## **CONTENTS**

Preface xv

About the Companion Website xvii

Chapter 1	Active Transport 38
	Membrane Potentials and Excitable Cells 39
Introduction to Anatomy	Resting Membrane Potential 39
and Physiology 1	Excitable Cells and Action Potentials 40
Anatomical Nomenclature, Directional Terms,	Membrane Receptors and Intracellular
and Planes of Section 2	Signaling 41
Microscopic Anatomy: Animal Cells	Cytoplasm and Cytoplasmic Organelles 45
and Tissues 5	Cytoplasm 45
Epithelial Tissues 6	The Golgi Apparatus 45
Connective Tissues 11	The Endoplasmic Reticulum
Muscle Tissue 14	and Ribosomes 45
Nervous Tissue 15	Mitochondria 46
The General Plan of the Animal Body 16	Lysosomes 46
·	Other Structures 47
	Nucleus 47
Chapter 2	Structure of the Nucleus 47
	DNA and DNA Replication 48
Anatomy and Physiology of the Cell 19	RNA: Transcription and Translation 49
Properties of Life 20	Biotechnology 51
Chemical Composition of the Cell 22	Cell Division 53
Water 22	Mitosis 53
Proteins 22	Meiosis 54
Lipids 24	Regulation of Cell Growth and Replication 55
Carbohydrates 26	
Inorganic Substances 26	Chapter 3
Acids, Bases, and pH 27	
Microscopic Study of the Cell 27	Embryology 57
Light Microscopy 28	Early Development 58
Electron Microscopy 30	Principles of Differentiation 59
The Cell Membrane 32	Neurulation 61
Structure of the Membrane 32	Mesodermal Differentiation 62
Intercellular Contact and Adhesion 33	Teratogenesis 64

Transport Across Cell Membranes 34

Osmosis 36

Simple and Facilitated Diffusion 34

Skeletal Muscle Organization 124

Chapter 4	Muscle Attachments 125
The Skeletal System 67	Functional Grouping of Muscles 127
Functions of Bones 68	Synovial Structures 128
Terminology 68	Muscles of the Thoracic Limb 129  Extrinsic Muscles of the Thoracic Limb 129
Classification of Bones According to Gross	Muscles Acting on the Shoulder Joint 134
Appearance 71	Muscles Acting on the Elbow 135
Axial Skeleton 73	Muscles Acting on the Distal Forelimb 136
Skull 73	Muscles of the Pelvic Limb 138
Vertebral Column 76	Muscles Acting on the Hip Joint 138
Sternum and Ribs 79	Muscles Acting on the Stifle 143
Appendicular Skeleton 80	Muscles Acting on the Hock 143
Thoracic Limbs 81	Muscles Acting on the Digit 143
Pelvic Limbs 85	Muscles of the Head 144
	Muscles of Mastication 144
Chapter 5	Muscles of Facial Expression 145
Joints 91	Other Muscles of the Head 145
Classification of Joints 92	Muscles of the Trunk and Neck 148
Fibrous Joints 92	Extensors of the Vertebral Column 148
Cartilaginous Joints 93	Flexors of the Vertebral Column 150
Synovial Joints 93	Abdominal Muscles 150
Other Synovial Structures 94	Muscles of Respiration 154
Movements of Joints 94	
Types of Synovial Joints 96	Chapter 8
Joints of the Axial Skeleton 97	The Ungulate Foot and Equine Passive
Joints of the Appendicular Skeleton 98	Stay Apparatus 157
Joints of the Thoracic Limb 98	Structural Plan of the Ungulate Foot 158
Joints of the Pelvic Limb 102	The Artiodactyl Foot 159
Pathology of Joints and Related	Ruminants 159
Structures 104	Suidae 161
Chapter 6	The Equine Foot 161
	Bones and Cartilages 161
Microscopic Anatomy and Growth	The Equine Hoof 162
and Development of Bone 111	Tendons 165
Microscopic Anatomy and Formation of	Ligaments 166
Bone 112	Synovial Structures 168
Ossification 114	Function 168
Endochondral (Intracartilaginous)	Concussion and Storage of Energy 168
Ossification 114	Equine Stay Apparatus 169 Thoracic Limb 170
Intramembranous Ossification 116	Pelvic Limb 171
Physiology of Bone 116	PEIVICEIIIIO 171
Bone Mechanics and Remodeling 116	Chapter 9
Calcium of Bone 117	
Fractures and Fracture Healing 117 Other Pathologic Conditions 120	Microscopic Anatomy and Physiology
Other Fathologic Conditions 120	of Muscle 175
Chapter 7	Skeletal Muscle 176
	Structure 176
Anatomy of the Muscular System 123	Excitation, Contraction, and Relaxation 179
Anatomical Nomenclature of Muscles 124	Strength of Contraction 183
Types of Muscle Tissue 124	Drugs That Affect Skeletal Muscle Function 185

Types of Muscle Contraction 186

Smooth Muscle 187 Structure 187 Stress-Relaxation 187 Contraction and Relaxation 188 Role and Sources of Calcium 188 Action Potentials and Slow Waves 189 Autonomic Innervation 190	Somatosensation 238 Pain 238 Proprioception 239 Touch 240 Visceral Sensations 240 Chemical Senses 240 Gustation 240
Cardiac Muscle 191 Excitation and Contraction 191 Cardiac Hypertrophy 192	Olfaction 241 Hearing and Balance 242 External Ear 242 Middle Ear 243
Chapter 10	Internal Ear 244 Physiology of Hearing 245
Anatomy of the Nervous System 193	Physiology of Hearing 245 Physiology of Vestibular Sense 248
Microscopic Neuroanatomy 196	Vision 251
Embryology 198	Ocular Adnexa 251
Central Nervous System 201	Globe 254
Brain 201	Lens 257
Meninges 205 Spinal Cord 206	Visual Field and Light Path 257
Peripheral Nervous System 209	Visual Pathways of the Brain 258
Spinal Nerves 209	Chapter 13
Cranial Nerves 210	
Autonomic Nervous System 212	Endocrinology 261
Sympathetic Nervous System 215	Hormones and Their Receptors 262
Parasympathetic Nervous System 216 Enteric Nervous System 217	Chemical Classes of Hormones 262 Eicosanoids 263
Litteric Nervous System 217	Hormone Receptors 264
Chapter 11	Cellular Effects of Peptide Hormones 264
Physiology of the Nervous System 219	Cellular Effects of Steroid and Thyroid Hormones 267
Functional Regions of the Neuron 220	Negative and Positive Feedback
Physiology of the Nerve Impulse 220	Regulation 267
Conduction Velocity and Myelination 222	Hypothalamopituitary Axis 268
Synaptic Transmission 223	Hormones of the Neurohypophysis 270
Neurotransmitters 226	Hormones of the Adenohypophysis 271
Neural Control of Skeletal Muscle 227	Growth Hormone 271
Reflexes Involving Skeletal Muscle Contraction 228	Adrenocorticotropic Hormone 271
Voluntary Movement 229	Thyroid-Stimulating Hormone 273 Other Endocrine Glands 276
Physiology of the Autonomic Nervous	Parathyroid Glands 276
System 230	Pancreatic Islets 278
Regulation of Autonomic Nervous System Activity 230	Epiphysis (Pineal Gland) 279
Activity 230 Autonomic Neurotransmitters	Chapter 14
and Their Receptors 232	
Regeneration and Repair in the Nervous	The Integument 281
System 233	Integument 282
	Skin 282
Chapter 12	Epidermis 282
Sense Organs 235	Dermis 283 Hypodermis 284
gain	Hypodermis 284

Adnexa of the Skin 284

Sensory Receptors 236

Hair 284	Cardiac Anatomy 327
Glands 286	Vessels 330
Modified Epidermis 287	Blood Vessels 330
Horns 287	Lymphatic Vessels 330
Chestnuts and Ergots 288	Pulmonary Circulation 330
Coat Color in Horses 288	Systemic Circulation 331
Wool 291	Aorta 332
	Arterial Distribution to the Head 333
Chapter 15	Arterial Distribution to the
Chapter 13	Thoracic Limb 333
Blood and Other Body Fluids 293	Arterial Distribution to the Pelvic Limb 334
Blood 294	Veins 335
Formed Elements of Blood	Cranial Vena Cava 336
and Hematopoiesis 295	Caudal Vena Cava 337
Erythrocytes 296	Portal System 337
Platelets 300	Fetal Circulation 338
Leukocytes 300	retar circulation 550
Plasma and Serum 302	Chapter 10
Blood pH 303	Chapter 18
Hemostasis and Coagulation 303	Physiology of the Heart
Platelets and the Endothelium 303	and Circulation 341
Intrinsic and Extrinsic Coagulation	Basic Design and Function of the
Pathways 304	Cardiovascular System 342
Lymph 306	Cardiac Cycle 343
Serous Fluids 307	Systole 346
	Diastole 346
Chapter 16	Heart Sounds and Murmurs 346
	Imaging the Heart 347
Body Defenses and the Immune	Electrical Activity of the Heart 347
System 309	Sinoatrial Node and Heart Rate 348
Nonspecific Defenses 310	Atrioventricular Node and Other Specialized
Specific Immune Response 312	Conductive Cells in the Heart 349
B Lymphocytes 313	Electrocardiography and Arrhythmias 349
Immunoglobulins 314	Cardiac Output and Its Regulation 350
T Cells and Cell-Mediated Immunity 315	Ventricular Filling and Stroke Volume 350
Lymphocyte Origin, Development, and	Cardiac Contractility and Stroke Volume 351
Residence 316	Structure and Function of Blood Vessels 351
Active and Passive Immunities 317	Microscopic Structure of Blood Vessels 351
Immunological Surveillance 317	Function of Blood Vessels 352
Lymphatic System 317	Regulation of Arterial Blood Pressure and
Lymphatic Vessels 319	Blood Volume 354
Lymph Nodes 319	Neural Reflexes 355
Spleen 320	Humoral Agents 356
Thymus 322	Paracrine Agents 356
Tonsils 322	Cardiovascular Function During Exercise and
	Hypovolemia 357
	/I

### Chapter 17

# Anatomy of the Cardiovascular System 325

Heart 326

Pericardium 326

### The Respiratory System 359

Upper Respiratory Tract 360 Nose 360

Chapter 19

Paranasal Sinuses 362	Gastric Glands and Secretions 412
Pharynx 363	Gastric Motility 414
Larynx 364 Trachea and Bronchi 366	Physiology of the Small Intestine, Exocrine Pancreas, and Liver 415
Thorax 368	Small Intestine Secretions and Motility 415
Lungs 368	Exocrine Pancreas 415
Pleura 369	Liver Digestive Function and Secretion of
Physiology of Respiration 370	Bile 418
Ventilation 370	Nutrient Absorption in the
Gas Exchange 372	Small Intestine 419
Gas Transport in Blood 375	Physiology of the Cecum
Control of Ventilation 376	and Colon 422
	Cecum and Colon of the Horse 422
Chapter 20	Rectum and Defecation 422
Anatomy of the Digestive System 379	Neuroendocrine Control
	of Feeding 423
Organization of the Digestive System 380  Mouth 381	Gut–Brain Axis 424
Teeth 382	
Tongue 386	Chapter 22
Pharynx 387	Nutrition and Metabolism 427
Tonsils 388	Nutrition 428
Esophagus 390	Metabolism 428
Simple Stomach 390	Absorptive State: Anabolism 429
Ruminant Stomach 392	Postabsorptive State: Catabolism 432
Ruminoreticulum 392	Energy Needs During Exercise 433
Omasum 396	Blood Glucose in Ruminants and
Abomasum 396	Camelids 434
Small Intestine 396	Ketosis 435
Large Intestine 397	
Ruminants 398	Chapter 23
Pig 398	The Urinary System 437
Horse 398	
Peritoneal Features 399	Anatomy of the Kidney 438  Blood and Nerve Supply 440
Accessory Digestive Organs 399	Ureters, Urinary Bladder,
Salivary Glands 399	and Urethra 440
Pancreas 401 Liver 402	Micturition 442
Liver 402	Overview of Function and Histology of the
Charter 21	Kidneys 442
Chapter 21	Glomerular Filtration 444
Physiology of Digestion 405	Proximal Tubule Transport 446
Pregastric Physiology 407	Concentration and Dilution of Urine: Role of
Prehension and Chewing 407	the Nephron Loop and Collecting Duct
Saliva and Salivary Glands 408	Transport 448
Swallowing 408	Sodium Chloride and Water Reabsorption by
Ruminant and Camelid Forestomach 409	the Nephron Loop 448
Fermentative Digestion 409	Collecting Duct Transport
Forestomach Motility 410	and Antidiuretic Hormone 450
Esophageal Groove 411	Osmotic Regulation of Antidiuretic
Omasum 412	Hormone 450

Polyuria and Polydipsia 450

Gastric Physiology 412

Ovaries 484

Sodium, Potassium, and Aldosterone 451 Urine Acidification 452 Regulation of Acid-Base Balance 453 Extracellular and Intracellular Buffers 453 Classification of Alkalosis and Acidosis and Compensation 454	Uterine Tubes 486 Uterus 486 Vagina 490 Vestibule and Vulva 490 Blood and Nerve Supply of the Female Reproductive Tract 491  Chapter 27
Chapter 24	
	The Ovary and Estrous Cycles 493
Anatomy of the Male	Oogenesis 494
Reproductive System 457	Secondary Follicles 495
Testis 458	Hormones and Follicular
Epididymis 460	Development 496
Ductus Deferens 460	Ovulation 499
Scrotum 462	Luteinizing Hormone Surge 499
Inguinal Canal 463	Spontaneous and Reflex Ovulators 499
Descent of the Testis 463	Seasonal Transition 500
Castration 465	Corpus Luteum 500
Accessory Sex Glands 466 Ampullae 466	Phases of the Estrous Cycle 502
Vesicular Glands 467	Proestrus 502 Estrus 502
Prostate Gland 467	Metestrus 503
Bulbourethral Glands 467	Diestrus and Anestrus 503
Penis 467	Puberty 503
Prepuce 470	Specifics of Selected
Muscles of the Male Genitalia 470	Estrous Cycles 503
Blood and Nerve Supply	Mare 503
of the Male Genitalia 470	Cow 504
	Ewe 504
Chapter 25	Sow 505
	Hembra 505
Physiology of Male Reproduction 473	
Seminiferous Tubules	Chapter 28
and Spermatogenesis 474	Pregnancy and Parturition 507
Seminiferous Tubules 474	Fertilization 508
Germ Cells and Spermatogenesis 475	Spermatozoa Transport and
Spermatozoa Morphology	Viability 508
and Spermatogenesis 477 Rates and Timing of Spermatogenesis 478	Gamete Fusion and Early Embryonic
Epididymis 478	Development 509
Semen and Semen Technology 479	Implantation and Placentation 511
Hormones of Male Reproduction 480	Hormones of Pregnancy 514
Endocrine Regulation of Testicular	Progesterone 514
Function 480	Equine Chorionic Gonadotrophin 515
Testosterone and Its Effects 481	Relaxin 515
Erection and Ejaculation 482	Pregnancy Diagnosis 515
•	Parturition 516
Chapter 26	Late Gestation 516
	Initiation of Parturition 516
Anatomy of the Female Reproductive	Oxytocin 517
System 483	Fetal Presentations and Delivery 517

Dystocia 518

### Chapter 29

## Anatomy and Physiology of the Mammary Gland 519

Mammary Glands of the Cow 520

Suspensory Apparatus 522

Blood Supply 522

Lymphatic Vessels 524

Microscopic Anatomy of the Mammary Gland 524

Mammary Glands of Sheep and Goats 526

Mammary Glands of Swine 526

Mammary Glands of the Horse 527

Physiology of Lactation 527

Composition of Milk 527

Milk Secretion 528

Lactogenesis 529

Galactogenesis 530

Milk Ejection or Letdown 531

Colostrum 532

### Chapter 30

#### Poultry 535

Integument 536 Body Design 539 Skeleton and Bone 539

Cessation of Lactation 533

Musculature 541
Gastrointestinal System 543
Respiratory System 545
Ventilation and Gas Exchange 546
Cardiovascular System 548
Lymphatic System 548
Urinary System 549
Female Reproductive System 552
Egg Formation and Oviposition 552
Male Reproductive System 555
Sex Chromosomes 556
Reproduction and Photoperiods 556

### Chapter 31

#### Llamas and Alpacas 559

Musculoskeletal System 560
Gastrointestinal Anatomy and
Physiology 561
Cardiopulmonary Anatomy
and Physiology 563
Reproductive Anatomy and Physiology 564

Appendix: Abbreviations 567 Bibliography 573 Index 577

Note: throughout the text, **clinical extracts** are set in blue type. These are examples of the application of basic anatomy and/or physiology in clinical settings.