

# Muscular Strength and Endurance



## LOOKING AHEAD...

After reading this chapter, you should be able to:

- Describe the basic physiology of muscles and explain how strength training affects muscles
- Define muscular strength and endurance, and describe how they relate to wellness
- Assess muscular strength and endurance
- Apply the FITT principle to create a safe and successful strength training program
- Describe the effects of supplements and drugs that are marketed to active people and athletes
- Explain how to safely perform common strength training exercises using free weights and weight machines

## TEST YOUR KNOWLEDGE

1. For women, weight training typically results in which of the following?
  - a. bulky muscles
  - b. significant increases in body weight
  - c. improved body image
2. To maximize strength gains, it is a good idea to hold your breath as you lift a weight. True or false?
3. Regular strength training is associated with which of the following benefits?
  - a. denser bones
  - b. reduced risk of heart disease
  - c. improved body composition
  - d. fewer injuries
  - e. improved metabolic health
  - f. Increased longevity

## Answers

1. **c.** Because the vast majority of women have low levels of testosterone, they do not develop large muscles or gain significant amounts of weight in response to a moderate-intensity weight training program. Men have higher levels of testosterone, so they can build large muscles more easily.
2. **False.** Holding one's breath while lifting weights can significantly elevate blood pressure; it also reduces blood flow to the heart and may cause faintness. You should breathe smoothly and normally while weight training. Some experts recommend that you exhale during the most difficult part of each exercise.
3. **All six.** Regular strength training has many benefits for both men and women.



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**M**uscles make up more than 40% of your body mass. You depend on them for movement, and, because of their mass, they are the site of a large portion of the energy reactions (metabolism) that take place in your body. Strong, well-developed muscles help you perform daily activities with greater ease, protect you from injury, and enhance your well-being in other ways.

As described in Chapter 2, muscular strength is the amount of force a muscle can produce with a single maximum effort; muscular endurance is the ability to hold or repeat a muscular contraction for a long time. This chapter explains the benefits of strength training (also called *resistance training* or *weight training*) and describes methods of assessing muscular strength and endurance. It then explains the basics of strength training and provides guidelines for setting up your own training program. The musculoskeletal system is depicted on pages T4-2 and T4-3 of the color transparency insert “Touring the Musculoskeletal System” in this chapter. You can refer to this illustration as you set up your program.

## BASIC MUSCLE PHYSIOLOGY AND THE EFFECTS OF STRENGTH TRAINING

Muscles move the body and enable it to exert force because they move the skeleton. When a muscle contracts (shortens), it moves a bone by pulling on the tendon that attaches the muscle to the bone, as shown in Figure 4.1. When a muscle relaxes (lengthens), the tension placed on the tendon is released and the bone moves back to—or closer to—its starting position.

## Muscle Fibers

Muscles consist of individual muscle cells, or **muscle fibers**, connected in bundles (see Figure 4.1). A single muscle is made up of many bundles of muscle fibers and is covered by layers of connective tissue that hold the fibers together. Muscle fibers, in turn, are made up of smaller protein structures called **myofibrils**. Myofibrils are made up of a series of contractile units called *sarcomeres*, which are composed largely of actin and myosin molecules. Muscle cells contract when the myosin molecules glide across the actin molecules in a ratchetlike movement.

Strength training increases the size and number of myofibrils, resulting in larger individual muscle fibers. Larger muscle fibers mean a larger and stronger muscle. The development of large muscle fibers is called **hypertrophy**; inactivity causes **atrophy**, the reversal of this process. For a depiction of the process of hypertrophy, see page T4-4 of the color transparency insert “Touring the Musculoskeletal System” in this chapter. In some species, muscles can increase in size through a separate process called **hyperplasia**, which involves an increase in the number of muscle fibers rather than the size of muscle fibers. In humans, hyperplasia is not thought to play a significant role in determining muscle size. Each muscle cell has many **nuclei** containing genes that direct the production of enzymes and structural proteins required for muscle contraction.

Muscle fibers are classified as slow-twitch or fast-twitch fibers according to their strength, speed of contraction, and energy source.

- **Slow-twitch muscle fibers** are relatively fatigue-resistant, but they don’t contract as rapidly or strongly as fast-twitch fibers. The principal energy system that fuels slow-twitch fibers is aerobic (oxidative). Slow-twitch muscle fibers are typically reddish in color.

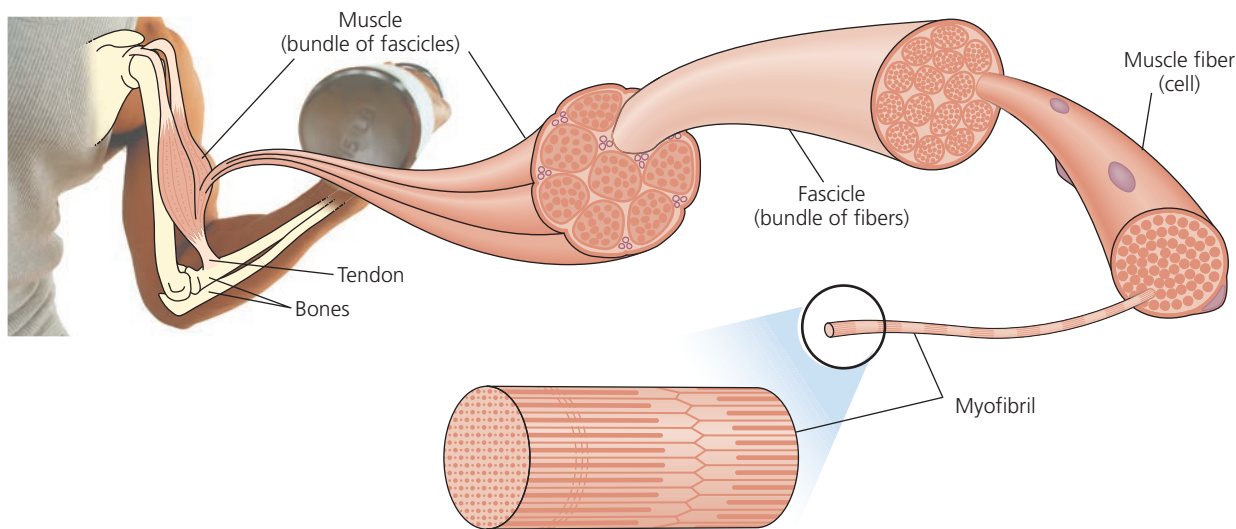


FIGURE 4.1 Components of skeletal muscle tissue.

Table 4.1

## Physiological Changes and Benefits from Strength Training

CHANGE	BENEFITS
Increased muscle mass* and strength	Increased muscular strength Improved body composition Higher rate of metabolism Improved capacity to regulate fuel use with aging Toned, healthy-looking muscles Increased longevity Improved quality of life
Increased utilization of motor units during muscle contractions	Increased muscular strength and power
Improved coordination of motor units	Increased muscular strength and power
Increased strength of tendons, ligaments, and bones	Lower risk of injury to these tissues
Increased storage of fuel in muscles	Increased resistance to muscle fatigue
Increased size of fast-twitch muscle fibers (from a high-resistance program)	Increased muscular strength and power
Increased size of slow-twitch muscle fibers (from a high-repetition program)	Increased muscular endurance
Increased blood supply to muscles (from a high-repetition program) and improved blood vessel health	Increased delivery of oxygen and nutrients Faster elimination of wastes
Biochemical improvements (for example, increased sensitivity to insulin)	Enhanced metabolic health
Improved blood fat levels	Reduced risk of heart disease
Increased muscle endurance	Enhanced ability to exercise for long periods and maintain good body posture

\*Due to genetic and hormonal differences, men will build more muscle mass than women, but both genders make about the same percent gains in strength through a good program.

• **Fast-twitch muscle fibers** contract more rapidly and forcefully than slow-twitch fibers but fatigue more quickly. Although oxygen is important in the energy system that fuels fast-twitch fibers, they rely more on anaerobic (nonoxidative) metabolism than do slow-twitch fibers. (See Chapter 3 for a discussion of energy systems.) Fast-twitch muscle fibers are typically whitish in color.

Most muscles contain both slow-twitch and fast-twitch fibers. The proportion of the types of fibers varies significantly among different muscles and different individuals, and that proportion is largely fixed at birth, although fibers can contract faster or slower following a period of training or a period of inactivity. The type of fiber that acts during a particular activity depends on the type of work required. Endurance activities like jogging tend to use slow-twitch fibers, whereas strength and **power** activities like sprinting use fast-twitch fibers. Strength training can increase the size and strength of both fast-twitch and slow-twitch fibers, although fast-twitch fibers are preferentially increased.

## Motor Units

To exert force, a muscle recruits one or more motor units to contract. A **motor unit** is made up of a nerve connected to a number of muscle fibers. The number of muscle fibers in a motor unit varies from two to hundreds. Small motor units contain slow-twitch fibers, whereas large motor units contain fast-twitch fibers. When a motor unit calls on its fibers to contract, all fibers contract to their full capacity. The number of motor units recruited depends on the

amount of strength required: When you pick up a small weight, you use fewer and smaller motor units than when picking up a large weight.

Strength training improves the body's ability to recruit motor units—a phenomenon called **muscle learning**—which increases strength even before muscle size increases. The physiological changes and benefits that result from strength training are summarized in Table 4.1.

**muscle fiber** A single muscle cell, usually classified according to strength, speed of contraction, and energy source.

**myofibrils** Protein structures that make up muscle fibers.

**hypertrophy** An increase in the size of muscle fibers, usually stimulated by muscular overload, as occurs during strength training.

**atrophy** A decrease in the size of muscle fibers.

**hyperplasia** An increase in the number of muscle fibers.

**nucleus** A cell structure containing DNA and genes that direct the production of proteins; plural, *nuclei*.

**slow-twitch muscle fibers** Red muscle fibers that are fatigue resistant but have a slow contraction speed and a lower capacity for tension; usually recruited for endurance activities.

**fast-twitch muscle fibers** White muscle fibers that contract rapidly and forcefully but fatigue quickly; usually recruited for actions requiring strength and power.

**power** The ability to exert force rapidly.

**motor unit** A motor nerve (one that initiates movement) connected to one or more muscle fibers.

**muscle learning** The improvement in the body's ability to recruit motor units, brought about through strength training.

KEY  
TERMS



## Does Muscular Strength Reduce the Risk of Premature Death?

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Strength training can make you stronger, but can it also help you live longer? According to a growing body of evidence, the answer is yes—especially for men.

A number of studies have associated greater muscular strength with lower rates of death from all causes, including cancer and cardiovascular disease. According to the results of a study that followed nearly 9000 men over 18 years, the stronger a man is, the lower his risk of premature death from a variety of causes. This study gauged participants' strength through exercises such as bench and leg presses; other studies have measured strength using a handgrip test, with similar outcomes. The resulting data showed significant differences in death rates among the participants, with the strongest men having the lowest death rates. This effect was particularly important for older and overweight men.

When participants in the study died, researchers analyzed causes of death and correlated the numbers of dead and surviving participants with data about their muscular fitness, the amount of time they spent exercising, and other factors (such as metabolic data, cardiovascular health, smoking status, and age). The findings revealed that, compared to men with the lowest levels of muscular strength, stronger men were

- 1.5 times less likely to die from all causes
- 1.6 times less likely to die from cardiovascular disease
- 1.25 times less likely to die from cancer

These correlations held across all age groups (ranging from age 20 to 82) and body mass indexes. They were particularly striking in older men (age 60 and older), who were more than four times more likely to die from cancer than similar-age men with greater muscular strength.

Similarly, an earlier study of more than 3000 men demonstrated an inverse relationship between muscular strength and metabolic syndrome, a cluster of symptoms that includes high blood pressure, high blood glucose levels, high triglyceride levels, low HDL cholesterol levels, and abdominal obesity. Metabolic syndrome increases risk for diabetes, heart disease, and other illnesses. The results were true regardless of participants' age, weight, or waist circumference. The findings led researchers to suggest that weight training may be a valuable way for men to avoid metabolic syndrome. Protection against metabolic syndrome is also provided by cardiorespiratory fitness, according to a 2004 study of 8570 men, in which scientists measured

each participant's level of muscular strength and cardiorespiratory fitness.

You don't have to be a power lifter or bodybuilder to enjoy the benefits of strength training. In the first study, for example, participants were advised on basic fitness techniques and healthy lifestyle behaviors. Although participants were encouraged to incorporate weight training into their fitness routine, each man chose the type and amount of weight training he felt most comfortable doing. Many researchers believe that the basic minimum recommendation of doing weight training on 2 nonconsecutive days per week may be enough to lower the average male's risk of premature death, provided he is not obese and does not already have risk factors such as diabetes, hypertension, or preexisting cancer. At the same time, as noted in Chapter 3, strength training can have negative effects on the cardiovascular system in some men, at least temporarily, if not followed by aerobic exercise. To date, only small-scale studies have been performed on women, so more research is needed to see if the same conclusions apply to women.



**SOURCES:** Physical Activity Guidelines Advisory Committee. 2008. *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington, D.C.: U.S. Department of Health and Human Services; Ruiz, J. R., et al. 2008. Association between muscular strength and mortality in men: Prospective cohort study. *BMJ* 337: a439; Ruiz, J. R., et al. 2009. Muscular strength and adiposity as predictors of adulthood cancer mortality in men. *Cancer Epidemiology, Biomarkers, and Prevention* 18: 1468; Rantanen, T., et al. 2011. Midlife muscle strength and human longevity up to age 100 years: A 44-year prospective study among a decedent cohort. *Age* published online: DOI 10.1007/s11357-011-9256-y.

## BENEFITS OF MUSCULAR STRENGTH AND ENDURANCE

Enhanced muscular strength and endurance can lead to improvements in the areas of performance, injury prevention, body composition, self-image, lifetime muscle and bone health, and metabolic health. Most important, greater muscular strength and endurance reduce the

risk of premature death. Stronger people—particularly men—have a lower death rate due to all causes, including cardiovascular disease and cancer (see the box “Does Muscular Strength Reduce the Risk of Premature Death?”). The link between strength and death rate is independent of age, physical activity, smoking, alcohol intake, body composition, and family history of cardiovascular disease.

## Improved Performance of Physical Activities

A person with a moderate to high level of muscular strength and endurance can perform everyday tasks—such as climbing stairs and carrying groceries—with ease. Increased strength can enhance your enjoyment of recreational sports by making it possible to achieve high levels of performance and to handle advanced techniques. Strength training also results in modest improvements in maximal oxygen consumption. People with poor muscle strength tire more easily and are less effective in both everyday and recreational activities.

## Injury Prevention

Increased muscular strength and endurance help protect you from injury in two key ways:

- By enabling you to maintain good posture
- By encouraging proper body mechanics during everyday activities such as walking and lifting

Good muscle strength and, particularly, endurance in the abdomen, hips, lower back, and legs, maintain the spine in proper alignment and help prevent low-back pain, which afflicts more than 85% of Americans at some time in their lives. (Prevention of low-back pain is discussed in Chapter 5.)

Training for muscular strength and endurance also makes the **tendons**, **ligaments**, and **cartilage** cells stronger and less susceptible to injury. Resistance exercise prevents injuries best when the training program is gradual and progressive and builds all the major muscle groups.

## Improved Body Composition

As Chapter 2 explained, healthy body composition means that the body has a high proportion of fat-free mass (composed primarily of muscle) and a relatively small proportion of fat. Strength training improves body composition by increasing muscle mass, thereby tipping the body composition ratio toward fat-free mass and away from fat.

Building muscle mass through strength training also helps with losing fat because metabolic rate is related to muscle mass: The greater your muscle mass, the higher your metabolic rate. A high metabolic rate means that a nutritionally sound diet coupled with regular exercise will not lead to an increase in body fat. Strength training

can boost resting metabolic rate by up to 15%, depending on how hard you train. Resistance exercise also increases muscle temperature, which in turn slightly increases the rate at which you burn calories over the hours following a weight training session.

## Enhanced Self-Image and Quality of Life

Strength training leads to an enhanced self-image in both men and women by providing stronger, firmer-looking muscles and a toned, healthy-looking body. Women tend to lose inches, increase strength, and develop greater muscle definition. Men tend to build larger, stronger muscles. The larger muscles in men combine with high levels of the hormone **testosterone** for a strong tissue-building effect; see the box “Gender Differences in Muscular Strength.”

Because strength training involves measurable objectives (pounds lifted, repetitions accomplished), a person can easily recognize improved performance, leading to greater self-confidence and self-esteem. Strength training also improves quality of life by increasing energy, preventing injuries, and making daily activities easier and more enjoyable.

## Improved Muscle and Bone Health with Aging

Research has shown that good muscular strength helps people live healthier lives. A lifelong program of regular strength training prevents muscle and nerve degeneration that can compromise the quality of life and increase the risk of hip fractures and other potentially life-threatening injuries.

In the general population, people begin to lose muscle mass after age 30, a condition called *sarcopenia*. At first they may notice that they cannot play sports as well as they could in high school. After more years of inactivity and strength loss, people may have trouble performing even the simple movements of daily life, such as walking up a flight of stairs or doing yard work. By age 75, about 25% of men and 75% of women cannot lift more than 10 pounds overhead. Although aging contributes to decreased strength, inactivity causes most of the loss. Poor strength makes it much more likely that a person will be injured during everyday activities.

**tendon** A tough band of fibrous tissue that connects a muscle to a bone or other body part and transmits the force exerted by the muscle.

**ligament** A tough band of tissue that connects the ends of bones to other bones or supports organs in place.

**cartilage** Tough, resilient tissue that acts as a cushion between the bones in a joint.

**testosterone** The principal male hormone, responsible for the development of secondary sex characteristics and important in increasing muscle size.

KEY  
TERMS



### Wellness Tip

Circuit training involves a series of exercises with minimal rest in between. Circuits can include almost any kind of exercises. Circuit training is an excellent way to develop strength and endurance at the same time.



## Gender Differences in Muscular Strength

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Men are generally stronger than women because they typically have larger bodies and a larger proportion of their total body mass is made up of muscle. But when strength is expressed per unit of cross-sectional area of muscle tissue, men are only 1–2% stronger than women in the upper body and about equal to women in the lower body. Men have a larger proportion of muscle tissue in the upper body, so they can more easily build upper-body strength than women can. Individual muscle fibers are larger in men, but the metabolism of cells within those fibers is the same in both sexes.

Two factors that help explain these disparities are testosterone levels and the speed of nervous control of muscle. Testosterone promotes the growth of muscle tissue in both males and females. Testosterone levels are 5–10 times higher in men than in women, so men tend to have larger muscles. Also,

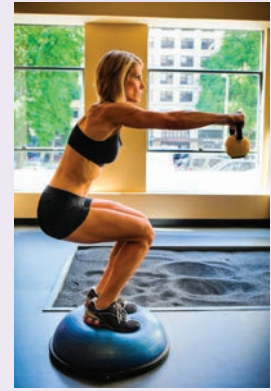
because the male nervous system can activate muscles faster, men tend to have more power.

Women are often concerned that they will develop large muscles from strength training. Because of hormonal differences, most women do not develop big muscles unless they train intensely over many years or take anabolic steroids. Women do gain muscle and improve body composition through strength training, but they don't develop bulky muscles or gain significant amounts of weight. A study of average women who weight trained 2–3 days per week for 8 weeks found that they gained about 1.75 pounds of muscle and lost about 3.5 pounds of fat. Losing muscle over time is a much greater health concern for women than small gains in muscle weight, especially because any gains in muscle weight are typically more than offset by loss of fat weight. Both men and women lose muscle mass and power as

they age, but because men start out with more muscle and don't lose power as quickly, older women tend to have greater impairment of muscle function than older men.

This may partially account for the higher incidence of life-threatening falls in older women.

The bottom line is that both men and women can increase strength through strength training. Women may not be able to lift as much weight as men, but pound for pound of muscle, they have nearly the same capacity to gain strength as men.



As a person ages, motor nerves can become disconnected from the portion of muscle they control. By age 70, 15% of the motor nerves in most people are no longer connected to muscle tissue. Aging and inactivity also cause muscles to become slower and therefore less able to perform quick, powerful movements. Strength training helps maintain motor nerve connections and the quickness of muscles.

Osteoporosis (bone loss) is common in people over age 55, particularly postmenopausal women. Osteoporosis leads to fractures that can be life-threatening. Hormonal changes from aging account for much of the bone loss that occurs, but lack of bone mass due to inactivity and a poor diet are contributing factors. Strength training can lessen bone loss even if it is taken up later in life, and if practiced regularly, strength training may even build bone mass in postmenopausal women and older men. Increased muscle strength can also help prevent falls, which are a major cause of injury in people with osteoporosis.



### Ask yourself

#### QUESTIONS FOR CRITICAL THINKING AND REFLECTION

What benefits of strength training are most important to you? Are you more interested in improved physical performance? Better body composition and appearance? Long-term health benefits? How can you define your goals so they are most meaningful and motivating for you?

## Metabolic and Heart Health

Strength training helps prevent and manage both cardiovascular disease (CVD) and diabetes by:

- Improving glucose metabolism
- Increasing maximal oxygen consumption
- Reducing blood pressure
- Increasing HDL cholesterol and reducing LDL cholesterol (in some people)
- Improving blood vessel health

Stronger muscles reduce the demand on the heart during ordinary daily activities such as lifting and carrying objects. The benefits of resistance exercise to the heart are so great that the American Heart Association recommends that healthy adults and many low-risk cardiac patients do strength training 2–3 days per week. Resistance training may not be appropriate for people with some types of heart disease.

## ASSESSING MUSCULAR STRENGTH AND ENDURANCE

Muscular strength is usually assessed by measuring the maximum amount of weight a person can lift one time. This single maximum effort is called a **repetition maximum (RM)**. You can assess the strength of your major muscle groups by taking the one-repetition maximum (1 RM) test

# How Strong Are You?



Tests of strength have challenged humans since the dawn of history. Strength is highly specific; one type of strength does not necessarily predict another. Strength tests help you determine your current fitness level and help you set achievable goals. You could test your capacity doing almost any exercise. Test your maximum performance on as many of the following tests as you can.

TEST	MAXIMUM REPETITIONS OR TIME	GOAL
Push-ups (Modified Or Regular)	_____	_____
Pull-ups or bent-arm bar hang	_____	_____
One-arm kettlebell snatches	_____	_____
Two-arm kettlebell swings	_____	_____
Bench press for reps (at a specific weight; e.g., 135 pounds, 225 pounds)	_____	_____

Write down your performance for each exercise in the second column of the list. (Note that you should wait at least a few minutes between tests.) If you aren't happy with the results, set a reasonable goal for each exercise in the third column. If you aren't sure what a reasonable goal would be, talk to your instructor or a certified personal trainer. Use these goals as a starting point for a broad-ranging strength training program.

for the bench press and by taking functional leg strength tests. You can measure 1 RM directly or estimate it by doing multiple repetitions with a submaximal (lighter) weight. It is best to train for several weeks before attempting a direct 1 RM test; once you have a baseline value, you can retest after 6–12 weeks to check your progress. See Lab 4.1 for guidelines on taking these tests. For more accurate results, avoid strenuous weight training for 48 hours beforehand.

Muscular endurance is usually assessed by counting the maximum number of **repetitions** of an exercise a person can do (such as in push-ups or kettlebell snatches) or the maximum amount of time a person can hold a muscular contraction (such as in the flexed-arm hang). You can test the muscular endurance of major muscle groups in your body by taking the curl-up test, the push-up test, and the squat endurance test. See Lab 4.2 for complete instructions on taking these assessment tests.

## CREATING A SUCCESSFUL STRENGTH TRAINING PROGRAM

When the muscles are stressed by a greater load than they are used to, they adapt and improve their function. The type of adaptation that occurs depends on the type of stress applied.

### Static Versus Dynamic Strength Training Exercises

Strength training exercises are generally classified as static or dynamic. Each involves a different way of using and strengthening muscles.

**Static Exercise** Also called **isometric** exercise, **static exercise** involves a muscle contraction without a change in the length of the muscle or the angle in the joint on which the muscle acts. In isometrics, the muscle contracts, but there is no movement. To perform an isometric exercise, a

**?** **Ask yourself**

**QUESTIONS FOR CRITICAL THINKING AND REFLECTION**

Considering your lifestyle and the physical activities you most commonly do, which is more important to you—muscular strength or muscular endurance? Why is this the case? Do you think your priority may change some day?

**KEY TERMS**

**repetition maximum (RM)** The maximum amount of resistance that can be moved a specified number of times.

**repetitions** The number of times an exercise is performed during one set.

**static (isometric) exercise** Exercise involving a muscle contraction without a change in the muscle's length.

person can use an immovable object like a wall to provide resistance, or simply tighten a muscle while remaining still (for example, tightening the abdominal muscles while sitting at a desk). The spine extension and the side bridge, shown on pp. 119–120, are both isometric exercises.

Static exercises are not used as widely as dynamic exercises because they don't develop strength throughout a joint's entire range of motion. During almost all movements, however, some muscles contract statically to support the skeleton so that other muscles can contract dynamically. For example, when you throw, hit a ball, or ski, the core muscles in the abdomen and back stabilize the spine. This stability allows more powerful contractions in the lower- and upper-body muscles. The core muscles contract statically during dynamic exercises, such as squats, lunges, and overhead presses.

Static exercises are useful in strengthening muscles after an injury or surgery, when movement of the affected joint could delay healing. Isometrics are also used to overcome weak points in an individual's range of motion. Statically strengthening a muscle at its weakest point will allow more weight to be lifted with that muscle during dynamic exercise. Certain types of calisthenics and Pilates exercises (described in more detail later in the chapter) also involve static contractions. For maximum strength gains, hold the isometric contraction maximally for 6 seconds; do 2–10 repetitions.

**Dynamic Exercise** Also called **isotonic** exercise, **dynamic exercise** involves a muscle contraction with a change in the length of the muscle. Dynamic exercises are the most popular type of exercises for increasing muscle strength and seem to be most valuable for developing strength that can be transferred to other forms of physical activity. They can be performed with weight machines, free weights, or a person's own body weight (as in curls or push-ups).

There are two kinds of dynamic muscle contractions:

- A **concentric muscle contraction** occurs when the muscle applies enough force to overcome resistance and shortens as it contracts.
- An **eccentric muscle contraction** (also called a *plyometric contraction*) occurs when the resistance is greater than the force applied by the muscle and the muscle lengthens as it contracts.

For example, in an arm curl, the biceps muscle works concentrically as the weight is raised toward the shoulder and eccentrically as the weight is lowered.

**CONSTANT AND VARIABLE RESISTANCE** Two of the most common dynamic exercise techniques are constant resistance exercise and variable resistance exercise.

- **Constant resistance exercise** uses a constant load (weight) throughout a joint's full range of motion. Training with free weights is a form of constant resistance exercise. A problem with this technique



A concentric contraction.



An eccentric contraction.

is that, because of differences in leverage, there are points in a joint's range of motion where the muscle controlling the movement is stronger and points where it is weaker. The amount of weight a person can lift is limited by the weakest point in the range.

- In **variable resistance exercise**, the load is changed to provide maximum load throughout the entire range of motion. This form of exercise uses machines that place more stress on muscles at the end of the range of motion, where a person has better leverage and can exert more force. Use elastic bands and chains with free weights to add variable resistance to the exercises.

Constant and variable resistance exercises are both extremely effective for building strength and endurance.

Pneumatic strength training machines use air pressure for resistance and are popular in many gyms and health clubs. They build strength in beginners but are less effective for more advanced strength trainers. The machines provide resistance only during the concentric (muscle shortening) phase of the exercise and not during the eccentric (muscle lengthening) phase. Such machines do not preload the muscles with resistance; they provide resistance only after the movement has been started.

**OTHER DYNAMIC EXERCISE TECHNIQUES** Athletes use four other kinds of isotonic techniques, primarily for training and rehabilitation.

- **Eccentric (plyometric) loading** involves placing a load on a muscle as it lengthens. The muscle contracts eccentrically in order to control the weight. Eccentric loading is practiced during most types of resistance training. For example, you are performing an eccentric movement as you lower the weight to your chest during a bench



press in preparation for the active movement. You can also perform exercises designed specifically to overload muscle eccentrically, a technique called *negatives*.

- **Plyometrics** is the sudden eccentric loading and stretching of muscles followed by a forceful concentric contraction. An example would be the action of the lower-body muscles when jumping from a bench to the ground and then jumping back onto the bench. This type of exercise is used to develop explosive strength; it also helps build and maintain bone density.

- **Speed loading** involves moving a weight as rapidly as possible in an attempt to approach the speeds used in movements like throwing a softball or sprinting. In the bench press, for example, speed loading might involve doing five repetitions as fast as possible using a weight that is half the maximum load you can lift. You can gauge your progress by timing how fast you can perform the repetitions.

Training with **kettlebells** is a type of speed loading. Kettlebell training is highly ballistic, meaning that many exercises involve fast, pendulum-type motions, extreme decelerations, and high-speed eccentric muscle contractions. Kettlebell swings require dynamic concentric muscle contractions during the upward phase of the exercise followed by high-speed eccentric contractions to control the movement when returning to the starting position. Kettlebell training is very popular around the world, but more research is needed to better understand its effects on strength, power, and fitness.

- **Isokinetic** exercise involves exerting force at a constant speed against an equal force exerted by a special strength training machine. The isokinetic machine provides variable resistance at different points in the joint's range of motion, matching the effort applied by the individual while keeping the speed of the movement constant. Isokinetic exercises are excellent for building strength and endurance.

**Comparing Static and Dynamic Exercise** Static exercises require no equipment, so they can be done virtually



Kettlebells are growing in popularity. They provide a fast, effective workout when used properly.

## Fitness Tip



As you create a personalized weight training program, focus on specificity and eliminate training methods that do not help you achieve your goal. Follow a well-designed training program that builds strength gradually and progressively. Don't adopt the program of the week just because it's popular.

anywhere. They build strength rapidly and are useful for rehabilitating injured joints. On the other hand, they have to be performed at several different angles for each joint to improve strength throughout its entire range of motion. Dynamic exercises can be performed without equipment (calisthenics) or with equipment (weight training). They are excellent for building strength and endurance, and they tend to build strength through a joint's full range of motion. Most people develop muscular strength and endurance using dynamic exercises. Ultimately, the type of exercise a person chooses depends on individual goals, preferences, and access to equipment.

## Weight Machines Versus Free Weights

Muscles get stronger when made to work against resistance. Resistance can be provided by free weights, your own body weight, or exercise machines. Many people prefer weight machines because they are safe, convenient,

KEY  
TERMS

**dynamic (isotonic) exercise** Exercise involving a muscle contraction with a change in the muscle's length.

**concentric muscle contraction** A dynamic contraction in which the muscle gets shorter as it contracts.

**eccentric muscle contraction** A dynamic contraction in which the muscle lengthens as it contracts; also called a *plyometric contraction*.

**constant resistance exercise** A type of dynamic exercise that uses a constant load throughout a joint's full range of motion.

**variable resistance exercise** A type of dynamic exercise that uses a changing load, providing a maximum load at the strongest point in the affected joint's range of motion.

**eccentric (plyometric) loading** Loading the muscle while it is lengthening; sometimes called *negatives*.

**plyometrics** Rapid stretching of a muscle group that is undergoing eccentric stress (the muscle is exerting force while it lengthens), followed by a rapid concentric contraction.

**speed loading** Moving a load as rapidly as possible.

**kettlebell** A large iron weight with a connected handle; used for ballistic weight training exercises such as swings and one-arm snatches.

**isokinetic** The application of force at a constant speed against an equal force.

and easy to use. You just set the resistance, sit down at the machine, and start working. Machines make it easy to isolate and work specific muscles. You don't need a **spotter**—someone who stands by to assist when free weights are used—and you don't have to worry about dropping a weight on yourself. Many machines provide support for the back.

Free weights require more care, balance, and coordination to use, but they strengthen your body in ways that are more adaptable to real life. They are also more popular with athletes for developing functional strength for sports, especially sports that require a great deal of strength. Free weights are widely available, inexpensive, and convenient for home use.

## Other Training Methods and Types of Equipment

You don't need a fitness center or expensive equipment to strength train. If you prefer to train at home or like low-cost alternatives, consider the following options.

**Resistance Bands** Resistance or exercise bands are elastic strips or tubes of rubber material that are inexpensive, lightweight, and portable. They are available in a variety of styles and levels of resistance. Some are sold with instructional guides or DVDs, and classes may be offered at



Resistance bands are a popular and inexpensive alternative to training with weights or machines.

fitness centers. Many free weight exercises can be adapted for resistance bands. For example, you can do biceps curls by standing on the center of the band and holding one end of the band in each hand; the band provides resistance when you stretch it to perform the curl.

**Exercise (Stability) Balls** The exercise or stability ball is an extra-large inflatable ball. It was originally developed for use in physical therapy but has become a popular piece of exercise equipment for use in the home or gym. It can be used to work the entire body, but it is particularly effective for working the core stabilizing muscles in the abdomen, chest, and back—muscles that are important for preventing back problems. The ball's instability forces the exerciser to use the stability muscles to balance the body, even when just sitting on the ball. Moves such as crunches are more effective when performed with an exercise ball.

When choosing a ball, make sure that your thighs are parallel to the ground when you sit on it; if you are a beginner or have back problems, choose a larger ball so that your thighs are at an angle, with hips higher than knees. Beginners should use caution until they feel comfortable with the movements and take care to avoid poor form due to fatigue. See Chapter 7 for more on incorporating stability balls into a fitness program.

**Pilates** Pilates (*pil LAH teez*) was developed by German gymnast and boxer Joseph Pilates early in the twentieth



Proper fit is an important factor in choosing and using a stability ball.



## Fitness Tip

Think those resistance bands are just for beginners? Think again. Many serious weight trainers use elastic bands to provide variable resistance during large muscle lifts such as the squat and bench press. Bands might increase power, rate of force development, and speed.

century. It often involves the use of specially designed resistance training devices, although some classes feature just mat or floor work. Pilates focuses on strengthening and stretching the core muscles in the back, abdomen, and buttocks to create a solid base of support for whole-body movement; the emphasis is on concentration, control, movement flow, and breathing. Mat exercises can be done at home, but because there are hundreds of Pilates exercises, some of them strenuous, it is best to begin with some qualified instruction. The Pilates Method Alliance ([www.pilatesmethodalliance.org](http://www.pilatesmethodalliance.org)) offers advice on finding a qualified teacher.

**Medicine Balls, Suspension Training, Stones, and Carrying Exercises** Almost anything that provides resistance to movement will develop strength. Rubber medicine balls weigh up to 50 pounds and can be used for a variety of functional movements, such as squats and overhead throws. Suspension training uses body weight as the resistance and involves doing exercises with ropes or cords attached to a hook, bar, door jam, or sturdy tree branch. Stones can provide resistance to almost any movement, are free, and can be found in many shapes and sizes. Walking while carrying dumbbells, farmer's bars, or heavy stones is an easy and effective way to develop whole body strength.



Medicine balls can be used in many ways to get an effective resistance workout.

**No-Equipment Calisthenics** You can use your own body weight as resistance for strength training. Exercises such as curl-ups, push-ups, squats, step-ups, heel raises, chair dips, and lunges can be done anywhere.

## Applying the FITT Principle: Selecting Exercises and Putting Together a Program

A complete weight training program works all the major muscle groups. It usually takes about 8–10 different exercises to get a complete full-body workout. Use the FITT principle—frequency, intensity, time, and type—to set the parameters of your program.

**Frequency of Exercise** For general fitness, the American College of Sports Medicine (ACSM) recommends a frequency of at least 2 nonconsecutive days per week for weight training. Allow your muscles at least one day of rest between workouts; if you train too often, your muscles won't be able to work with enough intensity to improve their fitness, and soreness and injury are more likely to result. If you enjoy weight training and want to train more often, try working different muscle groups on alternate days—a training plan called a *split routine*. For example, work your arms and upper body one day, work your lower body the next day, and then return to upper-body exercises on the third day.

**Intensity of Exercise: Amount of Resistance** The amount of weight (resistance) you lift in weight training exercises is equivalent to intensity in cardiorespiratory endurance training. It determines how your body will adapt to weight training and how quickly these adaptations will occur.

Choose weights based on your current level of muscular fitness and your fitness goals. Choose a weight heavy enough to fatigue your muscles but light enough for you to complete the repetitions with good form. (For tips on perfecting your form, see the box “Improving Your Technique with Video.”) To build strength rapidly, you should lift weights as heavy as 80% of your maximum capacity (1 RM). If you're more interested in building endurance, choose a lighter weight (perhaps 40–60% of 1 RM), and do more repetitions.

For example, if your maximum capacity for the leg press is 160 pounds, you might lift 130 pounds to build strength and 80 pounds to build endurance. For a general fitness program to develop both strength and endurance, choose a weight in the middle of this range, perhaps 70% of 1 RM. Or you can create a program that includes

**spotter** A person who assists with a weight training exercise done with free weights.

KEY  
TERM



## Improving Your Technique with Video

Want to get stronger? Then you need to focus on developing your skills at least as much as you focus on lifting more weight. Improving skill is the best way to increase strength during movements such as hitting a tennis ball or baseball, performing a bench press, driving a golf ball, skiing down a slope, or carrying a bag of groceries up a flight of stairs. In the world of weight training, skill means lifting weights with proper form; the better your form, the better your results.

The brain develops precise neural pathways as you learn a skill. As you improve, the pathways conduct nervous impulses faster and more precisely until the movement almost becomes reflexive. The best way to learn a skill is through focused practice that involves identifying mistakes, correcting them, and practicing the refined movement many times. However, simply practicing the skill is not enough if you want to improve and perform more powerful movements. You must perform the movements correctly instead of practicing mistakes or poor form over and over again.

Here's where technology can help. Watch videos of people performing weight-training movements correctly. You may be able to borrow videos from your instructor, purchase low-cost training videos through magazines and sporting goods stores, or find them on the Internet. If you watch training videos online, however, make sure they were produced by an authoritative source on weight training. Otherwise, you may be learning someone else's mistakes.

both higher-intensity exercise (80% of 1 RM for 8–10 repetitions) and lower-intensity exercise (60% of 1 RM for 15–20 repetitions); this routine will develop both fast-twitch and slow-twitch muscle fibers.

Because it can be tedious and time-consuming to continually reassess your maximum capacity for each exercise, you might find it easier to choose a weight based on the number of repetitions of an exercise you can perform with a given resistance.

**Time of Exercise: Repetitions and Sets** To improve fitness, you must do enough repetitions of each exercise to fatigue your muscles. The number of repetitions needed to cause fatigue depends on the amount of resistance: The heavier the weight, the fewer repetitions to reach fatigue. In general, a heavy weight and a low number of repetitions (1–5) build strength and overload primarily fast-twitch fibers, whereas a light weight and a high number of repetitions (15–20) build endurance and overload primarily slow-twitch fibers.

For a general fitness program to build both strength and endurance, try to do about 8–12 repetitions of each exercise; a few exercises, such as abdominal crunches and calf raises, may require more. To avoid injury, older (approximately age 50–60 and above) and frailer people should perform more repetitions (10–15) using a lighter weight.

Film your movements using a phone camera or inexpensive video camera. Compare your movements with those of a more skilled person performing them correctly. Make a note of poor movement patterns and try to change your technique to make it more mechanically correct. Share your videos with your instructor or a certified personal trainer, who can help you identify poor form and teach you ways to correct your form.



In weight training, a **set** refers to a group of repetitions of an exercise followed by a rest period. To develop strength and endurance for general fitness, you can make gains doing a single set of each exercise, provided you use enough resistance to fatigue your muscles. (You should just barely be able to complete the 8–12 repetitions—using good form—for each exercise.) Doing more than one set of each exercise will increase strength development, and most serious weight trainers do at least three sets of each exercise (see the section “More Advanced Strength Training Programs” for guidelines on more advanced programs).

If you perform more than one set of an exercise, you need to rest long enough between sets to allow your muscles to work with enough intensity to increase fitness. The length of the rest interval depends on the amount of resistance. In a program to develop a combination of strength and endurance for wellness, a rest period of 1–3 minutes between sets is appropriate. If you are lifting heavier loads to build strength, rest 3–5 minutes between sets. You can save time in your workouts by alternating sets of different exercises. One muscle group can rest between sets while you work on another group.

Training volume is one method of quantifying the total load lifted during weight training. Use this formula to calculate the training volume for a workout:

$$\text{repetitions} \times \text{weight} \times \text{sets}$$

For example, if you did three sets of 10 repetitions for biceps curls using 50 pounds, the training volume for the exercise would be 1500 pounds ( $3 \times 10 \times 50 = 1500$ ). Do the same calculation for every exercise in your program and add the results together to determine the total training volume for the entire workout.

Overtraining—doing more exercise than your body can recover from—can occur in response to heavy resistance training. Possible signs of overtraining include lack of progress or decreased performance, chronic fatigue, decreased coordination, and chronic muscle soreness. The best remedy for overtraining is rest; add more days of recovery between workouts. With extra rest, chances are you'll be refreshed and ready to train again. Adding variety to your program, as discussed later in the chapter, can also help you avoid overtraining with resistance exercise.

**Type or Mode of Exercise** For overall fitness, you need to include exercises for your neck, upper back, shoulders, arms, chest, abdomen, lower back, thighs, buttocks, and calves—about 8–10 exercises in all. If you are also training for a particular sport, include exercises to strengthen the muscles important for optimal performance *and* the muscles most likely to be injured. Weight training exercises for general fitness are presented later in this chapter, on pp. 116–124.

It is important to balance exercises between **agonist** and **antagonist** muscle groups. When a muscle contracts, it is known as the agonist; the opposing muscle, which must relax and stretch to allow contraction by the agonist, is known as the antagonist. Whenever you do an exercise that moves a joint in one direction, also select an exercise that works the joint in the opposite direction. For example, if you do knee extensions to develop the muscles on the front of your thighs, also do leg curls to develop the antagonist muscles on the back of your thighs.

The order of exercises can also be important. Do exercises for large-muscle groups or for more than one joint before you do exercises that use small-muscle groups or single joints. This allows for more effective overload of the larger, more powerful muscle groups. Small-muscle groups fatigue more easily than larger ones, and small-muscle fatigue limits your capacity to overload large-muscle groups. For example, lateral raises, which work the shoulder muscles, should be performed after bench presses, which work the chest and arms in addition to the shoulders. If you fatigue your shoulder muscles by doing lateral raises first, you won't be able to lift as much weight and effectively fatigue all the key muscle groups used during the bench press.

Also, order exercises so that you work agonist and antagonist muscle groups in sequence, one after the other. For example, follow biceps curls, which work the biceps, with triceps extensions, which exercise the triceps—the antagonist muscle to the biceps.



## Wellness Tip

A standard push-up is equivalent to bench-pressing 60% of your body weight. A set of 12 push-ups is a quick, effective upper-body workout. No gym required!

## The Warm-Up and Cool-Down

As with cardiorespiratory endurance exercise, you should warm up before every weight training session and cool down afterward (Figure 4.2). You should do both a general warm-up—several minutes of walking or easy jogging—and a warm-up for the weight training exercises you plan

Warm-up 5–10 minutes	Strength training exercises for major muscle groups (8–10 exercises)	Cool-down 5–10 minutes																								
<b>Sample program</b>																										
	<table border="1"> <thead> <tr> <th>Exercise</th> <th>Muscle group(s) developed</th> </tr> </thead> <tbody> <tr> <td>Bench press</td> <td>Chest, shoulders, triceps</td> </tr> <tr> <td>Pull-ups</td> <td>Lats, biceps</td> </tr> <tr> <td>Shoulder press</td> <td>Shoulders, trapezius, triceps</td> </tr> <tr> <td>Upright rowing</td> <td>Deltoids, trapezius</td> </tr> <tr> <td>Biceps curls</td> <td>Biceps</td> </tr> <tr> <td>Lateral raises</td> <td>Shoulders</td> </tr> <tr> <td>Squats</td> <td>Gluteals, quadriceps</td> </tr> <tr> <td>Heel raises</td> <td>Calves</td> </tr> <tr> <td>Abdominal curls</td> <td>Abdominals</td> </tr> <tr> <td>Spine extensions</td> <td>Low- and mid-back spine extensors</td> </tr> <tr> <td>Side bridges</td> <td>Obliques, quadratus lumborum</td> </tr> </tbody> </table>	Exercise	Muscle group(s) developed	Bench press	Chest, shoulders, triceps	Pull-ups	Lats, biceps	Shoulder press	Shoulders, trapezius, triceps	Upright rowing	Deltoids, trapezius	Biceps curls	Biceps	Lateral raises	Shoulders	Squats	Gluteals, quadriceps	Heel raises	Calves	Abdominal curls	Abdominals	Spine extensions	Low- and mid-back spine extensors	Side bridges	Obliques, quadratus lumborum	
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<b>Start</b>		<b>Stop</b>																								
<p><b>Frequency:</b> 2–3 nonconsecutive days per week</p> <p><b>Intensity/Resistance:</b> Weights heavy enough to cause muscle fatigue when exercises are performed with good form for the selected number of repetitions</p> <p><b>Time: Repetitions:</b> 8–12 of each exercise (10–15 with a lower weight for people over age 50–60); <b>Sets:</b> 1 (doing more than 1 set per exercise may result in faster and greater strength gains); rest 1–2 minutes between exercises.</p> <p><b>Type of activity:</b> 8–10 strength training exercises that focus on major muscle groups</p>																										

**FIGURE 4.2** The FITT principle for a strength training workout.

**set** A group of repetitions followed by a rest period.

**agonist** A muscle in a state of contraction, opposed by the action of another muscle, its *antagonist*.

**antagonist** A muscle that opposes the action of a contracting muscle, its *agonist*.

KEY TERMS

to perform. For example, if you plan to do one or more sets of 10 repetitions of bench presses with 125 pounds, you might do one set of 10 repetitions with 50 pounds as a warm-up. Do similar warm-up exercises for each exercise in your program.

To cool down after weight training, relax for 5–10 minutes after your workout. Although this is controversial, a few studies have suggested that including a period of postexercise stretching may help prevent muscle soreness; warmed-up muscles and joints make this a particularly good time to work on flexibility.

## Getting Started and Making Progress

The first few sessions of weight training should be devoted to learning the movements and allowing your nervous system to practice communicating with your muscles so you can develop strength effectively. To start, choose a weight that you can move easily through 8–12 repetitions, do only one set of each exercise, and rest 1–2 minutes between exercises. Gradually add weight and (if you want) sets to your program over the first few weeks until you are doing one to three sets of 8–12 repetitions of each exercise.

As you progress, add weight according to the “two-for-two” rule: When you can perform two additional repetitions with a given weight on two consecutive training sessions, increase the load. For example, if your target is to perform 8–10 repetitions per exercise, and you performed 12 repetitions in your previous two workouts, it would be appropriate to increase your load. If adding weight means you can do only 7 or 8 repetitions, stay with that weight until you can again complete 12 repetitions per set. If you can do only 4–6 repetitions after adding weight, or if you can’t maintain good form, you’ve added too much and should take some off.

You can add more resistance in large-muscle exercises, such as squats and bench presses, than you can in small-muscle exercises, such as curls. For example, when you can complete 12 repetitions of squats with good form, you may be able to add 10–20 pounds of additional resistance; for curls, on the other hand, you might add only 3–5 pounds. As a general guideline, try increases of approximately 5%, which is half a pound of additional weight for each 10 pounds you are currently lifting.

You can expect to improve rapidly during the first 6–10 weeks of training—a 10–30% increase in the amount of weight lifted. Gains will then come more slowly. Your rate of improvement will depend on how hard you work and how your body responds to resistance training. Factors such as age, gender, motivation, and heredity also will affect your progress.

After you achieve the level of strength and muscularity you want, you can maintain your gains by training 2–3 days per week. You can monitor the progress of your program by recording the amount of resistance and the number of repetitions and sets you perform on a workout card like the one shown in Figure 4.3.

WORKOUT CARD FOR Sara Lopez										
Exercise/Date		9/14	9/16	9/18	9/21	9/23	9/25	9/28	9/30	10/2
Bench press	Wt.	45	45	45	50	50	50	60	60	60
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	10	12	12	10	12	12	10	9	12
Pull-ups (assisted)	Wt.	—	—	—	—	—	—	—	—	—
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	5	5	5	6	6	6	7	7	7
Shoulder press	Wt.	20	20	20	25	25	25	30	30	30
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	10	12	12	10	12	12	8	10	9
Upright rowing	Wt.	5	5	10	10	10	10	12	12	12
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	12	12	8	10	11	12	9	10	12
Biceps curls	Wt.	15	15	15	20	20	20	25	25	25
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	10	10	10	10	12	12	8	10	10
Lateral raise	Wt.	5	5	5	5	5	5	7.5	7.5	7.5
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	8	8	10	10	12	12	8	10	10
Squats	Wt.	—	—	—	45	45	45	55	55	55
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	10	12	15	8	12	12	8	12	12
Heel raises	Wt.	—	—	—	45	45	45	55	55	55
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	15	15	15	8	12	12	10	12	12
Abdominal curls	Wt.	—	—	—	—	—	—	—	—	—
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	20	20	20	20	20	20	25	25	25
Spine extensions	Wt.	—	—	—	—	—	—	—	—	—
	Sets	1	1	1	1	1	1	1	1	1
	Reps.	5	5	5	8	8	8	10	10	10
Side bridge	Wt.	—	—	—	—	—	—	—	—	—
	Sets	1	1	1	1	1	1	1	1	1
	Seconds	60	60	60	65	65	70	70	70	70

FIGURE 4.3 A sample workout card for a general fitness strength training program.

## More Advanced Strength Training Programs

The program just described is sufficient to develop and maintain muscular strength and endurance for general fitness. Performing more sets and fewer repetitions with a heavier load will cause greater increases in strength. Such a program might include three to five sets of 4–6 repetitions each; the load should be heavy enough to cause fatigue with the smaller number of repetitions. Rest long enough after a set (3–5 minutes) to allow your muscles to recover and work intensely during the next set.

Experienced weight trainers often practice some form of cycle training, also called *periodization*, in which the exercises, number of sets and repetitions, and intensity vary within a workout and/or between workouts. For example, you might do a particular exercise more intensely during some sets or on some days than others. You might also vary the exercises you perform for particular muscle groups. For more detailed information on these more advanced training techniques, consult a strength coach certified by the National Strength and Conditioning Association or

# Safe Weight Training



TAKE CHARGE

## General Guidelines

- When beginning a program or trying new exercises or equipment, ask a qualified trainer or instructor to show you how to do exercises safely and correctly.
- Lift weights from a stabilized body position; keep weights as close to your body as possible.
- Protect your back by maintaining control of your spine and avoiding dangerous positions. Don't twist your body while lifting.
- Observe proper lifting techniques and good form at all times. Don't lift beyond the limits of your strength.
- Don't hold your breath while doing weight training exercises. Doing so causes a decrease in blood returning to the heart and can make you become dizzy and faint. It can also increase blood pressure to dangerous levels. Exhale when exerting the greatest force, and inhale when moving the weight into position for the active phase of the lift. Breathe smoothly and steadily.
- Don't use defective equipment. Be aware of broken collars or bolts, frayed cables, broken chains, or loose cushions.
- Don't exercise if you're ill, injured, or overtrained. Do not try to work through the pain.

## Free Weights

- Make sure the bar is loaded evenly on both sides and that weights are secured with collars or spring clips.
- When you pick a weight up from the ground, keep your back straight and your head level. Don't bend at the waist with straight legs.
- Lift weights smoothly; don't jerk them. Control the weight through the entire range of motion.
- Do most of your lifting with your legs. Keep your hips and buttocks back. When doing standing lifts, maintain a good posture so that you protect your back. Bend at the hips, not with



the spine. Feet should be shoulder-width apart, heels and balls of the feet in contact with the floor, and knees slightly bent.

- Don't bounce weights against your body during an exercise.

## Spotting

- Use spotters for free weights exercises in which the bar crosses the face or head (e.g., the bench press), is placed on the back (e.g., squats), or is racked in front of the chest (e.g., overhead press from the rack).
- If one spotter is used, the spotter should stand behind the lifter; if two spotters are used, one spotter should stand at each end of the barbell.
- For squats with heavy resistance, use at least three spotters—one behind the lifter (hands near lifter's hips, waist, or torso) and one at each end of the bar. Squatting in a power rack will increase safety during this exercise.
- Spot dumbbell exercises at the forearms, as close to the weights as possible.
- For over-the-face and over-the-head lifts, the spotter should hold the bar with an alternate grip (one palm up and one palm down) inside the lifter's grip.
- Ensure good communication between spotter and lifter by agreeing on verbal signals before the exercise.

another reliable source. If you decide to adopt a more advanced training regimen, start off slowly to give your body a chance to adjust and to minimize the risk of injury.



## Fitness Tip

Doing three sets of resistance exercise is more anabolic than one set, meaning that doing multiple sets enhances muscle protein synthesis. If you're serious about strength training, do multiple sets of exercises to maximize muscle protein synthesis and muscle growth.

## Weight Training Safety

Injuries happen in weight training. Maximum physical effort, elaborate machinery, rapid movements, and heavy weights can combine to make the weight room a dangerous place if proper precautions aren't taken. To help ensure that your workouts are safe and productive, follow the guidelines in the box "Safe Weight Training" and the following suggestions.

**Use Proper Lifting Technique** Every exercise has a proper technique that is important for obtaining maximum benefits and preventing injury. Your instructor or weight room attendant can help explain the specific techniques for different exercises and weight machines.



## Dietary Supplements: A Consumer Dilemma

Wading through manufacturers' claims can be tricky when you are considering taking a dietary supplement. Although drugs and food products undergo stringent government testing, dietary supplements can be freely marketed without testing for safety or effectiveness. There is no guarantee that advertisements about dietary supplements are accurate or true.

What's the difference between a drug—which must be approved by the Food and Drug Administration (FDA)—and a dietary supplement? In some cases, the only real difference is in how the product is marketed. Some dietary supplements are as potentially dangerous as potent prescription drugs. But because dietary supplements have a different classification, manufacturers do not have to prove they are safe and effective before being sold; the FDA can, however, take action against any unsafe supplement product after it reaches the market.

Supplement manufacturers often make glowing claims about their products, such as “Builds lean muscle fast” or “Burns fat and gives you energy.” With all the hype, how can you determine if a particular supplement might be helpful? Ask yourself the following questions:

- **Do you really need a supplement at all?** Nutritional authorities agree that most athletes and young adults can obtain all the necessary ingredients for health and top athletic performance by eating a well-balanced diet and training appropriately. No dietary supplement outperforms

wholesome food and a good training regimen.

- **Is the product safe and effective?** The fact that a dietary supplement is available in your local store is no guarantee of safety. As described earlier, the FDA doesn't regulate supplements in the same way as drugs. The only way to determine if a supplement really works is to perform carefully controlled research on human subjects. Testimonials from individuals who claim to have benefited from the product don't count. Few dietary supplements have undergone careful human testing, so it is difficult to tell which of them may actually work.

- **Can you be sure that the product is of high quality?** There is no official agency that ensures the quality of dietary supplements. There is no guarantee that a supplement contains the desired ingredient, that dosages are appropriate, that potency is standardized, or that the product is free from contaminants. (See Chapter 8 for more information on dietary supplement labeling.)



Perform exercises smoothly and with good form. Lift or push the weight forcefully during the active phase of the lift and then lower it with control. Perform all lifts through the full range of motion and strive to maintain a neutral spine position during each exercise.

**Use Spotters and Collars with Free Weights** Spotters are necessary when an exercise has potential for danger; a weight that is out of control or falls can cause a serious injury. A spotter can assist you if you cannot complete a lift or if the weight tilts. A spotter can also help you move a weight into position before a lift and provide help or additional resistance during a lift. Spotting requires practice and coordination between the lifter and the spotter(s).

Collars are devices that secure weights to a barbell or dumbbell. Although people lift weights without collars, doing so is dangerous. It is easy to lose your balance or to raise one side of the weight faster than the other. Without collars, the weights can slip off and crash to the floor.

**Be Alert for Injuries** Report any obvious muscle or joint injuries to your instructor or physician, and stop exercising the affected area. Training with an injured joint or

muscle can lead to a more serious injury. Make sure you get the necessary first aid. Even minor injuries heal faster if you use the R-I-C-E principle of treating injuries described in Chapter 3.

Consult a physician if you have any unusual symptoms during exercise or if you're uncertain whether weight training is a proper activity for you. Conditions such as heart disease and high blood pressure can be aggravated during weight training. Immediately report symptoms such as headaches; dizziness; labored breathing; numbness; vision disturbances; and chest, neck, or arm pain.

### A Caution About Supplements and Drugs

Many active people use nutritional supplements and drugs in the quest for improved performance and appearance. Table 4.2 lists a selective summary of “performance aids” along with their potential side effects. Most of these substances are ineffective and expensive, and many are dangerous (see the box “Dietary Supplements: A Consumer Dilemma”). A balanced diet should be your primary nutritional strategy.



Table 4.2

## Performance Aids Marketed to Weight Trainers

SUBSTANCE	SUPPOSED EFFECTS	ACTUAL EFFECTS	SELECTED POTENTIAL SIDE EFFECTS
Adrenal androgens, such as dehydroepiandrosterone (DHEA), androstenedione	Increased testosterone, muscle mass, and strength; decreased body fat	Increased testosterone, strength, and fat-free mass; decreased fat in older subjects (more studies needed in younger people)	Gonadal suppression, prostate hypertrophy, breast development in males, masculinization in women and children; long-term effects unknown
Amino acids	Increased muscle mass	No effects if dietary protein intake is adequate; consuming before or after training may improve performance	Minimal side effects; unbalanced amino acid intake can cause problems with protein metabolism
Amphetamines	Prevention of fatigue; increased confidence and training intensity	Increased arousal, wakefulness, and confidence; feeling of enhanced decision-making ability	Depression and fatigue (after drug wears off), extreme confusion; neural and psychological effects including aggressiveness, paranoia, hallucinations, compulsive behavior, restlessness, irritability, heart arrhythmia, high blood pressure, and chest pain
Anabolic steroids	Increased muscle mass, strength, power, psychological aggressiveness, and endurance	Increased strength, power, fat-free mass, and aggression; no effects on endurance	Liver damage and tumors, decrease in high-density lipoprotein (good cholesterol), depressed sperm and testosterone production, high blood pressure, depressed immune function, problems with sugar metabolism, psychological disturbances, gonadal suppression, liver disease, acne, breast development in males, masculinization in women and children, heart disease, thicker blood, and increased risk of cancer; steroids are controlled substances*
Beta-agonists, such as clenbuterol, salmeterol, terbutaline	Enhanced performance; prevention of muscle atrophy; increased fat-free weight; decreased body fat	Used to treat asthma, including exercise-induced asthma	Insomnia, heart arrhythmia, anxiety, anorexia, nausea, heart enlargement, heart attack (particularly if used with steroids), and heart failure
Chromium picolinate	Increased muscle mass, decreased body fat; improved blood sugar control	Well-controlled studies show no significant effect on fat-free mass or body fat	Moderate doses (50–200 µg) appear safe; higher doses may cause DNA damage and other serious effects; long-term effects unknown
Creatine monohydrate	Increased creatine phosphate levels in muscles, muscle mass, and capacity for high-intensity exercise	Increased muscle mass and performance in some types of high-intensity exercise	Minimal side effects; long-term effects unknown
Diuretics	Promote loss of body fluid	Promote loss of body fluid to accentuate muscle definition; often taken with potassium supplements and very-low-calorie diets	Muscle cell destruction, low blood pressure, blood chemistry abnormalities, and heart problems
Energy drinks	Increased energy, strength, power	Increased training volume	Insomnia, increased blood pressure, heart palpitations
Ephedra	Decreased body fat; increased training intensity due to stimulant effect	Decreased appetite, particularly when taken with caffeine; some evidence for increased training intensity	Abnormal heart rhythms, nervousness, headache, gastrointestinal distress, and heatstroke; banned by the FDA
Erythropoietin, darbepoetin	Enhanced performance during endurance events	Stimulated growth of red blood cells; enhanced oxygen uptake and endurance	Increased blood viscosity (thickness); can cause potentially fatal blood clots

(Continued)

Table 4.2

Performance Aids Marketed to Weight Trainers (*continued*)

SUBSTANCE	SUPPOSED EFFECTS	ACTUAL EFFECTS	SELECTED POTENTIAL SIDE EFFECTS
Ginseng	Decreased effects of physical and emotional stress; increased oxygen consumption	Most well-controlled studies show no effect on performance	No serious side effects; high doses can cause high blood pressure, nervousness, and insomnia
Green tea extract	Decreased body fat	Some studies show decreases in body fat	Insomnia, headache, nausea, heart palpitations
Growth hormone	Increased muscle mass, strength, and power; decreased body fat	Increased muscle mass and strength; decreased fat mass; studies show no effect on muscle or exercise performance	Elevated blood sugar, high insulin levels, and carpal tunnel syndrome; enlargement of the heart and other organs; acromegaly (disease characterized by increased growth of bones in hands and face); diseases of the heart, nerves, bones, and joints; an extremely expensive controlled substance*
Human chorionic gonadotrophin (HCG)	Increased testosterone production; prevention of muscle atrophy during steroid withdrawal	Increased testosterone production	Interferes with normal testosterone regulation; banned in most sports
Beta-hydroxy beta-methylbutyrate (HMB)	Increased strength and muscle mass; decreased body fat	Some studies show increased fat-free mass and decreased fat; more research needed	No reported side effects; long-term effects unknown
Insulin	Increased muscle mass	Effectiveness in stimulating muscle growth unknown	Insulin shock (characterized by extremely low blood sugar), which can lead to unconsciousness and death
Insulin-like growth factor (IGF)	Increased muscle mass; improved cellular function	Actual effects in healthy, active people unknown	Similar to side effects of growth hormone; long-term use promotes cancer
“Metabolic-optimizing” meals for athletes	Increased muscle mass and energy supply; decreased body fat	No proven effects beyond those of balanced meals	No reported side effects, extremely expensive
Over-the-counter stimulants, such as caffeine, phenylpropanolamine (PPA)	Weight loss; improved endurance; stimulant effect	Can be used for weight control; may improve endurance; does not appear to enhance short-term maximal exercise capacity	Increased risk of heart attack and stroke in some people (in high doses); increased incidence of abnormal heart rhythm and insomnia; caffeine is addictive
Prescription appetite suppressants, such as diethylpropion, phentermine, sibutramine, rimonabant	Weight control, weight loss	Weight loss; typically prescribed only for short-term use	Restlessness, anxiety, dizziness, depression, tremors, increased urination, diarrhea, constipation, vomiting, high blood pressure, swelling of legs or ankles, insomnia, seizures, fast or irregular heart-beat, heart palpitations, blurred vision, rashes, and difficulty breathing; can be habit-forming
Protein, amino acids, polypeptide supplements	Increased muscle mass and growth hormone release; accelerated muscle development; decreased body fat	No effects if dietary protein intake is adequate; may promote protein synthesis if taken immediately before or after weight training	Can be dangerous for people with liver or kidney disease; substituting amino acid or polypeptide supplements for protein-rich food can cause nutrient deficiencies

\*Possession of a controlled substance is illegal without a prescription, and physicians are not allowed to prescribe controlled substances for the improvement of athletic performance. In addition, the use of anabolic steroids, growth hormone, or any of several other substances listed in this table is banned for athletic competition.

**SOURCES:** Brooks, G. A., et al. 2005. *Exercise Physiology: Human Bioenergetics and Its Applications*, 4th ed. New York: McGraw-Hill. Sports-supplement dangers. 2001. *Consumer Reports*, June. U.S. National Library of Medicine, National Institutes of Health. *MedlinePlus Medical Encyclopedia* (<http://www.nlm.nih.gov/medlineplus/encyclopedia.html>; retrieved).



## Wellness Tip

The FDA has issued several consumer warnings about dietary supplements—particularly the kinds that are marketed to people who want to build muscle and lose fat. A number of products have been pulled off store shelves after the FDA found they were not safe. Talk to your doctor before considering any dietary supplement.



## Ask yourself

### QUESTIONS FOR CRITICAL THINKING AND REFLECTION

Do you think athletes should be allowed to use drugs and supplements to improve their sports performance? Would you be tempted to use a banned performance-enhancing drug if you thought you could get away with it?

## WEIGHT TRAINING EXERCISES

A general book on fitness and wellness cannot include a detailed description of all weight training exercises. The following pages present a basic program for developing muscular strength and endurance for general fitness using free weights and weight machines. Instructions for each exercise are accompanied by photographs and a listing of the muscles being trained. See pages T4-2 and T4-3 of the color transparency insert “Touring the Musculoskeletal System” in this chapter for a clear illustration of the deep and superficial muscles referenced in the exercises.

Labs 4.2 and 4.3 will help you assess your current level of muscular endurance and design your own weight training program. If you want to develop strength for a

particular activity, your program should contain exercises for general fitness, exercises for the muscle groups most important for the activity, and exercises for muscle groups most often injured. Regardless of the goals of your program or the type of equipment you use, your program should be structured so that you obtain maximum results without risking injury.

## TIPS FOR TODAY AND THE FUTURE

You don't need a complicated or heavy training program to improve strength: Just one set of 8–12 repetitions of 8–10 exercises, done at least two nonconsecutive days per week, is enough for general fitness.

### RIGHT NOW YOU CAN

- Do a set of static (isometric) exercises. If you're sitting, try tightening your abdominal muscles as you press your lower back into the seat, or work your arms by placing the palms of your hands on top of your thighs and pressing down. Hold the contraction for 6 seconds and do 5–10 repetitions; don't hold your breath.
- Think of three things you've done in the past 24 hours that would have been easier or more enjoyable if you increased your level of muscular strength and endurance. Visualize improvements in your quality of life that could come from increased muscular strength and endurance.

### IN THE FUTURE YOU CAN

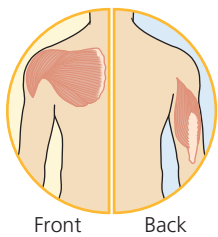
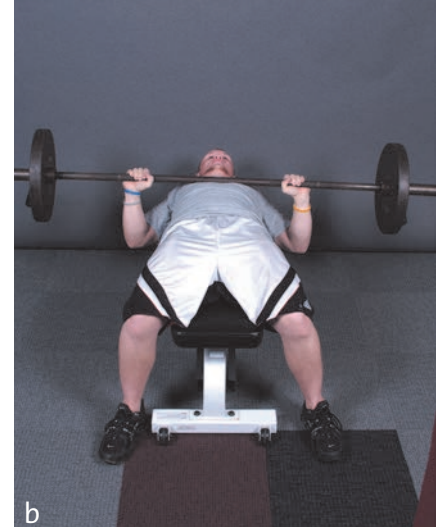
- Make an appointment with a trainer at your campus or neighborhood fitness facility. A trainer can help you put together an appropriate weight training program and introduce you to the equipment at the facility.
- Invest in an inexpensive set of free weights, kettlebells, a stability ball, or a resistance band. Then make a regular appointment with yourself to use your new equipment.

## WEIGHT TRAINING EXERCISES Free Weights

### EXERCISE 1

### Bench Press

**Instructions:** (a) Lying on a bench on your back with your feet on the floor, grasp the bar with palms upward and hands shoulder-width apart. If the weight is on a rack, move the bar carefully from the supports to a point over the middle of your chest or slightly above it (at the lower part of the sternum). (b) Lower the bar to your chest. Then press it in a straight line to the starting position. Don't arch your back or bounce the bar off your chest. You can also do this exercise with dumbbells.



**Muscles developed:**  
Pectoralis major,  
triceps, deltoids

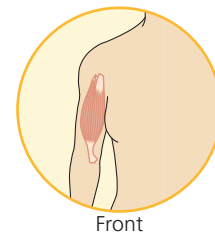
**Note:** To allow an optimal view of exercise technique, a spotter does not appear in these demonstration photographs; however, spotters should be used for most exercises with free weights.

### EXERCISE 2

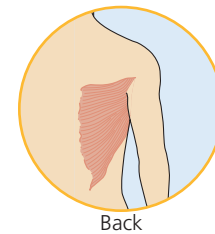
### Pull-Up



**Assisted pull-up:** (c) This is done as described for a pull-up, except that a spotter assists the person by pushing upward at the waist, hips, or legs during the exercise.



Front



Back

**Instructions:** (a) Begin by grasping the pull-up bar with both hands, palms facing forward and elbows extended fully. (b) Pull yourself upward until your chin goes above the bar. Then return to the starting position.

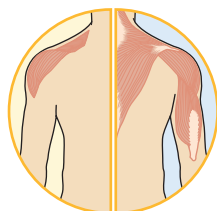
**Muscles developed:**  
Latissimus dorsi,  
biceps

### EXERCISE 3

### Shoulder Press (Overhead or Military Press)

**Instructions:** This exercise can be done standing or seated, with dumbbells or a barbell. The shoulder press begins with the weight at your chest, preferably on a rack. **(a)** Grasp the weight with your palms facing away from you. **(b)** Push the weight overhead until your arms are extended. Then return to the starting position (weight at chest). Be careful not to arch your back excessively.

If you are a more advanced weight trainer, you can “clean” the weight (lift it from the floor to your chest). The clean should be attempted only after instruction from a knowledgeable coach; otherwise, it can lead to injury.



Front Back

#### Muscles developed:

Deltoids, triceps, trapezius

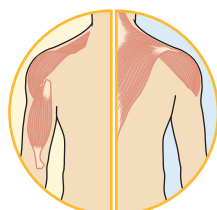


### EXERCISE 4

### Upright Rowing

**Instructions:** From a standing position with arms extended fully, grasp a barbell with a close grip (hands about 6–12 inches apart) and palms facing the body. Raise the bar to about the level of your collarbone, keeping your elbows above bar level at all times. Return to the starting position.

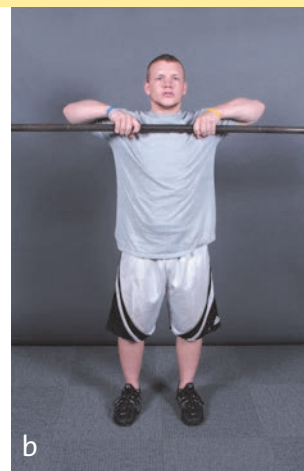
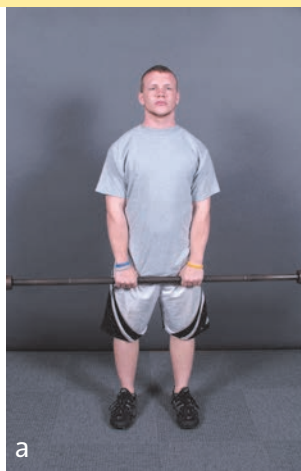
This exercise can be done using dumbbells, a weighted bar (shown), or a barbell.



Front Back

#### Muscles developed:

Trapezius, deltoids, biceps

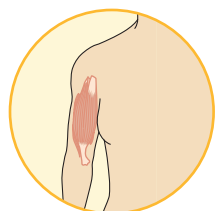


### EXERCISE 5

### Biceps Curl

**Instructions:** **(a)** From a standing position, grasp the bar with your palms facing away from you and your hands shoulder-width apart. **(b)** Keeping your upper body rigid, flex (bend) your elbows until the bar reaches a level slightly below the collarbone. Return the bar to the starting position.

This exercise can be done using dumbbells, a curl bar (shown), or a barbell; some people find that using a curl bar places less stress on the wrists.



Front

#### Muscles developed:

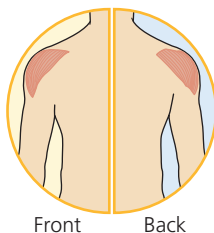
Biceps, brachialis



## EXERCISE 6

## Lateral Raise

**Instructions:** (a) Stand with feet shoulder-width apart and a dumbbell in each hand. Hold the dumbbells in front of you and parallel to each other. (b) With elbows slightly bent, slowly lift both weights until they reach shoulder level. Keep your wrists in a neutral position, in line with your forearms. Return to the starting position.



Front Back

**Muscles developed:**  
Deltoids



a

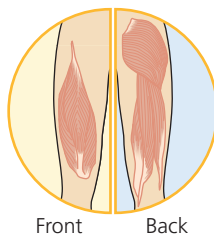


b

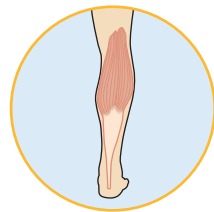
## EXERCISE 7

## Squat

**Instructions:** If the bar is racked, place the bar on the fleshy part of your upper back and grasp the bar at shoulder width. Keeping your back straight and head level, remove the bar from the rack and take a step back. Stand with feet slightly more than shoulder-width apart and toes pointed slightly outward. (a) Rest the bar on the back of your shoulders, holding it there with palms facing forward. (b) Keeping your head level and lower back straight and pelvis back, squat down until your thighs are below parallel with the floor. Let your thighs move laterally (outward) so that you “squat between your legs.” This will help keep your back straight and keep your heels on the floor. Drive upward toward the starting position, hinging at the hips and keeping your back in a fixed position throughout the exercise.

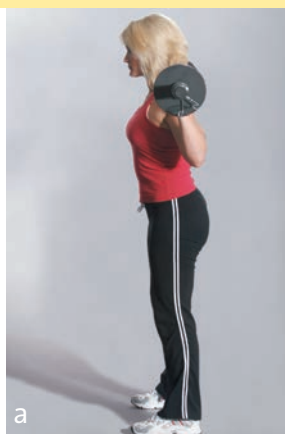


Front Back



Back

**Muscles developed:**  
Quadriceps, gluteus maximus, hamstrings, gastrocnemius



a

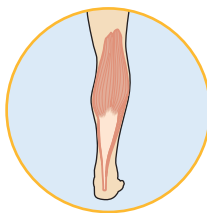


b

## EXERCISE 8

## Heel Raise

**Instructions:** Stand with feet shoulder-width apart and toes pointed straight ahead. (a) Rest the bar on the back of your shoulders, holding it there with palms facing forward. (b) Press down with your toes while lifting your heels. Return to the starting position.



Back

**Muscles developed:**  
Gastrocnemius, soleus



a



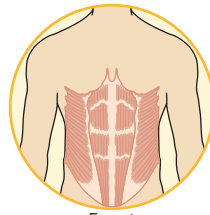
b

## EXERCISE 9

## Curl-Up or Crunch

**Instructions:** (a) Lie on your back on the floor with your arms folded across your chest and your feet on the floor or on a bench. (b) Curl your trunk up, minimizing your head and shoulder movement. Lower to the starting position. Focus on using your abdominal muscles rather than the muscles in your shoulders, chest, and neck.

This exercise can also be done using an exercise ball (see p. 106).



Front

### Muscles developed:

Rectus abdominis, obliques



## EXERCISE 10

## Spine Extension (“Bird Dog”) (Isometric Exercise)

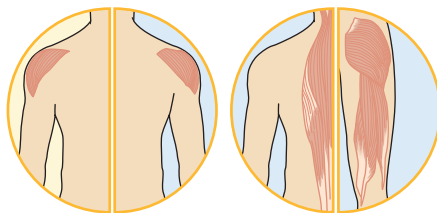
**Instructions:** Begin on all fours with your knees below your hips and your hands below your shoulders.

### Unilateral spine extension:

(a) Extend your right leg to the rear and reach forward with your right arm. Keep your spine neutral and your raised arm and leg in line with your torso. Don't arch your back or let your hip or shoulder sag. Hold this position for 10–30 seconds. Repeat with your left leg and left arm.

### Bilateral spine extension:

(b) Extend your left leg to the rear and reach forward with your right arm. Keep your spine neutral and your raised arm and leg in line with your torso. Don't arch your back or let your hip or shoulder sag. Hold this position for 10–30 seconds. Repeat with your right leg and left arm.



Front

Back

Back

**Muscles developed:** Erector spinae, gluteus maximus, hamstrings, deltoids

You can make this exercise more difficult by making box patterns with your arms and legs.



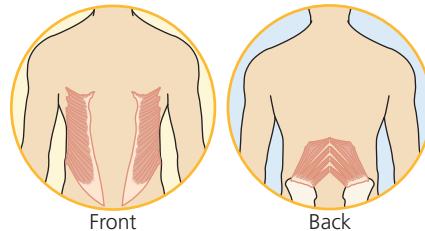
## EXERCISE 11

## Isometric Side Bridge

**Instructions:** Lie on the floor on your side with your knees bent and your top arm lying alongside your body. Lift and drive your hips forward so your weight is supported by your forearm and knee. Hold this position for 3–10 seconds, breathing normally. Repeat on the other side. Perform 3–10 repetitions on each side.



**Variation:** You can make the exercise more difficult by keeping your legs straight and supporting yourself with your feet and forearm (see Lab 5.3) or with your feet and hand (with elbow straight). You can also do this exercise on an exercise ball.



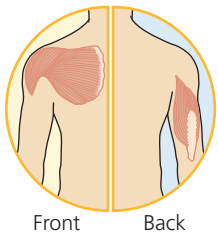
**Muscles developed:**  
Obliques,  
quadratus  
lumborum

## WEIGHT TRAINING EXERCISES Weight Machines

### EXERCISE 1

### Bench Press (Chest or Vertical Press)

**Instructions:** Sit or lie on the seat or bench, depending on the type of machine and the manufacturer's instructions. Your back, hips, and buttocks should be pressed against the machine pads. Place your feet on the floor or the foot supports.



**Muscles developed:**  
Pectoralis major,  
anterior deltoids,  
triceps



**(a)** Grasp the handles with your palms facing away from you; the handles should be aligned with your armpits.



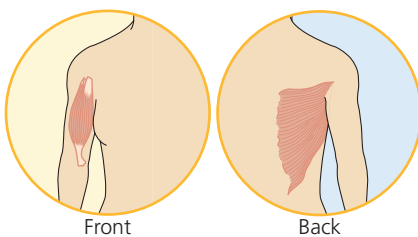
**(b)** Push the bars until your arms are fully extended, but don't lock your elbows. Return to the starting position.

### EXERCISE 2

### Lat Pull

**Instructions:** Begin in a seated or kneeling position, depending on the type of lat machine and the manufacturer's instructions.

**Note:** This exercise focuses on the same major muscles as the assisted pull-up (Exercise 3); choose an appropriate exercise for your program based on your preferences and equipment availability.



**Muscles developed:**  
Latissimus dorsi,  
biceps



**(a)** Grasp the bar of the machine with arms fully extended.



**(b)** Slowly pull the weight down until it reaches the top of your chest. Slowly return to the starting position.

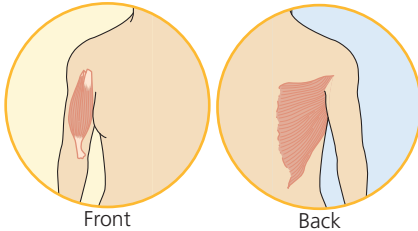


### EXERCISE 3

### Assisted Pull-Up

**Instructions:** Set the weight according to the amount of assistance you need to complete a set of pull-ups—the heavier the weight, the more assistance provided.

(a) Stand or kneel on the assist platform, and grasp the pull-up bar with your elbows fully extended and your palms facing away. (b) Pull up until your chin goes above the bar, and then return to the starting position.



**Muscles developed:**  
Latissimus dorsi,  
biceps

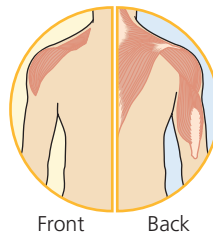


### EXERCISE 4

### Overhead Press (Shoulder Press)

**Instructions:** Adjust the seat so your feet are flat on the ground and the hand grips are slightly above your shoulders.

(a) Sit down, facing away from the machine, and grasp the hand grips with your palms facing forward. (b) Press the weight upward until your arms are extended. Return to the starting position.



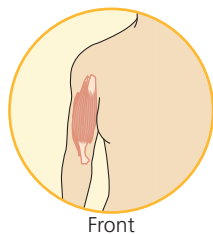
**Muscles developed:**  
Deltoids,  
trapezius, triceps



### EXERCISE 5

### Biceps Curl

**Instructions:** (a) Adjust the seat so that your back is straight and your arms rest comfortably against the top and side pads. Place your arms on the support cushions and grasp the hand grips with your palms facing up. (b) Keeping your upper body still, flex (bend) your elbows until the hand grips almost reach your collarbone. Return to the starting position.



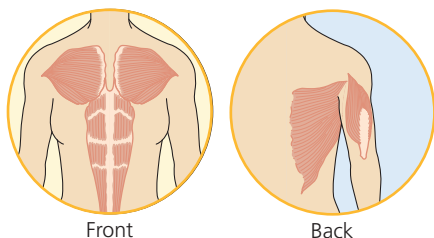
**Muscles developed:**  
Biceps, brachialis



## EXERCISE 6

## Pullover

**Instructions:** Adjust the seat so your shoulders are aligned with the cams. Push down on the foot pads with your feet to bring the bar forward until you can place your elbows on the pads. Rest your hands lightly on the bar. If possible, place your feet flat on the floor. **(a)** To get into the starting position, let your arms go backward as far as possible. **(b)** Pull your elbows forward until the bar almost touches your abdomen. Return to the starting position.



### Muscles developed:

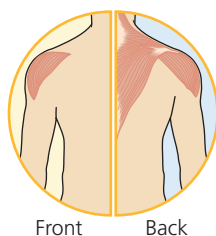
Latissimus dorsi, pectoralis major and minor, triceps, rectus abdominis



## EXERCISE 7

## Lateral Raise

**Instructions:** **(a)** Adjust the seat so the pads rest just above your elbows when your upper arms are at your sides, your elbows are bent, and your forearms are parallel to the floor. Lightly grasp the handles. **(b)** Push outward and up with your arms until the pads are at shoulder height. Lead with your elbows rather than trying to lift the bars with your hands. Return to the starting position.



### Muscles developed:

Deltoids, trapezius

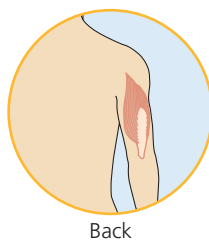


## EXERCISE 8

## Triceps Extension

**Note:** This exercise focuses on some of the same muscles as the assisted dip (Exercise 9); choose an appropriate exercise for your program based on your preferences and equipment availability.

**Instructions:** **(a)** Adjust the seat so your back is straight and your arms rest comfortably against the top and side pads. Place your arms on the support cushions and grasp the hand grips with palms facing inward. **(b)** Keeping your upper body still, extend your elbows as much as possible. Return to the starting position.



### Muscles developed:

Triceps

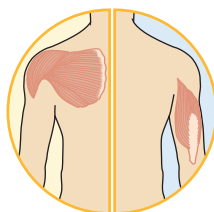


## EXERCISE 9

## Assisted Dip

**Instructions:** Set the weight according to the amount of assistance you need to complete a set of dips—the heavier the weight, the more assistance provided.

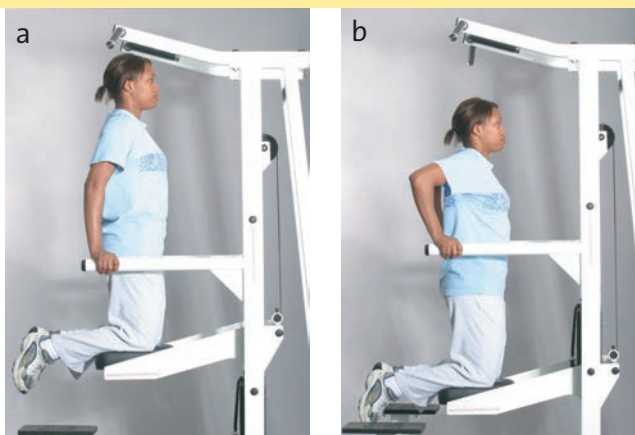
**(a)** Stand or kneel on the assist platform with your body between the dip bars. With your elbows fully extended and palms facing your body, support your weight on your hands. **(b)** Lower your body until your upper arms are approximately parallel with the bars. Then push up until you reach the starting position.



Front Back

### Muscles developed:

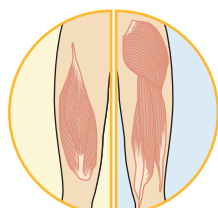
Triceps, deltoids, pectoralis major



## EXERCISE 10

## Leg Press

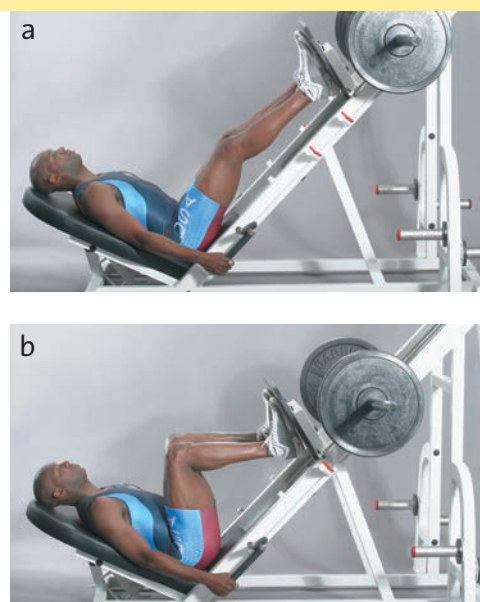
**Instructions:** Sit or lie on the seat or bench, depending on the type of machine and the manufacturer's instructions. Your head, back, hips, and buttocks should be pressed against the machine pads. Loosely grasp the handles at the side of the machine. **(a)** Begin with your feet flat on the foot platform about shoulder-width apart. Extend your legs, but do not forcefully lock your knees. **(b)** Slowly lower the weight by bending your knees and flexing your hips until your knees are bent at about a 90-degree angle or your heels start to lift off the foot platform. Keep your lower back flat against the support pad. Then extend your knees and return to the starting position.



Front Back

### Muscles developed:

Gluteus maximus, quadriceps, hamstrings

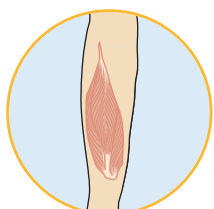


## EXERCISE 11

## Leg Extension (Knee Extension)

**Instructions:** **(a)** Adjust the seat so the pads rest comfortably on top of your lower shins. Loosely grasp the handles. **(b)** Extend your knees until they are almost straight. Return to the starting position.

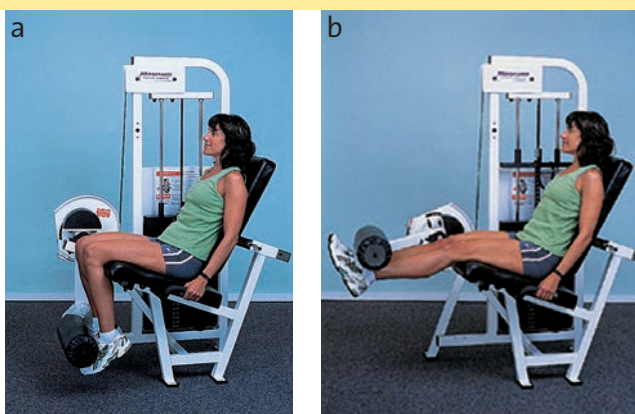
Knee extensions cause kneecap pain in some people. If you have kneecap pain during this exercise, check with an orthopedic specialist before repeating it.



Front

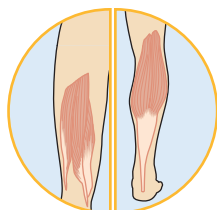
### Muscles developed:

Quadriceps



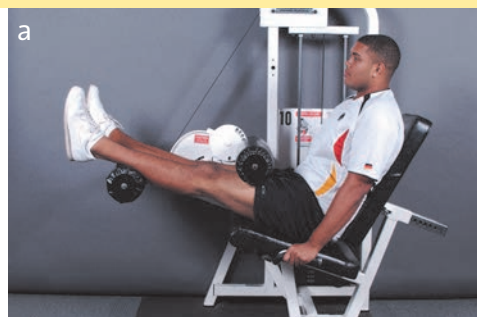
**EXERCISE 12****Seated Leg Curl**

**Instructions:** (a) Sit on the seat with your back against the back pad and the leg pad below your calf muscles. (b) Flex your knees until your lower and upper legs form a 90-degree angle. Return to the starting position.

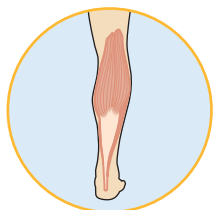


Back Back

**Muscles developed:**  
Hamstrings,  
gastrocnemius

**EXERCISE 13****Heel Raise**

**Instructions:** (a) Stand with your head between the pads and one pad on each shoulder. The balls of your feet should be on the platform. Lightly grasp the handles. (b) Press down with your toes while lifting your heels. Return to the starting position. Changing the direction your feet are pointing (straight ahead, inward, and outward) will work different portions of your calf muscles.



Back

**Muscles developed:**  
Gastrocnemius,  
soleus



**Note:** Abdominal machines, low-back machines, and trunk rotation machines are not recommended because of injury risk. Refer to the “Free Weights” exercise section for appropriate exercises to strengthen the abdominal and low-back muscles. For the rectus abdominus, obliques, and transverse abdominus, perform curl-ups (Exercise 9 in

the “Free Weights” section), and for the erector spinae and quadratus lumborum, perform the spine extension and the isometric side bridge (Exercises 10 and 11 in the “Free Weights” section).

## Q Will I gain weight if I do resistance exercises?

**A** Your weight probably will not change significantly as a result of a general fitness program: one set of 8–12 repetitions of 8–10 exercises, performed on at least two nonconsecutive days per week. You will increase muscle mass and lose body fat, so your weight will stay about the same. You may notice a change in how your clothes fit, however, because muscle is denser than fat. Increased muscle mass will help you control body fat. Muscle increases your metabolism, which means you burn more calories every day. If you combine resistance exercises with endurance exercises, you will be on your way to developing a healthier body composition. Concentrate on fat loss rather than weight loss.

## Q Do I need more protein in my diet when I train with weights?

**A** No. Although there is some evidence that power athletes involved in heavy training have a higher-than-normal protein requirement, there is no reason for most people to consume extra protein. Most Americans take in more protein than they need, so even if there is an increased protein need during heavy training, it is probably supplied by the average diet. Consuming a protein-rich snack before or after training may promote muscle hypertrophy.

## Q What causes muscle soreness the day or two following a weight training workout?

**A** The muscle pain you feel a day or two after a heavy weight training workout is caused by injury to the muscle fibers and surrounding connective tissue. Contrary to popular belief, delayed-onset muscle soreness

is not caused by lactic acid buildup. Scientists believe that injury to muscle fibers causes inflammation, which in turn causes the release of chemicals that break down part of the muscle tissue and cause pain. After a bout of intense exercise that causes muscle injury and delayed-onset muscle soreness, the muscles produce protective proteins that prevent soreness during future workouts. If you don't work out regularly, you lose these protective proteins and become susceptible to soreness again.

## Q Will strength training improve my sports performance?

**A** Strength developed in the weight room does not automatically increase your power in sports such as skiing, tennis, or cycling. Hitting a forehand in tennis and making a turn on skis are precise skills that require coordination between your nervous system and muscles. For skilled people, movements become reflex; you don't think about them when you do them. Increasing strength can disturb this coordination. Only by simultaneously practicing a sport and improving fitness can you expect to become more powerful in the skill. Practice helps you integrate your new strength with your skills, which makes you more powerful. Consequently, you can hit the ball harder in tennis or make more graceful turns on the ski slopes. (Refer to Chapter 2 for more on the concept of specificity in physical training.)

## Q Will I improve faster if I train every day?

**A** No. Your muscles need time to recover between training sessions. Doing resistance exercises every day will cause you to become overtrained, which will increase your chance of injury and impede your progress. If your strength training program reaches a plateau, try one of these strategies:

- Vary the number of sets. If you have been performing one set of each exercise, add sets.
- Train less frequently. If you are currently training the same muscle groups three or more times per week, you may not be allowing your muscles to fully recover from intense workouts.
- Change exercises. Using different exercises for the same muscle group may stimulate further strength development.
- Vary the load and number of repetitions. Try increasing or decreasing the loads you are using and changing the number of repetitions accordingly.
- If you are training alone, find a motivated training partner. A partner can encourage you and assist you with difficult lifts, forcing you to work harder.

## Q If I stop training, will my muscles turn to fat?

**A** No. Fat and muscle are two different kinds of tissue, and one cannot turn into the other. Muscles that aren't used become smaller (atrophy), and body fat may increase if caloric intake exceeds calories burned. Although the result of inactivity may be smaller muscles and more fat, the change is caused by two separate processes.

## Q Should I wear a weight belt when I lift?

**A** Until recently, most experts advised people to wear weight belts. However, several studies have shown that weight belts do not prevent back injuries and may, in fact, increase the risk of injury by encouraging people to lift more weight than they are capable of lifting with good form. Although wearing a belt may allow you to lift more weight in some lifts, you may not get the full benefit of your program because use of a weight belt reduces the effectiveness of the workout on the muscles that help support your spine.

For more Common Questions Answered about strength training, visit the Online Learning Center at [www.mhhe.com/fahey](http://www.mhhe.com/fahey).

## SUMMARY

- Hypertrophy (increased muscle fiber size) occurs when weight training causes the size and number of myofibrils to increase, thereby increasing total muscle size. Strength also increases through muscle learning. Most women do not develop large muscles from weight training.
- Improvements in muscular strength and endurance lead to enhanced physical performance, protection against injury, improved body composition, better self-image, improved muscle and bone health with aging, reduced risk of chronic disease, and decreased risk of premature death.
- Muscular strength can be assessed by determining the amount of weight that can be lifted in one repetition of an exercise. Muscular endurance can be assessed by determining the number of repetitions of a particular exercise that can be performed.
- Static (isometric) exercises involve contraction without movement. They are most useful when a person is recovering from an injury or surgery or needs to overcome weak points in a range of motion.
- Dynamic (isotonic) exercises involve contraction that results in movement. The two most common types are constant resistance (free weights) and variable resistance (many weight machines).
- Free weights and weight machines have pluses and minuses for developing fitness, although machines tend to be safer.
- Lifting heavy weights for only a few repetitions helps develop strength. Lifting lighter weights for more repetitions helps develop muscular endurance.
- A strength training program for general fitness includes at least one set of 8–12 repetitions (enough to cause fatigue) of 8–10 exercises, along with warm-up and cool-down periods. The program should be carried out at least 2 nonconsecutive days per week.
- Safety guidelines for strength training include using proper technique, using spotters and collars when necessary, and taking care of injuries.
- Supplements or drugs that are promoted as instant or quick “cures” usually don’t work and are either dangerous, expensive, or both.

## FOR FURTHER EXPLORATION

### BOOKS

Baechle, T., and R. W. Earl. 2008. *National Strength and Conditioning Association’s Essentials of Strength and Conditioning*. Champaign, Ill.: Human Kinetics. *A textbook of strength and conditioning for fitness professionals.*

Bjornlund, L. 2010. *How Dangerous Are Performance-Enhancing Drugs?* San Diego, Calif.: Referencepoint Press. *A discussion of the effects of performance-enhancing drugs on health, performance, and the integrity of sport. The author discusses the role of sports organizations in preventing drug use and whether they can be successful.*

Delavier, F. 2010. *Strength Training Anatomy*, 3rd ed. Champaign, Ill.: Human Kinetics. *Includes exercises for all major muscle groups as well as full anatomical pictures of the muscular system. Women’s Strength Training Anatomy, a matching volume for women, was published in 2003.*

Fahey, T. D. 2011. *Basic Weight Training for Men and Women*, 8th ed. New York: McGraw-Hill. *A practical guide to developing training programs, using free weights, tailored to individual needs.*

Goldenberg, L., and P. Twist. 2007. *Strength Ball Training*. Champaign, Ill.: Human Kinetics. *A guide to incorporating exercise balls and medicine balls into a complete weight training program.*

Lethi, A., et al. 2007. *Free-Weight Training*. Berkeley, Calif.: Thunder Bay Press. *A complete guide to training with free weights, with special instructions for using weights with an exercise ball.*

Tsatsouline, P. 2010. *Enter the Kettlebell*. Minneapolis, Minn.: Dragon Door Publications. *A guide to basic strength training using kettlebells.*

### ORGANIZATIONS AND WEB SITES

*American College of Sports Medicine Position Stand: Progression Models in Resistance Training for Healthy Adults.* Provides an in-depth look at strategies for setting up a strength training program and making progress based on individual program goals.

[http://journals.lww.com/acsm-msse/Fulltext/2009/03000/Progression\\_Models\\_in\\_Resistance\\_Training\\_for.26.aspx](http://journals.lww.com/acsm-msse/Fulltext/2009/03000/Progression_Models_in_Resistance_Training_for.26.aspx)

*Dan John.* An excellent Web site for people serious about improving strength and fitness, written by a world-class athlete and coach in track and field and Highland games.

<http://danjohn.net>

*Georgia State University: Strength Training.* Provides information about the benefits of strength training and ways to develop a safe and effective program; also includes illustrations of a variety of exercises.

<http://www2.gsu.edu/~wwwfit/strength.html>

*Human Anatomy On-line.* Provides text, illustrations, and animation about the muscular system, nerve-muscle connections, muscular contraction, and other topics.

<http://www.innerbody.com/html/body.html>

*Mayo Clinic: Weight Training: Improve Your Muscular Fitness.* Provides a basic overview of weight training essentials along with links to many other articles on specific weight training-related topics.

<http://www.mayoclinic.com/health/weight-training/HQ01627>

*National Strength and Conditioning Association.* A professional organization that focuses on strength development for fitness and athletic performance.

<http://www.nscf-lift.org>

*Pilates Method Alliance.* Provides information about Pilates and about instructor certification; includes a directory of instructors.

<http://www.pilatesmethodalliance.org>

*University of California, San Diego: Muscle Physiology Home Page.* Provides an introduction to muscle physiology, including information about types of muscle fibers and energy cycles.

<http://muscle.ucsd.edu/index.shtml>

University of Michigan: *Muscles in Action*. Interactive descriptions of muscle movements.

<http://www.med.umich.edu/lrc/Hypermuscle/Hyper.html>

See also the listings in Chapter 2.

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Name \_\_\_\_\_ Section \_\_\_\_\_ Date \_\_\_\_\_



## LAB 4.1 Assessing Your Current Level of Muscular Strength

For best results, don't do any strenuous weight training within 48 hours of any test. Use great caution when completing 1-RM tests; do not take the maximum bench press test if you have any injuries to your shoulders, elbows, back, hips, or knees. In addition, do not take these tests until you have had at least one month of weight training experience.

### The Maximum Bench Press Test

#### Equipment

The free weights bench press test uses the following equipment

1. Flat bench (with or without racks)
2. Barbell
3. Assorted weight plates, with collars to hold them in place
4. One or two spotters
5. Weight scale

If a weight machine is preferred, use the following equipment:

1. Universal Gym Dynamic Variable Resistance Machine
2. Weight scale

#### Preparation

Try a few bench presses with a small amount of weight so you can practice your technique, warm up your muscles, and, if you use free weights, coordinate your movements with those of your spotters. Weigh yourself and record the results.

Body weight: \_\_\_\_\_ lb



Maximum bench press test.

#### Instructions

1. Use a weight that is lower than the amount you believe you can lift. For free weights, men should begin with a weight about two-thirds of their body weight; women should begin with the weight of just the bar (45 lb).
2. Lie on the bench with your feet firmly on the floor. If you are using a weight machine, grasp the handles with palms away from you; the tops of the handles should be aligned with the tops of your armpits.

If you are using free weights, grasp the bar slightly wider than shoulder width with your palms away from you. If you have one spotter, she or he should stand directly behind the bench; if you have two spotters, they should stand to the side, one at each end of the barbell. Signal to the spotter when you are ready to begin the test by saying "1, 2, 3." On "3," the spotter should help you lift the weight to a point over your midchest (nipple line).

3. Push the handles or barbell until your arms are fully extended. Exhale as you lift. If you are using free weights, the weight moves from a low point at the chest straight up. Keep your feet firmly on the floor, don't arch your back, and push the weight evenly with your right and left arms. Don't bounce the weight on your chest.
4. Rest for several minutes, then repeat the lift with a heavier weight. It will probably take several attempts to determine the maximum amount of weight you can lift (1 RM).

1 RM: \_\_\_\_\_ lb      Check one: \_\_\_\_\_ Free weights \_\_\_\_\_ Universal \_\_\_\_\_ Other

5. If you used free weights, convert your free weights bench press score to an estimated value for 1 RM on the Universal bench press using the appropriate formula:

Males: Estimated Universal 1 RM =  $(1.016 \times \text{free weights 1 RM } \_\_\_\_\_\_ \text{ lb}) + 18.41 = \_\_\_\_\_\_ \text{ lb}$

Females: Estimated Universal 1 RM =  $(0.848 \times \text{free weights 1 RM } \_\_\_\_\_\_ \text{ lb}) + 21.37 = \_\_\_\_\_\_ \text{ lb}$

## Rating Your Bench Press Result

1. Divide your Universal 1-RM value by your body weight.  
1 RM \_\_\_\_\_ lb ÷ body weight \_\_\_\_\_ lb = \_\_\_\_\_
2. Find this ratio in the table to determine your bench press strength rating. Record the rating here and in the chart at the end of this lab.  
Bench press strength rating: \_\_\_\_\_

## Strength Ratings for the Maximum Bench Press Test

Men	Pounds Lifted/Body Weight (lb)					
	<i>Very Poor</i>	<i>Poor</i>	<i>Fair</i>	<i>Good</i>	<i>Excellent</i>	<i>Superior</i>
Age: Under 20	Below 0.89	0.89–1.05	1.06–1.18	1.19–1.33	1.34–1.75	Above 1.75
20–29	Below 0.88	0.88–0.98	0.99–1.13	1.14–1.31	1.32–1.62	Above 1.62
30–39	Below 0.78	0.78–0.87	0.88–0.97	0.98–1.11	1.12–1.34	Above 1.34
40–49	Below 0.72	0.72–0.79	0.80–0.87	0.88–0.99	1.00–1.19	Above 1.19
50–59	Below 0.63	0.63–0.70	0.71–0.78	0.79–0.89	0.90–1.04	Above 1.04
60 and over	Below 0.57	0.57–0.65	0.66–0.71	0.72–0.81	0.82–0.93	Above 0.93
<b>Women</b>						
Age: Under 20	Below 0.53	0.53–0.57	0.58–0.64	0.65–0.76	0.77–0.87	Above 0.87
20–29	Below 0.51	0.51–0.58	0.59–0.69	0.70–0.79	0.80–1.00	Above 1.00
30–39	Below 0.47	0.47–0.52	0.53–0.59	0.60–0.69	0.70–0.81	Above 0.81
40–49	Below 0.43	0.43–0.49	0.50–0.53	0.54–0.61	0.62–0.76	Above 0.76
50–59	Below 0.39	0.39–0.43	0.44–0.47	0.48–0.54	0.55–0.67	Above 0.67
60 and over	Below 0.38	0.38–0.42	0.43–0.46	0.47–0.53	0.54–0.71	Above 0.71

**SOURCE:** Based on norms from The Cooper Institute of Aerobic Research, Dallas, Texas; from *The Physical Fitness Specialist Manual*, revised 2002. Used with permission.

## Predicting 1 RM from Multiple-Repetition Lifts Using Free Weights

Instead of doing the 1-RM maximum strength bench press test, you can predict your 1 RM from multiple-repetition lifts.

### Instructions

1. Choose a weight you think you can bench press five times.
2. Follow the instructions for lifting the weight given in the maximum bench press test.
3. Do as many repetitions of the bench press as you can. A repetition counts only if done correctly.
4. Refer to the chart on p. 131, or calculate predicted 1 RM using the Brzycki equation:  
1 RM =  $weight \div (1.0278 - [0.0278 \times number\ of\ repetitions])$   
1 RM = \_\_\_\_\_ lb ÷  $(1.0278 - [0.0278 \times \text{_____ repetitions}]) = \text{_____}$
5. Divide your predicted 1-RM value by your body weight.  
1 RM \_\_\_\_\_ lb ÷ body weight \_\_\_\_\_ lb = \_\_\_\_\_
6. Find this ratio in the table above to determine your bench press strength rating. Record the rating here and in the chart at the end of the lab.  
Bench press strength rating: \_\_\_\_\_

## RMs from the Multiple-Repetitions Bench Press Test

Weight Lifted (lb)	Repetitions											
	1	2	3	4	5	6	7	8	9	10	11	12
66	66	68	70	72	74	77	79	82	85	88	91	95
77	77	79	82	84	87	89	92	96	99	103	107	111
88	88	91	93	96	99	102	106	109	113	117	122	127
99	99	102	105	108	111	115	119	123	127	132	137	143
110	110	113	116	120	124	128	132	137	141	147	152	158
121	121	124	128	132	136	141	145	150	156	161	168	174
132	132	136	140	144	149	153	158	164	170	176	183	190
143	143	147	151	156	161	166	172	178	184	191	198	206
154	154	158	163	168	173	179	185	191	198	205	213	222
165	165	170	175	180	186	192	198	205	212	220	229	238
176	176	181	186	192	198	204	211	219	226	235	244	254
187	187	192	198	204	210	217	224	232	240	249	259	269
198	198	204	210	216	223	230	238	246	255	264	274	285
209	209	215	221	228	235	243	251	259	269	279	289	301
220	220	226	233	240	248	256	264	273	283	293	305	317
231	231	238	245	252	260	268	277	287	297	308	320	333
242	242	249	256	264	272	281	290	300	311	323	335	349
253	253	260	268	276	285	294	304	314	325	337	350	364
264	264	272	280	288	297	307	317	328	340	352	366	380
275	275	283	291	300	309	319	330	341	354	367	381	396
286	286	294	303	312	322	332	343	355	368	381	396	412
297	297	305	314	324	334	345	356	369	382	396	411	428
308	308	317	326	336	347	358	370	382	396	411	427	444

**SOURCE:** Brzycki, M. 1993. Strength testing—predicting a one-rep max from reps to fatigue. *The Journal of Physical Education, Recreation and Dance* 64: 88–90. January 1993, a publication of the American Alliance for Health, Physical Education, Recreation and Dance, [www.aahperd.org](http://www.aahperd.org). Reprinted with permission.

## Functional Leg Strength Tests

The following tests assess functional leg strength using squats. Most people do squats improperly increasing their risk of knee and back pain. Before you add weight-bearing squats to your weight training program, you should determine your functional leg strength, check your ability to squat properly, and give yourself a chance to master squatting movements. The following leg strength tests will help you in each of these areas.

These tests are progressively more difficult, so do not move to the next test until you have scored at least a 3 on the current test. On each test, give yourself a rating of 0, 1, 3, or 5, as described in the instructions that follow the last test.

### 1. Chair Squat

#### Instructions

1. Sit up straight in a chair with your back resting against the backrest and your arms at your sides. Your feet should be placed more than shoulder-width apart so that you can get them under the body.
2. Begin the motion of rising out of the chair by flexing (bending) at the hips—not the back. Then squat up using a hip hinge movement (no spine movement). Stand without rocking forward, bending your back, or using external support, and keep your head in a neutral position.



- Return to the sitting position while maintaining a straight back and keeping your weight centered over your feet. Your thighs should abduct (spread) as you sit back in the chair. Use your rear hip and thigh muscles as much as possible as you sit.

Do five repetitions.

Your rating: \_\_\_\_\_

(See rating instructions that follow.)

## 2. Single-Leg Step-Up

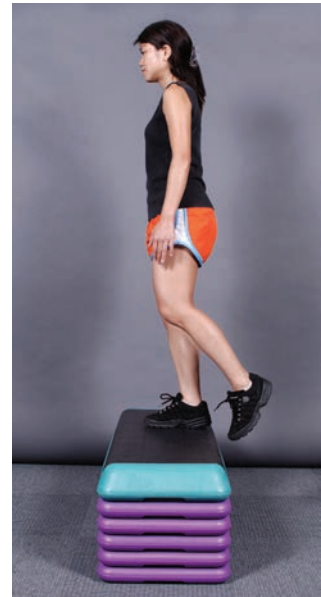
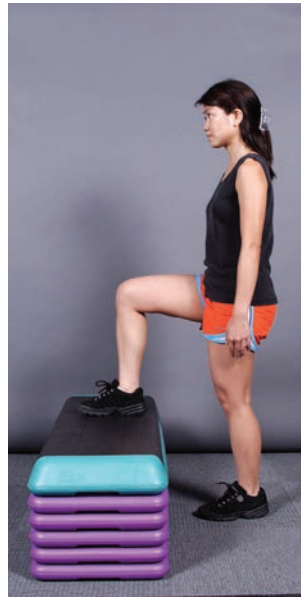
### Instructions

- Stand facing a bench, with your right foot placed on the middle of the bench, right knee bent at 90 degrees, and arms at your sides.
- Step up on the bench until your right leg is straight, maximizing the use of the hip muscles.
- Return to the starting position. Keep your hips stable, back straight, chest up, shoulders back, and head neutral during the entire movement.

Do five repetitions for each leg.

Your rating: \_\_\_\_\_

(See rating instructions that follow.)



## 3. Unweighted Squat

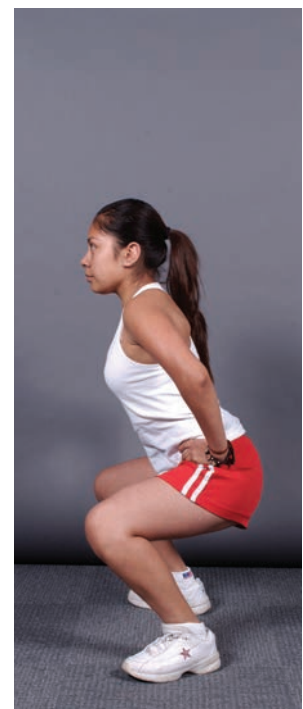
### Instructions

- Stand with your feet placed slightly more than shoulder-width apart, toes pointed out slightly, hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
- Squat down, keeping your weight centered over your arches and actively flexing (bending) your hips until your legs break parallel. During the movement, keep your back straight, shoulders back, and chest out, and let your thighs part to the side so that you are “squatting between your legs.”
- Push back up to the starting position, hinging at the hips and not with the spine, maximizing the use of the rear hip and thigh muscles, and maintaining a straight back and neutral head position.

Do five repetitions.

Your rating: \_\_\_\_\_

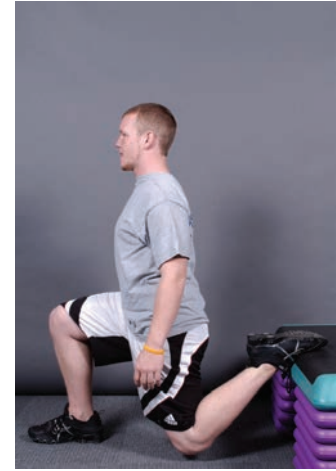
(See rating instructions that follow.)



#### 4. Single-Leg Lunge-Squat with Rear-Foot Support

##### Instructions

1. Stand about 3 feet in front of a bench (with your back to the bench).
2. Place the instep of your left foot on the bench, and put most of your weight on your right leg (your left leg should be bent), with your hands at your sides.
3. Squat on your right leg until your thigh is parallel with the floor. Keep your back straight, chest up, shoulders back, and head neutral.
4. Return to the starting position.



Do three repetitions for each leg.

Your rating: \_\_\_\_\_

(See rating instructions that follow.)

### Rating Your Functional Leg Strength Test Results

*5 points:* Performed the exercise properly with good back and thigh position, weight centered over the middle or rear of the foot, chest out, and shoulders back; good use of hip muscles on the way down and on the way up, with head in a neutral position throughout the movement; maintained good form during all repetitions; abducted (spread) the thighs on the way down during chair squats and double-leg squats; for single-leg exercises, showed good strength on both sides; for single-leg lunge-squat with rear-foot support, maintained straight back, and knees stayed behind toes.

*3 points:* Weight was forward on the toes, with some rounding of the back; used thigh muscles excessively, with little use of hip muscles; head and chest were too far forward; showed little abduction of the thighs during double-leg squats; when going down for single-leg exercises, one side was stronger than the other; form deteriorated with repetitions; for single-leg lunge-squat with rear-foot support, could not reach parallel (thigh parallel with floor).

*1 point:* Had difficulty performing the movement, rocking forward and rounding back badly; used thigh muscles excessively, with little use of hip muscles on the way up or on the way down; chest and head were forward; on unweighted squats, had difficulty reaching parallel and showed little abduction of the thighs; on single-leg exercises, one leg was markedly stronger than the other; could not perform multiple repetitions.

*0 points:* Could not perform the exercise.

### Summary of Results

Maximum bench press test from either the 1-RM test or the multiple-repetition test: Weight pressed: \_\_\_\_\_ lb Rating: \_\_\_\_\_

Functional leg strength tests (0–5): Chair squat: \_\_\_\_\_ Single-leg step-up: \_\_\_\_\_ Unweighted squat: \_\_\_\_\_

Single-leg lunge-squat with rear-foot support: \_\_\_\_\_

Remember that muscular strength is specific: Your ratings may vary considerably for different parts of your body.

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## Using Your Results

*How did you score?* Are you surprised by your ratings for muscular strength? Are you satisfied with your current ratings?

If you're not satisfied, set realistic goals for improvement:

Are you satisfied with your current level of muscular strength as evidenced in your daily life—for example, your ability to lift objects, climb stairs, and engage in sports and recreational activities?

If you're not satisfied, set realistic goals for improvement:

*What should you do next?* Enter the results of this lab in the Preprogram Assessment column in Appendix C. If you've set goals for improvement, begin planning your strength training program by completing the plan in Lab 4.3. After several weeks of your program, complete this lab again and enter the results in the Postprogram Assessment column of Appendix C. How do the results compare?

Name \_\_\_\_\_ Section \_\_\_\_\_ Date \_\_\_\_\_



## LAB 4.2 Assessing Your Current Level of Muscular Endurance

For best results, don't do any strenuous weight training within 48 hours of any test. To assess endurance of the abdominal muscles, perform the curl-up test. To assess endurance of muscles in the upper body, perform the push-up test. To assess endurance of the muscles in the lower body, perform the squat endurance test.

### The Curl-Up Test

#### Equipment

1. Four 6-inch strips of self-stick Velcro or heavy tape
2. Ruler
3. Partner
4. Mat (optional)

#### Preparation

Affix the strips of Velcro or long strips of tape on the mat or testing surface. Place the strips 3 inches apart.

#### Instructions

1. Start by lying on your back on the floor or mat, arms straight and by your sides, shoulders relaxed, palms down and on the floor, and fingers straight. Adjust your position so that the longest fingertip of each hand touches the end of the near strip of Velcro or tape. Your knees should be bent about 90 degrees, with your feet about 12–18 inches from your buttocks.
2. To perform a curl-up, flex your spine while sliding your fingers across the floor until the fingertips of each hand reach the second strip of Velcro or tape. Then return to the starting position; the shoulders must be returned to touch the mat between curl-ups, but the head need not touch. Shoulders must remain relaxed throughout the curl-up, and feet and buttocks must stay on the floor. Breathe easily exhaling during the lift phase of the curl-up; do not hold your breath.
3. Once your partner says “go,” perform as many curl-ups as you can at a steady pace with correct form. Your partner counts the curl-ups you perform and calls a stop to the test if she or he notices any incorrect form or drop in your pace.

Number of curl-ups: \_\_\_\_\_



#### Rating Your Curl-Up Test Result

Your score is the number of completed curl-ups. Refer to the appropriate portion of the table for a rating of your abdominal muscular endurance. Record your rating below and in the summary at the end of this lab.

Rating: \_\_\_\_\_

## Ratings for the Curl-Up Test

Men	Number of Curl-Ups					
	<i>Very Poor</i>	<i>Poor</i>	<i>Average</i>	<i>Good</i>	<i>Excellent</i>	<i>Superior</i>
Age: 16–19	Below 48	48–57	58–64	65–74	75–93	Above 93
20–29	Below 46	46–54	55–63	64–74	75–93	Above 93
30–39	Below 40	40–47	48–55	56–64	65–81	Above 81
40–49	Below 38	38–45	46–53	54–62	63–79	Above 79
50–59	Below 36	36–43	44–51	52–60	61–77	Above 77
60–69	Below 33	33–40	41–48	49–57	58–74	Above 74
<b>Women</b>						
Age: 16–19	Below 42	42–50	51–58	59–67	68–84	Above 84
20–29	Below 41	41–51	52–57	58–66	67–83	Above 83
30–39	Below 38	38–47	48–56	57–66	67–85	Above 85
40–49	Below 36	36–45	46–54	55–64	65–83	Above 83
50–59	Below 34	34–43	44–52	53–62	63–81	Above 81
60–69	Below 31	31–40	41–49	50–59	60–78	Above 78

**SOURCE:** Ratings based on norms calculated from data collected by Robert Lualhati on 4545 college students, 16–80 years of age, at Skyline College, San Bruno, California. Used with permission.

## The Push-Up Test

*Equipment:* Mat or towel (optional)

### Preparation

In this test, you will perform either standard push-ups or modified push-ups, in which you support yourself with your knees. The Cooper Institute developed the ratings for this test with men performing push-ups and women performing modified push-ups. Biologically, males tend to be stronger than females; the modified technique reduces the need for upper-body strength in a test of muscular endurance. Therefore, for an accurate assessment of upper-body endurance, men should perform standard push-ups and women should perform modified push-ups. However, in using push-ups as part of a strength training program, individuals should choose the technique most appropriate for increasing their level of strength and endurance—regardless of gender.

### Instructions

1. *For push-ups:* Start in the push-up position with your body supported by your hands and feet. *For modified push-ups:* Start in the modified push-up position with your body supported by your hands and knees. *For both positions,* keep your arms and your back straight and your fingers pointed forward.
2. Lower your chest to the floor with your back straight, and then return to the starting position.
3. Perform as many push-ups or modified push-ups as you can without stopping.  
Number of push-ups: \_\_\_\_\_ or number of modified push-ups: \_\_\_\_\_



### Rating Your Push-Up Test Result

Your score is the number of completed push-ups or modified push-ups. Refer to the appropriate portion of the table for a rating of your upper-body endurance. Record your rating below and in the summary at the end of this lab.

Rating: \_\_\_\_\_



## Ratings for the Push-Up and Modified Push-Up Tests

Men	Number of Push-Ups					
	Very Poor	Poor	Fair	Good	Excellent	Superior
Age: 18–29	Below 22	22–28	29–36	37–46	47–61	Above 61
30–39	Below 17	17–23	24–29	30–38	39–51	Above 51
40–49	Below 11	11–17	18–23	24–29	30–39	Above 39
50–59	Below 9	9–12	13–18	19–24	25–38	Above 38
60 and over	Below 6	6–9	10–17	18–22	23–27	Above 27
Women	Number of Modified Push-Ups					
	Very Poor	Poor	Fair	Good	Excellent	Superior
Age: 18–29	Below 17	17–22	23–29	30–35	36–44	Above 44
30–39	Below 11	11–18	19–23	24–30	31–38	Above 38
40–49	Below 6	6–12	13–17	18–23	24–32	Above 32
50–59	Below 6	6–11	12–16	17–20	21–27	Above 27
60 and over	Below 2	2–4	5–11	12–14	15–19	Above 19

**SOURCE:** Based on norms from The Cooper Institute of Aerobic Research, Dallas, Texas; from *The Physical Fitness Specialist Manual*, revised 2002. Used with permission.

## The Squat Endurance Test

### Instructions

- Stand with your feet placed slightly more than shoulder width apart, toes pointed out slightly hands on hips or across your chest, head neutral, and back straight. Center your weight over your arches or slightly behind.
- Squat down, keeping your weight centered over your arches, until your thighs are parallel with the floor. Push back up to the starting position, maintaining a straight back and neutral head position.
- Perform as many squats as you can without stopping.

Number of squats: \_\_\_\_\_

### Rating Your Squat Endurance Test Result

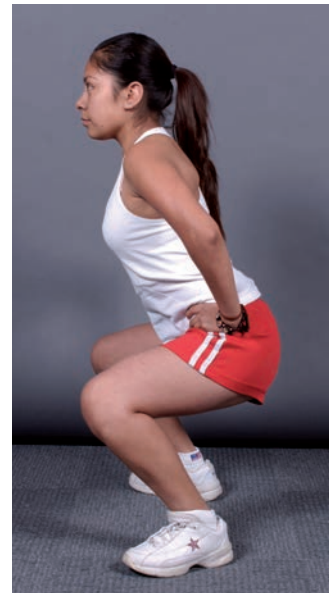
Your score is the number of completed squats. Refer to the appropriate portion of the table for a rating of your leg muscular endurance. Record your rating below and in the summary at the end of this lab.

Rating: \_\_\_\_\_

### Ratings for the Squat Endurance Test

Men	Number of Squats Performed						
	Very Poor	Poor	Below Average	Average	Above Average	Good	Excellent
Age: 18–25	<25	25–30	31–34	35–38	39–43	44–49	>49
26–35	<22	22–28	29–30	31–34	35–39	40–45	>45
36–45	<17	17–22	23–26	27–29	30–34	35–41	>41
46–55	<9	13–17	18–21	22–24	25–38	29–35	>35
56–65	<9	9–12	13–16	17–20	21–24	25–31	>31
65 +	<7	7–10	11–14	15–18	19–21	22–28	>28
Women	Very Poor	Poor	Below Average	Average	Above Average	Good	Excellent
Age: 18–25	<18	18–24	25–28	29–32	33–36	37–43	>43
26–35	<20	13–20	21–24	25–28	29–32	33–39	>39
36–45	<7	7–14	15–18	19–22	23–26	27–33	>33
46–55	<5	5–9	10–13	14–17	18–21	22–27	>27
56–65	<3	3–6	7–9	10–12	13–17	18–24	>24
65+	<2	2–4	5–10	11–13	14–16	17–23	>23

**SOURCE:** [www.topendsports.com/testing/tests/home-squat.htm](http://www.topendsports.com/testing/tests/home-squat.htm)



### Summary of Results

Curl-up test: Number of curl-ups: \_\_\_\_\_ Rating: \_\_\_\_\_

Push-up test: Number of push-ups: \_\_\_\_\_ Rating: \_\_\_\_\_

Squat endurance test: Number of squats: \_\_\_\_\_ Rating: \_\_\_\_\_

Remember that muscular endurance is specific: Your ratings may vary considerably for different parts of your body.

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### Using Your Results

*How did you score?* Are you surprised by your ratings for muscular endurance? Are you satisfied with your current ratings?

If you're not satisfied, set realistic goals for improvement:

Are you satisfied with your current level of muscular endurance as evidenced in your daily life—for example, your ability to carry groceries or your books, hike, and do yard work?

If you're not satisfied, set realistic goals for improvement:

*What should you do next?* Enter the results of this lab in the Preprogram Assessment column in Appendix C. If you've set goals for improvement, begin planning your strength training program by completing the plan in Lab 4.3. After several weeks of your program, complete this lab again and enter the results in the Postprogram Assessment column of Appendix C. How do the results compare?

Name \_\_\_\_\_ Section \_\_\_\_\_ Date \_\_\_\_\_



## LAB 4.3 Designing and Monitoring a Strength Training Program

1. *Set goals.* List goals for your strength training program. Your goals can be specific or general, short or long term. In the first section, include specific, measurable goals that you can use to track the progress of your fitness program—for example, raising your upper-body muscular strength rating from fair to good or being able to complete 10 repetitions of a lat pull with 125 pounds of resistance. In the second section, include long-term and more qualitative goals, such as improving self-confidence and reducing your risk for back pain.

Specific Goals: Current Status

Final Goals

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Other goals: \_\_\_\_\_

2. *Choose exercises.* Based on your goals, choose 8–10 exercises to perform during each weight training session. If your goal is general training for wellness, use the sample program in Figure 4.2 on p. 109. List your exercises and the muscles they develop in your program plan.
3. *Frequency: Choose the number of training sessions per week.* Work out at least 2 nonconsecutive days per week. Indicate the days you will train in your program plan; be sure to include days of rest to allow your body to recover.
4. *Intensity: Choose starting weights.* Experiment with different amounts of weight until you settle on a good starting weight, one that you can lift easily for 10–12 repetitions. As you progress in your program, add more weight. Fill in the starting weight for each exercise in your program plan.
5. *Time: Choose a starting number of sets and repetitions.* Include at least 1 set of 8–12 repetitions of each exercise. (When you add weight, you may have to decrease the number of repetitions slightly until your muscles adapt to the heavier load.) If your program is focusing on strength alone, your sets can contain fewer repetitions using a heavier load. If you are over approximately age 50–60, your sets should contain more repetitions (10–15) using a lighter load. Fill in the starting number of sets and repetitions of each exercise in your program plan.
6. *Monitor your progress.* Use the workout card on the next page to monitor your progress and keep track of exercises, weights, sets, and repetitions.

**Program Plan for Weight Training**

Exercise	Muscle(s) Developed	Frequency (check ✓)							Intensity: Weight (lb)	Time	
		M	T	W	Th	F	Sa	Su		Repetitions	Sets

