

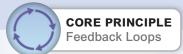
Human Anatomy & Physiology



# **Quick Reference**

### **CORE PRINCIPLES in A&P**

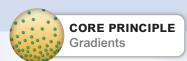
introduced in chapter one and referenced throughout this book:



Feedback loops are homeostatic control mechanisms in which a change in a regulated variable causes effects that *feed back* and in turn affect that same variable.



The form of a structure best suits its function.



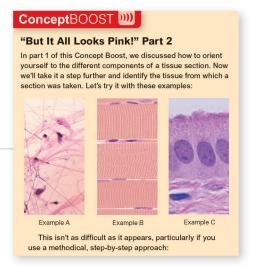
A gradient is present any time more of something exists in one area than in another and the two areas are connected.



Cells in the body generally communicate via electrical signals or chemical messengers to coordinate functions in the body.

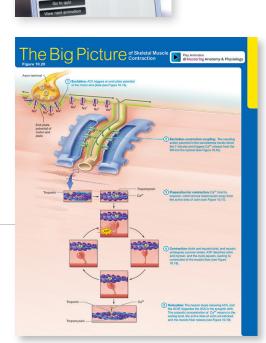
# Amerman guides you every step of the way with...

# **Coaching** that clarifies tough concepts



Big Picture
Animations that bring
Big Picture Figures
to life and help
reinforce key ideas





# **Human Anatomy & Physiology, Global Edition**

# **Table of Contents**

$\sim$	_		_	
( ,	D	v	е	r

Title Page

Copyright Page

About the Author

About the Media Author

**Preface** 

Acknowledgments

**Brief Contents** 

### Contents

# 1. Introduction to Anatomy and Physiology

### 1.1. How to Succeed in Your Anatomy and Physiology Course

How to Develop Study Skills

How to Make the Best Use of Class and Lab Time

How to Use This Book and Its Associated Materials

### 1.2. Overview of Anatomy and Physiology

Characteristics of Living Organisms

Levels of Structural Organization and Body Systems

Types of Anatomy and Physiology

### 1.3. The Language of Anatomy and Physiology

The Anatomical Position and Directional Terms

Regional Terms

Planes of Section

### 1.4. The Organization of the Human Body

The Posterior Body Cavity

The Anterior Body Cavity

### 1.5. Core Principles in Anatomy and Physiology

Overall Theme: Physiological Processes Operate to Maintain the Bodys Homeostasis

Core Principle One: Feedback Loops Are a Key Mechanism Used to Maintain Homeostasis

Core Principle Two: Structure and Function Are Related at All Levels of Organization

Core Principle Three: Gradients Drive Many Physiological Processes



Core Principle Four: Cell-Cell Communication Is Required to Coordinate Body Functions

Concept Boost: Putting Anatomical Terms Together

Concept Boost: Debunking Some Common Misconceptions about Homeostasis

A&P in the Real World: Medical Errors
A&P in the Real World: Abdominal Pain
A&P in the Real World: Medical Imaging

A&P in the Real World: Childbirth, Pitocin, and Positive Feedback Loops

# 2. The Chemistry of Life

### 2.1. Atoms and Elements

Atoms and Atomic Structure

Elements in the Periodic Table and the Human Body

Isotopes and Radioactivity

### 2.2. Matter Combined: Mixtures and Chemical Bonds

Mixtures

**Chemical Bonds** 

Ions and Ionic Bonds

Covalent Bonds

### 2.3. Chemical Reactions

**Chemical Notation** 

**Energy and Chemical Reactions** 

Homeostasis and Types of Chemical Reactions

Reaction Rates and Enzymes

### 2.4. Inorganic Compounds: Water, Acids, Bases, and Salts

Water

Acids and Bases

Salts and Electrolytes

### 2.5. Organic Compounds: Carbohydrates, Lipids, Proteins, and Nucleotides

Monomers and Polymers

Carbohydrates

Lipids

**Proteins** 

Nucleotides and Nucleic Acids

Concept Boost: Determining the Type of Bonds in a Molecule or Compound

Concept Boost: Making Sense of the pH Scale A&P in the Real World: Nuclear Medicine

A&P in the Real World: Enzyme Deficiencies



A&P in the Real World: The Good, the Bad, and the Ugly of Fatty Acids

### 3. The Cell

### 3.1. Introduction to Cells

Basic Processes of Cells

Overview of Cell Structure

Cell Size and Diversity

### 3.2. Structure of the Plasma Membrane

The Phospholipid Bilayer

The Fluid Mosaic Model of the Plasma Membrane

### 3.3. Transport across the Plasma Membrane

**Passive Transport Processes** 

Active Transport via Membrane Proteins

Consequences of Ion Transport across the Plasma Membrane: Introduction to Electrophysiology

Active Transport via Vesicles

### 3.4. Cytoplasmic Organelles

Mitochondria

Peroxisomes

Ribosomes

The Endomembrane System

### 3.5. The Cytoskeleton

Types of Filaments

Cellular Extensions

### 3.6. The Nucleus

Nuclear Envelope

Chromatin and Chromosomes

Nucleoli

### 3.7. Protein Synthesis

Genes and the Genetic Code

Transcription

Translation

Putting It All Together: The Big Picture of Protein Synthesis

Regulation of Gene Expression

### 3.8. The Cell Cycle

Phases of the Cell Cycle

Cell Cycle Control and Cancer

Study Boost: Comparing Diffusion and Osmosis



Concept Boost: Is Osmosis the Diffusion of Water? Taking a Closer Look

Concept Boost: Connecting a DNA Triplet to a Particular Amino Acid

The Big Picture of Protein Synthesis

A&P in the Real World: Drugs and Membrane Receptors

A&P in the Real World: Dehydration, Sports Drinks, and Water

A&P in the Real World: Cystic Fibrosis

A&P in the Real World: Lysosomal Storage Diseases

A&P in the Real World: Primary Ciliary Dyskinesia

A&P in the Real World: Toxicity of the Death Cap Mushroom

A&P in the Real World: Spindle Poisons

# 4. Histology

### 4.1. Introduction to Tissues

Types of Tissues

The Extracellular Matrix

**Cell Junctions** 

### 4.2. Epithelial Tissues

Components and Classification of Epithelia

Covering and Lining Epithelia

Glandular Epithelia

### 4.3. Connective Tissues

Connective Tissue Proper

Specialized Connective Tissues

### 4.4. Muscle Tissues

Components of Muscle Tissue

Types of Muscle Tissue

### 4.5. Nervous Tissue

### 4.6. Putting It All Together: The Big Picture of Tissues in Organs

### 4.7. Membranes

True Membranes

Membrane-like Structures

### 4.8. Tissue Repair

Capacity of Specific Tissues for Tissue Repair

Other Factors Affecting Tissue Repair

Concept Boost: But It All Looks Pink! Part 1

Concept Boost: But It All Looks Pink! Part 2

The Big Picture of Tissues in Organs



A&P in the Real World: Marfan Syndrome

A&P in the Real World: Carcinogens and Epithelial Tissues

A&P in the Real World: Adipose Tissue and Obesity

A&P in the Real World: Osteoarthritis and Glucosamine Supplements

A&P in the Real World: Friction Rubs

# 5. The Integumentary System

# 5.1. Overview of the Integumentary System

Skin Structure

Functions of the Integumentary System

### 5.2. The Epidermis

Keratinocytes

Other Cells of the Epidermis

Thick and Thin Skin

### 5.3. The Dermis

Papillary Layer

Reticular Layer

Skin Markings

### 5.4. Skin Pigmentation

Melanin

Other Pigments That Affect Skin Color: Carotene and Hemoglobin

Skin Color as a Diagnostic Tool

### 5.5. Accessory Structures of the Integument: Hair, Nails, and Glands

Hair

Nails

Glands

### 5.6. Pathology of the Skin

Burns

Skin Cancer

Study Boost: Remembering the Strata of the Epidermis

Concept Boost: Understanding Epidermal Growth

A&P in the Real World: Cellulite

A&P in the Real World: Topical Medications

A&P in the Real World: Skin Wrinkles

A&P in the Real World: Pseudoscience Exposed: Tanning and a Healthy Tan

A&P in the Real World: Acne

### 6. Bones and Bone Tissue



### 6.1. Introduction to Bones as Organs

Functions of the Skeletal System

Bone Structure

### 6.2. Microscopic Structure of Bone Tissue

The Extracellular Matrix of Bone

Bone Cells

Histology of Bone Tissue

### 6.3. Bone Formation: Ossification

Intramembranous Ossification

**Endochondral Ossification** 

### 6.4. Bone Growth in Length and Width

Growth in Length

Growth in Width

The Role of Hormones in Bone Growth

### 6.5. Bone Remodeling and Repair

Bone Remodeling

Bone Repair

A&P in the Real World: Bone Marrow Transplantation

A&P in the Real World: Osteopetrosis

A&P in the Real World: Osteoporosis and Healthy Bone Tissue

A&P in the Real World: Achondroplasia

A&P in the Real World: Gigantism and Acromegaly

# 7. The Skeletal System

### 7.1. Overview of the Skeletal System

Structure of the Skeleton and Skeletal Cartilages

Bone Markings

### 7.2. The Skull

Overview of Skull Structure

Cavities of the Skull

Fetal Skull

Hyoid Bone

### 7.3. The Vertebral Column and Thoracic Cage

Overview of the Vertebral Column

Structure of the Vertebrae

Intervertebral Discs

The Thoracic Cage



### 7.4. Bones of the Pectoral Girdle and Upper Limb

The Pectoral Girdle

The Humerus

Bones of the Forearm: The Radius and Ulna

Bones of the Wrist: Carpals

Bones of the Hand and Fingers: Metacarpals and Phalanges

### 7.5. Bones of the Pelvic Girdle and Lower Limb

The Pelvis and Bones of the Pelvic Girdle

The Femur and Patella

Bones of the Leg: The Tibia and Fibula

Bones of the Ankle and Foot: The Tarsals, Metatarsals, and Phalanges

Study Boost: Remembering Skull Bones and Vertebrae

Study Boost: Remembering Bones of the Upper and Lower Limbs

Concept Boost: Understanding How Skull Bones Relate to One Another

A&P in the Real World: Forensic Skull Anatomy

A&P in the Real World: Vertebral Compression Fractures

A&P in the Real World: Herniated Disc

A&P in the Real World: The Sternum and CPR

A&P in the Real World: Wrist Fractures

# 8. Articulations

### 8.1. Overview of Joints

**Functions of Joints** 

Classes of Joints

### 8.2. Fibrous and Cartilaginous Joints

Fibrous Joints

Cartilaginous Joints

### 8.3. Structure of Synovial Joints

The Joint Cavity

Stabilizing and Supportive Structures

**Arthritis** 

### 8.4. Function of Synovial Joints

Functional Classes of Synovial Joints

Movements at Synovial Joints

Range of Motion

### 8.5. Types of Synovial Joints

Structural Classes of Synovial Joints



Putting It All Together: The Big Picture of Joint Classifications and Stability versus Mobility

Specific Hinge Joints: The Elbow and the Knee

Specific Ball-and-Socket Joints: The Shoulder and the Hip Study Boost: Keeping Synovial Joint Movements Straight

Concept Boost: Understanding Axes of Motion

The Big Picture of Joint Classifications and Stability versus Mobility

A&P in the Real World: Epiphyseal Plate Fractures

A&P in the Real World: Bursitis

A&P in the Real World: Knee Injuries and the Unhappy Triad

A&P in the Real World: Shoulder Dislocations

A&P in the Real World: Hip Joint Replacement Surgery

# 9. The Muscular System

### 9.1. Overview of Skeletal Muscles

Structure of Skeletal Muscles

Naming Muscles

Functions of Skeletal Muscles

Studying Muscles

### 9.2. Muscles of the Head, Neck, and Vertebral Column

Muscles of Facial Expression

Extrinsic Eye Muscles

Muscles of the Head and Neck

Muscles of the Vertebral Column

### 9.3. Muscles of the Trunk and Pelvic Floor

Muscles of Ventilation

**Abdominal Muscles** 

Muscles of the Pelvic Diaphragm, Urogenital Diaphragm, and Perineum

### 9.4. Muscles of the Pectoral Girdle and Upper Limb

Muscles That Move the Scapula at the Pectoral Girdle

Muscles That Move the Arm at the Shoulder Joint

Muscles That Move the Forearm and Hand

### 9.5. Muscles of the Hip and Lower Limb

Muscles of the Hip, Thigh, Knee, and Leg

Muscles of the Ankle, Foot, and Toes

### 9.6. Putting It All Together: The Big Picture of Muscle Movement

Study Boost: How to Tell the Three Types of Levers Apart

Concept Boost: Demystifying Muscle Actions



The Big Picture of Muscle Movement

A&P in the Real World: Muscle Knots

A&P in the Real World: Urinary Incontinence and Kegel Exercises

A&P in the Real World: Rotator Cuff Injuries

A&P in the Real World: Calcaneal Tendon Injuries

# 10. Muscle Tissue and Physiology

### 10.1. Overview of Muscle Tissue

Types of Muscle Tissue

Properties of Muscle Cells

Structure of Muscle Cells

### 10.2. Structure and Function of Skeletal Muscle Fibers

Structure of the Skeletal Muscle Fiber

Structure of the Myofibril

Myofilament Arrangement and the Sarcomere

Putting It All Together: The Big Picture of Skeletal Muscle Structure

The Sliding-Filament Mechanism of Contraction

### 10.3. Skeletal Muscle Fibers as Electrically Excitable Cells

Membrane Potentials in Our Cells

**Action Potentials** 

### 10.4. The Process of Skeletal Muscle Contraction and Relaxation

The Neuromuscular Junction

Skeletal Muscle Contraction

Muscle Relaxation

Putting It All Together: The Big Picture of Skeletal Muscle Contraction and Relaxation

### 10.5. Energy Sources for Skeletal Muscle

Glycolytic Energy Sources

Oxidative Energy Sources

### 10.6. Muscle Tension at the Fiber Level

**Twitch Contraction** 

Tension Production and the Timing and Frequency of Stimulation

The Length-Tension Relationship

Classes of Skeletal Muscle Fibers

### 10.7. Muscle Tension at the Organ Level

Motor Units

### 10.8. Skeletal Muscle Performance

Changes Caused by Physical Training



Muscular Fatigue

Excess Postexercise Oxygen Consumption and the Recovery Period

### 10.9. Smooth and Cardiac Muscle

Smooth Muscle

Cardiac Muscle

Study Boost: Remembering the Bands of the Sarcomere

Concept Boost: How Do Positive Ions Create a Negative Resting Membrane Potential?

Concept Boost: Linking a Crossbridge Cycle to the Sliding-Filament Mechanism

The Big Picture of Levels of Organization within a Skeletal Muscle

The Big Picture of Skeletal Muscle Contraction

A&P in the Real World: Duchenne Muscular Dystrophy

A&P in the Real World: Rigor Mortis

A&P in the Real World: Pseudoscience Exposed: Creatine Supplementation

A&P in the Real World: Botulism and BOTOX

A&P in the Real World: Delayed-Onset Muscle Soreness

### Introduction to the Nervous System and Nervous Tissue

### 11.1. Overview of the Nervous System

Structural Divisions of the Nervous System

Functional Divisions of the Nervous System

### 11.2. Nervous Tissue

Neurons

Neuroglia

The Myelin Sheath

Regeneration of Nervous Tissue

### 11.3. Electrophysiology of Neurons

Principles of Electrophysiology

Local Potentials

**Action Potentials** 

The Refractory Period

Local and Action Potentials Compared

**Propagation of Action Potentials** 

Putting It All Together: The Big Picture of Action Potentials

### 11.4. Neuronal Synapses

Overview of Neuronal Synapses

**Electrical Synapses** 

Chemical Synapses



Putting It All Together: The Big Picture of Chemical Synaptic Transmission

### 11.5. Neurotransmitters

Neurotransmitter Receptors

Major Neurotransmitters

Neuromodulation

### 11.6. Functional Groups of Neurons

**Neuronal Pools** 

**Neural Circuits** 

Concept Boost: How Does Myelin Insulate an Axon and Increase Its Speed of Propagation?

Concept Boost: Sorting Out the Different Types of Channels and Pumps in the Membrane of a Neuron

The Big Picture of Action Potentials

The Big Picture of Chemical Synaptic Transmission

A&P in the Real World: Poliovirus and Retrograde Axonal Transport

A&P in the Real World: Gliomas and Astrocytomas

A&P in the Real World: Local Anesthetic Drugs

A&P in the Real World: Multiple Sclerosis

A&P in the Real World: Arthropod Venom

A&P in the Real World: Psychiatric Disorders and Treatments

A&P in the Real World: Epileptic Seizures

# 12. The Central Nervous System

### 12.1. Overview of the Central Nervous System

Overview of CNS Functions

Basic Structure of the Brain and Spinal Cord

Overview of CNS Development

### 12.2. The Brain

The Cerebrum

The Diencephalon

The Cerebellum

The Brainstem

Putting It All Together: The Big Picture of Major Brain Structures and Their Functions

### 12.3. Homeostasis Part I: Role of the Brain in Maintenance of Homeostasis

Homeostasis of Vital Functions

Body Temperature and Feeding

Sleep and Wakefulness

### 12.4. Higher Mental Functions



Cognition and Language

Learning and Memory

**Emotion** 

### 12.5. Protection of the Brain

The Cranial Meninges

The Ventricles and Cerebrospinal Fluid

The Blood Brain Barrier

### 12.6. The Spinal Cord

Protection of the Spinal Cord

External Spinal Cord Anatomy

Internal Spinal Cord Anatomy

### 12.7. Sensation Part I: Role of the CNS in Sensation

General Somatic Senses

Introduction to the Special Senses

### 12.8. Movement Part I: Role of the CNS in Voluntary Movement

Motor Pathways from the Brain through the Spinal Cord

Role of the Brain in Voluntary Movement

Putting It All Together: The Big Picture of CNS Control of Voluntary Movement

Concept Boost: Where Exactly Is the Blood Brain Barrier?

The Big Picture of Brain Anatomy

The Big Picture of Major Brain Structures and Their Functions

The Big Picture of CNS Control of Voluntary Movement

A&P in the Real World: Pseudoscience Exposed: The Myth of Brain Differences between the Sexes

A&P in the Real World: Locked-In Syndrome

A&P in the Real World: Fever

A&P in the Real World: States of Altered Consciousness Mimicking Sleep

A&P in the Real World: Dementia

A&P in the Real World: Aphasias

A&P in the Real World: Infectious Meningitis

A&P in the Real World: Epidural Anesthesia and Lumbar Punctures

A&P in the Real World: Phantom Limb Pain
A&P in the Real World: Parkinsons Disease

# 13. The Peripheral Nervous System

### 13.1. Overview of the Peripheral Nervous System

Divisions of the PNS

Overview of Peripheral Nerves and Associated Ganglia



Functional Overview of the PNS

### 13.2. The Cranial Nerves

The Sensory Cranial Nerves

The Motor Cranial Nerves

The Mixed Cranial Nerves

### 13.3. The Spinal Nerves

Structure of Spinal Nerves and Spinal Nerve Plexuses

Cervical Plexuses

**Brachial Plexuses** 

**Thoracic Spinal Nerves** 

**Lumbar Plexuses** 

Sacral Plexuses

Summary of the Distribution of Spinal Nerve Branches

### 13.4. Sensation Part II: Role of the PNS in Sensation

Sensory Receptors

Sensory Neurons

Putting It All Together: The Big Picture of the Detection and Perception of Somatic Sensation by the Nervous

### 13.5. Movement Part II: Role of the PNS in Movement

From CNS to PNS: Motor Output
The Role of Lower Motor Neurons

Putting It All Together: The Big Picture of Control of Movement by the Nervous System

### 13.6. Reflex Arcs: Integration of Sensory and Motor Function

Reflex Arcs

The Role of Stretch Receptors in Skeletal Muscles

Types of Reflexes

Sensory and Motor Neuron Disorders

Study Boost: Remembering the Cranial Nerves Concept Boost: Sorting Out the Brachial Plexus

The Big Picture of Detection and Interpretation of Somatic Sensation by the Nervous System

The Big Picture of Control of Movement by the Nervous System

A&P in the Real World: Trigeminal Neuralgia

A&P in the Real World: Bells Palsy

A&P in the Real World: A Hiccups Cure That Really Works

A&P in the Real World: Capsaicin

A&P in the Real World: Amyotrophic Lateral Sclerosis

# 14. The Autonomic Nervous System and Homeostasis



### 14.1. Overview of the Autonomic Nervous System

Functions of the ANS and Visceral Reflex Arcs

Comparison of Somatic and Autonomic Nervous Systems

Divisions of the ANS

### 14.2. The Sympathetic Nervous System

Gross and Microscopic Anatomy of the Sympathetic Nervous System

Sympathetic Neurotransmitters and Receptors

Effects of the Sympathetic Nervous System on Target Cells

Pharmacology and Sympathetic Nervous System Receptors

### 14.3. The Parasympathetic Nervous System

Gross and Microscopic Anatomy of the Parasympathetic Nervous System

Parasympathetic Neurotransmitters and Receptors

Effects of the Parasympathetic Nervous System on Target Cells

### 14.4. Homeostasis Part II: PNS Maintenance of Homeostasis

Interactions of Autonomic Divisions

**Autonomic Tone** 

Summary of Nervous System Control of Homeostasis

Study Boost: Remembering the Difference between Preganglionic and Postganglionic Neurons

Concept Boost: Understanding the Different Effects of the Sympathetic and Parasympathetic Nervous Systems

A&P in the Real World: Pseudoscience Exposed: The Sympathetic Nervous System and Weight Loss Supplements

A&P in the Real World: Side Effects of Anticholinergic Drugs

A&P in the Real World: Postural Orthostatic Tachycardia Syndrome

# 15. The Special Senses

### 15.1. Overview of the Special Senses

Comparison of the General and Special Senses

Sensory Transduction

### 15.2. Olfaction

Structures of Olfaction

Physiology of Olfaction

### 15.3. Gustation

Structures of Gustation: Taste Buds

Physiology of Gustation

The Gustatory Pathway

### 15.4. Anatomy of the Eye



Accessory Structures of the Eye

The Eyeball

### 15.5. Physiology of Vision

Principles of Light

Focusing Light on the Retina

Errors of Refraction: Presbyopia, Hyperopia, and Myopia

Photoreceptors and the Retina

The Visual Pathway

Putting It All Together: The Big Picture of Vision

### 15.6. Anatomy of the Ear

Outer Ear

Middle Ear

Inner Ear

### 15.7. Physiology of Hearing

Principles of Sound

Transmission of Sound to the Inner Ear

Processing of Sound in the Inner Ear

The Auditory Pathway

Hearing Loss

Putting It All Together: The Big Picture of Hearing

### 15.8. Vestibular Sensation

Utricle and Saccule: Static Equilibrium and Linear Acceleration

Semicircular Ducts: Rotational Equilibrium

The Vestibular Sensation Pathway

### 15.9. How the Special Senses Work Together

Concept Boost: Understanding Accommodation

Concept Boost: How Inertia Influences Movement of the Otolithic Membrane and Endolymph

The Big Picture of Vision
The Big Picture of Hearing

A&P in the Real World: Anosmia

A&P in the Real World: Cataracts

A&P in the Real World: Glaucoma

A&P in the Real World: Color Blindness

A&P in the Real World: Otitis Media

A&P in the Real World: Tinnitus

A&P in the Real World: Cochlear Implants

A&P in the Real World: Motion Sickness



# 16. The Endocrine System

### 16.1. Overview of the Endocrine System

Comparison of the Endocrine and Nervous Systems

Paracrine and Autocrine Signals

Overview of the Endocrine Organs

Hormones

Regulation of Hormone Secretion

### 16.2. The Hypothalamus and the Pituitary Gland

Structure of the Hypothalamus and Pituitary Gland

Hormones of the Hypothalamus and Posterior Pituitary

Functional Relationship of the Hypothalamus and Anterior Pituitary

### 16.3. The Thyroid and Parathyroid Glands

Structure of the Thyroid and Parathyroid Glands

Thyroid Hormones: Metabolic Regulators

Parathyroid Hormone and Calcitonin: Calcium Ion Homeostasis

### 16.4. The Adrenal Glands

Structure of the Adrenal Glands

Hormones of the Adrenal Cortex

Hormones of the Adrenal Medulla: Messengers of the Sympathetic Nervous System

### 16.5. The Endocrine Pancreas

Structure of the Pancreas

Hormones of the Endocrine Pancreas: Glucose Homeostasis

**Blood Glucose Regulation** 

### 16.6. Other Endocrine Glands and Hormone- Secreting Tissues

The Thymus: Thymosin and Thymopoietin

The Gonads: Sex Hormones
The Pineal Gland: Melatonin

Adipose Tissue: Leptin

The Heart: Atrial Natriuretic Peptide

The Kidneys: Erythropoietin

### 16.7. Three Examples of Endocrine Control of Physiological Variables

Hormonal Control of Fluid Homeostasis

Hormonal Control of Metabolic Homeostasis

Putting It All Together: The Big Picture of the Hormonal Response to Stress

Concept Boost: Understanding the Relationship between Negative Feedback Loops and Thyroid

**Function** 



The Big Picture of the Hormonal Response to Stress

A&P in the Real World: Paraneoplastic Syndrome

A&P in the Real World: Pseudoscience Exposed: Human Growth Hormone and the Fountain of

Youth

A&P in the Real World: Calcitonin, Parathyroid Hormone, and Osteoporosis

A&P in the Real World: HPA Axis Suppression and Corticosteroid Therapy

A&P in the Real World: Pseudoscience Exposed: Leptin and Obesity

# 17. The Cardiovascular System I: The Heart

### 17.1. Overview of the Heart

Location and Basic Structure of the Heart

Functions of the Heart

### 17.2. Heart Anatomy and Blood Flow Pathway

The Pericardium, Heart Wall, and Heart Skeleton

The Great Vessels, Chambers, and Valves of the Heart

Putting It All Together: The Big Picture of Blood Flow through the Heart

The Coronary Circulation

### 17.3. Cardiac Muscle Tissue Anatomy and Electrophysiology

Histology of Cardiac Muscle Tissue and Cells

Cardiac Electrophysiology: Pacemaker Cells and the Cardiac Conduction System

Cardiac Electrophysiology: Contractile Cells

The Electrocardiogram

### 17.4. Mechanical Physiology of the Heart: The Cardiac Cycle

The Relationship between Pressure Changes, Blood Flow, and Valve Function

**Heart Sounds** 

Events of the Cardiac Cycle

Connecting the Electrical and Mechanical Events in the Heart

### 17.5. Cardiac Output and Regulation

**Determination of Cardiac Output** 

Factors That Influence Stroke Volume

Factors That Influence Heart Rate

Regulation of Cardiac Output

Heart Failure

Study Boost: Revisiting Electrophysiology

Concept Boost: Deconstructing the Cardiac Cycle Diagram

Concept Boost: Understanding How Changes in Preload, Contractility, and Afterload Affect

Stroke Volume



The Big Picture of Blood Flow through the Heart

A&P in the Real World: Thoracotomy

A&P in the Real World: Cardiac Tamponade

A&P in the Real World: Valvular Heart Diseases

A&P in the Real World: Dysrhythmias

A&P in the Real World: Heart Murmurs and Extra Heart Sounds

A&P in the Real World: Ventricular Hypertrophy

# 18. The Cardiovascular System II: The Blood Vessels

### 18.1. Overview of Arteries and Veins

Structure and Function of Arteries and Veins

Vascular Anastomoses

### 18.2. Physiology of Blood Flow

Introduction to Hemodynamics

Factors That Determine Blood Pressure

Blood Pressure in Different Portions of the Circulation

### 18.3. Maintenance of Blood Pressure

Short-Term Maintenance of Blood Pressure

Long-Term Maintenance of Blood Pressure by the Endocrine and Urinary Systems

Summary of Blood Pressure Maintenance

Disorders of Blood Pressure: Hypertension and Hypotension

### 18.4. Capillaries and Tissue Perfusion

Capillary Structure and Function

Blood Flow through Capillary Beds

Tissue Perfusion in Special Circuits

### 18.5. Capillary Pressures and Water Movement

Pressures at Work in a Capillary

Capillary Net Filtration Pressure

Edema

### 18.6. Anatomy of the Systemic Arteries

Arteries of the Head and Neck

Arteries of the Thorax

Arteries of the Upper Limb

Arteries of the Lower Limb

**Pulse Points** 

### 18.7. Anatomy of the Systemic Veins

Veins of the Head and Neck



Veins of the Thorax and Abdomen

Veins of the Upper Limb

Veins of the Lower Limb

### 18.8. Putting It All Together: The Big Picture of Blood Vessel Anatomy

Study Boost: Another Way to Think about Hydrostatic and Osmotic Pressures

Concept Boost: A Closer Look at Cross-Sectional Area and Velocity

Concept Boost: Taking a Closer Look at Systolic and Diastolic Pressures

The Big Picture of Systemic Blood Flow in the Body

A&P in the Real World: Atherosclerosis A&P in the Real World: Varicose Veins

A&P in the Real World: Vasovagal Syncope

A&P in the Real World: Cerebrovascular Accident

A&P in the Real World: Drugs and the Hepatic Portal System

A&P in the Real World: Vein Grafting

### 19. Blood

### 19.1. Overview of Blood

Overview of Blood Functions

Plasma

### 19.2. Erythrocytes and Oxygen Transport

Erythrocyte Structure

Lifespan of an Erythrocyte

Anemia

### 19.3. Leukocytes and Immune Function

Granulocytes

Agranulocytes

Leukocyte Formation: Leukopoiesis

### 19.4. Platelets

Platelet Characteristics

**Platelet Formation** 

Putting It All Together: The Big Picture of Formed Elements

### 19.5. Hemostasis

Hemostasis Part 1: Vascular Spasm

Hemostasis Part 2: Platelet Plug Formation

Hemostasis Part 3: Coagulation Hemostasis Part 4: Clot Retraction Hemostasis Part 5: Thrombolysis



Putting It All Together: The Big Picture of Hemostasis

Regulation of Clotting
Disorders of Clotting

### 19.6. Blood Typing and Matching

**Blood Typing** 

**Blood Transfusions** 

Concept Boost: Making Sense of the Coagulation Cascade

Concept Boost: What about the Donors Antibodies?

The Big Picture of Formed Elements

The Big Picture of Hemostasis A&P in the Real World: Cirrhosis

A&P in the Real World: Complete Blood Count

A&P in the Real World: Leukemias

A&P in the Real World: Anticlot Medications

A&P in the Real World: Hemolytic Disease of the Newborn, or Erythroblastosis Fetalis

### 20. The Lymphatic System and Immunity

### 20.1. Structure and Function of the Lymphatic System

Functions of the Lymphatic System

Lymphatic Vessels and Lymph Circulation

Lymphoid Tissues and Organs

### 20.2. Overview of the Immune System

Types of Immunity

**Surface Barriers** 

Overview of Cells and Proteins of the Innate and Adaptive Immune Systems

How the Lymphatic and Immune Systems Work Together

### 20.3. Innate Immunity: Internal Defenses

Cells of Innate Immunity

**Antimicrobial Proteins** 

Inflammatory Response

Fever

### 20.4. Adaptive Immunity: Cell-Mediated Immunity

**Antigens** 

T Cell Response to Antigen Exposure

Effects of T Cells

Organ and Tissue Transplantation and Rejection

### 20.5. Adaptive Immunity: Antibody-Mediated Immunity



Phase 1: B Cell Activation, Clonal Selection, and Differentiation

Phase 2: Antibodies and Their Effects

Phase 3: Immunological Memory

### 20.6. Putting It All Together: The Big Picture of the Immune Response

Scenario 1: The Common Cold

Scenario 2: Bacterial Infection

Scenario 3: Cancer

Pathogens That Evade the Immune Response

### 20.7. Disorders of the Immune System

Hypersensitivity Disorders

Type I: Immediate Hypersensitivity

Type II: Antibody-Mediated Hypersensitivity

Type III: Immune Complex-Mediated Hypersensitivity

Type IV: Delayed-Type Hypersensitivity

Immunodeficiency Disorders

Autoimmune Disorders

Concept Boost: Why Do We Need Both Class I and Class II MHC Molecules?

The Big Picture of the Immune Response to the Common Cold

The Big Picture of the Immune Response to a Bacterial Infection

The Big Picture of the Immune Response to Cancer Cells

A&P in the Real World: Lymphedema

A&P in the Real World: How Pathogens Can Evade Surface Barriers

A&P in the Real World: Anti-inflammatory Medications

A&P in the Real World: Pseudoscience Exposed: The Myth of Vaccines and Autism

A&P in the Real World: Complete Blood Count with Differential

A&P in the Real World: Treatments for Allergies A&P in the Real World: The Tuberculin Skin Test

# 21. The Respiratory System

### 21.1. Overview of the Respiratory System

Anatomy of the Respiratory System: An Overview

Basic Functions of the Respiratory System

### 21.2. Anatomy of the Respiratory System

The Nose and Nasal Cavity

The Pharynx

The Larynx

The Trachea



The Bronchial Tree

Alveoli and the Respiratory Membrane

The Lungs and Pleurae

### 21.3. Pulmonary Ventilation

The Pressure-Volume Relationship

The Process of Pulmonary Ventilation

Physical Factors Influencing Pulmonary Ventilation

Pulmonary Volumes and Capacities

### 21.4. Gas Exchange

The Behavior of Gases

Pulmonary Gas Exchange

Factors Affecting Efficiency of Pulmonary Gas Exchange

Tissue Gas Exchange

Factors Affecting Efficiency of Tissue Gas Exchange

### 21.5. Gas Transport through the Blood

Oxygen Transport

Carbon Dioxide Transport

### 21.6. Putting It All Together: The Big Picture of Respiration

### 21.7. Neural Control of Ventilation

Control of the Basic Pattern of Ventilation

Control of the Rate and Depth of Ventilation

### 21.8. Diseases of the Respiratory System

Restrictive Lung Diseases

Obstructive Lung Diseases

Study Boost: Relating Ventilation and Blood pH

Concept Boost: Making Sense of the Oxygen-Hemoglobin Dissociation Curve

Concept Boost: How Does a Buffer Work? The Big Picture of Pulmonary Ventilation

The Big Picture of Respiration

A&P in the Real World: Smokers Cough

A&P in the Real World: Tuberculosis

A&P in the Real World: Pleuritis and Pleural Friction Rub

A&P in the Real World: Infant Respiratory Distress Syndrome

A&P in the Real World: Hyperbaric Oxygen Therapy

A&P in the Real World: V/Q Mismatch

A&P in the Real World: Carbon Monoxide Poisoning



A&P in the Real World: High-Altitude Acclimatization

# 22. The Digestive System

### 22.1. Overview of the Digestive System

Basic Digestive Functions and Processes

Organization of the Digestive System

Regulation of Motility by the Nervous and Endocrine Systems

### 22.2. The Oral Cavity, Pharynx, and Esophagus

Structure of the Oral Cavity

The Teeth and Mastication

The Tongue

The Salivary Glands

The Pharynx

The Esophagus

Swallowing

### 22.3. The Stomach

Gross Anatomy of the Stomach

Histology of the Stomach

Functions of the Stomach

### 22.4. The Small Intestine

Divisions of the Small Intestine

Structure and Functions of the Small Intestine

Motility of the Small Intestine

### 22.5. The Large Intestine

Gross Anatomy of the Large Intestine

Histology of the Large Intestine

Bacteria in the Large Intestine

Motility of the Large Intestine and Defecation

### 22.6. The Pancreas, Liver, and Gallbladder

The Pancreas

The Liver and Gallbladder

### 22.7. Nutrient Digestion and Absorption

Overview of Digestion and Absorption

Digestion and Absorption of Carbohydrates

Digestion and Absorption of Proteins

Digestion and Absorption of Lipids

Digestion and Absorption of Nucleic Acids



Absorption of Water, Electrolytes, and Vitamins

### 22.8. Putting It All Together: The Big Picture of Digestion

Study Boost: An Analogy to Understand Emulsification

Concept Boost: Understanding Absorption in the Alimentary Canal

The Big Picture of Digestion

A&P in the Real World: Peritonitis

A&P in the Real World: Dental Caries

A&P in the Real World: Gastroesophageal Reflux Disease (GERD)

A&P in the Real World: Vomiting A&P in the Real World: Appendicitis

A&P in the Real World: Pseudoscience Exposed: Do We Really Need to Detox?

A&P in the Real World: Lactose Intolerance

A&P in the Real World: Intrinsic Factor and Vitamin B12 Deficiency

### 23. Metabolism and Nutrition

### 23.1. Overview of Metabolism and Nutrition

Phases of Metabolism: Catabolism and Anabolism

**Energy Requirements of Metabolic Reactions** 

Adenosine Triphosphate (ATP) and Phosphorylation

**Nutrients and ATP Generation** 

### 23.2. Glucose Catabolism and ATP Synthesis

Overview of Glucose Catabolism and ATP Synthesis

Glucose Catabolism Part 1: Glycolysis Intermediate Step: The Fate of Pyruvate

Glucose Catabolism Part 2: The Citric Acid Cycle

ATP Synthesis: The Electron Transport Chain and Oxidative Phosphorylation
Putting It All Together: The Big Picture of Glucose Catabolism and ATP Synthesis

### 23.3. Fatty Acid and Amino Acid Catabolism

Fatty Acid Catabolism

Amino Acid Catabolism

Putting It All Together: The Big Picture of Nutrient Catabolism

### 23.4. Anabolic Pathways

Glucose Anabolism

Fatty Acid Anabolism

Amino Acid Anabolism

Putting It All Together: The Big Picture of Nutrient Anabolism

### 23.5. Metabolic States and Regulation of Feeding



Metabolic States

Regulation of Feeding

### 23.6. The Metabolic Rate and Thermoregulation

Metabolic Rate

Heat Exchange between the Body and the Environment

Thermoregulation: Body Temperature Regulation

### 23.7. Nutrition and Body Mass

Overview of Nutrients

Macronutrients

Micronutrients

Structural Lipid: Cholesterol

Diet and Body Mass

Obesity

Concept Boost: How Electron Movement Can Be Harnessed to Do Work

Concept Boost: Why Do We Breathe?

Concept Boost: ATP Yield from Oxidative Catabolism

The Big Picture of Glucose Catabolism and Oxidative Phosphorylation

The Big Picture of Nutrient Catabolism
The Big Picture of Nutrient Anabolism

A&P in the Real World: Cyanide and the ETC

A&P in the Real World: Phenylketonuria
A&P in the Real World: Fatty Liver Disease

A&P in the Real World: Fasting and Protein Wasting

A&P in the Real World: Pseudoscience Exposed: Rev Your Metabolism

A&P in the Real World: Pseudoscience Exposed: Vitamin and Mineral Megadoses

# 24. The Urinary System

### 24.1. Overview of the Urinary System

Overview of Urinary System Structures

Overview of Kidney Function

### 24.2. Anatomy of the Kidneys

External Anatomy of the Kidneys

Internal Anatomy of the Kidneys

Blood Supply of the Kidneys

Microanatomy of the Kidney: The Nephron and Collecting System

Types of Nephrons

### 24.3. Overview of Renal Physiology



### 24.4. Renal Physiology I: Glomerular Filtration

The Filtration Membrane and the Filtrate

The Glomerular Filtration Rate (GFR)

Factors That Affect the Glomerular Filtration Rate

Renal Failure

### 24.5. Renal Physiology II: Tubular Reabsorption and Secretion

Principles of Tubular Reabsorption and Secretion

Reabsorption and Secretion in the Proximal Tubule

Reabsorption in the Nephron Loop

Reabsorption and Secretion in the Distal Tubule and Collecting System

How Tubular Reabsorption and Secretion Maintain Acid-Base Balance

Putting It All Together: The Big Picture of Tubular Reabsorption and Secretion

### 24.6. Renal Physiology III: Regulation of Urine Concentration and Volume

Osmolarity of the Filtrate

Production of Dilute Urine

The Countercurrent Mechanism and the Production of Concentrated Urine

### 24.7. Putting It All Together: The Big Picture of Renal Physiology

### 24.8. Urine and Renal Clearance

Urine Composition and Urinalysis

Renal Clearance

### 24.9. Urine Transport, Storage, and Elimination

Anatomy of the Urinary Tract

Micturition

### 24.10. Putting It All Together: The Big Picture of Urine Formation, Storage, and Elimination

Concept Boost: How Changes in Arteriolar Diameter Influence the GFR

Concept Boost: Demystifying the Countercurrent Multiplier

The Big Picture of Tubular Reabsorption and Secretion

The Big Picture of Renal Physiology

The Big Picture of Urine Formation, Storage, and Elimination

A&P in the Real World: Nephrolithiasis

A&P in the Real World: Glomerulonephritis

A&P in the Real World: The RAAS, Hypertension, and Renal Disease

A&P in the Real World: Glycosuria

A&P in the Real World: Diuretics

A&P in the Real World: SIADH

A&P in the Real World: Interstitial Cystitis



# 25. Fluid, Electrolyte, and Acid-Base Homeostasis

### 25.1. Overview of Fluid, Electrolyte, and Acid-Base Homeostasis

**Body Fluids** 

Electrolytes

Acids, Bases, and pH

### 25.2. Fluid Homeostasis

**Total Body Water** 

Fluid Compartments: Intracellular and Extracellular Fluids

Movement of Water between Compartments

Water Losses and Gains

Hormonal Regulation of Fluid Balance

Imbalances of Fluid Homeostasis

### 25.3. Electrolyte Homeostasis

Sodium Ions

Potassium Ions

Calcium and Phosphate Ions

Other Ions Critical to Human Physiology

### 25.4. Acid-Base Homeostasis

Sources of Acids and Bases in the Body

Chemical Buffer Systems

Physiological Buffer Systems: Respiratory and Renal Regulation of Blood pH

Acid-Base Imbalances

### 25.5. An Example of Fluid, Electrolyte, and Acid-Base Homeostasis

Concept Boost: Why Does the Amount of Water in the Body Affect the Sodium Ion Concentration?

Concept Boost: How Can Respiratory Changes Compensate for Metabolic Acidosis?

A&P in the Real World: Intravenous Fluids

A&P in the Real World: Digoxin Toxicity and Hyperkalemia

A&P in the Real World: Pseudoscience Exposed: Alkaline Diets

# 26. The Reproductive System

### 26.1. Overview of the Reproductive System and Meiosis

Introduction to the Male and Female Reproductive Systems

Overview of Meiosis

Meiosis I (First Meiotic Division)

Meiosis II (Second Meiotic Division)

Comparing Mitosis and Meiosis

### 26.2. Anatomy of the Male Reproductive System



**Testes** 

**Duct System** 

Penis

Accessory Sex Glands

Semen

Support Structures: Scrotum and Spermatic Cord

### 26.3. Physiology of the Male Reproductive System

Spermatogenesis

Sustentacular Cells

Spermiogenesis

Hormonal Control of Male Reproduction

Male Sexual Response

Effects of Testosterone on Other Body Systems

Effects of Aging: Male Climacteric

### 26.4. Anatomy of the Female Reproductive System

**Ovaries** 

**Uterine Tubes** 

Uterus

Vagina

Female External Genitalia

Mammary Glands

### 26.5. Physiology of the Female Reproductive System

Oogenesis

Ovarian Follicles and the Ovarian Cycle

Other Effects of Female Hormones

The Uterine Cycle

Female Sexual Response

Puberty and Menopause

Putting It All Together: The Big Picture of Hormonal Regulation and Female Reproductive Cycles

### 26.6. Methods of Birth Control

Behavioral Methods

**Barrier Methods** 

### 26.7. Sexually Transmitted Infections (STIs)

Bacterial and Parasitic STIs

Viral STIs

Concept Boost: Understanding Diploid and Haploid Cells



Concept Boost: Spermatogenesis versus Oogenesis

The Big Picture of Hormonal Regulation of the Ovarian and Uterine Cycles A&P in the Real World: Benign Prostatic Hyperplasia and Prostate Cancer

A&P in the Real World: Male Infertility

A&P in the Real World: Erectile Dysfunction

A&P in the Real World: Breast Cancer
A&P in the Real World: Female Infertility
A&P in the Real World: Cervical Cancer

### 27. Development and Heredity

### 27.1. Overview of Human Development

The Process of Prenatal Development

The Postnatal Period

### 27.2. Pre-embryonic Period: Fertilization through Implantation (Weeks 1 and 2)

Fertilization

Cleavage and Blastocyst Formation

Implantation

Development of Extraembryonic Membranes

### 27.3. Embryonic Period: Week 3 through Week 8

Gastrulation and Formation of Germ Layers

Organogenesis

### 27.4. Fetal Period: Week 9 until Birth (about Week 38)

Placentation

Fetal Development

Putting It All Together: The Big Picture of Prenatal Development

### 27.5. Pregnancy and Childbirth

Maternal Changes during Pregnancy

Parturition

### 27.6. Postnatal Changes in the Newborn and Mother

Changes in the Newborn

Changes in the Mother

### 27.7. Heredity

Introduction to Heredity

Patterns of Inheritance

The Big Picture of Prenatal Development

A&P in the Real World: Assisted Reproductive Technology

A&P in the Real World: Ectopic Pregnancy



A&P in the Real World: Placenta Previa A&P in the Real World: Prematurity

A&P in the Real World: Preeclampsia

A&P in the Real World: Patent Ductus Arteriosus and Patent Foramen Ovale

A&P in the Real World: Prenatal and Newborn Genetic Screening

Appendix A: Answers to Apply What You Learned and Assess What You

Learned

Appendix B: The Metric System

Appendix C: Laboratory Reference Values

Appendix D: Scientific Method

Credits

Glossary

Index

Student Questionnaire

Prefixes, Suffixes, Word Roots, and Combining Forms

**Back Cover**