Contents

1 Introduction to the Body, 1

Scientific Method, 2 Levels of Organization, 3 Anatomical Position, 5 Anatomical Directions, 6

DirectionalTerms, 6
Anatomical Compass Rosette, 6

Planes of the Body, 7 Body Cavities, 8

Dorsal Cavities, 8 Ventral Cavities, 8

Body Regions, 11

Balance of Body Functions, 13

Homeostasis, 13
Feedback Control, 13
Negative Feedback, 14
Positive Feedback, 14
Healthy Fluctuations, 16

Human Microbiome, 16

2 Chemistry of Life, 24

Levels of Chemical Organization, 25

Atoms, 25

Elements and Compounds, 26

Chemical Bonding, 27

Ionic Bonds, 27 Covalent Bonds, 28 Hydrogen Bonds, 29

Inorganic Chemistry, 29

Water, 29

Acids, Bases, and Salts, 30

Organic Chemistry, 31

Types of Organic Compounds, 31

Carbohydrates, 31

Lipids, 32

Proteins, 34

Nucleic Acids, 35

Chemistry in the Human Body, 38

3 Cells, 43

Overview of Cells, 44

Size and Shape, 44 Composition, 45

Parts of the Cell, 45

Plasma Membrane, 45 Cytoplasm, 46 Cell Extensions, 50 Nucleus, 51

Relationship of Cell Structure and Function, 52 Movement of Substances Through Cell Membranes, 52

Types of Membrane Transport, 52
Passive Transport Processes, 53
Active Transport Processes, 55

Cell Growth and Reproduction, 58

Cell Growth, 58
Cell Reproduction, 61

4 Tissues, 71

Introduction to Tissues, 72

TissueTypes, 72 Matrix, 73

Epithelial Tissue, 73

Introduction to EpithelialTissue, 73
Squamous Epithelium, 74
Cuboidal Epithelium, 76
Columnar Epithelium, 76
Pseudostratified Epithelium, 77
Transitional Epithelium, 77

Connective Tissue, 78

Introduction to Connective Tissue, 78
Fibrous Connective Tissue, 78
Bone Tissue, 80
CartilageTissue, 81
BloodTissue, 81
HematopoieticTissue, 82

Muscle Tissue, 82

Introduction to MuscleTissue, 82
Skeletal Muscle Tissue, 82
Cardiac Muscle Tissue, 82
Smooth Muscle Tissue, 83

Nervous Tissue, 84

Tissues and the Whole Body, 84

	Dana Davidanmant 420
5 Organ Systems, 92	Bone Development, 136 Making and Remodeling Bone, 136
Organ Systems of the Pody 02	Endochondral Ossification, 137
Organ Systems of the Body, 93 Integumentary System, 93	Intramembranous Ossification, 138
Skeletal System, 94	Axial Skeleton, 138
Muscular System, 94	Skull, 139
Nervous System, 95	Hyoid Bone, 142
Endocrine System, 96	Vertebral Column (Spine), 142
Cardiovascular System, 96	Thorax, 145
Lymphatic and Immune Systems, 97	Appendicular Skeleton, 145
Respiratory System, 98	Upper Extremity, 145
Digestive System, 99	Lower Extremity, 147
Urinary System, 100	Skeletal Variations, 150
Reproductive Systems, 100	Sex-Related Skeletal Differences, 150
The Body as a Whole, 103	Age Differences, 151
Homeostasis, 103	Environmental Factors, 151
Applying Organ System Concepts, 104	Joints, 152
	Articulation of Bones, 152
	Kinds of Joints, 152
6 Skin & Membranes, 111	Synarthroses, 152
	Amphiarthroses, 152
Body Membranes, 112	Diarthroses, 152
Classification of Membranes, 112	
Epithelial Membranes, 112	
ConnectiveTissue Membranes, 114	8 Muscular System, 164
Skin, 115	Marcala Tianana AGE
Structure of the Skin, 115	Muscle Tissue, 165
Hair, Nails, and Skin Receptors, 118	Skeletal Muscle, 165 Cardiac Muscle, 165
Skin Glands, 119	Smooth Muscle, 166
Functions of the Skin, 120 Skin Cancer, 121	Structure of Skeletal Muscle, 166
•	Muscle Organs, 166
Squamous Cell Carcinoma, 121 Basal Cell Carcinoma, 122	Muscle Fibers, 167
Basal Cell Carcinoma, 122 Melanoma, 122	Functions of Skeletal Muscle, 169
Kaposi Sarcoma, 123	Movement, 169
Burns, 123	Posture. 170
Classification of Burns, 123	Heat Production, 170
Estimating Body Surface Area, 124	Fatigue, 170
Latinating Body Sunded Filed, 121	Role of Other Body Systems in Movement, 171
	Motor Unit, 171
7 Skeletal System, 131	Muscle Stimulus, 171
	Types of Skeletal Muscle Contractions, 172
Functions of the Skeletal System, 132	Twitch and Tetanic Contractions, 172
Support, 132	Isotonic Contraction, 172
Protection, 132	Isometric Contraction, 173
Movement, 133	Effects of Exercise on Skeletal Muscle, 173
Storage, 133	Movements Produced by Skeletal Muscle
Hematopoiesis, 133	Contractions, 174
Gross Structure of Bones, 133	Angular Movements, 174
Bone Types, 133	Circular Movements, 174
Structure of Long Bones, 133	
	Special Movements, 175
Structure of Flat Bones, 134	Skeletal Muscle Groups, 176
Structure of Flat Bones, 134 Microscopic Structure of Bones, 134 Bone Tissue Structure, 134	•

Muscles of the Trunk, 180

MusclesThat Move the Lower Extremities,

180

Cartilage Tissue Structure, 136

9 Nervous System, 190

Organization of the Nervous System, 191 Cells of the Nervous System, 192

Neurons. 193 Glia. 193

Nerves and Tracts, 195 Nerve Signals, 195

Reflex Arcs, 195 Nerve Impulses, 199 Synapses, 200

Central Nervous System, 202

Brain, 202 Spinal Cord, 207

Coverings and Fluid Spaces, 208

Peripheral Nervous System, 211

Cranial Nerves, 211 Spinal Nerves, 212

Autonomic Nervous System, 214

Overview. 214

Functional Anatomy, 215

Autonomic Conduction Paths, 215

Sympathetic Division, 216 Parasympathetic Division,

Autonomic Neurotransmitters, 217

Autonomic Nervous System as a Whole, 218

10 Senses, 228

Classification of Senses, 229

General Senses, 229 Special Senses, 229

Sensory ReceptorTypes,

Sensory Pathways, 230 General Senses, 231

Distribution of General Sense Receptors, 231 Modes of Sensation, 231

Special Senses, 231 Vision, 231

Hearing and Equilibrium,

Taste, 242 Smell, 243

Integration of Senses, 244

11 Endocrine System, 252

Endocrine Glands, 253

Mechanisms of Hormone Action, 254

Nonsteroid Hormones, 254 Steroid Hormones, 256

Regulation of Hormone Secretion, 257

Negative Feedback, 257 Positive Feedback, 257 Levels of Regulation, 257

Prostaglandins, 257

Pituitary Gland, 259

Structure of the Pituitary Gland, 259 Anterior Pituitary Gland Hormones, 259 Posterior Pituitary Gland Hormones, 261

Hypothalamus, 261 Thyroid Gland, 261

Thyroid Hormone, 261 Calcitonin. 262

Parathyroid Glands, 262 Adrenal Glands, 264

Location of Adrenal Glands, 264 Adrenal Cortex, 264

Adrenal Medulla,

Pancreatic Islets, 267

Sex Glands, 269

Ovaries, 269 Testes, 269

Thymus, 270

Placenta, 270

Pineal Gland, 270

Endocrine FunctionsThroughout the Body, 270

Other Endocrine Tissues, 270 Hormone Actions in Every Organ, 270

12 Blood, 279

Blood Composition, 280

280 BloodTissue, Blood Plasma, 281 Formed Elements, 282 Hematopoiesis.

Red Blood Cells, 283

RBC Structure and Function, 283 RBC Count, 284 Hemoglobin, 284 Anemia, 285

Blood Types, 286 White Blood Cells, 289

Introduction to WBCs, 289

WBC Count, 290 WBC Types, 290

WBC Conditions, 291

Platelets and Blood Clotting, 291

Platelets, 291 Blood Clotting, 292 Atypical Blood Clots, 294

Lower Respiratory Tract. 368 Cardiovascular System, 301 Trachea, 368 Bronchial Tree, 370 Heart, 302 Alveoli, 371 Location, Size, and Position, 302 Lungs, 371 Functional Anatomy, 304 Pleurae, 372 Heart Sounds. 305 Respiration, 374 Blood FlowThrough the Heart, 305 **Pulmonary Ventilation, 375** Blood Supply to Heart Muscle, 308 Mechanics of Breathing, 375 Cardiac Cycle, 309 Pulmonary Volumes, 376 Electrical Activity of the Heart, 310 Regulation of Ventilation, 376 Cardiac Output, 312 Breathing Patterns, 378 Bloodvessels, 314 Gas Exchange and Transport, 379 Types, 314 Pulmonary Gas Exchange, 379 Structure, 314 Systemic Gas Exchange, 379 Functions, 316 Blood Transportation of Gases, 380 Routes of Circulation, 320 Systemic and Pulmonary Routes of Circulation, 320 Hepatic Portal Circulation, Digestive System, Fetal Circulation, 322 Hemodynamics, 322 Overview of Digestion, 391 Defining Blood Pressure, 322 Wall of the Digestive Tract, 393 FactorsThat Influence Blood Pressure, Wall Structure, 393 Fluctuations in Arterial Blood Pressure, 326 Mucosa. 393 Central Venous Blood Pressure, 326 Submucosa. 394 Pulse, 327 Muscularis. 394 Serosa, 394 Mouth, 395 Lymphatic System & Immunity, 337 Structure of Oral Cavity, 395 Teeth, 396 Lymphatic System, 338 Organization of the Lymphatic System, Salivary Glands, 397 338 Pharynx, 398 Lymph, 339 Structure, 398 Lymphatic Vessels, 340 Function. 398 Lymphoid Organs, 341 Esophagus, 398 Immune System, 343 Stomach, 399 Function of the Immune System, 343 Structure, 399 Innate Immunity, 343 Function, 400 Adaptive Immunity, Immune System Molecules, 346 Small Intestine, 401 Structure, 401 Cytokines, 346 Function, 402 Antibodies. 346 Liver and Gallbladder, 403 Complement, 348 Structure, 403 Immune System Cells, 349 Function, 404 Phagocytes, 349 Pancreas, 405 Lymphocytes, 350 Large Intestine, 405 Structure, 405 Respiratory System, 362 Function. 406

Appendix, 407

Peritoneum, 408

Extensions,

Location, 408

408

15

Structural Plan, 363

363

Respiratory Tract, 364

Respiratory Mucosa, Upper Respiratory Tract, 365

Overview.

Nose, 365 Pharynx, 366 Larynx, 368

Digestion, 409

Overview of Digestion, 409
Enzymes and Chemical Digestion, 409
Carbohydrate Digestion, 409
Protein Digestion, 410
Fat Digestion, 410
End Products of Digestion, 410

Absorption, 411

Mechanisms of Absorption, 411 Surface Area and Absorption, 412

17 Nutrition & Metabolism, 421

Metabolic Function of the Liver, 422 Macronutrients, 423

Dietary Sources of Nutrients, 423 Carbohydrate Metabolism, 424 Fat Metabolism, 427 Protein Metabolism, 427

Micronutrients, 428

Vitamins, 428 Minerals, 428

Regulating Food Intake, 429 Metabolic Rates, 430 Body Temperature, 431

18 Urinary System, 438

Kidneys, 439

Location of the Kidneys, 439 Gross Structure of the Kidney, 440 Microscopic Structure of the Kidney, 441 Overview of Kidney Function, 442

Formation of Urine, 445

Overview of Urine Formation, 445
Filtration, 445
Reabsorption, 445
Secretion, 447
Summary of Urine Formation, 447

Control of Urine Volume, 448

Antidiuretic Hormone, 448 Aldosterone, 448 Atrial Natriuretic Hormone, 449 Atypical Urine Volume, 449

Elimination of Urine, 449

Ureters, 449
Urinary Bladder, 450
Urethra, 450
Micturition, 451
Atypical Urine Output, 451
Urinalysis, 453

19 Fluid & Electrolyte Balance, 459

Body Fluid Volumes, 460 Body Fluid Compartments, 461

Concept of Fluid Compartments, 461 Extracellular Fluid, 461 Intracellular Fluid, 462

MechanismsThat Maintain Fluid Balance, 462

Overview of Fluid Balance, 462 Regulation of Fluid Output, 463 Regulation of Fluid Intake, 464 Exchange of Fluids by Blood, 465

Fluid Imbalances, 465

Dehydration, 465 Overhydration, 466

Importance of Electrolytes in Body Fluids, 466

Electrolytes and Nonelectrolytes, 466 lons, 466

Electrolyte Functions, 467

Electrolyte Imbalances, 468

Homeostasis of Electrolytes, 468 Sodium Imbalance, 468 Potassium Imbalance, 468 Calcium Imbalance, 469

20 Acid-Base Balance, 475

pH of Body Fluids, 476

Using the pH Scale, 476 The pH Unit, 477

MechanismsThat Control pH of Body Fluids, 477

Overview of pH Control Mechanisms, 477 Integration of pH Control, 478 Chemical pH Control Mechanisms, 478 Physiological pH Control Mechanisms, 480

pH Imbalances, 482

Acidosis and Alkalosis, 482 Metabolic and Respiratory Disturbances, 482 Compensation for pH Imbalances, 485

21 Reproductive Systems, 490

Sexual Reproduction, 491

Producing Offspring, 491 Male and Female Systems, 492

Male Reproductive System, 492

Structural Plan, 492
Testes, 493
Reproductive Ducts, 497
Accessory Glands, 497
External Genitals, 498

Female Reproductive System, 499

Structural Plan, 499
Ovaries, 500
Reproductive Ducts, 502
Accessory Glands, 503
External Genitals, 505
Menstrual Cycle, 506

Summary of the Male and Female Reproductive Systems, 508

22 Growth, Development, & Aging, 516

Prenatal Period, 517

Fertilization to Implantation, 517

Amniotic Cavity and Placenta, 518

Periods of Development 520

Formation of the Primary Germ Layers, 521

Histogenesis and Organogenesis, 522

Birth Defects, 523

Birth, 523

Parturition, 523 Stages of Labor, 525 Multiple Births, 526

Postnatal Period, 527

Growth, Development, and Aging, 527
Infancy, 528
Childhood, 528
Adolescence, 529
Adulthood, 529
Older Adulthood, 529

Effects of Aging, 530

Integumentary System, 530
Skeletal System, 530
Muscular System, 530
Central Nervous System, 530
Special Senses, 530
Cardiovascular System, 531
Respiratory System, 531
Urinary System, 531
Reproductive Systems, 531

Appendices

A Body Mass Index, 538

B Common Medical Abbreviations, Prefixes, & Suffixes, 539

C Chapter Test Answers, 541

Glossary, G-1

Illustration/Photo Credits, C-1