation HAP-LS2-1AR)	**SE:** 5.2b Vertebral Column (Spine), 148-151 6.2 Microscopic Anatomy of Skeletal Muscle, 181-183 6.4d Arrangement of Fascicles, 198 Critical Thinking and Clinical Application Questions, #19, 219 Neural Regulation: Setting the Basic Rhythm, 448
Stability and Change	
Feedback (negative or positive) can stabilize or destabilize a system. (Performance Expectation HAP-LS2-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Energy and Matter	
Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (Performance Expectation HAP-LS2-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 11.2c Physiology of Circulation, 374-383 Did You Get It?, 383 Short Answer Essay, #21, 391 12.1 Lymphatic Vessels, 393-394 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 Figure 13.10 Gas exchanges in external and internal respiration, 446 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Did You Get It?, 448 Figure 14.20 The formation of ATP in the cytosol and the mitochondria during cellular respiration, 489 Figure 14.21 Energy release in the electron transport chain, 490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Gas Exchange >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation Pathway of Blood through the Heart; IP Animation: Gas Exchange
Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (Performance Expectation HAP-LS2-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 14.21 Energy release in the electron transport chain, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
The total amount of energy and matter in closed systems is conserved. (Performance Expectation HAP-LS2-1AR)	**SE:** 2.1b Energy, 24-25
Energy drives the cycling of matter within and between systems. (Performance Expectation HAP-LS2-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Mitochondria, 65 Carbohydrate Metabolism, 488-490
Topic 3: Scale, Proportion, and Quantity	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS3-1AR Use mathematics and computational thinking to support explanations for physiological processes in body systems.	For supporting content, please see: **SE:** 4.2a Functions of the Integumentary System, 109 Short Answer Essay, #13, 129 5.1d Bone Formation, Growth, and Remodeling, 135-138 6.3a Stimulation and Contraction of Single Skeletal Muscle Fibers, 184-187 Did You Get It?, 187 6.3b Contraction of a Skeletal Muscle as a Whole, 188-192 Short Answer Essay, #12, 218 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Did You Get It?, 234 Short Answer Essay, #16, 271 11.1d Physiology of the Heart, 359-365 Did You Get It?, 365 12.4b Cells and Chemicals: Second Line of Defense, 400-405 12.5d Cellular (Cell-Mediated) Immune Response, 414-416 Short Answer Essay, #16, #19, 430 13.2c External Respiration, Gas Transport, and Internal Respiration, 445-448 Short Answer Essay, #9, #13, #16, 459 14.2a Overview of Gastrointestinal Processes and Controls, 474-476

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life. (Performance Expectation HAP-LS3-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549
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. (Performance Expectation HAP-LS3-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #10
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. (Performance Expectation HAP-LS3-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues

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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. (Performance Expectation HAP-LS3-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis
LS1.B: Growth and Development of Organisms	
In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (Performance Expectation HAP-LS3-1AR)	**SE:** 3.3b Cell Division, 80-83 16.6a Accomplishing Fertilization, 560-561 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Mitosis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #12

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LS1.C: Organization for Matter and Energy Flow in Organisms	
The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (Performance Expectation HAP-LS3-1AR)	This objective falls outside the scope of this program.
The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (Performance Expectation HAP-LS3-1AR)	**SE:** Carbohydrates, 42-43 Lipids, 43-45 Proteins, 47-51 Nucleic Acids, 51-54 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration; Protein Synthesis
As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (Performance Expectation HAP-LS3-1AR)	**SE:** 2.1a Matter, 23-24 2.1b Energy, 24-25 2.4b Patterns of Chemical Reactions, 35-37 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (Performance Expectation HAP-LS3-1AR)	**SE:** Carbohydrate Metabolism, 488-490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism

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LS1.D: Information Processing	
Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (Performance Expectation HAP-LS3-1AR)	**SE:** 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Short Answer Essay, #16, 271 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>Propagation of an Action Potential
Science and Engineering Practices	
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 and/or computational representations of phenomena or design solutions to support explanations. (Performance Expectation HAP-LS3-1AR)	**SE:** Short Answer Essay, #13, 129 Did You Get It?, 138 Short Answer Essay, #12, 218 Did You Get It?, 234 Short Answer Essay, #16, 271 Did You Get It?, 304 Did You Get It?, 319 Short Answer Essay, #18, 330 Did You Get It?, 365 Did You Get It?, 380 Did You Get It?, 416 Short Answer Essay, #16, #19, 430 Short Answer Essay, #9, #13, #16, 459 Short Answer Essay, #18, 509 Short Answer Essay, #19, 539

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
Use mathematical representations of phenomena or design solutions to support and revise explanations. (Performance Expectation HAP-LS3-1AR)	**SE:** Short Answer Essay, #13, 129 Did You Get It?, 138 Short Answer Essay, #12, 218 Did You Get It?, 234 Short Answer Essay, #16, 271 Did You Get It?, 304 Did You Get It?, 319 Short Answer Essay, #18, 330 Did You Get It?, 365 Did You Get It?, 380 Did You Get It?, 416 Short Answer Essay, #16, #19, 430 Short Answer Essay, #9, #13, #16, 459 Short Answer Essay, #18, 509 Short Answer Essay, #19, 539
Create or revise a simulation of a phenomenon, designed device, process, or system. (Performance Expectation HAP-LS3-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle; Mechanism of Hormone Action; Second Messenger cAMP >Launch the Study Area>PhysioEx>Exercises>Simulating Filtration; The Effect of Stimulus Frequency on Skeletal Muscle Contraction; Studying the Effect of Blood Viscosity on Blood Flow Rate; Examining the Effects of Various Ions on Heart Rate
Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (Performance Expectation HAP-LS3-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; Studying the Effect of Blood Pressure on Blood Flow Rate; Examining the Effect of Temperature on Heart Rate; Examining the Effects of Chemical Modifiers on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation

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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. (Performance Expectation HAP-LS3-1AR)	**SE:** Figure 5.6 Growth and remodeling of long bones, 137 Figure 6.5 Events at the neuromuscular junction, 185 Figure 7.10 How neurons communicate at chemical synapses, 232 Figure 7.11 Simple reflex arcs, 233 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 11.22 Capillary transport mechanisms, 382 Short Answer Essay, #20, #21, 391 Figure 12.17 T cell activation and interactions with other cells of the immune response, 415 Figure 12.19 A summary of the adaptive immune responses, 417 Figure 13.11 The loading and unloading of oxygen (O_2) and carbon dioxide (CO_2) in the body, 447 Figure 14.11 Schematic summary of gastrointestinal tract activities, 474 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle >Launch the Study Area>Interactive Physiology (IP)>IP2: Cardiac Output

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Analyzing and Interpreting Data	
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (Performance Expectation HAP-LS3-1AR)	**SE:** Did You Get It?, 138 Critical Thinking and Clinical Application Questions, #19, 330
Obtaining, Evaluating, and Communicating Information	
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (Performance Expectation HAP-LS3-1AR)	**SE:** Short Answer Essay, #13, 129 Did You Get It?, 138 Short Answer Essay, #12, 218 Did You Get It?, 234 Short Answer Essay, #16, 271 Did You Get It?, 304 Did You Get It?, 319 Short Answer Essay, #18, 330 Did You Get It?, 365 Did You Get It?, 380 Did You Get It?, 416 Short Answer Essay, #16, #19, 430 Short Answer Essay, #9, #13, #16, 459 Short Answer Essay, #18, 509 Short Answer Essay, #19, 539
Connections to Nature of Science	
Scientific Knowledge is Open to Revision in Light of New Evidence	
Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (Performance Expectation HAP-LS3-1AR)	**SE:** Did You Get It?, 20 Did You Get It?, 319

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Crosscutting Concepts	
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS3-1AR)	**SE:** Did You Get It?, 319 Short Answer Essay, #18, 330 Did You Get It?, 365 Did You Get It?, 380 Short Answer Essay, #16, 430 Short Answer Essay, #13, #16, 459 Did You Get It?, 531 Short Answer Essay, #18, 578 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; Studying the Effect of Blood Pressure on Blood Flow Rate; Examining the Effect of Temperature on Heart Rate; Examining the Effects of Chemical Modifiers on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation
Scale, Proportion, and Quantity	
The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (Performance Expectation HAP-LS3-1AR)	**SE:** 5.1d Bone Formation, Growth, and Remodeling, 135-138 5.5a Birth to Adulthood, 169-170 Figure 5.33 Differences in the growth rates for some parts of the body compared to others determine body proportions, 170 5.5b Older Adults, 170-171 Did You Get It?, 171 Figure 16.10 Events of oogenesis, 554 16.4c Uterine (Menstrual) Cycle, 556 16.6b Events of Embryonic and Fetal Development, 561-563
Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (Performance Expectation HAP-LS3-1AR)	**SE:** Figure 5.33 Differences in the growth rates for some parts of the body compared to others determine body proportions, 170 Table 16.1 Development of the Human Fetus, 564-565

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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. (Performance Expectation HAP-LS3-1AR)	**SE:** Figure 5.6 Growth and remodeling of long bones, 137 Figure 6.5 Events at the neuromuscular junction, 185 Figure 7.10 How neurons communicate at chemical synapses, 232 Figure 7.11 Simple reflex arcs, 233 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Short Answer Essay, #20, #21, 391 Figure 11.22 Capillary transport mechanisms, 382 Figure 12.17 T cell activation and interactions with other cells of the immune response, 415 Figure 12.19 A summary of the adaptive immune responses, 417 Figure 13.11 The loading and unloading of oxygen (O_2) and carbon dioxide (CO_2) in the body, 447 Figure 14.11 Schematic summary of gastrointestinal tract activities, 474 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle; Mechanism of Hormone Action: Second Messenger cAMP >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism

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Topic 4: Stability and Change	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS4-1AR Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #18, #19, 22 Sweat Gland, 116-118 9.1c Stimuli for Control of Hormone Release, 305-306 9.2d Parathyroid Glands, 313 9.2g Pancreatic Islets, 318-319 Figure 10.4 Mechanism for regulating the rate of RBC production, 340 General Metabolic Functions, 493 15.3a Maintaining Water Balance of Blood, 524-527 15.3b Maintaining Electrolyte Balance, 527-529 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life. (Performance Expectation HAP-LS2-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS4-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #10
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. (Performance Expectation HAP-LS4-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues

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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. (Performance Expectation HAP-LS4-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis
LS3.A: Inheritance of Traits	
Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (Performance Expectation HAP-LS4-1AR)	**SE:** 3.2b The Nucleus, 63-64 Mitosis, 82-83 Homeostatic Imbalance 13.14, 453 16.7 Developmental Aspects of the Reproductive System, 579-573

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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.	
Ask questions that arise from examining models or a theory to clarify relationships. (Performance Expectation HAP-LS4-1AR)	**SE:** Figure 1.9 The elements of a homeostatic control system, 19 Figure 9.2 Endocrine gland stimuli, 305 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 9.12 Regulation of the blood glucose level by a negative feedback mechanism involving pancreatic hormones, 320 Figure 10.4 Mechanism for regulating the rate of RBC production, 340 Figure 14.23 Metabolic events occurring in the liver as the blood glucose rises and falls, 494 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.11 The thirst mechanism for regulating water intake, 526 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568
Analyzing and Interpreting Data	
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (Performance Expectation HAP-LS4-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #19, 330
Engaging in Argument from Evidence	
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	
Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (Performance Expectation HAP-LS4-1AR)	**SE:** Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS4-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis
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. (Performance Expectation HAP-LS4-1AR)	**SE:** Figure 9.2 Endocrine gland stimuli, 305 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 9.12 Regulation of the blood glucose level by a negative feedback mechanism involving pancreatic hormones, 320 Figure 10.4 Mechanism for regulating the rate of RBC production, 340 Figure 14.23 Metabolic events occurring in the liver as the blood glucose rises and falls, 494 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.11 The thirst mechanism for regulating water intake, 526 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis

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Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS4-1AR)	**SE:** Short Answer Essay, #14, 22 Critical Thinking and Clinical Application Questions, #18, 22 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis
Stability and Change	
Feedback (negative or positive) can stabilize or destabilize a system. (Performance Expectation HAP-LS4-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #19, 22 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 9.7 Hormonal control of the level of calcium ions in the blood, 313 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis >Launch the Study Area>PhysioEx>Exercises>Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis

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Connections to Nature of Science	
Science is a Human Endeavor	
Technological advances have influenced the progress of science and science has influenced advances in technology. (Performance Expectation HAP-LS4-1AR)	**SE:** A Closer Look: Medical Imaging: Illuminating the Body, 10-11 A Closer Look: Joint Ventures, 162 A Closer Look: Tracking Down CNS Problems, 265 A Closer Look: Electrocardiography: (Don't) Be Still My Heart, 362 A Closer Look: Renal Failure and the Artificial Kidney, 523 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 1: Student Activities, #16
Science and engineering are influenced by society and society is influenced by science and engineering. (Performance Expectation HAP-LS4-1AR)	**SE:** A Closer Look: Joint Ventures, 162 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
Topic 5: Cause and Effect	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS5-1AR Argue from evidence the cause(s) for a dysfunction in a body system and the mechanisms by which it occurred.	**SE:** Critical Thinking and Clinical Application Questions, #19, #20, 129 Critical Thinking and Clinical Application Questions, #21, #24, #25, 176 Critical Thinking and Clinical Application Questions, #18, 219 Critical Thinking and Clinical Application Questions, #21-#24, 271 Critical Thinking and Clinical Application Questions, #20, #22, 301 Critical Thinking and Clinical Application Questions, #19-#21, 330 Critical Thinking and Clinical Application Questions, #24, #25, 350 Critical Thinking and Clinical Application Questions, #29, 391 Critical Thinking and Clinical Application Questions, #23, 431 Critical Thinking and Clinical Application Questions, #26, 510 Critical Thinking and Clinical Application Questions, #25, 539
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life. (Performance Expectation HAP-LS5-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS5-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis
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. (Performance Expectation HAP-LS5-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues
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. (Performance Expectation HAP-LS5-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Critical Thinking and Clinical Application Questions, #18, #19, 22 Systems in Sync, 266 Homeostatic Imbalance 9.4, 311-312 Systems in Sync, 325 Systems in Sync, 426 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
LS1.B: Growth and Development of Organisms	
In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (Performance Expectation HAP-LS5-1AR)	**SE:** 3.3b Cell Division, 80-83 16.6a Accomplishing Fertilization, 560-561 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Mitosis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #12
LS1.D: Information Processing	
Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (Performance Expectation HAP-LS5-1AR)	**SE:** 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Short Answer Essay, #16, 271 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>Propagation of an Action Potential
LS4.A: Evidence of Common Ancestry and Diversity	
Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (Performance Expectation HAP-LS5-1AR)	**SE:** Proteins, 47-51 Nucleic Acids, 51-54 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-84

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LS4.C: Adaptation	
Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #22, 431 16.2a Spermatogenesis, 545-546
Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #22, 431
Adaptation also means that the distribution of traits in a population can change when conditions change. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #22, 431
Science and Engineering Practices	
Analyzing and Interpreting Data	
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #21, 176 Critical Thinking and Clinical Application Questions, #19, 330
Engaging in Argument from Evidence	
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.	
Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #29, 391

Arkansas Science Standards 2016 **Human Anatomy & Physiology**	**Essentials of Human Anatomy** **13th Edition, ©2022**
Construct an oral and written argument or counter-arguments based on data and evidence.	**SE:** Critical Thinking and Clinical Application Questions, #19, 129 Critical Thinking and Clinical Application Questions, #21, #24, #25, 176 Critical Thinking and Clinical Application Questions, #18, 219 Critical Thinking and Clinical Application Questions, #23, 271 Critical Thinking and Clinical Application Questions, #20, 301 Critical Thinking and Clinical Application Questions, #19, #21, 330 Critical Thinking and Clinical Application Questions, #24, 350 Critical Thinking and Clinical Application Questions, #23, 431
Obtaining, Evaluating, and Communicating Information	
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #19, #20, 129 Critical Thinking and Clinical Application Questions, #21, #24, #25, 176 Critical Thinking and Clinical Application Questions, #18, 219 Critical Thinking and Clinical Application Questions, #21-#24, 271 Critical Thinking and Clinical Application Questions, #20, #22, 301 Critical Thinking and Clinical Application Questions, #19-#21, 330 Critical Thinking and Clinical Application Questions, #24, #25, 350 Critical Thinking and Clinical Application Questions, #29, 391 Critical Thinking and Clinical Application Questions, #23, 431 Critical Thinking and Clinical Application Questions, #26, 510 Critical Thinking and Clinical Application Questions, #25, 539

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Connections to Nature of Science	
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	
A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (Performance Expectation HAP-LS5-1AR)	**SE:** 3.1 Overview of the Cellular Basis of Life, 60-61 Mechanism of Muscle Contraction: The Sliding Filament Theory, 186-187
Crosscutting Concepts	
Patterns	
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #19, 219
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS5-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #24, #25, 176 Critical Thinking and Clinical Application Questions, #20, 301 Critical Thinking and Clinical Application Questions, #20, #21, 330 Critical Thinking and Clinical Application Questions, #25, 350 Critical Thinking and Clinical Application Questions, #29, 391 Critical Thinking and Clinical Application Questions, #26, 510

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Stability and Change	
Much of science deals with constructing explanations of how things change and how they remain stable. (Performance Expectation HAP-LS5-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 Malignant Melanoma, 123 Critical Thinking and Clinical Application Questions, #19, 129 Critical Thinking and Clinical Application Questions, #23, 271 Critical Thinking and Clinical Application Questions, #22, 301 Critical Thinking and Clinical Application Questions, #19, 330 Critical Thinking and Clinical Application Questions, #24, #25, 350 Critical Thinking and Clinical Application Questions, #23, 431
Connections to Nature of Science	
Scientific Knowledge Assumes an Order and Consistency in Natural Systems	
Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (Performance Expectation HAP-LS5-1AR)	**SE:** Graded Responses, 188 Regulation of Stroke Volume, 363

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Topic 6: Energy and Matter	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS6-1AR Construct and revise an explanation based on evidence for the cycling of matter and flow of energy among body systems and their associated processes.	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 11.1d Physiology of the Heart, 359-365 11.2c Physiology of Circulation, 374-383 Short Answer Essay, #21, 391 12.1 Lymphatic Vessels, 393-394 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 13.2c External Respiration, Gas Transport, and Internal Respiration, 445-448 Did You Get It?, 448 Short Answer Essay, #9, 459 Carbohydrate Metabolism, 488-490 16.4c Uterine (Menstrual) Cycle, 556 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart
Disciplinary Core Ideas	
LS1.C: Organization for Matter and Energy Flow in Organisms	
The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (Performance Expectation HAP-LS6-1AR)	**SE:** Carbohydrates, 42-43 Lipids, 43-45 Proteins, 47-51 Nucleic Acids, 51-54 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration; Protein Synthesis

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As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (Performance Expectation HAP-LS6-1AR)	**SE:** 2.1a Matter, 23-24 2.1b Energy, 24-25 2.4b Patterns of Chemical Reactions, 35-37 14.4a Carbohydrate, Fat, and Protein Metabolism in Body Cells, 488-491 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (Performance Expectation HAP-LS6-1AR)	**SE:** Carbohydrate Metabolism, 488-490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
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 world(s).	
Use a model to provide mechanistic accounts of phenomena. (Performance Expectation HAP-LS6-1AR)	**SE:** Figure 6.10 Methods of regenerating ATP during muscle activity, 190 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Short Answer Essay, #20, #21, 391 Figure 12.1 Relationship of lymphatic vessels to blood vessels, 393 Figure 13.10 Gas exchanges in external and internal respiration, 446 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Figure 14.20 The formation of ATP in the cytosol and the mitochondria during cellular respiration, 489 Figure 14.21 Energy release in the electron transport chain, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart; IP Animation: Gas Exchange

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Analyzing and Interpreting Data	
Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	
Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (Performance Expectation HAP-LS6-1AR)	For related content, please see: **SE:** Figure 6.10 Methods of regenerating ATP during muscle activity, 190 Did You Get It?, 190 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 12.3 Relationship of lymphatic vessels to blood vessels, 393 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 Figure 13.10 Gas exchanges in external and internal respiration, 446 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Did You Get It?, 448 Figure 14.20 The formation of ATP in the cytosol and the mitochondria during cellular respiration, 489 Figure 14.21 Energy release in the electron transport chain, 490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart; IP Animation: Gas Exchange

Arkansas Science Standards 2016 Human Anatomy & Physiology	**Essentials of Human Anatomy 13th Edition, ©2022**
Analyze data using computational models in order to make valid and reliable scientific claims. (Performance Expectation HAP-LS6-1AR)	**SE:** Figure 6.10 Methods of regenerating ATP during muscle activity, 190 Did You Get It?, 190 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 12.3 Relationship of lymphatic vessels to blood vessels, 393 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 Figure 13.10 Gas exchanges in external and internal respiration, 446 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Did You Get It?, 448 Figure 14.20 The formation of ATP in the cytosol and the mitochondria during cellular respiration, 489 Figure 14.21 Energy release in the electron transport chain, 490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart; IP Animation: Gas Exchange
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. (Performance Expectation HAP-LS6-1AR)	**SE:** A Closer Look: Atherosclerosis? Get Out the Cardiovascular Plumber's Snake!, 381
Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation HAP-LS6-1AR)	**SE:** A Closer Look: Atherosclerosis? Get Out the Cardiovascular Plumber's Snake!, 381

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Obtaining, Evaluating, and Communicating Information	
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (Performance Expectation HAP-LS6-1AR)	**SE:** Did You Get It?, 25 Did You Get It?, 190 Short Answer Essay, #20, #21, 391 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 Did You Get It?, 448 Short Answer Essay, #9, 459 Did You Get It?, 490
Connections to Nature of Science	
Scientific Investigations Use a Variety of Methods	
Science investigations use diverse methods and do not always use the same set of procedures to obtain data. (Performance Expectation HAP-LS6-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Studying the Effect of Blood Vessel Radius on Blood Flow Rate; Studying the Effect of Blood Viscosity on Blood Flow Rate; Studying the Effect of Blood Vessel Length on Blood Flow Rate; Studying the Effect of Blood Pressure on Blood Flow Rate
New technologies advance scientific knowledge. (Performance Expectation HAP-LS6-1AR)	**SE:** A Closer Look: Electrocardiography: (Don't) Be Still My Heart, 362 **Mastering® A&P Digital Resources:** **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 1: Student Activities, #16
Scientific Knowledge is Based on Empirical Evidence	
Science knowledge is based on empirical evidence. (Performance Expectation HAP-LS6-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #29, 391
Science arguments are strengthened by multiple lines of evidence supporting a single explanation. (Performance Expectation HAP-LS6-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #23, #24, 431

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Crosscutting Concepts	
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS6-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #29, 391 Critical Thinking and Clinical Application Questions, #23, 431 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Studying the Effect of Blood Vessel Radius on Blood Flow Rate; Studying the Effect of Blood Viscosity on Blood Flow Rate; Studying the Effect of Blood Vessel Length on Blood Flow Rate; Studying the Effect of Blood Pressure on Blood Flow Rate
Stability and Change	
Feedback (negative or positive) can stabilize or destabilize a system. (Performance Expectation HAP-LS6-1AR)	**SE:** 1.5b Feedback Mechanisms, 19-20 Homeostatic Imbalance 11.6, 365 Homeostatic Imbalance 11.8, 380 Homeostatic Imbalance 11.9, 380-382 Homeostatic Imbalance 12.1, 396 Homeostatic Imbalance 13.9, 447 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis
Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (Performance Expectation HAP-LS6-1AR)	**SE:** Intrinsic Conduction System of the Heart: Setting the Basic Rhythm, 359-360 Cardiac Cycle and Heart Sounds, 360-362 Cardiac Output, 363-365 Arterial Pulse, 375 Figure 13.8 Changes in (a) intrapulmonary pressure and (b) air flow during inspiration and expiration, 443 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>Studying the Effect of Blood Vessel Radius on Blood Flow Rate; Studying the Effect of Blood Viscosity on Blood Flow Rate; Studying the Effect of Blood Vessel Length on Blood Flow Rate; Studying the Effect of Blood Pressure on Blood Flow Rate

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Energy and Matter	
Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (Performance Expectation HAP-LS6-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 11.2c Physiology of Circulation, 374-383 Did You Get It?, 383 Short Answer Essay, #21, 391 12.1 Lymphatic Vessels, 393-394 Did You Get It?, 394 Critical Thinking and Clinical Application Questions, #24, 431 Figure 13.10 Gas exchanges in external and internal respiration, 446 Figure 13.11 The loading and unloading of oxygen (O2) and carbon dioxide (CO2) in the body, 447 Did You Get It?, 448 Figure 14.20 The formation of ATP in the cytosol and the mitochondria during cellular respiration, 489 Figure 14.21 Energy release in the electron transport chain, 490 Did You Get It?, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart

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Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (Performance Expectation HAP-LS6-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 14.21 Energy release in the electron transport chain, 490 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Cellular Respiration >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
The total amount of energy and matter in closed systems is conserved. (Performance Expectation HAP-LS6-1AR)	**SE:** 2.1b Energy, 24-25
Energy drives the cycling of matter within and between systems. (Performance Expectation HAP-LS6-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Mitochondria, 65 Carbohydrate Metabolism, 488-490

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Topic 7: Systems and System Models	
Students who demonstrate understanding can:	
Performance Expectation HAP-LS7-1AR Develop and use a model to illustrate the interactions between systems that control or affect specific functions within the human body.	**SE:** Systems in Sync, 125 Systems in Sync, 172 Systems in Sync, 215 Systems in Sync, 266 Systems in Sync, 325 Systems in Sync, 386 Systems in Sync, 426 Systems in Sync, 454 Systems in Sync, 501 Systems in Sync, 534 Systems in Sync, 572 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle
Disciplinary Core Ideas	
LS1.A: Structure and Function	
Systems of specialized cells within organisms help them perform the essential functions of life. (Performance Expectation HAP-LS7-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.3a Necessary Life Functions, 7-9 3.2e Cell Diversity, 72-74 3.6 Muscle Tissue, 96-98 7.2a Supporting Cells, 222-224 7.2b Neurons, 224-229 Short Answer Essay, #15, 271 12.5b Cells of the Adaptive Defense System: An Overview, 406-408 Short Answer Essay, #19, 430 16.3a Ovaries, 549

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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. (Performance Expectation HAP-LS7-1AR)	**SE:** 3.2b The Nucleus, 63-64 3.3c Protein Synthesis, 83-86 Short Answer Essay, #16, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Protein Synthesis **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 3: Student Activities, #10
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. (Performance Expectation HAP-LS7-1AR)	**SE:** 1.2a From Atoms to Organisms, 2-3 1.2b Organ System Overview, 3-7 Short Answer Essay, #10, 22 3.4 Epithelial Tissue, 86-91 3.5 Connective Tissue, 91-96 3.6 Muscle Tissue, 96-98 3.7 Nervous Tissue, 98 Short Answer Essay, #18, 105 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Tissues

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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. (Performance Expectation HAP-LS7-1AR)	**SE:** 1.5a Components of Homeostatic Control Systems, 18-19 1.5b Feedback Mechanisms, 19-20 Did You Get It?, 20 9.1c Stimuli for Control of Hormone Release, 305-306 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 Figure 16.22 Oxytocin promotes labor contractions during birth by a positive feedback mechanism, 568 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>BioFlix>Homeostasis >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Mechanisms to Control Acid-Base Homeostasis
LS1.D: Information Processing	
Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (Performance Expectation HAP-LS7-1AR)	**SE:** 7.2b Neurons, 224-229 7.2c Physiology: Nerve Impulses, 229-232 7.2d Physiology: Reflexes, 232-234 Systems in Sync, 267 Short Answer Essay, #16, 271 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>Propagation of an Action Potential

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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. (Performance Expectation HAP-LS7-1AR)	For supporting content, please see: **SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-416 Homeostatic Imbalance 12.4, 421-423 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570
Obtaining, Evaluating, and Communicating Information	
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (Performance Expectation HAP-LS7-1AR)	**SE:** Short Answer Essay, #13, 129 Short Answer Essay, #12, 218 Short Answer Essay, #16, 271 Short Answer Essay, #13, #18, 330 Short Answer Essay, #23, 391 Short Answer Essay, #16, 430 Short Answer Essay, #13, 459 Short Answer Essay, #18, 509 Short Answer Essay, #14, #17, #19, 538-539 Short Answer Essay, #18, #30, 578

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
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 world(s).	
Use a model to provide mechanistic accounts of phenomena. (Performance Expectation HAP-LS7-1AR)	**SE:** Systems in Sync, 125 Systems in Sync, 172 Systems in Sync, 215 Systems in Sync, 266 Systems in Sync, 325 Systems in Sync, 386 Systems in Sync, 426 Systems in Sync, 454 Systems in Sync, 501 Systems in Sync, 534 Systems in Sync, 572 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle
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.	
Create a computational model or simulation of a phenomenon, designed device, process, or system. (Performance Expectation HAP-LS7-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Frequency on Skeletal Muscle Contraction; Studying the Effect of Stroke Volume on Pump Activity; Examining the Effect of Temperature on Heart Rate; The Effect of Arteriole Radius on Glomerular Filtration; Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis

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Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (Performance Expectation HAP-LS7-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; Studying the Effect of Blood Vessel Length on Blood Flow Rate; Examining the Effects of Various Ions on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Hormones on Urine Formation; Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis
Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (Performance Expectation HAP-LS7-1AR)	**Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; Examining the Effect of Chemical Modifiers on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Arteriole Radius on Glomerular Filtration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation; Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis

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Crosscutting Concepts	
Cause and Effect	
Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (Performance Expectation HAP-LS7-1AR)	**SE:** Critical Thinking and Clinical Application Questions, #22, 301 9.2d Parathyroid Glands (Q/A), 313 Critical Thinking and Clinical Application Questions, #29, 391 Short Answer Essay, #16, 459 Critical Thinking and Clinical Application Questions, #19, 459 16.2b Testosterone Production (Q/A), 548 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; The Effect of Stimulus Frequency on Skeletal Muscle Contraction; Examining the Effect of Temperature on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation

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Systems and System Models	
When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (Performance Expectation HAP-LS7-1AR)	**SE:** Figure 1.9 The elements of a homeostatic control system, 19 Figure 7.21 Schematic of ascending (sensory) and descending (motor) pathways between the brain and the spinal cord, 250 Figure 9.2 Endocrine gland stimuli, 305 Figure 11.8 Summary of events occurring during the cardiac cycle, 361 Figure 11.9 Influence of selected factors on cardiac output, 364 Figure 11.21 Summary of factors that increase arterial blood pressure, 379 Figure 14.24 Mechanisms of body temperature regulation, 497 Figure 15.5 Sites of filtration, reabsorption, and secretion in a nephron, 518 Figure 15.11 The thirst mechanism for regulating water intake, 526 Figure 15.12 Flowchart of mechanisms regulating sodium ion and water balance to help maintain blood pressure homeostasis, 528 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>PhysioEx>Exercises>The Effect of Stimulus Voltage on Skeletal Muscle Contraction; Examining the Effect of Chemical Modifiers on Heart Rate; Effect of Surfactant and Intrapleural Pressure on Respiration; The Effect of Arteriole Radius on Glomerular Filtration; The Effect of Pressure on Glomerular Filtration; The Effect of Hormones on Urine Formation; Renal Responses to Respiratory Acidosis and Respiratory Alkalosis; Respiratory Responses to Metabolic Acidosis and Metabolic Alkalosis

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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. (Performance Expectation HAP-LS7-1AR)	**SE:** Systems in Sync, 125 Systems in Sync, 172 Systems in Sync, 215 Systems in Sync, 266 Systems in Sync, 325 Systems in Sync, 386 Systems in Sync, 426 Systems in Sync, 454 Systems in Sync, 501 Systems in Sync, 534 Systems in Sync, 572 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Animations & Videos>A&P Flix>A&P 3D Animations>Events at the Neuromuscular Junction; Excitation-Contraction Coupling; The Cross Bridge Cycle
Energy and Matter	
Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (Performance Expectation HAP-LS7-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 11.9 Influence of selected factors on cardiac output, 364 Figure 15.5 Sites of filtration, reabsorption, and secretion in a nephron, 518 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism; IP Animation: Pathway of Blood through the Heart

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Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (Performance Expectation HAP-LS7-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Providing Energy for Muscle Contraction, 188-190 Did You Get It?, 190 Figure 14.21 Energy release in the electron transport chain, 490 14.4c Body Energy Balance, 494-498 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Interactive Physiology (IP)>IP Animation: Muscle Metabolism
The total amount of energy and matter in closed systems is conserved. (Performance Expectation HAP-LS7-1AR)	**SE:** 2.1b Energy, 24-25
Energy drives the cycling of matter within and between systems. (Performance Expectation HAP-LS7-1AR)	**SE:** 2.1b Energy, 24-25 Did You Get It?, 25 Mitochondria, 66 Carbohydrate Metabolism, 488-490
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. (Performance Expectation HAP-LS7-1AR)	**SE:** Systems in Sync, 125 Systems in Sync, 172 Systems in Sync, 215 Systems in Sync, 266 Systems in Sync, 325 Systems in Sync, 386 Systems in Sync, 426 Systems in Sync, 454 Systems in Sync, 501 Systems in Sync, 534 Systems in Sync, 572 **Mastering® A&P Digital Resources:** **Study Area** >Launch the Study Area>Practice Anatomy Lab (PAL)>Anatomical Models

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Connections to Nature of Science	
Science is a Human Endeavor	
Science is a result of human endeavors, imagination, and creativity. (Performance Expectation HAP-LS7-1AR)	**SE:** A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570
Science Addresses Questions About the Natural and Material World	
Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (Performance Expectation HAP-LS7-1AR)	**SE:** A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 12: Student Activities, #3
Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (Performance Expectation HAP-LS7-1AR)	**SE:** A Closer Look: Anabolic Steroids: Dying to Win?, 201 A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 12: Student Activities, #3
Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (Performance Expectation HAP-LS7-1AR)	**SE:** A Closer Look: The "Terrible Three", 246-247

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Topic 8: Career Exploration with Engineering Practices	
Students who demonstrate understanding can:	
Performance Expectation HAP-8-1AR Obtain, evaluate, and communicate information related to health science professions.	**SE:** Focus on Careers: Pharmacy Technician, 53 Focus on Careers: Medical Transcriptionist, 124 Focus on Careers: Radiologic Technologist, 139 Focus on Careers: Physical Therapy Assistant, 291 Focus on Careers: Phlebotomy Technician, 345 Focus on Careers: Licensed Practical Nurse (LPN), 532
Science and Engineering Practices	
Obtaining, Evaluating, and Communicating Information	
Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	
Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (Performance Expectation HAP-8-1AR)	This objective falls outside the scope of this program. For supporting content, please see: **SE:** Focus on Careers: Pharmacy Technician, 53 Focus on Careers: Medical Transcriptionist, 124 Focus on Careers: Radiologic Technologist, 139 Focus on Careers: Physical Therapy Assistant, 291 Focus on Careers: Phlebotomy Technician, 345 Focus on Careers: Licensed Practical Nurse (LPN), 532
Connections to Nature of Science	
Science is a Human Endeavor	
Science is a result of human endeavors, imagination, and creativity. (Performance Expectation HAP-8-1AR)	**SE:** A Closer Look: Medical Imaging: Illuminating the Body, 10-11 A Closer Look: A Wrinkle Out of Time, 114 A Closer Look: Joint Ventures, 162 A Closer Look: Tracking Down CNS Problems, 265 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570

Arkansas Science Standards 2016 Human Anatomy & Physiology	Essentials of Human Anatomy 13th Edition, ©2022
Science Addresses Questions About the Natural and Material World	
Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (Performance Expectation HAP-8-1AR)	**SE:** A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 12: Student Activities, #3
Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (Performance Expectation HAP-8-1AR)	**SE:** A Closer Look: Anabolic Steroids: Dying to Win?, 201 A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 12: Student Activities, #3
Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (Performance Expectation HAP-8-1AR)	**SE:** A Closer Look: The "Terrible Three", 246-247
Performance Expectation HAP-8-2AR Design a solution to a complex real-world problem affecting body systems that can be solved through engineering.	For supporting content, please see: **SE:** A Closer Look: Joint Ventures, 162 **Mastering® A&P Digital Resources: Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2

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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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For related content, please see: **SE:** A Closer Look: Joint Ventures, 162 **Mastering® A&P Digital Resources:** **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: Joint Ventures, 162 A Closer Look: COVID-19: A Global Pandemic, 418-419 Homeostatic Imbalance 12.4, 421-423 A Closer Look: AIDS: An Ongoing Pandemic, 424-425
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: The “Terrible Three”, 246-247
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: Joint Ventures, 162

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Science and Engineering Practices	
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 knowledge, 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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**Mastering® A&P Digital Resources:** **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2
Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For supporting content, please see: **SE:** A Closer Look: Joint Ventures, 162 A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources:** **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2
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 (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For supporting content, please see: **SE:** A Closer Look: Joint Ventures, 162 A Closer Look: The "Terrible Three", 246-247 **Mastering® A&P Digital Resources:** **Instructor Resources** >Launch the Instructor Resources>Instructor Guide>Instructor Manual>Chapter 4: Media, #2

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Performance Expectation HAP-8-3AR Evaluate a solution to a complex real-world human health 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.	**SE:** Critical Thinking and Clinical Application Questions, #24, 105 A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For related content, please see: **SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: COVID-19: A Global Pandemic, 418-419 Homeostatic Imbalance 12.4, 421-423 A Closer Look: AIDS: An Ongoing Pandemic, 424-425

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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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: Contraception: Preventing Pregnancy, 570
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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	**SE:** A Closer Look: Joint Ventures, 162
Science and Engineering Practices	
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 knowledge, 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. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For supporting content, please see: **SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570

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Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For supporting content, please see: **SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570
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 (Performance Expectation HAP-8-2AR, Performance Expectation HAP-8-3AR)	For supporting content, please see: **SE:** A Closer Look: The "Terrible Three", 246-247 A Closer Look: COVID-19: A Global Pandemic, 418-419 A Closer Look: AIDS: An Ongoing Pandemic, 424-425 A Closer Look: Renal Failure and the Artificial Kidney, 523 A Closer Look: Contraception: Preventing Pregnancy, 570

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