

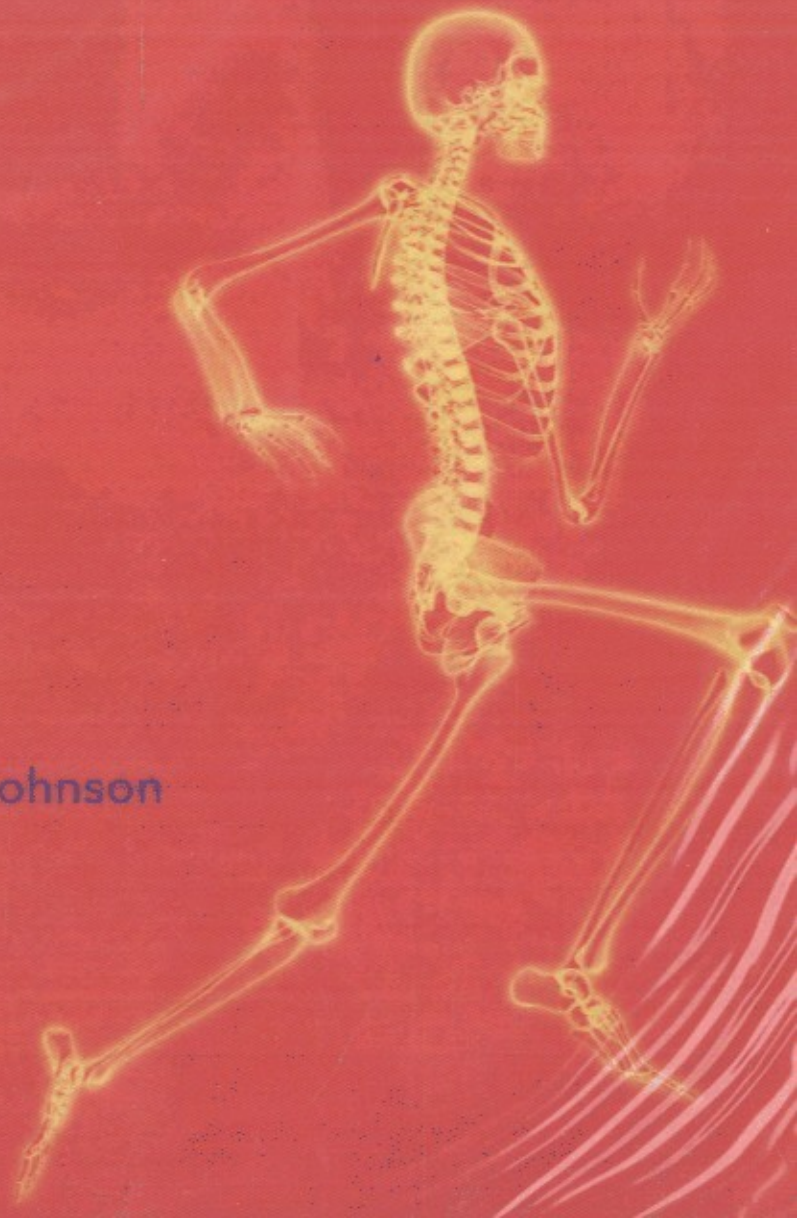
Pearson International Edition

# Human Biology

*Concepts and Current Issues*

FOURTH EDITION

Michael D. Johnson



# Detailed Contents

## I Human Biology, Science, and Society 1

- 1.1 The characteristics of life 2
- 1.2 How humans fit into the natural world 4
  - Living things are grouped according to their characteristics 4
  - The defining features of humans 5
  - Human biology can be studied on any level of biological organization 6
- 1.3 Science is both a body of knowledge and a process 9
  - The scientific method is a process for testing ideas 9
  - Making the findings known 11
  - A well-tested hypothesis becomes a theory 12
- 1.4 Sources of scientific information vary in style and quality 12
- 1.5 Learning to be a critical thinker 12
  - Becoming a skeptic 13
  - Appreciate the value of statistics 13
  - Learn how to read graphs 13
  - Try It Yourself*
    - Evaluating a Scientific Claim* 13
  - Distinguish anecdotes from scientific evidence 15
  - Separate facts from conclusions 15
  - Understand the difference between correlation and causation 15
- 1.6 The role of science in society 15
  - Science improves technology and the human physical condition 15
  - Science has limits 15
  - The importance of making informed choices 16
  - Health Watch*
    - The Growing Threat of Antibiotic-Resistant Bacteria* 17
  - Current Issue*
    - Are Dietary Supplements Safe and Effective?* 18

## 2 The Chemistry of Living Things 22

- 2.1 All matter consists of elements 23
  - Atoms are the smallest functional units of an element 23
  - Isotopes have a different number of neutrons 24
- 2.2 Atoms combine to form molecules 25
  - Energy fuels life's activities 25

Electrons have potential energy 26  
Chemical bonds link atoms to form molecules 27  
Living organisms contain only certain elements 29

- 2.3 Life depends on water 30
  - Water is the biological solvent 30
  - Water helps regulate body temperature 30
- 2.4 The importance of hydrogen ions 31
  - Acids donate hydrogen ions, bases accept them 31
  - Try It Yourself*
    - Oil and Water Don't Mix* 31
  - The pH scale expresses hydrogen ion concentration 31
  - Buffers minimize changes in pH 32
- 2.5 The organic molecules of living organisms 33
  - Carbon is the common building block of organic molecules 33
  - Macromolecules are synthesized and broken down within the cell 33
- 2.6 Carbohydrates: Used for energy and structural support 34
  - Monosaccharides are simple sugars 35
  - Oligosaccharides: More than one monosaccharide linked together 35
  - Polysaccharides store energy 35
- 2.7 Lipids: Insoluble in water 36
  - Triglycerides are energy-storage molecules 36
  - Phospholipids are the primary component of cell membranes 36
  - Steroids are composed of four rings 37
- 2.8 Proteins: Complex structures constructed of amino acids 38
  - Directions in Science*
    - Why Protein Folding Is Important* 40
  - Enzymes facilitate biochemical reactions 42
- 2.9 Nucleic acids store genetic information 43
  - Try It Yourself*
    - Demonstrating an Enzyme in Your Saliva* 43
  - Current Issue*
    - Antioxidants: Hope or Hype?* 44
- 2.10 ATP carries energy 46

### 3 Structure and Function of Cells 50

- 3.1 Cells are classified according to their internal organization 51**  
 Eukaryotes have a nucleus, cytoplasm, and organelles 51  
 Prokaryotes lack a nucleus and organelles 52
- 3.2 Cell structure reflects cell function 52**  
 Cells remain small to stay efficient 52
- 3.3 A plasma membrane surrounds the cell 54**  
 The plasma membrane is a lipid bilayer 54
- 3.4 Molecules cross the plasma membrane in several ways 55**  
 Passive transport: Principles of diffusion and osmosis 55  
 Passive transport moves with the concentration gradient 56  
 Active transport requires energy 57  
 Endocytosis and exocytosis move materials in bulk 58  
 Information can be transferred across the plasma membrane 58  
 The sodium-potassium pump helps maintain cell volume 59  
 Isotonic extracellular fluid also maintains cell volume 61
- Try It Yourself*  
*Observing the Effect of Osmosis on Your Skin* 61
- 3.5 Internal structures carry out specific functions 61**  
 The nucleus controls the cell 62  
 Ribosomes are responsible for protein synthesis 62  
 The endoplasmic reticulum is the manufacturing center 63  
 The Golgi apparatus refines, packages, and ships 63  
 Vesicles: Membrane-bound storage and shipping containers 64  
 Mitochondria provide energy 65  
 Fat and glycogen: Sources of energy 65
- 3.6 Cells have structures for support and movement 66**  
 The cytoskeleton supports the cell 66  
 Cilia and flagella are specialized for movement 66  
 Centrioles are involved in cell division 67

#### *Directions in Science*

*The First Cultured Human Cells* 67

- 3.7 Cells use and transform matter and energy 68**  
 Glucose provides the cell with energy 68

#### *Current Issue*

*Should We Use Human Stem Cells for Research and Transplantation?* 74

Fats and proteins are additional energy sources 76  
 Anaerobic pathways make energy available without oxygen 77

### 4 From Cells to Organ Systems 80

- 4.1 Tissues are groups of cells with a common function 81**
- 4.2 Epithelial tissues cover body surfaces and cavities 81**  
 Epithelial tissues are classified according to cell shape 81  
 The basement membrane provides structural support 83
- 4.3 Connective tissue supports and connects body parts 84**  
 Fibrous connective tissues provide strength and elasticity 84  
 Specialized connective tissues serve special functions 85
- 4.4 Muscle tissues contract to produce movement 87**  
 Skeletal muscles move body parts 87  
 Cardiac muscle cells activate - each other 87  
 Smooth muscle surrounds hollow structures 87
- 4.5 Nervous tissue transmits impulses 88**
- 4.6 Organs and organ systems perform complex functions 88**  
 The human body is organized by organ systems 88  
 Tissue membranes line body cavities 88  
 Describing body position or direction 89
- 4.7 The skin as an organ system 92**  
 Skin has many functions 92  
 Skin consists of epidermis and dermis 92
- 4.8 Multicellular organisms must maintain homeostasis 94**  
 Homeostasis is maintained by negative feedback 95  
 Negative feedback helps maintain core body temperature 95

*Does Liposuction Improve Health?* 96

Positive feedback amplifies events 98

*Negative Feedback Systems* 98

#### *Health Watch*

*Suntans, Smoking, and Your Skin* 99

## 5 The Skeletal System 102

- 5.1 The skeletal system consists of connective tissue 103**  
 Bones are the hard elements of the skeleton 103  
 Bone contains living cells 103  
 Ligaments hold bones together 105  
 Cartilage lends support 105
- 5.2 Bone development begins in the embryo 105**
- 5.3 Mature bone undergoes remodeling and repair 106**  
 Bones can change in shape, size, and strength 106  
 Bone cells are regulated by hormones 107  
 Bones undergo repair 107
- Health Watch*  
*Osteoporosis 108*
- 5.4 The skeleton protects, supports, and permits movement 109**  
 The axial skeleton forms the midline of the body 109  
 The appendicular skeleton: Pectoral girdle, pelvic girdle, and limbs 112
- 5.5 Joints form connections between bones 114**  
 Joints vary from immovable to freely movable 114
- Try It Yourself*  
*Stabilizing a Joint 115*
- 5.6 Diseases and disorders of the skeletal system 115**  
 Sprains mean damage to ligaments 115  
 Arthritis is inflammation of joints 115  
 Bursitis and tendonitis are caused by inflammation 115

*Current Issue*  
*A Black Market in Human Bones? 116*

*Health Watch*  
*Treating a Sprained Ankle 119*

## 6 The Muscular System 122

- 6.1 Muscles produce movement or generate tension 123**  
 The fundamental activity of muscle is contraction 123  
 Skeletal muscles cause bones to move 124  
 A muscle is composed of many muscle cells 124  
 The contractile unit is a sarcomere 125
- 6.2 Individual muscle cells contract and relax 126**  
 Nerves activate skeletal muscles 126  
 Activation releases calcium 127  
 Calcium initiates the sliding filament mechanism 127

When nerve activation ends, contraction ends 129  
 Muscles require energy to contract and to relax 129

- 6.3 The activity of muscles can vary 131**  
 Isotonic versus isometric contractions:  
 Movement versus static position 131  
 The degree of nerve activation influences force 131  
 Slow-twitch versus fast-twitch fibers:  
 Endurance versus strength 133  
 Exercise training improves muscle mass, strength, and endurance 134

- 6.4 Cardiac and smooth muscles have special features 134**

*Directions in Science*  
*Science and Sports: Lessons Learned from Lance Armstrong 135*

How cardiac and smooth muscles are activated 135  
 Speed and sustainability of contraction 136  
 Arrangement of myosin and actin filaments 136

- 6.5 Diseases and disorders of the muscular system 137**  
 Muscular dystrophy 137  
 Tetanus 137  
 Muscle cramps 137

*Current Issue*  
*Are Anabolic Steroids Dangerous? 138*

*Health Watch*  
*Muscle Soreness 140*

Pulled muscles 140  
 Fasciitis 140

## 7 Blood 142

- 7.1 The components and functions of blood 143**  
 Plasma consists of water and dissolved solutes 144  
 Red blood cells transport oxygen and carbon dioxide 145  
 Hematocrit reflects oxygen-carrying capacity 146  
 All blood cells and platelets originate from stem cells 146  
 RBCs have a short life span 147  
 RBC production is regulated by a hormone 148  
 White blood cells defend the body 148  
 Platelets are essential for blood clotting 150
- 7.2 Hemostasis: Stopping blood loss 150**  
 Vascular spasms constrict blood vessels to reduce blood flow 150  
 Platelets stick together to seal a ruptured vessel 150  
 A blood clot forms around the platelet plug 151
- 7.3 Human blood types 151**  
 ABO blood typing is based on A and B antigens 152



## Chapter 7, continued

- Rh blood typing is based on Rh factor 153
- Blood typing and cross-matching ensure blood compatibility 154

**7.4 Blood disorders 155**

- Anemia: Reduction in blood's oxygen-carrying capacity 155
- Leukemia: Uncontrolled production of white blood cells 155

*Current Issue*

- Should You Bank Your Baby's Cord Blood? 156

*Health Watch*

- Donating and Receiving Blood 158

- Multiple myeloma: Uncontrolled production of plasma cells 158
- Mononucleosis: Contagious viral infection of lymphocytes 159
- Blood poisoning: Infection of blood plasma 159
- Thrombocytopenia: Reduction in platelet number 159

*Current Issue*

- Should You Bank Your Baby's Cord Blood? 156

**8 Heart and Blood Vessels 162****8.1 Blood vessels transport blood 163**

- Arteries transport blood away from the heart 163
- Arterioles and precapillary sphincters regulate blood flow 164
- Capillaries: Where blood exchanges substances with tissues 165
- Lymphatic system helps maintain blood volume 166
- Veins return blood to the heart 166

*Try It Yourself*

- Demonstrating that Veins Store Blood 167

**8.2 The heart pumps blood through the vessels 168**

- The heart is mostly muscle 168
- The heart has four chambers and four valves 169
- The pulmonary circuit provides for gas exchange 170
- The systemic circuit serves the rest of the body 170
- The cardiac cycle: The heart contracts and relaxes 171
- Heart sounds reflect closing heart valves 173
- Cardiac conduction system coordinates contraction 173

*Try It Yourself*

- Calculating Your Target Heart Rate 173

- Electrocardiogram records heart's electrical activity 174

**8.3 Blood exerts pressure against vessel walls 175**

- Hypertension: High blood pressure can be dangerous 176
- Hypotension: When blood pressure is too low 177

**8.4 How the cardiovascular system is regulated 178**

- Baroreceptors maintain arterial blood pressure 178
- Nerves and a hormone adjust cardiac output 178
- Local requirements dictate local blood flows 179
- Exercise: Increased blood flow and cardiac output 179

**8.5 Cardiovascular disorders:****A major health issue 180**

- Angina pectoris: Chest pain warns of impaired blood flow 180
- Heart attack: Permanent damage to heart tissue 180

*Health Watch*

- Cholesterol and Atherosclerosis 181

- Congestive heart failure: The heart becomes less efficient 182

- Embolism: Blockage of a blood vessel 182
- Stroke: Damage to blood vessels in the brain 183

**8.6 Reducing your risk of cardiovascular disease 183***Current Issue*

- Merck Faces Lawsuits over Vioxx 184

**9 The Immune System and Mechanisms of Defense 188****9.1 Pathogens cause disease 189**

- Bacteria: Prokaryotic pathogens 189
- Viruses: Tiny infectious agents 190
- Prions: Infectious proteins 191
- Transmissibility, mode of transmission, and virulence determine health risk 192

**9.2 The lymphatic system defends the body 192**

- Lymphatic vessels transport lymph 192
- Lymph nodes cleanse the lymph 192
- The spleen cleanses blood 192
- Thymus gland hormones cause T lymphocytes to mature 194
- Tonsils protect the throat 194

**9.3 The body has three lines of defense 195****9.4 Physical and chemical barriers:****The first line of defense 195**

- Skin: An effective deterrent 195
- Other physical and chemical barriers 196

**9.5 Nonspecific defenses:****The second line of defense 197**

- Phagocytes engulf foreign cells 197
- Inflammation: Redness, warmth, swelling, and pain 197
- Natural killer cells target tumors and virus-infected cells 198
- The complement system assists other defense mechanisms 199
- Interferons interfere with viral reproduction 199
- Fever raises body temperature 199

- 9.6 Specific defense mechanisms:**  
**The third line of defense 200**  
 The immune system targets antigens 200  
 Lymphocytes are central to specific defenses 201  
 B cells: Antibody-mediated immunity 201  
 The five classes of antibodies 202  
 Antibodies' structure enables them to bind to specific antigens 203  
 T-cells: Cell-mediated immunity 203

**9.7 Immune memory creates immunity 206**

- 9.8 Medical assistance in the war against pathogens 206**  
 Active immunization: An effective weapon against pathogens 206  
 Passive immunization can help against existing infections 207  
 Monoclonal antibodies: Laboratory-created for commercial use 207  
 Antibiotics combat bacteria 208

**9.9 Tissue rejection: A medical challenge 208**

*Health Watch*

The Benefits of Breast-Feeding 209

**9.10 Inappropriate immune system activity causes problems 209**

Allergies: A hypersensitive immune system 209  
 Autoimmune disorders: Defective recognition of "self" 210

**9.11 Immune deficiency; The special case of AIDS 211**

HIV targets helper T cells of the immune system 211  
 HIV is transmitted in body fluids 212  
 AIDS develops slowly 213  
 The AIDS epidemic: A global health issue 213  
 Risky behaviors increase your chances of getting AIDS 214  
 Sex can be safer 214  
 New treatments offer hope 215

*Current Issue*

AIDS: A Crisis in Africa and Asia, a Challenge for the World 216

## 10 The Respiratory System: Exchange of Gases 220

**10.1 Respiration takes place throughout the body 221**

**10.2 The respiratory system consists of upper and lower respiratory tracts 221**

The upper respiratory tract filters, warms, and humidifies air 222  
 The lower respiratory tract exchanges gases 223

*Health Watch*

Saving Lives with the Heimlich Maneuver 226

**10.3 The process of breathing involves a pressure gradient 229**

Inspiration brings in air, expiration expels it 229  
 Lung volumes and vital capacity measure lung function 230

**10.4 Gas exchange and transport occur passively 231**

Gases diffuse according to their partial pressures 231  
 External respiration: The exchange of gases between air and blood 231  
 Internal respiration: The exchange of gases with tissue fluids 231  
 Hemoglobin transports most oxygen molecules 232  
 Most CO<sub>2</sub> is transported in plasma as bicarbonate 233

*Health Watch*

Carbon Monoxide: An Invisible Odorless Killer 234

**10.5 The nervous system regulates breathing 234**

A respiratory center establishes rhythm of breathing 235  
 Chemical receptors monitor CO<sub>2</sub>, H<sup>+</sup>, and O<sub>2</sub> levels 236  
 We can exert some conscious control 236

**10.6 Disorders of the respiratory system 236**

Reduced air flow or gas exchange impedes respiratory function 236  
 Microorganisms can cause lung disease 237  
 Lung cancer is caused by proliferation of abnormal cells 238  
 Congestive heart failure impairs lung function 238  
 Cystic fibrosis is an inherited disease 238

*Current Issue*

Are We Facing an Epidemic of Childhood Asthma? 239

## 11 The Nervous System: Integration and Control 242

**11.1 The nervous system has two principal parts 243**

**11.2 Neurons are the communication cells of the nervous system 243**

**11.3 Neurons initiate action potentials 245**

Sodium-potassium pump maintains resting potential 245  
 Graded potentials alter the resting potential 246  
 An action potential is a sudden reversal of membrane voltage 246  
 Action potentials are all-or-none and self-propagating 248

Chapter 11, continued

<b>11.4 Neuroglial cells support and protect neurons</b>	<b>248</b>
<b>11.5 Information is transferred from a neuron to its target</b>	<b>250</b>
Neurotransmitter is released	250
Neurotransmitters exert excitatory or inhibitory effects	250
Postsynaptic neurons integrate and process information	252
<b>11.6 The PNS relays information between tissues and the CNS</b>	<b>253</b>
Nerves carry signals to and from the CNS	253
Sensory neurons provide information to the CNS	253
The somatic division controls skeletal muscles	253
The autonomic division controls automatic body functions	254
The sympathetic and parasympathetic divisions oppose each other	255
The sympathetic and parasympathetic divisions work antagonistically to maintain homeostasis	256
<b>11.7 The brain and spinal cord constitute the CNS</b>	<b>257</b>
Bone, meninges, and the blood-brain barrier protect the CNS	257
The spinal cord relays information	258
<b>11.8 The brain processes and acts on information</b>	<b>258</b>
The hindbrain: Movement and automatic functions	259
The midbrain: Vision and hearing	260
The forebrain: Emotions and conscious thought	260
<b>11.9 Brain activity continues during sleep</b>	<b>262</b>
<b>11.10 The limbic system is the site of emotions and basic behaviors</b>	<b>263</b>
<b>11.11 Memory involves storing and retrieving information</b>	<b>264</b>
<b>11.12 Psychoactive drugs affect higher brain functions</b>	<b>264</b>
<b>11.13 Disorders of the nervous system</b>	<b>265</b>
Trauma	265
Infections	266
Disorders of neural and synaptic transmission	266
<i>Health Watch</i>	
Repairing Spinal Cord Injuries	267
<i>Current Issue</i>	
Medically Induced Coma: Risks and Tradeoffs	268
Brain tumors: Abnormal growths	269

## 12 Sensory Mechanisms 272

<b>12.1 Receptors receive and convert stimuli</b>	<b>273</b>
Receptors are classified according to stimulus	273
The CNS interprets nerve impulses based on origin and frequency	274
Some receptors adapt to continuing stimuli	274
Somatic sensations and special senses provide sensory information	275
<b>12.2 Somatic sensations arise from receptors throughout the body</b>	<b>275</b>
Mechanoreceptors detect touch, pressure, and vibration	275
Mechanoreceptors indicate limb position, muscle length, and tension	275
Thermoreceptors detect temperature	276
Pain receptors signal discomfort	277
<b>12.3 Taste and smell depend on chemoreceptors</b>	<b>278</b>
Taste: Chemoreceptors bind with dissolved substances	278
Smell: Chemoreceptors bind with odorants	279
<b>12.4 Hearing: Mechanoreceptors detect sound waves</b>	<b>280</b>
<i>Directions in Science</i>	
The Discovery of Umami	281
The outer ear channels sound waves	281
The middle ear amplifies sound	281
The inner ear sorts and converts sound	282
<b>12.5 The inner ear plays an essential role in balance</b>	<b>284</b>
Sensing rotational movement	285
Sensing head position and acceleration	285
<i>Try It Yourself</i>	
A Model of Fluid Movement in the Semicircular Canals	285
<b>12.6 Vision: Detecting and interpreting visual stimuli</b>	<b>286</b>
Structure of the eye	286
Regulating the amount of light and focusing the image	287
Eyeball shape affects focus	288
<i>Try It Yourself</i>	
Find Your Blind Spot	288
Light is converted into action potentials	289
Rods and cones respond to light	289
Rods provide vision in dim light	290
Cones provide color vision and accurate images	291
Visual receptors adapt	291

**12.7 Disorders of sensory mechanisms 291**

Disorders of the ears 291

Disorders of the eyes 292

*Current Issue**Do Portable Music Players Endanger Your Hearing?* 294**13 The Endocrine System 297****13.1 The endocrine system produces hormones 298****13.2 Hormones are classified as steroid or nonsteroid 300**

Steroid hormones enter target cells 300

Nonsteroid hormones bind to receptors on target cell membranes 300

Hormones participate in negative feedback loops 301

**13.3 The hypothalamus and the pituitary gland 302**

The posterior pituitary stores ADH and oxytocin 302

The anterior pituitary produces six key hormones 303

Pituitary disorders: Hypersecretion or hyposecretion 305

**13.4 The pancreas secretes glucagons, insulin, and somatostatin 306****13.5 The adrenal glands comprise the cortex and medulla 307**

The adrenal cortex: Glucocorticoids and mineralocorticoids 307

The adrenal medulla: Epinephrine and norepinephrine 308

**13.6 Thyroid and parathyroid glands 308**

The thyroid gland: Thyroxine speeds cellular metabolism 309

Parathyroid hormone (PTH) controls blood calcium levels 310

**13.7 Testes and ovaries produce sex hormones 310**

Testes produce testosterone 310

Ovaries produce estrogen and progesterone 311

**13.8 Other glands and organs also secrete hormones 312**

Thymus gland hormones aid the immune system 312

The pineal gland secretes melatonin 312

Endocrine functions of the heart, the digestive system, and the kidneys 313

**13.9 Other chemical messengers 313**

Histamine is important in inflammation 313

Prostaglandins: Local control of blood flow 313

Nitric oxide has multiple functions 313

*Current Issue**Dealing with Diabetes* 314

Growth factors regulate tissue growth 316

**13.10 Disorders of the endocrine system 316**

Diabetes mellitus: Inadequate control of blood sugar 316

Hypothyroidism: Underactive thyroid gland 316

Hyperthyroidism: Overactive thyroid gland 316

Addison's disease: Too little cortisol and aldosterone 317

Cushing's syndrome: Too much cortisol 317

**14 The Digestive System and Nutrition 320****14.1 The digestive system brings nutrients into the body 321**

The walls of the GI tract are composed of four layers 321

Five basic processes accomplish digestive system function 322

Two types of motility aid digestive processes 323

**14.2 The mouth processes food for swallowing 323**

Teeth bite and chew food 323

The tongue positions and tastes food 324

Saliva begins the process of digestion 324

**14.3 The pharynx and esophagus deliver food to the stomach 325****14.4 The stomach stores food, digests protein, and regulates delivery 326**

Gastric juice breaks down proteins 326

Stomach contractions mix food and push it forward 326

**14.5 The small intestine digests food and absorbs nutrients 327**

The small intestine has a large surface area for absorption 328

**14.6 Accessory organs aid digestion and absorption 328**The pancreas secretes enzymes and  $\text{NaHCO}_3$  328

The liver produces bile and performs many other functions 329

*Directions in Science**Treating Peptic Ulcers* 330

The gallbladder stores bile until needed 331

**14.7 The large intestine absorbs nutrients and eliminates wastes 332****14.8 How nutrients are absorbed 332**

Proteins and carbohydrates are absorbed by active transport 332

Lipids are broken down, then reassembled 332

Water is absorbed by osmosis 333

Vitamins and minerals follow a variety of paths 333

**14.9 Endocrine and nervous systems regulate digestion 334**

Regulation depends on volume and content of food 334

Nutrients are used or stored until needed 334



Chapter 14, continued

- 14.10 Nutrition: You are what you eat 335**  
 MyPyramid plan offers a personalized approach 335  
 Carbohydrates: A major energy source 337  
 Lipids: Essential cell components and energy sources 337  
 Complete proteins contain every amino acid 338  
 Vitamins are essential for normal function 338  
 Minerals: Elements essential for body processes 340  
 Fiber benefits the colon 340
- 14.11 Weight control: Energy consumed versus energy spent 340**  
 BMR: Determining how many calories we need 340
- Try It Yourself*  
 Calculate Your BMR 340
- Energy balance and body weight 341  
 Physical activity: An efficient way to use Calories 342  
 Healthy weight improves overall health 342
- Try It Yourself*  
 What Is Your Body Mass Index? 342
- 14.12 Disorders of the digestive system 343**  
 Disorders of the GI tract 343  
 Disorders of the accessory organs 343
- Current Issue*  
 Weight-Loss Diets: Do They Work? 344
- Malnutrition: Too many or too few nutrients 346  
 Obesity: A worldwide epidemic? 346
- 14.13 Eating disorders: Anorexia nervosa and bulimia 347**

## 15 The Urinary System 350

- 15.1 The urinary system contributes to homeostasis 351**  
 The urinary system regulates waste levels 352  
 The urinary system regulates nitrogenous waste and other solutes 352
- 15.2 Organs of the urinary system 353**  
 Kidneys; the principle urinary organs 353  
 Ureters transport urine to the bladder 354  
 Urinary bladder stores urine 354  
 Urethra carries urine from the body 354
- 15.3 Nephrons produce urine 354**  
 The tubule filters fluid and reabsorbs substances 354  
 Special blood vessels supply the tubule 355
- 15.4 Formation of urine: Filtration, reabsorption, and secretion 356**  
 Glomerular filtration filters fluid from capillaries 356  
 Tubular reabsorption returns filtered water and solutes to blood 356

Tubular secretion removes other substances from blood 358

- 15.5 The kidneys can produce dilute or concentrated urine 359**  
 Producing dilute urine: Excreting excess water 359  
 Producing concentrated urine: Conserving water 359
- 15.6 Urination depends on a reflex 360**
- 15.7 The kidneys maintain homeostasis in many ways 361**  
 Water balance determines blood volume and blood pressure 362  
 Aldosterone, renin, and ADH control blood volume 363  
 Kidneys help maintain acid-balance and blood pH 364  
 Erythropoietin stimulates production of red blood cells 365  
 Kidneys activate vitamin D 365
- 15.8 Disorders of the urinary system 366**  
 Kidney stones can block urine flow 366  
 Urinary tract infections are often caused by bacteria 366  
 Acute and chronic renal failure impair kidney function 366  
 Dialysis cleanses the blood artificially 366
- Directions in Science*  
 Is It Safe to Donate a Kidney? 367
- Kidney transplants are a permanent solution to renal failure 367
- How Should We Allocate Scarce Organs? 368*

## 16 Reproductive Systems 372

- 16.1 The male reproductive system delivers sperm 373**  
 Testes produce sperm 373  
 Accessory glands help sperm survive 374  
 Sperm production requires several cell divisions 374  
 Testosterone affects male reproductive capacity 375
- 16.2 The female reproductive system produces eggs and supports pregnancy 376**  
 Ovaries release oocytes and secrete hormones 376  
 The uterus nurtures the fertilized egg 376  
 The vagina: Organ of sexual intercourse and birth canal 377  
 Mammary glands nourish the infant 378
- 16.3 Menstrual cycle consists of ovarian and uterine cycles 378**  
 The ovarian cycle: Oocytes mature and are released 378  
 The uterine cycle prepares the uterus for pregnancy 380  
 Cyclic changes in hormone levels produce the menstrual cycle 381

- 16.4 Human sexual response, intercourse, and fertilization 382**  
*Health Watch*  
*Erectile Dysfunction and Viagra Abuse 383*  
 The male sexual response 383  
 The female sexual response 384  
 Fertilization: One sperm penetrates the egg 384
- 16.5 Birth control methods: Controlling fertility 384**  
 Abstinence: Not having intercourse 384  
 Surgical sterilization: Vasectomy and tubal ligation 384  
 Hormonal methods: Pills, injections, patches, and rings 385  
 IUDs are inserted into the uterus 387  
 Diaphragms and cervical caps block the cervix 387  
 Chemical spermicides kill sperm 387  
 Condoms trap ejaculated sperm 387
- Do Natural Membrane Condoms Leak More than Latex Condoms? 387*  
 Withdrawal and periodic abstinence 388  
 Pills that can be used after intercourse 388  
 Elective abortion 388  
 The future in birth control 388
- 16.6 Infertility: Inability to conceive 388**  
 Infertility can have many causes 389  
 Enhancing fertility 389
- Directions in Science*  
*Assisted Reproductive Technologies 390*
- 16.7 Sexually transmitted diseases: A worldwide concern 391**  
 Bacterial STDs: Gonorrhea, syphilis, and chlamydia 391  
 Viral STDs: AIDS, hepatitis B, genital herpes, and genital warts 393  
 Other STDs: Yeast infections, trichomoniasis, and public lice 393
- Would You Like a Boy or a Girl? 394*  
 Protecting Yourself Against STDs 396
- 17 Cell Reproduction and Differentiation 399**
- 17.1 The cell cycle creates new cells 400**
- 17.2 Replication, transcription, and translation: An overview 401**  
 Replication: Copying DNA before cell division 402  
 Transcription: Converting a gene's code into mRNA 405  
 Translation: Making a protein from RNA 406
- 17.3 Cell reproduction: One cell becomes two 408**  
 Mitosis: Daughter cells are identical to the parent cell 408  
 Cytokinesis divides one cell into two identical cells 408  
 Mitosis produces diploid cells and meiosis produces haploid cells 409  
 Meiosis: Preparing for sexual reproduction 409  
 Sex differences in meiosis: Four sperm versus one egg 409
- 17.4 How cell reproduction is regulated 411**
- 17.5 Environmental factors influence cell differentiation 412**  
 Differentiation during early development 412  
 Differentiation later in development 413
- Should We Clone Humans? 414*
- 18 Cancer: Uncontrolled Cell Division and Differentiation 419**
- 18.1 Tumors can be benign or cancerous 420**
- 18.2 Cancerous cells lose control of their functions and structures 420**
- 18.3 How cancer develops 422**  
 Mutant forms of proto-oncogenes, tumor suppressor genes, and mutation genes contribute to cancer 422  
 A variety of factors can lead to cancer 423  
 The immune system plays an important role in cancer prevention 424
- 18.4 Advances in diagnosis enable early detection 425**  
 Tumor imaging: X-rays, PET, and MRI 425  
 Genetic testing can identify mutated genes 426  
 Enzyme tests may identify cancer markers 427
- 18.5 Cancer treatments 427**  
 Conventional cancer treatments: Surgery, radiation, and chemotherapy 427  
 Magnetism and photodynamic therapy target malignant cells 427  
 Immunotherapy promotes immune response 427  
 "Starving" cancer by inhibiting angiogenesis 427  
 Molecular treatments target defective genes 428
- 18.6 The 10 most common cancers 428**  
 Skin cancer: Look for changes in your skin 428  
 Prostate cancer: Most common after age 50 428
- Health Watch*  
*Examining Yourself for Breast Cancer 430*  
 Breast Cancer: Early Detection Pays Off 430

*Chapter 18, continued*

*Health Watch*

*Examining Yourself for Testicular Cancer* 431

Lung cancer: Smoking is leading risk factor 431

Cancers of colon and rectum: Tests can detect them early 431

Lymphoma: Cancers of lymphoid tissues 432

Urinary bladder cancer: Surgery is often successful if done early 432

Cancer of the uterus: Unusual uterine bleeding is major symptom 432

Kidney cancer: Detected during examination for a renal-related problem 432

Leukemia: Chemotherapy is often effective 433

**18.7 Most cancers can be prevented 433**

*Current Issue*

*Experimental Cancer Vaccines: Is Restricted Access in the Best Public Interest?* 434

**19 Genetics and Inheritance 438**

**19.1 Your genotype is the genetic basis of your phenotype 439**

**19.2 Genetic inheritance follows certain patterns 440**

Punnett square analysis predicts patterns of inheritance 440

Mendel developed the basic rules of inheritance 440

Dominant alleles are expressed over recessive alleles 441

*Try It Yourself*

*Calculating the Probability of Inheriting a Dominant Trait* 441

Incomplete dominance: The heterozygote is an intermediate phenotype 442

Codominance: Both gene products are equally expressed 442

*Health Watch*

*Cystic Fibrosis* 444

Polygenic inheritance: Phenotype is influenced by many genes 444

Both genotype and the environment affect phenotype 445

Linked genes may or may not be inherited together 446

**19.3 Sex-linked inheritance: X and Y chromosomes carry different genes 446**

The sex chromosomes may have originated by chance mutations 447

Sex-linked inheritance depends on genes located on sex chromosomes 447

Sex-influenced traits are affected by actions of sex genes 448

**19.4 Chromosomes may be altered in number or structure 448**

Down syndrome: Three copies of chromosome 21 448

Alterations of the number of sex chromosomes 449

*Try It Yourself*

*Estimating the Probability of Inheriting an X-linked Trait* 449

Deletion and translocations alter chromosome structure 450

**19.5 Many inherited genetic disorders involve recessive alleles 451**

Phenylketonuria is caused by a missing enzyme 451

Tay-Sachs disease leads to brain dysfunction 451

Huntington disease is caused by a dominant-lethal allele 451

*Current Issue*

*The Promises and Perils of Genetic Testing* 452

**19.6 Genes code for proteins, not for specific behaviors 454**

**20 DNA Technology and Genetic Engineering 457**

**20.1 DNA sequencing reveals structure of DNA 458**

**20.2 DNA can be modified in the laboratory 459**

Recombinant DNA technology: Cutting, splicing, and copying DNA 460

**20.3 Genetic engineering creates transgenic organisms 461**

Transgenic bacteria have many uses 461

*Directions in Science*

*DNA Fingerprinting* 463

Transgenic plants: More vitamins and better resistance 464

Transgenic animals: A bigger challenge 465

**20.4 Gene therapy: The hope for the future? 465**

Gene therapy must overcome many obstacles 465

Vectors transfer genes into human cells 466

*Current Issue*

*Are Genetically Modified Foods Safe?* 468

Success with SCID gives hope 470

Research targets cystic fibrosis and cancer 471

**21 Development and Aging 474**

**21.1 Fertilization occurs when sperm and egg unite 475**

The journeys of egg and sperm 475

One sperm fertilizes the egg	475	Comparative biochemistry examines similarities between molecules	504
Twins may be fraternal or identical	477	Biogeography: The impact of geographic barriers and continental drift on evolutionary process	504
<b>21.2 Development: Cleavage, morphogenesis, differentiation, and growth</b>	<b>478</b>	<b>22.2 Natural selection contributes to evolution</b>	<b>505</b>
<b>21.3 Pre-embryonic development: The first two weeks</b>	<b>478</b>	Random mutations underlie evolution	505
<b>21.4 Embryonic development: Weeks three to eight</b>	<b>479</b>	Natural selection encourages changes in the gene pool	505
Tissues and organs derive from three germ layers	479	Genetic drift and gene flow alter populations	505
Extra-embryonic membranes and the placenta	480	Mass extinctions eliminate many species	505
The embryo develops rapidly	482	Evolutionary trees trace relationships between species	506
<b>21.5 Fetal development: Nine weeks to birth</b>	<b>483</b>	<b>22.3 The young earth was too hot for life</b>	<b>507</b>
<i>Directions in Science</i>		<b>22.4 The first cells were able to live without oxygen</b>	<b>507</b>
<i>Prenatal Diagnostic Techniques</i>	484	Organic molecules formed from atmospheric gases	507
Months three and four	484	Self-replicating RNA and DNA formed	508
Months five and six	485	The first living cells were anaerobic	508
Months seven through nine	486	<b>22.5 Photosynthetic organisms altered the course of evolution</b>	<b>508</b>
<b>21.6 Birth and the early postnatal period</b>	<b>486</b>	Photosynthesis increased oxygen in the atmosphere	508
Labor ends in delivery	486	Aerobic organisms evolved	508
Cesarean delivery: Surgical delivery of a baby	487	The rise of animals and our human ancestors	508
The transition from fetus to newborn	488	<b>22.6 Modern humans came from Africa</b>	<b>509</b>
Lactation produces milk to nourish the newborn	488	Humans are primates	509
<b>21.7 From birth to adulthood</b>	<b>489</b>	Evolution of <i>Homo sapiens</i>	510
The neonatal period: A helpless time	490	Differences within the human species	512
Infancy: Rapid development and maturation of organ systems	490	<i>Current Issue</i>	
Childhood: Continued development and growth	490	<i>The Mystery of the Flores People</i>	514
Adolescence: The transition to adulthood	491	<b>23 Ecosystems and Populations</b>	<b>517</b>
<b>21.8 Aging takes place over time</b>	<b>491</b>	<b>23.1 Ecosystems: Communities interact with their environment</b>	<b>518</b>
What causes aging?	492	<b>23.2 Populations: The dynamics of one species in an ecosystem</b>	<b>518</b>
Body systems age at different rates	493	Where a species lives: Habitat and range	518
<i>Directions in Science</i>		Population growth rate tends toward biotic potential	519
<i>Hormone Replacement Therapy: Helpful or Harmful?</i>	494	Environmental resistance limits biotic potential	520
Aging well	495	<i>Try It Yourself</i>	
<b>21.9 Death is the final transition</b>	<b>495</b>	<i>The Rule of 72</i>	520
<i>Current Issue</i>		<b>23.3 Human population growth</b>	<b>520</b>
<i>Who Should Make Life and Death Decisions for You?</i>	496	Fertility rates differ around the world	521
<b>22 Evolution and the Origins of Life</b>	<b>499</b>	Population age structure is linked to economic development	522
<b>22.1 Evidence for evolution comes from many sources</b>	<b>500</b>		
The fossil record: Incomplete but valuable	500		
Comparative anatomy and embryology provide more evidence	503		

*Chapter 23, continued*

<b>23.4 Communities: Different species living together</b>	<b>523</b>
Overlapping niches foster competition	523
Succession leads toward a climax community	523
Ecosystems: Communities and their physical environment	524
<b>23.5 Energy flows through ecosystems</b>	<b>524</b>
Producers capture and convert energy, consumers rely on stored energy	524
A food web: Interactions among producers and consumers	527
The lower levels of an ecological pyramid support consumer populations	527
Human activities disrupt ecological pyramids	527
<b>23.6 Chemical cycles recycle molecules in ecosystems</b>	<b>528</b>
The water cycle is essential to other biogeochemical cycles	528
The carbon cycle: Organisms exchange CO <sub>2</sub> with the atmosphere	528
Nitrogen: An essential component of nucleic acids and proteins	529
Phosphorus: A sedimentary cycle	530
<i>Try It Yourself</i>	
How Much Water Do You Use Each Day?	530
<i>Current Issue</i>	
Bird Flu: Will It Cause a Worldwide Pandemic in Humans?	532

## **24 Human Impacts, Biodiversity, and Environmental Issues 536**

<b>24.1 Pollutants impair air quality</b>	<b>537</b>
Excessive greenhouse gases could cause global warming	537
CFCs deplete the ozone layer	538

Pollutants produce acid rain	539
Smog blankets industrial areas	539

<b>24.2 Pollution jeopardizes scarce water supplies</b>	<b>539</b>
Water is scarce and unequally distributed	540
Human activities pollute freshwater	540

*Try It Yourself*

Calculating the CO <sub>2</sub> Emissions of Your Vehicle	540
---	-----

Groundwater pollution may impair human health	541
Oil pollution damages oceans and shorelines	541

<b>24.3 Pollution and overuse damage the land</b>	<b>542</b>
---	------------

<b>24.4 Energy: Many options, many choices</b>	<b>543</b>
--	------------

<b>24.5 Human impacts are creating a biodiversity crisis</b>	<b>544</b>
Humans alter and destroy habitats	544
Biodiversity is healthy for humans too	544

<b>24.6 Toward a sustainable future</b>	<b>545</b>
---	------------

*Current Issue*

The Debate over Global Warming	546
--------------------------------	-----

<b>Glossary</b>	<b>G-1</b>
-----------------	------------

<b>Answers to Test Yourself Questions</b>	<b>A-1</b>
---	------------

<b>Credits</b>	<b>C-1</b>
----------------	------------

<b>Index</b>	<b>I-1</b>
--------------	------------