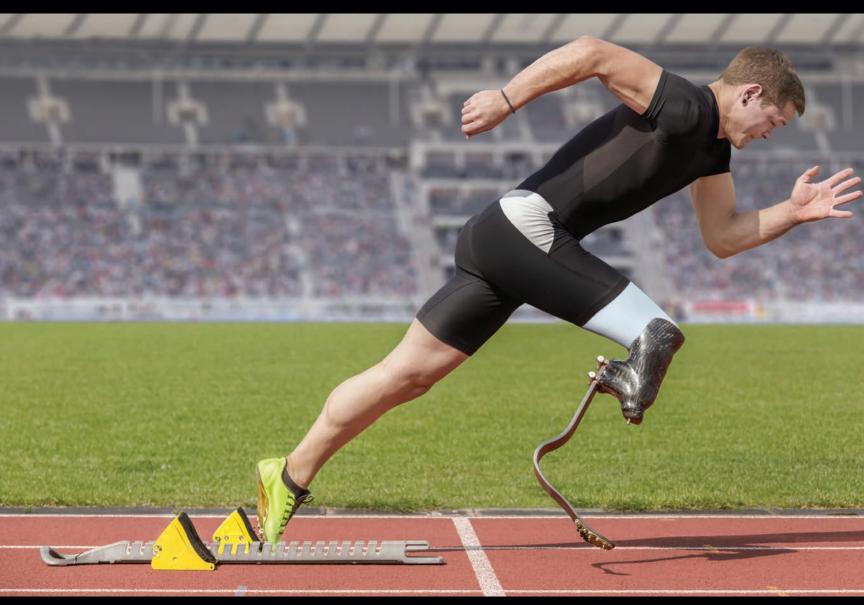


# ш fundamentals of **ANATOMY & PHYSIOLOGY**



MARTINI NATH BARTHOLOMEW



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# Fundamentals of Anatomy and Physiology, Global Edition

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Text and Illustration Team

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Mechanisms of Intercellular Communication

Comparison of Endocrine and Nervous Communication

18-2 The endocrine system regulates physiological processes by releasing bloodborne hormones that bind to receptors on remote target organs

Overview of Endocrine Organs and Tissues

Classes of Hormones

Transport and Inactivation of Hormones

Mechanisms of Hormone Action

Control of Hormone Secretion

18-3 The anterior lobe of the pituitary gland produces and releases hormones under hypothalamic control, while the posterior lobe releases hypothalamic hormones

Anatomy of the Hypothalamus and Pituitary Gland

Control of Pituitary Activity by the Hypothalamus

The Anterior Lobe of the Pituitary Gland

The Posterior Lobe of the Pituitary Gland

Summary: The Hormones of the Pituitary Gland

18-4 The thyroid gland synthesizes thyroid hormones that affect the rate of metabolism

Anatomy of the Thyroid Gland

Synthesis and Regulation of Thyroid Hormones

**Functions of Thyroid Hormones** 

Synthesis and Functions of Calcitonin

18-5 The four parathyroid glands secrete parathyroid hormone, which increases the blood calcium ion level



## 18-6 The paired adrenal glands secrete several hormones that affect electrolyte balance and stress responses

Anatomy of the Adrenal Glands

Corticosteroids of the Adrenal Cortex

Catecholamines of the Adrenal Medulla

#### 18-7 The pineal gland secretes melatonin, which affects the circadian rhythm

## 18-8 The pancreas is both an exocrine organ and an endocrine gland that produces hormones affecting the blood glucose level

Anatomy of the Pancreas

Functions of Pancreatic Islets

Hormones That Regulate the Blood Glucose Level

Diabetes Mellitus

#### 18-9 Many organs have secondary endocrine functions

The Intestines

The Kidneys

The Heart

The Thymus

The Gonads

Adipose Tissue

#### 18-10 Hormones interact over our lifetime to produce coordinated physiological responses

Role of Hormones in Growth

The Hormonal Responses to Stress

The Effects of Hormones on Behavior

Aging and Hormone Production

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Structural Classification of Hormones

G Proteins and Second Messengers

Diabetes Mellitus

The General Adaptation Syndrome

#### Clinical Case

Stones, Bones, and Groans

#### Clinical Notes

Diabetes Insipidus

Sex and Gender

**Endocrine Disorders** 

Hormones and Athletic Performance

## Unit 4: Fluids And Transport



#### Chapter 19. Blood

An Introduction to Blood and the Cardiovascular System

19-1 Blood, composed of plasma and formed elements, provides transport, regulation, and protective services to the body

Functions of Blood

Characteristics of Blood

Components of Blood

19-2 Red blood cells, formed by erythropoiesis, contain hemoglobin that transports respiratory gases

Abundance of RBCs: The Hematocrit

Relationship of RBC Structure to RBC Function

Hemoglobin

**RBC Formation and Turnover** 

19-3 The ABO and Rh blood groups are based on antigenantibody responses

ABO and Rh Blood Groups

Transfusions

19-4 The various types of white blood cells contribute to the bodys defenses

WBC Characteristics and Functions

Types of WBCs

The Differential Count and Changes in WBC Profiles

WBC Production: Leukopoiesis Regulation of WBC Production

19-5 Platelets, disc-shaped cell fragments, function in the clotting process

Platelet Functions

Platelet Production

19-6 The process of blood clotting, or hemostasis, stops blood loss

The Vascular Phase

The Platelet Phase

The Coagulation Phase

Clot Retraction

Fibrinolysis

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The Composition of Whole Blood

Hemolytic Disease of the Newborn

Clinical Case

Crisis in the Blood

Clinical Notes

Plasma Expanders

Collecting Blood for Analysis

Bleeding and Clotting Extremes

Chapter 20. The Heart



An Introduction to the Heart as Part of the Cardiovascular System

20-1 The heart is a four-chambered organ that pumps blood through the pulmonary and systemic circuits

Overview of Heart Function: The Pulmonary and Systemic Circuits

Heart Location and Position

Heart Superficial Anatomy, Heart Wall, and Cardiac Skeleton

Heart Chambers, Valves, and Great Vessels

Blood Flow through the Heart Valves

The Blood Supply to the Heart

20-2 The cells of the conducting system distribute electrical impulses through the heart, causing cardiac contractile cells to contract

Cardiac Physiology: Electrical Impulses Leading to the Contractions Making Up a Heartbeat

The Conducting System: Pacemaker and Conducting Cells

The Electrocardiogram (ECG)

Cardiac Contractions: Contractile Cells

20-3 The contractionrelaxation events that occur during a complete heartbeat make up a cardiac cycle

An Introduction to Pressure and Flow in the Heart

Phases of the Cardiac Cycle

Pressure and Volume Changes in the Cardiac Cycle

**Heart Sounds** 

20-4 Cardiac output is determined by heart rate and stroke volume

Factors Affecting the Heart Rate

Factors Affecting the Stroke Volume

Summary: The Control of Cardiac Output

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Cardiac Arrhythmias

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A Needle to the Chest

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Faulty Heart Valves

Broken Heart Syndrome

#### Chapter 21. Blood Vessels and Circulation

An Introduction to Blood Vessels and Circulation

21-1 Arteries, which are elastic or muscular, and veins, which contain valves, have three-layered walls;



capillaries have thin walls with only one layer

Vessel Wall Structure in Arteries and Veins

Differences between Arteries and Veins

Arteries

Capillaries

Veins

The Distribution of Blood

21-2 Pressure and resistance determine blood flow and affect rates of capillary exchange

Introduction to Pressure and Flow in Blood Vessels

Pressures Affecting Blood Flow

Total Peripheral Resistance

An Overview of Cardiovascular Pressures

Capillary Exchange and Capillary Pressures

21-3 Blood flow and pressure in tissues are controlled by both autoregulation and central regulation

Vasomotion

Overview of Autoregulation and Central Regulation

Autoregulation of Blood Flow within Tissues

Central Regulation: Neural Mechanisms

Central Regulation: Endocrine Mechanisms

21-4 The cardiovascular system adapts to physiological stress while maintaining a special vascular supply to the brain, heart, and lungs

Vascular Supply to Special Regions

Cardiovascular Response to Exercise

The Cardiovascular Response to Hemorrhaging and Shock

- 21-5 The vessels of the cardiovascular system make up both pulmonary and systemic circuits
- 21-6 In the pulmonary circuit, deoxygenated blood enters the lungs in arteries, and oxygenated blood leaves the lungs by veins
- 21-7 The systemic circuit carries oxygenated blood from the left ventricle to tissues and organs other than the lungs, and returns deoxygenated blood to the right atrium

Systemic Arteries

The Ascending Aorta

The Aortic Arch

Systemic Veins

21-8 Modifications of fetal and maternal cardiovascular systems promote the exchange of materials; the fetal cardiovascular system changes to function independently after birth

Fetal Circulatory Route and Placental Blood Supply

Fetal Heart and Great Vessels

Cardiovascular Changes at Birth

21-9 Aging affects the blood, heart, and blood vessels

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Arteriosclerosis

Varicose Veins

Edema

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Preparing the Circulation for Dialysis

#### Chapter 22. The Lymphatic System and Immunity

An Introduction to the Lymphatic System and Immunity

22-1 The vessels, tissues, and organs of the lymphatic system maintain fluid volume and function in body defenses

Functions of the Lymphatic System

Lymphatic Vessels and Circulation of Lymph

Lymphoid Cells

Lymphoid Tissues

Lymphoid Organs

22-2 Lymphocytes are important to innate (nonspecific) and adaptive (specific) immunity

Types of Immunity

Lymphocytes

22-3 Innate defenses respond the same regardless of the invader

Physical Barriers

Phagocytes

Immune Surveillance

Interferons

Complement System

Inflammation

Fever

22-4 Adaptive (specific) defenses respond to particular threats and are either cell mediated or antibody mediated

Lymphocytes of Adaptive Immunity

Types of Adaptive Immunity

An Introduction to Adaptive Immunity

Forms of Adaptive Immunity

Properties of Adaptive Immunity

22-5 In cell-mediated adaptive immunity, presented antigens activate T cells, which respond by producing cytotoxic and helper T cells

Activation and Clonal Selection of T Cells

Functions of Activated CD8 T Cells



Functions of Activated CD4 T Cells: Helper T (TH) and Memory TH Cells

Cytokines of Adaptive Defenses

Summary of Cell-Mediated Adaptive Immunity

22-6 In antibody-mediated adaptive immunity, sensitized B cells respond to antigens by producing specific antibodies

B Cell Sensitization and Activation

Antibody Structure and Function

Primary and Secondary Responses to Antigen Exposure

22-7 Immunocompetence enables a normal immune response; abnormal responses result in immune disorders

Summary of Innate and Adaptive Immunity

The Development of Immunocompetence

Stress and the Immune Response

Immune Disorders

22-8 The immune response diminishes as we age

22-9 The nervous and endocrine systems influence the immune response

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## Unit 5: Environmental Exchange

### Chapter 23. The Respiratory System

An Introduction to the Respiratory System

23-1 The respiratory system, organized into an upper respiratory system and a lower respiratory system, functions primarily to aid gas exchange

Functions of the Respiratory System

Organization of the Respiratory System

The Respiratory Mucosa and the Respiratory Defense System

23-2 The conducting portion of the upper respiratory system filters, warms, and humidifies air

The Nose and Nasal Cavity

The Pharynx



23-3 The conducting portion of the lower respiratory system conducts air to the respiratory portion and produces sound

The Larynx

Sound Production

The Trachea

The Bronchial Tree

23-4 The respiratory portion of the lower respiratory system is where gas exchange occurs

The Respiratory Bronchioles

Alveolar Ducts and Alveoli

The Blood-Air Barrier

23-5 Enclosed by pleural cavities, the lungs are paired organs made up of multiple lobes

Anatomy of the Lungs

Blood Supply to the Lungs

Pleural Cavities and Pleural Membranes

- 23-6 External respiration and internal respiration allow gas exchange within the body
- 23-7 Pulmonary ventilationair exchange between the atmosphere and the lungsinvolves muscle actions and volume changes that cause pressure changes

An Introduction to Airflow

Overview of Pulmonary Ventilation: Volume Changes and Pressure Gradients

Actions of the Respiratory Muscles

Volume Changes in Pulmonary Ventilation

Pressure Gradients in Pulmonary Ventilation

Summary of Volume Changes and Pressure Gradients during a Respiratory Cycle

Physical Factors Affecting Pulmonary Ventilation

Measuring Respiratory Rates and Volumes

23-8 Gas exchange depends on the partial pressures of gases and the diffusion of gas molecules

An Introduction to the Diffusion of Gases

Diffusion of Gases across the Blood-Air Barrier

Summary of Gas Exchange

Internal Respiration

23-9 In gas transport, most oxygen is transported bound to hemoglobin, whereas carbon dioxide is transported in three ways

Oxygen Transport

Carbon Dioxide Transport

Summary of Gas Transport

23-10 Respiratory centers in the brainstem, along with respiratory reflexes, control respiration

Local Regulation of Oxygen Delivery and Ventilation-to- Perfusion Ratio

Neural Control of Respiration

23-11 Respiratory performance changes over the life span

Changes in the Respiratory System in Newborns



Changes in the Respiratory System Associated with Aging

23-12 The respiratory system provides oxygen to, and eliminates carbon dioxide from, other organ systems

Build Your Knowledge Integration of the RESPIRATORY system with the other body systems presented so far

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Figure 2318 A Summary of Respiratory Processes and Partial Pressures in Respiration

Spotlight Pulmonary Ventilation

Control of Respiration

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No Rest for the Weary

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Breakdown of the Respiratory Defense System

Pneumothorax

**Decompression Sickness** 

**Blood Gas Analysis** 

Carbon Monoxide Poisoning

Smoking and the Lungs

#### Chapter 24. The Digestive System

An Introduction to the Digestive System

24-1 The digestive system, consisting of the digestive tract and accessory organs, functions primarily to break down and absorb nutrients from food and to eliminate wastes

Functions and Processes of the Digestive System

Relationship between the Digestive Organs and the Peritoneum: The Mesenteries

Histology of the Digestive Tract

Motility of the Digestive Tract

Regulation of Digestive Functions

24-2 The oral cavity, which contains the tongue, teeth, and salivary glands, functions in the ingestion and mechanical digestion of food

The Oral Cavity

The Tongue

The Teeth

The Salivary Glands

Mechanical Digestion: Mastication (Chewing)

24-3 The pharynx and esophagus are passageways that transport the food bolus from the oral cavity to the stomach

The Pharynx

The Esophagus

Ingestion: Deglutition (Swallowing)

24-4 The stomach is a J-shaped organ that receives the bolus and aids in its chemical and



#### mechanical digestion

Gross Anatomy of the Stomach

Histology of the Stomach

Secretory Glands and Gastric Secretions

Physiology of the Stomach: Chemical Digestion

Regulation of Gastric Activity in Phases of Digestion

## 24-5 Accessory digestive organs, such as the pancreas and liver, produce secretions that aid in chemical digestion

The Pancreas

The Liver

The Gallbladder

#### 24-6 The small intestine primarily functions in the chemical digestion and absorption of nutrients

Gross Anatomy of the Small Intestine

Histology of the Small Intestine

Physiology of the Small Intestine

Regulation: Coordination of Secretion and Absorption in the Digestive Tract

## 24-7 The large intestine, which is divided into three parts, absorbs water from digestive materials and eliminates the remaining waste as feces

Gross Anatomy and Segments of the Large Intestine

Histology of the Large Intestine

Physiology of the Large Intestine

## 24-8 Chemical digestion is the enzyme-mediated hydrolysis of food into nutrients that can be absorbed and used by the body

Hydrolysis of Nutrients by Enzymes

Carbohydrate Digestion and Absorption

Lipid Digestion and Absorption

Protein Digestion and Absorption

Nucleic Acid Digestion and Absorption

Absorption of Water, Ions, and Vitamins

#### 24-9 Many age-related changes affect digestion and absorption

#### 24-10 The digestive system is extensively integrated with other body systems

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The Regulation of Gastric Activity

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Epithelial Renewal and Repair

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Gastritis and Peptic Ulcers

**Pancreatitis** 

Liver Disease

Colorectal Cancer

Colonoscopy

#### Chapter 25. Metabolism, Nutrition, and Energetics

An Introduction to Metabolism, Nutrition, and Energetics

25-1 Metabolism is the sum of all the catabolic and anabolic reactions in the body, and energetics is the flow and transformation of energy

Metabolism

Energetics

Oxidation and Reduction

25-2 Carbohydrate metabolism generates ATP by glucose catabolism and forms glucose by

gluconeogenesis

Overview of Glucose Catabolism

Glucose Catabolism: Glycolysis

Glucose Catabolism: Fate of Pyruvate Glucose Catabolism: Aerobic Metabolism

Glucose Catabolism: Energy Yield of Glycolysis and Aerobic Metabolism

Glucose Anabolism: Gluconeogenesis

25-3 Lipid metabolism provides long-term storage and release of energy

Lipid Catabolism: Lipolysis

Lipid Anabolism: Lipogenesis

Lipid Storage and Energy Release

Lipid Transport and Distribution

25-4 Protein metabolism provides amino acids and synthesizes proteins

Amino Acid Catabolism

Protein Synthesis

25-5 There are two patterns of metabolic activity: energy storage in the absorptive state and energy release in the postabsorptive state

25-6 Adequate nutrition allows normal physiological functioning

Food Groups and a Balanced Diet

Nitrogen Balance

The Role of Minerals and Vitamins

25-7 Metabolic rate is the average caloric expenditure, and thermoregulation involves

balancing heat-producing and heat-losing mechanisms

**Energy Gains and Losses** 

Thermoregulation



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The Electron Transport Chain and ATP Formation

Absorptive and Postabsorptive States

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Anorexia

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Hypothermia in the Operating Room

Excess Body Heat

**Deficient Body Heat** 

#### Chapter 26. The Urinary System

An Introduction to the Urinary System

26-1 The organs of the urinary system function in excreting wastes and regulating body fluids

Organs of the Urinary System

**Urinary System Functions** 

26-2 Kidneys are highly vascular organs containing functional units called nephrons

Position and Associated Structures of the Kidneys

Gross Anatomy of the Kidneys

Blood Supply and Innervation of the Kidneys

Microscopic Anatomy of the Kidneys: The Nephron and Collecting System

26-3 Different segments of the nephron form urine by filtration, reabsorption, and secretion

Metabolic Wastes

Basic Processes of Urine Formation

26-4 The glomerulus filters blood through the filtration membrane to produce filtrate; several pressures determine the glomerular filtration rate

Function of the Filtration Membrane

Filtration Pressures

The Glomerular Filtration Rate (GFR)

Regulation of the GFR

26-5 The renal tubule reabsorbs nutrients, ions, and water and secretes ions and wastes; the collecting system reabsorbs ions and water

Principles of Reabsorption and Secretion

An Overview of Reabsorbed and Secreted Substances



Reabsorption and Secretion along the Proximal Convoluted Tubule

Reabsorption and Secretion along the Nephron Loop

Reabsorption and Secretion along the Distal Convoluted Tubule

Reabsorption and Secretion along the Collecting System

26-6 Countercurrent multiplication allows the kidneys to regulate the volume and concentration of urine

The Nephron Loop and Countercurrent Multiplication

Regulation of Urine Volume and Osmotic Concentration: Production of Dilute and Concentrated Urine

The Function of the Vasa Recta: Countercurrent Exchange

Urine Composition and Analysis

26-7 Urine is transported by the ureters, stored in the bladder, and eliminated through the urethra by urinary reflexes

The Ureters

The Urinary Bladder

The Urethra

Urinary Reflexes: Urine Storage and Urine Voiding

26-8 Age-related changes affect kidney function and urination

26-9 The urinary system is one of several body systems involved in waste excretion

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**Urinary Obstruction** 

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#### Chapter 27. Fluid, Electrolyte, and AcidBase Balance

An Introduction to Fluid, Electrolyte, and AcidBase Balance

27-1 Fluid balance, electrolyte balance, and acidbase balance are interrelated and essential to homeostasis

27-2 Extracellular fluid (ECF) and intracellular fluid (ICF) are fluid compartments with differing solute concentrations that are closely regulated

**Body Water Content** 

The Fluid Compartments of the ECF and ICF

Solute Exchanges between the ECF and the ICF

An Overview of the Regulation of Fluid and Electrolyte Balance

27-3 Fluid balance involves the regulation and distribution of water gains and losses



Fluid Gains and Losses

Water Movement between Fluid Compartments

Fluid Shifts between the ECF and ICF

27-4 In electrolyte balance, the concentrations of sodium, potassium, calcium, magnesium, phosphate, and chloride ions in body fluids are tightly regulated

Sodium Balance

Potassium Balance

Balance of Other Electrolytes

27-5 In acidbase balance, buffer systems as well as respiratory and renal compensation regulate pH changes in body fluids

Types of Acids in the Body

Mechanisms of pH Control: Buffer Systems

Regulation of AcidBase Balance

27-6 Disorders of acidbase balance can be classified as respiratory or metabolic

Respiratory AcidBase Disorders

Metabolic AcidBase Disorders

Combined Respiratory and Metabolic Acidosis

The Detection of Acidosis and Alkalosis

27-7 Aging affects fluid, electrolyte, and acidbase balance

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The Diagnosis of AcidBase Disorders

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When Treatment Makes You Worse

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Water and Weight Loss

Athletes and Salt Loss

Sports Drinks

### Unit 6: Continuity Of Life

### Chapter 28. The Reproductive System

An Introduction to the Reproductive System

28-1 Male and female reproductive system structures produce gametes that combine to form a new individual

28-2 The structures of the male reproductive system consist of the testes, duct system, accessory glands, and penis

The Testes and Associated Structures

Functional Anatomy of the Male Reproductive Duct System

The Accessory Glands

Semen

The Penis



28-3 Spermatogenesis occurs in the testes, and hormones from the hypothalamus, pituitary gland, and testes control male reproductive functions

Overview of Mitosis and Meiosis

Spermatogenesis

Maturation of Sperm

The Anatomy of a Sperm

Hormonal Regulation of Male Reproductive Function

28-4 The structures of the female reproductive system consist of the ovaries, uterine tubes, uterus, vagina, and external genitalia

The Ovaries

The Uterine Tubes

The Uterus

The Vagina

The Female External Genitalia

The Breasts

28-5 Oogenesis occurs in the ovaries, and hormones from the hypothalamus, pituitary gland, and ovaries control female reproductive functions

Oogenesis

The Ovarian Cycle

The Uterine (Menstrual) Cycle

Hormonal Coordination of the Ovarian and Uterine Cycles

28-6 The autonomic nervous system influences male and female sexual physiology

**Human Sexual Function** 

Contraception and Infertility

Sexually Transmitted Infections

28-7 Changes in levels of reproductive hormones cause functional changes throughout the life span

Development of the Genitalia

Effects of Aging

28-8 The reproductive system secretes hormones affecting growth and metabolism of all body systems

Build Your Knowledge Integration of the REPRODUCTIVE system with the other body systems presented so far

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Ovarian Cancer

Pap Smear

Fibrocystic Disease and Breast Cancer

Laparoscopy

Mammoplasty

#### Chapter 29. Development and Inheritance

An Introduction to Development and Inheritance

- 29-1 Directed by inherited genes, a fertilized ovum differentiates during prenatal development to form an individual; postnatal development brings that individual to maturity
- 29-2 Fertilizationthe fusion of a secondary oocyte and a spermforms a zygote

The Secondary Oocyte and Sperm before Fertilization

The Process of Fertilization

**Events after Fertilization** 

- 29-3 Gestation consists of three stages of prenatal development: the first, second, and third trimesters
- 29-4 The first trimester includes pre-embryonic and embryonic development, involving the processes of cleavage, implantation, placentation, and embryogenesis

The Pre-Embryonic Period

The Embryonic Period

- 29-5 During the second and third trimesters, fetal development involves growth and organ function
- 29-6 During gestation, maternal organ systems support the developing fetus; the reproductive system undergoes structural and functional changes

Hormonal Regulation during Gestation

Changes in Maternal Organ Systems

29-7 Childbirth occurs through the process of labor, which consists of the dilation, expulsion, and placental stages

Initiation of Labor

The Stages of Labor

Difficulties of Labor and Delivery and Multiple Births

29-8 Postnatal stages are the neonatal period, infancy, childhood, adolescence, and maturity, followed by senescence and death

The Neonatal Period, Infancy, and Childhood

Adolescence and Maturity

Senescence and Death

29-9 Genes and chromosomes determine patterns of inheritance

Genotype and Phenotype

Homologous Chromosomes and Alleles

Autosomal Patterns of Inheritance

Sex-Linked Patterns of Inheritance

Sources of Individual Variation



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