

Contents

Preface	ix
Acknowledgments	xi
Accessing and Using the Web Resource	xiii

PART I **PHYSIOLOGICAL ADAPTATIONS TO EXERCISE 1**

Chapter 1 Neuromuscular System and Exercise 3

Muscle Structure	3
Muscle Contraction	4
Neuromuscular System	7
Muscle Fiber Types	8
Muscle Recruitment	9
Muscle Proprioceptors	10
Neuromuscular Adaptations to Exercise Training	10
Summary	18
Review Questions	18

Chapter 2 Endocrine System and Exercise 19

Overview of the Endocrine System	19
Hormonal Transport and Binding	
Proteins	23
Hormones and Exercise	24
Metabolic Hormones	34
Fluid Regulatory Hormones	36
Opioids and Exercise	38
Summary	38
Review Questions	39

Chapter 3 Metabolic System and Exercise 41

ATP-PC Energy Source	42
Glycolytic Energy Source	43
Lactic Acid	
Controversy	45
Lactate Shuttle	45
Oxidative Energy Source	45
Interaction of the Energy Sources	47
Metabolic Adaptations to Endurance Training	47
Metabolic Adaptations to Anaerobic Exercise	51
Summary	54
Review Questions	54

Chapter 4 Cardiovascular System and Exercise 55

Overview of Cardiovascular System	55
Overview of Respiratory System	62
Cardiovascular Response to Acute Exercise	66
Pulmonary Ventilation During Exercise	69
Cardiovascular Response to Training	70
Respiratory Adaptations to Training	73
Training Effects on Minute Ventilation and Ventilatory Equivalent	73
Effect of Training on Blood Volume and Red Blood Cells	74
Summary	75
Review Questions	75

Chapter 5 Immunological System and Exercise 77

Cells of the Immune System	78
Lymphocytes	79
Immunoglobulins	80
Cytokines	80
Complement System	81
Acute-Phase Proteins	81
Exercise and Immune Response	82
Summary	89
Review Questions	90

PART II EXERCISE TRAINING PRINCIPLES AND PRESCRIPTIONS . . . 91

Chapter 6 Principles of Training 93

Specificity Principle 93 • Overload Principle 94 • Progression Principle 94 •
Individuality Principle 94 • Principle of Diminishing Returns 94 • Principle of
Reversibility 97 • Summary 101 • Review Questions 102

Chapter 7 Warm-Up, Flexibility, and Balance Training 103

Warm-Up 103 • Flexibility 107 • Stability and Balance Training 114 •
Summary 115 • Review Questions 115

Chapter 8 Resistance Training 117

Resistance Training Program Development 117 • Various Modes of Resistance
Training 123 • Alternative Methods of Resistance Training 126 • Resistance Training
Effects on the Components of Fitness 127 • Women and Resistance Training 134 •
Examples of Resistance Training Programs 134 • Summary 137 •
Review Questions 137

Chapter 9 Power Training 139

Scientific Basis for Power Training 139 • Relationship Between Force, Velocity, and
Power 141 • Training Methods for Power Development 143 • Plyometrics 143 •
Ballistic Training 151 • Olympic Weightlifting 153 • Summary 153 • Review
Questions 153

Chapter 10 Anaerobic Conditioning 155

Importance of Anaerobic Conditioning 155 • Selection of Rest Intervals for Anaerobic
Conditioning 162 • Anaerobic Conditioning Exercises 164 • Summary 166 •
Review Questions 167

Chapter 11 Speed and Agility Development 169

Speed Development 169 • Agility Development 175 • Summary 179 •
Review Questions 180

Chapter 12 Endurance Training 181

Physiological Adaptations to Endurance Training 181 • Factors Relating to Endurance
Performance 182 • Endurance Exercise Prescription 186 • Endurance Training
Programs 188 • Summary 193 • Review Questions 193

Chapter 13 Concurrent Training 195

Effect of Concurrent Strength and Endurance Training on $\dot{V}O_2$ 195 • Effect of Concurrent Strength and Endurance Training on Maximal Strength 197 • Effect of Sequence of Training on Endurance and Strength Improvements 199 • Effect of Concurrent Training on Muscle Growth and Muscle Fiber Characteristics 200 • Effect of Concurrent Training on Protein Signaling 202 • Effect of Concurrent Training on Hormonal Adaptations 202 • Effect of Concurrent Training on Basal Metabolic Rate and Weight Loss 203 • Effects of Combined Sprint and Resistance Training 204 • Summary 205 • Review Questions 205

Chapter 14 Periodization 207

Periodization for All Disciplines 207 • Models of Periodization 210 • Efficacy of Periodization 210 • Periodized Training Program for a Strength–Power Athlete in a Team Sport 213 • Periodized Training Program for a Strength–Power Athlete Preparing for a Specific Event 215 • Periodized Training Program for an Endurance Athlete 217 • Summary 218 • Review Questions 218

Chapter 15 Program Development and Implementation 219

Training Sessions 219 • Off-Season Training Program 220 • Preparatory–Hypertrophy Phase 222 • Strength Phase 224 • Competitive Season (Maintenance Phase) 230 • Training Program Considerations for Aerobic Endurance Athletes 230 • Summary 235 • Review Questions 235

Chapter 16 Athletic Performance Testing and Normative Data . 237

Factors Affecting Performance Testing 238 • Administrative Considerations for Assessment 239 • Tests for Needs Assessment and Program Evaluation 241 • Strength 242 • Anaerobic Power and Anaerobic Fitness 247 • Maximal Aerobic Capacity and Aerobic Endurance 252 • Speed 257 • Agility 259 • Body Composition 260 • Summary 267 • Review Questions 267

PART III NUTRITION, FLUID REGULATION, AND NUTRITIONAL SUPPLEMENTATION 269

Chapter 17 Sports Nutrition 271

Classes of Nutrients and Their Functions 272 • Nutrient Utilization in Athletic Performance 279 • Timing of Nutritional Intake 284 • Summary 288 • Review Questions 288

Chapter 18 Hydration 289

Water Balance at Rest and During Exercise 290 ▪ Effects of Hypohydration on Physiological Function 290 ▪ Electrolyte Balance During Exercise 292 ▪ Effects of Hypohydration on Performance 292 ▪ Fluid Replacement During Exercise 295 ▪ Summary 300 ▪ Review Questions 301

Chapter 19 Dietary Supplementation 303

Dietary Supplement Regulation 304 ▪ Dietary Supplements for Muscle Growth and Strength–Power Development 305 ▪ Creatine 310 ▪ β -Hydroxy- β -Methylbutyrate 315 ▪ Dietary Supplements for Intracellular and Intercellular Buffering 316 ▪ Dietary Supplements for Energy 321 ▪ Popular Dietary Supplements That May Have Ergogenic Potential 327 ▪ Summary 329 ▪ Review Questions 330

Chapter 20 Performance-Enhancing Drugs 331

Anabolic Steroids 331 ▪ Testosterone Precursors 340 ▪ Masking Agents 342 ▪ Human Chorionic Gonadotropin 343 ▪ Anti-Estrogens 343 ▪ Growth Hormone 344 ▪ Thyroid Drugs 345 ▪ Central Nervous System Stimulants 346 ▪ Site Enhancement Drugs 348 ▪ Blood Doping 348 ▪ Erythropoietin 348 ▪ β -Blockers 349 ▪ Summary 349 ▪ Review Questions 350

PART IV ENVIRONMENTAL FACTORS 351**Chapter 21 Heat 353**

Physiological Response to Exercise in the Heat 353 ▪ Heat and Performance 357 ▪ Heat Acclimatization 358 ▪ Heat Illnesses 360 ▪ Monitoring Heat Stress 362 ▪ Heat Stress Indices 363 ▪ Summary 364 ▪ Review Questions 364

Chapter 22 Cold 365

Cold Stress: Factors Contributing to Heat Loss 365 ▪ Physiological Responses to Exercise in the Cold 366 ▪ Acclimatization to the Cold 369 ▪ Exercise Performance and the Cold 370 ▪ Medical Concerns 372 ▪ Summary 376 ▪ Review Questions 376

Chapter 23 Altitude 377

The Hypobaric Environment 377 ▪ Physiological Response to Altitude 379 ▪ Effect of Altitude on Athletic Performance 381 ▪ Altitude Acclimatization 382 ▪ Chronic Altitude Exposure and Benefits for Endurance Performance 386 ▪ Training at Altitude for Improved Performance at Altitude 387 ▪ Training at Altitude for Improved Performance at Sea Level 388 ▪ Simulated Altitude and Ethical Issues 389 ▪ Clinical Problems Associated With Acute Exposure to Altitude 390 ▪ Summary 391 ▪ Review Questions 392

PART V MEDICAL AND HEALTH CONDITIONS. 393

Chapter 24 Overtraining 395

Definitions of Overtraining 396 • Contributing Factors 396 • Comparison of Endurance and Strength–Power Athletes 397 • Susceptibility to Overtraining 397 • Recognition of Overtraining 398 • Methods Used to Monitor Athletic Performance 404 • Treatment of Overtraining 410 • Summary 410 • Review Questions 411

Chapter 25 Diabetes 413

Overview of Diabetes Mellitus 413 • Exercise and Diabetes 416 • Exercise Prescription for Athletes With Diabetes 421 • Exercise Prescription for Noncompetitive, Recreational Athletes With Diabetes 423 • Summary 423 • Review Questions 423

Chapter 26 Exercise-Induced Bronchospasm 425

What Is Exercise-Induced Bronchospasm? 426 • Pathophysiology of EIB 427 • Diagnosis of EIB 428 • Factors Modifying the Asthmatic Response to Exercise 429 • Treatment of EIB 430 • How to Exercise With Asthma (Nonpharmacologic Therapy) 431 • Summary 433 • Review Questions 433

Chapter 27 Sudden Death in Sport 435

Sickle Cell Trait 435 • Exertional Heatstroke 437 • Cardiac Events 439 • Traumatic Brain Injury 442 • Summary 445 • Review Questions 446

References 447

Index 495

About the Author 505

Organization

Physiological Aspects of Sport Training and Performance, Second Edition is organized into five parts. Part I examines physiological adaptation and the effects of various modes of training (aerobic, anaerobic, and resistance) on biochemical, hormonal, muscular, cardiovascular, neural, and immunological adaptations. These adaptations are discussed as they relate to the training level of the athlete and their impact on sport performance.

Part II covers exercise training principles and prescription. Each chapter describes in detail the

Updates to the Second Edition

Many of the updates in this second edition focus on relevant issues that have come to the forefront in sport science and sports medicine over the past few years. This second edition presents a more in-depth discussion on sport supplementation and performance-enhancing drugs. New content has been added on power training, speed and agility development, and goals and program development. In addition, two new chapters have been added to this edition: a chapter on sudden death and a chapter providing a practical approach to developing the yearly training program.

This new edition also features two new pedagogical aids: chapter objectives, which help students and instructors tell at a glance what is covered in the chapter, and chapter review questions, which help