

# Contents

Preface xi  
Acknowledgments xiii

## **PART I History and Current Status of the Study of Physical Activity and Health**

---

- 1 Why Study Physical Activity and Health? 3**  
**Claude Bouchard, PhD; Steven N. Blair, PED; and William L. Haskell, PhD**  
Human Evolution, History, and Physical Activity 4 • Burden of Chronic Diseases 6 • Health and Its Determinants 9 • Aging and Health 11 • Defining Physical Activity and Physical Fitness 12 • Physical Inactivity Versus Physical Activity 14 • Summary 18 • Review Materials 19
- 2 Historical Perspectives on Physical Activity, Fitness, and Health 21**  
**Russell R. Pate, PhD**  
Early Beliefs About Physical Activity and Health 22 • Scientific Inquiry on Exercise and Health 24 • Evolution of Physical Activity Guidelines 27  
Summary 35 • Review Materials 35
- 3 Physical Activity and Fitness With Age, Sex, and Ethnic Differences 39**  
**Peter T. Katzmarzyk, PhD, FACSM**  
Physical Activity 40 • Physical Fitness 45 • Summary 50 • Review Materials 50
- 4 Sedentary Behavior and Inactivity Physiology 53**  
**Marc Hamilton, PhD; and Neville Owen, PhD**  
Sedentary Behavior, Physical Activity, and Public Health 54 • Inactivity Physiology: The Underlying Biology of Acute and Chronic Muscular Inactivity 58 • Sedentary Behavior and Metabolic Health: Emerging Epidemiological Evidence 62 • Humans May Not Have Reached the Pinnacle of Physical Inactivity 64 • A Comprehensive Sedentary Behavior Research Agenda 65 • Public Health Implications 66 • Summary 66 • Review Materials 66

## **PART II Effects of Physical Activity on the Human Organism**

- 5 Metabolic, Cardiovascular, and Respiratory Responses to Physical Activity** **71**  
**Edward T. Howley, PhD**  
 Relationship of Energy to Physical Activity 72 • Oxygen Consumption and Cardiovascular and Respiratory Responses to Exercise 73 • Effect of Training, Age, and Gender on Maximal Oxygen Uptake 81 • Application to Exercise Training and Physical Activity Interventions 82 • Summary 83 • Review Materials 84
- 6 Acute Responses to Physical Activity and Exercise** **87**  
**Adrienne E. Hardman, MSc, PhD**  
 Lipids and Lipoproteins 88 • Endothelial Function 91 • Insulin–Glucose Dynamics 91 • Blood Pressure 94 • Hematological Changes 95 • Immune Function and Inflammation 96 • Responses Related to Energy Balance 98 • Augmentation of Acute Effects by Training 100 • Summary 101 • Review Materials 101
- 7 Hormonal Response to Regular Physical Activity** **103**  
**Peter A. Farrell, PhD**  
 Defining Hormones 104 • Importance of Hormonal Regulation 106 • Regular Physical Activity and Hormonal Adaptations 112 • Summary 118 • Review Materials 118
- 8 Skeletal Muscle Adaptation to Regular Physical Activity** **121**  
**Howard J. Green, PhD**  
 Skeletal Muscle and Human Survival 122 • Muscle Cell: Composition, Structure, and Function 123 • Muscle Fiber Types and Subtypes 129 • Muscle Adaptation and Functional Consequences 135 • Aging Muscle: The Role of Training 144 • Summary 146 • Review Materials 146
- 9 Response of Liver, Kidney, and Other Organs and Tissues to Regular Physical Activity** **149**  
**Roy J. Shephard, MB, BS, MD (London), PhD, DPE, DLL**  
 Acute Effects of Physical Activity 150 • Chronic Effects of Physical Activity 155 • Strengths and Limitations of the Current Evidence 159 • Summary 160 • Review Materials 160

## PART III Physical Activity, Fitness, and Health

- 10 Physical Activity, Fitness, and Mortality Rates** **167**  
**Michael J. LaMonte, PhD, MPH\***; and **Steven N. Blair, PED**  
**\*Corresponding Author**  
 Physical Activity and Mortality 169 • Fitness and Mortality 174 • Activity or Fitness and Mortality in Adults With Existing Diseases 178 • Quantifying the Population Mortality Burden of Inactivity 180 • Summary 181 • Review Materials 181
- 11 Physical Activity, Fitness, and Cardiac, Vascular, and Pulmonary Morbidities** **185**  
**Ian Janssen, PhD**  
 Low Physical Activity and Low Cardiorespiratory Fitness as Risk Factors for Cardiovascular Morbidities 186 • Low Physical Activity and Low Cardiorespiratory Fitness as Risk Factors for Pulmonary Morbidities 189 • Biological Mechanisms 190 • Role of Physical Activity in Patients with Cardiac, Vascular, and Pulmonary Morbidities 191 • Summary 193 • Review Materials 193
- 12 Physical Activity, Fitness, and Obesity** **197**  
**Robert Ross, PhD, FACSM; and Ian Janssen, PhD**  
 Definition and Problem of Overweight and Obesity 198 • Fat Depots 201 • Relationships Among Excess Weight, Physical Activity, and Fitness 204 • Role of Physical Activity in Prevention and Treatment of Excess Weight 207 • Summary 211 • Review Materials 212
- 13 Physical Activity, Fitness, and Diabetes Mellitus** **215**  
**Roeland J. Middelbeek, MD, MS; and Laurie J. Goodyear, PhD**  
 Diabetes: Definitions and Prevalence 216 • Epidemiology, Etiology, and Complications of Type 2 Diabetes 216 • Impact of Physical Activity on Insulin and Glucose Metabolism 220 • Epidemiological Evidence Indicating Benefits of Physical Activity in Preventing Type 2 Diabetes 223 • Summary of Randomized Controlled Trials on the Prevention of Type 2 Diabetes 225 • Importance of Regular Physical Activity for People With Type 2 Diabetes 226 • Summary 227 • Review Materials 227
- 14 Physical Activity, Fitness, and Cancer** **231**  
**I-Min Lee, MBBS, MPH, ScD**  
 Importance of Cancer 232 • How Physical Activity and Physical Fitness Decrease the Risk of Developing Cancer 233 • How We Study Whether Physical Activity and Physical Fitness Decrease the Risk of Developing Cancer 234 • Physical Activity, Physical Fitness, and Site-Specific Cancers 236 • Physical Activity and Cancer Survivors 241 • Summary 241 • Review Materials 242

- 15 Physical Activity, Fitness, and Joint and Bone Health** **245**  
**Jennifer M. Hootman, PhD, ATC, FACSM, FNATA**  
 Scientific Evidence 246 • Strengths and Limitations of the Evidence 252 • Summary 253 • Review Materials 254
- 16 Physical Activity, Muscular Fitness, and Health** **257**  
**Neil McCartney, PhD; and Stuart M. Phillips, PhD**  
 History of Resistance Training and Its Role in Health 258 • Fundamental Aspects of Resistance Training 258 • Resistance Training Throughout the Life Span 263 • Resistance Training in Disease and Disability 265 • Summary 270 • Review Materials 271
- 17 Physical Activity, Fitness, and Children** **273**  
**Thomas Rowland, MD**  
 Understanding the Exercise–Health Link in Children 275 • Measurement of Physical Activity in Youth 279 • Defining the Kinds and Amount of Physical Activities for Health 281 • Optimal Intervention Strategies 283 • Biological Effects on Physical Activity in Youth 284 • Summary 284 • Review Materials 284
- 18 Risks of Physical Activity** **287**  
**Evert A.L.M. Verhagen, PhD, FECSS; Esther M.F. van Sluijs, PhD; and Willem van Mechelen, MD, PhD, FACSM, FECSS**  
 Risks of Physical Activity and Sport Participation 288 • Minimizing Risk and Maximizing Benefits 294 • Recommendations for Future Research 297 • Summary 297 • Review Materials 298

---

**PART IV Physical Activity, Fitness, Aging, and Brain Functions**

---

- 19 Physical Activity, Fitness, and Aging** **303**  
**Loretta DiPietro, PhD, MPH**  
 The Aging Process 304 • Methodological Considerations in Aging Research 307 • Demographics of Physical Activity Among Older Adults 309 • Dimensions of Physical Activity and Their Relationship to Health and Function in Aging 312 • Programmatic Issues in Promoting Physical Activity in Older Populations 314 • Summary 315 • Review Materials 315
- 20 Physical Activity and Brain Functions** **317**  
**Kirk I. Erickson, PhD**  
 Descriptive Questions 319 • Mechanistic Questions 323 • Applied Questions: Populations Benefiting From Physical Activity 326 • Moderating Questions: Factors Moderating the Effect of Physical Activity 327 • Summary 328 • Review Materials 328

- 21 Exercise and Its Effects on Mental Health** 331  
**John S. Raglin, PhD; and Gregory S. Wilson, PED, FACSM**  
 Research Paradigms of Exercise and Mental Health Research 332 • Exercise and Depression 334 • Exercise and Anxiety 335 • Exercise and Schizophrenia 337 • Putative Mechanisms for the Psychological Benefits of Exercise 337 • Detrimental Psychological Responses to Exercise: The Overtraining Syndrome 338 • Summary 340 • Review Materials 341

## **PART V How Much Is Required and How Do We Get There?**

- 22 Dose–Response Issues in Physical Activity, Fitness, and Health** 345  
**William L. Haskell, PhD**  
 Principles Guiding the Body's Response to Activity 346 • Components of the Physical Activity Dose 347 • Factors Determining Optimal Activity Dose 349 • Physical Activity and Fitness: Dose for Health Benefits 355 • Summary 357 • Review Materials 357
- 23 From Science to Physical Activity Guidelines** 359  
**Mark S. Tremblay, PhD; and William L. Haskell, PhD**  
 Stages of Physical Activity Guideline Development 360 • Strengths, Limitations, and Challenges 370 • Summary 376 • Review Materials 376

## **PART VI New Challenges and Opportunities**

- 24 Genetic Differences in the Relationships Among Physical Activity, Fitness, and Health** 381  
**Tuomo Rankinen, PhD; and Claude Bouchard, PhD**  
 Basics of Human Genetics 382 • Events in Human Genes and Genomes 386 • Genetic Variation in Exercise Traits Among Sedentary People 392 • Genetics of Physical Activity Level 394 • Individual Differences in Response to Regular Exercise 394 • Genes and Responses to Exercise 395 • Trait-Specific Response to Exercise 403 • Personalized Exercise Medicine 405 • Summary 406 • Review Materials 406
- 25 An Integrated View of Physical Activity, Fitness, and Health** 409  
**William L. Haskell, PhD; Steven N. Blair, PED; and Claude Bouchard, PhD**  
 Physical Activity Versus Inactivity: Universal Value Versus Damaging Consequences 410 • Developing and Implementing Physical Activity Plans 415 • Research Questions and Issues 422 • Summary 423 • Review Materials 423

Index 427

About the Contributors 435

About the Editors 440