Essentials of Eccentric Training

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You will notice a reference throughout this version of Essentials of Eccentric Training to the online video. This resource is available to supplement your e-book.

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Contents

Exercise Finder

Video	Exercise name	Eccentric training method	Machine	Body weight	Weights	Medicine ball or band
Chest: pectoralis major, pectoralis minor						
X	5.1: Bench Press	CON–ECC, EE, SUP			X	
X	8.1: Cable Crossover Fly	2UP/1DN, CON–ECC, EE	X			
X	6.1: Dumbbell Chest Fly	2UP/1DN, CON–ECC, EE, SUP			X	
	7.1: Incline Bench Press	CON–ECC, EE, SUP			X	
	9.1: Machine Chest Press	2UP/1DN, CON–ECC, EE, SUP	X			
X	7.5: Muscle-Up (on bar or rings)	CON–ECC, EE, SUP		X		
X	7.4: Plyometric Push-Up	CON–ECC, EE, SUP		X		
X	8.12: Push–Pull With Partner	CON–ECC, EE		X		
	10.4: Shoulder Extension	CON–ECC, EE, SUP			X	
Back: latissimus dorsi, rhomboids, trapezius						
X	5.3: Bent-Over Barbell Row	CON–ECC, EE, SUP			X	
	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
X	9.4: Dumbbell Pull-Over	2UP/1DN, CON–ECC, EE, SUP			X	
X	7.3: Gorilla Pull-Up	CON–ECC, EE		X		
X	7.5: Muscle-Up (on bar or rings)	CON–ECC, EE, SUP		X		
X	9.3: One-Arm Dumbbell Row	CON–ECC, EE, SUP			X	
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
	8.4: Pull-Up Assist Machine	2UP/1DN, CON–ECC, EE	X			
X	6.4: Pull-Up (with body weight or weighted)	2UP/1DN, CON–ECC, EE, SUP		X	X	
X	8.12: Push–Pull With Partner	CON–ECC, EE		X		

X	6.3: Seated Cable Row	CON–ECC, EE, SUP	X			
	10.4: Shoulder Extension	CON–ECC, EE, SUP			X	
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	
X	6.8: Stiff-Leg Deadlift	CON–ECC, EE			X	
	5.4: Wide-Grip Latissimus Dorsi Pull-Down	CON–ECC, EE, SUP	X			
Lower back: erector spinae, transverse abdominis						
X	9.8: Barbell Good Morning	CON–ECC, EE			X	
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	
X	6.8: Stiff-Leg Deadlift	CON–ECC, EE			X	
Shoulders: deltoids (medial, posterior, anterior), trapezius						
X	8.2: Arnold Press	2UP/1DN, CON–ECC, EE, SUP			X	
	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
	8.3: Dumbbell Shrug	CON–ECC, EE, SUP			X	
X	7.6: Handstand Push-Up	CON–ECC, EE, SUP		X		
	10.5: One-Arm Shoulder Flexion	CON–ECC, EE, SUP				X
X	5.2: Overhead Press	CON–ECC, EE			X	
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
X	7.2: Push Jerk	CON–ECC, EE			X	
	9.2: Seated Machine Shoulder Press	2UP/1DN, CON–ECC, EE, SUP	X			
X	6.2: Seated Shoulder Press	2UP/1DN, CON–ECC, EE, SUP			X	
	10.4: Shoulder Extension	CON–ECC, EE, SUP			X	
X	10.1: Side-Lying External Shoulder Rotation	CON–ECC, EE, SUP			X	
Triceps: triceps brachii (long head, short head, medial head)						
	8.6: Bent-Over Triceps Kickback	2UP/1DN, CON–ECC, EE, SUP			X	
	5.6: Lying Triceps Extension	CON–ECC, EE			X	
		2UP/1DN, CON–				

	9.6: Machine Triceps Extension	ECC, EE, SUP	X			
X	7.5: Muscle-Up (on bar or rings)	CON–ECC, EE, SUP		X		
	10.4: Shoulder Extension	CON–ECC, EE, SUP			X	
	6.6: Triceps Cable Press-Down	CON–ECC, EE, SUP	X			
Biceps: biceps brachii (long head, short head), brachialis, brachioradialis						
X	6.5: Alternating Dumbbell Curl	2UP/1DN CON–ECC, EE, SUP			X	
	5.5: Barbell Curl	CON–ECC, EE, SUP			X	
X	7.3: Gorilla Pull-Up	CON–ECC, EE		X		
	9.5: Machine Preacher Curl	2UP/1DN, CON–ECC, EE, SUP	X			
X	7.5: Muscle-Up (on bar or rings)	CON–ECC, EE, SUP		X		
	8.4: Pull-Up Assist Machine	2UP/1DN, CON–ECC, EE	X			
X	6.4: Pull-Up (with body weight or weighted)	2UP/1DN, CON–ECC, EE, SUP		X	X	
X	10.2: Shoulder Flexion, Elbow Flexion, Shoulder Adduction	CON–ECC, EE			X	
X	8.5: Zottman Curl	2UP/1DN, CON–ECC, EE			X	
Forearms: brachioradialis, extensor ulnaris and radialis, flexor ulnaris and radialis						
X	6.5: Alternating Dumbbell Curl	2UP/1DN, CON–ECC, EE, SUP			X	
	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
	10.3: Forearm Extension	CON–ECC, EE, SUP			X	
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
X	8.5: Zottman Curl	2UP/1DN, CON–ECC, EE			X	
Quadriceps: rectus femoris, vastus lateralis, vastus medialis, vastus intermedius						
X	5.7: Barbell Back Squat	CON–ECC, EE, SUP			X	
X	7.7: Barbell Front Squat	CON–ECC, EE, SUP			X	
	7.11: Box Jump	CON–ECC, EE		X		
	7.12: Broad Jump	CON–ECC, EE		X		
X	9.9: Bulgarian Lunge	CON–ECC, EE, SUP			X	

	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
X	8.7: Exercise-Ball Squat	CON–ECC, EE, SUP				X
	5.10: Leg Extension	2UP/1DN, CON–ECC, EE, SUP	X			
X	5.9: Leg Press	2UP/1DN, CON–ECC, EE, SUP	X			
	9.10: One-Leg Extension	CON–ECC, EE, SUP	X			
	6.9: One-Leg Press	CON–ECC, EE, SUP	X			
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
X	9.7: Smith Machine Squat	CON–ECC, EE, SUP	X			
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	
X	8.9: Step-Up	CON–ECC, EE, SUP			X	
X	6.7: Sumo Squat With Dumbbell or Kettlebell	CON–ECC, EE, SUP			X	
	6.10: Walking Lunge	CON–ECC, EE		X		
Quads and patellar tendon: rectus femoris, vastus lateralis, vastus medialis, vastus intermedius						
X	10.8: Standing Hip Flexion and Knee Flexion on Slant Board	CON–ECC, EE		X		
Hamstrings: biceps femoris, semitendinosus, semimembranosus						
X	9.8: Barbell Good Morning	CON–ECC, EE			X	
X	6.11: Hamstring Curl on Ball	2UP/1DN, CON–ECC, EE				X
	5.11: Lying Hamstring Curl	2UP/1DN, CON–ECC, EE	X			
	9.11: Lying One-Leg Hamstring Curl	CON–ECC, EE, SUP	X			
X	10.7: Nordic Knee Flexion	EE, SUP		X		
	8.11: Seated Hamstring Curl	CON–ECC, EE, SUP	X			
	10.9: Seated Knee Flexion	2UP/1DN, CON–ECC, EE, SUP	X			
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	

X	6.8: Stiff-Leg Deadlift	CON–ECC, EE			X	
X	6.7: Sumo Squat With Dumbbell or Kettlebell	CON–ECC, EE, SUP			X	
Glutes: Gluteus minimus, gluteus medius, gluteus maximus						
X	5.7: Barbell Back Squat	CON–ECC, EE, SUP			X	
X	7.7: Barbell Front Squat	CON–ECC, EE, SUP			X	
X	9.8: Barbell Good Morning	CON–ECC, EE			X	
	7.11: Box Jump	CON–ECC, EE		X		
	7.12: Broad Jump	CON–ECC, EE		X		
X	9.9: Bulgarian Lunge	CON–ECC, EE, SUP			X	
	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
X	8.7: Exercise-Ball Squat	CON–ECC, EE, SUP				X
X	8.10: Gluteal Bridge	CON–ECC, EE, SUP		X		
X	6.11: Hamstring Curl on Ball	2UP/1DN, CON–ECC, EE				X
X	5.9: Leg Press	2UP/1DN, CON–ECC, EE, SUP	X			
X	10.7: Nordic Knee Flexion	EE, SUP		X		
	6.9: One-Leg Press	CON–ECC, EE, SUP	X			
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
X	9.7: Smith Machine Squat	CON–ECC, EE, SUP	X			
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	
X	8.9: Step-Up	CON–ECC, EE, SUP			X	
X	6.8: Stiff-Leg Deadlift	CON–ECC, EE			X	
X	6.7: Sumo Squat With Dumbbell or Kettlebell	CON–ECC, EE, SUP			X	
	6.10: Walking Lunge	CON–ECC, EE		X		
Abductors: gluteus minimus, gluteus medius, gluteus maximus, sartorius						
	8.8: Inner and Outer Thigh Machine	CON–ECC, EE, SUP	X			

Adductors: adductor longus, adductor brevis, adductor magnus, sartorius						
	8.8: Inner and Outer Thigh Machine	CON–ECC, EE, SUP	X			
X	10.10: Lying Leg Adduction Against Wall	CON–ECC, EE		X		
Calves: gastrocnemius, soleus						
	7.12: Broad Jump	CON–ECC, EE		X		
X	9.12: Donkey Calf Raise	2UP/1DN, CON–ECC, EE, SUP		X		
X	6.12: Seated Calf Raise	2UP/1DN, CON–ECC, EE, SUP	X			
X	5.12: Standing Calf Raise	2UP/1DN, CON–ECC, EE, SUP	X			
X	10.6: Standing Plantar Flexion	CON–ECC, EE, SUP	X			
Abs and core: rectus abdominis, transverse abdominis, serratus anterior, intercostals						
X	7.7: Barbell Front Squat	CON–ECC, EE, SUP			X	
X	7.3: Gorilla Pull-Up	CON–ECC, EE		X		
X	7.5: Muscle-Up (on bar or rings)	CON–ECC, EE, SUP		X		
	10.4: Shoulder Extension	CON–ECC, EE, SUP			X	
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	
Total-body exercises						
X	5.7: Barbell Back Squat	CON–ECC, EE, SUP			X	
X	7.7: Barbell Front Squat	CON–ECC, EE, SUP			X	
	7.8: Clean-Grip or Snatch-Grip Pull	CON–ECC, EE, SUP			X	
X	7.9: Power Clean	CON–ECC, EE			X	
X	7.10: Power Snatch	CON–ECC, EE			X	
X	8.12: Push–Pull With Partner	CON–ECC, EE		X		
X	5.8: Standard Deadlift	CON–ECC, EE, SUP			X	

Preface

Fitness professionals and resistance training enthusiasts continually seek the newest weight-lifting techniques and methodologies in order to obtain maximal benefits from their programs. In particular, interest is surging in an area of scientific resistance training known as eccentric exercise. Evidence-based studies have shown that eccentric training is highly effective in bolstering postworkout metabolic rate, improving muscular strength and endurance, and preventing and rehabilitating injury (Schoenfeld, 2010; Gerber et al., 2009). In addition, eccentric training can be incorporated by exercise enthusiasts of all ages and fitness levels.

History of Research on Eccentric Training

One of the first research observations of eccentric muscle action was made in 1882 by Dr. Adolf Eugen Fick, who noted that a contracting muscle under stretch could produce greater force than a shortening muscle contraction (Lindstedt, LaStayo, & Reich, 2001). In 1927, an investigation by Levin and Wyman demonstrated that the maximum positive work done by a fully active isolated jaw muscle of a dogfish (a small shark) was one-sixth of the negative work done at the same speed with the muscle stretched under a similar load (Abbott, Bigland, & Ritchie, 1952).

Abbot and colleagues (1952) further investigated the physiological cost of doing negative work with two participants in a pioneering experiment using two bicycle ergometers coupled back to back to work in opposition. The oxygen consumption for positive work (i.e., pedaling forward by one participant) was compared with that of negative work (i.e., pedaling in reverse by the other participant). The participants' leg muscles were exerting the same speed and force. The researchers determined that positive work always costs more energy than negative work. Yet another researcher, Archibald V. Hill (who became a Nobel laureate), also ascertained that the body experienced lower energy demand when doing an eccentric muscle action than when doing a concentric muscle action (Lindstedt et al., 2001). More recent research on the metabolic aspects of eccentric training is discussed in chapter 3.

Eccentric exercise itself was introduced by Asmussen in 1953 as "excentric" exercise—*ex* for "away from" and *centric* for "center," thus producing an overall meaning of moving away from the center. Remarkably, however, despite the initial intriguing research into eccentric training, very little follow-up was completed for exploring the properties of lengthening muscle contractions. Instead, most researchers directed their research toward understanding the intricate mechanisms and physiological events of shortening muscle actions.

Furthermore, most of the classic studies in muscle physiology, which have shaped our basic understanding of how muscle works, have been developed from two experimental approaches: isometric (constant-length) contractions and isotonic contractions (shortening against a constant load). As a consequence, much less is known about the mechanics and energetics of activated muscle during forced *lengthening*. Fortunately, Lindstedt and colleagues (2001) began to realize the importance and prevalence of lengthening contractions in normal locomotion and exercise, and this type of training then began to receive much more attention. Today, throughout the world, a vast amount of research is being conducted on eccentric training in sports, rehabilitation, disease prevention, and general musculoskeletal health.

About This Book

Three distinctive methods of eccentric training can be used with both entry-level fitness enthusiasts and highly competitive athletes: eccentric emphasis, supramaximal eccentric, and two-up/one-down. The key to using these regimens lies in individualizing the exercise design and intensity—a task that can be readily accomplished based on the understanding of resistance training, which is provided in this text. Eccentric training is an innovative approach that strength training professionals and personal trainers can use to help their clients meet and even exceed their training goals.

This book begins with an introduction providing research highlights and observations of the development of eccentric training as it is known today. To make good use of eccentric training methods, one must also understand the anatomical structures and physiological mechanisms of muscle contraction. To meet this need, chapter 1 provides a detailed explanation of muscle anatomy, muscle physiology, and the complex physiological mechanisms involved in concentric and eccentric training. Understanding these underlying physiological mechanisms enables you to better explain and apply eccentric training methods with students, clients, and patients.

In chapter 2, the three eccentric methods are explained in detail. The first, the eccentric emphasis technique, can be used readily in all training programs. The second, the supramaximal method, incorporates greater-intensity stimulus into the workout regimen; therefore, it is an excellent option for pushing past plateaus and increasing strength. And the third—the distinctive two-up/one-down training system—can be employed with any exercise using the upper or lower limbs.

Chapter 3 provides in-depth discussion of resting metabolic rate and how exercise can improve this important component of weight management. One distinctive quality of eccentric training is its capacity to elevate postworkout metabolism for several hours, thereby contributing to a winning approach for clients' weight loss goals. It is true that eccentric exercise has been associated with some degree of delayed-onset muscle soreness; however, researchers have now determined an effective training approach to minimizing this soreness. The technique hinges on a phenomenon referred to as the repeated bout effect, which is fully explained in chapter 4.

Personal trainers and other professionals regularly design programs to help a client improve some component of fitness or athletic performance. You can find assistance for developing these goal-oriented programs in chapter 5 (muscular strength), chapter 6 (muscular endurance), chapter 7 (explosive power), chapter 8 (weight loss), and chapter 9 (muscle size, or hypertrophy). Each of these chapters presents exercises, program designs, and change-out (alternative) exercises.

Last but certainly not least, chapter 10 addresses an expanding area of interest in training: exercise rehabilitation. A focus on eccentric training in rehabilitation can be directed to athletes and enthusiasts recovering from surgery or joint injury or adults and older adults with diseases. This chapter synthesizes current research understandings about how eccentric exercise can be incorporated to help clients with rehabilitation.

To cover a wide range of workout ideas, chapters 5 through 10 provide a combination of traditional exercises (which we refer to as concentric–eccentric, or CON–ECC, exercises) and eccentric exercises. The CON–ECC exercises are performed with a one- to two-second concentric and one- to two-second eccentric movement actions. In these chapters, the three types of eccentric exercise are abbreviated as follows: EE for eccentric emphasis, SUP for supramaximal eccentric, and 2UP/1DN for two-up/one-down.

We have also put together sample workout routines and samples of case studies for each goal program in chapters 5 to 10. The samples serve as starting points for putting together routines for a variety of clients. The case studies include exercises described in the book as well as foundational exercises commonly used by personal trainers. To design effective exercise programs, professionals must factor in several variables, including a person's age, fitness level, body composition, sex, health risk status, diet, exercise barriers, and goals. Additionally, the three-week eccentric method mesocycles presented in the case studies should not be completed without the guidance and supervision of a credentialed fitness professional. Skilled personal trainers are able to work closely with clients to ensure correct exercise technique and appropriate progression of intensity.

Additional dimensions are provided by the three innovative eccentric training methods presented in this book: eccentric emphasis, supramaximal eccentric, and two-up/one-down. This multifactorial complexity of exercise programming means that there is no one-size-fits-all training design. Instead, conscientious professionals are like artists who master their education, as well as the science and technique of their craft, and skillfully design individualized training programs. With this perspective, let these sample exercise programs give you a foundational guide from which to create highly effectual personalized exercise programs.

Appendixes A and B present two sample eight-week resistance training programs that integrate eccentric exercises. Appendix C presents some foundational exercises, categorized by sport, to help you train your sport-specific clients and athletes.

The accompanying online video shows 45 eccentric training exercises. The online video content provides you with demonstrations of the four different eccentric training methods (EE, SUP, and two variations of the 2UP/1DN technique) for selected exercises. Exercises included in the online video are highlighted by this icon:

Information on accessing the online video is on page xv.

These power-generating methods for eccentric training provide exercise professionals with boundless opportunities. Use them to strive for greatness in your training!

Accessing the Online Video

Accompanying this book is high-definition online streaming video of 45 exercises. The video clips demonstrate the different eccentric training methods that may be used when performing the exercises.

The online video can be accessed by visiting www.HumanKinetics.com/EssentialsOfEccentricTraining. If you purchased a new print book, follow the directions included on the orange-framed page at the front of your book. That page includes access steps and the unique key code that you'll need the first time you visit the *Essentials of Eccentric Training* website. If you purchased an e-book from HumanKinetics.com, follow the access instructions that were e-mailed to you following your purchase.

Once at the *Essentials of Eccentric Training* website, select Online Video in the ancillary items box in the upper left corner of the screen. You'll then see an Online Video page with description about the video. At the bottom of the screen, select the link to open the online video.

Select the button for the chapter's videos you want to watch. The video numbers along the right side of the player correspond with video number cross-references in the book, and the title under the player corresponds with the exercise title in the book.

Scroll through the list of clips until you find the exercise you want to watch. Select that clip and the full video will play.

Chapter 1
Understanding Muscular Structure and the Physiological Mechanisms of Concentric and Eccentric Action

To properly apply concentric and eccentric muscle training, personal trainers and applied-exercise professionals must have solid knowledge of the muscular system's functions and structure. The muscular system delivers the forces that enable the human body to perform physical activity. Muscles also serve an essential role in regulating the body's metabolism. This chapter describes the types and functions of muscle fiber, as well as the anatomy and physiology of both the gross structure of muscle and its microscopic composition. The chapter also explains the mechanisms of concentric and eccentric contraction.

Muscular Tissue

The human body includes three types of muscle tissue: cardiac, smooth, and skeletal. Cardiac muscle composes the walls of the heart and is involuntary because it has its own autorhythmic signaling system that is not subject to conscious control. Smooth muscle, which is also involuntary, borders the internal organs (e.g., intestines, stomach). Skeletal muscle is attached to the skeleton via tendons to enable the use of force and voluntary body movement. The voluntary capacity of skeletal muscle is controlled by the nervous system, which stimulates it to contract and relax by conscious effort. Skeletal muscle is the most abundant tissue in the human body, accounting for up to 40% of total body weight (Janssen, Heymsfield, Wang, & Ross, 2000) and including more than 600 muscles.

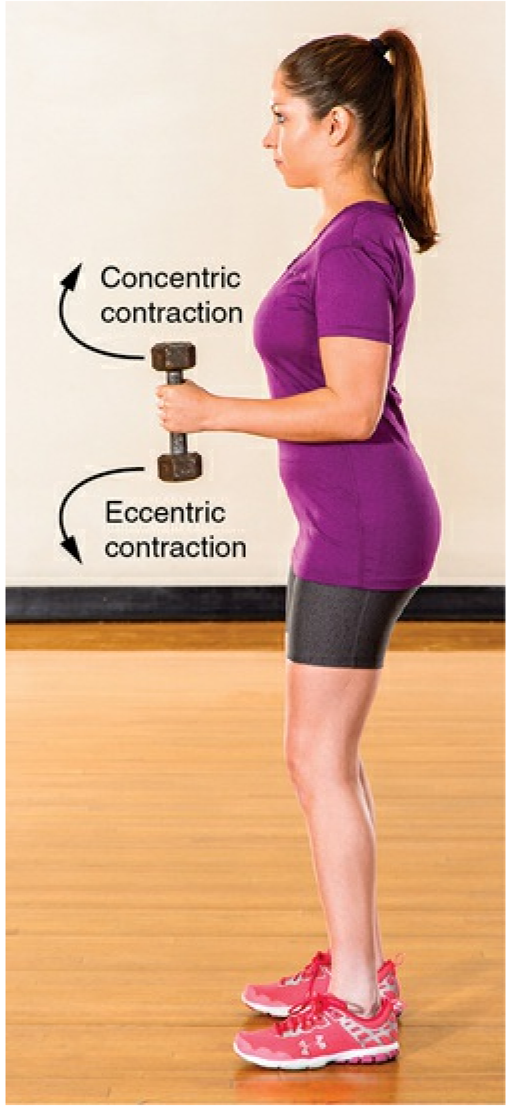
Muscles work together in groups to enable the body to move efficiently with force, power, and speed. Most of the muscle groups of the trunk and upper and lower extremities work in opposing pairs, so that when one muscle (the agonist) initiates a desired movement, the opposite muscle (the antagonist) is lengthened or extended. For example, when a person performs a biceps curl in an upright position, the biceps muscle group (biceps brachii and brachialis) acts as the agonist, and the triceps muscle group (long, medial, and lateral head) acts as the antagonist.

The properties of skeletal muscle are elasticity, extensibility, excitability, and contractility. The first two properties—elasticity and extensibility—permit a muscle to be stretched (in a manner similar to that of an elastic band) and, when the stretching is discontinued, to return to its normal resting length. Excitability (or irritability) is the ability to receive and respond to stimuli via generation of an electrical pulse, which causes contraction of the muscle cells. Contractility is the unique ability of a muscle to shorten or produce tension at its endpoints.

Most skeletal muscles can be shortened to about 50% of their resting length and stretched to about 170% (Herrel, Meyers, Timmermans, & Nishikawa, 2002). Neural stimulation of skeletal muscle can lead to three primary types of muscle action: concentric, eccentric, and isometric. In a *concentric* action, a muscle overcomes a load and shortens, as in the biceps curl motion shown in figure 1.1.

In an *eccentric* action, a muscle develops tension in a lengthening movement (again, see figure 1.1). Eccentric actions are commonly involved in deceleration (or slowing down) of a joint motion; for example, walking downstairs involves an eccentric action of the quadriceps muscle group to slow the flexion of the knee.

Figure 1.1 Concentric and eccentric action with biceps curl.

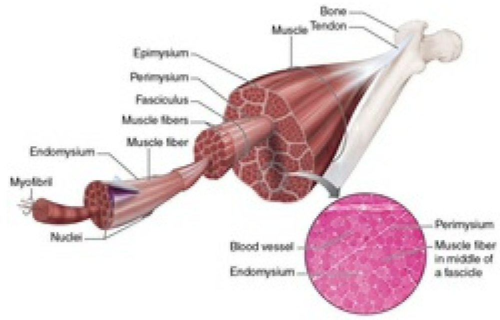


Thus, concentric and eccentric muscle actions involve dynamic work, in which the muscle is moving a joint toward a shortening or lengthening endpoint of movement. In *isometric* action, on the other hand, the muscle generates force against a resistance but does not overcome it and therefore does not shorten, lengthen, or cause joint motion. Many of the body's postural muscles work isometrically in order to keep the skeleton upright in opposition to the force of gravity.

Gross Structure of Muscle

The entire muscle is encased by an outer fascia of connective tissue called the epimysium (see figure 1.2). This thick, protective sheath is attached to tendons. Within the muscle, muscle fibers are grouped into different-sized bundles, or fascicles, each of which contains up to 150 muscle fibers. Each fascicle is surrounded by another connective tissue—the perimysium.

Figure 1.2 Gross structure of muscle.

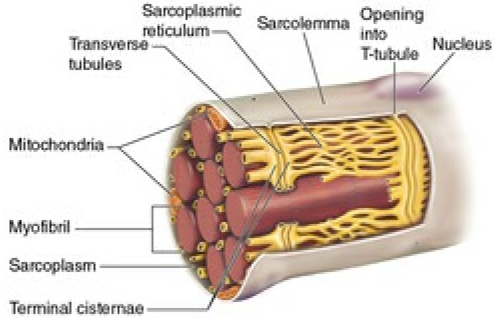


The structural component of skeletal muscle is the muscle fiber itself, which is also known as the muscle cell. Muscle fibers are cylindrical cells that each contain hundreds of nuclei. Their length ranges from about one-eighth of an inch (a few millimeters) in the eye muscles to more than 4 inches (10 cm) in the limbs. Each muscle cell is covered by a connective-tissue sheath called the endomysium, which separates the fiber from others.

Muscle Cell Structure and Organization

Beneath the endomysium, each muscle fiber is surrounded by a thin plasma membrane called the sarcolemma, which fuses with the endomysium (figure 1.3). The primary function of the sarcolemma is to conduct the electrochemical depolarization of the action potential—in other words, an excitatory message—from the nerve's axon (i.e., the part of the nerve cell that extends to the target tissue) along the surface of the muscle fiber. The message is transmitted through the fiber by the transverse tubules, which extend from the sarcolemma; they also carry substances (e.g., glucose for fuel) to the center of muscle cells (Dohm & Dudek, 1998).

Figure 1.3 Ultrastructure of muscle cell.



The ultrastructure of the muscle cell represents the organelle structures and constituents observed with the light microscope. Beneath the sarcolemma is found the basement membrane (or basal lamina), which serves a regenerative function in the muscle cell for growth and injury repair. Beneath the basement membrane itself lie satellite cells, which serve important regulatory functions for cellular growth (Zammit, Partridge, & Yablonka-Reuveni, 2006).

The spaces within the muscle fiber are filled by sarcoplasm, a gelatin-like fluid that is part of the cell. Sarcoplasm contains lipids, glycogen, enzymes, nuclei, mitochondria, and other cellular organelles. Unlike the cytoplasm found in other cells, sarcoplasm contains large quantities of stored glycogen for energy use and myoglobin for oxygen binding. The sarcoplasm also contains an extensive network of transverse tubules.

Muscle fiber also contains a network of tissues known as the sarcoplasmic reticulum—a highly specialized conduit system that serves as a storage site for calcium ions. The important functions of this system are described in a later section of this chapter addressing the theory of muscle contraction.

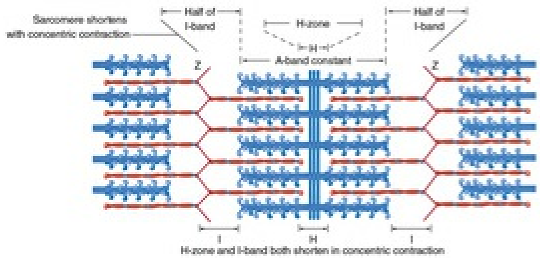
Muscle Fiber Protein Organization

Each muscle fiber contains hundreds or thousands of myofibrils, which lie parallel to one another and serve as the contractile elements of skeletal muscle. Myofibrils consist primarily of two proteins—actin and myosin—which are referred to as myofilaments (meaning muscle filaments); see figure 1.4. Close inspection of myofilaments reveals a thinner actin protein and a thicker myosin protein. Several other proteins are also present in the myofibrillar complex, including troponin, tropomyosin, the M-line protein, and titin.

When the surface of a muscle fiber is viewed with a light microscope, the arrangement of actin and myosin myofilaments creates distinctive light and dark striations. These striation patterns exist throughout the muscle fiber and explain why skeletal muscle is also called striated muscle. The darker zone is termed the “A-band,” and the lighter region is referred to as the “I-band.” The actin protein is attached to what is called the “Z-line,” which bisects the I-band. The Z-line is attached to the sarcolemma to bring stability to this ultrastructure of muscle tissue.

The repeating sequence from Z-line to Z-line delineates the functional unit of skeletal muscle, which is called the sarcomere. Myofibrils are composed of numerous sarcomeres, which are joined end to end at the Z-line. On either side of the Z-line lies a lighter I-band region, which contains only the actin protein. Both actin and myosin proteins are contained in the darker A-band. However, in the center of the A-band, a gap exists where only myosin is present. This region is the H-zone, and its center includes a darker area known as the M-line (the center of the sarcomere), which is produced by proteins that link adjacent myosin filaments.

Figure 1.4 The sarcomere is the basic functional unit of the myofibril.



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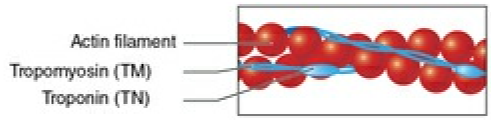
Actin–Myosin Orientation

To understand how muscles contract concentrically and eccentrically to create force for movement, we must examine more closely the biological architecture of actin and myosin. Actin is composed of two thin filaments shaped in a double helix, which means that it appears as two strands twisting around each other (see figure 1.5). Two other important protein constituents are attached—tropomyosin and troponin—that help with actin's function in muscle actions. Tropomyosin is a long, cordlike protein that spirals around the actin double helix and lies in a groove formed by the actin strands. It is believed that tropomyosin blocks the binding sites for actin–myosin interaction or coupling when the muscle is not creating force. Troponin, on the other hand, is a globular molecule attached to the tropomyosin at regular intervals. Troponin has a strong affinity to calcium ions (Ca^{2+}). This biochemical union serves a crucial function in muscle actions.

Figure 1.5 Actin filament with actin subunits tropomyosin and troponin.



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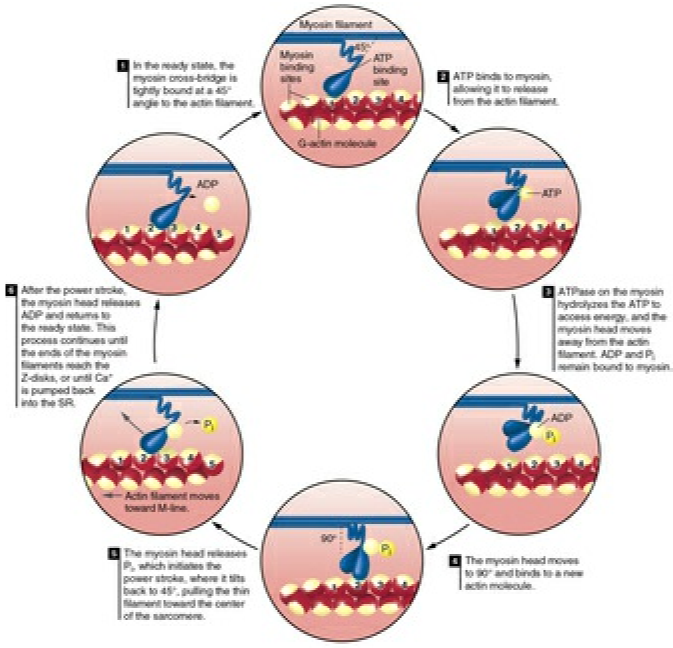
Myosin is a thicker filament with distinct components. The molecule has two globular heads—called myosin heads, S1 units, or cross-bridges—which are attached to protein strands (see figure 1.6). The components containing the cross-bridges are sometimes referred as the "heavy chains." The protein strands are twisted together to form long shafts, "tails," or "light chains." Hundreds of myosin molecules are packed tail to tail in a sheaf, and the globular heads point in one direction along half of the filament and in the opposite direction along the other half. In the middle, where no globular heads are present, lies the M-line. An array of fine filaments composed of the protein titin help stabilize myosin along its longitudinal axis. In muscle contraction, the myosin globular heads extend as cross-bridges and bind to specific sites on the actin filament, thus forming the structural and functional link between the two filaments.

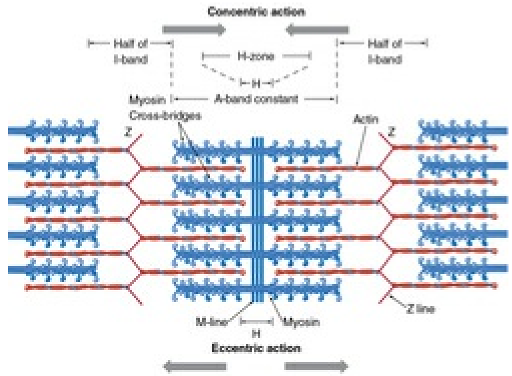
Figure 1.6 Myosin and actin protein molecules during a contraction cycle.



Sliding Filament Theory of Muscle Contraction

The sliding filament theory of muscle contraction suggests that changes in muscle length occur as the myosin and actin myofilaments slide past each other (see figure 1.7). The myofilaments themselves do not change in length; rather, it is the sarcomere that shortens (in a concentric action) or lengthens (in an eccentric action), thus producing force. The change in length occurs as the myosin cross-bridges bind to sites on the actin and then rotate, thus causing filament sliding. The actin filaments slide over the myosin filaments, and the force of the contraction comes from the myosin cross-bridges, which swivel in an arc around their fixed position, much like boat oars.

Figure 1.7 Sarcomere structure: mechanisms of concentric and eccentric actions. In a concentric action, myosin cross-bridges attach and draw the actin proteins toward each other, thus shortening the sarcomere. In an eccentric action, myosin cross-bridges attach, and the actin proteins move away from each other (because the weight is greater than the force produced by the muscle), thus lengthening the sarcomere.



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As the Z-lines of the sarcomere are pulled together in a concentric action, the regions of the I-band and H-zone decrease. There is no change in the length of the myosin, as seen by the length of the A-band. During an isometric contraction, however, the spacing of the I-band and H-zone remains unchanged. The energy for this molecular motion comes from the splitting of adenosine triphosphate (ATP).

The following steps lay out the complex sequence of the sliding filament theory for a concentric, isometric, or eccentric muscle action.

1. Before any muscle action, a muscle cell must receive an action potential message from a motor neuron.
2. Once the message is received by the sarcolemma of the muscle cell, the electrical impulse travels inward through the transverse tubules to the sarcoplasmic reticulum.
3. The electrical charge causes the sarcoplasmic reticulum to quickly release calcium ions (Ca^{2+}) into the sarcoplasm.
4. While in a resting state, the tropomyosin protein strands cover the binding sites on the actin filaments, thus preventing any actin–myosin interface. This condition changes, however, once the calcium ions are released from the sarcoplasmic reticulum. The ions bind with troponin, which has a strong affinity for calcium ions. Next, troponin, which lies on top of the tropomyosin, initiates a molecular process of shifting the tropomyosin molecules off of the binding sites (on the actin).
5. The myosin cross-bridges can now attach to the binding sites on the actin filaments.
6. When the myosin cross-bridges are activated, they bind with actin, leading to the mechanical change at the cross-bridges, where they swivel in an arc around their fixed position in an action referred to as the power stroke.
7. This action causes the actin filaments to slide over (or be pulled over) the myosin protein, which results in muscle shortening, referred to as a concentric muscle action (or contraction).
8. The globular heads of the myosin cross-bridges are home to the enzyme adenosine triphosphatase (ATPase), which speeds up the splitting of ATP to yield adenosine diphosphate (ADP), inorganic phosphate (P_i), and energy. ATP is the energy molecule for all concentric, eccentric, and isometric muscle actions.

9. Immediately after the power stroke, the myosin cross-bridges detach from their receptor sites and rotate back to their original positions. ATP provides the energy required for the dissociation of actin and myosin.
10. Following this detachment of the cross-bridges, the splitting of ATP (referred to as hydrolysis of ATP, since water is the splitting molecule) can occur again. The myosin cross-bridges then reattach to new binding sites on the actin filaments farther along, undergo another power stroke, and again cause actin to slide over myosin. Each cycle of cross-bridge attachment or detachment is powered by the splitting of one ATP molecule (Herzog, Leonard, Joumaa, & Mehta, 2008).
11. In an isometric action, the myosin cross-bridges continue to bind, swivel, and detach, but they reattach at the same sites because no movement is occurring in the sarcomere.
12. In an eccentric muscle action (see figure 1.7), the myosin cross-bridges undergo the movements of attachment, power stroke, detachment, and recombining, but the Z-lines move apart due to the muscle lengthening that characterizes an eccentric action.

Termination of Muscle Action

Muscle actions continue until the muscle stimulation stops, which in turn prevents further release of calcium ions from the sarcoplasmic reticulum. During this period, calcium ions in the sarcoplasm are moved back into the sarcoplasmic reticulum for storage by an ATP-mediated calcium-pumping system. With the removal of calcium ions, troponin becomes deactivated, which leads tropomyosin to shift to its resting position, thus once again covering the receptor sites for the myosin cross-bridges (on the actin filaments). The hydrolysis of ATP ceases, and the muscle fiber returns to a relaxed state.

Muscle Fiber Types

Muscle fiber comes in two distinct types: fast twitch (Type II) and slow twitch (Type I). The fiber types are differentiated by their metabolic and contractile properties. Fast-twitch fibers can generate rapid, powerful muscle actions due to a number of metabolic factors. These factors include, for example, the speedy release of calcium ions from a highly developed sarcoplasmic reticulum and a high level of myosin ATPase, the enzyme that catalyzes the splitting of ATP into ADP plus P_i plus energy release. A fast-twitch fiber’s speed of shortening and force development is three to five times faster than that of a slow-twitch fiber. Fast-twitch fibers use mainly blood glucose and muscle glycogen for fuel and thus are predominantly recruited in anaerobic-type activities, such as weight training, baseball, volleyball, and tennis.

Fast-twitch muscle fibers can be further subdivided into Type IIa and Type IIx fibers. Type IIa fibers are considered intermediate fibers because they have a moderate capacity for anaerobic and aerobic energy production. They are referred to as fast oxidative-glycolytic (FOG) fibers. Type IIx fibers exhibit the most extensive anaerobic potential and are referred to as fast glycolytic or FG fibers. Slow-twitch or Type I fibers, on the other hand, are characteristically involved in energy production for prolonged aerobic activities and are therefore described as fatigue resistant, whereas fast-twitch fibers fatigue rapidly. Because Type 1 fibers have a less developed sarcoplasmic reticulum, they exhibit slower handling of calcium ions and a low activity level of myosin ATPase, which in turn inhibits the speed of the hydrolysis (or splitting with water) of ATP. However, Type I fibers contain a large number of mitochondria (the cell’s energy powerhouses) and mitochondrial enzymes, all of which enhances their capacity for aerobic metabolism. Type I fibers are often described as slow oxidative (SO) fibers in reference to their high involvement in aerobic metabolism and their slower rate of shortening. SO fibers also have greater capacity for blood flow—a structural and functional adaptation due to their greater need for oxygen delivery. More characteristics of human muscle fiber types are presented in table 1.1.

TABLE 1.1 Characteristics of Human Muscle Fiber Types

Charactesristic	Slow (Type I)	Intermediate (Type IIa)	Fast (Type IIx)
Energy system (predominant)	Aerobic	Combination	Anaerobic
Thickness	Small	Intermediate	Large
Glycogen content	Low	High	High
Twitch rate	Slow	Fast	Fast
Myoglobin content	High	Moderate	Low
Capillaries	Many	Moderate	Few
Force per cross-sectional area	Low	Intermediate	High
Endurance	High	Intermediate	Low

Distribution of Fiber Types in Special Populations

A person's arm and leg muscles generally have very similar fiber-type compositions. (One exception is the soleus muscle, an ankle plantar flexor involved in walking activities, which is predominantly a slow-twitch muscle.) Generally, most men, women, and children possess an equal mixture of Type 1 and Type II fibers (Kraemer, Fleck, & Deschenes, 2012). Thus, there does not appear to be a gender difference in muscle fiber distribution—just a difference in absolute muscle size.

Differences in fiber type are, however, apparent among world-class athletes. Sprinters tend to have more fast-twitch fibers in their legs, whereas endurance athletes exhibit a predominance of slow-twitch fibers, and middle-distance athletes frequently have an equal distribution of fast-twitch and slow-twitch fibers. Still, fiber type is only one component of athletic success, and it has not been shown to be a valid predictor of athletic performance (Kraemer et al., 2012).

The fast-twitch and slow-twitch characteristics of muscle fibers emerge in the first few years of life; thus, they are genetically determined, and they change very little until late in life. As people grow older, they tend to lose fast-twitch fibers due to age-related changes and physical inactivity.

Summary Thoughts

For personal trainers and exercise professionals, teaching correct exercise techniques is central to the development of any type of muscular fitness program. To enable this kind of teaching, this chapter provides you with a robust understanding of the unique ability of skeletal muscles to create force through concentric, eccentric, and isometric actions. It also provides you with a deeper understanding of how the body produces and controls movement by explaining the structure and function of skeletal muscles and the characteristic differences between muscle fiber types. This command of both gross-structure and microstructure muscle mechanisms gives you a rich awareness of the human body's movement potential.

Chapter 2
Discovering the Eccentric Training Methods

Throughout this text, we provide reminders to personal trainers and applied-exercise professionals to ensure that each exercising client completes a proper full-body warm-up, followed by appropriate muscle-joint preparation, for each resistance training workout. A suitable warm-up prepares the circulatory and neuromuscular systems for the increased demands of the workout. This preparation is particularly important for entry-level clients.

The health and fitness improvements that can be gained through resistance exercise are wide ranging, and they vary by the individual. Generally, however, we can say that long-lasting improvement in muscular fitness requires systematic use of a sufficient training stimulus, followed by adaptation in the individual and then the introduction of a (progressively) greater stimulus. To that end, this book describes how to stimulate the muscles through three distinctive eccentric training methods: eccentric emphasis, supramaximal eccentric, and two-up/one-down.

Whether a person trains for sport performance or health enhancement, success depends largely on the exercise professional's ability to manipulate the progression of the resistance stimulus, the variation in workouts, and the individualization of the training plan. Our goal is to help you develop this mastery so that you can use these highly effective eccentric training techniques with your clients.

Resistance exercises are commonly performed to the point of momentary muscular fatigue (i.e., failure)—that is, the repetition at which the client is unable to create enough force to overcome the load. For example, 10RM means the client can complete 10 repetitions but is unable to complete an 11th repetition in the same set. Although load is critical to attaining gains in muscular fitness, the concept of always performing exercises to momentary muscular fatigue is still being critically researched and analyzed.

Another component involved with resistance training, and particularly with eccentric training, is the movement speed, often referred to as the tempo. The tempo in resistance exercise is the rate at which weight is lifted and lowered. It may be referred to as the lifting tempo, lifting speed, or the repetition speed. Essentially it is the rate at which a given set of repetitions is performed. Traditional weight training, referred to in this text as CON-ECC, incorporates a 1-2 second concentric (i.e., lifting phase of a movement) with a 1-2 second eccentric (i.e., lowering phase of a movement). The eccentric training methods presented in *Essentials of Eccentric Training* utilize evidence-based applications that enhance physiological and metabolic changes by varying the approach to the eccentric component of the lift.

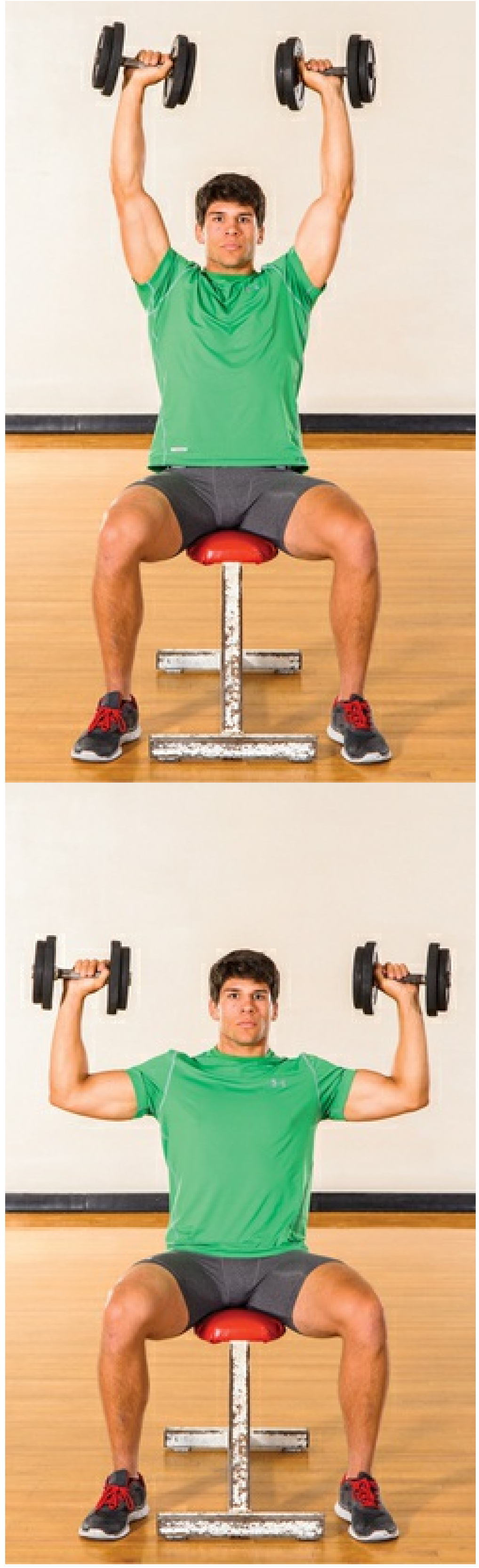
Eccentric Emphasis Training Method

The eccentric emphasis training method provides a unique external load methodology by slowing the lowering or eccentric-loading phase of an exercise. As a training stimulus, this increase in the time under tension elicits changes in the muscles that improve their strength, function, and size (Schoenfeld, 2010). In fact, recent research indicates that longer times under tension increase the metabolic processes that promote muscle protein synthesis, which have been observed for 24 to 30 hours after the muscle experiences the training stimulus (Burd et al., 2012).

This training method must be applied in a gradual overloading fashion, particularly when working with entry-level clients. And for all fitness levels, research shows that a unique exercise stimulus is required for continued muscle growth and development (Burd et al., 2012). Strong scientific evidence supports the use of all of the eccentric training techniques presented in this text.

Theories about why eccentric loading leads to increases in strength include the following: enhanced neural stimulation to and within muscle, higher stored elastic energy in muscle, and increases in muscle hypertrophy. These factors are all discussed further in chapter 5. The current chapter focuses instead on the specific technical steps in performing the three eccentric training methods. When using the eccentric emphasis technique, exercise professionals should allow time for the client to become familiar with this method of training. Figure 2.1 shows an exercise using the eccentric emphasis method.

Figure 2.1 Seated dumbbell shoulder press: *(a)* starting position and *(b)* slow lowering phase with the eccentric emphasis method.



Steps for Eccentric Emphasis Training

1. Start with a weight that the client normally uses for the particular muscular fitness goal.
2. For instance, let's assume that the client normally does an 8-repetition maximum (8RM) set, meaning that she or he does eight repetitions using a weight that produces momentary muscular fatigue (i.e., failure) after the eighth repetition.
3. The client does the concentric contraction—that is, the muscle-shortening phase of the movement—by lifting the load in a one-second motion.

4. The client proceeds to the eccentric contraction—that is, the muscle-lengthening phase of the movement—by lowering the load in three to four seconds, thus emphasizing the eccentric phase of the exercise. (This is why the training method gets the name "eccentric emphasis.") For each repetition in the set, the client performs a one-second shortening (concentric) action followed by a three- to four-second lowering (eccentric) action.
5. The client completes eight repetitions to momentary muscular fatigue (thus an 8RM). The exercise professional will likely need to aid the client with the concentric lifts as he or she begins to fatigue.
6. Individualize the number of sets to each client's goals.
7. Decide the number of repetitions in each set based on the client's training goal: strength, explosive power, endurance, weight loss, muscle size, or rehabilitation. The number of repetitions may range from as few as 2 to 20 or even more—all using the one-second shortening motion followed by the three- to four-second lowering action.

For a specific example, let's now consider a client who typically does six repetitions on the seated shoulder press. In preparation for having the client use the eccentric emphasis technique, the trainer gives the client the appropriately weighted dumbbells for this exercise. The trainer then instructs the client to proceed as follows:

Step 1: Grasp the two dumbbells tightly and bring them to your shoulders. Keep your upper arms toward the sides of your torso. Push the dumbbells upward in a one-second extension until your arms are fully extended.

Step 2: Lower your arms back to the sides of your torso with an even, slow motion in three to four seconds, thus emphasizing the eccentric phase of the exercise. Continue the set with this eccentric emphasis training technique.

Supramaximal Eccentric Training Method

The supramaximal eccentric training method has been shown to be quite effective in eliciting changes in muscle strength and hypertrophy (Schoenfeld, 2011). To produce the desired changes, the principles for designing strength training involve manipulating the number of repetitions and sets, the movement speed, the rest interval between sets, the recovery between workouts, the selection of exercises, and the load. The specific combination of repetitions, sets, exercises, resistance, and force help define the goal or purpose chosen by the individual performing the exercise.

The supramaximal eccentric training method (see figure 2.2) closely parallels the theoretical concepts validating progressive overload. To develop more strength, the skeletal muscles must be challenged in a way that stimulates the body's natural adaptive processes to manage new demands. In progressive overload resistance training, the participant exercises his or her muscles against a resistance that is gradually increased. Progressive overload may be applied creatively by using exercise machines, free weights, medicine balls, elastic bands, and other exercise devices. Progressive overload not only stimulates muscle strength and hypertrophy but also contributes to the development of stronger bones, ligaments, tendons, and joint cartilage, thus protecting the skeletal system.

Figure 2.2 Incline bench press: *(a)* starting position and *(b)* slow lowering phase with the supramaximal eccentric training technique.

Strength and power athletes focus on improving their 1RM, which provides a way to gauge strength increases and decreases. An increase in maximum strength typically increases the muscle's force production capability across a wide range of movement velocities. In addition, a higher 1RM allows an exerciser or athlete to perform a higher relative submaximal training volume, thus leading to improved submaximal muscle performance.

Steps for Supramaximal Eccentric Training

1. Start with the weight that the client normally uses for the particular muscular fitness goal.
2. Let's assume that the client normally does a 10RM incline bench press with 130 pounds (about 59 kg); in other words, she or he can do 10 repetitions with 130 pounds but is unable to do an 11th repetition with this weight.

   For the supramaximal technique, start with approximately 105% of the client's usual load—in this case, 135 pounds (about 61 kg).
3. The client lifts the weight, which in this example means that he or she completes the lift phase of the incline bench press, in one second.
4. The client lowers the load more slowly, in three to four seconds, thus emphasizing the eccentric phase of the lift. In this way, the eccentric emphasis technique is incorporated into the supramaximal training method.

   As the client advances, you may progressively increase the supramaximal load (e.g., to 107%, 109%, 111%, and so on, up to 125%). For some exercise enthusiasts, the supramaximal loading technique may become fatiguing. Be prepared to help the client during the lifting (concentric) phase of the exercise.
5. Individualize the number of sets based on each client's goals.

For example, let's now consider a client who typically performs eight repetitions of the incline bench press with the normal load on the bar. In preparation for using the supramaximal eccentric technique, the trainer places 5% more weight on the bar, thus adding more load. The trainer then instructs the client to proceed as follows:

Step 1: Lie back on the bench. Grasp the bar in an overgrip with your hands about 3 or 4 inches (8 to 10 cm) farther apart than shoulder width. Lift the bar off the rack and slowly bend your arms to bring the bar just above your chest, close to the base of your neck. Steadily extend your arms by pushing the barbell directly over your chest in a one-second concentric action.

Step 2: Gradually lower the bar close to the base of your neck in a three- to four-second eccentric action, thus emphasizing the eccentric phase of the movement.

Even with just 5% more weight than usual, the client will begin to fatigue. Spot the client throughout, assisting when necessary, especially on the last few repetitions of the set. It is often helpful to count the three- to four-second lowering tempo for the client in order to emphasize the slow lowering of the weight (i.e., to highlight the eccentric emphasis).

Two-Up/One-Down Eccentric Training Method

Scientific researchers are still investigating how the body responds to muscular overload in order to elicit muscle growth and increase strength and endurance. We already know, however, that several outcomes of muscular performance are produced by various types of training. This fact is demonstrated by athletes in numerous sports who exhibit wonderful muscular development, strength, and performance capacity yet incorporate different protocols into their training.

During the initial period of any resistance training program, increases in muscular strength are not associated directly with changes in the cross-sectional area of the muscle. Instead, changes in strength evidenced in the first two to eight weeks of resistance training are more associated with neural adaptations, which involve the development of more efficient neural pathways along the route to the muscle. These early training adaptations are referred to as an enhancement of neural drive (Gabriel, Kamen, & Frost, 2006).

One central factor in these early strength gains from neural drive is the recruitment of the motor unit (i.e., the motor nerve fiber and the muscle fibers it innervates) (Gabriel, Kamen, & Frost, 2006). As discussed elsewhere in this text, skeletal muscles are composed of a mixture of fiber types, or motor units, as they are called when including their neural input. Motor units contribute a range of mechanical and physiological properties to the entire muscle. For a muscle to contribute to smooth, coordinated movement, it must activate an appropriate number and combination of motor units to generate the required force over a suitable time period.

Much evidence indicates that motor units are activated in an orderly fashion, from the slowest to the fastest. The effectiveness of the two-up/one-down eccentric training method in particular may be due largely to its capacity for increasing the neural drive to muscle, thus enhancing the recruitment of motor units. This possibility calls for more evidence-based research.

Trainers can use the two-up/one-down training method in two ways: the alternating-sides technique and the same-side technique. Let's first learn the alternating-sides technique.

Steps for the Alternating-Sides Technique

1. The alternating-sides technique involves the arms and legs, often with fixed-weight exercise machine. These devices use load-stabilizing technology, such as pulley-like or sliding-load mechanisms. Fixed-weight machines (see figure 2.3) are frequently used initially with this technique from a safety standpoint, because the client is lowering a weight with one limb.

Therefore, with a fixed-weight machine there is no chance of dropping a weight as the client transitions from a two-limb movement to a single-limb movement. However, once a client is familiar with this technique, it can be performed with some free-weight exercises.
Start with a load that is 40% to 50% of the weight normally used by the client for the particular muscular fitness goal being trained. Increase the load gradually as the client adapts.
For example, let's assume that a client normally does a 10RM biceps curl (on a fixed-weight biceps curl machine) with 100 pounds (45 kg), meaning that she or he does 10 repetitions with 100 pounds. To use the two-up/one-down method, start the client with 40% or 50% of that weight, which is 40 to 50 pounds (18 to 23 kg).

2. To perform the alternating-sides technique, the client curls the weight concentrically with both arms, then lowers the weight with one arm. The client then repeats the concentric lift but on this next repetition lowers the load with the other arm. The client continues the set by alternating between the arms in the eccentric lowering phase—hence the name "two-up/one-down alternating-sides method."
3. Have the client complete the concentric portion of the action with a one-second movement and lower the weight in three to four seconds.
4. Individualize the number of sets based on each client's goals.
5. Remember that if the goal is 10 repetitions per arm, the client needs to do a total of 20 repetitions—10 lowering with the left arm and 10 lowering with the right arm.

Figure 2.3 The 45-degree leg press: *(a)* starting position and *(b)* slow lowering phase.

For a specific example, let's now consider a client who typically performs 10 repetitions of the 45-degree leg press. In preparation for the alternating-sides technique, the trainer sets the weight with 50% of the load the client normally uses. The trainer then instructs the client to proceed as follows:

Step 1: Lie back on the angled back of the machine. Place your feet on the platform at about shoulder-width apart. Straighten both of your legs and release the stop bars. You have completed the concentric phase of the lift by straightening both legs.

Step 2: Lower with your *right* leg for three to four seconds by bending your legs until you reach the bottom of the movement with your thighs near your chest. Your left leg should be just slightly away from the platform (not making contact). This is the one-down phase.

Step 3: Place your left foot on the platform and straighten both your right and left legs to return to the starting position. This is the two-up phase.

Step 4: Lower with your *left* leg for three to four seconds by bending your legs until you reach the bottom of the movement with your thighs near your chest. Your right leg should be just slightly away from the platform.

Step 5: Place your right foot on the platform and straighten both legs to return to the starting position.

Step 6: Continue alternating your right and left legs, lowering for a total of 20 repetitions (10 right and 10 left).

Remind the client to keep breathing normally while performing this exercise.

Now, let's go through the steps of the two-up/one-down same-side technique.

Steps for the Same-Side Technique

1. The same-side technique also involves the arms and legs. Start with a load that is 40% to 50% of the weight normally used by the client for the particular muscular fitness goal being trained.

Increase the load gradually as the client adapts.

For example, let's assume that a client normally does a 10RM hamstring curl with an appropriate load (see figure 2.4). To use the two-up/one-down same-side method, start the client with 40% to 50% of that weight, To perform the same-side technique, the client leg-curls the weight concentrically with both legs, then lowers the weight with one leg. The client repeats this sequence 10 times—performing the concentric lift with both legs and lowering the load with the same leg. The client then continues the set by lowering with the other leg for 10 repetitions—hence the name two-up/one-down same-side method.

2. Have the client complete the concentric portion of the action with a one-second movement and lower the weight in three to four seconds.
3. Individualize the number of sets based on each client's goals.
4. Remember that if the goal is 10 repetitions per leg, the client needs to do a total of 20 repetitions—10 lowering with the left leg and 10 lowering with the right leg.

Figure 2.4 Two-up/one-down leg-curl exercise with the same-side technique: (*a*) starting position and (*b*) slow lowering phase.

For a specific example, let's now consider a client who typically does 10 repetitions on a leg-curl machine. In preparation for the same-side technique, the trainer sets the weight with 50% of the load the client normally uses. The trainer then instructs the client to proceed as follows:

Step 1: Lie facedown on the leg-curl machine with your knees at the edge of the padded surface. Place the back of your heels under the roller pads and extend your legs. Grasp the handles or edges of the pad at the top end of the device to brace your body. Gradually bend both legs as far as they go in a one-second concentric action.

Step 2: Lower with your *left* leg for three to four seconds by extending your legs until you reach the bottom of the movement (hold your right leg slightly away from the roller pad so that it is not part of the load-bearing effort).

Step 3: Place the backs of your heels under the roller pads and gradually bend both legs as far as they go. As before, lower with only your left leg.

Step 4: Complete 10 repetitions of this sequence—lifting with both legs and lowering with your left leg.

Step 5: Now it is time to switch to your *right* leg for the lowering phase. Lower with your right leg for three to four seconds by extending both legs until you reach the bottom of the movement (hold your left leg slightly away from the roller pad so that it is not part of the load-bearing effort).

Step 6: Complete 10 repetitions of this sequence—lifting with both legs and lowering with your right leg.

Step 7: Keep the rest of your body braced during the single-limb movement. Doing so keeps your body from awkwardly turning or twisting.

Switch regularly between the alternating-sides and same-side training techniques in order to challenge the client continually with different types of overload.

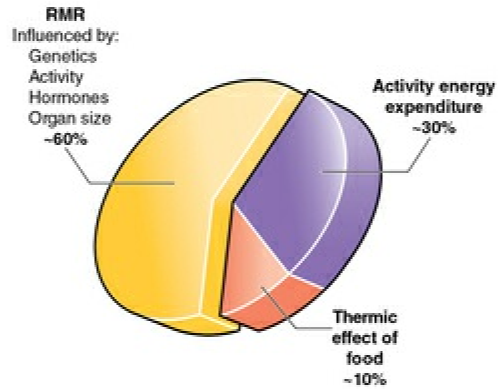
Summary Thoughts

When properly performed, eccentric training provides functional benefits, which are due to neurological, mechanical, and cellular adaptations in muscle that affect a person's balance and movement performance (LaStayo et al., 2014) as well as overall improvements in strength, endurance, and well-being. We encourage exercise professionals to take appropriate time in teaching and demonstrating for their clients the three distinctive eccentric training methods: eccentric emphasis, supramaximal eccentric, and two-up/one-down. Optimal strength training benefits result from a combination of good performance technique and strategic program design. Proceed gradually with your clients when introducing them to the three eccentric methods so that they feel confident in performing them. Once the eccentric techniques are mastered, challenge clients with varying workloads and repetition zones that help them attain their musculoskeletal goals.

Chapter 3
Boosting the Metabolism With Eccentric Exercise

To help you better understand how to boost metabolism through eccentric exercise, we begin this chapter with a broad discussion of energy balance. In weight management, traditional components of energy balance include resting energy expenditure, the thermic effect of food, and activity energy expenditure. Resting energy expenditure (REE) is the non-exercise energy needed simply to maintain life; it is also commonly referred to as resting metabolic rate (RMR), which is the term we use here. RMR accounts for about two-thirds of the human body's energy needs; see figure 3.1 for a breakdown of the major components of energy expenditure in a 24-hour day.

Figure 3.1 Components of total energy expenditure (TEE) for a 24-hour day.



Resting Metabolic Rate

RMR is affected by a person's body composition (fat versus muscle), body size (more body mass requires a higher RMR to stay alive), hormones, genetics, organ size, and other factors that are not yet fully understood (Hall et al., 2012). Remarkably, the brain, heart, kidney, and liver weigh relatively little but demand considerable energy and therefore contribute substantially to total RMR. When clients learn the significance of resting metabolic rate, they often want to know their own RMR.

RMR is reported in terms of kilocalories per day. Technically speaking, a kilocalorie, or "large calorie," is equivalent to 1,000 "small calories." On food labels, however, a kilocalorie is typically referred to simply as a calorie. It is also the unit of measurement used to express the energy expended during exercise.

A review of four popular equations for estimating RMR was conducted by Frankenfield, Roth-Yousey, and Compher (2005). They found the most accurate option to be the Mifflin–St Jeor equation (Mifflin et al., 1990). This equation was derived from data collected on about 250 males and 250 females aged 19 to 78. It comes in two versions—one for men and one for women.

Males: RMR = (10 × weight in kilograms) + (6.25 × height in centimeters) − (5 × age in years) + 5

Females: RMR = (10 × weight in kilograms) + (6.25 × height in centimeters) − (5 × age in years) − 161

Let's work through an example for a 30-year-old female client who weighs 140 pounds and is 5 feet 6 inches (i.e., 66 inches) tall. First, to determine a client's body weight in kilograms from his or her weight in pounds, simply divide by 2.205. In our sample case, therefore, the client calculates her body weight in kilograms as follows: 140 ÷ 2.205 = 63.5. Next, height in centimeters is easily determined by multiplying a client's height in inches by 2.54. Our sample female client calculates her height in centimeters as follows: 66 × 2.54 = 167.64 cm. With these conversions in hand, we can now estimate the client's RMR as follows:

$$\text{RMR} = (10 \times 63.5) + (6.25 \times 167.64) - (5 \times 30) - 161$$
$$\text{RMR} = 635 + 1{,}048 - 150 - 161$$
$$\text{RMR} = 1{,}372 \text{ kilocalories per day}$$

Calculating RMR is a wonderful educational tool for exercise professionals to incorporate into their work with clients. Many people are simply unaware of how many kilocalories they consume per day as compared with how many their body needs in order to sustain life.

Predictably, RMR appears to vary quite a bit between people. Lazzer et al. (2010) investigated the relationships between RMR, gender, age, and body composition in 8,780 obese participants whose age ranged from 7 to 74 years. The study found considerable variability between participants in RMR, and the researchers propose that this result can be explained by a combination of genetic factors, physical activity level, organ mass, and hormonal factors. Indeed, because of this individual

variability, the Mifflin–St Jeor equation for estimating RMR carries a margin of error of plus or minus 10%.
Once a person grasps what RMR means, it is common for him or her to ask the exercise professional how much RMR changes as a result of traditional resistance exercise. To answer this question, Hunter et al. (2000) conducted a 26-week resistance training study with males and females who were sedentary and older (61 to 77 years old). Study volunteers completed supervised workouts consisting of two sets of 10 repetitions (with two minutes of rest between sets) of the following exercises: lateral pull-down, chest press, seated row, elbow extension, elbow flexion, leg extension, leg curl, seated press, back extension, bent-leg sit-up (15 to 25 repetitions), and squat or leg press (as determined by the supervising exercise physiologist).
The participants trained at an intensity of 65% to 80% of their 1-repetition maximum (1RM). Resistance overload was progressed sensibly based on daily training logs and 1RM retesting conducted every three weeks. At the end of the six-month investigation, both male and female participants had increased their RMR by 7%, or approximately 100 kilocalories per day.
To this day, no studies have examined the long-term effects of eccentric training on RMR, but, given the unique physiological differences of this type of training (as compared with traditional resistance training), the long-term effect may indeed be greater. For now, the six-month study by Hunter et al. (2000) provides a great foundation for recognizing that RMR is particularly influenced by consistent, progressively increased resistance training. The outcomes experienced by the men and women in this study show that regular resistance exercise carries profound implications for use in weight management programs.

Thermic Effect of Food

The thermic effect of food (TEF) is the energy expenditure devoted to processing and digesting consumed food. The physiological processes involved in TEF include digestion of consumed foodstuffs, transport of foodstuffs to the body's cells, breaking of the bonds in the food to liberate energy, and storage of some food as glycogen (in muscle and liver) or as fat (in adipose tissue deposits). These processes require energy, and exercise professionals should explain to clients that the human body not only increases its energy expenditure during exercise but also burns approximately 10% of its total daily energy in the process of breaking down foodstuffs and storing energy (Tappy, 1996).
In comparing how the body processes carbohydrate, fat, and protein, Tappy (1996) indicates that protein produces the greatest effect on TEF, followed by carbohydrate and then fat. We can get an index of the thermic effect of a nutrient (i.e., fat, carbohydrate, or protein) by determining the ratio of the adenosine triphosphate (ATP) used in the initial metabolic steps to the ATP made upon complete breakdown of the foodstuff (Tappy, 1996). There is one caveat: Some overweight or obese individuals experience a drop in the TEF. This reduction may be attributable to insulin resistance, which is related to the body's inefficiency in using glucose and glycogen for fuel.
To maintain the thermic effect, it may help to eat more frequently during the day (Rosenbaum & Leibel, 2010). Indeed, an exercise professional should worry if a client chooses to skip meals because this unwise strategy puts the client at risk for inadequate nutrient intake and low blood glucose. In addition, the resulting condition may be interpreted by the brain as a threat and therefore lead to a series of physiological reactions to conserve the body's fat reserves.

Activity Energy Expenditure

Activity energy expenditure (AEE) is the fuel used by the body to perform both structured exercise and non-exercise movement, such as shopping, moving around, and doing daily chores. AEE varies greatly between persons because many people move a great deal during their waking day and perform a considerable amount of daily exercise, whereas others live primarily in a sedentary manner.

One new line of research about activity energy expenditure looks at the role that non-exercise movement can play in weight loss. As part of this work, researchers talk about a rather new component of energy expenditure: NEAT, which stands for non-exercise activity thermogenesis (a physiological process that produces heat) (Levine et al., 2005). This component consists of the energy expenditure of daily activities other than the planned physical activity or exercise of a person's daily life.

NEAT can be determined with the help of sensitive equipment (e.g., inclinometer, triaxial accelerometer) worn on the hips or legs in a manner similar to that of wearing a pedometer. These devices capture data related to body position through all planes of movement 120 times per minute. This information can be combined with other laboratory measurements of energy expenditure in order to calculate NEAT.

Findings indicate that changes in NEAT accompany changes in energy balance, which affect weight loss very meaningfully (Levine et al., 2005). Levine and colleagues recruited 20 healthy volunteers who did no structured exercise; indeed, all of the participants were self-proclaimed "couch potatoes." Of the 20 volunteers, 5 men and 5 women had a body mass index (BMI) of 23 ± 2 (whom the researchers referred to as "lean" participants, following standard BMI classification), and another 5 men and 5 women had a BMI of 33 ± 2 (classifying them as mildly obese). Each participant wore an inclinometer and a triaxial accelerometer, and the researchers collected data every half-second for 10 days.

The investigators were searching for movement clues about why the 10 lean non-exercisers differed from the 10 mildly obese non-exercisers. The study results indicated that the obese participants were seated for 164 minutes longer each day than their lean counterparts. The lean participants performed significantly more total-body ambulatory movement, which consisted of standing and walking. This extra movement by the lean participants averaged 352 ± 65 kilocalories per day, which is equivalent to about 36.5 pounds (16.5 kg) per year.

This pioneering study shows the importance of general physical movement during a person's waking day. As a result, it shows exercise professionals that they can help their clients increase their activity energy expenditure not only through structured exercise but also through engaging in more spontaneous movement during the day. Indeed, educating clients about the value of making general movement changes in their daily lives—in addition to sticking with their structured exercise plan—may very well contribute to profound success in meeting weight management goals.

Positive Energy Balance

A positive energy balance occurs when a person takes in more kilocalories than he or she expends. Over time, a positive energy balance results in overweight or obesity. On average, the human body stores 130,000 kilocalories of fat, primarily in the form of triglycerides. According to Hall et al. (2012), a lean adult may have about 35 billion adipocytes (fat cells), whereas a severely obese individual may have 140 billion.

Both positive energy balance (which causes weight gain) and negative energy balance (which causes weight loss) can affect the interaction of REE, TEF, and AEE. Scientists currently theorize that each person has what is called a set point to regulate body weight (Hall et al., 2012). According to this theory, the body has a highly organized feedback control system (regulated in the brain by the hypothalamus) that regulates food intake and energy output. This system is characterized by some give and take. More precisely, due to daily changes in energy intake (the meals we eat) and energy output (our exercise and other activity), Hall and colleagues note that humans regularly exist in a state of energy imbalance, in which we go back and forth between positive and negative energy balance.

The hormone most associated with a person's set point is leptin—a protein secreted by adipose tissue in direct proportion to the total amount of body fat. Leptin regulates a person's energy intake by acting on the hypothalamus through a negative feedback loop. In normal eating conditions (i.e., person is not fasting), adipocytes release leptin in response to increased triglyceride deposits, and the released leptin triggers the hypothalamus to reduce the person's appetite and the drive to eat. Fasting, on the other hand, induces a decrease in the leptin produced in adipose tissue and a subsequent decrease in serum leptin levels. This decrease stimulates hunger (Arch, 2005).

When leptin was discovered in 1994, researchers hypothesized that obese individuals must have low leptin levels, but research has now shown that most obese individuals have elevated levels of plasma leptin (Arch, 2005). In obese children and adults whose weight is stable, plasma leptin circulates in direct proportion to adipose tissue mass in amounts four times higher than in lean individuals (Gutin et al., 1999). As a result, it is now thought that obese individuals may be leptin resistant in a manner similar to insulin resistance in obese individuals with moderate type 2 diabetes. This theory is supported by the observation that leptin transport across the blood–brain barrier is impaired in obese individuals. It is possible that elevated leptin levels reflect increased adiposity, just as insulin is elevated in response to increased blood glucose after a meal.

Leptin is not significantly affected by either short-term or long-term exercise. Similarly, injections of leptin do not stimulate an increase in fat loss in obese participants who produce adequate amounts of leptin but are resistant to it. Physiologically, leptin level reflects the amount of energy stores in adipose tissue, which then guides the central nervous system in regulating energy homeostasis (Kelesidis et al., 2010).

Muscle Metabolism in Eccentric Training

Muscle tissue is metabolically active—that is, it burns calories—even at rest. Fat tissue does not. Therefore, having more muscle tissue raises a person's resting energy expenditure, particularly among older people. As a person ages, muscle tissue is typically lost at a rate of 3 to 5% every 10 years after the age of 25 (Elia, 1999).This age-related decline can be slowed by performing resistance exercise, which increases muscle mass, thus leading to higher caloric expenditure at rest and reducing the chance of obesity.

Research has shown that performing exercise with an eccentric emphasis can acutely and meaningfully raise the RMR of both untrained and trained individuals after a total-body workout (Hackney, Engels, & Gretebeck, 2008). Hackney and colleagues found that performing one full-body workout with an eccentric emphasis (i.e., with a one-second concentric phase and a three-second eccentric phase on all exercises) elevated resting energy expenditure by about 8% for up to 72 hours after the workout. The increased REE is likely caused by two major factors. The first factor is referred to as excess post-exercise oxygen consumption (EPOC), and it may be explained by several physiological functions that last for several hours after exercise, including the following (Borsheim & Bahr, 2003; Mole, 1990):

- Reestablishment of body temperature to normal
- Resynthesis of glycogen fuel sources that have been depleted
- Restoration of electrolyte concentrations to their intracellular and extracellular environments

- Replenishment of oxygen stores in bone and muscle
- Resynthesis of ATP and creatine phosphate (CP)
- Restoration of circulatory and ventilatory processes
- Return of hormones to preexercise levels

Hackney et al. (2008) also note that EPOC does not fully explain the findings from their study showing elevated REE for up to 72 hours after eccentric emphasis exercise. They propose that the following factors also contribute to the elevation: (1) recovery-and-repair cellular alterations associated with delayed-onset muscle soreness and (2) the overall muscle-cell repair process and the energy costs associated with protein synthesis. More specifically, the researchers suggest the involvement of the following mechanisms:

- Restoration of the muscle-cell immune system's inflammatory agents (e.g., neutrophils, macrophages, cytokines, and prostaglandins)
- The energetic cost of postexercise protein synthesis (estimated to account for 20% of REE and significantly elevated after resistance exercise [MacDougall et al., 1995])
- Elevated insulin response in conjunction with amino acid availability during this postexercise recovery period

Maximizing Metabolism With Eccentric Exercise

Here are some guidelines for maximizing the metabolism-boosting effects of an eccentric training workout.

- Perform an eccentric training workout at least once per week.
- For optimal boosting of metabolism, choose predominantly multijoint exercises (e.g., squat, lunge, bench press, shoulder press, row, and latissimus dorsi pull-down).
- Vary the workout by using the three eccentric training methods: eccentric emphasis, supramaximal eccentric, and two-up/one-down.
- Complete multiple sets (two or three) of each exercise.

Here is an example of how to put together a metabolism-boosting workout with eccentric exercise.

Case Study: Total-Body Metabolism-Boosting Workout Using All Three Eccentric Training Methods

1. Bench press: two sets of eccentric emphasis (figure 3.2*a*)
2. Split squat: two sets of eccentric emphasis
3. Latissimus dorsi pull-down: two sets of supramaximal eccentric
4. 45-degree leg press: two sets of two-up/one-down (figure 3.2*b*)
5. Shoulder press: two sets of two-up/one-down
6. Seated row: two sets of supramaximal eccentric

Figure 3.2 *(a)* Bench press with eccentric emphasis and *(b)* 45-degree leg press with two-up/one-down.

Summary Thoughts

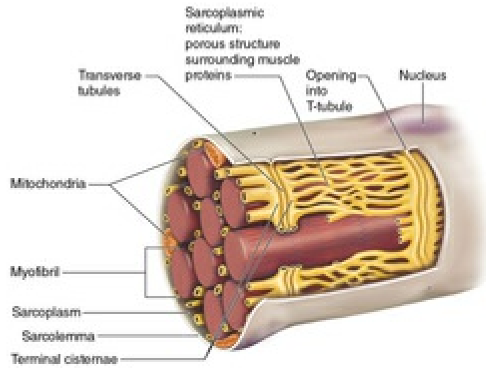
Exercise professionals can help clients boost their metabolism with a two-fold approach. First, research into non-exercise activity thermogenesis (NEAT) shows the remarkable benefits of engaging in more spontaneous movement each day—an increase in daily energy expenditure up to 350 kilocalories just from moving more. Second, research also shows the potential of eccentric emphasis resistance training to elevate resting energy expenditure (REE) by about 8% for up to 72 hours after exercise. These lines of research provide exercise professionals with effective non-exercise and exercise strategies for helping clients boost their metabolism.

Chapter 4
Eliminating Muscle Soreness With the Repeated Bout Effect

All types of muscle contraction can lead to delayed-onset muscle soreness (DOMS), and this is particularly true of eccentric exercise. DOMS is classically characterized as muscle soreness and swelling that become evident 8 to 10 hours after exercise and peaks 24 to 48 hours after the training session (Balnave & Thompson, 1993). When describing DOMS, some clients indicate more discomfort or tenderness than outright pain (Proske & Allen, 2005).

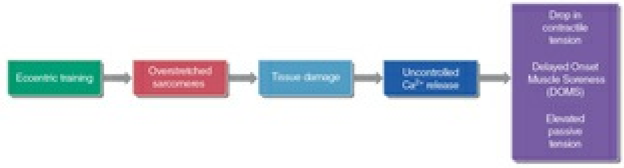
DOMS is a multifactorial physiological phenomenon for which scientists have proposed several theories. For example, the connective tissue theory posits a disruption of noncontractile elements in the sarcomere, such as the sarcoplasmic reticulum and the connective tissues surrounding muscle proteins (McHugh, Connolly, Easton, & Gleim, 1999). McHugh and colleagues also note a widely known cellular theory of DOMS that focuses on strain experienced by sarcomeres during eccentric contraction, which disrupts certain sarcomere components (specifically, the Z-line and the A-band). A newer theory suggests that DOMS may result in part from a cascade of events involving the excitation–coupling mechanism by which myosin cross-bridges attach to actin proteins (Proske & Allen, 2005). As Lamb (2009) explains, the sarcoplasmic reticulum tissue (see figure 4.1), which releases calcium ions to initiate the power stroke movement (i.e., the sliding of actin over myosin proteins), can be overstretched by eccentric contractions (as compared to concentric actions). According to Lamb, this overstretched sarcoplasmic reticulum leads to excessive calcium ion release not typically observed with concentric muscle contractions. This elevated calcium ion concentration has a deleterious effect on the sarcomeres' voltage-regulating sensors, which regulate neural input in the muscle. This cascade of events contributes to DOMS.

Figure 4.1 Excitation–coupling mechanism: sarcoplasmic reticulum surrounding muscle proteins. The sarcoplasmic reticulum surrounds muscle proteins and contains calcium ions. It may be overstretched by an eccentric contraction, thus causing a substantial release of calcium ions, which carry a double-positive electrical charge and may disrupt voltage-regulating sensors in the muscle, thus contributing to DOMS.



Given the numerous theories about what causes DOMS, it is safe to say that much remains to be learned through research. However, the existing theories discussed clearly indicate that exercise-induced DOMS is a multifaceted event in the muscle (see figure 4.2).

Figure 4.2 Sequence of mechanisms in DOMS resulting from eccentric exercise.



Based on Proske and Allen 2005.

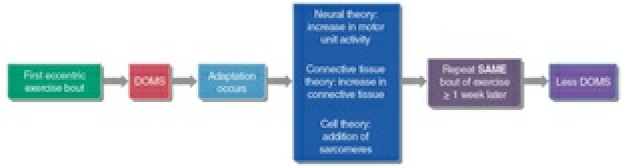
Repeated Bout Effect of Eccentric Training

One promising area of research about DOMS and eccentric exercise involves what is called the repeated bout effect (RBE). One way to prevent or reduce DOMS associated with eccentric exercise (or hasten recovery from it) is to stimulate the muscles with a lower-intensity eccentric training bout approximately one week (or more) before a planned eccentric bout (Pettitt, Symons, Eisenman, Taylor, & White, 2005). The resulting reduction of DOMS is referred to as the RBE.

Several studies have addressed diminished DOMS by performing a bout of lower-intensity eccentric exercise (of the specific targeted muscles) and then repeating the eccentric bout at higher intensity several days later. This is the RBE. The outcomes of incorporating the RBE include the following: noticeably lower levels of DOMS on subsequent higher-intensity eccentric workouts, reduced levels of circulating creatine kinase (a marker of muscle damage), increased range of motion during recovery, and enhanced strength during recovery (Nosaka, Sakamoto, Newton, & Sacco, 2001; Pettitt et al., 2005; Balnave & Thompson, 1993).

The proposed mechanisms of the RBE are not fully understood. However, theories suggest that it involves adaptations from neural input to the muscle, restructuring of connective tissue in muscle, and cellular adaptations (a longitudinal increase in sarcomeres) in the muscle cell (LaStayo et al., 2014; McHugh, 2003; McHugh et al., 1999). See figure 4.3.

Figure 4.3 Proposed mechanisms of the repeated bout effect.



Based on McHugh et al. 1999.

Implementing the Repeated Bout Effect With a Client

An exercise professional can use the RBE with a client in order to begin a more challenging eccentric training program. All of the research with the RBE strategy has used the eccentric emphasis training method. We therefore support this eccentric method for introducing the RBE. To incorporate the RBE strategy, use the following guidelines. Start by having the client perform the RBE exercises one week before completing a challenging eccentric training workout (with any of the three eccentric training methods). Begin by having the client complete one or two sets of traditional concentric/eccentric (CON—ECC) resistance training for his or her normal workout. The last set for each exercise will be the RBE. If a client does single-set training, then the RBE will be the first and last set.

As a reminder, the eccentric emphasis method involves using a one-second concentric contraction with a three- to four-second eccentric contraction. For the eccentric emphasis RBE set, choose a resistance intensity that is 50% to 60% of what the client normally lifts with that particular load. Explain to the client that he or she will perform the normal lifting phase of the movement, pause, and then lower the weight to the starting point very slowly—for three to four seconds. Encourage the client to focus on the muscles contracting while lowering the weight. The introduction of the RBE offers an excellent platform for explaining eccentric training methodology to a client.

Now let's consider a case study. Imagine that you are a personal trainer introducing the RBE to a client who currently performs three sets of each exercise at 10-repetition-maximum (10RM) intensity. In other words, the client can do 10 repetitions but reaches momentary muscular fatigue on the 11th repetition. The client does the following six exercises in her or his workout: bent-over row, incline bench press, lateral dumbbell raise, deadlift, front squat, and standing triceps extension.

Have the client perform the first two sets of each exercise with the usual 10RM intensity using the traditional CON—ECC lifting method. For the third set of each exercise, however, have the client lift 50% to 60% of the normal resistance and introduce the eccentric emphasis method on the lowering phase of the movement. Let's assume that the client normally performs three sets (with a 10RM intensity) on the incline bench press with 100 pounds (45 kg). To introduce the RBE on the third set, set the weight at 60% of 100 pounds, which is 60 pounds (27 kg).

The client should complete the upward phase of the incline bench press in one second; this is the concentric contraction, because the triceps and pectoral muscles are in a shortening phase of contraction. Then have the client lower the weight for three to four seconds; this is the eccentric contraction or muscle-lengthening phase of the movement. The client should complete each repetition in this manner: a one-second shortening action followed by a three- to four-second lowering (i.e., the eccentric emphasis, or EE) action. Have the client continue until all 10 repetitions have been completed.

You must now wait about one week before having the client do any eccentric training method at full intensity. This one-week period allows the muscles to make the molecular and neural adaptations that bring about the RBE. The client may experience mild muscle soreness after completing the eccentric workout at 60% of normal load. Explain to the client that this soreness is a normal response to the new stimulus experienced by his or her muscles. Then, one week later, have the client do the same workout using 100% of his or her 10RM for the EE workout (i.e., the one-second concentric phase and the three- to four-second eccentric phase).

In this example, the client has been training with three sets of six exercises. For progression, since eccentric loading is more challenging to the muscles, it may be appropriate to have the client do only one or two sets for each of the six exercises the first time that he or she uses eccentric training technique at 100% of 10RM. Because the client's body has had a week to adapt from the RBE, it is now prepared for the more demanding eccentric training load; as a result, the client should have much less muscle soreness than would otherwise be the case. From this point on, you can progress and regularly incorporate eccentric training into the client's workouts—using the three eccentric methods presented in this book—without having to repeat the RBE. However, if the client is inactive for a period of time (e.g., due to illness, time off, or vacation), it would be prudent for you to reintroduce eccentric training by means of the RBE.

Educating Clients About the Repeated Bout Effect

Personal trainers will surely receive questions from their clients about eccentric training. Since the use of the RBE is often the first time that a client learns about eccentric training, this is an appropriate place in the book to offer some educational tips to share with clients.

Eccentric training focuses on the lowering phase of an exercise, during which the muscle is elongating but is still very challenged by the resistance. All sports and everyday activities demand both lengthening and shortening actions by the muscles (Vogt & Hoppeler, 2014). These actions are referred to respectively as the eccentric (lengthening) and concentric (shortening) phases of movement, and a person needs to strengthen his or her muscles in both phases in order to participate effectively in sports as well as in activities of daily living.

In sports, the eccentric phase is often the braking action of an athletic skill—for example, when descending after a jump in volleyball or basketball. Therefore, this type of braking action by the muscles can be strengthened by eccentric training. The research shows that incorporating eccentric training in the program design for clients will lead to increased joint strength, stability, and mobility (LaStayo et al., 2014). This potential outcome may be most effective for injury prevention in many sports and athletic activities.

Traditionally, most resistance training programs have focused on the shortening (concentric) phase of the movement. More recently, however, the lengthening (eccentric) phase has attracted much attention because of its potential benefits for muscular strength, muscular hypertrophy, rehabilitation after musculoskeletal injury (LaStayo et al., 2014), and sport performance. In workout facilities, eccentric exercise is now often referred to as doing eccentrics or negatives.

A few caveats are also in order. First, even though the RBE can markedly reduce muscle soreness, you may wish to advise clients that they could still experience mild soreness 24 to 48 hours after performing eccentric training exercise. In addition, if a client has osteoarthritis or another joint-related disease, eccentric exercise may not be recommended due to the extra stress it puts on the musculoskeletal system. Often, personal trainers are also asked whether eccentric training is appropriate for older clients. The general answer is absolutely yes. According to LaStayo and colleagues (2014), eccentric muscle contractions can benefit older adults requiring rehabilitation not only to improve their mobility but also to avoid falls, which can improve confidence when moving about during daily activities. Older adults living with diseases that result in bodily weakness, fatigue, and atrophy can progressively load muscles eccentrically without inducing classic DOMS responses.

However, some older clients may have a low level of muscular strength or endurance or may experience joint pain (due to a preexisting condition) in daily life. For these clients, personal trainers may wish to introduce eccentric training with very light loads and progress very gradually.

Understanding Muscle Recovery

Exercise professionals should discuss the concept of recovery with any client who is starting eccentric training. Recovery from exercise training is an integral component of the overall training program; indeed, it is essential for optimal improvement and performance. If a client's rate of recovery improves, he or she can use higher training volumes and intensities without the detrimental effects of overtraining (Bishop, Jones, & Woods, 2008).

Understanding the physiological realities of recovery is essential for designing optimal training programs, particularly those using eccentric training. In essence, recovery includes the following processes: (1) normalization of physiological functions (e.g., blood pressure, cardiac cycle), (2) return to homeostasis (i.e., a resting cell environment), (3) restoration of energy stores (blood glucose and muscle glycogen), and (4) replenishment of cellular energy enzymes (e.g., phosphofructokinase, a key enzyme in carbohydrate metabolism) (Jeffreys, 2005). Muscle recovery occurs during and (primarily) after exercise and is characterized by continued removal of metabolic end products (e.g., lactate and hydrogen ions). During exercise, recovery is needed in order to reestablish intramuscular blood flow for oxygen delivery, which promotes replenishment of phosphocreatine stores (used to resynthesize ATP), restoration of intramuscular pH (acid–base balance), and regain of muscle membrane potential (balance between sodium and potassium exchanges inside and outside of a cell) (Weiss, 1991).

For clients to achieve optimal exercise performance, the exercise professional needs to be proactive in planning recovery as part of the training program. Although no consensus exists about a central recovery strategy, monitoring and observing a client's exercise performance is always helpful in adjusting and planning for this essential ingredient of training. The recovery process varies by the individual due to multiple factors—for example, training status (trained or untrained); level of fatigue; and the person's ability to deal with physical, emotional, and psychological stressors (Jeffreys, 2005). In addition, educating clients about the importance of recovery (e.g., the quantity and quality of sleep) may empower them to complete suitable recovery interventions that will enhance their training outcomes.

Summary Thoughts

Delayed-onset muscle soreness (DOMS) has long been associated with increased physical exertion. It is typically experienced by all individuals, regardless of fitness level, and is a normal physiological response to increased exertion and to the introduction of unfamiliar physical activity. Typical symptoms of DOMS are strength loss, pain, muscle tenderness, stiffness, and swelling. Loss of strength usually peaks within the first 48 hours after an exercise bout, and full recovery often takes several days.

Because pain and discomfort can impair physical training and performance, DOMS prevention and treatment are of great concern to personal trainers and coaches. One intervention is the repeated bout effect (RBE), which is a progressive adaptation to eccentric exercise. Research shows that performing a lower-intensity eccentric exercise at least one week before the initial higher-intensity eccentric bout reduces DOMS and exercise-induced muscle damage. This strategy is referred to as the repeated bout effect. Thus, exercise professionals are encouraged to introduce eccentric exercise with this approach.

Another component of exercise program design is recovery from exercise training. Strategically planned recovery periods prepare the exerciser to use higher training volumes and intensities that enable optimal performance in sport and exercise.

Chapter 5
Eccentric Training for Strength

Strength and power athletes often focus on increasing their 1-repetition maximum (1RM), which serves as a way to gauge strength increases and decreases. A higher 1RM allows an exerciser or athlete to use a greater submaximal training volume and thus provides the potential to improve submaximal muscle performance. Doan et al. (2002) found that the 1RM could be acutely increased by using a supramaximal load (i.e., 105% of 1RM) during the eccentric phase of the lift. This acute increase (5% greater than 1RM) improved 1RM concentric performance by 5 to 15 pounds (roughly 2 to 7 kg) for all participants.

Theories about why strength increases after eccentric loading include enhanced neural stimulation to and within muscle, higher stored elastic energy in muscle, and overall increase in muscle hypertrophy. Neural stimulation within muscle from eccentric exercise causes greater muscle-spindle stretch. The muscle spindle is a stretch receptor that lies parallel to the contractile proteins (actin and myosin). It is responsive to the amount of stretch in a muscle and the speed of muscle stretch. Increased muscle-spindle stretch leads to an increase of firing motor nerves (nerves that travel to muscle), thus potentially increasing the force of concentric contraction in muscle fiber (Deitz, Schmidtbleicher, & Noth, 1979).

Doan et al. (2002) also suggest that supramaximal eccentric training is an excellent tool for helping athletes and other clients break through a training plateau. The reason may be that the client realizes he or she is able to lift a heavier weight with eccentric exercise. In other words, the researchers further explain that the heavier descending stimulus of the eccentric phase of the movement leads to a larger neural signal message for an enhanced concentric muscle action. Another theory of increased concentric 1RM performance after supramaximal eccentric training views the muscle as responding like a rubber band. Doan and colleagues explain that the dynamic eccentric force leads to an increase in the storage of elastic energy in muscle fibers and tendons. This results in greater force production capabilities in a concentric action.

Further evidence that eccentric training promotes strength is provided by researchers whose meta-analyses show that eccentric exercise performed at higher intensities than concentric training yields higher total concentric strength gains (Roig et al., 2009). In addition, eccentric strength gains increase more noticeably than concentric strength (Roig et al.). Furthermore, eccentric training performed at high intensities appears to be more effective in promoting increases in muscle mass (measured as muscle girth) and muscle cross-sectional area measured with magnetic resonance imaging or computed tomography. Roig et al. consider this superiority of eccentric training to the use of higher training loads during eccentric contractions to be a direct result of a greater neural stimulation to muscle.

In addition to the neural response, research also points to an increase in Type II (fast-twitch) muscle fiber activity. Researchers in the Netherlands found that after performing one high-intensity eccentric exercise bout, satellite cell content increased in the Type II fibers of that particular muscle, whereas Type 1 fibers were unaffected (Cermak et al., 2013). This satellite-cell increase suggests that the larger Type II fibers were much more responsive to the higher-intensity training from eccentric exercise.

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 5 to 10 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for strength training: The exerciser should perform one to three traditional warm-up sets (i.e., concentric phase followed by eccentric phase) of the exercise at about 50% to 75% of what he or she normally lifts. The goal is specifically to warm up the joint, which includes the tendons, ligaments, connective tissues, synovial fluid, and all surrounding muscles and fascia.

For the purpose of increasing strength, combining the three eccentric training methods with CON—ECC is recommended. However, create a foundation of strength first with CON—ECC training, which can be followed by a mesocycle (two- to six-week period) incorporating the eccentric training methods. Many strength training plans that increase the exerciser's squat and bench press include mesocycles using the eccentric emphasis method of training.

The exercise design for increasing strength calls for the client to complete two to six sets of one to six repetitions of each exercise. Guidelines from the National Strength and Conditioning Association (2008) suggest working at an intensity of 85% of 1RM, with two to five minutes of rest between sets.

Application Tools for Exercises

Here are some instructions for optimal resistance training:

- Concentric–eccentric (CON–ECC): one- to two-second concentric with a one- to two- second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three or four seconds (eccentric)
- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client's needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options. The exercises presented a bit later in this chapter include six for the upper body and six for the lower body, each of which is shown in its starting and ending positions.

Training Intensity Suggestions

A principle of resistance training calls for completing each set to volitional fatigue—the "sticking point" at which the exerciser is unable to perform another rep with correct form. Surprisingly, however, there is not a great deal of research to prove that taking every set to volitional fatigue is necessary or even optimal for maximal muscular fitness. Therefore, it may be advisable to take some sets to volitional fatigue but end others slightly before reaching that point.

Here are some safety tips for successful resistance training that you can share with clients as they begin an eccentric training program.

1. Do not lock your joints while lifting weight; doing so may put too much stress on the joint and lead to injury.
2. Lift and lower all weights with control.
3. Use a spotter for heavier loads.
4. Always protect the spine by maintaining correct posture and body alignment during your lifts.
5. Do not hold breath during the lifts.
6. Use the appropriate collars on free-weight bars.

Summary Thoughts

An optimal strength training program can be implemented only if the individual is committed to and consistent in performing the workout program. Therefore, motivational and inspirational strategies (e.g., writing down goals) are an integral component of a successful strength training program.

In addition, during strength training phases, personal trainers and exercise enthusiasts should always be mindful of the heavier loads placed on the musculoskeletal system. When lifting heavier loads, in particular, the exerciser should avoid locking the joints (especially the knees and elbows). Each client should also perform each exercise in an optimal range of motion for him or her, because some people have a limited range of motion in some joints. Indeed, exercise design for heavy strength workouts must always embrace injury prevention strategies, which are crucial if the exerciser is to fully realize optimal training outcomes.

The rest of this chapter contains descriptions of exercises for increasing strength, sample workout routines, and options for change-out exercises.

Training for Strength

One element in muscular strength training is breathing technique. Traditionally, exercisers have been taught to exhale while either pulling or pushing the load against gravity (i.e., during the concentric action) and to inhale when returning the weight to the starting position (i.e., during the eccentric action). This breathing technique is recommended when performing a CON–ECC exercise.

However, when an exerciser performs an eccentric technique, the eccentric motion takes longer, which can make the use of one long inhalation both awkward and tiring. Instead, have clients take two or three relaxed breaths—inhaling, exhaling, and repeating—and time their breathing so that they exhale as they exert during the concentric phase of the movement. This technique allows the exerciser to keep a comfortable tempo with the eccentric technique being employed.

Table 5.1 presents exercises that maximize strength, and full descriptions of the exercises appear on the following pages. While guiding clients through these exercises, keep good breathing technique in mind and provide cues as necessary.

TABLE 5.1 Exercises for Strength

Upper body	Lower body
Bench press	Barbell back squat
Overhead press	Standard deadlift
Bent-over barbell row	Leg press
Wide-grip latissimus dorsi pull-down	Leg extension
Barbell curl	Lying hamstring curl
Lying triceps extension	Standing calf raise

5.1: Bench Press

(CON–ECC, EE, or SUP)

5.1*a* Starting position for the bench press.

Starting Position

1. Lie flat on the bench with your feet fully contacting the floor.
2. Grasp the barbell in an overhand grip with your hands slightly farther than shoulder-width apart.
3. Lift the bar from the rack and position it above your chest.

Trainer Recommendations

- Stand directly behind the client as he or she performs the bench press.
- If the weight is heavy, assist in the lift-off to help prevent shoulder injury.
- Maintaining contact with the bar, follow the movement path with client from beginning to end.
- To decrease risk of shoulder injury, help the client return the barbell to the rack in the starting position.

5.1*b* Ending position for the bench press.

Video 5.1

See online video 5.1 for the CON–ECC, EE, and SUP methods of the bench press.

Exercise Motion

1. Lower the barbell until it touches the lower part of your chest.
2. Push the bar up, squeezing your pectoralis major muscles, until your arms are extended.

Performance Improvement Tips

- Keep a stable position and avoid bouncing the bar off of your chest.
- Keep your forearms directly under the bar and perpendicular to the floor.
- Adjust your hand position from wide to narrow, because this slightly varies the challenge to the muscles.

5.2: Overhead Press

(CON–ECC or EE)

5.2*a* Starting position for the overhead press with barbell.

Starting Position

1. The overhead barbell press often starts with the barbell on a squat rack at about chest height.
2. Grasp the barbell in a pronated grip (palms facing forward) with your hands slightly farther than shoulder-width apart.
3. Bend your knees slightly and place the barbell on your collarbone.
4. Lift the barbell, keeping it close to your chest.
5. Take a step back and position your feet shoulder-width apart.

Trainer Recommendations

- Observe the client from the side and the front to make sure that she or he performs each repetition with correct form and does not favor one side of the body.
- Make sure that the client keeps his or her back and core tight (without arching the back) with the arms over the head.
- When using eccentric training techniques, it is often helpful to complete a push jerk (shown on video) on the concentric action. This helps the client lift the weight over her or his head.

Video 5.2

See online video 5.2 for the CON–ECC and EE methods of the overhead press with barbell.

5.2*b* Ending position for the overhead press with barbell.

Exercise Motion

1. From the starting position, press the bar up over your head by extending your arms. Be sure to tilt your head back slightly before pressing the bar overhead.
2. Once the bar is overhead, return your head to neutral.
3. Lower the bar back to your collarbone slowly and with control.

Performance Improvement Tips

- As you press, get your head out of the way. Look up as you press to ensure that your head is safely out of the bar's path.
- Always select a weight that you can control during the entire range of motion.

5.3: Bent-Over Barbell Row

(CON–ECC, EE, or SUP)

5.3*a* Starting position for the bent-over barbell row.

Starting Position

1. Holding a barbell with a pronated grip (palms facing down), bend your knees slightly. Bring your torso forward by bending at your waist until your back is somewhat parallel to the floor. Make sure you are activating all of the core muscles of the lower spine to keep it stable.
2. The barbell should hang directly in front of you as your arms hang perpendicular to the floor and your torso.

Trainer Recommendations

- Observe the client from the side and make sure that he or she performs each repetition with optimal form.
- Make sure that the client keeps her or his back and core tight without rounding the back.
- To add variety to this exercise, try having the client change his or her grip. It can be wide, narrow, overhand, or underhand. These position variations will slightly vary the challenge placed on the contracting muscle groups.

5.3*b* Ending position for the bent-over barbell row.

Video 5.3

See online video 5.3 for the CON–ECC and EE methods of the bent-over barbell row.

Exercise Motion

1. While maintaining a stationary torso, lift the barbell toward your abdomen just below your sternum. Your elbows should remain close to your body. Focus on using your forearms to hold the weight with your hands.
2. At the top position of the movement, squeeze your back muscles. These muscles should be your main focus while performing this movement.
3. Once at the top of the movement, slowly lower the barbell back to the starting position.

Performance Improvement Tips

- This exercise requires great core strength and should be avoided by people with back issues, for whom a better choice may be a seated rowing machine.
- As with any movement, always practice using perfect form and never round your back forward; doing so may lead to injury.
- If the exercise is new, always use less weight and focus on tightening the working muscle.

5.4: Wide-Grip Latissimus Dorsi Pull-Down

(CON–ECC, EE, or SUP)

5.4*a* Starting position for the wide-grip latissimus dorsi pull-down.

Starting Position

1. Sit at the pull-down machine with a wide bar attached to the top pulley. Adjust the machine's kneepads to the appropriate comfort level for your height; these pads prevent your body from being raised by the resistance attached to the bar.
2. Reach up and grasp the bar with your palms facing forward. For this wide-grip exercise, place your hands farther than shoulder-width apart.
3. Bring your torso back about 30 degrees while creating a slight curvature in your lower back. As with the bench press, this position should feel like the natural arch in your back —not a hyperextension.

Trainer Recommendations

- At the beginning of the movement, place a hand behind the client, who should then lean back until he or she feels your hand. This touch gives the client an idea of the proper positioning for the start of the movement.
- Keep your hand on the upper portion of the client's middle back and be sure that he or she uses the back muscles as the primary movers.
- Encourage the client to achieve full contraction at the bottom of each repetition and full stretch at the top. This range can be achieved by having the client use a lighter weight until she or he can use a heavier load while maintaining the same technique.
- As the load increases, stand behind the client and help guide the bar down to his or her chest; also help the client safely return the weight to the starting position.

5.4*b* Ending position for the wide-grip latissimus dorsi pull-down.

Exercise Motion

1. Bring the bar down until it touches your upper chest. To accomplish this, squeeze your shoulder blades together and pull your arms down and back.
2. In the fully contracted position, concentrate on squeezing your back muscles. Only your arms should move; your upper torso should remain stationary.
3. For a good reminder, visualize your arms as straps or hooks and envision the main pull coming from the large muscles of your back and shoulders.
4. After the bar touches your chest and your back muscles have contracted, slowly return the bar to the starting position. Be sure to extend your arms fully and stretch your latissimus dorsi at the top of the movement.

Performance Improvement Tips

- Always keep your torso upright and avoid swinging motions.
- Keep the pulling emphasis on your back muscles rather than pulling with your forearms or biceps.
- When performing heavy sets, consider using a hook grip. These hand grips help you maintain your grasp on the bar while fully challenging the back muscles during the exercise.

5.5: Barbell Curl

(CON–ECC, EE, or SUP)

5.5*a* Starting position for the barbell curl.

Starting Position

1. Stand with your torso upright while holding a barbell in a shoulder-width grip.
2. The palms of your hands should face forward, and your elbows should be close to your sides.

Trainer Recommendations

- Watch the client perform the curls from the side to ensure that his or her elbows remain in the proper position throughout entire range of motion.
- Ensure that the client uses a weight that allows for correct form, in particular keeping the lower back from arching.
- As the weight becomes heavier to the exerciser, stand in front of the client and help guide the bar from the starting position to the ending position during each repetition. Doing so greatly decreases breakdown in form as the client tires.
- To vary the movement, have the client try different hand positions (e.g., wide, close, standard) or a reverse grip (overhand or pronated). Variation of grip and hand position will activate different secondary muscles of the forearm.

5.5*b* Ending position for the barbell curl.

Exercise Motion

1. Keeping your upper arms stationary, curl the weight forward while contracting your biceps. All movement should be done around the axis of your elbow joints. Your elbows should remain in line with your shoulder joints and hips at all times during the movement.
2. Curl the bar up until your biceps are fully contracted and the bar is at shoulder level.
3. Slowly return the bar to the starting position.

Performance Improvement Tips

- Keep your knees slightly bent and your spine neutral throughout the range of motion. Neutral spine is the natural curvature of the spine, which is also its most stress-free position.
- Your elbows should always remain in a fixed position and in line with your shoulder and hip joints.
- Select a weight that allows for perfect form with no swinging or "cheating."

5.6: Lying Triceps Extension

(CON–ECC or EE)

5.6*a* Starting position for the lying triceps extension.

Starting Position

1. While lying on a flat bench, hold a cambered barbell (i.e., barbell with an arch in it) directly in front of you.
2. Your arms should be fully extended at a 90-degree angle from your torso and the floor. Your palms should face away from you, and your elbows should be parallel to each other.

Trainer Recommendations

- Stand behind the client as she or he lowers the weight toward the head. Place your hands lightly on the bar to help the client guide the weight along the right path.
- Instruct the client not to allow movement of the upper arms at the shoulder joints and to focus instead on moving only at the elbow joints.
- As the client tires, have the client lie on the bench with his or her arms extended above the chest. Place the bar into the client's hands to prepare for the exercise.

5.6*b* Ending position for the lying triceps extension.

Exercise Motion

1. As you breathe in, slowly lower the weight until the barbell rests just above the top of your head. Throughout the movement, keep your upper arms stationary and your elbows in.
2. Still keeping your elbows in and your upper arms stationary, use your triceps to lift the weight back to the starting position.

Performance Improvement Tips

- Brace your core as you lower the weight toward the extended position. Do so by tightening your abdominal and lower back muscles toward your spine.
- Keeping your core muscles engaged, exhale as you extend the weight away from your head.
- Avoid resting the barbell on your forehead. This variation, commonly seen in a movement called the "skull crusher," increases the risk of injury and places greater stress on the elbow joints.
- Using a hook grip may reduce your chance of injury by helping prevent the bar from slipping out of your hands.

5.7: Barbell Back Squat

(CON–ECC, EE, or SUP)

5.7*a* Starting position for the barbell back squat.

Starting Position

1. Begin with a barbell inside a squat rack. Position the barbell across the top of your shoulders. The bar should rest just above your scapula, directly on top of your trapezius muscles.
2. In a standing position with the barbell across your shoulders, place your feet directly under your hips for a narrow stance. Or, for a wider stance, position your feet slightly wider than your hips with a slight external rotation of your hips (20 to 30 degrees).
3. Your weight should be balanced directly over your ankles.

Trainer Recommendations

- Guide the participant out of the squat rack to a safe starting position.
- Prepare to spot the squat by positioning yourself in a wide stance behind the client.
- Position your hands underneath the client’s rib cage and prepare to help her or him perform a safe squat.
- During the motion, squat and rise with the client.
- Help the exerciser select an appropriate load for his or her strength level. The client should be able to perform the movement on her or his own; you are there strictly to prevent injury.

5.7*b* Ending position for the barbell back squat.

Video 5.7

See online video 5.7 for the CON–ECC, EE, and SUP methods of the barbell back squat.

Exercise Motion

1. Bend your knees and lower your legs until you either create a 90-degree angle or reach your maximum range of motion. During the descent, maintain a natural curve in your lower back; avoid hyperextending or leaning forward excessively. You should feel a slight stretch in your hamstrings as you reach the bottom of the squat.
2. Once at the bottom of the squat, use your gluteus maximus, hamstring, and quadriceps muscles to return to the starting position of the movement.
3. Keep your heels firmly in contact with the floor at all times during the movement; doing so keeps your weight over your ankles.

Performance Improvement Tips

- Keep your heels firmly planted on the floor throughout the squat.
- Keep your knees in line with your ankles.
- Keep your head and neck in a neutral position.
- Keep your core tight!

5.8: Standard Deadlift

(CON–ECC, EE, or SUP)

5.8*a* Starting position for the standard deadlift.

Starting Position

1. Stand in front of a loaded barbell with your feet shoulder-width apart.
2. While keeping your back as stable as possible, bend your knees, bend forward, and grasp the bar using a medium (shoulder-width) overhand grip. If it is difficult to hold on to the bar with this grip, alternate your grip (one overhand and other underhand) or use wrist straps.

Trainer Recommendations

- Monitor the client to make sure that she or he maintains proper positioning during the lift.
- Watch closely for rounding of the back and for hyperextension at the top of the movement.
- Encourage the client to use a light weight to work on form and technique before increasing to a heavy load.

5.8*b* Ending position for the standard deadlift.

Video 5.8

See online video 5.8 for the CON–ECC and EE methods of the standard deadlift.

Exercise Motion

1. Start the lift by pushing with your legs while simultaneously getting your torso to the upright position. In the upright position, stick your chest out and contract your back by bringing your shoulder blades back.
2. Go back to the starting position by bending at your knees while simultaneously leaning your torso forward at your waist and keeping your back straight. When the weights on the bar touch the floor, you are back at the starting position and ready to perform another repetition.

Performance Improvement Tips

- This is not an exercise to be taken lightly. If you have back issues, replace it with a rowing motion instead.
- Even if you have a healthy back, maintain correct form and do not round your back; doing so may cause back harm or injury. Also be cautious about the weight you use; if in doubt, use less weight rather than more.

5.9: Leg Press

(2UP/1DN, CON–ECC, EE, or SUP)

5.9*a* Starting position for the leg press.

Starting Position

1. Adjust the back pad of the machine to provide the greatest range of motion and comfort. The proper position varies depending on your leg length and mobility.
2. Once seated, press your lower back and shoulders firmly against the back pad. Allow a natural arch in your lower back. Your neck should remain relaxed and neutral.
3. Place your feet on the platform and adjust them to the proper level. Your feet can be set high or low, depending on your individual body structure. Proper foot placement allows you to maintain your tibia at a 90-degree angle (or greater) in relation to your femur during the full range of each repetition.
4. Your feet may be placed either shoulder-width apart, close together, or wider than shoulder-width apart. Each foot placement slightly challenges the load on the quadriceps and other primary movers. Adjust your feet according to your goals.

Trainer Recommendations

- Check the client’s body alignment.
- When the client is ready to begin the movement, position yourself in a kneeling lunge, which allows you to use one hand to ensure that the client maintains proper body position. Place the other hand on the platform.
- As the client tires and the weight appears to become heavier, you may need to stand up and help spot on the platform with two hands. Maintain visual contact with the client.

5.9*b* Ending position for the leg press.

Video 5.9

See online video 5.9 for the 2UP/1DN, EE, and SUP methods of the leg press.

Exercise Motion

1. Bend your knees and lower your legs until you either create a 90-degree angle or reach your maximum range of motion. Your lower back and shoulders should continue touching the back pad during the entire movement. Keep your heels in contact with the foot platform at all times. You should feel a stretch in your hamstrings.
2. Once at the bottom of the movement, press the platform back to the starting position using your hamstrings, glutei maximi, and quadriceps.

Performance Improvement Tips

- Keep your head and neck in a neutral position.
- Keep your knees in line with your ankles.
- Keep your heels planted on the platform throughout each repetition.
- Keep your shoulders and lower back pressed against the back pad at all times. Maintain a natural arch in your lower back. Avoid hyperextending!

5.10: Leg Extension

(2UP/1DN, CON–ECC, EE, or SUP)

5.10*a* Starting position for the leg extension.

Starting Position

1. Sit on the machine with your legs under the pad and your hands holding the sidebars, if desired. The footpad should fall along your shins, just above your ankles.
2. Be sure that your legs form a 90-degree angle at the axis of the knee joint.

Trainer Recommendations

- Make sure that client positions the footpad properly before beginning the exercise.
- Be sure that the back pad is adjusted appropriately to fully support the client’s back.
- Monitor for proper range of motion. Coach the client to avoid hyperextending or slamming the weight stack in the return phase of the movement.
- For variety, you may have the client use different foot positions (e.g., turned out, turned in, standard).

5.10*b* Ending position for the leg extension.

Exercise Motion

1. Extend your legs fully, using your quadriceps. Your knees should remain in a soft or neutral position. Avoid locking your knee joints or hyperextending at the knees.
2. Slowly lower back to the starting position. To keep constant tension in the muscle, avoid letting the weight rest on the weight stack.

Performance Improvement Tips

- Begin with a light weight.
- This is an isolation movement; therefore, you should focus less on moving a large load and more on squeezing the muscle with a full range of motion.
- Do not hyperextend at the knee or lock the joint.

5.11: Lying Hamstring Curl

(2UP/1DN, CON–ECC, or EE)

5.11*a* Starting position for the lying hamstring curl.

Starting Position

1. Adjust the machine to fit your height and lie facedown on the leg curl machine with the footpad lever just above your ankles.
2. Keeping your stomach flat on the bench, extend your legs fully and grab the side handles of the machine (if desired). Using dorsiflexion, flex your feet to increase hamstring recruitment.

Trainer Recommendations

- Make sure that the footpad is in the proper position at the ankles before allowing the client to begin the exercise.
- Monitor to ensure that the client performs an optimal range of motion, completely shortening the hamstring at the top of the movement and lengthening it at the bottom.

5.11*b* Ending position for the lying hamstring curl.

Exercise Motion

1. Contracting your hamstrings, curl your legs up to a full contraction. Your upper thighs and stomach should remain pressed against the machine.
2. Stretching your hamstrings, extend your legs back to the starting position.

Performance Improvement Tips

- Use ankle dorsiflexion to increase hamstring contraction.
- Use a weight that you can lift with your hamstrings only, without swinging or recruiting your lower back.

5.12: Standing Calf Raise

(2UP/1DN, CON–ECC, EE, or SUP)

5.12*a* Starting position for the standing calf raise.

Starting Position

1. Adjust the padded lever of the calf raise machine to fit your height.
2. Place your shoulders under the pads and position your toes facing forward. The balls of your feet should rest on top of the foot platform with your heels extending over the edge.

Trainer Recommendations

- Because this exercise involves inherent risk to the lower back, closely monitor the client to ensure that she or he keeps the torso straight and the knees bent throughout the movement.
- If the client has lower back problems, a better option may be the seated calf raise or the seated calf extension.
- Be sure that the client uses a full range of motion. If the weight is too heavy, the movement often gets shortened, which results in less benefit to the targeted muscle.

5.12*b* Ending position for the standing calf raise.

Video 5.12

See online video 5.12 for the 2UP/1DN and CON–ECC methods of the standing calf raise.

Exercise Motion

1. With your shoulders pressing against the pads, rise onto your toes by contracting your calf muscles. Your knees should be kept slightly bent and not locked out.
2. As you rise, extend your ankles as much as possible. Keep your torso and knees stationary at all times. All movement should take place at the ankle joint only.
3. Slowly lower back to the starting position, achieving a full stretch in your calves at the bottom of the movement.

Performance Improvement Tips

- Avoid rounding your back and locking out your knees during this movement. To help avoid these pitfalls, select an appropriate weight.
- Achieve full contraction and full stretch on each repetition.
- You can perform the exercise with your toes angled in to better target the outer head of the calves or with your toes pointed out in order to stimulate the inner calves.

Upper- and Lower-Body Workout Routines for Strength Training

These sample strength training routines are designed to provide a full upper-body and lower-body strength regimen. Each routine should be implemented with 48 to 72 hours of rest.

Therefore, the program works best with Monday and Wednesday used for the upper-body routine and Tuesday and Thursday used for the lower-body routine. If the exerciser needs more time between sessions, another programming possibility is to perform the upper-body routine on Monday and Thursday and the lower-body routine on Tuesday and Friday.

For the purpose of increasing strength, we encourage progression when using the three eccentric training methods with these heavier intensities. Although these techniques provide a meaningful overload stimulus, too much of the greater forces (due to the higher external loads) they create may be excessive and a precursor to undue muscle soreness or overtraining syndrome in a client. Always plan for a sufficient recovery between harder workouts. It is helpful to monitor some basic signs of fatigue during strength overload mesocycles. Fatigue may manifest itself as any reduction in physical or mental performance

One strength training protocol is two to four weeks of the three eccentric training methods, perhaps followed by one or two weeks of traditional CON–ECC training.

Case Study: Client Profile and Goals

Michael is a 30-year-old public servant who works at a desk for 8 hours a day. He is 6 feet 2 inches (188 cm) and weighs in 180 pounds (81.6 kg). He was involved in college intramural sports: rugby, basketball, and baseball. Since starting his career, he has remained active in sports and does recreational resistance training two or three times a week. Michael’s expressed goals are to improve his overall strength. He has allocated two days a week for training with a personal trainer. Michael does not have any injures or physical limitations. He has completed a foundational resistance training program mesocycle with the traditional CON–ECC. His trainer has tested Michael on some 1RMs on some major muscle groups to better determine Michael’s overall body strength and to identify any weaknesses.

Three-Week Mesocycle of Strength Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Bench press	4-5	2-3	SUP (use a spotter for assist)
	Overhead press	4-5	3-6	EE
	Lying triceps extension	4-5	5-6	EE
	Body-weight sit-up	4-5	15-20	CON–EE
Tuesday	Wide-grip latissimus dorsi pull-down	4-6	5-6	EE
	Bent-over barbell row	4-6	5-6	EE
	Barbell curl	3-5	2-3	SUP (use spotter for assist)
	Plank	4-6	30-60 sec	
Wednesday	Barbell back squat	4-6	1-3	SUP (use a spotter for assist)
	Leg press	4-6	5-6	EE
	Standard deadlift	4-5	3-5	EE
	Seated hamstring curl	4-6	5-6	2UP/1DN
Thursday	Off			
Friday	Incline Smith machine press	4-6	4-6	2UP/1DN
	Seated shoulder press	4-6	4-6	2UP/1DN
	Pull-up (with body weight or weighted)	4-6	5-6	EE
	Triceps cable press-down	4-6	5-6	EE
	Dumbbell hammer curl	4-6	5-6	EE
Saturday	Barbell front squat	4-6	3-6	EE
	Walking lunge	4-6	5-6 per side	EE
	Leg extension	4-6	5-6 per side	2UP/1DN
	Standing calf raise	4-6	5-6 per side	2UP/1DN
	Leg raise	4-5	6-10 reps	EE
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. These exercises also give you options for meeting the multiple needs and goals of your clients, whether they involve fitness-level adaptations, musculoskeletal considerations, or improvements in movement ability. Change-out exercises provide a different stimulus to muscles, which may be necessary to enhance the musculoskeletal fitness of some clients or help them overcome a training plateau. These exercises also promote flexibility and creativity in designing resistance training. Effective workouts and resistance training programs change regularly in order to address the fitness status of each exerciser.

Exercise	Change-out exercise options
Upper-body strength training exercises	
Bench press	Incline bench press; dumbbell bench press
Overhead press	Seated shoulder-press machine; dumbbell shoulder press
Bent-over barbell row	One-arm dumbbell row; seated row
Wide-grip latissimus dorsi pull-down	Close-grip lat pull-down; pull-up
Barbell biceps curl	Dumbbell biceps curl; hammer curl
Lying triceps extension	Machine triceps extension; triceps straight-bar press-down
Lower-body strength training exercises	
Barbell back squat	Barbell front squat; overhead squat; Smith machine
Standard deadlift	Romanian deadlift; dumbbell deadlift
Leg press	Lunge; one leg at a time
Leg extension	One leg at a time
Lying hamstring curl	Seated hamstring curl; one-leg hamstring curl
Standing calf raise	Seated calf raise; one-leg calf raise

Upper-Body Strength

Routine A

1: Bench press\

2: Overhead press

3: Bent-over barbell row

4: Wide-grip latissimus dorsi pull-down

5: Barbell curl

6: Lying triceps extension

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Upper-Body Strength

Routine B

1: Wide-grip latissimus dorsi pull-down

2: Bent-over barbell row

3: Bench press

4: Overhead press

5: Lying triceps extension

6: Barbell curl

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Strength

Routine A

1: Barbell back squat

2: Standard deadlift

3: Leg press

4: Leg extension

5: Lying hamstring curl

6: Standing calf raise

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Strength

Routine B

1: Lying hamstring curl

2: Leg extension

3: Barbell back squat

4: Leg press

5: Standard deadlift

6: Standing calf raise

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Chapter 6
Eccentric Training for Endurance

The effect of eccentric exercise on endurance is often overlooked, but it is quite important. Having a solid endurance base is essential for optimal performance. Furthermore, endurance training is especially popular right now, and it could become a new wave of training for the future.

Several studies have shown that eccentric exercise training can directly improve an individual's ability to continue an endurance activity. In 2001, Horstman and colleagues discovered that the metabolic stress (e.g., buildup of hydrogen ions and CO_2) associated with eccentric exercise training is far lower than that associated with conventional concentric exercise. This decreased metabolic stress may allow an individual to implement a more rigorous exercise workout plan—that is, to exercise longer using more weight.

Further evidence of this was found by Drexel et al. (2008), who discovered that downhill walking (which involves a boundless number of eccentric contractions) is less strenuous than uphill walking (which relies on concentric contraction). This less vigorous nature of downhill walking may be evidence of a unique exercise alternative for sedentary or deconditioned individuals who want to improve their fitness.

Eccentric exercise can also reduce LDL cholesterol (the "bad" cholesterol) and improve glucose tolerance (the ability for muscle cells to take up glucose) (Zeppetzauer et al., 2013). In turn, these clinical health benefits may be associated with reduced risk of heart disease and diabetes.

For athletes, eccentric exercise protocols are now commonly used as a component of endurance running. For example, an athlete who has a decreased ability for high volume of running training—whether due to injury or time constraints—can incorporate eccentric exercise protocols to improve his or her athleticism. Eccentric contractions not only strengthen the muscles being worked but also improve the ability of muscle to withstand potential damage under similar or even greater forces (McHugh, 2003; Pettitt, Symons, Eisenman, Taylor, & White, 2005). This process provides the practical benefit of the repeated bout effect discussed in chapter 4. With regular eccentric training, the body adapts by developing the ability to work harder with less delayed-onset muscle soreness. This capability for muscle to become resistant to potential damage can be invaluable to an endurance athlete.

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 5 to 10 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for endurance training: The exerciser should perform one or two traditional warm-up sets (i.e., concentric phase followed by eccentric phase) of the exercise at about 50% to 60% of what he or she normally lifts. The goal is specifically to warm up the joint, which includes the tendons, ligaments, connective tissues, synovial fluid, and all surrounding muscles and fascia.

For the purpose of improving endurance, it is uncommon to use an eccentric-only exercise protocol. However, using the three eccentric training methods on a regular basis as part of an overall program improves endurance and resistance to muscle damage by means of the repeated bout effect. The design for improving endurance calls for the exerciser to complete two to four sets of at least 12 repetitions of each exercise. Guidelines from the National Strength and Conditioning Association (2008) suggest working at an intensity of less than 70% of 1-repetition maximum (1RM) with 30 to 60 seconds of rest between sets.

Application Tools for Exercises

Here are some directions for optimal resistance training.

- Concentric–eccentric (CON–ECC): one- to two-second concentric with a one- to two-second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three or four seconds (eccentric)
- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client’s needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options. The exercises presented a bit later in this chapter include six for the upper body and six for the lower body, each of which is shown in its starting and ending positions.

Endurance training builds the stamina needed to reach the client’s fitness goals. The muscles’ ability to sustain contractions enhances overall energy production and holds off early fatigue. As a result, the ability of a client’s muscles to contract repeatedly over an extended period benefits his or her performance both in activities of daily living and in lifetime fitness pursuits.

A Caution for Training

The interest in endurance exercise also comes with some caution for training. It appears that some exercise participants joining some vigorously taught extreme conditioning programs, which promote endurance training protocols beyond the point of fatigue, are vulnerable to a dangerous health syndrome referred to as exertional rhabdomyolysis (ER). With ER, the muscle cell membranes begin to break down, leading to spillage of some proteins (like myoglobin) into the blood (Landau et al., 2012). This leakage of cellular proteins into the blood may cause kidney damage and unsafe heart rhythms. Exercise that is too intense, excessive, or repetitive may cause ER. Only a medical professional can diagnose an individual with ER; however, early detection is important. This is why personal trainers should be alert to early signs of the syndrome so that they may refer clients at risk of ER to medical professionals for prompt diagnosis. A typical triad of symptoms includes reddish-brown (cola-colored) urine, muscular pain, and weakness. Reddish-brown urine may indicate myoglobinuria, which is the presence of myoglobin in the urine. Some personal trainer recommendations are as follows:

- Ensure suitable rest periods between sets and workouts.
- Vary workouts so all are not to exhaustive fatigue.
- Discourage clients from using caffeine and energy drinks before a workout as they can offset the body's ability to sense fatigue.
- Track client records to note signs of performance decrements.
- Be cautious of training in hot environments at high intensities as this may exaggerate ER symptoms.

Summary Thoughts

A muscle's ability to contract—and sustain contraction against resistance for an extended time—is associated with many health and performance benefits. Muscular endurance is most beneficial for exercise enthusiasts who play sports (e.g., soccer, basketball, hockey, volleyball) in which they need to sustain activity for long periods of time. Muscular endurance training also improves neuromuscular activation by means of increased motor unit recruitment and synchronization.

In addition, muscular endurance training is the optimal complement to muscular strength training. Incorporating both types of training improves the bodily energy systems' ability to deliver ATP to fuel repeated muscle contractions during exercise.

The rest of this chapter provides you with descriptions of resistance exercises for endurance, sample workout routines, and change-out exercise options.

Training for Endurance

Building muscle endurance involves training the energy-capacity characteristics in muscle fibers with the different repetition zones (e.g., 12-14, 14-16, 16-18 repetition zones, for instance, depending on the activity and client needs). Many clients and exercisers have not developed this potential and may fatigue early due to the buildup of metabolic waste products (e.g., hydrogen ions and CO_2). The great news is that muscle fibers adapt readily to consistent endurance-oriented training, thus improving exercise stamina while slowing the effects of muscular fatigue. Table 6.1 presents a list of exercises designed to emphasize endurance, and full descriptions of the exercises appear on the following pages.

TABLE 6.1 Exercises for Endurance

Upper body	Lower body
Dumbbell chest fly	Sumo squat with dumbbell or kettlebell
Seated shoulder press	Stiff-leg deadlift
Seated cable row	One-leg press
Pull-up (with body weight or weighted)	Walking lunge
Alternating dumbbell curl	Hamstring curl on ball
Triceps cable press-down	Seated calf raise

6.1: Dumbbell Chest Fly

(2UP/1DN, CON–ECC, EE, or SUP)

6.1*a* Starting position for the dumbbell chest fly.

Starting Position

1. Lie on a flat bench or incline bench with a dumbbell in each hand and your palms facing each other. Bring the dumbbells up to chest level and hold them shoulder-width apart.
2. Press the dumbbells out from your chest. Stop at the top and hold in a soft-elbow position.

Trainer Recommendations

- Stand directly behind the client as he or she performs the movement. With your hands, guide the dumbbells down to the stretched position. Experiment with spotting at the wrist and at the elbows; some clients may prefer one method to the other.
- During the upward phase, ensure that the dumbbells do not collapse inward on the client. This may happen if the weight becomes too heavy or the arms are rounded more than they should be.

6.1*b* Ending position for the dumbbell chest fly.

Video 6.1

See online video 6.1 for the CON–ECC and EE methods of the dumbbell chest fly.

Exercise Motion

1. Keeping a slight bend in your elbows, lower your arms to either side in a wide arc until you feel a stretch in your chest muscles.
2. Return your arms to the starting position as you squeeze your chest muscles.

Performance Improvement Tips

- Throughout the movement, your arms should remain stationary; the motion should occur only at your shoulder joints.
- During the eccentric phase, focus on the stretch in your pectoralis muscles.
- At the top of the movement, imagine hugging a small tree; in fact, this exercise could be called “the tree hugger.”

6.2: Seated Shoulder Press

(2UP/1DN, CON–ECC, EE, or SUP)

6.2*a* Starting position for the seated shoulder press.

Starting Position

1. Sit on a straight-back bench that fully supports your back.
2. Grab the bar slightly above shoulder height with your palms facing away from your body.

Trainer Recommendations

- Stand behind the client and help her or him position the weight at the top of the shoulders. Spot at the elbow.
- As the client performs each repetition, guide the movement by applying a light touch to the elbows.
- For variation, perform this exercise with dumbbells.

6.2*b* Ending position for the seated shoulder press.

Video 6.2

See online video 6.2 for the 2UP/1DN, EE, and SUP methods of the seated shoulder press

Exercise Motion

1. Keeping your core tight, push the weight upward until the bar is at the top of the movement. Your elbow joints should be fully extended but not locked out. The movement can be completed either by full extension of your arms or by touching the dumbbells together at the top.
2. With controlled form, lower the weights back to the starting position.

Performance Improvement Tips

- Always keep your core tight to improve performance and decrease the risk of injury.
- For variety, you may perform the exercise while seated or standing. Sitting with your back supported is the safest method for beginners and people with back problems or weaknesses.

6.3: Seated Cable Row

(CON–ECC, EE, or SUP)

6.3*a* Starting position for the seated cable row.

Starting Position

1. Begin by sitting on the cable-row pulley machine. Be sure that the close-grip pulley accessory is attached to the pulley. Place your feet on the front platform, keeping your knees slightly bent (not locked out).
2. Reach out and grasp the close-grip handle.
3. Keeping your arms fully extended, sit back until your upper body is at about a 90-degree angle in relation to your lower body. Sit up tall with your chest up and your core tight.

Trainer Recommendations

- Stand at the client's side. Before the client begins the first repetition, make sure that she or he is fully upright with the chest up and the knees softly extended.
- As the client performs each repetition, monitor that he or she does not let the torso sway backward or forward while pulling up the load.
- If the weight becomes challenging, you may help the client on the concentric portion of the movement by lightly pressing the handle toward the client's abdomen as she or he pulls.
- For variation, have the client perform the movement with different accessories (e.g., wide grip or rope; it is unlikely that these devices change the challenge on the middle back, but they do provide a movement variation for the exerciser, which is always good for exercise adherence objectives).

6.3*b* Ending position for the seated cable row.

Video 6.3

See online video 6.3 for the CON–ECC and EE methods of the seated cable row.

Exercise Motion

1. Using your back muscles, pull the handle all the way back, until it touches your abdomen. Imagine that your arms are hooks and your back muscles are doing all the work. Focus on squeezing your shoulder blades together during each repetition.
2. Slowly, with controlled form, return the cable to the starting position, with your arms fully extended. Repeat.

Performance Improvement Tips

- Always keep your core tight and your chest upright.
- Do not let your torso change from the 90-degree-angle starting position—no full-body rowing here!
- Keep your knees soft rather than locked out in order to prevent lower-back injury.
- Select a weight with which you can always perform a full range of motion.

6.4: Pull-Up (with body weight or weighted)

(2UP/1DN, CON–ECC, EE, or SUP)

6.4*a* Starting position for the pull-up with a wide-grip position.

Starting Position

1. Stand on a box or step and grasp the pull-up bar with your palms facing forward. Place your hands farther than shoulder-width apart.
2. Let your body weight hang as your arms are fully extended.

Trainer Recommendations

- As the client begins the pull-up, stand to the side and watch for proper form, making sure that the client achieves full contraction and motion at the top. When fatigue sets in, you may assist the client on the concentric portion by having him or her bend the legs at the knees and applying pressure directly underneath the knee joint to help with the upward movement.
- For clients who are unable to perform five pull-ups, we recommend having them use a pull-up assist machine or an elastic band for help in progressing their strength.
- For clients who need a greater challenge, begin by progressing them from strict pull-ups to strict (i.e., starting from the dead hang) chest-to-bar pull-ups. For more than 10 repetitions, you may want to teach the client a gymnastic kip or butterfly kip, but be aware that these movements require tremendous core strength, shoulder mobility, and total-body agility.
- For clients who want to increase their pull-up strength, add weighted pull-ups to the routine.

6.4*b* Ending position for the pull-up with a wide-grip position.

Video 6.4

See online video 6.4 for the CON–ECC, EE, and SUP methods of the pull-up.

Exercise Motion

1. With a slight arch in your lower back, extending your chest upward, pull your body up toward the bar until your chin crosses the bar line.
2. With control, slowly lower back to the starting position. At the bottom of the movement, get a full stretch of your latissimus dorsi.

Performance Improvement Tips

- Keep your chest up as you pull toward the bar above your head.
- Experiment with varying hand-width positioning.
- For a greater challenge, try to bring your chest to the bar.

6.5: Alternating Dumbbell Curl

(2UP/1DN, CON–ECC, EE, or SUP)

6.5*a* Starting position for the alternating dumbbell curl.

Starting Position

1. Stand while holding a dumbbell in each hand with your arms fully extended downward at your sides.
2. Keep your elbows close to your body and in line with your shoulder, hip, and knee joints.

Trainer Recommendations

- As the client begins the movement, stand to the side and make sure that his or her elbows are in direct line with the shoulder, hip, and knee joints. The elbow joint fulcrum should stay in a fixed position throughout the range of motion.
- If the client needs a light spot, you may stand in front of her or him and lightly help guide the dumbbell to the top of the range of motion.
- For variety, have the client perform hammer and reverse-grip curls in alternating fashion because this will add a variation of challenge to the forearm flexors.
- For additional variety, perform the two arm dumbbell curls with supinated, hammer, and reverse-grip curls.

6.5*b* Ending position for the alternating dumbbell curl.

Video 6.5

See online video 6.5 for the 2UP/1DN, CON–ECC, and EE methods of the alternating dumbbell curl.

1. Keeping your upper arms in a fixed position, hold the dumbbells with your palms facing forward (i.e., in a supinated position). Bend one elbow and curl that arm up to a full contraction of the biceps. As you reach the top, your hand should remain in a supinated position.
2. Squeeze the biceps at the top the movement, then slowly lower back to the starting position. Perform on the other side. Repeat.

Performance Improvement Tips

- Movement should come from the elbows only. Your shoulder joints should remain stationary.
- Avoid swinging the weight up to the top. The curl movement should be performed with control. If swinging occurs, then the weight is too heavy or the movement is too fast.
- The alternating dumbbell curl is an effective variation of the 2UP/1DN curl exercise, which is traditionally completed on a fixed device such as the Smith machine.

6.6: Triceps Cable Press-Down

(CON–ECC, EE, or SUP)

6.6*a* Starting position for the triceps cable press-down.

Starting Position

1. Using a straight-bar attachment for the high-pulley cable column, grasp the bar with an overhand grip (palms facing down) at shoulder width and bring the bar down to a 90-degree angle at your torso.
2. Simultaneously, bring your elbows into line with your shoulder, hip, and knee joints.
3. Keep your arms close to your body. Your forearms should be parallel to the pulley as you hold the bar.

Trainer Recommendations

- Stand to the client’s side and ensure that he or she performs the movement at the elbow joints only.
- As the client tires, you may need to help with the concentric portion of the movement by applying light pressure to the cable as the client presses and extends the arms downward.
- For variation, have the client use a rope attachment.

6.6*b* Ending position for the triceps cable press-down.

Exercise Motion

1. Keeping your core engaged and your chest and torso upright, extend your arms fully until the bar presses against the top of your hips at about 180 degrees of extension.
2. Slowly, with control, allow the bar to return to the 90-degree-angle starting position. Repeat.

Performance Improvement Tips

- Select a weight that you can press down without having it move your body weight. If you are unable to hold your body fixed to the floor while performing the movement, then you may need to use a weight belt for additional gravitational pull.
- Always maintain good posture and exercise form. Your upper arms should remain parallel to the cable column at all times. No movement should occur at your shoulder joints. All movement should occur at your elbow joints only!

6.7: Sumo Squat With Dumbbell or Kettlebell

(CON–ECC, EE, or SUP)

6.7*a* Starting position for the sumo squat with dumbbell or kettlebell.

Starting Position

1. Stand with your feet farther than shoulder-width apart and your toes pointed slightly outward.
2. Your knees should always face in the same direction as your toes.
3. When holding a kettlebell, make sure the bell is hanging straight down. Stand tall with your chest upright and your core tight.

Trainer Recommendations

- To help the client maintain proper form, stand to the side and make sure that she or he keeps an upright torso with the body weight on the heels at all times.
- You may coach and cue the client to keep the weight on the heels and to keep an upright torso by saying things such as “weight on heels” and “chest up.”
- For variety, have the client use a medicine ball.

6.7*b* Ending position for the sumo squat with dumbbell or kettlebell.

Video 6.7

See online video 6.7 for the CON–ECC, EE, and SUP methods of the sumo squat.

Exercise Motion

1. Squat slowly as you lower the weight straight down toward the floor. Keep your upper body upright throughout the range of motion. Do not lean forward.
2. Once at the bottom of the squat, contract your glutei maximi and drive through your heels as you return to the starting position.

Performance Improvement Tips

- Always keep your toes pointed slightly outward.
- Your torso should remain upright throughout the movement.
- Keep your weight on your heels at all times!

6.8: Stiff-Leg Deadlift

(CON–ECC or EE)

6.8*a* Starting position for the stiff-leg deadlift.

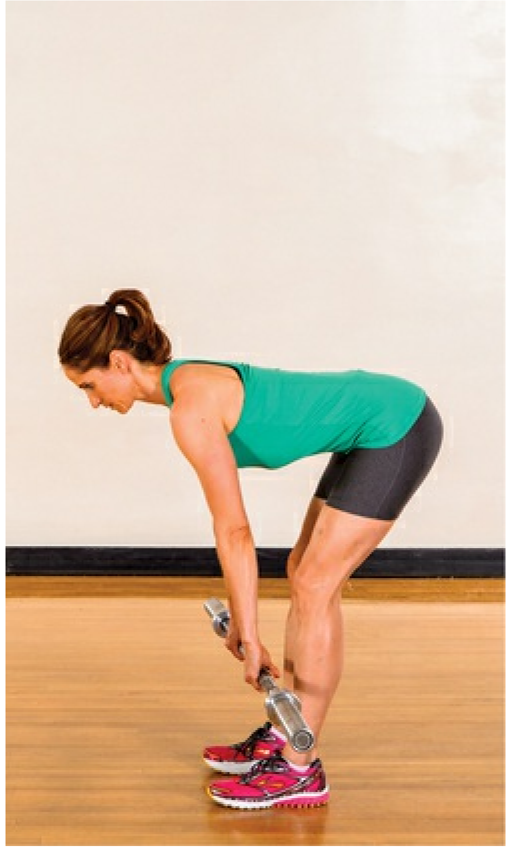
Starting Position

1. Stand with your torso upright while holding the weight at arm's length. Your palms should face inward toward your body.
2. Position yourself in a shoulder-width stance with a slight knee bend.

Trainer Recommendations

- Stand to the client's side and make sure that her or his back stays flat throughout the movement. The tendency is to round the back during the lowering phase; make sure that this does not happen.
- Remind the client to keep his or her weight on the heels and focus on stretching the hamstrings during the eccentric phase and on squeezing the glutei maximi during the concentric phase.
- To add challenge for clients who are flexible and strong, have them lower the weight until it touches their feet. Make sure that the client maintains an activated core with the back in anatomical neutral (i.e., natural stress-free position) as she or he progresses past a 90-degree-angle flexion at the hip joint.

6.8*b* Ending position for the stiff-leg deadlift.



Video 6.8

See online video 6.8 for the CON–ECC and EE methods of the stiff-leg deadlift.

Exercise Motion

1. Keeping your chest upright, slowly fold forward at your hips until your back is at a 90-degree angle to your legs. Your back and neck should be neutral and all core muscles engaged. The weight should remain close to your body as you lower them toward the ground.
2. Squeezing your glutei maximi, return the weight to the starting position at your hips.

Performance Improvement Tips

- Keep your legs slightly bent. Focus on stretching your hamstrings during the eccentric portion of the movement.
- Keep a tight core and a flat back as you fold forward at your hips.
- Always keep your weight on your heels.

6.9: One-Leg Press

(CON–ECC, EE, or SUP)

6.9*a* Starting position for the one-leg press.

Starting Position

1. Adjust the back pad of the machine to provide the greatest range of motion and comfort for your individual leg length and mobility.
2. Once seated, press your lower back and shoulders firmly against the back pad with a natural arch in your lower back region. Your neck should remain relaxed and neutral.
3. Place your feet on the platform and adjust them to the proper level (higher or lower) for your individual body structure. Proper foot placement allows the tibia to maintain a 90-degree angle or greater in relation to the femur throughout the full range of each repetition.
4. Press out with your feet at shoulder width, then bring one leg slightly outside shoulder width and angle it slightly outward. Remove your other leg from the platform of the leg press machine.

Trainer Recommendations

- Check alignment and posture as the client performs the movement.
- Once the client is ready to begin the movement, position yourself in a kneeling lunge. In this position, you can use one hand to ensure that the client maintains proper body position while using your other hand on the leg press machine.
- As the exerciser fatigues, you may need to stand up and help spot on the platform of the leg press machine with two hands. Maintain visual contact with the client. Since this movement is performed with one leg, take extra care to be available for spotting the weight throughout the eccentric and concentric portions of the movement.

6.9*b* Ending position for the one-leg press.

Exercise Motion

1. Bend your knee and lower your leg until you either create a 90-degree angle or reach your maximum range of motion. Your lower back and shoulders should continue touching the back pad during the entire movement. Keep your heel in contact with the foot platform at all times. You should feel a stretch in your hamstrings.
2. Once at the bottom of the movement, press the platform back to the starting position using your hamstrings, glutei maximi, and quadriceps.
3. Once done with the intended repetitions on the first leg, perform the exercise with the other leg.

Performance Improvement Tips

- Keep your head and neck in a neutral position.
- Keep your knee in line with your ankle.
- Keep your heel firmly planted on the platform throughout each repetition.
- Keep your shoulders and lower back pressed against the back pad at all times. Maintain a natural lordodic curve (i.e., arch) in your lower back. Avoid hyperextending (i.e., overarching).

6.10: Walking Lunge

(CON–ECC or EE)

6.10*a* Starting position for the walking lunge.

Starting Position

Begin in a standing position with your feet shoulder-width apart.

Trainer Recommendations

- Monitor the client from the side as he or she does the walking lunge. Make sure that the knee is always in line with the ankle during each repetition.
- To add a challenge for the client, have her or him pause at the bottom of each repetition for three to five seconds. You can also add weight by having the client hold dumbbells or place a barbell on his or her back.

6.10*b* Ending position for the walking lunge.

Exercise Motion

1. Begin by taking a big step forward. The step should be long enough that your front knee is directly over, and in alignment with, the corresponding ankle during the knee bend.
2. Once your front foot is firmly planted, bend your front and back legs simultaneously and lower your torso directly down and below your hips. Your torso should remain upright during the lowering and raising phases of the movement. Do not lean forward. Keep your front knee in line with your ankle. Do not let it go forward past the ankle; doing so may injure the knee joint over time.
3. Using your hamstrings, glutei maximi, and quadriceps, push off of your back foot and bring it back into line with your other foot. Repeat the motion on the other side.

Performance Improvement Tips

- Always take big steps. These longer steps keep the movement emphasis on the muscles of your upper legs and away from your knee joints.
- Keep your knee in line with the corresponding ankle during the exercise motion.

6.11: Hamstring Curl on Ball

(2UP/1DN, CON–ECC, or EE)

6.11*a* Starting position for the hamstring curl on ball.

Starting Position

1. Lie on your back on the floor with your lower legs on an exercise ball. Your arms should be extended out to either side to provide stability.
2. Raise your back and hips off of the floor while keeping your lower back, knees, and hips in a straight line.

Trainer Recommendations

- Monitor the client from the side to make sure that her or his starting position is proper, with the bottom and the middle back off of the ground. Only the shoulders should be left on the ground.
- As the client performs the movement, remind him or her to keep the core tight and press the heels into the ball.
- To challenge the client, you may have her or him bring the arms in closer to the body, which makes balancing more difficult.

6.11*b* Ending position for the hamstring curl on ball.

Video 6.11

See online video 6.11 for the CON–ECC and EE methods of the hamstring curl on ball.

Exercise Motion

1. While maintaining a stable and balanced starting position, bend your knees by pulling your heels toward your glutei maximi. Your feet should be allowed to roll up on the ball.
2. Squeeze your hamstrings and glutei maximi at the top of movement, then slowly lower back to the starting position.

Performance Improvement Tips

- Focus on keeping your core engaged at all times. Doing so helps you keep your balance on the ball.
- Squeeze your glutei maximi and hamstrings by keeping your weight pressed through your heels onto the balls of your feet.

6.12: Seated Calf Raise

(2UP/1DN, CON–ECC, EE, or SUP)

6.12*a* Starting position for the seated calf raise.

Starting Position

1. While seated on the calf-raise machine, place your toes on the lower portion of the platform with your heels hanging off of the edge. Your feet should be positioned parallel to each other in a shoulder-width stance.
2. Your thighs, near the knee cap (but not on it), should be placed under the lever pad. If the machine allows, adjust the height of the lever pad to suit your leg diameter. Place your hands around the handles above the lever pad.
3. Lift the lever by pushing your heels up, contracting your calves, and release the safety bar.

Trainer Recommendations

- Stand to the side of the calf-raise machine and help the client release the safety lever.
- Now stand next to the bar, near where the weight is loaded, and assist the client during the concentric portion of the movement as fatigue becomes apparent.
- Help the client rerack the weight with the safety lever to complete the movement.
- When programming for the seated calf raise, think about the soleus as a prime mover and a predominantly Type 1 muscle that most likely responds best to a high number of repetitions.

6.12*b* Ending position for the seated calf raise.

Video 6.12

See online video 6.12 for the 2UP/1DN, CON–ECC, EE, and SUP methods of the seated calf raise.

Exercise Motion

1. Begin the motion by lowering your heels until your calves are in a fully stretched position.
2. Raise your heels by contracting your calf muscles until the weight is fully distributed over your feet.
3. Repeat.
4. Once done, return the safety lever to a locked position.

Performance Improvement Tips

- Because this exercise tends to stress the Achilles tendon region, select a weight that is not too heavy.
- Always perform an optimal range of motion with the contraction.
- Adjust the thigh-pad lever to a comfortable setting.

Upper- and Lower-Body Workout Routines for Endurance Training

These sample endurance training routines are designed to provide a full upper-body and lower-body strength regimen. Each routine should be implemented with 48 to 72 hours of rest. Therefore, the program works best if the upper-body routine is performed on Monday and Wednesday, the lower-body routine on Tuesday and Thursday, and a cardiorespiratory and flexibility routine on alternative days, or light intensity days. If the exerciser needs more time between sessions, another programming possibility is to do the upper-body routine on Monday and Thursday, the lower-body routine on Tuesday and Friday, and either the cardio and stretching routine or a rest day on Wednesday and Saturday.

For the purpose of increasing muscular endurance, we recommend performing any one of the eccentric training exercise on a regular basis as part of a balanced muscular endurance training program. Because lighter loads are used in endurance exercise, the potential damage and soreness associated with eccentric training is less severe in this case. An appropriate protocol would be 8 to 12 weeks of concentric and eccentric training paired in a reasonably balanced format. Design the exercise protocol based on the priority goals and needs of the client.

Case Study: Client Profile and Goals

Ann is a 33-year-old producer of public relations events. She is 5 feet 3 inches (160 cm) and weighs 130 pounds (59 kg). She loves running and competing in 5K and 10K events. She has stayed active in running since high school, regularly running 15 miles (24 km) a week. Over the years she has suffered running-related knee injuries and would like to do some type of resistance training to prevent injuries from recurring. Ann has done a modest amount of resistance training in her life. Her upper body is lacking in muscle tone, something she has said she would like to improve, and has been weight training on her own for several months. She belongs to a local sports and wellness club, where she enjoys going with her two children during the week. For an endurance enthusiast, the personal trainer needs to focus on the client’s bodily condition and endurance goals. Endurance enthusiasts, particularly runners and triathletes, do a lot of road work, which may lead to immense strain on the lower body from the repetitive pounding. If the lower-body muscles aren’t prepared to handle the load, these impact stresses get absorbed in the joints, bones, and connective tissue.

Three-Week Mesocycle of Endurance Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Dumbbell chest fly	2-3	10-15	EE
	Seated cable row	2-3	10-15	2UP/1DN
	Seated dumbbell shoulder press	2-3	10-15	EE
	Triceps cable press-down	2-3	10-15	EE
	Alternating dumbbell curl	2-3	10-15	EE
Tuesday	Sumo squat with dumbbell or kettlebell	2-3	10-15	EE
	Stiff-leg deadlift	2-3	10-15	EE
	Leg press	2-3	10-15	2UP/1DN
	Plank	2-3	MAX	
Wednesday	Off or cardio day			
Thursday	Incline Smith machine press	2-3	10-15	EE
	Seated shoulder press	2-3	10-15	2UP/1DN
	Wide-grip latissimus dorsi pull-down	2-3	10-15	EE
	Machine triceps extension	2-3	10-15	2UP/1DN
	Zottman curl	2-3	10-15	EE
Friday	Barbell back squat	2-3	10-15	EE
	Barbell good morning	2-3	10-15	EE
	Walking lunge	2-3	10-15/ side	EE
	Standard mat crunch	2-3	15-20	
Saturday	Cardio (30-45 minutes)			
	Full-body stretching (possibly add yoga)			
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. These exercises also give you options for meeting the multiple needs and goals of your clients, whether they involve fitness-level adaptations, musculoskeletal considerations, or improvements in movement ability. Change-out exercises provide a different stimulus to muscles, which may be necessary to enhance the musculoskeletal fitness of some clients or help them overcome a training plateau. These exercises also promote flexibility and creativity in designing resistance training. Effective workouts and resistance training programs change regularly in order to address the fitness status of each exerciser.

Exercise	Change-out exercise options
Upper-body endurance training exercises	
Dumbbell chest fly	Cable fly; machine fly; barbell bench press
Seated shoulder press	Overhead barbell press; seated dumbbell shoulder press
Seated cable row	One-arm dumbbell row; bent-over barbell row
Pull-up (with body weight or weighted)	Lat pull-down; seated row; cable row
Alternating dumbbell curl	Barbell curl; preacher curl; Zottman curl
Triceps cable press-down	Machine triceps extension; lying triceps extension; dumbbell kickback
Lower-body endurance training exercises	
Sumo squat with dumbbell or kettlebell	Front squat; back squat; overhead squat; Smith machine squat
Stiff-leg deadlift	Standard deadlift; good morning; stiff-leg deadlift with dumbbells
One-leg press	Ball squat; standard leg press with two feet; walking lunge
Walking lunge	Leg extension; pistol; alternating lunge in place; Bulgarian lunge
Hamstring curl on ball	Seated leg curl; lying leg curl; one-leg hamstring curl using cable column
Seated calf raise	Standing calf raise; one-leg calf raise; box jump

Upper-Body Endurance

Routine A

1: Dumbbell chest fly

2: Seated cable row

3: Pull-up (with body weight or weighted)

4: Seated shoulder press

5: Alternating dumbbell curl

6: Triceps cable press-down

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Upper-Body Endurance

Routine B

1: Pull-up (with body weight or weighted)

2: Seated cable row

3: Dumbbell chest fly

4: Seated shoulder press

5: Triceps cable press-down

6: Alternating dumbbell curl

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Endurance

Routine A

1: Sumo squat with dumbbell or kettlebell

2: Stiff-leg deadlift

3: One-leg press

4: Walking lunge

5: Hamstring curl on ball

6: Seated calf raise

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Endurance

Routine B

1: Walking lunge

2: Hamstring curl on ball

3: Stiff-leg deadlift

4: Sumo squat with dumbbell or kettlebell

5: Seated calf raise

6: One-leg press

Chapter 7
Eccentric Training for Explosive Power

Some people use the words *strength* and *power* interchangeably. These terms do not, however, mean the same thing. In the context of fitness and exercise, *strength* refers to the ability to move a heavy object from point A to point B. Typically, it is measured by means of a 1-repetition maximum (1RM) lift in a particular exercise (e.g., the bench press or leg press). *Power*, on the other hand, refers to the ability to produce force at a high rate or speed.

Strength and power can be trained independently. For example, many individuals are strong in the bench press in terms of 1RM. However, they may have less ability to move a lighter weight at high speed than someone who has a lower 1RM. This apparent contradiction can be explained by observing the considerable differences between training protocols for power (which include a speed component) and training programs for strength (which involve improvement of maximal force). However, the fact that strength and power differ from each other does not mean that a person cannot attain both. In fact, in some sports, having power without strength would be pointless. For example, imagine an Olympic weight lifter who displays near-perfect powerful form on a snatch or a clean and jerk—but only with the weight of a barbell. Sure, the weight of a barbell (or PVC pipe) is where all beginners start, but it is certainly not where they strive to end up. In order to explode out of the front squat position on a clean with a heavy weight—or snatch a heavy weight overhead—a person must possess the *strength* to move that weight (no matter how *powerful* or explosive he or she may be). Therefore, it is essential to establish a strength base in order to enhance one's ability to produce maximum power (rate of force) with high-intensity (high-weight) loads.

Research shows that, initially, eccentric exercise may decrease an exerciser's ability to produce a high amount of force with heavy loads, and the decrease may last for up to seven days (Linnamo, Strojnik, & Komi, 2006). This decrease results from the fact that eccentric exercise tends to recruit Type II (i.e., fast-twitch) muscle fibers, which may be damaged and fatigued for several days after an eccentric bout (Linnamo et al.). However, even though heavy-load force production is decreased, the exerciser's ability to produce force at moderate loads is increased. This increase is caused by a higher recruitment of Type I (i.e., slow-twitch) fibers while the Type II fibers get repaired and rebuilt (Byrne & Eston, 2002).

In addition, even though eccentric exercise decreases power production with heavy loads in the short term, it increases power production in the long term. For example, in one study, athletes performed the bench throw (a plyometric bench press in which the bar is released in the upward phase of the lift) at 66% of 1RM. The researchers found that performing explosive eccentrics increased concentric power (Sheppard & Young, 2010). Explosive eccentrics have also been shown to produce more muscle tissue growth by causing increased protein synthesis. Always keep in mind that high-intensity eccentric exercise may initially damage muscle tissue and therefore produce soreness and decreased power output for a few days (Linnamo et al., 2006). Over the long term, however, eccentric exercise enables increased power output at higher intensities.

In fact, in a recent three-week study that measured running speed and power output, researchers discovered that combining eccentric training with overspeed and basic running drills yielded greater speed and power improvements than did traditional resistance training (Cook, Beaven, & Kilduff, 2013). Thus, with a short (three-week) stimulus, it appears that combining training methods is preferable. One suggestion in combining methods is to perform the concentric strength movements before the eccentric power movements. For example, one could perform heavy hang cleans at 80% to 90% of 1RM, followed by box jumps with an emphasis on the eccentric landing portion at the bottom of the jump (Beaven, Gill, Ingram, & Hopkins, 2011). Because researchers are still elucidating effective combinations of training to improve power, personal trainers are encouraged to explore different combinations of training methods with clients and evaluate what works best for each client.

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 5 to 10 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for explosive power training: The exerciser should perform one or two traditional warm-up sets (i.e., concentric phase followed by eccentric phase) of the exercise at about 50% to 60% of what he or she normally lifts. The goal is specifically to warm up the joint, which includes the tendons, ligaments, connective tissues, synovial fluid, and all surrounding muscles and fascia.

For the purpose of improving explosive power, it is uncommon to use an eccentric-only exercise protocol. However, incorporating the three eccentric training methods in some training microcycles would be appropriate. For example, one could perform two or three weeks of power and strength movements (e.g., power clean) combined with some eccentric emphasis power movements (e.g., box depth jump). The design for improving explosive power calls for the exerciser to complete three to five sets of one or two repetitions of each exercise. Guidelines from the National Strength and Conditioning Association (2008) suggest working at an intensity of 80% to 90% of 1RM with three to five minutes of rest between sets.

Application Tools for Exercises

Here are some directions for optimal resistance training.

- Concentric-eccentric (CON–ECC): one- to two-second concentric with a one- to two-second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three to four seconds (eccentric)
- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client's needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options. The exercises presented a bit later in this chapter include six for the upper body and six for the lower body, each of which is shown in its starting and ending positions.

Power is a product of both strength and speed and is an important aspect of functional exercise, especially as a person ages. Power training helps the exerciser maintain and enhance muscle contractions, particularly in everyday activities in which one needs to respond quickly to a certain event. Therefore, we've included power exercises aimed at improving all aspects of an active lifestyle.

Summary Thoughts

Explosive power training is essential for sport and movement activities that require sudden bursts of activity, such as sprinting, jumping, throwing, pushing, and quick directional movement changes. Muscular strength training establishes a solid foundation from which power training can be developed and improved.

Power training enables a recreational athlete or exercise enthusiast to incorporate a great amount of maximal strength in a short time. A person can be exceptionally strong but lack explosive power if she or he is unable to apply that strength quickly—thus the need for specific power training. Use of eccentric exercise has been shown to improve power performance (Vogt & Hoppeler, 2014).

The rest of this chapter provides you with descriptions of exercises for increasing explosive power, sample workout routines, and change-out exercise options.

Training for Explosive Power

In explosive power training, the speed with which a person lifts a weight is an indication of how successful he or she is at quickly recruiting the worked muscles. Therefore, in many ways, the signaling messages from the nervous system form a main component of this type of training. In effect, in explosive power training, the exerciser's central nervous system learns to control her or his muscles in a more efficient way. Since most people do not do this type of recruitment regularly, it is advantageous to really focus on the muscles being recruited for each exercise. For better power efficiency and explosiveness, have your clients concentrate on the target muscles of each power exercise as they perform it. Table 7.1 presents exercises designed to maximize explosive power.

TABLE 7.1 Exercises for Explosive Power

Upper body	Lower body
Incline bench press	Barbell front squat
Push jerk	Clean-grip or snatch-grip pull
Gorilla pull-up	Power clean
Plyometric push-up	Power snatch
Muscle-up (on bar or rings)	Box jump
Handstand push-up	Broad jump

7.1: Incline Bench Press

(CON–ECC, EE, or SUP)

7.1*a* Starting position for the incline bench press.

Starting Position

1. Lie on an incline bench with your feet flat on the floor.
2. Grasp the barbell with an overhand grip and with your hands slightly farther than shoulder-width apart.
3. Lift the bar from the rack and position it above your chest.

Trainer Recommendations

- Stand directly behind the client as he or she performs the incline bench press.
- Assist in the lift-off if the weight is heavy; doing so helps prevent shoulder injury.
- Maintaining contact with the bar, follow the movement with the client from beginning to end.
- To decrease the risk of shoulder injury, help the client return the barbell to the starting position on the rack.

7.1*b* Ending position for the incline bench press.

Exercise Motion

1. Lower the barbell until it touches the upper part of your chest, right across your collarbone.
2. Push the bar up, squeezing your pectoralis major muscles, until your arms are extended.

Performance Improvement Tips

- Maintain a stable position and avoid bouncing the bar off of your chest.
- Keep your forearms directly under the bar, perpendicular to the floor.
- Adjust your hand positioning from wide to narrow, depending on your shoulder stability and range of motion.

7.2: Push Jerk

(CON–ECC or EE)

7.2*a* Starting position for the push jerk.

7.2*b* Second position for the push jerk.

Starting Position

1. Begin by standing upright with the barbell resting directly across the top of your chest. Put your hands under the bar with your palms facing upwards.
2. Your hands should be positioned shoulder-width apart or slightly wider. Your knees should be slightly bent.

Trainer Recommendations

- Stand at the client's side and monitor the bar path; it should travel in a straight line to the overhead position.
- Remind the client to keep her or his weight on the heels.
- Have the client focus on getting his or her chin out of the way as the bar goes overhead, then letting the head go "through the window of the extended arms" as the arms fully extend.

7.2*c* Third position for the push jerk.

7.2*d* Ending position for the push jerk.

Video 7.2

See online video 7.2 for the CON–ECC and EE methods of the push jerk.

Exercise Motion

1. Slowly bend your knees while keeping your torso upright. This action is called a slow dip.
2. Next, begin standing back up to full extension and simultaneously begin to press the barbell overhead. Focus on driving the bar overhead explosively. Look up as you press in order to prevent the bar from hitting your chin.
3. As the bar passes overhead, drop underneath the bar into a soft bent-knee landing with your arms fully extended. Extend your knees to a full upright standing position.
4. Lower the bar slowly back to the top of your chest. Repeat.

Performance Improvement Tips

- Always keep your core tight to improve performance and decrease the risk of injury.
- Focus on keeping your weight on your heels.
- Remember to dip, drive, and drop when performing push jerks.

7.3: Gorilla Pull-Up

(CON–ECC or EE)

7.3*a* Starting position for the gorilla pull-up.

Starting Position

1. Stand on a box or step and grasp the pull-up bar with your palms facing forward. Place your hands one to two inches wider than shoulder-width apart.
2. Let your body weight hang as your arms are fully extended.

Trainer Recommendations

- As the client begins the pull-up, stand to the side and watch his or her form to ensure full contraction and range of motion. When fatigue sets in, you may assist the client during the concentric portion by having the client bend his or her legs at the knees while you apply pressure directly underneath the knee joints to help with the upward movement.
- For clients who are unable to perform five pull-ups, we recommend having them use a pull-up assist machine and not attempting to perform the gorilla pull-up.
- This exercise is an advanced movement for clients who have mastered pull-ups.
- For an even greater challenge, add weight.

7.3*b* Ending position for the gorilla pull-up.

Video 7.3

See online video 7.3 for the EE method of the gorilla pull-up.

Exercise Motion

1. Pull yourself up toward the bar overhead, using your arms, and bring your knees up toward your chest.
2. At the top of the movement, your chin should be over the bar and you should be in a full crunch position.

Performance Improvement Tips

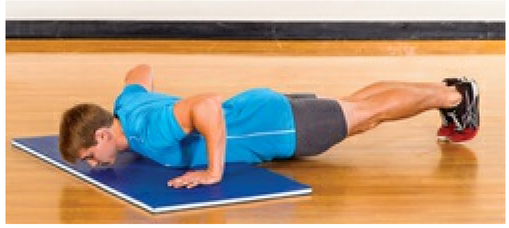
- Keep your chest up as you pull toward the bar above your head.
- Experiment with hand positioning of varying widths.
- For an even greater challenge, try to bring your chest to the bar.

7.4: Plyometric Push-Up

(CON–ECC, EE, or SUP)

7.4*a* Starting position for the plyometric push-up.

7.4*b* Middle position for the plyometric push-up.



Starting Position

1. Place your hands on the floor slightly farther than shoulder-width apart. Spread your fingers outward and point them forward.
2. Rise onto your toes so that all of your body weight is on your hands and feet. Your torso should be in a straight line—no arching your back or pointing your bottom in the air.

Trainer Recommendations

- Observe the client from the side and make sure that she or he maintains a flat back.
- This movement takes a lot of strength, so make sure that the client can perform at least 10 regular chest-to-ground push-ups before he or she attempts a plyometric push-up.
- For an added challenge, have the client wear a weighted vest.
- For less of a challenge, have clients perform a regular push-up emphasizing a dynamic concentric action during the push-up phase of the movement. Lower with an EE.
- It would be most helpful to always use a nonslip mat or pad for safety.

7.4*c* Ending position for the plyometric push-up.

Video 7.4

See online video 7.4 for the CON–ECC and EE methods of the plyometric push-up.

Exercise Motion

1. Bend your elbows and lower your chest toward the floor.
2. Once your chest touches the floor, explode off of the floor and propel your body into the air.
3. Your arms should become fully extended, and your hands should lose contact with the ground.
4. Catch yourself with your hands and land with arms slightly flexed at the elbow.
5. Repeat.

Performance Improvement Tips

- Keep your core tight and your back flat at all times.
- Land with soft elbows (i.e., arms slightly flexed) to prevent injury of your elbows or shoulder joints.

7.5: Muscle-Up (on bar or rings)

(CON–ECC, EE, or SUP)

7.5*a* Starting position for the muscle-up on bar.

7.5*b* Middle position for the muscle-up on bar.

Starting Position

1. Stand on a box or step and grasp the pull-up bar with your palms facing forward. Place your hands one to two inches farther than shoulder-width apart.
2. Let your body weight hang as your arms are fully extended.

Trainer Recommendations

- Help the client build strength in this movement by stressing the concentric phases of the repetitions.
- For variation, this movement can also be done on the still rings.

7.5*c* Ending position for the muscle-up on bar.

Video 7.5

See online video 7.5 for the CON–ECC and SUP methods of the muscle-up.

Exercise Motion

1. Begin by explosively pulling your body up toward the bar as if trying to propel yourself to the ceiling.
2. As your body begins its upward motion, begin rotating your wrists over the bar.
3. At the top of the movement, as your head passes the bar, lean forward and transition into a dip.
4. Extend your arms fully.
5. Slowly lower yourself. Repeat.

Performance Improvement Tips

- Begin learning this movement by using a gymnastics kip. The kip from the bottom can help you generate the needed upward momentum to reach the full muscle-up position.
- To gain strength in this movement, start at the top position and slowly lower to the starting position.
- Another variation of this exercise is to bend the legs and have a spotter stand behind, grabbing the legs, and help push the client to the up position.

7.6: Handstand Push-Up

(CON–ECC, EE, or SUP)

7.6*a* Starting position for the handstand push-up.

Starting Position

1. Place an exercise mat on the floor in contact with a bare wall. With your back to the wall, bend at your waist and place both hands on the floor or exercise mat shoulder-width apart.
2. Kick up against the wall, keeping your arms straight. In an upside-down position, your arms and legs should be fully extended.
3. Keep your body as straight as possible.

Trainer Recommendations

- Stand to the client's side and spot at the ankle and lower leg. Help the client on the eccentric and concentric portions, if needed.
- To increase the challenge, add weight plates or parallel bars to create a deficit.

7.6*b* Ending position for the handstand push-up.

Video 7.6

See online video 7.6 for the EE and SUP methods of the handstand push-up.

Exercise Motion

1. Begin the motion by slowly lowering to the ground until your head rests against the abdominal mat.
2. Bracing your core for balance, press back up to the starting position.

Performance Improvement Tips

- Be sure to control the eccentric phase—this is very important for avoiding head injury.
- Always get a spotter if this movement is challenging for you.
- Strength for this movement can be improved by simply holding the isometric starting position.

7.7: Barbell Front Squat

(CON–ECC, EE, or SUP)

7.7*a* Starting position for the barbell front squat.

Starting Position

1. With a bar in a rack slightly below shoulder level, position yourself with the bar on top of your deltoids, pushing into your clavicles. Your hands should be in a clean grip about shoulder-width apart or slightly wider.
2. Bracing your core, remove the bar from the rack by pushing with your legs and standing upright. Step away from the rack and position your feet shoulder-width apart or slightly wider. Your toes should be pointed out slightly.
3. Focus on keeping your head and elbows up.

Trainer Recommendations

- Spot the client from behind with your hands directly beneath his or her shoulders and the bar.
- Help the client maintain an upright torso.
- Remind the client to keep the weight on the heels and to keep the knees pointed outward.

7.7*b* Ending position for the barbell front squat.

Video 7.7

See online video 7.7 for the CON–EE, EE, and SUP methods of the barbell front squat.

Exercise Motion

1. From the starting position, bend with your knees into a deep squat. Descend until your hamstrings are almost touching your calves.
2. Keep your knees back and your weight on your heels. Your knees should go outward as you squat.
3. Pushing through your heels and bracing your core, drive back up to the starting position.

Performance Improvement Tips

- Always keep your toes pointed slightly outward.
- Keep your weight on your heels.
- Keep your elbows high and the bar high on your chest.
- Keep your core tight!

7.8: Clean-Grip or Snatch-Grip Pull

(CON–ECC, EE, or SUP)

7.8*a* Starting position for the clean-grip pull.

Starting Position

1. Stand in front of a loaded barbell with your feet shoulder-width apart.
2. While keeping your back as straight as possible, bend your knees, bend forward, and grasp the bar using a clean grip with your hands about shoulder-width apart or slightly wider.

Trainer Recommendations

- Monitor the client to make sure that she or he maintains proper positioning during the lift.
- Watch closely for rounding of the back and for hyperextending at the top of the movement.
- Encourage the client to initially use a light weight in order to work on form and technique before increasing to heavy loads.

7.8*b* Ending position for the clean-grip pull.

Exercise Motion

1. Push with your legs while simultaneously getting your torso to the upright position as you breathe out. In the upright position, stick your chest out and contract your back by bringing your shoulder blades back. Think of a military posture.
2. At the very top of the movement, the bar should be at your hips. In one fluid motion, begin rising onto your toes as the bar reaches that top position. As you rise onto your toes, shrug the barbell upward, keeping your arms straight.
3. Lower slowly and with control to the starting position by bending at your knees while simultaneously leaning your torso forward at your waist. Keep your back straight. When the weights on the bar touch the floor, you are back at the starting position and are ready to perform another repetition.

Performance Improvement Tips

- This is not an exercise to be taken lightly. If you have back problems, replace it with an exercise and movement that do not harm the back.
- Even if you have a healthy back, ensure correct form and never round your back; doing so can cause back injury. Be cautious as well with the weight used—in case of any doubt, use less weight rather than more.
- Use a hook grip (i.e., grip made stronger by trapping the thumb in between the bar and the first two fingers) to prevent the bar from slipping.

7.9: Power Clean

(CON–ECC or EE)

7.9*a* Starting position for the power clean.

7.9*b* Second position for the power clean.

Starting Position

1. Stand over the barbell with the balls of your feet positioned under the bar and your feet pointing forward. Your feet should be shoulder-width apart or slightly wider.
2. Squat down and grasp the bar with a shoulder-width overhand grip. Your shoulders should be over the bar, your chest should be up, and your core should be tight.
3. Your arms should be fully extended.

Trainer Recommendations

- Stand at the client’s side as he or she performs the movement.
- Make sure that the bar remains close to the client’s body and travels in a straight line up and down.
- Encourage the client to start light and focus on achieving stellar form.

7.9*c* Third position for the power clean.

7.9*d* Ending position for the power clean.

Video 7.9

See online video 7.9 for the CON–EE and EE methods of the power clean.

Exercise Motion

1. To begin the power clean, pull the bar off of the floor by extending your hips and knees. When the bar reaches your knee level, explosively raise your shoulders while keeping the barbell close to your thighs. After the barbell passes your mid-thighs, allow it to contact your thighs.
2. Jump upward, extending your body.
3. With a shoulder shrug, pull the barbell upward, with your arms bending at the elbows as it becomes weightless. Keep the bar close to your body.
4. With speed, pull your body underneath the bar, rotating your elbows around the bar.
5. Catch the bar on your shoulders while moving into a quarter-squat position. Stand up immediately.
6. To return to the starting position, control the weight as it moves back down to your hips and slides across your thighs to your knee level and then to the floor.
7. As you begin to tire, simply drop it from the top position of the power clean, then reset and perform again.

Performance Improvement Tips

- Always keep your core tight.
- The bar should remain close to your body at all times!
- Use a hook grip (i.e., grip made stronger by trapping the thumb in between the bar and the first two fingers) to help with heavier loads.
- Start light and focus primarily on form.

7.10: Power Snatch

(CON–ECC or EE)

7.10*a* Starting position for the power snatch.

7.10*b* Second position for the power snatch.

Starting Position

1. Stand over the barbell with the balls of your feet positioned under the bar and your feet shoulder-width apart or wider, depending on your preference.
2. Get into a deep squat, grasping the bar with an overhand grip two to four inches wider than shoulder width. (Vary this grip placement on the bar depending on personal preference and flexibility level.)
3. Your shoulders should be positioned over the bar, your chest should be up, and your core should be engaged. You arms should be fully extended.

Trainer Recommendations

- Stand at the client's side as she or he performs the movement.
- Make sure that the bar remains close to the client's body and travels in a straight line up and down.
- Encourage the client to start light and focus on achieving stellar form.

7.10*c* Third position for the power snatch.

7.10*d* Ending position for the power snatch.

Video 7.10

See online video 7.10 for the CON–EE and EE methods of the power snatch.

Exercise Motion

1. Pull the barbell off of the floor by extending your hips and knees.
2. Keep your back at the same angle as in the starting position until the bar is at knee level.
3. Once the barbell crosses knee level, raise your shoulders explosively while keeping the bar as close to your legs as possible and maintaining a straight up-and-down bar path.
4. Allow the barbell to contact your hips or the top of your thighs as it travels upward. Jump upward, extending your body.
5. Pull the barbell upward by shrugging your shoulders. As the bar becomes weightless, allow your elbows to pull up to the side; keep them over the bar as long as possible. Pull your body under the bar quickly.
6. Above your head, catch the bar with fully extended arms before bending your knees to a 90-degree angle.
7. Once you have caught the barbell, in a quarter-squat position with your arms extended overhead, stand up immediately with the barbell overhead.
8. To return to the starting position, you may control the movement back down to your hips, slowly down your thighs to the knee position, and back to the floor. Or you may simply drop the barbell from the overhead position as you begin to fatigue. Be sure to drop the barbell slightly out in front of you and step back as it falls.

Performance Improvement Tips

- Always keep your core tight.
- The bar should remain close to your body at all times!
- Use a hook grip (i.e., grip made stronger by trapping the thumb in between the bar and the first two fingers) to help with heavier loads.
- Start light and focus primarily on form.

7.11: Box Jump

(CON–ECC or EE)

7.11*a* Starting position for the box jump.

Starting Position

1. Begin by selecting a box of an appropriate height—one that you can jump onto comfortably.
2. Stand directly in front of the box but allow enough room between it and yourself to avoid hitting your feet on the box during the jump.

Trainer Recommendations

- Help the client select an appropriate box-jump height.
- Encourage the client to perform the exercise with correct form on each repetition.
- If the movement becomes too easy, have the client increase the height or practice with the EE or 2UP/1DN method.

7.11*b* Middle position for the box jump.

7.11*c* Ending position for the box jump.

Exercise Motion

1. Bend your knees, keeping your weight on your heels. As you bend your knees, swing your arms back directly behind your body.
2. Jump as high as needed in order to clear the box completely. As you jump, swing your arms forward and upward to help you gain momentum.
3. Land on the box with both feet. Stand up with full extension of your hips.
4. In a controlled fashion, either step or jump off of the box and land on both feet. Jumping off of the box is much more challenging.

Performance Improvement Tips

- Use a short box until you are comfortable, then progress to a higher box.
- From the top position, use the step-down method at first, then progress to jumping off.
- Do not jump off of the box if you have knee problems of any kind.

7.12: Broad Jump

(CON–ECC or EE)

7.12*a* Starting position for the broad jump.

7.12*b* Second position for the broad jump.

Starting Position

1. Stand with your feet shoulder-width apart and your hands at your sides.
2. Engage your core by bracing your abdominals.

Trainer Recommendations

- Establish measurement criteria so that the client has a goal to shoot for. A target seems to improve performance for most people.
- Encourage the client to land softly on all jumps.
- To add challenge, this movement may also be done with the EE or 2UP/1DN method.

7.12*c* Third position for the broad jump.

7.12*d* Ending position for the broad jump.

Exercise Motion

1. Bend your knees to a medium-depth squat while keeping your weight on the balls of your feet.
2. Lean forward slightly and swing your arms back directly behind your body.
3. Leap forward and upward, as high as possible. Swing your arms forward and upward at the same time to enhance your jump performance.
4. Land with both feet in a soft-knee position. Stand up and return to the starting point.

Performance Improvement Tips

- Lean forward as you begin your jump, but keep your weight on your heels. The forward lean will help propel you forward.
- Try to land softly.

Upper- and Lower-Body Workout Routines for Power Training

These sample power training routines provide a general upper-body and lower-body power-building regimen. Depending on your sport or athletic needs, you may wish to modify them. These routines should be implemented with 48 to 72 hours of rest between exercise bouts. Therefore, the program works best if the upper-body routine is performed on Monday and Wednesday, the lower-body routine on Tuesday and Thursday, and a cardiorespiratory and flexibility routine on alternative days or light-intensity days. Another programming possibility is to do the upper-body routine on Monday and Thursday, the lower-body routine on Tuesday and Friday, and the cardiorespiratory and stretching routine on Wednesday and Saturday. If a recovery day is needed, Wednesday or Saturday would be suitable days.

For the purpose of improving explosive power, we recommend performing the eccentric training on an intermittent basis as part of a normal power training program. Because power training typically uses heavy loads, the excessive soreness and damage associated with the eccentric training may reduce power output and performance quality. Therefore, an initial protocol for explosive power training is four to six weeks of concentric training followed by one week where you incorporate some eccentric training with some of your foundational CON-ECC exercises. This way, you will be building on your musculoskeletal base with progressive increases in power.

Case Study: Client Profile and Goals

Tammy is a 23-year-old who just began working on a master’s degree in exercise science. She is 5 feet 4 inches tall (162.5 cm) and weighs 128 pounds (58 kg). She enjoys competing in popular fitness challenges. She stays quite active by running and participating in high-intensity group exercise classes during the week. She also enjoys yoga classes at least two times a week. Tammy has done free-weight resistance training for the past four years. Her upper body is quite strong and her lower body is moderately strong. She seeks power training in her exercise program because she thinks it will help her greatly with her high-intensity competitions. For power training enthusiasts, a personal trainer needs to focus on the client's fitness level and specific sport and athletic applications to improve. Power enthusiasts often combine a lot of strength with plyometric training, which may lead to considerable total-body fatigue. Make sure the client is getting adequate rest between workouts and recovery between sets.

Three-Week Mesocycle of Power Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Incline bench press	4-5	3-5	EE
	Push jerk	4-5	3-5	CON–ECC
	Gorilla pull-up	4-5	3-5	EE
	Plyometric push-up	4-5	5-10	EE
Tuesday	Barbell front squat	4-5	3-5	EE
	Power clean	4-5	1-3	EE
	Clean-grip or snatch-grip pull	4-5	3-5	EE
	Box jump	4-5	5-10	EE
Wednesday	Off			
Thursday	Power snatch	4-5	1-3	EE
	Overhead press	4-5	3-5	EE
	Muscle-up (on bar or rings)	4-5	3-5	EE
	Handstand push-up	4-5	5-10	EE
Friday	Barbell back squat	3-4	1-3	SUP
	Hang clean (at the knee or power position)	3-4	3-5	EE
	Clean-grip or snatch-grip pull	3-4	3-5	EE
	Burpee broad jump	3-4	5-10	CON–EE
Saturday	Pull-up (add weight belt or vest to overload)	4-5	1-5	SUP (use a spotter or kip for assist)
	Handstand push-up (create overload with deficit plates or parallel bars)	3-4	1-5	EE (use a spotter for assist)
	Split jerk from rack or blocks (preferably blocks)	3-4	1-3	CON–EE
	Standard push-up	3-4	MAX Reps	EE
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. These exercises also give you options for meeting the multiple needs and goals of your clients, whether they involve fitness-level adaptations, musculoskeletal considerations, or improvements in movement ability. Change-out exercises provide a different stimulus to muscles, which may be necessary to enhance the musculoskeletal fitness of some clients or help them overcome a training plateau. These exercises also promote flexibility and creativity in designing resistance training. Effective workouts and resistance training programs change regularly in order to address the fitness status of each exerciser.

Exercise	Change-out exercise options
Upper-body power training exercises	
Incline bench press	Flat barbell bench press; dumbbell bench press; push-up
Push jerk	Split jerk; overhead barbell press; seated shoulder press machine
Gorilla pull-up	Standard pull-up; lat pull-down; row
Plyometric push-up	Standard push-up; hand-release burpee
Muscle-up (on bar or rings)	Pull-up; barbell curl; muscle-up on rings
Handstand push-up	Shoulder press machine; regular push-up; dumbbell shoulder press
Lower-body power training exercises	
Barbell front squat	Back squat; overhead squat; lunge; leg press
Clean-grip or snatch-grip pull	Standard deadlift; snatch-grip pull; stiff-leg deadlift; good morning
Power clean	Squat clean; hang clean; front squat; clean and jerk
Power snatch	Hang snatch; full snatch; overhead squat; back squat; leg press
Box jump	Broad jump; squat jump; plyometric squat jump with barbell; lunge
Broad jump	Box jump; squat jump; plyometric squat jump with barbell; lunge

Upper-Body Power

Routine A

1: Incline bench press

2: Push jerk

3: Gorilla pull-up

4: Plyometric push-up

5: Muscle-up (on bar or rings)

6: Handstand push-up

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Upper-Body Power

Routine B

1: Gorilla pull-up

2: Plyometric push-up

3: Muscle-up (on bar or rings)

4: Incline bench press

5: Handstand push-up

6: Push jerk

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Power

Routine A

1: Barbell front squat

2: Clean-grip or snatch-grip pull

3: Power clean

4: Power snatch

5: Box jump

6: Broad jump

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Power

Routine B

1: Broad jump

2: Box jump

3: Clean-grip or snatch-grip pull

4: Power clean

5: Barbell front squat

6: Power snatch

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Chapter 8
Eccentric Training for Weight Loss

Excess body weight is associated with increased risk of heart disease, high blood pressure, type 2 diabetes, gallstones, breathing problems, musculoskeletal disabilities, and certain cancers (endometrial, breast, and colon) (National Institutes of Health, 2012). It is also associated with early mortality (American College of Sports Medicine, 2013). In addition, the financial costs of treating these conditions means that obesity hurts the economy of many countries.

Ultimately, the primary reason for overweight and obesity is positive energy balance—that is, more input (via food consumed) than output (via physical activity and exercise) (American College of Sports Medicine, 2013). In other words, overweight and obesity develop when a person's energy balance is disrupted because food intake overmatches the body's energy output. True energy balance means that energy intake *equals* energy output.

The human genome has developed the ability to function biologically with great energy efficiency by storing large amounts of excess fat in fat tissue. This capability exists because we have evolved to deal with famine as a constant threat to life (Loos & Bouchard, 2003). Today, however, many people spend hours watching television, playing video games, doing deskbound schoolwork, and engaging in other sedentary activities. These choices have effects. For example, research has linked more than two hours of daily television viewing to both overweight and obesity (National Institutes of Health, 2012).

The food abundance enjoyed today by many people is a by-product of the achievements of modern society; on the other hand, it enables a positive energy imbalance in our lifestyle. Other contributors to obesity include environmental factors that either encourage sedentary living or discourage active living—for example, inadequate sidewalks, trails, parks, and affordable fitness facilities for all people. At the same time, many people are surrounded by restaurants, fast food eateries, movie theaters, and other recreational outlets that compete for business by offering huge food portions. Not only that, but major media outlets are filled with advertisements promoting high-calorie, high-fat snacks and sugared drinks. Unfortunately, healthy food choices are more expensive, which makes

them less of a viable option for people who face financial challenges.
Research about resistance exercise and weight loss has been focused on traditional concentric–eccentric training as a treatment for obesity and overweight. This knowledge base provides the foundational constructs for using eccentric training to promote weight management. One key factor in weight management is resting metabolic rate (RMR), which is also referred to as resting energy expenditure (REE). In turn, one important determinant of RMR is skeletal muscle—more muscle means a higher RMR.
Muscle mass declines with age, and this change can bring diverse consequences, including reduced muscle strength and power, reduced RMR, reduced capacity to break down fat, and increased abdominal adiposity (central obesity). However, evidence also indicates that these changes can be minimized in part through maintaining large muscle mass by means of resistance training, which may also reduce one's risk of type 2 diabetes mellitus (LaStayo et al., 2014). More specifically, studies indicate that resistance exercise increases lean body mass and REE and helps mobilize visceral and subcutaneous adipose tissue, thus decreasing total fat mass (Strasser & Schobersberger, 2011).
To obtain these benefits, however, one must use a sufficient resistance training stimulus, which is precisely why eccentric training may be a beneficial intervention for clients with weight-loss goals. Clear evidence shows that eccentric training is a very effective stimulus for promoting an increase in muscle mass (de Souza-Teixeira & de Paz, 2012). Therefore, eccentric exercise is a strategic tool for exercise professionals to use in any multifactorial weight-loss program (i.e., one that uses, for example, behavior management, cardiovascular exercise, resistance training, and cognitive interventions). Research also shows that all resistance training programs help overweight and obese people maintain reductions in fat mass after exercise training or restriction of energy intake (Strasser & Schobersberger, 2011). Additionally, research shows that positive changes from resistance training affecting muscle and metabolism are possible in older men and women (Melov et al., 2007; Hunter et al., 2007).

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 15 to 20 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for weight loss training: The exerciser should perform one or two traditional warm-up sets (i.e., concentric phase followed by eccentric phase) of the exercise at about 50% to 60% of what he or she normally lifts. The goal is specifically to warm up the joint, which includes the tendons, ligaments, connective tissues, synovial fluid, and all surrounding muscles and fascia.

For the purpose of weight loss, eccentric exercise should be used in combination with concentric training techniques. Each method provides a different stimulus on muscle, both of which positively effect metabolic outcomes, contributing to better weight management success. Emphasizing the eccentric portion of the lift helps the client establish correct form and boosts his or her metabolism after exercise by as much as 10% (Hackney et al., 2008).
Here are some basic guidelines and founding premises for exercise interventions aimed at weight loss. To burn more fat, one should burn more calories. In order to lose weight, one must develop a caloric deficit, which can be done through a combination of diet and exercise. Research shows that greater muscle mass contributes to an increase in the resting metabolism (Elia, 1999). Therefore, adding muscle tissue while decreasing body fat is one of the best strategies for weight management.

In order to add muscle tissue, we recommend having the client follow a periodized plan that includes phases of training geared toward strength, hypertrophy, and endurance. In addition, multijoint exercises have been shown to produce larger increases in anabolic hormones than single-joint exercises. Therefore, they should be prioritized earlier in order to help elicit positive changes in muscle mass (Simao et al., 2012) and, therefore, in RMR (Hansen, Kvorning, Kjaer, & Sjogaard, 2001).

The exercise design for increasing strength calls for the client to complete two to six sets of one to six repetitions of each exercise. Guidelines from the National Strength and Conditioning Association (NSCA, 2008) suggest working at an intensity of 85% of 1-repetition maximum (1RM) with two to five minutes of rest between sets.

The exercise design for improving hypertrophy calls for the client to complete two to four sets of eight to twelve repetitions of each exercise. NSCA (2008) guidelines suggest working at an intensity of 70% to 85% of 1RM with 60 to 90 seconds of rest between sets.

The exercise design for improving endurance calls for the client to complete two to four sets of at least 12 repetitions of each exercise. NSCA (2008) guidelines suggest working at an intensity of less than 70% of 1RM with 30 to 60 seconds of rest between sets.

Application Tools for Exercises

Here are some directions for optimal resistance training.

- Concentric–eccentric (CON–ECC): one- to two-second concentric with a one- to two-second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three or four seconds (eccentric)
- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client’s needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options. The exercises presented a bit later in this chapter include six for the upper body and six for the lower body, each of which is shown in its starting and ending positions.

Many personal trainers focus on the benefits of resistance training in increasing muscle mass and resting metabolic rate, but it is also important to emphasize its health benefits. Resistance exercise has been shown to reduce the signs and symptoms of many chronic conditions, including back pain, arthritis, obesity, heart disease, and diabetes (LaStayo et al., 2014). Therefore, as you help clients use these exercises to pursue their weight management goals, it is also good to help them understand the many other health benefits they may experience.

Summary Thoughts

For many individuals in modern society, food availability and convenience in daily life have led to the adoption of a sedentary lifestyle that promotes a positive energy balance and therefore gradual weight gain. The resulting loss in muscle mass—which also occurs with aging—directly lowers RMR, slows the effect of fat breakdown, and leads to increases in fat deposits, particular in the abdominal area. Evidence suggests that these ill effects can be reduced by maintaining muscle mass through resistance training, which may also reduce one’s risk for various health problems, including type 2 diabetes (LaStayo et al., 2014).

The rest of this chapter provides you with descriptions of resistance exercises for weight loss, sample workout routines, and change-out exercise options.

Training for Weight Loss

When you use the exercises presented in table 8.1 with your clients, remind them that muscles are the engine of fat loss (and thus weight loss) and that every muscle contraction counts. Therefore, the more muscle mass they contract, the more calories they burn. In addition, help your clients focus their energy and intensity on completing each exercise to ensure the release of specific hormones that aid in reducing body fat. In particular, the eccentric methods of resistance training facilitate the goals of a weight loss program because of the increase in postworkout energy expenditure to restore the cells to preexercise levels and promote muscle cell repair.

TABLE 8.1 Exercises for Weight Loss

Upper body	Lower body
Cable crossover fly	Exercise-ball squat
Arnold press	Inner and outer thigh machine
Dumbbell shrug	Step-up
Pull-up assist machine	Gluteal bridge
Zottman curl	Seated hamstring curl
Bent-over triceps kickback	Push–pull with partner

8.1: Cable Crossover Fly

(2UP/1DN, CON–ECC, or EE)

8.1*a* Starting position for the cable crossover fly.

Starting Position

1. Position the pulleys higher than your head level on a cable column machine. Select the resistance that is most appropriate for your strength level. Place a pulley in each hand.
2. Step forward in front of both pulleys.
3. Pull both hands together in front of you, directly in front of your hips, with your palms facing each other.
4. Lean forward slightly.

Trainer Recommendations

- Help the client select an appropriate load for the movement, so that he or she can complete both the eccentric and the concentric portions with perfect technique.
- Stand in front of the client and help guide her or his hands together during the concentric portion of the movement.

8.1*b* Ending position for the cable crossover fly.

Video 8.1

See online video 8.1 for the CON–ECC and EE methods of the cable crossover fly.

Exercise Motion

1. Before starting, bend your elbows slightly.
2. Simultaneously, extend your arms to your sides—slowly, with control, and with your elbows bent—until you feel a stretch in your chest.
3. At the top of the movement, it should be as if your arms are wrapped around a large beach ball.
4. Move your hands back to the starting position with force; this portion is the concentric phase.

Performance Improvement Tips

- Maintain an arc in your arms at all times.
- Do not use a weight that is too heavy; if you do, your range of motion will suffer!
- Maintain a slight forward lean.

8.2: Arnold Press

(2UP/1DN, CON–ECC, EE, or SUP)

8.2*a* Starting position for the Arnold press.

Starting Position

1. With a slight incline or straight back support, sit with two dumbbells positioned in front of your shoulders (raised to eye level).
2. Your palms should face toward you and your elbows should be under your wrists.

Trainer Recommendations

- Spot the client at the elbow from behind. Guide the weight toward the top, then help guide it back down to the starting position.
- Make sure that the client's forearms are always parallel to each other and perpendicular to the ground.
- This exercise may be done using an incline bench, straight back support, or no support for an extra challenge.

8.2*b* Ending position for the Arnold press.

Video 8.2

See online video 8.2 for the 2UP/1DN, CON–ECC, EE, and SUP methods of the Arnold press.

Exercise Motion

1. As you would when opening up two sliding doors, twist your elbows open as you begin to press upward. Continue to raise your elbows out and up while pressing the dumbbells overhead until your arms are fully extended.
2. Once at the top, slowly reverse the initial pattern and return to the starting position.

Performance Improvement Tips

- Keep the weight light in the beginning.
- Make sure that when you externally rotate your shoulders, you do so in a controlled fashion.

8.3: Dumbbell Shrug

(CON–ECC, EE, or SUP)

8.3*a* Starting position for the dumbbell shrug.

Starting Position

1. Standing with your feet shoulder-width apart, hold a dumbbell in each hand, each directly hanging to the side.
2. Engage the lower back and core muscles by tightening (often called bracing) the abdominal and lower back muscles around the spine.

Trainer Recommendations

- Monitor the client's technique from the side.
- Make sure that the client achieves full contraction at the top of the movement.
- As the client fatigues, consider suggesting that he or she use lifting straps to help with grip.
- For variety, change the movement to the cable column machine or have the client use a barbell.

8.3*b* Ending position for the dumbbell shrug.

Exercise Motion

1. Perform the movement by lifting your shoulders upward toward your ears. Keep your arms straight.
2. Squeeze the upper trapezius muscles at the top of the movement (elevating the shoulders to their endpoint of movement), then slowly lower to the starting position.

Performance Improvement Tips

- Always keep a slight bend in your knees, but do not bounce.
- Look straight ahead when performing the movement. Do not turn your head when performing a shrug; doing so can lead to neck injury.

8.4: Pull-Up Assist Machine

(2UP/1DN, CON–ECC, or EE)

8.4*a* Starting position for the pull-up assist machine.

Starting Position

1. Prior to getting on the machine, select a weight that adds enough assistance to help you perform the correct number of repetitions.
2. Stand on the top step of the assist machine and grasp the pull-up bar with your palms facing forward. Place your hands farther than shoulder-width apart.
3. Place your knees or feet (depending on the type of machine) on the assist platform.

Trainer Recommendations

- As the client begins the pull-up, stand to the side and watch her or his form. Make sure that the client achieves full contraction and motion at the top.
- For clients who need a greater challenge, begin by progressing them to pull-ups with less assistance. The ultimate goal, of course, is for the client to perform a body-weight pull-up with no assistance.

8.4*b* Ending position for the pull-up assist machine.

Exercise Motion

1. With a slight arch in your lower back, extending your chest upward, pull your body up toward the bar until your chin crosses the bar line.
2. With control, slowly lower yourself back to the starting position. At the bottom of the movement, get a full stretch of your latissimus dorsi.
3. To exit, slowly bring the weight on the assist platform back to a resting position on the weight stack. After the weight is racked, you may exit the machine.

Performance Improvement Tips

- Keep your chest up as you pull toward the bar above your head.
- Experiment with various hand-width positioning.
- For a greater challenge, try to bring your chest up to the bar.

8.5: Zottman Curl

(2UP/1DN, CON–ECC, or EE)

8.5*a* Starting position for the Zottman curl.

8.5*b* Second position for the Zottman curl.

Starting Position

1. Stand upright with a dumbbell in each hand and arms extended down at the sides of your body.
2. Bring your elbows close to your body.

Trainer Recommendations

- Stand to the client's side, initially, and make sure that his or her elbows remain in line with the shoulders, hips, and knees.
- There should be no movement at the shoulder joints; all movement should take place at the elbows.

8.5*c* Third position for the Zottman curl.

8.5*d* Ending position for the Zottman curl.

Video 8.5

See online video 8.5 for the 2UP/1DN, CON–ECC, and EE methods of the Zottman curl.

Exercise Motion

1. Begin to perform the curl, but as you raise your arms (at the elbow only) begin twisting your wrists until your palms face up.
2. Bring the dumbbells all the way to the top of the curl position and contract your biceps hard!
3. Slowly return the weights to the starting position.

Performance Improvement Tips

- Use a weight with which you can control the motion completely—from the pronated grip all the way through the supinated grip and back down.
- Keep your chest up during this exercise.

8.6: Bent-Over Triceps Kickback

(2UP/1DN, CON–ECC, EE, or SUP)

8.6*a* Starting position for the bent-over triceps kickback.

Starting Position

1. With a dumbbell in each hand, position your feet in a shoulder-width stance and fold over at your waist. Your back should be flat.
2. Bring your arms up to the same level as your upper torso. Your arms should be parallel to the ground and your forearms perpendicular.

Trainer Recommendations

- Monitor the client to make sure that she or he maintains a flat back.
- Also make sure that the client keeps his or her elbows up and attains full extension on every repetition.

8.6*b* Ending position for the bent-over triceps kickback.

Exercise Motion

1. Begin by extending your elbows outward until the dumbbells are in a straight line with your torso. Contract your triceps hard.
2. Slowly lower back to the starting position.

Performance Improvement Tips

- Keep your back flat and your core tight. It helps to think "chest up."
- The tendency is to use a too-heavy weight for this movement. Select a weight with which you can keep your arms in line with your torso at all times.

8.7: Exercise-Ball Squat

(CON–ECC, EE, or SUP)

8.7*a* Starting position for the exercise-ball squat.

Starting Position

1. Start in a slightly leaning position with an exercise ball pressed firmly against the lower to middle portion of your back and the other side of the ball pressed against the wall.
2. Make sure that your weight is on your heels.

Trainer Recommendations

- Stand at the client's side and monitor that his or her knees remain in line with the ankles at all times throughout the movement.
- Cue the client to keep her or his core tight and to keep the weight on the heels.
- To add a challenge, you can hand the client a dumbbell or kettlebell to add resistance to the movement. You can also have the client perform the movement with one leg at a time.

8.7*b* Ending position for the exercise-ball squat.

Video 8.7

See online video 8.7 for the CON–ECC and EE methods of the exercise-ball squat.

Exercise Motion

1. Slowly lower by bending your knees into a squat position. Try to reach a 90-degree angle (or less) at the knee. Keep your weight on your heels at all times.
2. Focus on pressing against the ball to ensure that it does not slip out from behind you.
3. Once at the bottom, engage your glutei maximi, hamstrings, and quadriceps and press back up to the top. Be sure to drive through your heels!

Performance Improvement Tips

- Always keep your weight on your heels when performing the squat.
- Focus on going down slowly, then exploding back to the top.

8.8: Inner and Outer Thigh Machine

(CON–ECC, EE, or SUP)

8.8*a* Starting position for the inner thigh machine.

8.8*b* Ending position for the inner thigh machine.

Starting Position

1. Sit on the machine's seat pad and adjust the lever to allow your legs to go on the outside of the thigh pads. This set-up is for the adductor (inner) work.
2. Open the thigh pads to allow as much range of motion as is comfortable for you. Select an appropriate weight for the movement.

Trainer Recommendations

- Encourage the client to use this exercise as an optimal stretch and to focus on achieving a complete range of motion in both directions.
- For clients with shorter ranges of motion due to decreased flexibility, encourage them to aim for an increase in their initial range of motion.

8.8*c* Starting position for the outer thigh machine.

8.8*d* Ending position for the outer thigh machine.

Exercise Motion

1. Bring your legs together until the thigh pads touch. Slowly return to the starting position.
2. To perform the outer thigh (abductor) exercise, simply change the thigh pads so that they are outside of your thighs. Select the lever and close your legs completely, then secure the lever in place. To work your abductors, simply open your legs as wide as possible, then slowly return to the starting position.

Performance Improvement Tips

- Be careful when adding weight on the adductor motion—the stretch may be more than you are accustomed to.
- Always perform both movements with a complete range of motion.

8.9: Step-Up

(CON–ECC, EE, or SUP)

8.9*a* Starting position for the step-up.

8.9*b* Middle position for the step-up.

Starting Position

1. Place a bench or step in front of you. The height of the step should be enough to challenge you but not enough to cause a breakdown in form.
2. Stand with your feet shoulder-width apart.

Trainer Recommendations

- Stand to the client's side and make sure that he or she drives each step-up through the heel and keeps the knee in line with the ankle.
- To make the exercise more challenging, you can add weight in the form of dumbbells, a medicine ball, or a barbell; you can also increase the step height.

8.9*c* Ending position for the step-up.

Video 8.9

See online video 8.9 for the CON–ECC and EE methods of the step-up.

Exercise Motion

1. Begin by stepping up onto the step or bench with one foot. The movement should look like a shallow lunge. Then, keeping your knee in line with your ankle, push through your front heel and stand up onto the step. Both feet should now be flat on the bench.
2. Step off of the bench and bring both feet back to the starting position. Switch legs and repeat.

Performance Improvement Tips

- Always keep your knee in line with your ankle.
- Push through your heels.
- For a greater challenge, hold dumbbells or place a barbell on your back.

8.10: Gluteal Bridge

(CON–ECC, EE, or SUP)

8.10*a* Starting position for the gluteal bridge.

Starting Position

1. Lie on your back with your feet resting flat on the floor and your knees bent.
2. Engage the core (abdominal) and lower back muscles in an effort to support the spine.

Trainer Recommendations

- Encourage the client to raise his or her hips as high as possible off of the floor while keeping the weight on the heels.
- To add a challenge, have the client place a dumbbell or weight plate directly across the hips.

8.10*b* Ending position for the gluteal bridge.

Video 8.10

See online video 8.10 for the CON–ECC and EE methods of the gluteal bridge.

Exercise Motion

1. Lift your hips upward toward the ceiling, extending your hips fully and squeezing your glutei maximi.
2. As always, keep your weight pushing through your heels.
3. Slowly lower back to the starting position.

Performance Improvement Tips

- At the top of the movement, continue to squeeze your gluteals and focus on stretching your hip flexors.
- Do not let your back arch during this exercise.

8.11: Seated Hamstring Curl

(CON–ECC, EE, or SUP)

8.11*a* Starting position for the seated hamstring curl.

Starting Position

1. Sit on seated hamstring curl machine with your back leaning against the back support.
2. Place both legs on top of the pad, adjusting the pad closer to back of angle.

Trainer Recommendations

- Pad placement makes a big difference in the load. The closer to the back of the ankles, the longer the lever and greater resistance. Therefore, for clients with knee issues, adjusting the pad to be closer to the knee will decrease the lever arm and reduce the strain at the knee joint.
- Encourage the client to attain a full range of motion, particularly as she or he begins to fatigue.

8.11*b* Ending position for the seated hamstring curl.

Exercise Motion

1. To perform the movement, push the lower legs against the pad, contracting the hamstring muscles. Keep the hips from twisting during this exercise.
2. Contract hamstrings to reach your optimal range of motion.
3. Slowly return your legs to the starting position, resisting the eccentric force of the machine.
4. Perform the specified number of repetitions, then switch legs.

Performance Improvement Tips

- One leg is often stronger than the other leg. So, performing a one-leg hamstring curl would be most beneficial to improve the balance in leg strength.
- When performing the one-leg hamstring curl, do the specific number of repetitions and then switch legs.
- Try to keep the movement continuous, particularly during the eccentric phase.

8.12: Push–Pull With Partner

(CON–ECC or EE)

Starting Position

1. This exercise involves both the trainer and the client. At the start, the trainer holds a lightweight but strong bar perpendicular to his or her torso with either a wide, narrow, or neutral grip.
2. The client stands facing the trainer and places his or her hands on the bar.

Trainer Recommendations

- Have fun with this exercise. It is a great trust builder and motivator for clients who tend not to enjoy traditional exercise.
- Another great way to work less clinically is the sled pull; unfortunately, it does not allow for eccentric loading.

8.12 Push–pull with partner.

Video 8.12

See online video 8.12 for the CON–ECC method of the push–pull with partner.

Exercise Motion

1. First, the trainer instructs the client to push against the trainer as hard as possible. The trainer resists as much as possible (or as much as necessary to make it very challenging for the client).
2. Next, the client resists as the trainer pushes. The trainer should push hard but should not knock the client to the ground!

Performance Improvement Tips

- Focus on getting low and driving through your legs.
- When resisting the trainer's push, use a wide, bent-knee stance.
- Keep your core tight!

Upper- and Lower-Body Workout Routines for Weight Loss

One way to increase caloric expenditure is to add a 30-second to 3-minute aerobics station between resistance exercises. This approach is commonly referred to as aerobic circuit training. The term *circuit* refers to a number of carefully selected exercises arranged consecutively, such as the routine presented here. Variations of the aerobic circuit-training model include performing two, three, four, or more exercise stations in series and then performing the aerobics station. The aerobics station can involve walking, jogging, cycling, rope skipping, or another aerobic activity. However, focus the workout intensity on the resistance training exercises with a lighter intensity (i.e., a recovery intensity) during the aerobic stations. In addition, when using this circuit training approach, always mix up the sequence of exercises in order to constantly challenge the muscles to contract optimally.

Case Study: Client Profile and Goals

Sam is a 50-year-old college professor. He is 5 feet 10 inches (178 cm) and weighs 185 pounds (84 kg). Sam enjoys walking and is currently walking 8,000 to 10,000 steps each day, which he tracks with a pedometer application on his mobile device. He has recently seen a registered dietitian to develop some new dietary modifications. He will be doing his workouts at the university, which has a vastly equipped weight room. He keeps active but hasn't worked out consistently for over a decade. So he is somewhat lacking in muscle tone and development. He has completed a six-week basic resistance training program where he has learned all of the major exercises for the body and can perform them with very good technique. He is now ready for a priority resistance training program in order to start adding more muscle. For a weight loss enthusiast, a personal trainer needs to focus on the client's positive energy balance from cardiorespiratory exercise and resistance training. A periodization program including endurance, strength, and hypertrophy phases may be a very good programming option for weight loss clients.

Three-Week Mesocycle of Weight Loss Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Barbell bench press	3-5	5-6	EE
	Seated machine shoulder press	3-5	5-6	EE
	Pull-up assist machine	3-5	5-6	EE
	Exercise-ball squat	3-5	4-6	EE
	Standard deadlift	3-5	3-5	EE
Tuesday	Cardio (30-45 minutes of moderate intensity)			
	Full-body stretching, ab, and core work			
Wednesday	Incline Smith machine press	3-4	8-12	2UP/1DN
	Arnold press	3-4	8-12	EE
	Smith machine squat	3-4	8-12	EE
	Seated cable row	3-4	8-12	2UP/1DN
	Stiff-leg deadlift	3-4	8-12	EE
Thursday	Rest day			
	OR			
	Cardio (30-45 minutes of moderate intensity)			
	Full-body stretching, ab, and core work			
Friday	Cable crossover fly	3-4	10-15	EE
	Seated shoulder press	3-4	10-15	2UP/1DN
	Leg press	3-4	10-15	2UP/1DN
	One-arm dumbbell row	3-4	10-15	EE
	Zottman curl	3-4	10-15	EE
	Bent-over triceps kickback	3-4	10-15	EE
Saturday	Cardio (30-45 minutes moderate intensity)			
	Full-body stretching, ab, and core work			
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. These exercises also give you options for meeting the multiple needs and goals of your clients, whether they involve fitness-level adaptations, musculoskeletal considerations, or improvements in movement ability. Change-out exercises provide a different stimulus to muscles, which may be necessary to enhance the musculoskeletal fitness of some clients or help them overcome a training plateau. These exercises also promote flexibility and creativity in designing resistance training. Effective workouts and resistance training programs change regularly in order to address the fitness status of each exerciser.

Exercise	Change-out exercise options
Upper-body weight loss exercises	
Cable crossover fly	Barbell bench press; dumbbell bench press; chest fly
Arnold press	Dumbbell shoulder press; barbell overhead press; dumbbell lateral raise
Dumbbell shrug	Seated machine row; one-arm dumbbell row; bent-over barbell row
Pull-up assist machine	Cable straight-arm pull-down using rope or straight-bar attachment; lat pull-down; pull-up
Zottman curl	Barbell preacher curl; alternating dumbbell curl; hammer curl
Bent-over triceps kickback	Rope or straight-bar press-down; overhead dumbbell extension; lying triceps extension with barbell or dumbbells
Lower-body weight loss exercises	
Exercise-ball squat	Barbell front squat; barbell back squat; overhead squat; leg press; any other squat variation
Inner and outer thigh machine	Standard walking lunge; barbell lunge; leg press
Step-up	Leg extension with two feet; pistol; lunge; leg press
Gluteal bridge	Stiff-leg deadlift; hamstring curl; hyperextension; gluteal cable kickback
Seated hamstring curl	Lying leg curl; reverse hamstring-gluteal raise; ball hamstring curl with one or two feet
Push–pull with partner	Seated calf raise; standing calf raise; high box jump or vertical jump (weighted or nonweighted); one-leg calf raise

Upper-Body Weight Loss

Routine A

1: Cable crossover fly

2: Arnold press

3: Dumbbell shrug

4: Pull-up assist machine

5: Zottman curl

6: Bent-over triceps kickback

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Upper-Body Weight Loss

Routine B

1: Pull-up assist machine

2: Dumbbell shrug

3: Cable crossover fly

4: Arnold press

5: Bent-over triceps kickback

6: Zottman curl

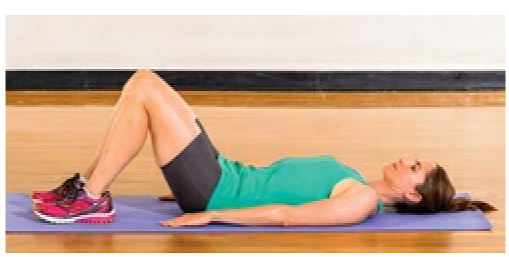
From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Weight Loss

Routine A

1: Exercise-ball squat

2: Gluteal bridge



3: Step-up

4: Inner and outer thigh machine

5: Seated hamstring curl

6: Push–pull with partner

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Weight Loss

Routine B

1: Push–pull with partner

2: Seated hamstring curl

3: Step-up

4: Exercise-ball squat

5: Inner and outer thigh machine

6: Gluteal bridge

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

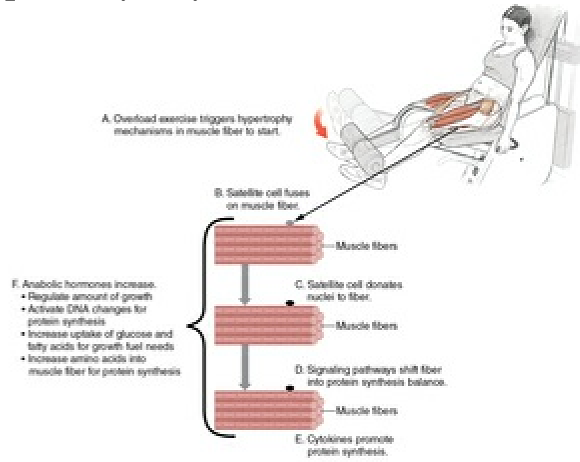
Chapter 9
Eccentric Training for Muscle Hypertrophy

Muscle hypertrophy is an increase in muscle fiber size; it is observed as a muscle gets larger in diameter or cross-sectional area. In humans, hypertrophy does not involve the creation of new muscle fibers, although, as Paul and Rosenthal (2002) note, that phenomenon has been observed in some animal studies due to unique structural differences in muscle anatomy between species. In human muscle hypertrophy at the cellular level, the actin and myosin contractile proteins increase in both size and number (Schoenfeld, 2010). In addition, as Schoenfeld (2010) adds, there are also increases in the fluid (sarcoplasm) and the noncontractile connective tissues interspersed within muscle; collectively, these developments are referred to as sarcoplasmic hypertrophy. With eccentric training, in which muscle is overloaded while lengthening, muscle cells also add sarcomeres (the smallest functional unit of muscle fiber) longitudinally (i.e., in series with the muscle fiber), thus adding length to the muscle fiber (Proske & Allen, 2005).

The physiological mechanisms of muscle hypertrophy involve complex interactions of satellite cells, which function as the stem cells of skeletal muscle (Schoenfeld, 2010). Like stem cells, satellite cells possess unique physiological characteristics and functions. Satellite cells are small mononuclear (one nucleus) cells located between the basement membrane (basal lamina) of a muscle fiber and the sarcolemma (the polarized plasma membrane). They repair damaged muscle tissue and trigger skeletal muscle growth after any type of overload. Once satellite cells are stimulated by a muscular overload, they fuse to muscle fiber and facilitate muscle hypertrophy by forming a new nucleus (human muscle fibers are unique in having numerous nuclei). As Schoenfeld (2010) describes, each nucleus is responsible for a finite area of volume and tissue within the muscle fiber—its myonuclear domain.

The exercise-induced stimulus from resistance exercise also activates a complex response of cellular messaging pathways, cytokines, and hormones that set muscle hypertrophy in motion (see figure 9.1). In particular, three distinctive messaging pathways (calcium-dependent, mitogen-activated protein-kinase, and rapamycin) shift the cell into a protein synthesis condition while also inhibiting protein breakdown (Schoenfeld, 2010). Messaging proteins called cytokines from the immune system interact with specialized receptors on muscle to promote tissue growth. In addition, some anabolic or muscle-growth hormones play a primary role in promoting hypertrophy; these hormones include insulin-like growth factor, testosterone, and growth hormone (Schoenfeld, 2010).

Figure 9.1 Cellular messaging pathways, cytokines, and hormones that promote muscle hypertrophy.



Eccentric exercise has been shown to have a greater effect on muscle size than concentric exercise does. In fact, optimal hypertrophy may be unattainable without performing eccentric movements in a strategically planned program (Schoenfield, 2011). At the same time, depending on the workout stimulus, eccentric exercise occasionally causes muscle damage, which may limit performance in the short term. In the long term, however, delayed-onset muscle soreness causes increased inflammation and protein turnover and actually leads to hypertrophic adaptations. These long-term adaptations occur because the muscle is forced to become stronger in order to protect against further injury (Schoenfield, 2011).

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 5 to 10 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for hypertrophy training: The exerciser should perform one or two traditional warm-up sets (i.e., concentric phase followed by eccentric phase) of the exercise at about 50% to 60% of what he or she normally lifts. The goal is specifically to warm up the joint, which includes the tendons, ligaments, connective tissues, synovial fluid, and all surrounding muscles and fascia.

For the purpose of hypertrophy improvement, it is not uncommon to use an eccentric-only exercise protocol. However, doing eccentric training methods only may cause excessive soreness and neural fatigue. Therefore, concentric and eccentric techniques should be used throughout a hypertrophy plan. Hypertrophy training may attain its best outcomes with the use of all three eccentric training methods. The exercise design for improving hypertrophy calls for the client to complete two to four sets of eight to twelve repetitions of each exercise. Guidelines from the National Strength and Conditioning Association (2008) suggest working at an intensity of 70% to 85% of 1-repetition maximum (1RM) with 60 to 90 seconds of rest between sets. Multijoint exercises have been shown to produce larger increases in anabolic hormones than single-joint exercises and should be prioritized accordingly (Hansen, Kvorning, Kjaer, & Sjogaard, 2001).

Application Tools for Exercises

Here are some directions for optimal resistance training.

- Concentric-eccentric (CON–ECC): one- to two-second concentric with a one- to two-second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three or four seconds

(eccentric)

- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client's needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options. The exercises presented a bit later in this chapter include six for the upper body and six for the lower body, each of which is shown in its starting and ending positions.

Most athletes and competitive bodybuilders know that getting enough rest after exercise is essential to performance and muscle growth. The recovery period is the time when the body adapts to the stress of exercise, repairing and strengthening itself. Therefore, rest days are arguably just as critical as workout days in attaining a client's goals. Without sufficient time to repair and replenish, a person may experience the signs and symptoms of overtraining, which can include staleness, weakness, depression, injury, and decreased performance. To avoid these pitfalls and help your clients get the most benefit from training, make sure that you allow them adequate time for rest, recovery, and sleep.

Summary Thoughts

Physiological responses to hypertrophy training vary according to a person's age, fitness, hormone levels, sex, and tolerance for mechanical overload. Muscle enlargement deriving from resistance training results from an exercise-induced stimulus that activates an intricate response of cellular messaging pathways, cytokines, and hormones that initiate the physiological change. Then three unique signaling pathways (calcium-dependent, mitogen-activated protein-kinase, and rapamycin) shift the muscle cell into a protein synthesis condition. Exercise professionals must understand these physiological adaptations and design resistance training programs that help clients attain them.

The rest of this chapter provides you with descriptions of exercises for emphasizing hypertrophy, sample workout routines, and change-out exercise options.

Training for Muscle Hypertrophy

Hypertrophy training involves completing a variety of exercise movements (see table 9.1) with an appropriate amount of training volume (i.e., total work done). Rest between repeated sets contributes to maximizing muscle gain (Schoenfeld, 2010). For some enthusiasts, shorter rest intervals (~60 seconds) between multiple sets on the same exercise may enhance the hormonal growth-signaling pathways. At the same time, hypertrophy training is often very demanding; therefore, the exercise professional must ensure that the program includes adequate sleep time and proper nutrition strategies.

TABLE 9.1 Exercises for Hypertrophy

Upper body	Lower body
Machine chest press	Smith machine squat
Seated machine shoulder press	Barbell good morning
One-arm dumbbell row	Bulgarian lunge
Dumbbell pull-over	One-leg extension
Machine preacher curl	Lying one-leg hamstring curl
Machine triceps extension	Donkey calf raise

9.1: Machine Chest Press

(2UP/1DN, CON–ECC, EE, or SUP)

9.1*a* Starting position for the machine chest press.

Starting Position

1. Sitting on the chest press machine, select a weight.
2. Grip the handles horizontally with your palms down.
3. Angle your elbows so that your upper arms are parallel to the floor.

Trainer Recommendations

- Stand directly in front of the client and help guide the handles to the fully extended position as the movement becomes challenging.
- Have the client vary his or her hand position (from palms facing down to palms facing in).

9.1*b* Ending position for the machine chest press.

Exercise Motion

1. Press the handles out and away from your chest until your arms are fully extended. Do not lock your elbow joints.
2. Slowly bring the handles back to your chest.
3. Repeat for the recommended number of repetitions.

Performance Improvement Tips

- Focus on squeezing your chest muscles as you press the handles out directly in line with your chest.
- Maintain good posture throughout the range of motion.
- Keep your chest up and your core tight.

9.2: Seated Machine Shoulder Press

(2UP/1DN, CON–ECC, EE, or SUP)

9.2*a* Starting position for the seated machine shoulder press.

Starting Position

1. Sit on the shoulder press machine.
2. Grasp the handles with a supinated grip; your palms should face outward away from your body.

Trainer Recommendations

- Stand directly in front of the client. As the weight becomes challenging, help the client with the upward motion by gently pressing against the handles.
- Have the client try using an alternative hand position. You can also have the client perform one arm at a time for any of the eccentric exercise methods!

9.2*b* Ending position for the seated machine shoulder press.

Exercise Motion

1. Extend your arms directly overhead until they are fully extended. Do not lock your elbow joints.
2. Slowly lower the weight back to the starting position. Repeat.

Performance Improvement Tips

- Maintain a slight natural arch (or neutral spine position) in your back while performing the movement. Keep your core muscles braced by contracting them.
- Experiment with different grips (e.g., palms in versus palms out).

9.3: One-Arm Dumbbell Row

(CON–ECC, EE, or SUP)

9.3*a* Starting position for the one-arm dumbbell row.

Starting Position

1. Hold a dumbbell in one hand.
2. Kneel on the bench with the arm and leg opposite of the hand holding the dumbbell.
3. Keep your torso and back firmly in place.
4. While kneeling on the bench, let the dumbbell hang down toward the ground.

Trainer Recommendations

- Observe the client from the side. Be sure that she or he has a flat back, or the person's normal neutral spine.
- Remind the client to focus on pulling the weight with his or her back muscles rather than the biceps.

9.3*b* Ending position for the one-arm dumbbell row.

Video 9.3

See online video 9.3 for the CON–ECC, EE, and SUP methods of the one-arm dumbbell row.

Exercise Motion

1. Maintaining a supported back, pull the dumbbell up toward the middle of your abdomen.
2. Pause at the top of the movement, then slowly lower the weight back to the starting position.

Performance Improvement Tips

- Focus on contracting your latissimus dorsi muscles on every repetition.
- Keep your back flat and your core tight.
- Emphasize the stretch in your latissimus dorsi during the lowering phase of the movement.

9.4: Dumbbell Pull-Over

(2UP/1DN, CON–ECC, EE, or SUP)

9.4*a* Starting position for the dumbbell pull-over.

Starting Position

1. Using a flat weight bench, lie with your upper back on the bench. Grasp one dumbbell from behind or from the side with both hands.
2. Hold the dumbbell underneath the top of one of the large end sections. Position the dumbbell directly over your chest. Your elbows should be slightly bent.

Trainer Recommendations

- Encourage the client to use a weight that is appropriate for a stretch; using a weight that is too heavy leads to poor form, which may cause injury.
- Spot the weight from behind the client. Help guide the dumbbell back to the starting position from the bottom of the stretch.

9.4*b* Ending position for the dumbbell pull-over.

Video 9.4

See online video 9.4 for the 2UP/1DN, EE, and SUP methods of the dumbbell pull-over.

Exercise Motion

1. Lower the dumbbell over and beyond your head until your upper arms are in line with your torso in a full stretch. You may extend your arms even farther for a greater stretch.
2. Pull the dumbbell back up and over your chest to the starting position.

Performance Improvement Tips

- Start light and focus on the stretch.
- Keep your shoulder blades pressed against the weight bench.

9.5: Machine Preacher Curl

(2UP/1DN, CON–ECC, EE, or SUP)

9.5*a* Starting position for the machine preacher curl.

Starting Position

1. Sit on the seated preacher curl machine. Place the back of your arms across the arm pad.
2. Grab the lever handles with an underhand grip.

Trainer Recommendations

- Make sure that the client is seated upright and assumes the proper position with his or her arms pressed against the preacher curl pad.
- Spot the client by standing in front of the movement; depending on the client's need, help guide the weight up and down.

9.5*b* Ending position for the machine preacher curl.

Exercise Motion

1. Lift the lever handles toward your shoulders, fully contracting your biceps at the top of the movement.
2. Lower the weight back to the starting position.

Performance Improvement Tips

- Adjust the seat to allow your armpits to rest near the top of the pad.
- The backs of your upper arms should remain in contact with the arm pad throughout the movement.

9.6: Machine Triceps Extension

(2UP/1DN, CON–ECC, EE, or SUP)

9.6*a* Starting position for the machine triceps extension.

Starting Position

1. Begin seated in the machine.
2. Grasp the handles and place the back of your upper arms on the padding.

Trainer Recommendations

- Make sure that the client keeps the back of his or her arms pressed against the triceps pad.
- As the movement becomes easy, have the client increase the weight.
- The 2UP/1DN method is a great choice for this exercise because of its ease of completion and progressive overload.

9.6*b* Ending position for the machine triceps extension.

Exercise Motion

1. Keeping your upper arms flat against the pad, push the handles down until your arms are fully extended. Do not lock your elbow joints.
2. Reverse the motion and slowly bring the weight back to the original starting position.

Performance Improvement Tips

- Begin light.
- Keep the backs of your arms in contact with the arm pad at all times.
- Keep your abs tight!

9.7: Smith Machine Squat

(CON–ECC, EE, or SUP)

9.7*a* Starting position for the Smith machine squat.

Starting Position

1. Inside a Smith machine rack, position a barbell across the top of your shoulders. The bar should rest just above your scapulas, directly on top of your trapezius muscles.
2. Stand up and unrack the machine hooks as you lift off.
3. Standing with the barbell across your shoulders, place your feet just slightly forward so that you will sit back more on the squat.
4. Your feet should be in a shoulder-width stance.
5. Body weight should be balanced directly over your ankles before you begin the movement.

Trainer Recommendations

- Help the client safely unrack the bar.
- Prepare to spot the squat by positioning yourself in a wide stance behind the client.
- Position your hands beneath the client's rib cage and prepare to help him or her perform a safe squat.
- Squat down with the client, then come back up with the client's motion.
- Whenever spotting a client who is performing squats, help the client select an appropriate load for his or her strength level. The client should be able to perform the movement on her or his own; you are there to prevent injury and help with any malfunction.
- Help the client rerack the weight and safety hooks.

9.7*b* Ending position for the Smith machine squat.

Video 9.7

See online video 9.7 for the CON–ECC, EE, and SUP methods of the Smith machine squat.

Exercise Motion

1. Bend your knees and lower your legs until you either create a 90-degree angle or reach your maximum range of motion. During the descent, maintain a natural arch in your lower back. You should feel a slight stretch in your hamstrings as you reach the bottom of the squat.
2. Once at the bottom of the squat, use your gluteus maximus, hamstring, and quadriceps muscles to return to the starting position.
3. You heels should remain firmly in contact with the floor at all times during the movement; doing so keeps your weight over your ankles.
4. Push through your heels during the exercise.
5. Once you complete the desired number of repetitions, lock the safety hooks back into position.

Performance Improvement Tips

- Keep your heels firmly planted on the floor throughout the squat.
- Keep your knees in line with your ankles.
- Keep your head and neck in a neutral position.
- Keep your core muscles contracted!

9.8: Barbell Good Morning

(CON–ECC or EE)

9.8*a* Starting position for the barbell good morning.

Starting Position

1. Start with a barbell resting on top of your shoulders.
2. Place your arms in a wide-grip (about 2 to 3 inches wider than shoulder width) position to provide greater stability.
3. Keep your chest up and your core tight. Your knees should be slightly bent.

Trainer Recommendations

- If the client is not using a squat rack, help the client place the barbell on his or her shoulders.
- As the client performs the movement, stand directly behind her or him, hold on to the bar, and help guide the bar along the right path through both motions.

9.8*b* Ending position for the barbell good morning.

Video 9.8

See online video 9.8 for the CON–ECC and EE methods of the barbell good morning.

Exercise Motion

1. To begin, push your hips and glutei maximi back, causing a bend in your waist at your hips.
2. Keep your weight on your heels. Lower your torso until it is parallel to the floor. Your back should be flat.
3. Push through your heels and thrust your hips forward as you return to the starting position.

Performance Improvement Tips

- Keep your back flat. Do not round it!
- Keep your core contracted, your chest up, and your weight on your heels.

9.9: Bulgarian Lunge

(CON–ECC, EE, or SUP)

9.9*a* Starting position for the Bulgarian lunge.

Starting Position

1. Stand with a flat bench two or three feet (about one-half to one meter) behind you.
2. With a dumbbell in each hand, place the top of one foot on the bench behind you while maintaining a lunge position with the opposite leg.
3. The leg planted on the ground in front of you should have its ankle in line with its knee.

Trainer Recommendations

- Once the client is in proper position, assist by handing him or her the dumbbells.
- Stand to the side and make sure that the client's front leg maintains the knee-over-ankle position.
- Be sure that the knee of the client's front leg does not go past the toes.

9.9*b* Ending position for the Bulgarian lunge.

Video 9.9

See online video 9.9 for the CON–ECC and EE methods of the Bulgarian lunge.

Exercise Motion

1. Slowly bend your front knee while keeping your weight on your heel.
2. Lower all the way to a full stretch.
3. Squeeze your gluteus maximus and hamstrings muscles and return to the starting position.
4. Switch legs and repeat.

Performance Improvement Tips

- Always keep your knee in line with the ankle of your front foot.
- Focus on and feel the stretching in your hamstrings and hip flexors.
- Start light.

9.10: One-Leg Extension

(CON–ECC, EE, or SUP)

9.10*a* Starting position for the one-leg extension.

Starting Position

1. Sit on the machine with both legs under the footpads, which should fall on your shins just above your ankles. Some seated leg extension machines allow the exerciser to place the non-working leg to the side (as shown in 9.10*a*).
2. Be sure that your legs form a 90-degree angle at the axis of the knee joint.

Trainer Recommendations

- Make sure that the client establishes proper footpad positioning before beginning the exercise.
- Be sure that the back pad is adjusted appropriately to fully support the client’s back.
- Monitor for proper range of motion during the movement. Coach the client to avoid hyperextending and slamming the weight stack during the return phase of the movement.
- For variety, you may have the client position his or her feet at different angles (e.g., turned out, turned in, standard).

9.10*b* Ending position for the one-leg extension.

Exercise Motion

1. Extend one leg fully, using your quadriceps muscle. Your knee should remain in a soft or neutral position; avoid locking the knee joint or hyperextending at the knee.
2. Slowly lower the leg back to the starting position. To keep constant tension in the muscle, avoid letting the weight rest on the weight stack.

Performance Improvement Tips

- Start out with a light weight.
- This movement is an isolation movement; therefore, you should focus less on moving a large load and more on squeezing the muscle with a full range of motion.
- Do not hyperextend your knee or lock the joint.

9.11: Lying One-Leg Hamstring Curl

(CON–ECC, EE, or SUP)

9.11*a* Starting position for the lying one-leg hamstring curl.

Starting Position

1. Adjust the machine to fit your height and lie facedown on the leg curl machine with the footpad lever on your calf just above your ankle.
2. Keeping your stomach flat on the bench, extend one leg fully. Using dorsiflexion, flex your foot to increase hamstring recruitment. Depending on the hamstring curl machine, the non-exercising limb will be placed to the side of the machine or next to the working leg.

Trainer Recommendations

- Make sure that the footpad is in the proper position before allowing the client to begin the exercise.
- Monitor to ensure that the client performs a full range of motion, fully shortening the hamstrings at the top of the movement and lengthening at the bottom.

9.11*b* Ending position for the lying one-leg hamstring curl.

Exercise Motion

1. Shortening your hamstrings, curl both legs up to a full contraction. One leg creates the force and the other leg simply follows through the range of motion. Your upper thighs, hips, and lower torso should remain pressed against the machine.
2. Stretching your hamstrings, extend both legs back to the starting position.

Performance Improvement Tips

- Use ankle dorsiflexion to increase hamstring contraction.
- Use a weight that you can lift with your hamstrings only—one that does not require swinging or recruitment of your lower back.

9.12: Donkey Calf Raise

(2UP/1DN, CON–ECC, EE, or SUP)

9.12*a* Starting position for the donkey calf raise.

Starting Position

1. Begin by positioning your lower back and hips under the padded lever on the donkey calf machine.
2. Position the balls of your feet on the foot platform with your heels extending off the platform. Keep your knees slightly bent and your feet shoulder-width apart.

Trainer Recommendations

- If a donkey calf machine is unavailable, this exercise may be done with a partner on the back.
- For a challenge, experiment with having the client use the 2UP/1DN method.

9.12*b* Ending position for the donkey calf raise.

Video 9.12

See online video 9.12 for the 2UP/1DN, CON–ECC, and EE methods of the donkey calf raise.

Exercise Motion

1. Rise onto your toes, fully contracting your calf muscles.
2. Lower back into a full stretch. Repeat.

Performance Improvement Tips

- Start light.
- Maintain a soft knee bend.

Upper- and Lower-Body Workout Routines for Muscle Hypertrophy

These sample hypertrophy training routines are designed to provide a full upper-body and lower-body strength regimen. Each routine should be implemented with 48 to 72 hours of rest. Therefore, the program works best with Monday and Wednesday used for the upper-body routine, Tuesday and Thursday used for the lower-body routine, and Wednesday and Saturday used for a cardiorespiratory and stretch routine.

Case Study: Client Profile and Goals

Eric is a 24-year-old with an MBA who just attained his first job with an investment firm. He is 5 feet 11 inches (180 cm) and weighs 165 pounds (74.8 kg). He was a recreational weight lifter in college, and now he wants to develop more muscularity. He has stayed active in aerobic exercise since college, regularly cycling or running 35 minutes three or four times a week. Eric's goals are to add 10 pounds (about 5 kg) of muscle over the next year. He has a weight room in his apartment complex, which is fully equipped with exercise machines and ample free weights. Eric reports occasional foot-related pain from running but has never seen a medical practitioner for any diagnosis. He has completed a series of foundational musculoskeletal tests, which indicate that he has weak core strength. Ongoing evaluations of changes in hypertrophy are often assessed by taking limb and body circumference measurements and tracking changes in body composition. This program began with a transition week of one or two sets of concentric–eccentric (CON–ECC) training and eccentric emphasis (EE), respectively.

Three-Week Mesocycle of Hypertrophy Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Machine chest press	3-4	8-12	EE
	Incline Smith machine press	3-4	8-12	2UP/1DN
	Seated cable row	3-4	8-12	2UP/1DN
	Dumbbell pull-over	3-4	8-12	EE
Tuesday	Seated machine shoulder press	3-4	8-12	EE
	Dumbbell lateral raise	3-4	8-12	EE
	Machine preacher curl	3-4	8-12	2UP/1DN
	Machine triceps extension	3-4	8-12	EE
Wednesday	Smith machine squat	3-4	8-12	EE
	Bulgarian lunge	3-4	8-12	EE
	Barbell good morning	3-4	8-12	EE
	Leg extension	3-4	8-12	2UP/1DN
	Hamstring curl	3-4	8-12	2UP/1DN
Thursday	Off			
Friday	Bench press	3-4	2-3	SUP
	Wide-grip latissimus dorsi pull-down	3-4	8-12	EE
	Seated shoulder press	3-4	8-12	2UP/1DN
	Barbell curl	3-4	2-3	SUP
	Triceps cable press-down	3-4	8-12	EE
Saturday	Leg press	3-4	2-3	SUP
	Stiff-leg deadlift	3-4	8-12	EE
	Donkey calf raise	3-4	8-12	2UP/1DN
	Plank	3-4	60sec	None
	Hanging leg raise	3-4	8-12	EE
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. These exercises also give you options for meeting the multiple needs and goals of your clients, whether they involve fitness-level adaptations, musculoskeletal considerations, or improvements in movement ability. Change-out exercises provide a different stimulus to muscles, which may be necessary to enhance the musculoskeletal fitness of some clients or help them overcome a training plateau. These exercises also promote flexibility and creativity in designing resistance training. Effective workouts and resistance training programs change regularly in order to address the fitness status of each exerciser.

Exercise	Change-out exercise options
Upper-body muscle hypertrophy exercises	
Machine chest press	Barbell bench press; dumbbell bench press; chest fly
Seated machine shoulder press	Dumbbell shoulder press; barbell overhead press; dumbbell lateral raise movement
One-arm dumbbell row	Seated machine row; seated cable row; bent-over barbell row
Dumbbell pull-over	Cable straight-arm pull-down using rope or straight-bar attachment; latissimus dorsi pull-down; pull-up
Machine preacher curl	Barbell or dumbbell preacher curl; alternating dumbbell curl; hammer curl
Machine triceps extension	Rope or straight-bar press-down; overhead dumbbell extension; lying triceps extension with barbell or dumbbells
Lower-body muscle hypertrophy exercises	
Smith machine squat	Barbell front squat; barbell back squat; overhead squat; leg press; any other squat variation
Barbell good morning	Stiff-leg deadlift; hamstring-gluteal raise; hamstring curl; hyperextension; gluteal cable kickback; weighted gluteal bridge
Bulgarian lunge	Standard walking lunge; barbell lunge; leg press
One-leg extension	Leg extension with two feet; pistol; lunge; leg press
Lying one-leg hamstring curl	Seated leg curl; lying leg curl; reverse hamstring-gluteal raise; ball hamstring curl with one or two feet
Donkey calf raise	Seated calf raise; standing calf raise; high box jump or vertical jump (weighted or nonweighted); one-leg calf raise

Upper-Body Hypertrophy

Routine A

1: Machine chest press

2: Seated machine shoulder press

3: One-arm dumbbell row

4: Dumbbell pull-over

5: Machine preacher curl

6: Machine triceps extension

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Upper-Body Hypertrophy

Routine B

1: Dumbbell pull-over

2: One-arm dumbbell row

3: Machine chest press

4: Seated machine shoulder press

5: Machine triceps extension

6: Machine preacher curl

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Hypertrophy

Routine A

1: Smith machine squat

2: Barbell good morning

3: Bulgarian lunge

4: One-leg extension

5: Lying one-leg hamstring curl

6: Donkey calf raise

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Lower-Body Hypertrophy

Routine B

1: Donkey calf raise

2: Lying one-leg hamstring curl

3: One-leg extension

4: Smith machine squat

5: Bulgarian lunge

6: Barbell good morning

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Chapter 10
Eccentric Exercise and Rehabilitation

To ground our discussion of eccentric exercise and rehabilitation, we begin by explaining the function and structure of key connective tissues: tendons, ligaments, and fascia. We then provide a synthesis of research about the use of eccentric exercise for rehabilitation.

Tendons

Muscle is attached to bone by means of strong tissues called tendons, which transfer the tension created by the muscle to the bone, thus creating movement. The main constituent of tendon is the protein referred to as collagen, which is arranged in bundles in a somewhat wavy manner. Collagen, an inelastic tissue with great tensile strength, is the most abundant protein in the body and is a structural component of all living tissue. Collagen fibers provide a negligible amount of extensibility. Another constituent that contributes to the tensile strength of tendons is ground substance. Ground substances are nonfibrous materials composed of several different molecules, which, when combined, create a more stable and rigid structure.

Tendons are vulnerable to various mechanisms of injury because they are linked with every muscle in the body. The most common sites of tendon-related structural damage are the calf, knee, and elbow. Tendinopathy involves soft-tissue inflammation and is a common problem in the athletic population. The pathology of tendinopathy is associated with chronic overuse or repeated overloading of a tendon, which results in the progression of structural damage.

Ligaments

Ligaments support joints by binding bone to bone. Therefore, unlike tendons, ligaments attach to bone at both ends. As with tendons, ligaments are made up of collagen bundles located parallel to one another. Depending on the shape of the bone to which they are attached, ligaments themselves exhibit various shapes, including thin sheets, thick cords, and band structures. Ligaments also contain a concentration of the protein referred to as elastin. This protein has a very complex biochemical composition that allows ligaments some extensibility and the capacity to return to their original length once a stretch or force is removed. This characteristic provides a joint with a balanced mix of support and resilience.

Fascia

Fascia is a Latin word that refers to a bandage or band. From an anatomical viewpoint, it is a broad term used to designate all connective tissue that does not have a specific name. Fascia varies in shape and thickness depending on the functional demands placed on it. Fascia serves three major functions: (1) providing the intramuscular framework that binds muscle, thus safeguarding its stability; (2) permitting the forces developed by the muscle to be transmitted securely and efficiently; and (3) offering a necessary insulation between organs and tissues, thus permitting them to function without inhibiting adjacent structures.

Feasibility of Eccentric Exercise for Rehabilitation

A growing body of research is now showing that people of various ages and levels of fitness and health are able to safely progress with eccentric exercise as a prominent part of the rehabilitation process. Eccentric resistance exercise training has been shown to improve quality of life and physical function and helps to rehabilitate acute and chronic injuries (LaStayo et al., 2014). Personal trainers will find it helpful to know that a fair amount of research on eccentric training has targeted people with exercise-related injuries, some of which are discussed in the following section.

Rehabilitation for anterior cruciate ligament reconstruction (ACLR) continues to be an area of development; indeed, researchers are constantly investigating safe and effective methods of ACLR rehabilitation. One key is already known: effective recovery requires careful, progressive overloading of the muscle early after surgery. Gerber and colleagues (2009) found that patients who performed a 12-week eccentric training program (beginning 3 weeks after surgery and combined with functional rehabilitation exercise) experienced greater improvement in quadriceps femoris and gluteus maximus muscle volume, as well as overall function, than patients who followed a standard rehabilitation protocol of weight-bearing exercise, resistance exercise, and functional training.

A one-year follow-up found the eccentric exercise group to have 50% more improvement in muscle volume in the quadriceps femoris and gluteus maximus. The eccentric group also continued to show greater improvement of overall function than did the standard rehabilitation control group. These results demonstrate the importance of using eccentric exercise in the early and ongoing stages of an ACLR rehabilitation program.

Another common injury treated in rehabilitation settings is patellar tendinopathy, which is also known as jumper’s knee. This injury is especially common among athletes, and it occurs frequently in high-level volleyball, basketball, and soccer players (Lian, Engebretsen, & Bahr, 2005). Jumper’s knee can be treated by either surgery or eccentric exercise. One study using a 12-week eccentric rehabilitation intervention found no measurable difference in outcomes between surgical intervention and eccentric exercise rehabilitation for jumper’s knee in a mostly male group that included both athletes and nonathletes (Bahr, Bjorn, Sverre, & Engebretsen, 2006). Both treatments—surgery and eccentric strength training—resulted in definite improvement in knee function. The researchers concluded that eccentric training is a low-risk and low-cost option that should be considered before a person with jumper’s knee undergoes surgical intervention.

In a similar finding, Alfredson’s review (2003) of studies of midportion Achilles tendinopathy found that treatment with eccentric calf-muscle training produced very good short-term clinical results that reduced the need for surgical treatment. As Alfredson notes, the individual's progression during post-rehabilitation training should be monitored to evaluate range of motion, strength, and functional performance. Eccentric training thus provides personal trainers with a viable intervention for post-rehabilitation conditioning that they can use with the many fitness enthusiasts who push themselves to compete in recreational sports.

Exercise Program Design

Any exercise program requires two elements before the workout is performed:

1. Full-body warm-up: The exerciser should perform 5 to 10 minutes of general aerobics (e.g., cycling, rowing, walking, running, use of an elliptical trainer, or any other multijoint movement).
2. Specific warm-up for rehabilitation: The exerciser should perform range of motion movements around the injured or affected joint structure. The goal is to specifically and carefully move the joint structure and surrounding tissues through a dynamic range of motion. This dynamic warm-up will prepare the connecting joint tissues for the challenge that will come from the appropriate eccentric loading of the area.

For the purpose of rehabilitation, we suggest using a combination of the concentric–eccentric, supramaximal eccentric, eccentric emphasis, and two-up/one-down methods. However, when rehabilitating an injury it is always best for the personal trainer to consult with the client's physical therapist or medical professional for guidance in devising the most appropriate method of treatment. The intensity level should progress from mild to moderate to (eventually) high, based on the client's comfort level and recovery from injury. The rehabilitation process may cause the client to experience mild discomfort. Pain, however, is a warning signal to stop.

The rehabilitation should consist of two or three sets of 10 to 15 repetitions. Rehabilitation training is often performed daily, and for some rehabilitation program goals the exercises are completed two more times during a day.

Application Tools for Exercises

Here are some directions for optimal resistance training.

- Concentric-eccentric (CON–ECC): one- to two-second concentric with a one- to two-second eccentric
- Eccentric emphasis (EE): movement ratio of one second (concentric) to three or four seconds (eccentric)
- Supramaximal (SUP): 105% to 125% of repetition maximum (from 1RM to 10RM)
- Two-up/one-down (2UP/1DN): 40% to 50% of repetition maximum (from 1RM to 10RM), incorporating the alternating-sides or same-side method at the discretion of the personal trainer

Trainers are encouraged to modify training methods based on each client's needs and goals. With this aim in mind, change-out exercises are presented to give trainers a variety of options and exercise variations. The exercises presented a bit later in this chapter include five for the upper body and five for the lower body, each of which is shown in its starting and ending positions.

Summary Thoughts

The studies reviewed here show that gradual progression in eccentric training provides multiple benefits, including decreased pain, improved function, and overall satisfaction with outcomes (LaStayo et al., 2014). Although this chapter focuses on the benefits of eccentric training, the literature suggests that a comprehensive rehabilitation approach includes both eccentric and concentric–eccentric training. The challenge in any rehabilitation program lies in managing the resistance training intervention to provide a safe yet progressive stimulus for eventual return to physical activity and exercise.

The rest of this chapter provides you with descriptions of exercises for rehabilitation, sample workout routines, and change-out exercise options.

Training for Rehabilitation

Eccentric training offers promise as an effective means to manage a host of common musculoskeletal conditions encountered in exercise. Effective rehabilitation programs require proper progression in manipulating all training variables: load, volume, intensity, and frequency. Another important focus is range of motion. Training in the optimal range of motion for a joint (or group of joints) places positive stress on the surrounding connective tissue and increases the stability of the joint.

Indeed, the word *optimal* is key in rehabilitation training. For some exercises, especially when using more load, it may not be advantageous to go through the full range of motion. Training at an optimal range of motion also increases the efficiency of movement. In addition, it provides a degree of injury prevention when loads or surfaces are uneven.

Table 10.1 presents a list of exercises to consider for a rehabilitation program using eccentric training methods. Full descriptions of the exercises appear on the following pages. Because many rehabilitation specialists design programs from a perspective of joint movement, we present the exercises by their joint motion in this section.

TABLE 10.1 Exercises for Rehabilitation

Upper body	Lower body
Side-lying external shoulder rotation	Standing plantar flexion
Shoulder flexion, elbow flexion, shoulder adduction	Nordic knee flexion
Forearm extension	Standing hip flexion and knee flexion on slant board
Shoulder extension	Seated knee flexion
One-arm shoulder flexion	Lying leg adduction against wall

10.1: Side-Lying External Shoulder Rotation

(CON–ECC, EE, or SUP)

10.1*a* Starting position for the side-lying external shoulder rotation.

Starting Position

1. While side-lying with a dumbbell in hand, begin by externally rotating the shoulder with 90 degrees of elbow flexion.
2. Your forearm should be perpendicular to the floor.

Trainer Recommendations

- Stand directly in front of the client.
- Spot by helping the client return the dumbbell to the starting position after each eccentric repetition.

10.1*b* Ending position for the side-lying external shoulder rotation.

Video 10.1

See online video 10.1 for the CON–ECC, EE, and SUP methods of the side-lying external shoulder rotation.

Exercise Motion

1. Slowly lower the hand of the involved side toward the table.
2. Lower your arm until you achieve maximal internal rotation.
3. For a spotting technique, use your opposite hand to help return your exercising hand to the starting position.

Performance Improvement Tips

- Focus on the eccentric phase.
- Maintain a stable body position while performing this exercise.

10.2: Shoulder Flexion, Elbow Flexion, Shoulder Adduction

(CON–ECC or EE)

10.2*a* Starting position for the shoulder flexion, elbow flexion, and shoulder adduction.

10.2*b* Second position for the shoulder flexion, elbow flexion, and shoulder adduction.

10.2*c* Third position for the shoulder flexion, elbow flexion, and shoulder adduction.

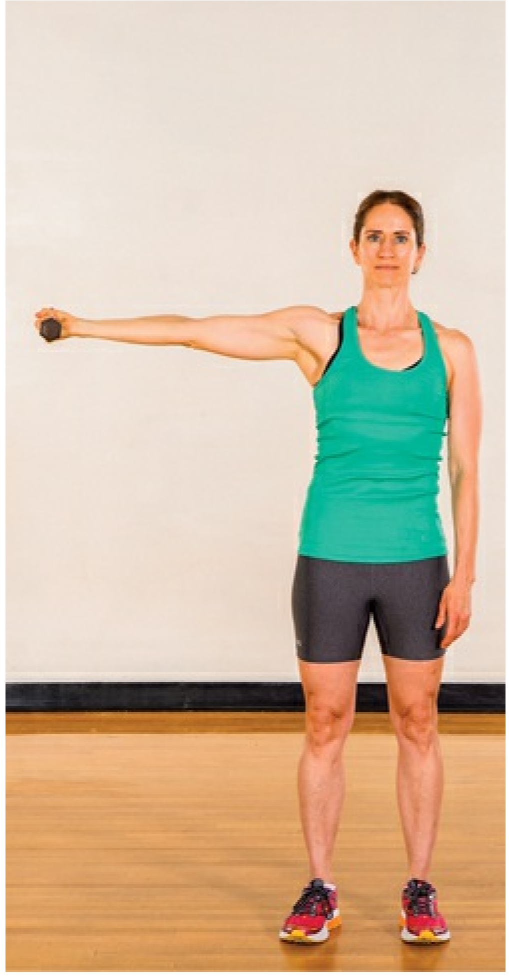
Starting Position

1. Begin by holding a dumbbell in one hand and assisting with the opposite hand to bring it to an overhead extended position.
2. Keep feet shoulder-width apart and core engaged for body balance and spine stability.

Trainer Recommendations

- Standing directly in front of the client, help guide the arm down as the movement progresses.
- Once at the bottom of the movement, help the client return the weight to the starting position.

10.2*d* Fourth position for the shoulder flexion, elbow flexion, and shoulder adduction.



10.2*e* Ending position for the shoulder flexion, elbow flexion, and shoulder adduction.

Video 10.2

See online video 10.2 for the CON–ECC and EE methods of the shoulder flexion, elbow flexion, and shoulder adduction.

Exercise Motion

1. Lower the arm to a 90-degree angle at the side and with the elbow bent to 90 degrees.
2. Extend your arm at the elbow until you reach full extension to the side.
3. Slowly lower arm to the side.
4. Using the opposite hand, return the arm back to the starting position to repeat exercise.

Performance Improvement Tips

- Start with a light weight.
- Focus on a slow, controlled lowering motion.

10.3: Forearm Extension

(CON–ECC, EE, or SUP)

10.3*a* Starting position for the forearm extension.

Starting Position

1. Place one arm on a workout bench or therapy table with your wrist off the bench. Hold a light dumbbell in your wrist.
2. Make sure your wrist can move freely without contacting the table. Start in full extension by bringing your knuckles upward toward the ceiling.

Trainer Recommendations

- Help the client return the weight to the starting position after the eccentric loading phase.
- The forearm extensor muscles may weaken toward then end of a set. Make sure the client does not start twisting the wrist to compensate for the fatiguing muscles. Aid client with spot if needed.

10.3*b* Ending position for the forearm extension.

Exercise Motion

1. Slowly lower the weight toward the ground.
2. Lower the weight until you achieve optimal range of motion.
3. Using your opposite hand to help if needed, return the weight to the starting position.

Performance Improvement Tips

- Start light.
- Gradually increase the weight as the exercise becomes less difficult.

10.4: Shoulder Extension

(CON–ECC, EE, or SUP)

10.4*a* Starting position for the shoulder extension.

Starting Position

1. Lie on a padded bench, making sure your entire back is supported. Brace the core muscles to keep the spine stable. When doing this exercise for rehabilitation of an acute or chronic shoulder impingement (or related shoulder complications), it is safer to initially grasp the dumbbell from your personal trainer. As your shoulder rehabilitation therapy improves your strength and flexibility, you can place the weight in position by yourself.
2. Place both your hands on the plate section of the dumbbell. Balance the dumbbell over your torso. Bend at your elbows slightly and always avoid locking the elbow joint during the movement, as this will transmit undesirable pressure on the shoulder.

Trainer Recommendations

- Shoulder impingement syndrome is a common cause of shoulder pain. Overhead activity of the shoulder may induce discomfort as a client strives to regain previous range of motion. Regularly communicate with the client to ensure the exercise is helping and not harming.
- Stand behind the client and actually guide the movement on the first few repetitions. Lift the weight on the return phase of the movement, as you want the client to focus her or his effort on the eccentric phase of the motion.

10.4*b* Ending position for the shoulder extension.

Exercise Motion

1. Try to attain your optimal stretch in the shoulder that has the least amount of joint discomfort. Slowly lower the dumbbell beyond your head to your end point of motion. Your eventual goal is for the shoulder range of motion to improve to the point where your arms are in line with your torso.
2. Slowly bring the arms back to the starting point and make sure you brace your abdominals to keep from arching your back.

Performance Improvement Tips

- With shoulder impingement and related issues (i.e., frozen shoulder), a chief goal is a gradual increase in range of motion without pain and an increase in shoulder joint stability.
- During the initial rehabilitation phase, it may be smarter to do fewer repetitions and focus more on a slow, lowering eccentric phase of the movement. This will be the better stimulus from this exercise for the restoration of muscular strength and range of motion.

10.5: One-Arm Shoulder Flexion

(CON–ECC, EE, or SUP)

10.5*a* Starting position for the one-arm shoulder flexion.

Starting Position

1. Select a band with appropriate tension for performing the movement with full range of motion.
2. Stand with an elastic band secured under your foot on the same side as the shoulder that will be exercised.

Trainer Recommendations

- As the client fatigues, you may need to help him or her perform the concentric portion of the movement.
- For variety, this exercise may be performed with a dumbbell or with two hands on a barbell.

10.5*b* Ending position for the one-arm shoulder flexion.

Exercise Motion

1. Clasping the band in one hand, raise your arm in front of your body to shoulder height.
2. Slowly lower back to the starting position.
3. Once done with the repetitions on the first side, perform with the other arm.

Performance Improvement Tips

- Keep your arm fully extended throughout the range of motion.
- Keep your core tight.
- Start with a light-tension band and progress as the tension becomes too light.

10.6: Standing Plantar Flexion

(CON–ECC, EE, or SUP)

10.6*a* Starting position for the standing plantar flexion.

Starting Position

1. Adjust the padded lever of the calf-raise machine to fit your height.
2. Place your shoulders under the pads provided and position your toes facing forward. The balls of your feet should rest on top of the foot platform with your heels extending over the edge.

Trainer Recommendations

- Because this exercise involves a slight risk to the lower back, monitor closely to ensure that the client maintains a straight torso, bent knees, and an engaged core throughout the entire movement.
- If a client has lower-back problems, a better option may be the seated calf raise or the seated calf extension.
- Be sure that the client performs an optimal range of motion. Often, if the weight is too heavy, the movement becomes shortened, which provides less benefit.
- For initial rehabilitation needs, this movement may be done without added resistance by simply using a step or block.

10.6*b* Ending position for the standing plantar flexion.

Video 10.6

See online video 10.6 for the SUP method of the standing plantar flexion.

Exercise Motion

1. With your shoulders pressing against the pads, rise onto your toes by contracting your calf muscles. Keep your knees slightly bent—not locked out.
2. As you rise, extend your ankles as much as possible. Keep your torso and knees stationary at all times. All movement should take place at your ankle joints.
3. Slowly lower back to the starting position. Achieve a full stretch of the calves at the bottom of the movement.
4. This is an excellent exercise for the 2UP/1DN method. As more challenge is desired, more weight can be added to the exercise device.

Performance Improvement Tips

- Avoid rounding your back and locking out your knees during this movement. To help avoid these pitfalls, select an appropriate weight.
- Achieve a full contraction on each repetition.
- Try different foot positions to target different calf regions.

10.7: Nordic Knee Flexion

(EE or SUP)

10.7*a* Starting position for the Nordic knee flexion.

Starting Position

1. Begin in an upright position on your knees.
2. Your ankles should be fixed to the floor, most often with the aid of a partner or personal trainer.

Trainer Recommendations

- Apply firm pressure to the lower legs in order to keep the client planted on the ground.
- For a greater challenge, have the client do a longer (2 to 3 seconds longer) eccentric lowering phase of the exercise, because that is an optimal way to add progressive overload.

10.7*b* Ending position for the Nordic knee flexion.

Video 10.7

See online video 10.7 for the EE method of the Nordic knee flexion.

Exercise Motion

1. Once in the starting position, lower your upper body steadily to the floor. To control the motion, contract your hamstrings and gluteals—the slower, the better.
2. Your torso should remain upright throughout the movement.
3. Once at the bottom of the movement, catch yourself with your hands, then press yourself back up to the starting position.
4. This movement is totally focused on the eccentric lowering phase; the concentric portion is self-assisted and thus just a preparatory part of the movement to return to the starting position.

Performance Improvement Tips

- Stay focused throughout each repetition. This move is challenging!
- Bend your elbows as you catch your torso moving into the mat. Do not lock elbows as you make contact with the mat.

10.8: Standing Hip Flexion and Knee Flexion on Slant Board

(CON–ECC or EE)

10.8*a* Starting position for the standing hip flexion and knee flexion on slant board.

Starting Position

1. While standing, place your feet on a 25-degree slant board.
2. Bend forward at the hips and allow the buttocks to go backward for balance.
3. The slant board presents a particularly unique balance challenge. The use of a 3- to 4-foot wood dowel or PVC pipe provides a stability aid when doing this exercise.

Trainer Recommendations

- Monitor the client's technique during this exercise. Have the client focus on doing the exercise with control and keeping the lower back from arching too much. Make sure the client doesn't feel any discomfort in the knees with this exercise; it is often used to strengthen the musculature surrounding knees that have weakened from too much repetition in jumping activities (i.e., jumper's knee observed in volleyball players).
- Encourage the client to focus on the eccentric lowering. Add an isometric hold at the end point of the movement in the squat position for extra muscular challenge.

10.8*b* Ending position for the standing hip flexion and knee flexion on slant board.

Video 10.8

See online video 10.8 for the CON–ECC and EE methods of the standing hip flexion and knee flexion on slant board.

Exercise Motion

1. Bend your knees into 90-degree flexion with a three-second eccentric lowering movement when completing the exercise with the EE method.
2. Extend your knees back to a standing position in a one-second upward movement.

Performance Improvement Tips

- Start with body weight only and focus on the eccentric lowering phase of the movement.
- As the movement becomes easier and less painful, you may wear a backpack and progressively increase the load of the pack.

10.9: Seated Knee Flexion

(2UP/1DN, CON–ECC, EE, or SUP)

10.9*a* Starting position for the seated knee flexion.

Starting Position

1. Adjust the back pad of the machine to provide the greatest comfort and range of motion. The proper setting depends on the extensibility of your legs.
2. Once seated, press your lower back and shoulders firmly against the back pad while allowing a neutral spine. Your neck should remain relaxed and in its normal neutral curvature.
3. Put the backs of your ankles on the pads directly in front of you.

Trainer Recommendations

- Check the client's body alignment during the movement.
- Help the client select an appropriate weight, which for rehabilitation is attaining momentary muscular fatigue in 10 to 15 repetitions with each leg.
- As the client begins to fatigue during the set, you may need to assist him or her with the lowering of the weight.
- This movement is quite an effective challenge using the 2UP/1DN eccentric method. Developing muscular balance in the legs is an excellent approach in the rehabilitation of a hamstring injury.

10.9*b* Ending position for seated knee flexion.

Exercise Motion

1. Once in position with an appropriate weight selected, curl the weight back with both feet, fully contracting your hamstrings.
2. Slowly return the weight to the starting position.

Performance Improvement Tips

- Keep your head and neck in a neutral position.
- Keep your shoulders and lower back pressed against the back pad at all times. Maintain a neutral lower back. Avoid locking out the knees when returning to the starting position.
- Focus on controlling the eccentric movement as you return to the starting position.
- As with any resistance exercise, progressively add resistance when the load appears to be too easy.

10.10: Lying Leg Adduction Against Wall

(CON–ECC or EE)

10.10*a* Starting position for the lying leg adduction against wall.

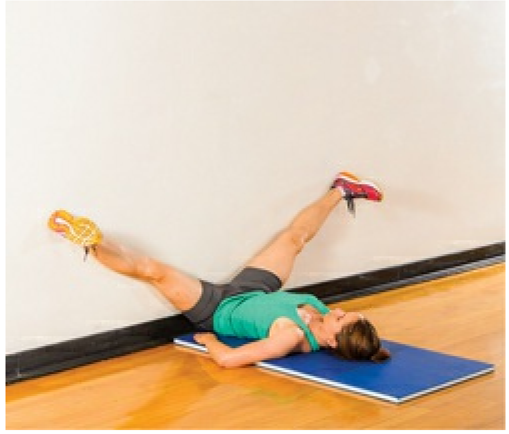
Starting Position

1. Lie on your back on the floor.
2. Position your legs against a wall with your hamstrings, glutei maximi, and ankles touching the wall. Your legs should be straight.

Trainer Recommendations

- Monitor the client from the side to make sure that his or her legs remain in contact with the wall.
- As the concentric phase becomes difficult, encourage the client to assist that portion of the movement with her or his hands.

10.10*b* Ending position for the lying leg adduction against wall.



Video 10.10

See online video 10.10 for the CON–ECC and EE methods of the lying leg adduction against wall.

Exercise Motion

1. Lower your legs slowly into a wide straddle position.
2. Bring your legs back up to the starting position.

Performance Improvement Tips

- Start with body weight only.
- As the movement becomes challenging, you may use your hands to assist with the concentric portion.
- As the movement becomes too easy, you may add ankle weights to increase the load during the eccentric phase.

Upper- and Lower-Body Workout Routines for Rehabilitation

Injuries to muscles, joints, tendons, and ligaments are often rehabilitated with resistance training. This is particularly true when the injury has immobilized normal joint and tissue range of motion and muscular function. The primary goal is to start with a light load and progressively add more weight as the muscles and joint structures involved in the injury become stronger. At the start of rehabilitation, exercises may involve only body weight and range of motion. Note that rehabilitation populations present special considerations for personal trainers. Many frail and exercise-limited people often have chronic conditions such as type 2 diabetes, chronic obstructive pulmonary disease, cardiovascular disease, and neurologic disorders. These clients may be incapable of producing adequate force to maintain their muscle mass or lack energy to complete some training sessions. Therefore, to safely introduce eccentric training with these clients, a gradual increase during the eccentric loading phases will help in avoiding adverse responses, muscle damage, or undesirable pain.

Case Study: Client Profile and Goals

Rosemary is a 58-year-old accountant for a local business. She is 5 feet 2 inches tall (157.4 cm) and weighs 149 pounds (67.6 kg). Her body fat has been estimated to be 35%. She lives a sedentary lifestyle and has recently been diagnosed with type 2 diabetes. Her physician wants her to become much more active and is concerned that if she doesn't change her lifestyle she will experience muscle wasting, which could result in a life-threatening fall. She has joined a community association and has been walking regularly for the past 2 months. She uses a pedometer on her smartphone as an incentive and is currently walking about 4,500 steps per day. Her goal is to reach 8,000 steps in 3 months and achieve general strength and muscular endurance. Rosemary does not have any major musculoskeletal injuries; however, since adding walking to her routine, she has started to have mild plantar fasciitis and a mild strain to her left hamstring. Note: For consistency with the case studies in chapters 5 to 9, which are presented as examples for personal trainers, in chapter 10 we are presenting the actual exercise selected for this client's training program.

Three-Week Mesocycle of Rehabilitation Program With Eccentric Training Emphasis

Day	Exercise	Sets	Reps	Technique
Monday	Machine chest press	1-2	10-15	EE
	Wide-grip latissimus dorsi pull-down	1-2	10-15	EE
	Seated machine shoulder press	1-2	10-15	EE
	Alternating dumbbell curl	1-2	10-15	EE
	Triceps cable press-down	1-2	10-15	EE
Tuesday	Leg press	1-2	10-15	EE
	Seated unilateral hamstring curl	1-2	10-15	2UP/1DN
	Leg extension	1-2	8-12	2UP/1DN
	Standing heel raise	1-2	8-12	2UP/1DN
	Plank	1-2	30-60 sec	
Wednesday	Off			
Thursday	Dumbbell chest fly	1-2	10-15	EE
	Seated shoulder press	1-2	10-15	2UP/1DN
	Seated cable row	1-2	10-15	2UP/1DN
	Barbell curl	1-2	10-15	EE
	Machine triceps extension	1-2	10-15	EE
Friday	Smith machine squat	1-2	10-15	EE
	Lying hamstring curl	1-2	10-15	CON–ECC
	Walking lunge	1-2	10-15	EE
	Standing calf raise	1-2	10-15	2UP/1DN
	Leg raise	1-2	10-15	EE
Saturday	Cardio (15-25 minutes light intensity) Full-body stretching			
Sunday	Off			

Before we turn to the main workout routines, here is a list of change-out exercises that you can use to add variety to your clients' workouts. It is important for personal trainers to realize that rehabilitation interventions targeting eccentric muscle contractions can also benefit older clients with a goal of improving mobility and avoiding falls. LaStayo and colleagues (2014) state that even for those not at a high risk of falls, the increased reserve of muscle mass, strength, and power resulting from eccentric muscle training will provide a physical-functioning safety factor for the activities they perform. Programs incorporating eccentric training in the rehabilitation process typically have favorable levels of participant adherence and exercise compliance.

Exercise	Change-out exercise options
Upper-body rehabilitation exercises	
Side-lying external shoulder rotation	Elastic band instead of dumbbell
Shoulder flexion, elbow flexion, shoulder adduction	Kettlebell instead of dumbbell
Forearm extension	Kettlebell instead of dumbbell
Shoulder extension	Weight plate instead of dumbbell
One-arm shoulder flexion	Dumbbell or kettlebell instead of elastic band; two-arm raise with barbell
Lower-body rehabilitation exercises	
Standing plantar flexion	Standing plantar flexion with 2UP/1DN same-side method (explained in chapter 2)
Nordic knee flexion	Reverse machine hamstring-gluteal raise
Standing hip flexion and knee flexion on slant board	Complete exercise wearing weighted vest or backpack
Seated knee flexion	Seated knee flexion with 2UP/1DN with alternating-sides and same-side methods (explained in chapter 2)
Lying leg adduction against wall	Add ankle weights

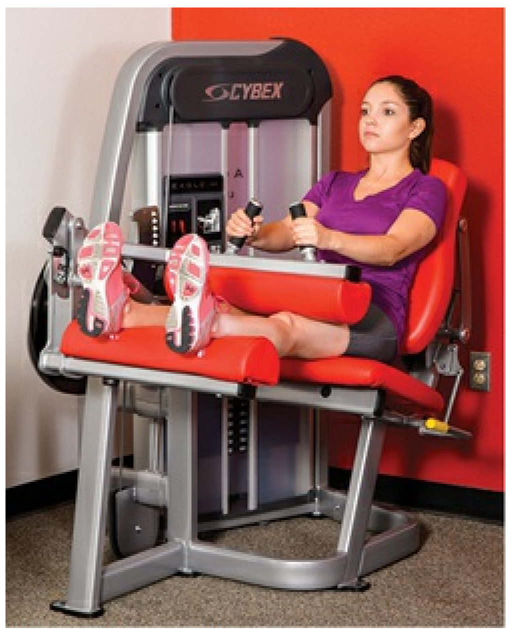
Full-Body Rehabilitation

Routine A

1: Standing hip flexion and knee flexion on slant board

2: One-arm shoulder flexion

3: Seated knee flexion



4: Shoulder flexion, elbow flexion, shoulder adduction

5: Standing plantar flexion

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Full-Body Rehabilitation

Routine B

1: Side-lying external shoulder rotation

2: Shoulder flexion, elbow flexion, shoulder adduction

3: Standing plantar flexion

4: Standing hip flexion and knee flexion on slant board

5: Nordic knee flexion

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

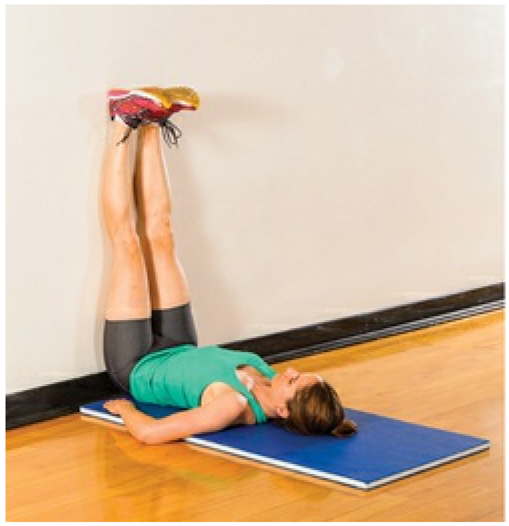
Full-Body Rehabilitation

Routine C

1: Forearm extension

2: Side-lying external shoulder rotation

3: Lying leg adduction against wall



4: Standing hip flexion and knee flexion on slant board

5: Seated knee flexion

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Full-Body Rehabilitation

Routine D

1: Nordic knee flexion

2: Lying leg adduction against wall

3: Shoulder extension

4: One-arm shoulder flexion

5: Side-lying external shoulder rotation

From L. Kravitz and A. Bubbico, 2015, *Essentials of Eccentric Training* (Champaign, IL: Human Kinetics).

Appendix A

Eight-Week Hypertrophy Phase

This sample shows you how to integrate eccentric training into the hypertrophy phase of a resistance training program.

Weeks 1 and 2: Intro Phase

Sunday: Off

Monday: Pull Day (Back and Biceps)

- Wide-grip latissimus dorsi pull-down (3 sets at 12–15RM)
- Standard deadlift (3 sets at 12–15RM)
- Dumbbell one-arm row (3 sets at 12–15RM)
- Barbell curl (3 sets at 12–15RM)
- Dumbbell standing biceps curl (3 sets at 12–15RM)

Tuesday: Push Day (Chest, Shoulders, and Triceps)

- Dumbbell chest press (3 sets at 12–15RM)
- Dumbbell chest fly (3 sets at 12–15RM)
- Dumbbell shoulder press (3 sets at 12–15RM)
- Dumbbell side lateral raise (3 sets at 12–15RM)
- Triceps cable press-down (3 sets at 12–15RM)

Wednesday: Leg and Abdominal Day (Quadriceps, Hamstrings, Calves)

- Barbell back squat (3 sets at 12–15RM)
- Lying hamstring curl (3 sets at 12–15RM)
- Leg extension (3 sets at 12–15RM)
- Standing calf raise (3 sets at 12–15RM)
- Weighted crunch (3 sets at 12–15RM): complete on physioball; hold a 6- to 10-pound (~3-5 kg) medicine ball on chest for extra load; use EE method

Thursday: Off

Friday: Full Upper Body

- Dumbbell bench press (3 sets at 12–15RM)
- Wide-grip latissimus dorsi pull-down (3 sets at 12–15RM)
- Dumbbell chest fly (3 sets at 12–15RM)
- Seated machine row (3 sets at 12–15RM)
- Dumbbell shoulder press (3 sets at 12–15RM)
- Reverse dumbbell fly (3 sets at 12–15RM)
- Bent-over triceps kickback (3 sets at 12–15RM)
- Alternating dumbbell curl (3 sets at 12–15RM)

Saturday: Full Lower Body

- Leg press (3 sets at 12–15RM)
- Walking lunge (3 sets at 12–15RM)
- Stiff-leg deadlift (3 sets at 12–15RM)
- Seated calf raise (3 sets at 12–15RM)
- Leg raise on Roman chair (3 sets at 12–15RM)

Weeks 3 and 4: General Hypertrophy

Sunday: Off

Monday: Pull (Back and Biceps)

Pull-up (with assist machine if needed) (4 sets at 8–12RM zone; client will fatigue with exercise in this 8- to 12-repetition range)
Standard deadlift (4 sets at 8–12RM)
Bent-over barbell row (4 sets at 8–12RM)
Straight-bar curl (4 sets at 8–12RM)
Machine preacher curl (4 sets at 8–12RM)

Tuesday: Push (Chest, Shoulders, and Triceps)

Bench press (4 sets at 8–12RM)
Incline dumbbell press (4 sets at 8–12RM)
Dumbbell chest fly (4 sets at 8–12RM)
Skull crusher with EZ curl barbell (4 sets at 8–12RM)
Triceps rope press-down (4 sets at 8–12RM)

Wednesday: Legs

Barbell back squat (4 sets at 8–12RM)
Leg extension (4 sets at 8–12RM)
Lying leg curl (4 sets at 8–12RM)
Standing calf raise (4 sets at 8–12RM)
Weighted crunch (3 sets at 8–12RM): complete on physioball; hold a 4- to 10-pound (~2-5 kg) medicine ball over head with extended arms for extra load; use EE method

Thursday: Off

Friday: Full Upper Body

Cable crossover fly(4 sets at 8–12RM)
Wide-grip latissimus dorsi pull-down (4 sets at 8–12RM)
Dumbbell flat chest press (4 sets at 8–12RM)
One-arm dumbbell row (4 sets at 8–12RM)
Side lateral raise (4 sets at 8–12RM)
Seated dumbbell alternating-shoulder press (4 sets at 8–12RM)
Dumbbell overhead triceps extension (4 sets at 8–12RM)
Dumbbell hammer curl (4 sets at 8–12RM)
Plank (3 sets at max effort)

Saturday: Full Lower Body

Barbell front squat (4 sets at 8–12RM)
Walking lunge (4 sets at 8–12RM)
Stiff-leg deadlift (4 sets at 8–12RM)
Seated calf raise (4 sets at 8–12RM)
Hanging leg raise (4 sets at 8–12RM)

Week 5: Eccentric Emphasis

Focus on making movement slow in the eccentric phase and fast in the concentric phase.

Sunday: Off

Monday: Push and Pull (Chest and Back)

Bench press (4 sets at 8–12RM)
Incline barbell press (4 sets at 8–12RM)
Dumbbell pull-over (4 sets at 8–12RM)
Wide-grip latissimus dorsi pull-down (4 sets at 8–12RM)

Seated cable row (4 sets at 8–12RM)

Tuesday: Accessory (Shoulders, Biceps, and Triceps)

Side lateral raise (4 sets at 8–12RM)
Reverse dumbbell fly (4 sets at 8–12RM)
Smith machine military press (4 sets at 8–12RM)
Standing dumbbell curl (4 sets at 8–12RM)
Bent-over triceps kickback (4 sets at 8–12RM)
EZ bar curl (4 sets at 8–12RM)
Triceps cable press-down (4 sets at 8–12RM)

Wednesday: Legs

Barbell back squat (4 sets at 8–12RM)
Standard deadlift (4 sets at 8–12RM)
Seated hamstring curl (4 sets at 8–12RM)
Leg extension (4 sets at 8–12RM)
Standing calf raise (4 sets at 8–12RM)
Weighted crunch (4 sets at 8–12RM): complete on physioball; hold a 6- to 10-pound (~3-5 kg) medicine ball on chest for extra load; use EE training method

Thursday: Off

Friday: Upper Body (Push, Pull)

Dumbbell chest fly on flat bench (4 sets at 8–12RM)
Dumbbell chest press on flat bench (4 sets at 8–12RM)
Close-grip latissimus dorsi pull-down (4 sets at 8–12RM)
Reverse-grip bent-over row (4 sets at 8–12RM)
Close-grip bench press (4 sets at 8–12RM)
Triceps rope press-down (4 sets at 8–12RM)
Straight-bar curl (4 sets at 8–12RM)
Dumbbell hammer curl (4 sets at 8–12RM)

Saturday: Full Lower Body

Walking lunge (4 sets at 8–12RM)
Stiff-leg deadlift (4 sets at 8–12RM)
Leg press (4 sets at 8–12RM)
Seated calf raise (4 sets at 8–12RM)
Hanging leg raise (4 sets at 8–12RM)

Week 6: General Hypertrophy

Sunday: Off

Monday: Pull (Back and Biceps)

Pull-up (with assist machine if needed) (4 sets at 8–12RM zone; client will fatigue with exercise in this 8- to 12-repetition range)
Bent-over barbell row (4 sets at 8–12RM)
EZ bar curl (4 sets at 8–12RM)
Machine preacher curl (4 sets at 8–12RM)

Tuesday: Push (Chest and Triceps)

Flat dumbbell press (4 sets at 8–12RM)
Incline dumbbell press (4 sets at 8–12RM)
Dumbbell chest fly (4 sets at 8–12RM)

Skull crusher with EZ curl barbell (4 sets at 8–12RM)
Triceps cable press-down (4 sets at 8–12RM)

Wednesday: Legs

Barbell back squat (4 sets at 8–12RM)
Stiff-leg deadlift (4 sets at 8–12RM)
Lying leg curl (4 sets at 8–12RM)
Seated calf raise (4 sets at 8–12RM)
Standing calf raise (3 sets at 8–12RM)

Thursday: Shoulders

One-arm leaning side lateral raise (4 sets at 8–12RM)
Dumbbell front raise (4 sets at 8–12RM)
Reverse dumbbell fly (4 sets at 8–12RM)
Barbell shrug (4 sets at 8–12RM)
Seated machine shoulder press (3 sets at 8–12RM)

Friday: Off

Saturday: Full Body

Barbell front squat (4 sets at 8–12RM)
Leg press (4 sets at 8–12RM)
Lying hamstring curl (4 sets at 8–12RM)
Incline barbell press (4 sets at 8–12RM)
Machine row (4 sets at 8–12RM)
Zottman curl (4 sets at 8–12RM)
Reverse-grip triceps cable press-down (4 sets at 8–12RM)
Plank (3 sets at max effort)
Weighted crunch on mat (3 sets at 8–12RM): complete on physioball; hold a 4- to 10-pound (~2-5 kg) medicine ball overhead with extended arms for extra load; use EE method

Week 7: Eccentric Emphasis With Supramaximal and Two-Up/One-Down Techniques

Sunday: Off

Monday: Push and Pull (Chest and Back)

Bench press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Incline dumbbell press (4 sets at 8–12RM)—2UP/1DN
Dumbbell pull-over (4 sets at 8–12RM)—EE
Wide-grip latissimus dorsi pull-down (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Two-arm bent-over dumbbell row (4 sets at 8–12RM)—2UP/1DN

Tuesday: Accessory (Shoulders, Biceps, and Triceps)

Side lateral raise (3 sets at 8–12RM)—2UP/1DN
Reverse dumbbell fly (3 sets at 8–12RM)—EE
Smith machine military press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric)
Standing dumbbell curl (3 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric)
Bent-over triceps kickback (3 sets at 8–12RM)—2UP/1DN

Wednesday: Legs

Barbell back squat (4 sets of 1 at 110%–130% of RM)—negative only (spotter helps with concentric phase; power rack used for safety)
Standard deadlift (4 sets at 8–12RM)—EE
Seated hamstring curl (4 sets at 8–12RM)—2UP/1DN
Leg extension (4 sets at 8–12RM) —2UP/1DN
Standing calf raise (4 sets at 8–12RM)—2UP/1DN
Hanging leg raise (4 sets at 8–12RM)—EE

Thursday: Off

Friday: Full Upper Body

Dumbbell chest fly on flat bench (4 sets at 8–12RM)—EE
Dumbbell chest press on flat bench (4 sets at 8–12RM) —2UP/1DN
Close-grip latissimus dorsi pull-down (4 sets of 1 or 2 reps at 100%–130% of RM)—SUP (spotter helps with concentric phase)
Reverse-grip bent-over row (4 sets at 8–12RM)—EE
Military press (4 sets at 8–12RM)—EE
Close-grip bench press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Triceps cable press-down (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Dumbbell hammer curl (4 sets at 8–12RM)—2UP/1DN

Saturday: Full Lower Body

Walking lunge (4 sets at 8–12RM)—EE
Stiff-leg deadlift (4 sets at 8–12RM)—EE
Leg press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Seated calf raise (4 sets at 8–12RM)—2UP/1DN
Weighted crunch (4 sets at 8–12RM): complete on physioball; hold a 6- to 10-pound (~3-5 kg) medicine ball on chest for extra load; use EE method

Week 8: General Hypertrophy

Sunday: Off

Monday: Pull (Back and Biceps)

Cable crossover fly (3 sets at 8–12RM)
Wide-grip latissimus dorsi pull-down (3 sets at 8–12RM)
Dumbbell flat chest press (3 sets at 8–12RM)
One-arm dumbbell row (3 sets at 8–12RM)
Side lateral raise (4 sets at 8–12RM)
Triceps cable press-down (4 sets at 8–12RM)
Dumbbell hammer curl (4 sets at 8–12RM)
Plank (3 sets at max effort)

Tuesday: Full Lower Body

Barbell back squat (3 sets at 8–12RM)
Walking lunge (3 sets at 8–12RM)
Stiff-leg deadlift (3 sets at 8–12RM)
Seated calf raise (3 sets at 8–12RM)
Hanging leg raise (3 sets at 8–12RM)

Wednesday: Off

Thursday: Full Upper Body

Dumbbell chest fly (3 sets at 8–12RM)
Incline dumbbell press (3 sets at 8–12RM)
Bent-over barbell row (3 sets at 8–12RM)
Dumbbell shoulder press (3 sets at 8–12RM)
Rope press-down (3 sets at 8–12RM)
Machine preacher curl (3 sets at 8–12RM)
Weighted crunch (3 sets at 8–12RM): complete on physioball; hold a 4- to 10-pound medicine ball overhead with extended arms for extra load; use EE method

Friday: Full Lower Body

Barbell front squat (3 sets at 8–12RM)
Leg press (3 sets at 8–12RM)
Hamstring curl (3 sets at 8–12RM)
Standing calf raise (3 sets at 8–12RM)
Plank (3 sets at max effort)

Saturday: Off

Appendix B

Eight-Week Ultimate Conditioning Phase for Endurance and Body Composition Change

This sample shows you how to integrate eccentric training into an ultimate conditioning phase for endurance and body composition change in a resistance training program.

Weeks 1 and 2: Intro Phase

Sunday: Off

Monday: Pull Day (Back and Biceps)

Wide-grip latissimus dorsi pull-down (3 sets at 12–15RM)
Standard deadlift (3 sets at 12–15RM)
One-arm dumbbell row (3 sets at 12–15RM)
Barbell curl (3 sets at 12–15RM)
Dumbbell standing biceps curl (3 sets at 12–15RM)

Tuesday: Push Day (Chest, Shoulders, and Triceps)

Dumbbell chest press (3 sets at 12–15RM)
Dumbbell chest fly (3 sets at 12–15RM)
Dumbbell shoulder press (3 sets at 12–15RM)
Dumbbell side lateral raise (3 sets at 12–15RM)
Triceps cable press-down (3 sets at 12–15RM)

Wednesday: Leg and Abdominals Day (Quads, Hamstrings, Calves)

Barbell back squat (3 sets at 12–15RM)
Lying hamstring curl (3 sets at 12–15RM)
Leg extension (3 sets at 12–15RM)
Standing calf raise (3 sets at 12–15RM)
Weighted crunch (3 sets at 12–15RM): complete on physioball; hold a 6- to 10-pound (~3-5 kg) medicine ball on chest for extra load; use EE method

Thursday: Off

Friday: Full Upper Body

Dumbbell bench press (3 sets at 12–15RM)
Wide-grip latissimus dorsi pull-down (3 sets at 12–15RM)
Dumbbell chest fly (3 sets at 12–15RM)
Seated machine row (3 sets at 12–15RM)
Dumbbell shoulder press (3 sets at 12–15RM)
Reverse dumbbell fly (3 sets at 12–15RM)
Bent-over triceps kickback (3 sets at 12–15RM)
Alternating dumbbell curl (3 sets at 12–15RM)

Saturday: Full Lower Body

Leg press (3 sets at 12–15RM)
Walking lunge (3 sets at 12–15RM)
Stiff-leg deadlift (3 sets at 12–15RM)
Seated calf raise (3 sets at 12–15RM)
Leg raise on Roman chair (3 sets at 12–15RM)

Weeks 3 and 4: Strength Phase

Sunday: Off

Monday: Legs and Shoulders

Barbell back squat (5 sets at 3–5RM)
Leg press (3 sets at 6–10RM)
Overhead press (5 sets at 3–5RM)
Dumbbell side lateral raise (3 sets at 6–10RM)

Tuesday: Chest and Back

Bench press (5 sets at 3–5RM)
Dumbbell chest fly (3 sets at 6–10RM)
Wide-grip latissimus dorsi pull-down (5 sets at 6–10RM)—EE
Bent-over row (3 sets at 6–10RM)

Wednesday: Rest Day

Thursday: Legs, Shoulders, and Trapezius

Overhead squat (5 sets at 3–5RM)
Barbell front squat (3 sets at 3–5RM)
Barbell shrug (5 sets at 3–5RM)
Barbell upright row (3 sets at 6–10RM)

Friday: Assistance Work

Wide-grip latissimus dorsi pull-down (5 sets at 3–5RM)—EE
Close-grip bench press (5 sets at 3–5RM)
Barbell curl (5 sets at 3–5RM)
Bent-over triceps kickback (3 sets at 6–10RM)
Dumbbell hammer curl (3 sets of 6–10RM)
Hanging leg raise (3 sets at 6–10RM)
Plank (3 sets at 30 seconds)

Saturday: Recovery

Easy to moderate cardio and full-body stretch (20–30 minutes cardiorespiratory exercise on any mode (e.g., treadmill, cycle, elliptical)

Weeks 5 and 6: Eccentric Emphasis

Sunday: Off

Monday: Push and Pull (Chest and Back)

Bench press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Incline dumbbell press (4 sets at 8–12RM)—2UP/1DN
Dumbbell pull-over (4 sets at 8–12RM)—EE slow down, fast up
Wide-grip latissimus dorsi pull-down (4 sets of 1 or 2 reps at 100%–130% of RM)—SUP negative only (spotter helps with concentric phase)
Two-arm bent-over dumbbell row (4 sets at 8–12RM)—2UP/1DN

Tuesday: Shoulders, Biceps, and Triceps

Side lateral raise (3 sets at 8–12RM)—2UP/1DN
Reverse dumbbell fly (3 sets at 8–12RM)—EE
Smith machine military press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)
Standing dumbbell curl (3 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)

Bent-over triceps kickback (3 sets at 8–12RM)—2UP/1DN

Wednesday: Legs

Barbell back squat (4 sets of 1 at 110%–130% of RM)—negative only (spotter helps with concentric phase; power rack used for safety)

Standard deadlift (4 sets at 8–12RM)—EE

Seated hamstring curl (4 sets at 8–12RM)—2UP/1DN

Leg extension (4 sets at 8–12RM)—2UP/1DN

Standing calf raise (4 sets at 8–12RM)—2UP/1DN

Hanging leg raise (4 sets at 8–12RM)—EE

Thursday: Off

Friday: Full Upper Body

Dumbbell chest fly on flat bench (4 sets at 8–12RM)—EE

Dumbbell chest press on flat bench (4 sets at 8–12RM)—2UP/1DN

Close-grip latissimus dorsi pull-down (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)

Reverse-grip bent-over row (4 sets at 8–12RM)—EE

Military press (4 sets at 8–12RM)—EE

Close-grip bench press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)

Triceps cable press-down (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)

Dumbbell hammer curl (4 sets at 8–12RM)—2UP/1DN

Saturday: Full Lower Body

Walking lunge (4 sets at 8–12RM)—EE

Stiff-leg deadlift (4 sets at 8–12RM)—EE

Leg press (4 sets of 1 or 2 reps at 100%–130% of RM)—negative only (spotter helps with concentric phase)

Seated calf raise (4 sets at 8–12RM)—2UP/1DN

Crunch (4 sets at 8–12RM)—EE

Weeks 7 and 8: Ripped Conditioning

Sunday: Off

Monday: Full Body

Barbell front squat (4 sets at 15–20RM)

Strict barbell press (4 sets at 15–20RM)

Strict pull-up (with machine assist) (4 sets at 10–15RM)

Body-weight dip (with machine assist) (4 sets at 15–20RM)

Dumbbell walking lunge (4 sets at 20RM)

Tuesday: Intervals at Track

8 × 400-meter sprints at 80%–90% of max effort and 1:1 rest–recovery ratio (i.e., rest the same amount of time that it takes to run the 400-meter sprint)

Wednesday: Core Blaster

Standard deadlift (5 sets at 3–5RM)

Hanging leg raise or toes-to-bar (4 sets of max effort)

100 burpees (as fast as possible)

Thursday: Off

Friday: Back to Basics

Barbell back squat (4 sets at 15–20RM)
Lying hamstring curl (4 sets at 15–20RM)
Bench press (4 sets at 15–20RM)
Wide-grip latissimus dorsi pull-down (4 sets at 15–20RM)
Barbell curl (4 sets at 15–20RM)
Triceps cable press-down (4 sets at 15–20RM)
Plank (3 sets holding for up to 2 minutes each)
Crunch on mat (3 sets of 20 to 30 crunches any variation)

Saturday: Row for Your Life

5 × 500-meter sprints on the rower (max effort for each set, full recovery after each set as long as needed before doing another 500-meter sprint)

Appendix C

Exercises for Improving in Seven Popular Sports

The following lists include foundational resistance training exercises for anyone participating in the indicated sports. The exercises are *not* presented in order of importance. They should be done in various combinations on multiple days to obtain the best results!

1. Football

[7.12: Broad Jump]

[5.7: Barbell Back Squat]

[7.7: Barbell Front Squat]

5.1: Bench Press

5.3: Bent-Over Barbell Row

5.4: Wide-Grip Latissimus Dorsi Pull-Down

[7.9: Power Clean]

[6.10: Walking Lunge]

[9.9: Bulgarian Lunge]

[10.7: Nordic Knee Flexion]

2. Basketball

[7.12: Broad Jump]

[5.7: Barbell Back Squat]

5.1: Bench Press

7.4: Plyometric Push-Up

5.9: Leg Press

9.3: One-Arm Dumbbell Row

7.9: Power Clean

8.5: Zottman Curl

6.10: Walking Lunge

[9.9: Bulgarian Lunge]

[10.7: Nordic Knee Flexion]

3. Soccer

[7.12: Broad Jump]

[5.7: Barbell Back Squat]

[7.4: Plyometric Push-Up]

[8.12: Push–Pull With Partner]

[8.4: Pull-Up Assist Machine]

[7.9: Power Clean]

[6.10: Walking Lunge]

[9.9: Bulgarian Lunge]

[5.11: Lying Hamstring Curl](#) or [8.11: Seated Hamstring Curl](#)

[10.7: Nordic Knee Flexion](#)

4. Volleyball

[7.7: Barbell Front Squat](#)

5.7: Barbell Back Squat

5.1: Bench Press

5.2: Overhead Press

[9.6: Machine Triceps Extension]

[6.3: Seated Cable Row]

[7.9: Power Clean]

6.10: Walking Lunge

10.8: Standing Hip Flexion and Knee Flexion on Slant Board

5.11: Lying Hamstring Curl or 8.11: Seated Hamstring Curl

10.7: Nordic Knee Flexion

5. Golf

[8.4: Pull-Up Assist Machine]

[7.4: Plyometric Push-Up]

[5.9: Leg Press]

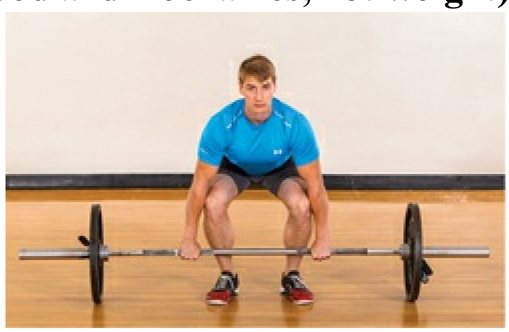
[6.10: Walking Lunge]

[6.6: Triceps Cable Press-Down]

[6.3: Seated Cable Row]

[10.1: Side-Lying External Shoulder Rotation]

[7.9: Power Clean] (focused on speed and mechanics, not weight)



[6.8: Stiff-Leg Deadlift]

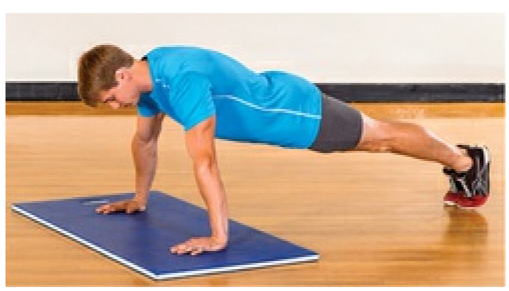
6. Baseball

[7.12: Broad Jump]

[5.7: Barbell Back Squat]

[5.1: Bench Press]

[7.4: Plyometric Push-Up]



[9.3: One-Arm Dumbbell Row]

[5.4: Wide-Grip Latissimus Dorsi Pull-Down]

[7.9: Power Clean]

[8.5: Zottman Curl]

6.10: Walking Lunge

5.12: Standing Calf Raise

10.7: Nordic Knee Flexion

7. Ice hockey

5.7: Barbell Back Squat

7.12: Broad Jump

7.7: Barbell Front Squat

5.1: Bench Press

7.4: Plyometric Push-Up

8.4: Pull-Up Assist Machine

[7.5: Muscle-Up (on bar or rings)]

[7.3: Gorilla Pull-Up]

[7.9: Power Clean]

[5.3: Bent-Over Barbell Row]

6.10: Walking Lunge

9.9: Bulgarian Lunge

10.7: Nordic Knee Flexion

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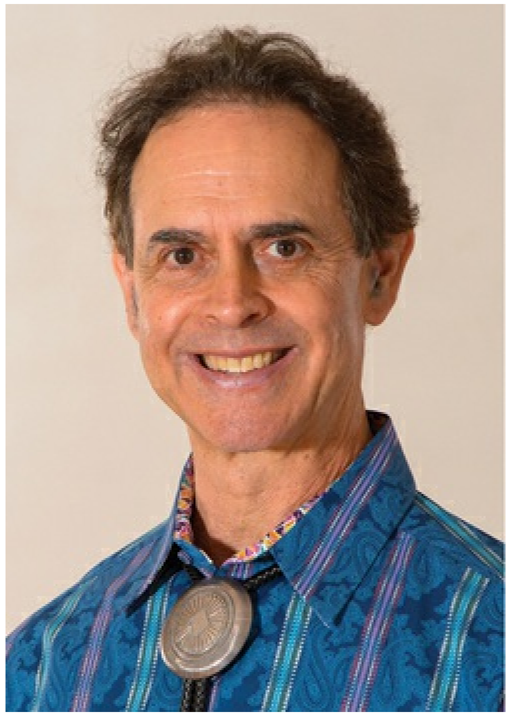

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