Building Muscular Strength and Endurance

OBJECTIVES

Define muscular strength and muscular endurance and describe the benefits of each.

Discuss the basic structure and function of skeletal muscle.

Outline the fitness and wellness improvements that occur with regular resistance training.

Assess your muscular strength and muscular endurance.

Set appropriate muscular fitness goals.

Describe common resistance-training methods and programs and create an exercise plan compatible with your goals and lifestyle.

Identify and observe precautions for safe resistance training.

Describe the benefits and side effects of supplement use, including anabolic steroids.
resistance training
Controlled and progressive stressing of the body's musculoskeletal system using resistance (i.e., weights, resistance bands, body weight) exercises to build and maintain muscular fitness

muscular endurance
The ability of a muscle to contract repeatedly over an extended period of time

muscular fitness
The ability of your musculoskeletal system to perform daily and recreational activities without undue fatigue and injury

muscular strength
The ability of a muscle to contract with maximal force

resistance training
Controlled and progressive stressing of the body's musculoskeletal system using resistance (i.e., weights, resistance bands, body weight) exercises to build and maintain muscular fitness

CASE STUDY

Gina

“Hi, I’m Gina. I’m from San Francisco and I’m a sophomore majoring in economics. I’m taking a fitness and wellness class this semester, and this week we’re starting the section on muscular fitness. I’m curious about it because I’ve never lifted weights before! I like to go hiking, and I take yoga classes from time to time, but I wouldn’t call myself an athlete. Does it really make sense for someone like me to start a strength-training program?”

Whether you’re a beginner like Gina or an athlete interested in conditioning, this chapter will answer common questions about muscular fitness, explain the many benefits of strength training, and give you the tools for designing a program that is custom-made for you.

Muscular fitness is the ability of your musculoskeletal system to perform daily and recreational activities without undue fatigue and injury. Muscular fitness involves having adequate muscular strength and endurance. Muscular strength is the ability of a muscle or group of muscles to contract with maximal force. It describes how strong a muscle is or how much force it can exert. Exercise professionals often measure muscular strength by determining the maximum weight a person can lift at one time. Muscular endurance is the ability of a muscle to contract repeatedly over an extended period of time. It describes how long you can sustain a given type of muscular exertion. One way that fitness professionals measure muscle endurance is by determining the maximum weight a person can lift 20 times consecutively.

You can build better muscular strength and endurance through resistance training. Resistance training is also referred to as weight training or strength training and can be done with measured weights, body weight, or other resistive equipment (i.e., exercise bands or exercise balls). Resistance exercises stress the body’s musculoskeletal system, which enlarges muscle fibers and improves neural control of muscle function, resulting in greater muscular strength and endurance.

Are you already participating in a resistance-training program? If so, you are not alone. According to the National Health Interview Survey (NHIS), resistance training is the fourth most popular leisure-time activity for adults over the age of 18.1 It is more popular than jogging, aerobics, and many other recreational sports (but is less popular than walking, working in the yard, or stretching.) In 2004, 17.5 percent of women and 21.5 percent of men reported regular resistance training.2 These numbers have climbed steadily since 1998 but still do not approach the Healthy People 2010 national
health objective: that 30 percent of adults participate in strength-training exercises at least two times per week. If you are not participating, now may be the perfect time to start because of readily available facilities and classes at most colleges and universities.

Resistance training offers such varied benefits that exercise professionals recommend it in nearly all health-related fitness programs. Regular resistance training can make daily activities easier: carrying around a backpack full of heavy textbooks won’t tire you as much; bringing in a bag of groceries will be less taxing; and taking the stairs will seem natural and feel better than riding in an elevator. No matter what your health and fitness goals may be, resistance training can be an important and rewarding wellness tool throughout your life.

HOW DO MUSCLES WORK?

The human body contains hundreds of muscles, each of which belongs to one of three basic types: (1) voluntary skeletal muscle, which allows movement of the skeleton and generates body heat; (2) involuntary cardiac muscle, which exists only in the heart and facilitates the pumping of blood through the body; and (3) involuntary smooth muscle, which lines some internal organs and moves food through the stomach and intestines. Together, resistance training and cardiorespiratory exercise will benefit all three muscle types. Here we will focus on skeletal muscles and the signals from the nervous system that coordinate and control their contraction.

AN OVERVIEW OF SKELETAL MUSCLE

Each skeletal muscle is surrounded by a sheet of connective tissue that draws together at the ends of the muscle, forming the tendons (see Figure 5.1). Muscular contractions allow for skeletal movement because muscles are attached to bones via tendons. These attached muscles pull the bones, which pivot at joints, creating a specific body movement.

Within each skeletal muscle are individual muscle cells called muscle fibers. Bundles of muscle fibers are called fascicles. Each muscle fiber extends the full length of the muscle. Within each muscle fiber are many myofibril strands, each containing contractile protein filaments. These filaments are made up of two kinds of protein—actin and myosin—which are arranged in alternating bands that give the whole cell a striped appearance. The microscopic structure and function of actin and myosin allow them to slide across each other and shorten the muscle. You can picture this sliding and shortening as similar to the way your forearms can slide past each other inside the front pocket of a hooded sweatshirt, pulling your elbows closer together. Simultaneous shortening of the many fibers within a whole muscle causes the pattern of muscular tension we call contraction. It is this whole-muscle contraction that moves bones and surrounding body parts.

Every muscle fiber can be categorized as either slow or fast, depending on how quickly it can contract. Slow-twitch muscle fibers (Type I) are oxygen-dependent and contract relatively slowly, but can contract for longer periods of time without fatigue. Fast-twitch muscle fibers (Type II) are not oxygen-dependent and contract more rapidly than slow-twitch fibers, but tire relatively quickly (they also produce greater muscle power). In slow-twitch fibers, the energy for contraction comes from the breakdown of fat from the blood, muscle cells, and adipose tissue. Fat breakdown requires oxygen and minimal levels of glucose breakdown as well. In fast-twitch fibers, the energy for contraction comes from phosphocreatine and glycogen reserves within the muscles, glycogen stored within the liver, and glucose in the blood.

All fiber types exist in skeletal muscles, but some muscles within the body—such as postural trunk muscles—have more slow-twitch fibers, while other muscles (such as those in the calves) have more fast-twitch fibers. The proportion of muscle fiber types varies from person to person based on both genetics and training. Elite athletes have muscle fiber compositions that complement their sport. Marathoners, for instance, have higher levels of slow-twitch fibers that supply them with optimal muscular endurance. Power weight lifters, on the other hand, have more fast-twitch fibers that allow feats of enormous muscular

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**tendon** The connective tissue attaching a muscle to a bone
**muscle fiber** The cell of the muscular system
**myofibril** Thin strands within a single muscle fiber that bundle the skeletal muscle protein filaments and span the length of the fiber
**slow-twitch muscle fiber** Muscle fiber type that is oxygen-dependent and can contract over long periods of time
**fast-twitch muscle fiber** Muscle fiber type that contracts with greater force and speed but also fatigues quickly
strength over short periods of time. Sedentary individuals and people who do general resistance training typically have 50 percent slow-twitch and 50 percent fast-twitch fiber composition.

**MUSCLE CONTRACTION REQUIRES STIMULATION**

For a voluntary skeletal muscle to contract, your nervous system must send a signal directly to the muscle. When you want to move any part of your body—for example, a finger on your right hand—your brain will send a signal down the spinal cord and through motor nerves to the skeletal muscle fibers in that finger. One motor nerve will stimulate many skeletal muscle fibers, together creating a functional unit called a **motor unit** (see Figure 5.2).

**FIGURE 5.1**

A muscle is attached to bones via tendons. Tendons are a continuation of the connective tissue that surrounds the entire muscle as well as each muscle bundle (fascicle). A fascicle is made up of many muscle cells (muscle fibers). Within each muscle fiber, myofibril strands contain actin and myosin proteins.

A motor unit can be small or large, depending on the number of muscle fibers that it stimulates. Small motor units are comprised of slow-twitch fibers; larger motor units are comprised of fast-twitch fibers. The strength of a muscle contraction depends upon the intensity of the nervous system stimulus, the number and size of motor units activated, and the types of muscle fibers that are stimulated. For example, if you are getting ready to lift a heavy weight, your central nervous system will send a stronger signal. This will activate a greater number of large fast motor units, resulting in a more forceful muscle contraction than if you were merely picking up an apple.

**THREE PRIMARY TYPES OF MUSCLE CONTRACTIONS**

Muscle contractions all result in an increase in tension or force within the muscle, but some contractions move body parts while others do not. There are three primary types of contractions: isotonic,
isokinetic contraction with a constant speed of contraction.

**Isometric** A muscle contraction with no change in muscle length.

**Isotonic** A muscle contraction with relatively constant tension.

**Isokinetic** A muscle contraction with a constant speed of contraction.

**Concentric** A muscle contraction with overall muscle shortening.

**Eccentric** A muscle contraction with overall muscle lengthening.

**Isotonic contractions** are characterized by a consistent muscle tension as the contraction proceeds and a resulting movement of body parts (Figure 5.3a). An arm curl with a 10-pound hand weight involves isotonic contractions throughout your arm. **Isometric contractions** are characterized by a consistent muscle length throughout the contraction with no visible movement of body parts. An example of an isometric contraction is when you hold a hand weight at arm’s length in front of you; your arm is not moving, but you feel tension in your arm muscles (Figure 5.3b). **Isokinetic contractions** are characterized by a consistent muscle contraction speed within a moving body part. In order to perform isokinetic contractions, you need specialized equipment that holds the speed of movement constant as your arm, leg, or other muscles contract with varying forces.

Isotonic contractions are the most common in exercise programs. Lifting free weights, working on machines, and doing push-ups are all examples of isotonic contractions. Isotonic contractions can be either concentric or eccentric. **Concentric contractions** occur when force is developed in the muscle as the muscle is shortening—for example, when you curl a free weight up toward your shoulder. In **eccentric** muscle contractions, force remains in

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**CASE STUDY**

Gina

“I love to go on short hikes. There are some gorgeous trails in the San Francisco Bay Area. Some of them are kind of hilly, but I don’t mind—the views from the top are always worth it. My calves definitely get a workout! I’d like to be able to do longer hikes, but the truth is that I usually get tired after about three miles. I know there are some longer hikes with spectacular views, but I don’t feel ready for them yet.”

1. Given what you’ve learned so far, what would you tell Gina about how resistance training can benefit her?

2. Which type of muscle fibers would you guess that Gina has more of: slow-twitch fibers or fast-twitch fibers?

3. Name an outdoor activity that you enjoy. Can you give one or two examples of isotonic contractions that occur in your body during the course of that activity?

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**FIGURE 5.2**

**Motor Units and Muscle Contraction Strength**

(a) Motor unit X is smaller (5 fibers) than motor unit Y (7 fibers). (b) The strength of a muscular contraction increases with increased fibers per motor unit (X vs. Y) and with more motor units activated (X + Y).
FIGURE 5.3
(a) Isotonic contractions include concentric (shortening) and eccentric (lengthening) contractions. (b) Isometric contractions produce force in the muscle with no movement.

the muscle while the muscle is lengthening. This occurs as you lower a free weight back to its original position. Figure 5.3a illustrates these muscular contractions, using a bicep-curl exercise as an example.

greater gains in muscle size due to higher testosterone levels, women can often have a larger capacity to improve strength. Stronger lower- and upper-body muscles benefit both men and women.

HOW CAN REGULAR RESISTANCE TRAINING IMPROVE YOUR FITNESS AND WELLNESS?

People used to think that weight lifting was solely a means of improving body shape and producing bigger muscles. We now know that, in addition to improving physical appearance, resistance training can also result in specific physiological changes that have significant fitness and wellness benefits. Table 5.1 summarizes these changes. We discuss the benefits of resistance training in detail in the section that follows.

REGULAR RESISTANCE TRAINING INCREASES STRENGTH

Regular resistance training with an adequate load, or amount of weight lifted, will result in an increase in muscle strength. Although men tend to realize

TABLE 5.1
Physiological Changes from Resistance Training

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<thead>
<tr>
<th>Increased</th>
<th>Decreased</th>
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</thead>
<tbody>
<tr>
<td>Muscle mass</td>
<td>Percentage of body fat</td>
</tr>
<tr>
<td>Muscular strength and/or muscular endurance</td>
<td>Time required for muscle contraction</td>
</tr>
<tr>
<td>Bone mineral density</td>
<td>Blood pressure (if high)</td>
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<tr>
<td>Basal metabolic rate</td>
<td>Blood cholesterol (if high)</td>
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<tr>
<td>Intramuscular fuel stores (ATP, PC, glycogen)</td>
<td></td>
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<tr>
<td>Tendon, ligament, and joint strength</td>
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<tr>
<td>Tendon strength</td>
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<tr>
<td>Coordination of motor units</td>
<td></td>
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<td>Insulin sensitivity</td>
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Neural Improvements When you start a resistance-training program, you will gain muscular strength before noticing any increase in muscle size. This is because internal physiological adaptations to training take place before muscle enlargement. The strength of a muscular contraction depends, in large part, on effective recruitment of the motor units needed for that contraction. The better your body gets at recruiting the necessary motor units through voluntary neural signaling, the stronger your muscles will be. In the first few weeks or months of a resistance-training program, most of the adaptation involves an increased ability to recruit motor units, which causes more muscle fibers to contract.

Increased Muscle Size After the initial improved neural activation, the amount of actin and myosin within your muscle fibers increases in response to resistance training. This results in an increase in the size or cross-sectional area of the protein filaments or hypertrophy. With more contractile proteins, a muscle can contract more forcefully; in other words, larger muscles are stronger muscles. While both slow- and fast-twitch muscles will increase in size with resistance training, greater increases in strength will result from hypertrophy changes in fast-twitch muscle fibers.

Muscle growth in response to resistance training takes longer than neural improvements. Nevertheless, muscle growth is the most important contributor to strength gains if your program is long-term and consistent. The degree of hypertrophy or enlargement you can expect with weight training depends upon your gender, age, genetics, and how you design your training program. Some individuals will develop larger muscles more quickly than others; some will experience only limited hypertrophy. In particular, women and men with smaller builds will realize less muscle development than those with larger builds, even with identical training programs (see the box Understanding Diversity: Women and Weight Training). The same is true for older individuals, though they can still see significant improvements.

A program with heavier weights, longer durations, or more frequent training can produce greater gains than a more standard fitness-training program. People who stop resistance training due to injury, life circumstances, or disinterest will experience some degree of atrophy, a shrinking of the muscle to its pretraining size and strength. To avoid atrophy, you need to make a long-term commitment to resistance training.

REGULAR RESISTANCE TRAINING INCREASES MUSCULAR ENDURANCE

Muscular endurance helps you complete daily tasks and take part in recreational activities without tiring easily. It helps you perform both cardiorespiratory activities, such as hiking and running, and muscular fitness activities, such as circuit or sports training. In fact, just doing these activities will improve your muscular endurance. Muscle endurance exercises trigger physiological adaptations that improve your ability to regenerate ATP efficiently and thus sustain muscular contractions for a longer period of time. The end result will be the ability to snowboard five runs in a row instead of two before having to rest; to walk up three flights of stairs with ease; or to rake leaves vigorously for an hour without difficulty.

REGULAR RESISTANCE TRAINING IMPROVES BODY COMPOSITION, WEIGHT MANAGEMENT, AND BODY IMAGE

Improved body composition is an important outcome of resistance training: The amount of lean muscle tissue will increase, the amount of fat tissue will decrease, and thus the ratio of lean to fat will improve. Research has demonstrated that such higher lean-to-fat ratios improve your overall health profile and reduce your risk of heart attack, stroke, and death from cardiovascular diseases. Fat does not turn into muscle or vice versa; the number of fat and muscle cells remains the same, with cells merely enlarging or shrinking depending on food intake and activity levels.

More muscle means a faster metabolic rate, because pound for pound, muscle tissue expends more energy than fat tissue. With more total calories being expended during the day, weight control becomes easier and more effective. The most successful weight maintainers (those who lose weight and keep it off for long periods of time) incorporate some type of resistance training into their overall fitness programs. Resistance training during weight loss helps ensure that you will lose fat and not precious muscle tissue; your body can be

**hypertrophy** An increase in muscle cross-sectional area

**atrophy** A decrease in muscle cross-sectional area
measurable increases in overall body image after circuit weight training (a form of resistance training) for 6 weeks.\textsuperscript{6}

**REGULAR RESISTANCE TRAINING STRENGTHENS BONES AND PROTECTS THE BODY FROM INJURIES**

Bone health is an important issue for everyone, from children to older adults. Osteoporosis-related fractures are common among older women and men and can cause dramatic decreases in a person’s mobility, independence, and quality of life. By putting stress and controlled weight loads on the muscles, joint structures, and supporting bones, resistance training stimulates muscle tissue growth and the generation of harder, stronger bones, thereby reducing the risk of fracture.
Building strong bones is especially important in the period starting with childhood skeletal growth and development and ending at about age 30. The “reservoir” of bone tissue you lay down in those years and then maintain throughout life will help prevent weak, brittle bones as you age. Even the bones of older individuals can benefit from strength training. Several research studies have revealed a positive relationship between resistance training and bone density.7

Getting hurt will put you on the sidelines. Whether you exercise for fun, fitness, or competition, preventing injuries is a key to continued participation. Injury prevention tips are often specific to your chosen activity; however, strong muscles, bones, and connective tissues are the common denominator for preventing injury in any activity. Regular resistance training improves not only muscular strength and endurance, but also the strength of tendons, ligaments, and other supporting structures around each joint. As they grow stronger, the joints themselves are better protected from injury. A stronger body can handle the physical stresses of everyday life (carrying heavy books or groceries, lifting laundry baskets, moving furniture, etc.) with less chance of injury. A strong, pain-free back and proper posture are crucial to daily functioning without injury. Individuals who participate in regular resistance-training exercise have stronger postural muscles and report less low back pain.

Imbalanced muscles around a joint may result in a change in joint alignment with subsequent pain or injury. Muscular balance will reduce this risk. A well-designed muscle fitness program will work toward improving strength and muscle endurance in opposing muscular groups, promoting overall muscle balance.

**REGULAR RESISTANCE TRAINING HELPS MAINTAIN PHYSICAL FUNCTION WITH AGING**

Starting between the ages of 25 to 30, men and women begin to lose muscle mass. As they age, they lose up to one-third of their muscle mass due to changes in hormones, activity, nutrition, and chronic or acute illnesses. Sarcopenia, literally “poverty of flesh,” is the term applied to this aging-related loss in skeletal muscle (see Figure 5.4). Sarcopenia reduces overall physical functioning by decreasing muscular strength and endurance and causing losses in muscle power, or the capacity to exert force rapidly. While no one is immune from the aging process, resistance training throughout one's life can significantly slow natural muscle loss. In fact, older individuals who do resistance training can show a rate of improvement equal to that of younger people. The increase in muscular fitness and the improvements it brings to everyday physical functioning help individuals live independently for a longer portion of their lives.

**REGULAR RESISTANCE TRAINING HELPS REDUCE CARDIOVASCULAR DISEASE RISK**

Regular resistance training can lower your risk of cardiovascular disease by increasing blood flow to working muscles and vital tissues throughout your body. In fact, people who perform regular resistance-training exercise have lower blood pressure and blood cholesterol readings than sedentary people. Since being overfat (having a higher than recommended percentage of body fat) increases your risk of cardiovascular disease and adult-onset diabetes, an improved body composition achieved through resistance training can help you lower your risk of both of these diseases.

**REGULAR RESISTANCE TRAINING ENHANCES PERFORMANCE IN SPORTS AND ACTIVITIES**

Achieving muscular fitness through resistance training has yet another benefit: A stronger body is more resistant to fatigue, moves more quickly, and recovers more quickly from illness or injury. All of these traits contribute to better performance in sports, recreational activities, and other fitness pursuits. Resistance training is often the common denominator among training programs for different sports and activities. Because of these benefits, physically active adults often incorporate some form of resistance training that builds strength and endurance in the muscle groups most crucial to their sport.

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sarcopenia The degenerative loss of muscle mass and strength in aging
muscle power The ability of a muscle to quickly contract with high force
HOW CAN YOU ASSESS YOUR MUSCULAR STRENGTH AND ENDURANCE?

Before you can plan an appropriate resistance-training program, it is important to assess your current muscular strength and endurance. You can then compare the results to norm charts for your age and gender, or simply use them as a starting point for designing your program. After you’ve followed your program for a while, follow-up assessments will help you evaluate your progress and make adjustments to stay on track.

TEST YOUR MUSCULAR STRENGTH

Tests of muscular strength gauge the maximum amount of force you can generate in a muscle. People usually carry out these tests in a weight room where measured weights of all sizes are readily available.

1 RM Tests One repetition maximum (1 RM) tests are the most common tool fitness instructors and personal trainers use to assess their clients’ muscular strength. To participate in the tests safely, you must be medically cleared to lift heavier weights than you have in the past, have detailed instructions for the test procedure, know general weight-training guidelines, have a few weeks of weight-training experience, and have qualified spotters standing nearby to watch and assist if necessary. If you are weight training on campus or at a gym, an instructor will be able to help you through these preliminary steps.

One RM tests are performed by discovering the maximum amount of weight you can lift one time on a particular exercise. You need to accurately determine your 1 RM within three to five trials so that muscle fatigue from repetitions does not change your result. In general health and fitness classes or beginning weight-training programs, instructors often tell students to predict their 1 RM instead of actually attempting a maximum lift. This is particularly true when students are new to resistance training and are unfamiliar with weight-training guidelines. To predict your 1 RM, you will lift, press, or pull a
weight that will fully fatigue your upper- or lower-body muscles in 2 to 10 repetitions. You can then use a formula that converts your actual weight lifted and your real number of repetitions to a prediction of your 1 RM capacity for that exercise. In LAB5.1 (at the back of this chapter), you will use bench-press and leg-press exercises to determine your 1 RM. You can perform these tests for any weight-training exercise and then convert to the predicted 1 RM value. Many weight-training programs use a percentage of your 1 RM or predicted 1 RM to determine a safe starting level for weight lifting.

Grip Strength Test Another common test of muscle strength is the hand grip strength test using a piece of equipment called a grip strength dynamometer. As you squeeze the dynamometer (with one hand at a time), it measures the static or isometric strength of your grip-squeezing muscles in pounds or kilograms (kg).

TEST YOUR MUSCULAR ENDURANCE

Muscular endurance tests evaluate a muscle’s ability to contract for an extended period of time. Some of these tests must be performed in a weight room, whereas others require only your body weight for resistance and can be performed anywhere.

20 RM Tests You can use any weight-training exercise to find your 20 repetition maximum (20 RM). This test determines the maximal amount of weight you can lift exactly 20 times in a row before the muscle becomes too fatigued to continue.

Twenty repetition maximum tests are particularly useful for setting muscular endurance goals and then tracking your progress. Try to discover your 20 RM within one to three tries to avoid fatiguing your muscles and altering your results. Lab 5.1 also walks you through the steps of finding your 20 RM for the bench-press and leg-press exercises.

Calisthenic Tests Calisthenics are conditioning exercises that use your body weight for resistance. Calisthenic tests use sit-ups, curl-ups, pull-ups, push-ups, and flexed arm support/hang exercises to assess muscular endurance. The procedures for each test vary. You will learn how to perform the curl-up and push-up assessments in Lab 5.1. Calisthenic tests allow you to test yourself outside of a weight-training facility and to compare your results to well-established physical fitness norms.

HOW CAN YOU DESIGN YOUR OWN RESISTANCE-TRAINING PROGRAM?

Designing an effective resistance-training program takes some knowledge, and many people enlist the help of a personal trainer or fitness professional.

CASE STUDY

Gina

“I’ve always wanted to hike to the top of Nevada Falls in Yosemite National Park. I’m told that it can be done as a day hike, but it is about 7 miles round trip. There is also a steep section of rocks near another waterfall along the way—apparently you get completely soaked while hiking that part of the trail! I’m always extra careful hiking downhill, because I once sprained my ankle on a hike, which was not fun.

If resistance training can help me take on Nevada Falls, I’m interested. I’ve also always wished I had better muscle tone, but to be honest, I don’t want to ‘bulk up’ . . .”

1. Name at least two ways that resistance training can help Gina realize her goal of safely hiking to the top of Nevada Falls.

2. How would you respond to Gina’s concerns about ‘bulking up’?

3. What’s your “Nevada Falls”—that is, what is something you have always wanted to do, but feel like you need to be in better physical shape to take on?
CASE STUDY

Gina

“Okay—I’m ready to begin a resistance training program, but I’ve never lifted weights in my life. I’ve been to gyms, but mainly to take yoga classes. I don’t know my way around a weight room and don’t know where to start. I’ve heard about 1 RM and 20 RM tests, but am not sure what they test—are they dangerous?”

1. How would you explain to Gina the difference between a 1 RM test and a 20 RM test? Which one tests strength? Which one tests endurance?

You can become your own personal trainer, however, by using the guidelines in this section to plan a safe and effective muscular fitness program.

SET APPROPRIATE MUSCULAR FITNESS GOALS

Remember to use SMART goal-setting guidelines: Goals should be specific, measurable, action-oriented, realistic, and have a timeline. Your goals may be appearance-based, function-based, or a combination of the two.

Appearance-Based Goals Many people have appearance-based goals for muscular fitness: they want larger muscles, or muscles that are more toned and less flabby. “Spot reduction” (i.e., trimming down just one area of the body) is another often-voiced goal—but is not realistic as the box Facts and Fallacies: Does Spot Reduction Work? explains.

In order to judge your progress toward appearance-based goals, be sure to include some sort of measure of progress in your resistance-training plan. For muscle size, measure the circumference of your biceps or calves, for example, then set a goal to increase or decrease this number. For overall body size, your goal may be to increase lean tissue weight but decrease fat tissue and percentage of body fat. If your goal is to become more “toned,” quantify this in some way, too: look in the mirror and make notes about the way your body looks and moves. After you reach the target date for your plan, reread your notes, look in the mirror, and then reevaluate whether your muscle tone has improved.

Function-Based Goals Include some specific goals for improving muscle function in your fitness plan. Function-based goals focus on your muscular capabilities and include gaining better muscular strength, greater muscular endurance, or both. Labs.2 will guide you in setting goals for realistic changes in muscle function, and then help you to assess your improvements.

EXPLORE EQUIPMENT OPTIONS

Should you use weight machines in your resistance-training program? Free weights? Other equipment? No equipment at all? These are important decisions, and they depend on your fitness goals, the type of equipment available to you, your experience with weight-training exercises, and your preferences.

Machines If you are new to resistance training, weight machines can be very useful. Systems such as Cybex, Nautilus, Life Fitness, and many others allow you to isolate and strengthen specific muscle groups as well as to train without a spotting partner. Table 5.2 compares machine weight training and free weight training.

Free Weights Personal trainers and exercise physiologists consider free-weight exercises to be a more advanced approach to weight training than machine-weight exercises. Free-weight exercises use
DOES SPOT REDUCTION WORK?

Have you ever thought, “I don’t need a resistance-training program for my whole body, I just need to lose some fat off my hips (or thighs or abdomen)”?

Indeed, why work on your whole body when you could just work off the fat in one offending area? Despite people’s desire to spot-reduce and the multimillion-dollar industry it has spawned for ab-crunchers, thigh-slimmers, arm-toners, and cellulite creams, the answer is disappointingly simple: spot reduction doesn’t work.

Researchers have punctured the spot-reduction myth with several carefully controlled studies and have verified that fat doesn’t disappear through repeated exercise to one area. Instead, fat stores throughout the entire body dwindle when a negative caloric balance causes you to use up calories stored in fat tissue. In one study, researchers compared fat thickness in both arms of several tennis players. If anyone could work off fat selectively, it would be a tennis player, since he or she holds and swings the racquet thousands of times per week with his or her dominant hand and arm. The fat thickness, however, was identical in each arm.

Even though spot reducing won’t work, as you exercise—particularly with resistance training—you simultaneously strengthen and build lean tissue. If your calorie balance is also negative and you lose fat body-wide, your muscle definition will show more clearly, both in the offending spots and elsewhere as well!


FACTS AND FALLACIES

dumbbells; barbells; incline, flat, or decline benches; squat racks; and related equipment. Free-weight exercises allow your body to move through its natural range of motion instead of the path predetermined by a weight machine. This both requires and promotes development of more muscle control. Some athletes prefer free-weight exercises because the balance and movement patterns needed to successfully lift free weights are closer to their sport movement patterns, whether that be tossing a football, putting a shot, or doing the breaststroke. Since workout facilities often have both free weights and weight machines, many people start their resistance-training program exclusively with machine-weight exercises and then progress to free weights within the first few months.

Alternate Equipment You can increase resistance on your body with equipment other than machines or free weights. Resistance bands made of tubing or flat strips of rubber allow you to simultaneously increase resistance throughout a range of motion and to improve muscular endurance. You can perform many different exercises with these bands. They also fold up and pack perfectly in a suitcase or gym bag for a portable workout. Stability balls (also called Swiss, fitness, or exercise balls) are 18–30 inch diameter vinyl balls that have various uses for muscular fitness, endurance, and balance. Ball routines involve performing exercises while sitting, lying, and/or balancing on the ball. The ball exerciser must use core trunk muscles to counteract the natural instability of the ball, which enhances overall body function. People sometimes use heavily weighted balls called medicine balls to increase resistance, either individually, with a partner, or in a group. You can hold a medicine ball while doing calisthenic or free-weight exercises or pass a ball from partner to partner for a functional increase in muscle endurance.
GET FIT, STAY WELL!

usually includes a combination of machine-weight, free-weight, and calisthenic exercises. Individuals may work alone or with a partner and will usually perform multiple sets and repetitions of a particular exercise before moving on to the next exercise.

**Circuit Weight Training** Circuit weight training is done in a specialized circuit-training room, a general workout room, or a weight room. Exercisers move from one station to another in a set pattern (the “circuit”) after a certain amount of time at a station or after performing a certain number of repetitions of an exercise such as a biceps curl, leg press, or chest press. Some circuits include only resistance-training exercises and have the single goal of improving muscular fitness. Some circuits involve cardiorespiratory or aerobic training equipment, such as stair-steppers or stationary bicycles, mixed in with the resistance exercises to improve both cardiorespiratory and muscular fitness.

In circuit training, it is important to remember the specificity training principle: in order to get optimal muscle fitness benefits, you must focus on the resistance exercises, and in order to realize added cardiorespiratory benefits, you must spend a

**No-Equipment Training** Calisthenics such as push-ups, pull-ups, lunges, squats, leg lifts, and curl-ups do not involve equipment. Instead, they use your body weight to provide the resistance. Like resistance bands, they are perfect for maintaining muscular strength and endurance while traveling.

**UNDERSTAND THE DIFFERENT TYPES OF RESISTANCE-TRAINING PROGRAMS**

You can plan a resistance-training program with various types of equipment and numerous exercise routines. Choosing the right program will depend upon your goals, experience, and personal preference.

**Traditional Weight Training** Traditional weight training takes place in a weight room and usually includes a combination of machine-weight, free-weight, and calisthenic exercises. Individuals may work alone or with a partner and will usually perform multiple sets and repetitions of a particular exercise before moving on to the next exercise.

**TABLE 5.2 Machine Weight vs. Free Weight Training**

<table>
<thead>
<tr>
<th>Machine Weights</th>
<th>Free Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROS</strong></td>
<td><strong>PROS</strong></td>
</tr>
<tr>
<td>Safe and less intimidating for beginners</td>
<td>Can be tailored for individual workouts</td>
</tr>
<tr>
<td>Quicker to set up and use</td>
<td>Range of motion set by lifter not machine</td>
</tr>
<tr>
<td>Spotters not typically needed</td>
<td>Some exercises can be done anywhere</td>
</tr>
<tr>
<td>Support of standing posture not needed</td>
<td>Standing and sitting postural muscles worked</td>
</tr>
<tr>
<td>Adaptable for those with limitations</td>
<td>Movements can transfer to daily activities</td>
</tr>
<tr>
<td>Variable resistance is possible</td>
<td>Good for strength and power building</td>
</tr>
<tr>
<td>Good isolation of specific muscle groups</td>
<td>Additional stabilizer muscles worked</td>
</tr>
<tr>
<td>Only good option for some muscle groups</td>
<td>Lower cost and more available for home use</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>CONS</strong></th>
<th><strong>CONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine sets range of motion</td>
<td>More difficult to learn</td>
</tr>
<tr>
<td>May not fit every body size and type</td>
<td>A spotter may be needed</td>
</tr>
<tr>
<td>Some people lack access to weight machines</td>
<td>Incorrect form may lead to injuries</td>
</tr>
<tr>
<td>Core posture supporting muscles not used</td>
<td>More time may be needed to change weights</td>
</tr>
<tr>
<td>Limited number of exercises/machines</td>
<td>More training needed to create program</td>
</tr>
</tbody>
</table>

**set** A single attempt at an exercise that includes a fixed number of repetitions

**repetitions** The number of times an exercise is performed within one set
minimal amount of time on the cardio machines (20 to 30 minutes total per exercise session).

Circuit exercises should be organized properly in order to ensure a safe and effective exercise session. For example, multijoint exercises (bench press, leg press) are often performed before single-joint exercises (bicep curl, leg extension), muscle groups worked are spread out to allow recovery between sets, and exercises that stress the core postural muscles are reserved for the end of the workout.

**Plyometrics and Sports Training**

Resistance-training programs designed to support specific sports can be quite different from general resistance training. Athletes may use many of the general weight-training exercises illustrated in this chapter, but they usually also perform exercises or exercise methods that specifically benefit their sports performance. Plyometrics, power lifts, and speed and agility drills are examples.

A **plyometric exercise** program incorporates explosive exercises that mimic the quick, percussive movements needed in many sports (i.e., basketball, wrestling, and gymnastics). These exercises are characterized by a landing and slowing down of the body mass followed immediately by a rapid jump in the opposite direction (for instance, jumping down off of a box and then immediately jumping back up as high as you can). Plyometrics is a highly specialized training method that should be performed under proper direction and only by individuals who have achieved a high level of muscular fitness.

**Power lifting** is a type of resistance training in which an individual lifts a heavy weight quickly. Examples include the Olympic lifts such as the clean and jerk, snatch, front squat, and push press. Sports that require high levels of explosive movement and power (football, wrestling, gymnastics, and track-and-field events) may require power-lifting training to build strength with speed. Power lifting is also a competitive sport in itself. Like plyometrics, power lifting should be practiced only by experienced athletes or those with comparable weight-training experience. Spotters and proper form are necessary for safety.

The training regimens for certain athletes may include **speed** and **agility** drills. These drills are also making their way into mainstream sports training and boot-camp-style group exercise classes. Speed and agility drills improve muscle responsiveness, speed, footwork, and coordination. Typical speed and agility drills include line sprints, high-knee runs, fast foot turnover running, and hopping quickly through varying foot patterns (using agility dots or other markers). Speed and agility drills can be performed by anyone who is physically fit enough to learn and perform the skills. Proper instruction and modification of the drills for differing ability levels is essential to prevent injuries.

**LEARN AND APPLY FITT PRINCIPLES**

FITT stands for **frequency, intensity, time, and type**. The acronym represents a checklist for determining how often, how hard, and how long to exercise, and what types of exercise to choose at your current level of muscular fitness.

**Frequency of Training** Your goals and your schedule determine how often you will train each week. At a minimum, you should work each muscle group twice per week, and if you do a full-body muscle workout, that means two sessions in the weight room each week. If you split your muscle workouts (for example, into upper/lower body), then you would go to the weight room four times per week. Table 5.3 presents American College of Sports Medicine (ACSM) guidelines for muscle strength and muscle endurance programs.

It is important to let each muscle group rest for 48 hours before taxing it again with resistance training. Therefore, especially when you are just beginning, schedule your workouts so that they are at least 2 days apart.

When you perform an intense weight-training session, microdamage occurs within the muscle cells and rest time is needed for muscle repair and adaptation. Your muscles will adapt by constructing new actin and myosin contractile proteins and other supporting structures. Over time, this adaptation results in stronger, leaner, larger muscles. Intense workouts of the same muscle group on subsequent days will disrupt the repair and adaptation process. Rather than faster muscle development, this overtraining is more likely to cause injuries, muscle

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**plyometric exercise** An exercise that is characterized by a rapid deceleration of the body followed by a rapid acceleration of the body in the opposite direction

**speed** The ability to rapidly accelerate; exercises for speed will increase stride length and frequency

**agility** The ability to rapidly change body position or body direction without losing speed, balance, or body control
fatigue, and weakening. An exception can be made for lower intensity muscular fitness classes or calisthenics, which can be done daily as long as they are not overly fatiguing.

Muscle soreness that sets in within a day or two is called delayed-onset muscle soreness (DOMS) and is a sign that your body was not ready for the amount of overload you applied. Contrary to popular belief, it is not lactic acid that causes DOMS; accumulated lactic acid is cleared from the muscle cells within hours of exercise. If you choose weight amounts correctly, your muscles will sustain small amounts of microdamage that do not result in soreness and that your body can repair within 48 hours after the workout.

Intensity of Training The intensity of a weight-training program refers to the amount of resistance you apply through any given exercise. **Resistance** here means the weight that you are moving. For each exercise, the intensity you choose will depend on your fitness goals for that particular muscle group or your body as a whole. The ACSM guidelines in Table 5.3 for muscle strength and muscle endurance can help you choose weight-training intensities (shown as a percentage of your 1 RM or predicted 1 RM).

Each choice for each exercise should be enough to overload the muscle group you are working; that means you should feel slight discomfort or muscle fatigue near the end of your exercise set. If you feel no fatigue during the entire set of repetitions and feel you could lift the weight another 3 to 10 times, then the intensity is too low. If you choose the right intensity for building muscular strength, you will be almost completely fatigued by the end of each set of repetitions. The right intensity for building muscle endurance will leave the muscle group fatigued but not near maximal exhaustion as with strength building.

Resting between sets will affect your weight-training intensity and performance on subsequent exercises. The greater the weight you lift for strength building, the longer the rest period you need between sets. Resting periods should be shorter for muscular endurance building exercises. In fact, shorter rests will help build better muscular endurance. Table 5.3 provides guidelines for determining appropriate rest periods between sets.

**Time: Sets and Repetitions** Choosing the appropriate number of repetitions or lifts within each set is yet another important part of setting up your resistance-training program. Once again, your fitness goals help determine the number of sets you will execute for each exercise and the number of repetitions within each set. Your weight-training experience and the time you have available to work out will affect your planning as well. ACSM recommends that to start with, you perform one set of each exercise during a given workout session (see Table 5.3). If you are new to resistance training, you will see progress with just one set per muscle group. Although you will gain additional benefits from extra sets, two sets will not translate into double the benefits of one. If you are pressed for time, one is sufficient. As you progress in your resistance-training program, you can increase your sets from one to two, and eventually to three or more. Evidence suggests that three sets will produce twice the strength gains of one set. You can execute one, two, or three sets for all your exercises, or perform one set of certain exercises, two of others, and so on. Keep in mind, however, that overtraining one particular muscle group can lead to muscle imbalance and injury.

If your muscular fitness goals include improvement to both muscular strength and endurance, choose a number of sets and repetitions that falls between the ACSM recommendations for strength and endurance in Table 5.3. Intensity and repetitions
have an inverse relationship relative to muscular strength and endurance (see Figure 5.5): for muscular strength development, you will lift heavier weights and do fewer repetitions. For muscular endurance, you will lift lighter weights with more repetitions. A good starting point for a balanced strength/endurance program is one to two sets of 10 repetitions per exercise. Table 5.4 outlines sample resistance-training programs.

### Type: Choosing Appropriate Exercises
Which exercises should you do during each session? The final part of designing a muscular fitness program is deciding on appropriate exercises, remembering to work toward muscle balance within all of the major muscle groups. Create your own muscular fitness goals in Lab 5.2 and use Figure 5.6 to start planning your resistance-training program. The next step is deciding which exercises will help you attain your muscular fitness goals: complete **LAB 5.3** to plan a muscular fitness program using Figures 5.7 and 5.8 to assist you in exercise selection.

Muscle balance requires a selection of upper-body exercises, trunk exercises, and lower-body exercises. Choose exercises from Figure 5.8 that allow you to work muscles on both the front and back of your body. For a starting program, choose between 8 and 15 exercises, remembering that each additional exercise will add time to your exercise session; with too many exercises, you may need to split your workout into alternating selections of exercises on different days (see Table 5.4). In choosing exercises,
Fewer repetitions with higher resistance will produce gains in muscular strength. More repetitions with lower resistance will produce gains in muscular endurance. An overlap between the two kinds of development is reflected in the strength and endurance continuum.

**FIGURE 5.5**

Use this flowchart as you design your muscular fitness program. Just starting? Begin at the lower end of all recommended ranges (except rest period—begin at the upper end).
you may select weight machines, free weights, calisthenics, or a combination of all three. Most weight-training programs will include all three and will also depend upon the equipment available to you. As mentioned earlier, focus on weight-training machines if you are new to resistance training.

**WHAT IF YOU DON’T REACH YOUR GOALS?**

Once you’ve applied FITT principles, chosen training levels, designed a program, and set target dates, you may find that your muscular development is not keeping up with your ambitions, or you cannot follow through consistently with training sessions. What other steps can you take to ensure success in your muscular fitness program?

**Track Your Progress** Use a weight-training log or a notebook to track your progress. Lab 5.3 provides you with a log that allows you to (1) see your week-to-week progress, (2) stay motivated, (3) detect problems with your program design or goals, and (4) know where to redesign your program if needed.

**Evaluate and Redesign Your Program as Needed** Periodically reevaluate your muscular fitness program. Common times to reassess are at

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**Table 5.4 Sample Designs for Resistance Training Programs**

<table>
<thead>
<tr>
<th></th>
<th>Beginning</th>
<th>Intermediate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>2 days/week (all exercises done each day)</td>
<td>4 days/week (1/2 of upper/lower done each day; trunk done all days)</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>55%–65% 1 RM</td>
<td>70%–80% 1 RM</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>1 set, 10 reps (1–2 min rest)</td>
<td>2–3 sets, 5–12 reps (2–3 min rest)</td>
</tr>
<tr>
<td><strong>Exercises</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lower body</strong></td>
<td>Leg press</td>
<td>Squats or lunges</td>
</tr>
<tr>
<td></td>
<td>Leg extension</td>
<td>Leg extension</td>
</tr>
<tr>
<td></td>
<td>Leg curl</td>
<td>Leg curl</td>
</tr>
<tr>
<td></td>
<td>Heel raise</td>
<td>Heel raise</td>
</tr>
<tr>
<td><strong>Upper body</strong></td>
<td>Bench press</td>
<td>Bench press</td>
</tr>
<tr>
<td></td>
<td>Chest flys</td>
<td>Chest flys</td>
</tr>
<tr>
<td></td>
<td>Lat pull down</td>
<td>Lat pull down</td>
</tr>
<tr>
<td></td>
<td>Seated row</td>
<td>Seated row</td>
</tr>
<tr>
<td></td>
<td>Lateral raise</td>
<td>Upright row</td>
</tr>
<tr>
<td></td>
<td>Biceps curl</td>
<td>Overhead press</td>
</tr>
<tr>
<td></td>
<td>Triceps extension</td>
<td>Lateral raise</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trunk</strong></td>
<td>Abdominal curl</td>
<td>Abdominal curl</td>
</tr>
<tr>
<td></td>
<td>Oblique curl</td>
<td>Oblique curl</td>
</tr>
<tr>
<td></td>
<td>Back extension</td>
<td>Side bridge</td>
</tr>
</tbody>
</table>

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FIGURE 5.7
These muscles or muscle groups are commonly used in resistance-training exercises. Figure 5.8 illustrates exercises you can use to work the muscle groups shown.

your target completion date, when you feel you aren’t making progress, when your improvement rate is faster than anticipated, and when you feel overtraining fatigue or injury. First, retake the initial tests for muscular strength and endurance. Second, reassess your goals: accomplished or not? Third, evaluate your overall program and write out what you like and don’t like about it. If you have met your goals and enjoy your program, continue but set more challenging goals based on FITT parameters. If you have not met your goals or don’t like your program, rewrite the goals and target dates, redesigning to solve your issues. In addition, get help from an exercise professional if needed. Evaluating and redesigning should allow you, once again, to move toward your muscular fitness goals successfully. Lab 5.3 provides practice at evaluation and redesign.
Lower-Body Exercises

1. Squat
(a) Free weight squat and
(b) Machine squat: Place the barbell (or pad, if using machine) on your upper back and shoulders. Stand with feet shoulder-width apart, toes pointing forward, hips and shoulders lined up, abdominals pulled in. Looking forward and keeping your chest open, bend your knees and press your hips back. Lower until you have between a 45 and 90 degree angle between your thigh and calf. Keep your knees behind the front of your toes. To return to the start position, contract your abdominals, press hips forward, and extend your legs until they are straight.
(c) Ball squat: Stand with the ball between your lower back and the wall. Keep feet shoulder-width apart in front of your hips, so you are leaning back on the ball. Bend your knees to a 90 degree angle while pressing your hips back toward the wall. Contract your quadriceps, gluteals, and hamstrings, pressing your body upward until you are at the starting position again.

2. Leg Press
Sit with your back straight or firmly against the backrest. Place your feet on the foot pads so that your knees are at a 60 to 90 degree angle. Stabilize your torso by contracting your abdominals and holding the hand grips or seat pad. Press the weight by extending your legs slowly outward to a straight position without locking your knees. Return the weight slowly back to the starting position. If your buttocks rise up off of the seat pad, you may be lifting too much weight.
3. **Lunges**

Stand with feet shoulder-width apart. Step forward and transfer weight to the forward leg. Lower your body straight down with your weight evenly distributed between the front and back legs. Keep your front knee in line with your ankle by striding out far enough. Return to your starting stance and repeat with the other leg.

![Lunges](image)

Muscles targeted:
- Quadriceps
- Hamstrings
- Gluteus maximus

4. **Leg Extension**

Sit with your back straight or firmly against the backrest and place your legs under the foot pad. Stabilize your torso by contracting your abdominals and holding the handgrips or seat pad. Lift the weight by extending your legs slowly upward to a straight position without locking your knees. Return the weight slowly back down to the starting position. If your buttocks rise up off the seat pad, you may be lifting too much weight.

![Leg Extension](image)

Muscles targeted:
- Quadriceps

5. **Leg Curl**

(a) **Machine**: Lie on your stomach so that your knees are placed at the machine’s axis of rotation and the roller pad is just above your heel. Keep your head on the machine pad. Grasping the hand grips for support, lift the weight by contracting your hamstrings and pulling your heels toward your buttocks. Slowly lower the weight back to the start position.

(b) **Calisthenics with ball**: Lie on your stomach with knees bent and place the ball between your feet. Keep your head on the mat. Lower the ball to the ground and lift it back up by contracting your hamstrings and pulling your heels toward your buttocks.

![Leg Curl](image)

Muscles targeted:
- Quadriceps
- Hamstrings

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**22 GET FIT, STAY WELL!**
6. Hip Abduction
(a) Machine: Sit with your back straight or firmly against the backrest and place your legs behind the pads. Grasping the hand grips or seat pad for support, press your legs outward slowly by contracting your outer thighs or hip abductors. Be careful not to extend the legs further than your normal range of motion. Slowly lower the machine weight by bringing your legs back together.

(b) Calisthenics with resistance band: Connect the resistance band to a low point on a machine and attach the free end to your outside leg. Stand with good posture and hold onto a wall or machine for support. Contract your hip abductors and extend your leg out to the side of your body. Slowly release the outside leg back to the starting position beside or crossed slightly in front of the standing leg.

7. Hip Adduction
(a) Machine: Sit with your back straight or firmly against the backrest and place your legs behind the pads set at a comfortable range of motion. Grasping the hand grips or seat pad for support, press your legs together slowly by contracting your inner thighs or hip adductors. Slowly return your legs to the starting position.

(b) Calisthenics with ball: Lie on your back with a ball pressed between your knees. Press your knees firmly together, squeezing the ball. Hold the squeeze for 3–10 seconds and release.
8. Hip Extension
Stand tall with your working leg extended in front of you. Support yourself by contracting your abdominals and holding onto the machine or handrails. Press the working leg behind you, contracting the gluteals and hamstrings. Hold the end position for 1–3 seconds before slowly returning to the starting position.

9. Straight Leg Heel Raise
Stand tall with good posture and place your heels lower than the toes (you should feel just a slight stretch in the calf muscle). Looking forward and contracting your trunk muscles for balance and support, lift your heels up by contracting your gastrocnemius muscle. Be sure to do a full range of motion and slow, controlled repetitions.

10. Bent Leg Heel Raise
Place your body in the machine with your heels lower than the toes and the weight pad placed comfortably on your thighs. Lift your heels up slightly and release the weight support bar with your hand. Slowly lower and lift the weight by contracting your soleus calf muscle through its full range of motion.
Upper-Body Exercises

11. Chest Press

(a) Free-weight: Lie down on the bench and position yourself with the weight bar directly above your chest. Stabilize your legs and back by placing your feet firmly on the ground, a step, or the bench and keeping your lower back flat. Grasp the bar with your hands slightly wider than shoulder-width apart and lift the bar off the rack. Slowly lower the bar to just above your chest. Press the weight up to a straight arm position and return the bar to the rack when your set of repetitions is complete. Use a spotter when lifting heavier free weights.

(b) Machine: Place yourself on the chest press machine and adjust the seat height so that the hand grips are at chest height. Stabilize your torso by firmly pressing your back against the seat back and planting your feet on the ground or foot supports. Press the hand grips away from the body until the arms are straight. Slowly return your hands to the starting position.

12. Push-Ups

(a) Full push-ups and

(b) Modified push-ups: Support yourself in push-up position (from the knees or feet) by contracting your trunk muscles so that your neck, back, and hips are completely straight. Place hands slightly wider than shoulder width apart. Slowly lower your body down toward the floor, being careful to keep a straight body position. Your elbows will press out and back as you lower to a 90 degree elbow joint angle. Press yourself back up to the start position. Be careful not to let your trunk sag in the middle or your hips lift up during the exercise. Continually contract the abdominals to keep a strong, straight body position.
13. Chest Flys

(a) Machine: Sit with your back straight or firmly against the backrest, plant your feet on the ground, and place your arms behind the machine pads. Your arms should be directly to the side but not behind your body. Press your arms together slowly by contracting your chest and shoulder muscles. Slowly return your arms to the starting position.

(b) Bench chest flys: Lie down on the bench and position yourself with the dumbbells directly above your chest. Stabilize your legs and back by placing your feet firmly on the ground, a step, or the bench and keeping your lower back flat against the bench. Holding the dumbbells with a slight bend in the elbow joint, slowly lower the dumbbells out to the side until your upper arms are parallel with the floor. Be careful not to extend the arms beyond this position. Return your arms to the starting position by contracting your chest and shoulder muscles.

14. Lat Pull Down

Position the seat and leg pad on the lat pull down machine so that your thighs are snug under the pad while your feet are flat on the ground. Grab the pull down bar with a wide overhand grip on your way down to a seated position. Sitting directly under the cable, pull the bar down to your upper chest. Focus on contracting the mid-back first and then the arms by pulling the shoulder blades and elbows back and down. Slowly straighten your arms back to the start position.
15. Pull-Up
Grab the pull-up bar with a wide overhead grip. Contract the back and arms in order to pull your body up until the bar is at chin height. Slowly straighten your arms back to the start position.

16. Rows
(a) Machine compound row: Grab the handgrips and pull your elbows back until you have reached the end position (pictured.) Hold this position for 1–3 seconds, then slowly return to the start position.
(b) Free-weight dumbbell: Position right hand and right knee on bench as shown. Pull dumbbell up with left hand, leading with your elbow. Return to start position and repeat on other side.

17. Upright Row
Stand with your feet either in a stride or a shoulder-width position. Keep your hips and shoulders in line with each other and your abdominals pulled in. Hold a barbell down in front of the body with straight arms and your hands positioned slightly narrower than shoulder-width. Lift the weight to chest height keeping your elbows above the bar. Remember to lift without shrugging the shoulders up toward the ears.

Muscles targeted:

- Pectoralis major
- Latissimus dorsi
- Biceps brachii
- Deltoids (anterior and medial)
- Trapezius
- Rhomboid
- Deltoids (posterior)
18. **Overhead Press**

(a) **Machine and**

(b) **Free-weight dumbbell:**
Sit with your back straight or firmly against the backrest, plant your feet firmly on the ground, and pull in your abdominals. Position your hands just wider than shoulder width and just above the shoulders. Carefully press the weight over your head until your arms are straight but your elbows are not locked out. Slowly return the weight to the start position and repeat.

19. **Lateral Raise**

(a) **Machine:** Position yourself in the machine and sit with a tall, straight back. Contract your shoulders and lift your arms out to your sides until they are parallel with the ground. Slowly lower your arms back down to your sides.

(b) **Free-weight dumbbell:**
Stand with your feet shoulder-width apart. Hold the dumbbells to your sides or slightly in front of you. Lift your arms out to your sides until they are parallel with the ground. While lifting, your elbows should have a slight bent to avoid over-extension of the elbow joint. Keep the weights even with or slightly lower than your elbows and keep your shoulders down. Slowly return the dumbbells back down to the start position.

**Muscles targeted:**

- 9 Deltoids (anterior and medial)
- 13 Triceps brachii
- 9 Deltoids (anterior and medial)
20. Biceps Curl

(a) **Machine:** Position yourself in the machine so that your feet are on the ground and your elbows are placed at the axis of rotation for the exercise. Grab the hand grips and start with your arms straight but not over-extended. Lift your hands toward your head until your biceps are fully contracted. Slowly lower the weight back down to the starting position.

(b) **Free-weight barbell:** Stand with your feet either in a stride or a shoulder-width position and your knees slightly bent. Keep your hips and shoulders in line with each other and your abdominals pulled in. Hold a barbell down in front of the body with an underhand grip, straight arms, and your hands at shoulder-width. Lift the weight up to your shoulders while keeping your back straight and abdominal muscles tight. If you are leaning back to perform the lift, you may be lifting too much weight. Return the weight back down to the starting position slowly and repeat.

(c) **Free-weight dumbbell:** For one-arm concentration curls, sit on a bench and hold a dumbbell in one hand. Start with the working arm extended toward the ground and your elbow pressed into your inner thigh. Lift the dumbbell up to the shoulder and then return slowly back to the starting position.

(d) **Calisthenics with resistance band:** Place the center of a resistance band under one foot and grab the free ends of the band with a straight arm on the same side. Stand tall with your feet either in a stride or a side to side position and your knees soft. Keep your hips and shoulders in line with each other and your abdominals pulled in. Lift the resisted hand toward your shoulder until the biceps are fully contracted. Slowly lower the hand back down to the starting position and repeat.

**Muscles targeted:**

- Biceps brachii
21. Pullover

In the starting position your upper arms should be just above your ears and your elbows slightly bent. Pull the weight back up and over the body without changing your elbow angle. Stop when the weight bar is directly over the chest.

22. Triceps Extension

(a) **Machine:** Grab the hand grips and start with your arms bent to at least 90 degrees. Press your hands away and down until your elbows are straight but not locked out. Slowly release the weight back up to the start position.

(b) **Free-weight dumbbell:** Start with the weight behind your head and your elbows lifted to the ceiling. Contract the tricep muscles to lift the weight over the head until the arms are straight. Slowly return to the start position and repeat.

(c) **Calisthenics with resistance band:** Grasp the middle of a resistance band with one band and the free ends with the other hand. Place one hand behind you and “anchor” the band at your hips or low back. Extend the arm until straight by contracting the tricep muscle. Slowly return the working arm to the start position and repeat.
**Trunk Exercises**

23. **Back Extension**

(a) **Calisthenics on a mat:** Start in a prone position with arms and legs extended and your forehead on the mat. Lift and further extend your arms and legs using your back and hip muscles. If you are free of low-back problems, you can lift a little further up for increased intensity. Hold the position for 3–5 seconds and then slowly lower back down to the mat.

(b) **Calisthenics on a ball:** Lie with your stomach over the ball, anchoring your feet and knees on the ground. Place your hands behind your head or extend the arms out straight for increased exercise intensity. Lift the head, shoulders, arms, and upper back until you have a slight curve in the back. Hold this position for 3–5 seconds and then lower back down over the ball.

24. **Abdominal Curl**

(a) **Machine:** Place yourself in the sitting or lying abdominal machine per the machine instructions. Place your feet on the ground or foot pads and press your back firmly against the backrest. Grab the hand grips overhead and/or place your arms behind the arm pads. Contract your abdominals, pulling them in, while you flex your upper torso forward. Slowly return to the starting position and repeat.

(b) **Calisthenics on a ball:** Lie back with the ball placed at your low to mid-back region. Place your feet shoulder-width on the ground so that your knees are bent at about 90 degrees. Cross your hands at your chest or place lightly behind the head. Contract your abdominals, pulling them in, while you flex your upper torso forward. Slowly return to the starting position and repeat.
25. Reverse Curl
Lie on your back and place your hands near your hips. Lift your legs up so that your hips are at a 90 degree angle to the floor. Your knees may be bent or straight for this exercise. Contract your abdominals, pulling them in, while you lift your hips up off the mat. Slowly return to the starting position and repeat. Be careful not to rock the hips and legs back and forth when doing this exercise; instead perform a controlled lifting of the hips upward.

26. Oblique Curl
Lie on your back with your hip and knee joints bent to 90 degrees and your hands lightly supporting the head. Contract your oblique abdominals and lift one shoulder toward the opposite knee. Keep the other arm and elbow on the floor and refrain from pulling on the head and neck. Return to the starting position slowly and repeat to the other side.

27. Side Bridge
(a) Modified side bridge and
(b) Forearm side bridge and
(c) Intermediate side bridge: Lie on your side with your legs together and straight or bent behind you at 90 degrees. Support your body weight with your forearm or a straight arm. Lift your torso to a straight body position by contracting your abdominal and back muscles. Hold this position for a number of seconds or slowly drop the hip to the mat and lift back up for repeated repetitions.
CHAPTER 5 BUILDING MUSCULAR STRENGTH AND ENDURANCE

28. Plank
(a) Forearm plank and
(b) Push-up position plank: Lie on your stomach and support yourself in plank position (from the forearms or hands) by contracting your trunk muscles so that your neck, back, and hips are completely straight. Your forearms or hands should be under your chest and placed slightly wider than shoulder-width apart. Hold this position for 5–60 seconds, working up in length as you gain muscular endurance.

WHAT PRECAUTIONS SHOULD YOU TAKE TO AVOID RESISTANCE-TRAINING INJURIES?
The greater muscular fitness achieved through resistance training helps prevent general injury during sports or daily activity. However, weight training itself can cause injuries such as muscle or tendon strains, ligament sprains, fractures, dislocations, and other joint problems. This is especially true if the lifter pushes for an unrealistic overload. Injuries tend to occur while using free weights, but you can prevent them by getting proper instruction and guidance, and by heeding a few basic suggestions.

FOLLOW BASIC WEIGHT-TRAINING GUIDELINES
When starting your resistance-training program, be conservative: Do not begin with too many exercises, sets, or too much weight! Before increasing your resistance-training intensity or duration, observe how your body responds to the training over a few weeks. After that, you can safely increase the number of repetitions and/or amount of weight. The safest approach is to follow the “10 percent rule.” Do not increase exercise frequency, intensity, or time more than 10 percent per week. Gentle increases will help prevent injury, overtraining, or soreness. Break this rule only if the initial intensity you selected was very low or a certified fitness professional instructs you to do otherwise.

BE SURE TO WARM UP AND COOL DOWN PROPERLY
Weight-training guidelines include a warm-up and a cool-down before and after training sessions. A proper weight-training warm-up includes a general warm-up and a specific warm-up. The general warm-up consists of 3 to 10 minutes of cardiorespiratory exercises—walking, jogging (on or off a treadmill), biking, stationary biking, elliptical trainer use, or any activity that increases body temperature (breaking a light sweat) and blood flow to muscles. The specific warm-up should include range-of-motion exercises that mimic (without weight added) the resistance exercises you’ll be performing. Move your limbs through a full range of motion before using a given weight machine or lifting free weights. Then, do a warm-up set with very light resistance. Now you are ready to perform your serious sets.

Some people also like to stretch before weight training. If you want to add stretching to your warm-up, do so only after a general warm-up where the body has been adequately warmed up in preparation for stretching. The pre-exercise stretching should be light, and you should hold each stretch no more than 10 to 20 seconds. A proper cool-down for resistance training includes general range-of-motion exercises and stretches for the muscle groups applied during the weight-training session.
CASE STUDY

Gina

“My main goals in resistance training are to improve my muscle endurance so that I can go on longer hikes and to strengthen my muscles and joints so that I can lower the chances of getting injured on the trail. I live close to campus and there is a gym with weight equipment available, but how do I decide what equipment to use and what exercises to focus on?”

1. Describe to Gina the benefits of using free weights versus machines.

2. Explain to Gina the differences between traditional weight training, circuit weight training, and plyometrics programs. Which would you advise her to begin with?

3. Think about your own resistance-training goals. Are they appearance based or function based?

4. How would you apply the FITT principles to your own resistance-training goals?

KNOW BASIC WEIGHT-TRAINING SAFETY TIPS

Learn the proper use of weights and weight machines. When lifting free weights, use a spotter to watch, guide, and assist you. Ask the spotter to keep your free-weight movements slow and controlled, not fast, jerky, or bouncy. Spotters typically assist a weight lifter who is attempting to lift a weight near his or her maximal fatigue level and the lift requires full-body balance. Exercises such as squats and the bench press require the weight to be lifted over the head or in a position that could present a danger to the lifter. A personal trainer can help you learn the proper head and body position for lifting each type of weight (with or without the help of a spotter) and for using weight machines of each type. Learning to adjust the machines properly is part of this training.

Muscle strains are common among people who use improper lifting techniques and machine setups. Eccentric contractions, in particular, tend to cause microtears in the muscle fibers and connective tissue within and surrounding the muscles. Since eccentric contractions typically take place during the “lowering” of a weight, it is important not to “drop” a weight to its starting position, whether lifting free weights or using a machine. Lift the weight slowly and lower it at a slow, controlled rate. Some personal trainers recommend using a count of two up and four down to control the weight-lowering phase.

The box Tools for Change: Safety Tips for Weight Training gives you additional important safety tips.

GET ADVICE FROM A QUALIFIED EXERCISE PROFESSIONAL

Seek out people qualified to provide accurate resistance-training information, especially if you are just getting started. How can you recognize a qualified exercise professional? Ask any potential personal trainer or instructor questions such as the following:

- Are you certified as a personal trainer or fitness instructor by a reputable, nationally recognized organization such as ACSM, National Strength and Conditioning Association (NSCA), and the American Council on Exercise (ACE)?
- Do you have a certificate or degree in exercise science from an accredited two- or four-year college?
- What types of experience have you had as an instructor or personal trainer?
- How long have you been working in the field of fitness and wellness?
- What are your references from employers and past/present clients?
- How current are you with the changing guidelines and emerging trends in exercise and fitness, and how can you demonstrate this currency?

You’ll want to look at practical details such as how much the personal trainer charges, whether or not he or she has liability insurance, and how well his or her schedule will accommodate yours. Intangibles are equally important: How well do you get along with this potential trainer, and how motivated does he or she help you feel? Consider enrolling in a specific weight-training class at your college or university.
SAFETY TIPS FOR WEIGHT TRAINING

Always observe the general guidelines for safe resistance training (see Table 5.3), as well as these safety tips:

- Get a proper introduction to weight training before beginning. Learn the proper grips and postures; the right way to isolate muscle groups and stabilize others; the correct way to adjust machines for your height; and the safe way to sit, stand, and move during weight lifting to prevent injury.
- Wear gym shoes to protect your feet and wear gloves to improve your grip and protect your hands.
- When using free weights, ask a spotter to make sure you are lifting safely and can return the bar safely after the lift.
- Work out with a friend or partner to spot your lifts and point out any positional errors, equipment problems, and so on.
- Use safety collars at the end of weight bars to secure the weights on the bar.
- Perform all exercises through a full range of motion. With free weights, you must determine the range yourself and may need extra training and attention.
- Perform all exercises in a slow and controlled manner. Some trainers recommend counting as you lift: two up and four down. The object is to avoid fast, jerky, or bouncy motions that can injure your muscles or allow the weight to get away from you and cause injury.
- Stay balanced: Set up in a relaxed, balanced position and maintain that after a lift or set of lifts.

Instructors in such courses are already screened for the above-listed qualifications, and the cost will be significantly lower than hiring your own personal trainer.

PERSONS WITH DISABILITIES MAY HAVE DIFFERENT WEIGHT-TRAINING GUIDELINES

Weight-training programs benefit virtually everyone, including people with some limitations or disabilities. Resistance training can decrease pain and increase mobility in people with joint and muscle disabilities and orthopedic conditions such as arthritis, multiple sclerosis, or osteoarthritis.

Getting off balance is an easy way to create strain on one side and to pull or tear a muscle. Balance your exercise as well so that you build equal strength on both sides and from front to back.

- Breathe in deeply in preparation for a lift and breathe out continuously as you lift. Some weight lifters use a Valsalva maneuver (that is, they exhale forcibly with a closed throat so no air exits) as a way to stabilize the trunk during a lift. However, holding your breath this way can cause an unhealthy blood pressure increase and slow blood flow to the heart, lungs, and brain. Breathe out during the push or pull part of a lift, particularly while lifting heavy weights, to avoid doing the Valsalva maneuver.
- Use lighter weights when attempting new lifts or after taking time off from your routine. You can build up by 3 to 5 percent per session or 10 percent per week. Don’t assume you can pick up where you left off before a break in your training; that’s asking for muscle strain or injury.
- Do not continue resistance training if you are in pain. Learn to differentiate the effort of lifting from the pain of an injury, particularly to a joint.
- Seek the advice of a qualified fitness professional before significantly changing these aspects of your routine: amount of weight, number of repetitions, speed of movement, or body posture.

Source:
Georgia State University, Strength Training Main Page. www2.gsu.edu/~wwwfit/strength.html#safety.

Safety guidelines and appropriate exercises will vary for different individuals and depend on the disability or limitation of each person. Everyone will need medical clearance before beginning a resistance-training program, and those with certain chronic conditions and muscle disorders may need
CASE STUDY

Gina

“I started resistance training last week! It was fun—I have never been able to do a pull-up on my own, but the assisted-pull-up machine at the gym made me feel like I might be able to work up to one. I’m impatient, though. I know that I should warm up before beginning a workout, but I like to just go straight to the machines. I’m also thinking of hiring a personal trainer, but am not sure how to go about it.”

1. How might Gina build a warm-up and cool-down routine into her resistance training program in order to minimize her chances of getting injured while working out?

2. What advice can you give Gina about interviewing a personal trainer?

3. Do you have any injuries or chronic conditions that will affect your ability to resistance train? If so, how might you adapt your program in order to train safely?

specific exercise recommendations and directions from their physicians. If your gym lacks specialized equipment, look for a trainer who can help you perform modified exercises on the available machines. Wheelchair exercisers can perform many seated resistance-training exercises in the gym or at home. Visit this book’s website to view demonstrations of easily adaptable resistance-training exercises for people of all abilities.

IS IT RISKY TO USE SUPPLEMENTS FOR MUSCULAR FITNESS?

Many people are satisfied with the muscle changes and health-related benefits they realize from resistance training. Others, however, set expectations that their bodies can’t meet without taking supplements and/or steroids. These individuals are unsatisfied with their genetic limitations and the results they have gotten from exercise training alone. Their solution is often to use performance-aid supplements to improve muscle size, muscular fitness, and muscular performance. Is this safe, and do common muscular fitness supplements actually work?

Dietary supplements marketed as promoters of muscle conditioning are called performance aids or dietary ergogenic aids. Some supplements are safe but ineffective; some are both unsafe and ineffective. Few, if any, are worth the risk, making this an area to tread lightly into, if at all. Manufacturers of nutritional supplements need not prove their products are safe or effective before offering them on the open market. The FDA may remove unsafe products, but this occurs after the product is “tested” on the buying public. To avoid being an inadvertent subject in an uncontrolled experiment, look into the risks of any supplement very carefully before considering its use. Some ergogenic aids, such as anabolic steroids, are also controlled substances. This means they require a prescription for legal use and should not be used for nonprescription purposes. In addition, their use can get you banned from athletic competitions.

ANABOLIC STEROIDS

Anabolic steroids are synthetic drugs that are chemically related to the hormone testosterone. Physicians sometimes prescribe small doses within a medical setting for people with muscle diseases, burns, some cancers, and pituitary disorders. However, some athletes and recreational weight trainers take anabolic steroids—illegally, outside of a medical setting, without a prescription—to increase muscle mass, strength, and power. Anabolic steroids can produce some of these results in some users—but not without overwhelmingly negative side effects that far outweigh the benefits. Besides being illegal,
steroids increase the risk of liver and heart disease, cancer, acne, breast development in men, and masculinization in women. Anabolic steroid use can also promote connective tissue and bone injuries because dramatically stronger muscles may exert more force than the body can handle. Steroid use can also be habit forming, lead to other drug addictions, and even cause death, as explained in the box Spotlight: Behind the Steroid Warnings.

Steroid use is relatively high among young athletes in certain sports. Public awareness is continuing to increase along with media coverage of steroid scandals in the sports world. In 2005, for example, a series of congressional hearings investigated steroid usage in major league baseball. Members of Congress examined the adequacy of drug testing and the impact of steroid use by professional sports figures on impressionable teenagers. Most of the baseball players called before the committee denied using steroids, but popular player José Canseco stated that steroids were “as prevalent in . . . the late 1980s and 1990s as a cup of coffee.” A 2005 survey of drug use among U.S. adolescents reported that steroid use is down significantly among 8th and 10th graders from its peak in 2000 and has declined among 12th graders from its peak in 2004.

CREATINE

Creatine is a legal nutritional supplement containing amino acids. It is most often sold as creatine monohydrate in powder, tablet, capsule, or liquid form. The body’s natural form of creatine (phosphocreatine) is generated by the kidneys and stored in muscle cells. You can also consume creatine in the diet by eating meat products.

Creatine taken at recommended levels can improve performance by temporarily increasing the body’s normal muscle stores of phosphocreatine. Since this natural energy substance powers bursts of activity lasting less than 60 seconds, creatine users sometimes find they can train more effectively in power activities and may be able to maintain higher forces during lifting. This can result in increased training adaptations such as strength and muscle size. Creatine intake also causes a temporary retention of water in muscle tissue that produces a small temporary increase in size, strength, and ability to generate power. Creatine has no effect on performance of aerobic endurance exercise.

So far, there have been few serious side effects reported in studies of people using creatine for up to 4 years. Minor issues are water retention in muscles, muscle cramping, and overall body dehydration. Once a person stops taking creatine, water retention and temporary muscle enlargement due to that retention disappear. Since the long-term effects of creatine use are unknown, however, potential users should proceed with caution.

ADRENAL ANDROGENS (DHEA, ANDROSTENEDIONE)

Dehydroepiandrosterone (DHEA) is the body’s most common hormone and acts as a weak steroid chemical messenger (a conveyor of internal control signals and information). Although DHEA occurs naturally in the body, manufacturers produce and sell it as a supplement in a synthetic concentrated form despite no definitive proof of its safety or effectiveness. DHEA proponents claim that it increases muscle mass and strength, lowers body fat, alters natural hormone levels, slows aging, and boosts immune functions. Despite manufacturers’ claims, research studies have produced some conflicting results on DHEA but overall do not provide strong evidence of a large positive effect on muscle mass and strength, or on body fat levels.

Androstenedione (nickname “andro”) is another naturally occurring steroid hormone with a structure related to both DHEA and testosterone. It is found naturally in meats and some plants. Even though manufacturers claim “andro” will increase testosterone levels, one pivotal study found that it actually lowers the body’s natural production of testosterone, did not increase the body’s adaptations to resistance training, and increased heart disease risk in men. Androstenedione was ordered off the market by the FDA in 2004, and its use is dwindling. Both DHEA and androstenedione appear to decrease HDL or “good” cholesterol, which helps explain why these substances increase heart attack risks and other cardiovascular problems. Both also increase the risk of developing certain cancers and accelerating the growth of existing cancers. These serious side effects strongly argue against the use of DHEA or “andro.”

GROWTH HORMONE (GH)

Your body’s pituitary gland produces human growth hormone (GH), which promotes bone growth and muscle growth and decreases fat stores. Drug manufacturers produce GH synthetically for medical use
BEHIND THE STEROID WARNINGS

The National Institute on Drug Abuse (NIDA) publishes two postcards for young men and women with a potent message on the dangers of anabolic steroids. Each card lists the risks and side effects of steroid use, ranging from cancer and heart disease to HIV infection, behavioral problems, and unwelcome body changes. Why are government drug regulators—not to mention parents, educators, and coaches—so worried about steroid use in young people?

Steroid use in teens and young adults is a problem for several major reasons:

1. Use of these drugs is surprisingly common. More than half a million 8th and 10th graders have used anabolic steroids, as have tens of thousands of high school seniors. According to NIDA, steroid use is also “probably widespread among athletes and would-be sports competitors at all levels.”

2. Steroid use can lead to the abuse of other drugs. Some of the side effects of steroid use—insomnia, fatigue, restlessness, depression—are so disruptive that people turn to opiate drugs such as cocaine and heroin to relieve their distress.

3. Anabolic steroids can permanently disrupt normal development. A person’s body and brain are still developing during adolescence and into their early 20s. Steroids interfere with the normal maturational effects of sex hormones. In males, this interference can shrink the testes and reduce sperm production, stunt normal height, induce breast development, and cause baldness. In females, steroids can reduce breast size, deepen the voice, and induce excessive body hair growth while thinning the head hair. Most of these changes are irreversible.

4. Steroid use can lead to behavioral changes, including irritability, hostility, aggression, and depression. Researchers injected adolescent hamsters with commonly used steroids, then observed as their playful fighting—wrestling and nibbling—turned to outright attacking and biting at levels 10 times higher. This aggression went on even after the drugs were withdrawn and stayed throughout half of the hamsters’ remaining adolescence. The researchers found increased levels of a neurotransmitter called vasopressin coming from one brain region that closely resembles the same structure in the human brain. The same may be true of a region that produces serotonin and is involved in depression. Such changes during teenage brain development could mean lifelong changes in a person’s aggression and depression levels, even after he or she stops using steroids.

5. Steroids disrupt the way the body processes cholesterol. As a result, steroids promote heart disease, heart attacks, and strokes, even in athletes younger than 30. The liver and kidneys must detoxify and remove steroids from the body, and both organs are more prone to cancerous tumors in steroid users. The drugs also cause blood-filled cysts in the liver that can burst and cause serious internal bleeding.

6. Injecting steroids, rather than taking them orally, and sharing needles with other users can lead to dangerous infections transmitted through dirty needles. The disease risks include hepatitis; HIV; and endocarditis, a bacterial infection of the heart.

Sources:


in children and young adults with abnormally slow or reduced growth and related disorders. Although the FDA regulates growth hormone, athletes wanting to gain an edge over their competitors sometimes obtain and use it illegally. Marketers claim that growth hormone supplementation will counteract the muscle mass lost with disuse and aging, among other alleged benefits. However, GH side effects include irreversible bone growth (acromegaly/gigantism); increased risk of cardiovascular disease and diabetes; and decreased sexual desire, among others.

Marketers of oral GH supplements (GH promoters, not actual GH) claim the same positive benefits to lean muscle mass and fat mass, but this is not borne out in tests or actual use. Oral GH, in fact, cannot even be absorbed from your digestive tract into your bloodstream! A far better way to increase natural levels of growth hormone is to perform regular exercise. In a study of women who ran for exercise, baseline resting GH levels increased by 50 percent in those training at higher compared to lower intensities.12

## AMINO ACID AND PROTEIN SUPPLEMENTS

Many bodybuilders and weight lifters take amino acid supplements because they believe that consuming protein or its building blocks (amino acids) will lead to enhanced muscle development. However, evidence is mixed that high intake of protein or taking protein-based supplements will improve training, exercise performance, or build muscle mass beyond the levels achieved through normal dietary protein. When combined with resistance training, moderate increases in protein intake may lead to small increases in lean muscle mass and strength beyond resistance training alone.13 In contrast, supplementation with the amino acid glutamine produced no beneficial effect above and beyond resistance training itself.14 Taking moderate doses of these supplements has no dramatic side effects, but large doses of either the supplements or protein itself can create amino acid imbalances, alter protein and bone metabolism, and be dangerous to individuals with liver or kidney disease.15

### CASE STUDY

Gina

“I’m a big baseball fan. Growing up in San Francisco, I used to go to Giants and A’s games all the time. So I was kind of shocked to hear about the allegations of steroid and drug use among professional baseball players. I’m confused about the health risks of steroids and supplements. Are they all dangerous? What about the products you can buy in a health store, like creatine?”

1. How would you answer Gina’s questions about steroids and creatine?
2. Give two other examples of ergogenic supplements. How safe are they?
3. Have you ever taken an ergogenic supplement? If so, how much do you know about the pros and cons of taking that supplement?”
**Critical Thinking Questions**

1. Why is weight training a popular activity among college students and adults of all ages?

2. Define sarcopenia and discuss how it can be reversed through exercise. How are sarcopenia and atrophy different?

3. Which fiber type is activated most during a sprint? What is the predominant fiber type in the postural trunk muscles?

4. Discuss the role of resistance training in preventing injuries.

5. How does circuit weight training differ from regular weight training? What are the specific benefits of doing circuit weight training?
Chapter 5: Building Muscular Strength and Endurance

References


LAB 5.1

ASSESS YOURSELF

ASSESSING YOUR MUSCULAR STRENGTH
AND MUSCULAR ENDURANCE

Name: ____________________________________________________________ Date: ____________
Instructor: ___________________________________________________________ Section: ____________

Materials: Calculator, exercise mat, leg press machine, bench press machine, measuring tape (ruler or
yardstick), tape, weight scale, handgrip dynamometer, metronome.

Purpose: To assess your current level of muscular strength and muscular endurance.

Directions: Complete Sections I–III according to your instructor’s direction. If you are completing this lab
with weights, you must have proper supervision. You can complete calisthenic assessments safely on your
own if you follow the procedures carefully.

SECTION I: MUSCULAR STRENGTH ASSESSMENTS

One Repetition Maximum (1 RM) Prediction Assessment

The “gold standard” for measuring muscular strength is using a one repetition maximum (1 RM) to deter-
mine the maximum amount of weight that you can lift one time only. This lab will estimate 1 RM for the
bench press and leg press by finding the amount of weight you can maximally lift 2 to 10 times.

1. Warm-up. Complete 3 to 10 minutes of light cardiorespiratory activity to warm the muscles. Perform
range-of-motion exercises and light stretches for the joints and muscles that you will be using.

2. Use proper form while executing the bench press and leg press exercises. For the bench press, posi-
tion yourself so the bar or handles are across the middle of your chest. Spread your hands slightly
wider than shoulder width. Bring the handles/bar to just above your chest and then press upward/
outward until your arms are straight. For the leg press, position yourself so that your knees are at
a 90-degree angle. Press the weight away from your body until your legs are straight.

3. Perform one light warm-up set. Set the machine at a very light weight and lift this weight about
10 times as a warm-up for your assessment.

4. Find the appropriate strength-assessment weight and number of repetitions. Set a weight that you
think you can lift at least 2 times but no more than 10 times. Perform the lift as many times as you can
(to complete fatigue) up to 10 repetitions. If you can lift more than 10 repetitions, try again using heav-
ier weight. Repeat until you find a weight you cannot lift more than 2 to 10 times. In order to prevent
muscle fatigue from altering your results, attempt this assessment no more than three times to find the
proper weight and number of repetitions. If you do reach this level of muscle fatigue, rest and perform
the test again on another day. Record your results in the Muscular Strength RESULTS section (see step 7).

42 GET FIT, STAY WELL!
5. **Find your predicted 1 RM.** Predict your 1 RM based upon the number of repetitions you performed. If the weight you lifted was between 20 and 250 pounds, use the 1 RM Prediction Table to find your predicted 1 RM. If you lifted over 250 pounds, use the Multiplication Factor Table to find your predicted 1 RM.

6. **Find your strength-to-body weight ratio.** Divide your predicted 1 RM by your body weight for your strength-to-body-weight ratio (S/BW). Since heavier people often have more muscle, this is a better indicator of muscular strength than just the weight lifted alone. Record your results in the Muscular Strength RESULTS section.

7. **Find your muscle strength rating by using the Strength to Body Weight Ratio chart provided on page 45.** Finding your rating tells you how you compare to others who have completed this test in the past. Record your results below.

### Muscular Strength Results

**Bench Press:**

<table>
<thead>
<tr>
<th>Weight lifted (lb)</th>
<th>Multiplication factor*</th>
<th>Predicted 1 RM (lb)</th>
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\[
\text{Predicted 1 RM (lb)} = \frac{\text{Weight lifted (lb) \times Multiplication factor}}{\text{Predicted 1 RM (lb)}}
\]

**Leg Press:**

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<th>Weight lifted (lb)</th>
<th>Multiplication factor*</th>
<th>Predicted 1 RM (lb)</th>
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\[
\text{Predicted 1 RM (lb)} = \frac{\text{Weight lifted (lb) \times Multiplication factor}}{\text{Predicted 1 RM (lb)}}
\]

**Rating**

*Multiplication factor from the Multiplication Factor Table on page 45.
### 1 RM Prediction Table

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</table>

Table and multiplication factors generated using the Bryzcki equation: \[ 1 \text{ RM} = \text{weight (kg)} / (1.0278 - (0.0278 \times \text{repetitions})). \]


### STRENGTH TO BODY WEIGHT RATIO RATINGS

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## SECTION II: MUSCULAR ENDURANCE WEIGHT-LIFTING ASSESSMENTS

### Twenty Repetition Maximum (20 RM) Assessments

The 20 RM assessment is a weight-lifting assessment of your muscular endurance. Performed in a weight room, this assessment will help you plan your muscular fitness program. By performing the assessments before and after completing 8 to 12 weeks of muscular fitness exercises, you can measure your improvement.

1. **Prepare for the muscle endurance assessments.** If you have just completed the muscular strength assessments, you will already be warmed up. If not, perform a warm-up similar to the one described in Section I. Follow the position, form, and warm-up instructions for bench press and leg press in Section I.

2. **Find your 20 RM for bench press and leg press.** Set a weight that you think you can lift a maximum of 20 times. Perform the lift to see if you were correct. If not, increase or decrease the weight and try again until you find your 20 RM. In order to make sure that muscle fatigue does not alter your results, try to find your 20 RM within three tries. If it takes longer, rest and perform the test again on another day. Record your results on the next page.

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SECTION III: MUSCULAR ENDURANCE CALISTHENIC ASSESSMENTS

Push-Up Assessment

In this muscular endurance assessment, you will perform as many push-ups as you can with correct form. This test will assess the muscular endurance of your pectoralis major, anterior deltoid, and triceps brachii muscles. If you work with a partner, your partner can check your positioning, form, and count your repetitions.

1. **Get into the correct push-up position on an exercise mat.** Support the body in a push-up position from the knees (women) or from the toes (men). The hands should be just outside the shoulders and the back and legs straight. Review Figure 5.8 on page 25 for proper push-up positioning.

2. **Start in the “down” position** with your elbow joint at a 90-degree angle, your chest just above the floor, and your chin barely touching the mat. Push your body up until your arms are straight and then lower back to the starting position (count one repetition). Complete the push-ups in a slow and controlled manner.

3. **Complete as many correct technique push-ups** as you can without stopping and record your results in the Muscular Endurance Calisthenic RESULTS section on page 48.

4. **Find your muscle endurance rating** for push-ups in the chart below and record your results.

Curl-Up Assessment

In this muscular endurance assessment, you will perform as many curl-ups as you can (up to 25) with correct form. This test will assess the muscular endurance of your abdominal muscles.

1. **Lay back on a mat** with your arms by your sides, palms flat on the mat, elbows straight, and fingers extended. Bend your knees at a 90-degree angle. Mark the start and end positions with tape. Your instructor or partner will mark your starting finger position with a piece of tape under each hand. He or she will then mark the ending position 10 cm or 3 in away from the first piece of tape—one ending position tape for each hand. Your goal is to rise far enough on the curl-up to achieve a 30-degree trunk elevation.

2. **Your instructor or partner will set a metronome to 50 beats/min** and the exerciser will complete the curl-ups at this slow, controlled pace: one curl-up every 3 seconds (25 curl-ups per minute).

3. **To start the test,** curl your head and upper back upward, reaching your arms forward along the mat to touch the ending tape. Then curl back down so that your upper back and shoulders touch the floor. During the entire curl-up, your fingers, feet, and buttocks should stay on the mat. Your partner will count the number of correct repetitions you complete. Any curl-ups performed without touching the ending position tape will not be counted in the final results.
4. Perform as many curl-ups as you can without pausing, to a maximum of 25. Record your score below. Determine your muscular endurance rating for curl-ups using the chart below and record your results.

**Alternative: One minute timed curl-ups.** Your instructor may choose to have you complete as many curl-ups as you can within 1 minute (without the metronome pacing). Use the same start and end positions, perform controlled repetitions of curl-ups for 1 minute, and record your results below.

Muscular Endurance Calisthenic Results

**Push-Ups:**
- Repetitions _______________ Rating _______________

**Curl-Ups:**
- Repetitions _______________ Rating _______________

**Alternative – 1 min timed curl-ups:**
- Repetitions _______________

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SECTION IV: GRIP STRENGTH ASSESSMENT

If a handgrip dynamometer is available, your instructor may direct you to perform this assessment. In this muscular strength assessment, you will squeeze the dynamometer as hard as you can to test the isometric or static strength of your forearm gripping muscles.

1. **Adjust the dynamometer to fit your hands.** The second joint of the hand should fit under the handle. Make sure that the dynamometer is set to zero. Hold the dynamometer in the hand to be tested. Make sure that your hands are not wet or slippery.

2. **In a standing position, hold the dynamometer at your side** with a straight arm. Make sure that the elbow joint is not locked and keep the arm from touching the body or swinging. Support your back by slightly bending your knees. Squeeze the dynamometer as hard as you can for 2 to 3 seconds. Avoid holding your breath during the test.

3. **Repeat the test with the other hand.**

4. **Perform two trials on each hand.** Record the highest score of the two trials for each hand in the chart below. Add the best right-hand and the best left-hand scores together and record below.

5. **Find your handgrip muscular strength rating** in the chart below and record your results.

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### CURL-UPS

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Handgrip Muscular Strength Results

Right Hand: Trial 1 _______________ Trial 2 _______________
Left Hand: Trial 1 _______________ Trial 2 _______________
____________________ + ________________ = ______________
Best score right hand Best score left hand Best score total
Rating = ______________

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SECTION V: REFLECTION

1. What was surprising about your muscular fitness results, if anything?
2. Based upon your assessment results, which aspect of muscular fitness will your program focus on—muscular strength or muscular endurance?

GET FIT, STAY WELL!
SECTION 1: SHORT- AND LONG-TERM GOALS

Create short- and long-term goals for muscular strength and muscular endurance. Be sure to use SMART (specific, measurable, action-oriented, realistic, timed) goal-setting guidelines. Also apply information from the Chapter 5 text and use your results from Lab 5.1. Remember that choosing a goal to improve your assessment scores is a highly measurable way to set goals. Select appropriate target dates and rewards for completing your goals.

Short-Term Goals (3–6 months)

1. Muscular Strength Goal:

________________________________________________________________________________________________________

Target Date: __________________

Reward: _______________________________________________________________________________________

2. Muscular Endurance Goal:

________________________________________________________________________________________________________

Target Date: __________________

Reward: _______________________________________________________________________________________

Long-Term Goals (12+ months)

1. Muscular Strength Goal:

________________________________________________________________________________________________________

Target Date: __________________

Reward: _______________________________________________________________________________________
2. Muscular Endurance Goal:

________________________________________________________________________________________________

Target Date: ____________________

Reward: _______________________________________________________________________________________

SECTION II: MUSCULAR FITNESS OBSTACLES AND STRATEGIES

What barriers or obstacles might hinder your plan to improve your muscular fitness? Indicate your top three obstacles below and list strategies for overcoming each obstacle.

a.

b.

c.

SECTION III: GETTING SUPPORT

List resources you will use to help change your muscular fitness:

Friend/partner/relative: ____________________ School-based resource: ____________________

Community-based resource: ____________________ Other: ____________________

SECTION IV: REFLECTION

1. How realistic are the short- and long-term target dates you have set for achieving your muscular fitness goals?

2. Are there any other strategies not listed above that could assist you in reaching your goals?

3. Think about all of the opportunities that present themselves in your daily life to work toward muscular fitness. List as many of these as you can think of:
LAB 5.3
PLAN FOR CHANGE

YOUR RESISTANCE-TRAINING WORKOUT PLAN

Name: ____________________________________________ Date: __________
Instructor: __________________________________________________________________________ Section: __________

Materials: Lab pages, calculator

Purpose: To create a basic, personal resistance-training workout plan. Forms for following up and tracking your muscular fitness and your resistance-training program are included.

Directions: Complete the following sections.

SECTION I: MUSCULAR FITNESS PROGRAM QUESTIONS AND MOTIVATIONS

1. How many days per week are you planning to work on your muscular fitness program? __________

2. How experienced are you at resistance training? (circle one below)
   - Novice
   - Intermediate (training 1 to 2 years)
   - Advanced (training 3+ yrs)

3. Which will you focus on first? (circle one)
   - Muscular strength
   - Muscular endurance

4. The best muscular fitness programs are well-rounded and work the entire body. However, some people want to focus more heavily on one area than another. Which muscle groups do you want to focus on?

5. Which type of equipment do you plan to use and why? (check all that apply)
   - [ ] Weight machines
   - [ ] Free weights
   - [ ] No equipment (calisthenic exercises)

6. How much time do you plan to spend each day on your resistance-training program?

7. Do you have a workout partner? Do you plan to work with a partner, trainer, or instructor to help you get started?
SECTION II: RESISTANCE-TRAINING PROGRAM DESIGN

Plan your resistance-training program using resources available to you (facility, instructor, text). Complete one line for each exercise you have chosen to do in your program.

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<thead>
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<th>Exercise</th>
<th>Frequency (days/week)</th>
<th>Intensity (weight in lb)</th>
<th>Sets (number)</th>
<th>Reps (number per set)</th>
<th>Rest (time between sets)</th>
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SECTION III: TRACKING YOUR PROGRAM AND FOLLOWING THROUGH

1. **Goal and program tracking:** Use the following resistance-training chart to monitor your progress. Change the amount of resistance, sets, or repetitions frequently to accommodate your stronger musculature and ensure continuing progress toward your goals.

2. **Goal and program follow-up:** At the end of the course or at your short-term goal target date, reevaluate your muscular fitness and answer the following questions:
   a. Did you meet your short-term goal or your goal for the course?
   b. If so, what positive behavioral changes contributed to your success? If not, which obstacles blocked your success?
   c. Was your short-term goal realistic? After evaluating your progress during the course, what would you change about your goals or resistance-training plan?
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