

THIRD EDITION

ESSENTIALS of STRENGTH TRAINING and CONDITIONING

NATIONAL STRENGTH AND
CONDITIONING ASSOCIATION

THOMAS R. BAECHLE
ROGER W. EARLE

editors

Contents

Contributors vii ✎ Contributors to Previous Editions viii ✎ Preface ix
Acknowledgments xii ✎ Credits xiii

1

Section Concepts and Applications of the Exercise Sciences 1

CHAPTER 1 Structure and Function of the Muscular, Neuromuscular, Cardiovascular, and Respiratory Systems 3

Gary R. Hunter, PhD, and Robert T. Harris, PhD

Muscular System 4 ✎ Neuromuscular System 8 ✎ Cardiovascular System 13 ✎ Respiratory System 17 ✎ Conclusion 19 ✎ Learning Aids 19

CHAPTER 2 Bioenergetics of Exercise and Training 21

Jcel T. Cramer, PhD

Essential Terminology 22 ✎ Biological Energy Systems 23 ✎ Substrate Depletion and Repletion 33 ✎ Bioenergetic Limiting Factors in Exercise Performance 34 ✎ Oxygen Uptake and the Aerobic and Anaerobic Contributions to Exercise 35 ✎ Metabolic Specificity of Training 36 ✎ Conclusion 38 ✎ Learning Aids 38

CHAPTER 3 Endocrine Responses to Resistance Exercise 41

William J. Kraemer, PhD, Jakob L. Vangren, PhD, and Barry A. Sperling, PhD

Synthesis, Storage, and Secretion of Hormones 42 ✎ Muscle as the Target for Hormone Interactions 43 ✎ Role of Receptors in Mediating Hormonal Changes 45 ✎ Steroid Hormones Versus Polypeptide Hormones 47 ✎ Heavy Resistance Exercise and Hormonal Increases 49 ✎ Mechanisms of Hormonal Interactions 50 ✎ Hormonal Changes in Peripheral Blood 51 ✎ Adaptations in the Endocrine System 52 ✎ Primary Anabolic Hormones 52 ✎ Adrenal Hormones 61 ✎ Other Hormonal Considerations 63 ✎ Conclusion 64 ✎ Learning Aids 64

CHAPTER 4 Biomechanics of Resistance Exercise 65

Everett Harman, PhD

Musculoskeletal System 66 ✎ Human Strength and Power 73 ✎ Sources of Resistance to Muscle Contraction 79 ✎ Joint Biomechanics: Concerns in Resistance Training 84 ✎ Movement Analysis and Exercise Prescription 87 ✎ Conclusion 90 ✎ Learning Aids 90

CHAPTER 5 Adaptations to Anaerobic Training Programs 93

Nicholas A. Ratamess, PhD

Neural Adaptations 94 ✎ Muscular Adaptations 99 ✎ Connective Tissue Adaptations 103 ✎ Endocrine Responses and Adaptations to Anaerobic Training 108 ✎ Cardiovascular and Respiratory Responses to Acute Exercise 110 ✎ Compatibility of Aerobic and Anaerobic Modes of Training 112 ✎ Overtraining 114 ✎ Detraining 116 ✎ Conclusion 118 ✎ Learning Aids 118

CHAPTER 6 Adaptations to Aerobic Endurance Training Programs . . . 121

Ann Swank, PhD

Acute Responses to Aerobic Exercise 122 Chronic Adaptations to Aerobic Exercise 127 Designing Aerobic Endurance Programs for Optimizing Adaptations 131 External Influences on the Cardiorespiratory Response 134 Individual Factors Influencing Adaptations to Aerobic Endurance Training 136 Conclusion 139 Learning Aids 139

CHAPTER 7 Age- and Sex-Related Differences and Their Implications for Resistance Exercise 141

Avery D. Feigenbaum, EdD

Children 142 Female Athletes 151 Older Adults 153 Conclusion 157 Learning Aids 158

CHAPTER 8 Psychology of Athletic Preparation and Performance 159

Bradley D. Hatfield, PhD, and Evan B. Brody, PhD

Definitions of Key Concepts in Sport Psychology 160 How the Mind Affects the Athlete's Physical Performance 164 Ideal Performance State 165 Motivational Phenomena 166 Influence of Arousal on Performance 168 Mental Management of Physical Resources: Controlling Psychological Processes 170 Conclusion 177 Learning Aids 177

CHAPTER 9 Performance-Enhancing Substances 179

Jay R. Hoffman, PhD, and Jeffrey R. Stout, PhD

Types of Performance-Enhancing Substances 180 Hormones 183 Dietary Supplements 191 Conclusion 191 Learning Aids 200

CHAPTER 10 Nutritional Factors in Health and Performance 201

Kristin Reimers, PhD

Role of the Nutritionist 202 How to Evaluate the Adequacy of the Diet 203 Macronutrients 206 Micronutrients 214 Fluid and Electrolytes 217 Precompetition and Postexercise Nutrition 220 Weight and Body Composition 222 Eating Disorders: Anorexia Nervosa and Bulimia Nervosa 225 Obesity 230 Conclusion 232 Learning Aids 232

2**Section****Testing and Evaluation****235****CHAPTER 11 Principles of Test Selection and Administration 237**

Everett Harman, PhD

Reasons for Testing 238 Testing Terminology 238 Evaluation of Test Quality 239 Test Selection 241 Test Administration 243 Conclusion 246 Learning Aids 246

CHAPTER 12 Administration, Scoring, and Interpretation of Selected Tests 249

Everett Harman, PhD, and John Gernhamer, PhD

Measuring Parameters of Athletic Performance 250 Selected Test Protocols and Scoring Data 253 Statistical Evaluation of Test Data 271 Conclusion 273 Learning Aids 273

CHAPTER 13 Warm-Up and Stretching	295
Ian Jeffreys, MS	

Warm-Up **296** Flexibility **297** Types of Stretching **299** Conclusion **306** Static Stretching Techniques **307**
Dynamic Stretching Techniques **319** Learning Aids **324**

CHAPTER 14 Resistance Training and Spotting Techniques	325
Roger W. Earle, MA, and Thomas R. Baechle, EdD	

Exercise Technique Fundamentals **326** Spotting Free Weight Exercises **329** Conclusion **332** Resistance
Training Exercises **332** Learning Aids **376**

PART I Anaerobic Exercise Prescription	379
---------------------------------------------------------	------------

CHAPTER 15 Resistance Training	381
-------------------------------------------------	------------

Thomas R. Baechle, EdD, Roger W. Earle, MA, and Dan Wathen, MS

Step 1: Needs Analysis **382** Step 2: Exercise Selection **386** Step 3: Training Frequency **389** Step 4: Exercise
Order **390** Step 5: Training Load and Repetitions **392** Step 6: Volume **405** Step 7: Rest Periods **408**
Conclusion **409** Learning Aids **411**

CHAPTER 16 Plyometric Training	413
-------------------------------------------------	------------

David H. Potach, PT, and Donald A. Chu, PhD, PT

Plyometric Mechanics and Physiology **414** Plyometric Program Design **417** Age Considerations **422**
Plyometrics and Other Forms of Exercise **423** Safety Considerations **423** Conclusion **426** Plyometric Drills **427**
Learning Aids **456**

CHAPTER 17 Speed, Agility, and Speed-Endurance Development	457
---------------------------------------------------------------------------------	------------

Steven S. Pflak, MS

Movement Mechanics **459** Running Speed **462** Agility **469** Methods of Developing Speed and Agility **473**
Program Design **476** Conclusion **484** Learning Aids **484**

PART II Aerobic Exercise Prescription	487
--------------------------------------------------------	------------

CHAPTER 18 Aerobic Endurance Exercise Training	489
-----------------------------------------------------------------	------------

Benjamin H. Reuter, PhD, and Patrick S. Hagerman, EdD

Factors Related to Aerobic Endurance Performance **490** Designing an Aerobic Endurance Program **491** Types
of Aerobic Endurance Training Programs **497** Application of Program Design to Training Seasons **500** Special
Issues Related to Aerobic Endurance Training **501** Conclusion **503** Learning Aids **503**

PART III Applying Exercise Prescription Principles. 505

CHAPTER 19 Periodization 507

Dan Wathan, MS, Thomas R. Baechle, EdD, and Roger W. Earle, MA

Responses to Training Stress 508 • Periodization Cycles 509 • Periodization Periods 509 • Applying Sport Seasons to the Periodization Periods 513 • Undulating (Nonlinear) Versus Linear Periodization Models 514 • Example of a Macrocycle 515 • Conclusion 518 • Learning Aids 522

CHAPTER 20 Rehabilitation and Reconditioning. 523

David H. Potach, PT, and Terry L. Grincstaff, DPT

Sports Medicine Team 524 • Types of Injury 526 • Tissue Healing 529 • Rehabilitation and Reconditioning Strategies 530 • Conclusion 538 • Learning Aids 538

5

Section Organization and Administration 541

CHAPTER 21 Facility Organization and Risk Management. 543

Michael Greenwood, PhD, and Lori Greenwood, PhD

General Aspects of New Facility Design 544 • Existing Strength and Conditioning Facilities 546 • Assessing Athletic Program Needs 546 • Designing the Strength and Conditioning Facility 547 • Arranging Equipment in the Strength and Conditioning Facility 550 • Maintaining and Cleaning Surfaces 552 • Maintaining and Cleaning Equipment 552 • Scheduling the Strength and Conditioning Facility 553 • Litigation Issues 554 • Conclusion 557 • Learning Aids 557

CHAPTER 22 Developing a Policies and Procedures Manual 569

Boyd Epley, MEd, and John Taylor, MS

Mission Statement and Program Goals 570 • Program Objectives 571 • Job Titles, Descriptions, and Duties of the Strength and Conditioning Staff 571 • Staff Policies and Activities 574 • Facility Administration 579 • Conclusion 587 • Learning Aids 588

Answers to Study Questions 589 • References 591

Index 631 • About the Editors 641