

Human Anatomy

Third Edition

McKinley
O'Loughlin

**This
International
Student Edition
is for use
outside
the U.S.**



00033383

ห้องสมุด วพบ.สุรินทร์

McGraw-Hill International Edition



Contents

Preface xiii

Chapter 1

A First Look at Anatomy 1

- 1.1 History of Human Anatomy 2
- 1.2 Definition of Anatomy 3
 - 1.2a Microscopic Anatomy 3
 - 1.2b Gross Anatomy 4
- 1.3 Structural Organization of the Body 5

- 1.3a Characteristics of Living Things 6
- 1.3b Introduction to Organ Systems 6
- 1.4 Precise Language of Anatomy 11

1.4a Anatomic Position 11

1.4b Sections and Planes 11

1.4c Anatomic Directions 12

1.4d Regional Anatomy 13

1.4e Body Cavities and Membranes 14

1.4f Abdominopelvic Regions and Quadrants 16



Chapter 2

The Cell: Basic Unit of Structure and Function 23

2.1 The Study of Cells 24

2.1a Using the Microscope to Study Cells 24

2.1b General Functions of Human Body Cells 25

2.2 A Prototypical Cell 27

2.3 Plasma Membrane 30

2.3a Composition and Structure of Membranes 30

2.3b Protein-Specific Functions of the Plasma Membrane 31

2.3c Transport Across the Plasma Membrane 32

2.4 Cytoplasm 36

2.4a Cytosol 36

2.4b Inclusions 36

2.4c Organelles 36

2.5 Nucleus 44

2.5a Nuclear Envelope 44

2.5b Nucleoli 45

2.5c DNA, Chromatin, and Chromosomes 45



2.6 Life Cycle of the Cell 46

2.6a Interphase 47

2.6b Mitotic (M) Phase 47

2.7 Aging and the Cell 50



Chapter 3

Embryology 54

3.1 Overview of Embryology 55

3.2 Gametogenesis 56

3.2a Meiosis 57

3.2b Oocyte Development (Oogenesis) 58

3.2c Sperm Development (Spermatogenesis) 59

3.3 Pre-embryonic Period 60

3.3a Fertilization 62

3.3b Cleavage 63

3.3c Implantation 63

3.3d Formation of the Bilaminar Germinal Disc 64

3.3e Formation of Extraembryonic Membranes 65

3.3f Development of the Placenta 66

3.4 Embryonic Period 67

3.4a Gastrulation 68

3.4b Folding of the Embryonic Disc 68

3.4c Differentiation of Ectoderm 69

3.4d Differentiation of Mesoderm 72

3.4e Differentiation of Endoderm 72

3.4f Organogenesis 72

3.5 Fetal Period 74

Chapter 4

Tissue Level of Organization 80

4.1 Epithelial Tissue 81

4.1a Characteristics of Epithelial Tissue 81

4.1b Functions of Epithelial Tissue 82

4.1c Specialized Structure of Epithelial Tissue 82

4.1d Classification of Epithelial Tissue 84

4.1e Types of Epithelium 85

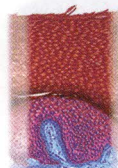
4.1f Glands 92

4.2 Connective Tissue 95

4.2a Characteristics of Connective Tissue 95

4.2b Functions of Connective Tissue 95

4.2c Development of Connective Tissue 96



- 4.2d Classification of Connective Tissue 98
- 4.3 Body Membranes 108
- 4.4 Muscle Tissue 109
 - 4.4a Classification of Muscle Tissue 109
- 4.5 Nervous Tissue 111
 - 4.5a Characteristics of Neurons 112
- 4.6 Tissue Change and Aging 112
 - 4.6a Tissue Change 112
 - 4.6b Tissue Aging 113



Chapter 5 Integumentary System 118

- 5.1 Structure and Function of the Integument 119
 - 5.1a Integument Structure 119
 - 5.1b Integument Functions 120
- 5.2 Epidermis 121
 - 5.2a Epidermal Strata 121
 - 5.2b Variations in the Epidermis 122
- 5.3 Dermis 125
 - 5.3a Papillary Layer of the Dermis 126
 - 5.3b Reticular Layer of the Dermis 126
 - 5.3c Stretch Marks, Wrinkles, and Lines of Cleavage 126
 - 5.3d Innervation and Blood Supply 127
- 5.4 Subcutaneous Layer (Hypodermis) 128
- 5.5 Epidermal Accessory Organs 129
 - 5.5a Nails 129
 - 5.5b Hair 130
 - 5.5c Exocrine Glands of the Skin 133
- 5.6 Integument Repair and Regeneration 136
- 5.7 Aging of the Integument 138
 - 5.7a Skin Cancer 139
- 5.8 Development of the Integumentary System 140
 - 5.8a Integument Development 140
 - 5.8b Nail Development 140
 - 5.8c Hair Development 140
 - 5.8d Sebaceous and Sweat Gland Development 140
 - 5.8e Mammary Gland Development 141



Chapter 6 Cartilage and Bone 146

- 6.1 Cartilage 147
 - 6.1a Functions of Cartilage 147
 - 6.1b Growth Patterns of Cartilage 148
- 6.2 Bone 148
 - 6.2a Functions of Bone 148

- 6.3 Classification and Anatomy of Bones 150
 - 6.3a General Structure and Gross Anatomy of Long Bones 150
- 6.4 Ossification 157
 - 6.4a Intramembranous Ossification 157
 - 6.4b Endochondral Ossification 157
 - 6.4c Epiphyseal Plate Morphology 160
 - 6.4d Growth of Bone 161
 - 6.4e Blood Supply and Innervation 162
- 6.5 Maintaining Homeostasis and Promoting Bone Growth 163
 - 6.5a Effects of Hormones 163
 - 6.5b Effects of Vitamins 164
 - 6.5c Effects of Exercise 165
 - 6.5d Fracture Repair 165
- 6.6 Bone Markings 167
- 6.7 Aging of the Skeletal System 168



Chapter 7 Axial Skeleton 173

- 7.1 Skull 175
 - 7.1a Views of the Skull and Landmark Features 176
 - 7.1b Sutures 183
 - 7.1c Bones of the Cranium 185
 - 7.1d Bones of the Face 194
 - 7.1e Nasal Complex 198
 - 7.1f Paranasal Sinuses 199
 - 7.1g Orbital Complex 200
 - 7.1h Bones Associated with the Skull 201
- 7.2 Sex Differences in the Skull 201
- 7.3 Aging of the Skull 201
- 7.4 Vertebral Column 204
 - 7.4a Divisions of the Vertebral Column 204
 - 7.4b Spinal Curvatures 205
 - 7.4c Vertebral Anatomy 206
- 7.5 Thoracic Cage 212
 - 7.5a Sternum 213
 - 7.5b Ribs 213
- 7.6 Aging of the Axial Skeleton 214
- 7.7 Development of the Axial Skeleton 214



Chapter 8 Appendicular Skeleton 220

- 8.1 Pectoral Girdle 221
 - 8.1a Clavicle 221
 - 8.1b Scapula 221

- 8.2 Upper Limb 225
 - 8.2a Humerus 225
 - 8.2b Radius and Ulna 225
 - 8.2c Carpals, Metacarpals, and Phalanges 230
- 8.3 Pelvic Girdle 232
 - 8.3a Os Coxae 232
 - 8.3b True and False Pelves 233
 - 8.3c Sex Differences Between the Female and Male Pelves 233
- 8.4 Lower Limb 236
 - 8.4a Femur 237
 - 8.4b Patella 240
 - 8.4c Tibia and Fibula 240
 - 8.4d Tarsals, Metatarsals, and Phalanges 241
- 8.5 Aging of the Appendicular Skeleton 245
- 8.6 Development of the Appendicular Skeleton 245

Chapter 9

Articulations 252

- 9.1 Articulations (Joints) 253
 - 9.1a Classification of Joints 253
- 9.2 Fibrous Joints 254
 - 9.2a Gomphoses 254
 - 9.2b Sutures 255
 - 9.2c Syndesmoses 255
- 9.3 Cartilaginous Joints 255
 - 9.3a Synchondroses 255
 - 9.3b Symphyses 256
- 9.4 Synovial Joints 256
 - 9.4a General Anatomy of Synovial Joints 257
 - 9.4b Types of Synovial Joints 258
 - 9.4c Movements at Synovial Joints 260
- 9.5 Selected Articulations in Depth 265
 - 9.5a Joints of the Axial Skeleton 265
 - 9.5b Joints of the Pectoral Girdle and Upper Limbs 268
 - 9.5c Joints of the Pelvic Girdle and Lower Limbs 274
- 9.6 Disease and Aging of the Joints 282
- 9.7 Development of the Joints 284

Chapter 10

Muscle Tissue and Organization 288

- 10.1 Properties of Muscle Tissue 289
- 10.2 Characteristics of Skeletal Muscle Tissue 289
 - 10.2a Functions of Skeletal Muscle Tissue 289
 - 10.2b Gross Anatomy of Skeletal Muscle 290
 - 10.2c Microscopic Anatomy of Skeletal Muscle 293

- 10.3 Contraction of Skeletal Muscle Fibers 298
 - 10.3a The Sliding Filament Theory 298
 - 10.3b Neuromuscular Junctions 298
 - 10.3c Physiology of Muscle Contraction 301
 - 10.3d Muscle Contraction: A Summary 303
 - 10.3e Motor Units 303
- 10.4 Types of Skeletal Muscle Fibers 305
 - 10.4a Distribution of Slow, Intermediate, and Fast Fibers 307
- 10.5 Skeletal Muscle Fiber Organization 307
 - 10.5a Circular Muscles 307
 - 10.5b Parallel Muscles 307
 - 10.5c Convergent Muscles 307
 - 10.5d Pennate Muscles 307
- 10.6 Exercise and Skeletal Muscle 309
 - 10.6a Muscle Atrophy 309
 - 10.6b Muscle Hypertrophy 309
- 10.7 Levers and Joint Biomechanics 309
 - 10.7a Classes of Levers 309
 - 10.7b Actions of Skeletal Muscles 310
- 10.8 The Naming of Skeletal Muscles 311
- 10.9 Characteristics of Cardiac and Smooth Muscle 312
 - 10.9a Cardiac Muscle 312
 - 10.9b Smooth Muscle 313
- 10.10 Aging and the Muscular System 313
- 10.11 Development of the Muscular System 317

Chapter 11

Axial Muscles 322

- 11.1 Muscles of the Head and Neck 323
 - 11.1a Muscles of Facial Expression 323
 - 11.1b Extrinsic Eye Muscles 328
 - 11.1c Muscles of Mastication 332
 - 11.1d Muscles That Move the Tongue 332
 - 11.1e Muscles of the Pharynx 334
 - 11.1f Muscles of the Anterior Neck 335
 - 11.1g Muscles That Move the Head and Neck 337
- 11.2 Muscles of the Vertebral Column 340
- 11.3 Muscles of Respiration 343
- 11.4 Muscles of the Abdominal Wall 345
- 11.5 Muscles of the Pelvic Floor 348

Chapter 12

Appendicular Muscles 354

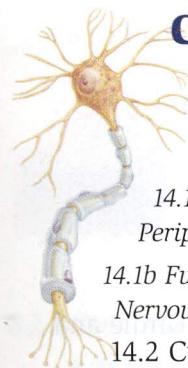
- 12.1 Muscles That Move the Pectoral Girdle and Upper Limb 355
 - 12.1a Muscles That Move the Pectoral Girdle 355

- 12.1b Muscles That Move the Glenohumeral Joint/
Arm 360
- 12.1c Arm and Forearm Muscles That Move the Elbow
Joint/Forearm 363
- 12.1d Forearm Muscles That Move the Wrist Joint, Hand,
and Fingers 366
- 12.1e Intrinsic Muscles of the Hand 374
- 12.2 Muscles That Move the Pelvic Girdle and Lower
Limb 377
 - 12.2a Muscles That Move the Hip Joint/Thigh 377
 - 12.2b Thigh Muscles That Move the Knee Joint/Leg 381
 - 12.2c Leg Muscles 385
 - 12.2d Intrinsic Muscles of the Foot 391



Chapter 13 Surface Anatomy 397

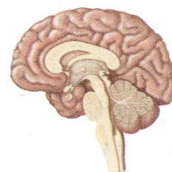
- 13.1 A Regional Approach
to Surface Anatomy 398
- 13.2 Head Region 398
 - 13.2a Cranium 399
 - 13.2b Face 399
- 13.3 Neck Region 399
- 13.4 Trunk Region 401
 - 13.4a Thorax 401
 - 13.4b Abdominopelvic Region 403
 - 13.4c Back 404
- 13.5 Shoulder and Upper Limb Region 405
 - 13.5a Shoulder 405
 - 13.5b Axilla 405
 - 13.5c Arm 405
 - 13.5d Forearm 406
 - 13.5e Hand 406
- 13.6 Lower Limb Region 408
 - 13.6a Gluteal Region 408
 - 13.6b Thigh 408
 - 13.6c Leg 409
 - 13.6d Foot 411



Chapter 14 Nervous Tissue 415

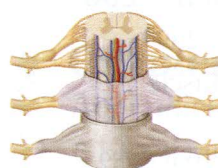
- 14.1 Organization of the Nervous
System 416
 - 14.1a Structural Organization: Central and
Peripheral Nervous Systems 416
 - 14.1b Functional Organization: Sensory and Motor
Nervous Systems 416
- 14.2 Cytology of Nervous Tissue 418
 - 14.2a Neurons 418

- 14.2b Glial Cells 422
- 14.3 Myelination of Axons 425
 - 14.3a Myelination 425
 - 14.3b Nerve Impulse Conduction 426
- 14.4 Axon Regeneration 427
- 14.5 Nerves 428
- 14.6 Synapses 430
 - 14.6a Synaptic Communication 431
- 14.7 Neural Integration and Neuronal Pools 432
- 14.8 Development of the Nervous System 434



Chapter 15 Brain and Cranial Nerves 439

- 15.1 Brain Development and Tissue
Organization 440
 - 15.1a Embryonic Development of the Brain 441
 - 15.1b Organization of Neural Tissue Areas in the
Brain 446
- 15.2 Support and Protection of the Brain 448
 - 15.2a Cranial Meninges 448
 - 15.2b Brain Ventricles 450
 - 15.2c Cerebrospinal Fluid 450
 - 15.2d Blood-Brain Barrier 454
- 15.3 Cerebrum 454
 - 15.3a Cerebral Hemispheres 454
 - 15.3b Functional Areas of the Cerebrum 457
 - 15.3c Central White Matter 459
 - 15.3d Cerebral Nuclei 461
- 15.4 Diencephalon 462
 - 15.4a Epithalamus 462
 - 15.4b Thalamus 463
 - 15.4c Hypothalamus 463
- 15.5 Brainstem 465
 - 15.5a Mesencephalon 465
 - 15.5b Pons 465
 - 15.5c Medulla Oblongata 468
- 15.6 Cerebellum 469
 - 15.6a Cerebellar Peduncles 470
- 15.7 Limbic System 470
- 15.8 Cranial Nerves 473



Chapter 16 Spinal Cord and Spinal Nerves 486

- 16.1 Gross Anatomy of the Spinal
Cord 487
- 16.2 Spinal Cord Meninges 489

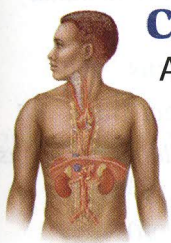
- 16.3 Sectional Anatomy of the Spinal Cord 491
 - 16.3a Location and Distribution of Gray Matter 491
 - 16.3b Location and Distribution of White Matter 493
- 16.4 Spinal Nerves 493
 - 16.4a Spinal Nerve Distribution 493
 - 16.4b Nerve Plexuses 495
 - 16.4c Intercostal Nerves 496
 - 16.4d Cervical Plexuses 496
 - 16.4e Brachial Plexuses 499
 - 16.4f Lumbar Plexuses 503
 - 16.4g Sacral Plexuses 506
- 16.5 Reflexes 510
 - 16.5a Components of a Reflex Arc 510
 - 16.5b Examples of Spinal Reflexes 512
 - 16.5c Reflex Testing in a Clinical Setting 512
- 16.6 Development of the Spinal Cord 513



Chapter 17

Pathways and Integrative Functions 518

- 17.1 General Characteristics of Nervous System Pathways 519
- 17.2 Sensory Pathways 519
 - 17.2a Functional Anatomy of Sensory Pathways 520
- 17.3 Motor Pathways 523
 - 17.3a Functional Anatomy of Motor Pathways 523
 - 17.3b Levels of Processing and Motor Control 528
- 17.4 Higher-Order Processing and Integrative Functions 529
 - 17.4a Development and Maturation of Higher-Order Processing 529
 - 17.4b Hemispheric Lateralization 529
 - 17.4c Language 530
 - 17.4d Cognition 531
 - 17.4e Memory 532
 - 17.4f Consciousness 532
- 17.5 Aging and the Nervous System 534

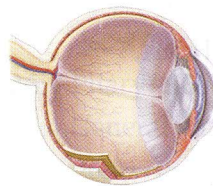


Chapter 18

Autonomic Nervous System 539

- 18.1 Comparison of the Somatic and Autonomic Nervous Systems 540
- 18.2 Overview of the Autonomic Nervous System 542
- 18.3 Parasympathetic Division 545
 - 18.3a Cranial Nerves 545
 - 18.3b Sacral Spinal Nerves 545

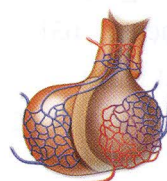
- 18.3c Effects and General Functions of the Parasympathetic Division 545
- 18.4 Sympathetic Division 547
 - 18.4a Organization and Anatomy of the Sympathetic Division 547
 - 18.4b Sympathetic Pathways 550
 - 18.4c Effects and General Functions of the Sympathetic Division 550
- 18.5 Other Features of the Autonomic Nervous System 552
 - 18.5a Autonomic Plexuses 552
 - 18.5b Neurotransmitters and Receptors 553
 - 18.5c Dual Innervation 554
 - 18.5d Autonomic Reflexes 555
- 18.6 CNS Control of Autonomic Function 556
- 18.7 Development of the Autonomic Nervous System 557



Chapter 19

Senses: General and Special 561

- 19.1 Receptors 562
 - 19.1a Classification of Receptors 563
- 19.2 Tactile Receptors 566
 - 19.2a Unencapsulated Tactile Receptors 566
 - 19.2b Encapsulated Tactile Receptors 567
- 19.3 Gustation 569
 - 19.3a Gustatory Discrimination 570
 - 19.3b Gustatory Pathways 570
- 19.4 Olfaction 571
 - 19.4a Olfactory Receptor Cells 571
 - 19.4b Olfactory Discrimination 572
 - 19.4c Olfactory Pathways 573
- 19.5 Vision 573
 - 19.5a Accessory Structures of the Eye 573
 - 19.5b Eye Structure 575
 - 19.5c Visual Pathways 582
 - 19.5d Development of the Eye 584
- 19.6 Equilibrium and Hearing 586
 - 19.6a External Ear 586
 - 19.6b Middle Ear 587
 - 19.6c Inner Ear 588
 - 19.6d Development of the Ear 598



Chapter 20

Endocrine System 605

- 20.1 Endocrine Glands and Hormones 606
 - 20.1a Overview of Hormones 606

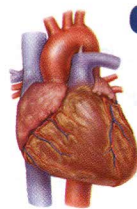
- 20.1b *Negative and Positive Feedback Loops* 606
- 20.2 Hypothalamic Control of the Endocrine System 609
- 20.3 Pituitary Gland 611
 - 20.3a *Anterior Pituitary* 611
 - 20.3b *Posterior Pituitary* 615
- 20.4 Thyroid Gland 617
 - 20.4a *Synthesis of Thyroid Hormone by Thyroid Follicles* 617
 - 20.4b *Thyroid Gland–Pituitary Gland Negative Feedback Loop* 618
 - 20.4c *Parafollicular Cells* 619
- 20.5 Parathyroid Glands 621
- 20.6 Adrenal Glands 622
 - 20.6a *Adrenal Cortex* 624
 - 20.6b *Adrenal Medulla* 626
- 20.7 Pancreas 627
- 20.8 Pineal Gland and Thymus 629
- 20.9 Endocrine Functions of the Kidneys, Heart, Gastrointestinal Tract, and Gonads 630
 - 20.9a *Kidneys* 630
 - 20.9b *Heart* 630
 - 20.9c *Gastrointestinal Tract* 630
 - 20.9d *Gonads* 630
- 20.10 Aging and the Endocrine System 631
- 20.11 Development of the Endocrine System 631
 - 20.11a *Adrenal Glands* 631
 - 20.11b *Pituitary Gland* 631
 - 20.11c *Thyroid Gland* 633

Chapter 21

Blood 637



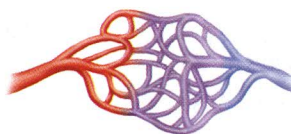
- 21.1 General Composition and Functions of Blood 638
 - 21.1a *Components of Blood* 638
 - 21.1b *Functions of Blood* 638
- 21.2 Blood Plasma 639
 - 21.2a *Plasma Proteins* 640
 - 21.2b *Differences Between Plasma and Interstitial Fluid* 640
- 21.3 Formed Elements in the Blood 640
 - 21.3a *Erythrocytes* 641
 - 21.3b *Leukocytes* 648
 - 21.3c *Platelets* 650
- 21.4 Hemopoiesis: Production of Formed Elements 651
 - 21.4a *Erythropoiesis* 653
 - 21.4b *Thrombopoiesis* 653
 - 21.4c *Leukopoiesis* 653



Chapter 22

Heart 656

- 22.1 Overview of the Cardiovascular System 657
 - 22.1a *Pulmonary and Systemic Circulations* 657
 - 22.1b *Position of the Heart* 658
 - 22.1c *Characteristics of the Pericardium* 659
- 22.2 Anatomy of the Heart 660
 - 22.2a *Heart Wall Structure* 660
 - 22.2b *External Heart Anatomy* 660
 - 22.2c *Internal Heart Anatomy: Chambers and Valves* 660
- 22.3 Coronary Circulation 666
- 22.4 How the Heart Beats: Electrical Properties of Cardiac Tissue 668
 - 22.4a *Characteristics of Cardiac Muscle Tissue* 668
 - 22.4b *Contraction of Heart Muscle* 669
 - 22.4c *The Heart's Conducting System* 670
- 22.5 Innervation of the Heart 672
- 22.6 Tying It All Together: The Cardiac Cycle 673
 - 22.6a *Steps in the Cardiac Cycle* 673
 - 22.6b *Summary of Blood Flow During the Cardiac Cycle* 673
- 22.7 Aging and the Heart 677
- 22.8 Development of the Heart 677

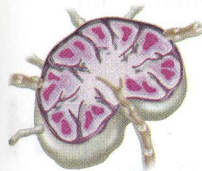


Chapter 23

Vessels and Circulation 683

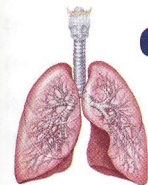
- 23.1 Anatomy of Blood Vessels 684
 - 23.1a *Blood Vessel Tunics* 684
 - 23.1b *Arteries* 685
 - 23.1c *Capillaries* 688
 - 23.1d *Veins* 689
- 23.2 Blood Pressure 691
- 23.3 Systemic Circulation 692
 - 23.3a *General Arterial Flow Out of the Heart* 693
 - 23.3b *General Venous Return to the Heart* 693
 - 23.3c *Blood Flow Through the Head and Neck* 693
 - 23.3d *Blood Flow Through the Thoracic and Abdominal Walls* 697
 - 23.3e *Blood Flow Through the Thoracic Organs* 700
 - 23.3f *Blood Flow Through the Gastrointestinal Tract* 701
 - 23.3g *Blood Flow Through the Posterior Abdominal Organs, Pelvis, and Perineum* 705
 - 23.3h *Blood Flow Through the Upper Limb* 705
 - 23.3i *Blood Flow Through the Lower Limb* 709
- 23.4 Pulmonary Circulation 712

- 23.5 Review of Heart, Systemic, and Pulmonary Circulation 714
- 23.6 Aging and the Cardiovascular System 715
- 23.7 Blood Vessel Development 716
 - 23.7a Artery Development 716
 - 23.7b Vein Development 717
 - 23.7c Comparison of Fetal and Postnatal Circulation 718



Chapter 24 Lymphatic System 724

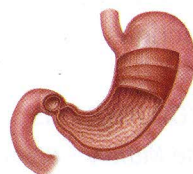
- 24.1 Functions of the Lymphatic System 725
- 24.2 Lymph and Lymph Vessels 726
 - 24.2a Lymphatic Capillaries 726
 - 24.2b Lymphatic Vessels 726
 - 24.2c Lymphatic Trunks 727
 - 24.2d Lymphatic Ducts 727
- 24.3 Lymphatic Cells 729
 - 24.3a Types and Functions of Lymphocytes 729
 - 24.3b Lymphopoiesis 734
- 24.4 Lymphatic Structures 735
 - 24.4a Lymphatic Nodules 735
 - 24.4b Lymphatic Organs 736
- 24.5 Aging and the Lymphatic System 741
- 24.6 Development of the Lymphatic System 741



Chapter 25 Respiratory System 747

- 25.1 General Organization and Functions of the Respiratory System 748
 - 25.1a Respiratory System Functions 748
- 25.2 Upper Respiratory Tract 750
 - 25.2a Nose and Nasal Cavity 750
 - 25.2b Paranasal Sinuses 750
 - 25.2c Pharynx 750
- 25.3 Lower Respiratory Tract 753
 - 25.3a Larynx 753
 - 25.3b Trachea 757
 - 25.3c Bronchial Tree 758
 - 25.3d Respiratory Bronchioles, Alveolar Ducts, and Alveoli 760
- 25.4 Lungs 762
 - 25.4a Pleura and Pleural Cavities 762
 - 25.4b Gross Anatomy of the Lungs 762
 - 25.4c Blood Supply To and From the Lungs 763
 - 25.4d Lymphatic Drainage 765
- 25.5 Pulmonary Ventilation 766

- 25.6 Thoracic Wall Dimensional Changes During External Respiration 767
- 25.7 Innervation of the Respiratory System 769
 - 25.7a Ventilation Control by Respiratory Centers of the Brain 770
- 25.8 Aging and the Respiratory System 771
- 25.9 Development of the Respiratory System 774

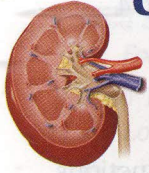


Chapter 26 Digestive System 779

- 26.1 General Structure and Functions of the Digestive System 780
 - 26.1a Digestive System Functions 780
- 26.2 Oral Cavity 781
 - 26.2a Cheeks, Lips, and Palate 781
 - 26.2b Tongue 782
 - 26.2c Salivary Glands 782
 - 26.2d Teeth 784
- 26.3 Pharynx 786
- 26.4 General Arrangement of Abdominal GI Organs 787
 - 26.4a Peritoneum, Peritoneal Cavity, and Mesentery 787
 - 26.4b General Histology of GI Organs (Esophagus to Large Intestine) 788
 - 26.4c Blood Vessels, Lymphatic Structures, and Nerve Supply 790
- 26.5 Esophagus 790
 - 26.5a Gross Anatomy 791
 - 26.5b Histology 791
- 26.6 The Swallowing Process 792
- 26.7 Stomach 793
 - 26.7a Gross Anatomy 793
 - 26.7b Histology 793
 - 26.7c Gastric Secretions 794
- 26.8 Small Intestine 797
 - 26.8a Gross Anatomy and Regions 797
 - 26.8b Histology 799
- 26.9 Large Intestine 799
 - 26.9a Gross Anatomy and Regions 799
 - 26.9b Histology 801
 - 26.9c Control of Large Intestine Activity 802
- 26.10 Accessory Digestive Organs 803
 - 26.10a Liver 804
 - 26.10b Gallbladder 805
 - 26.10c Pancreas 807
 - 26.10d Biliary Apparatus 808
- 26.11 Aging and the Digestive System 810

- 26.12 Development of the Digestive System 810
 - 26.12a Stomach, Duodenum, and Omenta Development 810
 - 26.12b Liver, Gallbladder, and Pancreas Development 810
 - 26.12c Intestine Development 810

Chapter 27



Urinary System 817

- 27.1 General Structure and Functions of the Urinary System 818
- 27.2 Kidneys 820
 - 27.2a Gross and Sectional Anatomy of the Kidney 820
 - 27.2b Blood Supply to the Kidney 821
 - 27.2c Nephrons 824
 - 27.2d How Tubular Fluid Becomes Urine 828
 - 27.2e Juxtaglomerular Apparatus 828
 - 27.2f Innervation of the Kidney 828
- 27.3 Urinary Tract 829
 - 27.3a Ureters 829
 - 27.3b Urinary Bladder 830
 - 27.3c Urethra 833
- 27.4 Aging and the Urinary System 834
- 27.5 Development of the Urinary System 835
 - 27.5a Kidney and Ureter Development 835
 - 27.5b Urinary Bladder and Urethra Development 835



Chapter 28

Reproductive System 842

- 28.1 Comparison of the Female and Male Reproductive Systems 843
 - 28.1a Perineum 843

- 28.2 Anatomy of the Female Reproductive System 844
 - 28.2a Ovaries 845
 - 28.2b Uterine Tubes 852
 - 28.2c Uterus 852
 - 28.2d Vagina 855
 - 28.2e External Genitalia 857
 - 28.2f Mammary Glands 857
- 28.3 Anatomy of the Male Reproductive System 861
 - 28.3a Scrotum 861
 - 28.3b Spermatic Cord 863
 - 28.3c Testes 863
 - 28.3d Ducts in the Male Reproductive System 866
 - 28.3e Accessory Glands 867
 - 28.3f Semen 868
 - 28.3g Penis 869
- 28.4 Aging and the Reproductive Systems 871
- 28.5 Development of the Reproductive Systems 872
 - 28.5a Genetic Versus Phenotypic Sex 872
 - 28.5b Formation of Indifferent Gonads and Genital Ducts 872
 - 28.5c Internal Genitalia Development 874
 - 28.5d External Genitalia Development 874

Appendix: Answers to Challenge Yourself Questions A-1

Glossary G-1

Credits C-1

Index I-1