TRIATHLON ANATOMY

SECOND EDITION

Your illustrated guide to faster, stronger multisport performance

MARK KLION, MD | JONATHAN CANE

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This book is dedicated to my wife and children, who have enabled me and supported me in all of my life's endeavors and who truly understand me and my motto of "Pain is inevitable, but suffering is optional."

—Mark Klion

This book is dedicated to the memory of my parents, who encouraged me to pursue a profession I love, and to the memory of Joe Glickman, who taught me about writing and humor. Mostly, it's dedicated to my wife, Nicole, for always demonstrating that hard work leads to results, and to my son, Simon, who motivates me to be the person he thinks I am.

—Jonathan Cane

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PREFACE

Triathlon participation has grown significantly over the last 10 years. Technology has paved the way for advances in almost every aspect of training and racing. Every year new and improved equipment is promoted to make athletes go faster, look better, and stay healthier while competing in triathlon. These improvements all come with a price tag. For the beginning triathlete, the advanced technology is probably less important than experiencing the simple joy of participating and achieving competitive goals.

Triathlon training and racing are not activities that most baby boomers grew up with. Generations X, Y, and now Z will all have benefited from our trials and tribulations. We still have Little League games, travel soccer, and the many other individual and team sports for youth, but we have also witnessed a marked increase in triathlon participation by young athletes. Clubs and collegiate teams are accessible at all age levels. A new breed of young and talented triathlete is being developed.

Triathlon is considered by some to have had its beginnings in France in the 1920s. The first modern swim, bike, and run event to be called a triathlon was held at Mission Bay, San Diego, California, on September 25, 1974. Since then, we have come to the point where races of every distance imaginable (sprint, Olympic, half Ironman, full Ironman, and Decaman—10 Ironmans all at once) are run almost every weekend in the United States and worldwide.

Whatever the distance may be, the principles of training remain the same. Improved cardiorespiratory fitness and increased musculoskeletal strength and power build the foundation of improved performance. Triathletes often like to say, "The larger the engine, the faster the train." A fast engine that breaks down often from overtraining can be problematic and frustrating. A well-thought-out training program that includes strength and flexibility training can create a large engine that runs smoothly.

As an athlete commits more time and effort to the sport, injury prevention and often injury management can become crucial. This book offers both novice and experienced athletes the opportunity to learn more about how the musculoskeletal system functions and responds to triathlon-specific exercises and training. We remind you never to stray far from the fundamentals of safe and effective endurance sports training for performance.

The first chapter introduces the triathlon world. This is followed by a discussion of the effects of exercise on the cardiovascular and cardiorespiratory systems, which make up the engine. Chapters 4 through 10 provide detailed anatomical descriptions and pictorial explanations of sport-specific exercises that have been shown to improve strength and performance. Every exercise includes a code that represents the three disciplines of triathlon participation.

Some exercises will be more specific to one or two sports. Use the symbols to guide your training program so it addresses both potential weaknesses and strengths in training and racing. Chapter 3 describes how to customize your training plan. Chapter 11 provides essential information on injury prevention, with a description of common injuries triathletes encounter as well as appropriate exercises and treatment principles to help them get back on track.

One unique feature of *Triathlon Anatomy* we hope you find helpful is the anatomical drawings that accompany the description of each exercise. They illustrate key muscles used during each movement, using color to highlight the engagement of primary and secondary muscle groups from start to finish.

Primary muscles   Secondary muscles

Some illustrations will include parts of the body that are not muscles, and these terms are noted in italics in an illustration.

Participation in triathlons is a commitment to health and fitness. For some athletes, racing is the pinnacle prize, but for many people, triathlon becomes a lifestyle enriched by training, racing, and a community that thrives on sharing information. This book contains pearls of wisdom we have learned only through experience. We hope that sharing them with you will help you to maintain consistency and good health in triathlon. Train smart and stay healthy.

1

THE TRIATHLETE IN MOTION

Triathlon participation continues to grow. The first triathlon was held in 1974, and the inaugural Ironman-distance triathlon in 1978 had only 15 competitors. Today USA Triathlon (USAT) boasts a membership of almost 500,000, and single-event participation in 2017 reached just over four million racers. The first edition of *Triathlon Anatomy* was written to provide readers with a basic understanding of what physiologic demands are being placed on one's body during triathlon training and racing. This can enable athletes to better focus on a training plan, and perhaps a lifestyle, that follows the dictum "Train hard, but train smart." Although athletes typically want to get faster, staying healthy and avoiding injury are primary objectives for success in triathlon participation and ultimately in one's athletic life.

As the saying goes, "If you build it, they will come," and the multisport generation has arisen. Today, with approximately 4,300 USAT-sanctioned triathlons in existence—including 40 branded Ironman races worldwide and many other so-called multisport events like Tough Mudder and Spartan series races—the concepts remain the same for training and racing. Train hard, but train smart. Whether the goal is to compete in a local small triathlon or the World Triathlon Championship in Hawaii, triathletes have created a community of like-minded athletes who share a passion for putting their minds and bodies through the rigors of training and racing to achieve a goal. Being able to train successfully for any of these events requires athletes to place their bodies under stresses that may be unfamiliar. This second edition continues to build on the basic principles of training and racing and includes valuable insights into how to put it all together and have a successful race.

Technology offers ways to improve training and racing. Information about heart rates, oxygen saturation, lactate levels, and other variables of training are now available without going to an exercise physiologist. Whether or not one can accurately make sense of all of this information is another issue, but the barriers to obtaining this information have broken down. Power monitors for cycling, running, and even swimming are available at reasonable prices.

The evolution of indoor training in a virtual world with the likes of Zwift have made indoor training more enjoyable, safe, and accessible. Our understanding of nutritional needs during racing and recovery has improved, and extremity compression devices are available to help athletes recover from training and potentially enhance their health. In 1982, *SWIM-BIKE-RUN*, the sport's first magazine, was launched. Now with *Triathlete* magazine representing the largest triathlon publication and countless triathlon blogs available, it is no wonder many athletes can swim faster, bike stronger, run faster, and look fashionable—and hopefully stay healthy—while doing it.

TRIATHLON DISTANCES

Although the world around triathlons is changing, a triathlon is still a multisport event involving the completion of three activities in succession, usually swimming, biking, and running. Races of every distance are available and accessible to all takers. Common distances are sprint, Olympic (or International), half Ironman (or IM 70.3), and full Ironman (table 1.1).

Sprint triathlons and other races of shorter distances can be attractive to beginning triathletes because the time required for training can be less. Also, some athletes simply excel at shorter distances and enjoy high-intensity, all-out racing. The duration of a sprint triathlon can vary, but usually a time of under 1 hour wins national-caliber events, and 1 hour and 20 minutes is considered competitive, depending on the age group.

At the Olympic distance, training and racing times correspondingly increase. According to former race director John Korff, the average finishing time of more than 3,500 athletes at the New York City Olympic-distance triathlon for 2010 was 3:04:39. The winner recorded a time of 1:48:11!

Training time and race duration continue to climb for half-Ironman and Ironman distances. Despite the simplicity of the metric system, these races are often better described in miles. A half Ironman is now often referred to as a 70.3, reflecting the total mileage of the race. The Ironman distance, or 140.6, is a 2.4-mile swim followed by 112 miles on the bike, finishing with a 26.2-mile run. The Ironman continues to be the Holy Grail for some athletes, and it attracts competitors of every age, size, and ability level.

TABLE 1.1 Triathlon Distances

	Swim	Bike	Run
SPRINT	750 m	20K	5K
OLYMPIC	1,500 m	40K	10K
HALF IRONMAN	1.2 mi	56 mi	13.1 mi
FULL IRONMAN	2.4 mi	112 mi	26.2 mi

TRANSITIONS

Between each leg of the triathlon is a transition from one activity to another. T1 and T2, as they are called, are transitions from swimming to biking and biking to running, respectively. Veteran triathletes know that the time to complete these transitions also needs to be calculated into the overall finishing time. Races can be won or lost in the transition area, and coaches often refer to fast transitions as "free speed." It is not a place for lounging. Transitions can also play a critical role in race recovery, offering a moment to rest, and they provide opportunities to manage certain issues, such as nutritional needs, sunscreen application, and bathroom breaks, that occur during a race.

BIOMECHANICS OF TRIATHLON

Triathlon participation involves three activities: swimming, biking, and running. Each activity requires a coordinated pattern of muscle recruitment that produces motion about the joints and creates the power to make the triathlete move. As a triathlete transitions from one discipline to the next, a concomitant increase in weight-bearing activity is seen.

The swim requires the triathlete to be prone, lying facedown in the water and using the arms and legs for propulsion. Most people without a swimming background quickly learn that swimming efficiency and thus speed are extremely dependent on technique. For those who are technically challenged, wetsuits, which are legal to use in certain water temperatures, provide buoyancy to help produce better swimming position, resulting in less drag on the legs. Most triathletes use the arms to a much greater extent than the lower extremities for propulsion in water, partly to prevent lower-extremity fatigue when biking and running.

The transition to the bike places a greater emphasis on both the lower extremities and the core. The upper extremities contribute stabilization and assist in bike-handling skills.

Running, the greatest weight-bearing activity of the three, places the most impact on the body and requires a smooth coordination between upper and lower extremities to enable efficient gait. Strength training with both isolated and sport-specific exercises, as described in later chapters, will help develop a strong foundation to create power and speed and also to prevent injury. A discussion of the ever-changing shoe market will also be introduced in later chapters because this may represent another component in injury prevention.

TEST OF ENDURANCE

The common thread that binds all triathlon distances together is that they all require prolonged exercise tolerance. This is unlike many other sports. Professional American football players play an average of 12 minutes over more than 3 hours during a 60-minute game. It has been calculated that during an average 90-minute soccer game, a player runs about 6 miles (10 km). At even the shortest triathlon distance, the ability to sustain exercise needs to be greater than this. It is through planned training that an athlete develops tolerance both physiologically and mentally to complete an endurance event like a triathlon. In chapter 2 we will describe some of those physiological changes. It is often said, “Pain may be inevitable, but suffering is optional.” Through persistent training, exercise and sustained efforts become more comfortable.

The cardiorespiratory and musculoskeletal systems can be trained to handle this endurance stress. As we learn more through research about our ability to perform both aerobic and anaerobic exercise and about techniques to improve our musculoskeletal functions, we can achieve true athletic performance.

Injury prevention and injury management are a significant part of triathlon participation. Repetitive stresses on the body can cause tissue breakdown and subsequent injury. A broken engine doesn’t go very fast. Along with injury management comes a psychological component of training and racing that includes learning to sustain efforts or, as some veterans like to say, to suffer. The ability to dig deep remains an important determinant of performance in endurance sport competition. Some people seem able to push harder and longer, but for most triathletes, the stresses of digging deep pale in comparison with the pressures of balancing family and work with the rigors of training and racing. The terms *triathlon widow* and *triathlon widower* are not uncommon in the triathlon community. For all that is said in jest, this stress, along with the commitment to a healthy life, can seem overwhelming to new triathletes. At the end of a triathlon of any distance, the elation and celebration often are shared by all those who supported the effort.

TRAINING CONSIDERATIONS

With all the knowledge and gear at our fingertips, why don’t we all train and race like the pros? Genetics plays a significant role in a person’s athletic ceiling. Some have the athletic genes, and some don’t, but personal commitment and a well-thought-out training program can help all athletes to improve their performance and achieve their potential.

From our knowledge of human physiology we learn that our bodies respond to a well-planned training program. Training haphazardly or disregarding the warning signs of common injuries will cause the body to break down. Every athlete has a unique threshold beyond which the body begins to break down and the risk of injury increases. That threshold varies between individuals, and it also depends on their triathlon experience. What might be good for one athlete may not be as effective and can even be detrimental to another.

The training philosophy for the volume and types of workouts, for quantity versus quality, has changed over the years. This is especially true for maturing athletes, those over age 40. We all like to think we can train with reckless abandon, but no matter what our age, our bodies can remind us differently with aches, pains, and potential injury if we don't pay attention to our well-being. Endurance capabilities peak at around age 35 and progressively decline until about age 50, after which they decline more significantly. Muscle mass peaks in the mid-20s and progressively declines each year. Sorry for the bad news. On the positive side, science also shows that exercises that focus on increasing strength can reduce this muscle loss. The loss of flexibility, which also accompanies increasing age, can be altered with stretching exercises that help maintain function and reduce injuries. Endurance training for the mature athlete requires special attention and a lot of tender loving care to sustain a consistent training and racing schedule.

Controversy exists as to whether strength training actually improves performance. Any coach or sports medicine physician will support a well-outlined training program that includes both strength and flexibility training. The goal of the program should be to promote musculoskeletal health and improve the body's ability to withstand the repetitive stresses placed on it by endurance activities. The development of strength with sport-specific exercises as outlined throughout this book also improves economy of motion, or the ease with which you perform an activity. This will help you go faster and decrease stress on the body.

Core stability, although not glamorous with respect to training, can be defined as the body's foundation for movement and power generation and is an essential part of training. The core muscles of the abdomen and pelvis are an untapped source of stability and power. Weaknesses in that region can be the primary reason for injuries seen in triathletes. Strengthening this group as described in chapter 9 can help increase power and speed in all three activities of triathlon.

Throughout the book are explanations of how each body part works with respect to triathlon participation. The interactions of the soft tissues, including muscles, tendons, and ligaments, as well as bones and specific joints, are described. Each chapter is a guide to how to best strengthen those areas for increased performance and injury prevention. The exercises described are sport specific. Common injury signs are discussed, and the importance of recovery and rest are reinforced to ensure injury-free years of triathlon participation. Chapter 11 provides insight into organizing and implementing a training program to help you remain injury free. In chapter 2, we examine the cardiovascular and cardiorespiratory systems as they relate to triathlon participation. The pumping heart supplies blood to the muscles as we race and train. The bigger the engine, the stronger the heart and the longer and faster we can go. Train hard, but train smart.

2

PRINCIPLES OF ENDURANCE TRAINING

Exercise is a way of life for most triathletes. It can define how they feel physically and mentally, and it can help to create the environment in which they live. For some people, exercise can help them reduce stress, maintain body weight, and feel good about themselves. The American Heart Association recommendations for exercise for people ages 18 to 64 include vigorous exercise for 150 minutes per week and two sessions a week of strength training. From a medical standpoint, research has shown that people who participate in regular exercise programs have remarkably reduced risks of cardiovascular disease, non-insulin-dependent diabetes, high blood pressure, osteoporosis, and colon cancer, and exercise is an integral part of weight loss programs. The rate of obesity continues to rise to crisis levels in the United States, affecting almost 93 million individuals from 2015 to 2016. Exercise needs to be part of everyone's life.

For some triathletes, these benefits may seem less important than the prime goal of getting faster and going longer. For them, building the biggest and strongest engine is what training is about. Recent reports suggest a link between excessive exercise and cardiac damage and abnormal heartbeats or arrhythmias. More research is needed to determine if there are indeed adverse effects of excessive endurance training. In this chapter, we will help develop an understanding of how exercise improves the cardiovascular and cardiorespiratory systems. When done systematically through a proper training program, one can build a big engine and improve health and performance.

CARDIOVASCULAR AND CARDIORESPIRATORY SYSTEMS

The cardiovascular and cardiorespiratory systems (figure 2.1), which include the heart, arteries, capillaries, and veins, along with the lungs and their vasculature, support and enable five important functions required for exercise:

1. The heart delivers oxygen, needed for energy production, to the working muscles via blood through the arteries.
2. Blood that is low in oxygen from the working muscles returns to the lungs via the veins to be reoxygenated.
3. Increases in body temperature from working muscles are regulated as arteries and capillary beds in the skin allow for heat dissipation.
4. Energy in the form of glucose and hormones for homeostasis or body regulation are transported to active tissues via the arteries.
5. Metabolic wastes from exercise are transported away from the active tissues via the veins and lymphatic vessels to allow continued activity.

Heart Delivers Oxygen to Working Muscles

The heart, which is a unique muscle, beats or contracts on its own. The rate at which it beats is controlled by our nervous system, and it responds to exercise or an increase in metabolic demand. Exercise of any form trains the cardiac muscle by increasing its size and efficiency. This increase in size produces a stronger force of contraction. In doing so it can efficiently pump more blood to the working muscles at a slower rate. Cardiac output (CO), the amount of blood the heart pumps through the circulatory system in a minute, is a medical measure used to determine heart function; the higher the number, the stronger the heart. It is calculated with this equation:

CO = stroke volume (amount of blood pushed with each contraction/beat) × heart rate (beats per minute)

Exercise-induced cardiac benefits include a decrease in resting, exercising, and recovery heart rates. Resting heart rates can be used to measure athletic recovery and overall health status. To measure your resting heart rate, take your heart rate after waking up while still lying in bed without moving. A variation of as few as five beats above normal can be an indication of impending illness or potential overtraining. This is because in either of these states, there is increased metabolic demand, and the heart reacts to this by beating faster even at rest. Understanding heart rate zones and how certain workouts can improve cardiac function is an important concept in proper training. Exercising heart rate is taken manually during a workout or with a heart rate monitor. A better-conditioned athlete will be able to swim, run, or bike (at any given intensity) at a lower heart rate, producing a lower metabolic demand. Another benefit of a strong heart is a decrease in the time it takes the heart rate to return to a resting level after exercise, known as the recovery rate. A good measure of overall conditioning is the following: During a recovery period after an intense effort in any of the sports, an athlete's heart rate will come down about 20 beats per minute within 1 minute of stopping that interval. A decline of less than 12 beats per minute may indicate a potential risk of cardiovascular disease.

Some other measures important for assessing physiological fitness include maximum heart rate, lactate threshold, and $\dot{V}O_2$max. Although new technology allows for some of this information to be obtained by the athlete, ideally the athlete has these measures assessed with appropriate equipment and in the presence of a trained professional who can best interpret the results.

For this discussion, $\dot{V}O_2$max is defined as a person's maximum capacity to transport and use oxygen. This concept relies on the ability to deliver oxygen to the tissues and then use it for energy production. Many conditions can affect $\dot{V}O_2$max, including lung disease, which decreases oxygen diffusion to the blood; a weak heart that can't pump blood to the tissues; and untrained muscles, which don't have the cellular tools, like mitochondria (the cellular power generators), to process the oxygen. Although it is often considered the single best measure of cardiorespiratory fitness and maximal

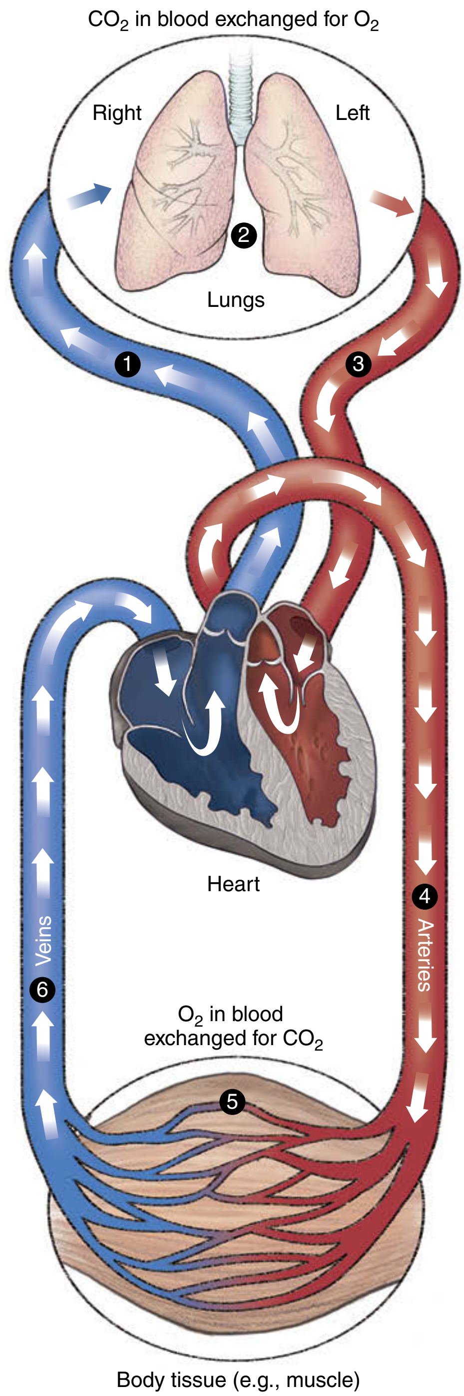

FIGURE 2.1 The blood circulates through the heart, lungs, and muscles.

aerobic power, $\dot{V}O_2max$ is often a very bad predictor of performance. $\dot{V}O_2max$ values are affected by many other variables including age, sex, body weight, fitness level, and individual genetic factors. For most trained athletes, $\dot{V}O_2max$ values change by as little as 10 percent with training. The greatest gains are seen in people who are untrained and start an exercise program.

What appears to be more accurate in determining performance is an athlete's ability to swim, bike, or run at or close to $\dot{V}O_2max$ for a given period of time. This is referred to as percent $\dot{V}O_2max$ and relates to a concept called anaerobic threshold, or lactate threshold, the point at which lactate production exceeds the body's ability to process it, and performance cannot be maintained. $\dot{V}O_2$ at lactate threshold has been shown to be a far more accurate predictor of performance than $\dot{V}O_2max$ itself. More is discussed later in the chapter. Through aerobic workouts that increase the cellular machinery to process oxygen and through lactate threshold workouts to help develop better exercise tolerance, athletes can build a bigger and more efficient engine. (This is discussed further in chapter 3.)

Blood Returns to Lungs and Oxygen Levels in Blood Are Restored

As blood passes through the lungs in the small capillary beds, oxygen is transported across a thin membrane and is bound to a protein called hemoglobin found in red blood cells. Oxygenated blood is then transported to muscles, where it is released into the muscles. Oxygen is required to make energy molecules called adenosine triphosphate (ATP) to enable muscles to contract. After ATP molecules are used, carbon dioxide is produced, released back into the blood, and carried back via veins to the lungs. This process repeats itself over and over again. The heart pumps about 2,000 gallons (7,571 liters) of blood per day, which is 83 gallons per hour or almost 6 quarts per minute. It takes about a minute for blood to complete one trip through the body.

The amount of oxygen that can be carried from the lungs to the muscles is also determined by the percentage of red blood cells in whole blood, which is called the hematocrit level. The normal values are 45 percent in men and 40 percent in women, although the percentage can vary from person to person. Living or training at altitude, where oxygen levels in inspired air are lower, can force the body to adjust and make more red blood cells. Some athletes may seek out artificial and illegal ways of creating more red blood cells through the use of blood doping—autotransfusing one's own stored red blood cells—or taking hormones, such as erythropoietin (EPO), which increase the amount of red blood cells in the body. Another way to increase hematocrit levels is by sleeping at altitude. This can be accomplished by sleeping in an altitude tent, even when at sea level. This was once a very expensive option but is now much more economical with readily available rental units. This process of acclimatization can take as long as 4 weeks to occur. This “train high, race low” concept has been challenged in the last few years and remains controversial. Training at altitudes above certain levels can actually be detrimental to performance and cardiorespiratory function. Nowadays, to gain the benefits of altitude training, it is recommended to “live/sleep high, train low,” which provides the altitude-induced benefits without compromising workouts.

Heat Transported to Skin for Temperature Regulation

Thermoregulation, the ability to keep the core body temperature within certain boundaries, is accomplished by heat loss from conduction, radiation, evaporation, and convection. Normal body temperature ranges from 97.7 degrees Fahrenheit to 99.5. As the body’s internal organs and muscles are worked through exercise, heat is generated, and core temperature can rise. Hyperthermia, a state in which the core temperature increases because of failed thermoregulation, is defined as a temperature of 100 to 101 degrees Fahrenheit (37.8 to 38.3 °C). Symptoms include nausea, vomiting, headache, and low blood pressure, which can lead to dizziness and fainting. If left untreated, heat stroke, a temperature in excess of 104 degrees Fahrenheit (40 °C), can be fatal.

The body uses only about 25 percent of the energy it produces, so the other 75 percent must be lost as heat. Conduction of heat occurs when heat is transferred from a warmer object to a colder one in direct contact. This could be a cold towel around the neck, wet sponges under a hat, or dunking oneself into an ice bath. Convection heat loss is the process where air or water flows over the body. These concepts help to explain why swimming and riding a bike can be very efficient ways to encourage heat loss. The process of heat loss through radiation occurs when the skin temperature is warmer than the outside temperature and creates a gradient that allows the body to lose heat.

Evaporation is the process of heat loss as water is converted to a gas. The body creates sweat to facilitate heat loss. As the core temperature increases, the brain sends signals to the heart and blood vessels to increase blood flow to the skin and activate sweat glands to help with thermoregulation. The increase in sweat loss, including water and electrolytes, can lead to dehydration. Losses of 1 to 2 percent of body weight in water can lead to decreased performance. A loss of more than 6 to 10 percent can lead to loss of thermoregulation and more serious health issues, including death. Heat-related illnesses may occur at any level of triathlon participation. Tips to prevent the negative effects of heat include properly hydrating with cool liquids; wearing a visor, hat, and light-colored wicking clothing to provide shade from the sun; and pouring water on the body or ice on the head to increase conduction loss.

Blood Transports Glucose and Hormones to Active Tissues

Muscle contraction and, thus, force generation depends not only on the availability of oxygen, but also on the availability of energy. Blood, which comprises plasma and water, carries nutrients, proteins, and hormones throughout the body to supply this needed energy. The terms *aerobic exercise* and *anaerobic exercise* describe whether cellular metabolism occurs in the presence (aerobic) or absence (anaerobic) of oxygen. At the training level, this can be translated based on the intensity and duration of exercise. Aerobic exercise, such as a long, slow run, is performed at a relatively low intensity for a longer time and in the presence of oxygen for energy production. Anaerobic exercise, such as weightlifting or sprinting, is of short duration and high intensity, and it is performed without the use of oxygen for energy production. During exercise, an active balance between these two processes creates a constant flow of energy to the working muscles.

One obvious source of energy is the food we eat. Initially, food is digested in the stomach and passed through the small and large intestines for absorption. Carbohydrates are taken up by muscles for energy, and the liver converts carbohydrates to glycogen for storage. The liver stores the most glycogen; when called upon, the liver can rapidly convert glycogen back to glucose to be transported to muscle via blood.

Fats are stored as adipose tissue in the peripheral areas of the body. To provide energy, fats must be broken down in a complex series of steps to a simpler form of glycerol and free fatty acids. Stored fats represent a substantial energy reservoir, but the time required to convert them to usable forms makes them unsuitable as an energy source for very intense exercise.

Proteins also provide energy for prolonged exercise but, similar to fats, they require initial breakdown (in this case into amino acids) into a form that can be used in aerobic metabolism. This represents only 5 to 10 percent of total energy expended during endurance exercise. Proteins do play a major role in the response to exercise; this includes building new tissue, such as muscle, and repairing tissues damaged by injury or even by intense exercise.

The hormonal system responds to exercise by producing endorphins, which can create the runner's high, and testosterone and growth hormone, which promote muscle growth and injury healing. These are transported to active tissues via blood plasma. Excessive exercise and overtraining, on the other hand, can stimulate cortisol production that can suppress the immune system, which may lead to illness and loss of training time.

A practical consideration for nutrition and energy production is the ability of the organs to digest and absorb nutrients in the gastrointestinal system during exercise. Blood flow to the gastrointestinal system that is normally needed for digestion is shunted away from the gut to provide more blood flow to working muscles. This slows the rate at which the stomach empties into the intestines and can cause symptoms such as bloating, nausea, and vomiting. Excessive caloric intake through too many gels, bars, or even concentrated replacement drinks can exacerbate this condition. Unless athletes reduce their exercise intensity or slow their eating and drinking, they can experience significant gastrointestinal distress. Hydrating with plain water for a short period to flush the system and avoiding solid foods during a race can sometimes alleviate these symptoms. Although there are many hydration and nutrition products that promise optimal performance, athletes need to understand their own bodies and how they respond to exercise and eating. Practice makes perfect, but always be prepared to change your plan.

Salt loss is also a consideration when discussing gastrointestinal distress. It is hard to quantify salt loss, but if you have ever noticed people who have a white film on their clothes after a race, most likely they sweat salt excessively. Salt is essential to the body, and its balance is crucial for sustained exercise. Replacement can come from drinks or salt tablets taken as supplements as well as from the chicken soup available at the aid stations of endurance triathlons.

Metabolic Wastes Moved Away From Active Tissues

In the first 2 minutes of high-intensity exercise, anaerobic metabolism is the main source of energy production. In this process, glucose is converted to lactate without the presence of oxygen. As exercise continues, aerobic metabolism provides continued energy production. If exercise intensity remains high, lactate production also continues until the body is unable to metabolize it or clear it from the muscles. This is referred to as the lactate threshold. Lactate often is mistakenly referred to as lactic acid and is thought to be responsible for muscle fatigue and the burning sensation associated with high-burst exercise. Current research suggests these symptoms are due to acidosis, a change in muscle pH caused by hydrogen ion production during anaerobic metabolism. Plasma is the medium that carries these metabolic waste products away from active tissues and helps maintain muscle pH balance. An athlete's lactate threshold and percent $\dot{V}O_2$max are useful measures when deciding exercise intensity for training and racing and when assessing athletic performance in endurance sports. How long can an athlete sustain high-intensity activity in relation to maximal aerobic capacity? That is the million-dollar question!

HEART RATE TRAINING

Similar to the motor in a race car that powers the vehicle, the heart is the motor of the triathlete. Some people are blessed with high-performance V8 turbos, while others are born with four-cylinders. Genetics plays a huge role in one's potential as an endurance athlete, but the good news is we can all improve the output of our engines through proper development and execution of a training plan.

Measuring the output of your motor and training in ideally suited training zones can be done by using a heart rate monitor. Just as a race car's tachometer measures the rpms and helps the driver to know when to shift gears, a heart rate monitor measures the relative intensity of exercise.

It is important to note that heart rate training, although an effective tool, is not an exact science. Heart rate can be affected by a number of external variables ranging from temperature to your current state of health. Many athletes use heart rate training as a gauge or as an intensity governor of sorts and adjust their training intensity based on how they are feeling.

The first step in using a heart rate monitor effectively is to determine your training zones. This can be done by performing a simple field test in training, at a race, or, for the sake of precision, in a lab setting. Each method has its pros and cons, but each can be an effective means of establishing performance benchmarks and training zones.

A variety of popular field tests are available for the triathlete to perform in each sport discipline. One of the simplest and most effective for the bike and the run is the 20-minute threshold test.

20-Minute Threshold Test

1. Warm up for 10 to 20 minutes or until you feel ready to increase the intensity.
2. Perform a few openers—short, high-intensity repetitions of 15 to 30 seconds with the same rest period, such as 30 seconds hard and 30 seconds rest.
3. On a repeatable course with limited variables such as stop signs or excessive traffic to interrupt the effort, perform a very hard but sustainable 20-minute effort at your best possible pace for that duration. Remember, pacing is important, so don't start out too hard. Take your average heart rate during the 20-minute effort as your result for the test. (Controlled settings such as a bike trainer and a treadmill are helpful for limiting variables.)
4. Cool down for 10 to 20 minutes.

Once you have this information, you can feel confident that you have discovered your approximate lactate threshold heart rate (LTHR) intensity range within a margin of error of a few percentage points. This number will be important in setting up your target zones (table 2.1).

For example, if your LTHR is 150, your range for zone 1 is 90 to 105 beats per minute (bpm), your range for zone 2 is 105 to 135 bpm, for zone 3 is 135 to 150 bpm, for zone 4 is 150 to 165 bpm, and for zone 5 is 165 bpm to your peak heart rate. For triathlon training, you will work primarily in zones 2

TABLE 2.1 Heart Rate Training Zones Based on Lactate Threshold Heart Rate (LTHR)

Zone	Description	Training use	Heart rate ranges
1	Easy	Warm up	60 to 70% of LTHR
2	Moderate	Develop aerobic capacity	70 to 90% of LTHR
3	Difficult	Develop aerobic endurance and increase lactate threshold (LTHR)	90 to 100% of LTHR
4	Very difficult	Increase aerobic economy	100 to 110% of LTHR
5	Extremely difficult	Develop speed and power	110% of LTHR to peak

and 3 to develop aerobic capacity and endurance. (See chapter 3 for more on creating a training program.)

Once you have determined your zones either by doing a field test or by getting tested at a human performance lab, you'll be able to train your energy systems in a more effective manner in order to build your engine.

COMPRESSION GARMENTS

No cardiovascular discussion can be complete without mentioning compression garments. It has been suggested that using compression garments during exercise may decrease muscle fatigue, improve recovery, and lead to better endurance and performance. Some of these benefits pertain to their effects on the cardiovascular system. Unfortunately, most have not been scientifically validated.

Unlike arteries, veins have no significant pump pushing blood back to the heart and lungs. Muscle action provides some propulsive force. One-way valves in veins stop backflow caused by gravity. It is in this low-flow system that wastes from cellular activity are returned to the heart and lungs. Venous insufficiency is a condition in which the veins of the lower extremities cannot facilitate efficient blood return to the heart. Veins become congested, creating varicose veins in the legs and perhaps causing pain and swelling. This can occur from genetic predisposition, pregnancy, and possibly standing for long periods. Endurance racing may also contribute to this problem, and compression garments may assist flow and prevent or treat lower-extremity swelling, pain, and varicose veins.

The cardiovascular and cardiorespiratory systems that make up the engine that drives the body are just one piece of the puzzle in improving health and fitness. The effect of exercise on these two systems is an extremely complex topic that we continue to study and learn more about. In chapter 3, you will discover the best way to develop an effective training program. In the remaining chapters, you will learn the exercises that build the apparatus. The end result will be better speed and strength as well as injury prevention.

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3

CREATING A CUSTOMIZED TRAINING PLAN

Athletes tend to be smart and inquisitive. So rather than simply diving straight into telling you what to do, we want to ensure that you have an understanding of *why* you're doing it. Having an appreciation for the principles of training program design will help keep you focused and motivated because you will know that it can help you to perform better. Our goal is to have your training be safe, effective, and efficient, making you a healthier and faster athlete.

TRAINING TERMS AND PRINCIPLES

This chapter covers some terms and principles used by coaches and athletes. Every athlete should be familiar with these concepts.

Periodization of Training

Periodization is defined as varying training volume and intensity in distinct cycles. When properly designed and executed, it can help you to peak for an event. The two types of exercise periodization are linear and nonlinear. In linear periodization, the athlete exclusively targets one energy system or training focus over the course of a microcycle of 4 to 6 weeks, progressing from lower- to higher-intensity work with each cycle. In nonlinear periodization, the athlete uses various energy systems and intensities throughout a training cycle, developing them simultaneously. Both methods have their staunch supporters (and critics), although many coaches today lean toward the nonlinear periodization model because of its apparent ability to produce results while minimizing the risk of overtraining and injury, which are common in the linear method, by jumping from one plane of intensity to the next.

Workload

For endurance athletes, workload is measured in terms of frequency, duration, and intensity of exercise. Frequency of training refers to the number of bouts of specific exercise per cycle, whether a week, month, or year. Duration is the length of the training session. Intensity is how hard the work is performed, and it is the hardest of these variables to quantify. These parameters are manipulated during the course of a training program to achieve the desired result of enhanced performance.

Recovery and Adaptation

Just as overall workload is an important concept to understand, so are recovery and adaptation. In simple terms, rest and recovery allow the human body to adapt to the stresses of training. When designing a program, it is important to consider the training adaptation cycle. Though it's sometimes tempting to do so, ignoring rest and recovery will decrease the benefit of the training stress while increasing the chance of injury.

Aerobic Metabolism

Endurance-based athletic events in which pacing is of particular importance, from running a 5K to doing an Ironman triathlon, are primarily grounded in aerobic metabolism. Aerobic metabolism uses an efficient energy production pathway that converts carbohydrate and fat to fuel in order to power movement. Scientists, coaches, and athletes have discovered that exercising at low to moderate intensities is best for improving long-distance endurance for both cardiorespiratory and muscular systems.

Anaerobic Metabolism

Essentially, anaerobic means "without oxygen," and it is a less efficient energy pathway for producing movement. As exercise intensity increases, there's a subtle yet noticeable shift in the body to using carbohydrate as a primary source of fuel. This shift is accompanied by the sensation of burning in the working muscles as well as an increased breathing rate. Exercise at this intensity or higher is short lived, but athletes and coaches understand that the higher the anaerobic threshold becomes through proper training, the faster athletes will be able to go at most intensity levels.

Functional Strength Development

Development of functional strength is very popular in the fitness industry. It can be defined as training to enhance the coordinated working relationship between the nervous and muscular systems. Functional training exercises use everyday movement patterns, such as standing, twisting, bending, lifting, jumping, walking, and running, in contrast to exercises that isolate joints. An example is the walking lunge versus the leg extension. Whereas the leg extension effectively isolates the muscles of the quadriceps and makes them stronger, it does so in a way that the muscles will likely never be used in any athletic activity. In contrast, the walking lunge also uses the quadriceps, but it also targets all the other muscles associated with the fluid movement patterns of standing, walking, and running. A balanced resistance training program will typically have both types of movements as part of the routine since one is most effective at strengthening a specific muscle, whereas the other uses that muscle in a more practical way.

Earlier we referred to the importance of understanding why you're doing certain training. In the case of strength work, that's particularly important. Many athletes envision a linear relationship between strength and speed. In other words, they believe that if their muscles are stronger, they will be faster. In truth, the fastest runner isn't necessarily the athlete with the strongest hamstrings or quadriceps, but rather the one who addresses complementary muscles like the abductors and adductors that help stabilize the hip and minimize wasted energy. Similarly, the swimmer with the strongest lats might not be the fastest in the water; instead, someone who has strengthened the small muscles in her rotator cuff, thereby avoiding injury, might be faster. And most certainly, the athlete who compromises form or safety in the weight room and ends up injured isn't going to be a fast one. In other words, check your ego at the door. Don't be overly attentive to "show" muscles. Don't compete with anyone but yourself in the weight room. The goal of your resistance training should be to gain strength, not demonstrate it.

Interval Training

Interval training, defined as performing high-intensity efforts followed by recovery periods, is popular among competitive athletes for its ability to improve lactate threshold and $\dot{V}O_2max$, as well as to elicit improvements in economy and a greater muscular challenge. Comprising of shorter bouts at higher intensities, interval training improves the athlete's ability to sustain a higher level of output and to perform at higher levels of speed for longer durations. An example of an interval session for a cyclist is as follows:

Warm up for 5 to 10 minutes.

Cycle 5 × 2 minutes hard at lactate threshold power (wattage) with 1 minute easy spin recoveries in between.

Cool down for 5 to 10 minutes.

Lactate threshold is a metabolic state the athlete reaches during high-intensity exercise in which lactate accumulates in the blood until it can no longer be removed as efficiently as it is during lower-intensity aerobic exercise. See more information on lactate threshold in chapter 2.

Long Steady Distance Training

A contrast to interval training, long steady distance training (also known by many as long slow distance training) was popularized by marathon runners in the 1970s. The idea was to develop cardiorespiratory and muscular endurance by incorporating training runs of an hour or longer, performed at much less than marathon pace (i.e., at a conversational pace) several days a week with at least one longer workout of around two hours in duration. Long steady distance training remains a staple training method of many top endurance athletes, and when combined with a proper dose of interval training, it elicits strong gains in endurance sports performance.

TRAINING PLAN DEVELOPMENT

There is a lot of science behind optimal training plan development for triathletes. As multisport participation becomes more popular, the research literature on best practices and training methodologies expands at a staggering rate. Although the science of effective training is certainly important, so is the art of developing a training plan.

Triathlon coaching has been an area of explosive growth over the past decade. A range of professional triathlon coaching certifications is now available, and scores of coaching companies, large and small, have sprung up to meet the growing demands of this burgeoning field. Developing a multisport training plan can be daunting, and as athletes try to train effectively for three sports, they discover that a knowledgeable coach can save them time and headaches by shortening the learning curve. Although good coaching involves the science of training, it is also important to acknowledge the art of training an athlete. After all, if human performance improvement was as simple as adding 1 and 1 to equal 2, everyone would be getting faster and competing at a similar level. In fact, each athlete is an experiment of one, and a good coach will discover the training balance needed to help an athlete reach his goals while remaining healthy and injury free. Some athletes are motivated by the desire to win, while others are driven because they hate losing. Some love to be challenged, and if they come up a little short, they welcome an opportunity for “redemption.” Others get frustrated and feel defeated if they don’t meet their goal. Even if the physiological goals are the same for all athletes, the path to reaching those goals can be different based on their individual personalities. Hence, the art of training.

In the context of triathlon training, it’s also important to choose your priorities. Many triathletes come to the sport with a strong background in one of the three disciplines—swim, bike, or run. Typically, they like to work on that discipline because it is where they are most comfortable and likely most proficient. But a smart triathlete (and coach) will live by the motto “race your strength, train your weakness.” In other words, if you’re a runner turned triathlete, you are probably best served deemphasizing your running while spending a disproportionate amount of your training time swimming and riding. It may not be as much fun in the short term, but the return (in terms of increased speed) on the investment (of training time) will be greater. A well-balanced triathlete—who may not post the fastest split in any discipline but who doesn't lose significant time in any—will often defeat the specialist who "wins" the swim but gets left behind on dry land.

Let's begin our discussion of developing a training plan by exploring the basic tools that all triathlon coaches have at their disposal. Planning and strategic oversight of a program are important, and when it comes to designing a training plan, the first step is to determine your ultimate goal for that season. We'll call this your A race. Next, you'll need to determine races of lesser importance you will use to gain competitive experience and develop your race legs. Many elite athletes use these B and C priority events as hard training days to race themselves into shape, both physically and mentally.

Once the race schedule is mapped out and the commitment is made, it's time to start developing your plan, working backward from your A race and using the principle of periodization. Your training ingredients include the variables of intensity, duration, and frequency; the mixture of these components will enable you to develop an effective plan.

For a more nonlinear approach to periodized training, focus on certain energy systems for periods of 4 to 6 weeks while also incorporating training intensities to bolster other systems simultaneously. No single energy system is developed to the exclusion of others. For example, an aerobic base development phase will also include some bouts of short, intense work that targets the anaerobic energy system. This makes the transition to a more specific block of hard training much easier while lowering the risk of overtraining and injury.

In addition to cardiorespiratory and sport-specific training, most coaches and athletes now agree that supplemental strength and flexibility training is crucial for enhanced performance and, more important, long-term health and well-being. Supplementary resistance work should be done year-round using a selection of exercises found in this book, with an approach that complements the seasonal training needs of the athlete. For example, when an athlete is in season, the focus of a strength training routine is mostly maintenance and injury prevention, and the training volume is low. On the other hand, during the preseason, the training focus is more on developing strength and a biomechanically sound foundation, and more time is spent on it.

Table 3.1 shows a sample preseason program used by a beginning to intermediate-level triathlete with 1 to 3 years of experience who is preparing for an Olympic-distance triathlon. The emphasis is on aerobic base and basic strength development, with a total training commitment of 10 to 12 hours per week.

From this example, you will notice that each sport discipline is trained at least three times during the week in addition to three strength training sessions. Athletes should typically perform sport-specific training before

TABLE 3.1 Sample Preseason Training Plan for a Beginning to Intermediate-Level Triathlete Training for the Olympic Distance

Day	Triathlon workout routine
MONDAY	**Rest day:** Focus on recovery after a long weekend of training. Get off your feet as much as possible, eat well, hydrate well, and take good care of yourself. A light massage is recommended.
TUESDAY	**Swim workout:** Focus on technique development with plenty of drill work. Don't worry about going fast or hard. Practice good form. Warm-up: 200 to 300 yd or m 8 × 50 drill (catch-up) with 10 sec rest 5 × 100 swim (form focus, reach and glide) with 20 sec rest 6 × 50 drill (fingertip drag) with 10 sec rest 5 × 100 swim (form focus, reach and glide) with 15 sec rest 4 × 50 drill (25 right arm, 25 left arm) with 10 sec rest Cool-down: 200 yd or m **Run workout:** Run 40 min aerobic or up to 5 mi (8 km). Steady-state, aerobic-paced effort (zone 2).
WEDNESDAY	**Brick workout:** Practice a smooth transition from the bike to the run. Bike 1 hr aerobic (zone 2 or 3) at 90 to 100 rpm, then transition to the run for 30 min or up to 3 mi (5 km) at a steady-state aerobic effort. **Strength training:** Full-body circuit workout routine. Move from one exercise to the next in the following sequence, performing three rounds: Warm-up: Perform 3 to 5 min light cardio such as jump rope or jumping jacks. Push-up (page 192): Perform as many repetitions as possible in 20 to 30 sec. Walking lunge: Take 10 steps with each leg; use hand weights if necessary. Stability ball crunch with trunk rotation (page 153): Perform for 30 sec. Pull-up (page 74) or lat pull-down (page 70): Perform for 20 to 30 sec, or complete up to 15 repetitions.

Day	Triathlon workout routine
THURSDAY	**Swim workout:** Warm-up: 200 yd or m 12 × 25 drill (25 right arm, 25 left arm) with 5 sec rest 300 continuous drill (25 kick/scull, 25 form swim, 25 kick/scull, 25 form swim) 8 × 50 drill (alternate catch-up for 50 and fingertip drag for 50) with 15 sec rest 500 pull (steady, swim with good form, aim for distance per stroke) Cool-down: 200 yd or m **Bike workout:** 1 hr aerobic bike with 3 × 5 min tempo with 3 min rest Warm-up: 10 to 15 min at 90 to 100 rpm 3 × 5 min zone 3 or 4 reps (LTHR), 80 to 90 rpm, with 3 min rest and recovery Cool-down: 10 to 15 min
FRIDAY	**Run workout:** Run 40 to 50 min or up to 5 mi (8 km) in aerobic zone 2. **Strength training:** Full-body circuit workout routine. Move from one exercise to the next in the following sequence, performing three rounds: Warm-up: Perform 3 to 5 min light cardio such as jump rope or jumping jacks. Push-up (page 92): Perform as many repetitions as possible in 20 to 30 sec. Walking lunge: Take 10 steps with each leg; use hand weights if necessary. Stability ball crunch with trunk rotation (page 153): Perform for 30 sec. Pull-up (page 74) or lat pull-down (page 70): Perform for 20 to 30 sec, or complete up to 15 repetitions.

(continued)

TABLE 3.1 *(continued)*

Day	Triathlon workout routine
SATURDAY	**Swim workout:** Endurance swim
	Warm-up: 200 yd or m
	6 × 50 drill (choice) with 10 sec rest
	2 × 800 steady swim (focus on good form, reach and glide) with 1 min rest
	Cool-down: 200 yd or m
	Bike workout: 2 hr aerobic endurance ride (zone 2 or 3) at 85 to 95 rpm, steady state
SUNDAY	**Run workout:** 75 min endurance run (zone 2 or 3) or up to 8 mi (13 km), steady state
	Strength training: Full-body circuit workout routine. Move from one exercise to the next in the following sequence, performing three rounds:
	Warm-up: Perform 3 to 5 min light cardio such as jump rope or jumping jacks.
	Push-up (page 92): Perform as many repetitions as possible in 20 to 30 sec.
	Walking lunge: Take 10 steps with each leg; use hand weights if necessary.
	Stability ball crunch with trunk rotation (page 153): Perform for 30 sec.
	Pull-up (page 74) or lat pull-down (page 70): Perform for 20 to 30 sec, or complete up to 15 repetitions.

strength work in order to ensure good form and enable solid development of technique. Muscles that are tired because of resistance training can foster poor movement patterns when swimming, cycling, and running, impeding efficiency and wasting energy.

With such a wide variety of strength training exercises from which to choose, it's imperative that you have a focused strategy for continual improvement. Using the expert help of a coach or certified personal trainer, choose from the recommended exercises in this book to create a plan tailored to suit your individual needs.

4

LEGS AND HIPS

Power and speed are qualities every triathlete dreams about. Both beginners and highly competitive athletes want to know the secret. The unfortunate truth is that there is no secret other than hard, intelligently designed work.

The triathlete in motion requires a stable and strong body. The upper extremities and the core and pelvic muscles contribute to the development of power and speed, but the lower extremities provide the most propulsive force for making us fast. To the dismay of some swimmers, most triathlons are won by being strong on the bike and fast on the run. For this reason, in our efforts to improve performance, we begin with some of the largest muscle groups in our bodies: the lower extremities.

Our ability to walk upright efficiently, or what is referred to as bipedal gait, evolved over millions of years. How this efficiency translates to swimming, biking, and running is yet to be determined. What is known is that to improve athletic performance, you must maximize muscular strength, defined as force production; increase power, defined as the rate at which work is done; improve endurance, defined as the length of time the muscles can sustain that power; and ultimately improve muscular efficiency, the body's ability to produce these effects at a lower metabolic cost. Training can help you to achieve all of these goals.

Strength and power can be developed by isolated strength training, such as leg extensions to isolate the quadriceps, and sport-specific strength training, such as lunges to mimic a running stride. These more complex exercises use compound movements that recruit multiple muscles to perform the action. The question is whether or not the methods differ in their effects on performance. The answer is not so simple, except to say that muscles respond to stress or resistance training by enlarging each muscle fiber, regardless of the specific exercise. A stronger muscle is not created by making more muscle fibers (hyperplasia); the fibers just get bigger (hypertrophy). Resistance created by lifting a static weight from the ground or resistance felt from pushing a big gear up a hill stresses each muscle or group of muscles proportionate to its use and will produce strength and power gains if done correctly.

Endurance and efficiency are developed by performing progressive and repetitive workouts that allow the body to adapt in a healthy fashion. We often talk about muscle memory and how it seems to get easier to do exercise over a period of time. (The term "muscle memory" is a misnomer because it's your brain that's learning the movement and telling your muscles what to do.) These improvements occur at a cellular level by increasing the machinery of metabolism but also by changing our neural circuitry so muscular contractions become more efficient.

Genetics plays a large role in determining who can sprint and who can run long distances. Muscle fibers can be divided into Type I (fast twitch) and Type II (slow twitch). Fast-twitch fibers are for quick contractions and use anaerobic energy. Slow-twitch fibers are for endurance activities and use aerobic energy (see chapter 2). Each person has a genetically determined ratio of each type. Unfortunately, we cannot change this ratio, but we can selectively train each fiber type with both isolated strength training and sport-specific exercises to maximize performance.

An advantage of sport-specific strength training is that it can help maintain muscular symmetry and lower-extremity biomechanics. This is an essential concept in injury prevention. Fatigue and weakness of the lower-extremity muscles can cause muscular imbalances that contribute to poor running and biking form and poor body position for swimming. The resulting abnormal stresses to the other tissues of the lower extremities may produce injuries, and the back and upper extremities may also be injured as they compensate for the loss of body balance.

ANATOMY OF THE LOWER EXTREMITIES

The anatomy of the lower extremities includes the femur, the long bone of the thigh; the tibia and fibula of the lower leg; the many bones of the foot and ankle; and the many muscles that cross each joint. These structures allow for efficient, stable gait. The lower extremities attach to the rest of the body, or axial skeleton, through the hip joint of the pelvis (figure 4.1). As we walk, run, or apply force to our legs, stress is transmitted to the pelvis and spine. The muscle contractions help deflect and dissipate these forces. Muscles not only provide force for motion but also can be thought of as dynamic shock absorbers. As discussed in chapter 5, the back and its S shape also help absorb impact.

The coordinated motions of the upper extremities, lower extremities, and pelvis create a gait cycle. The gait cycle (figure 4.2) can be divided into a stance phase, when one foot is on the ground, and a swing phase, when the opposite foot is off the ground, swinging forward in preparation for foot planting. When walking, there is always one foot on the ground. In running, though, at some point both feet are in the air at the same time. At foot impact in this unsupported position, approximately three times one's body weight is transmitted to the lower extremity.

Normal, healthy anatomy allows for a smooth and economical gait cycle and subsequent running form. Of the three triathlon activities, running places the highest impact loads on the skeleton. Biking and swimming, which are lower impact by nature, place other biomechanical demands on the lower extremities because of their somewhat unnatural motions. Over time, weight-bearing joints such as the hip and knee can be exposed to significant forces during impact activities. The potential risk of being injured and later developing arthritis, or loss of joint cartilage, is a concern. At this point, however, there is little scientific evidence that participation in endurance activities predisposes an athlete to arthritis. Continue with your training and racing, and do not fear that they are causing long-term injury and degeneration.

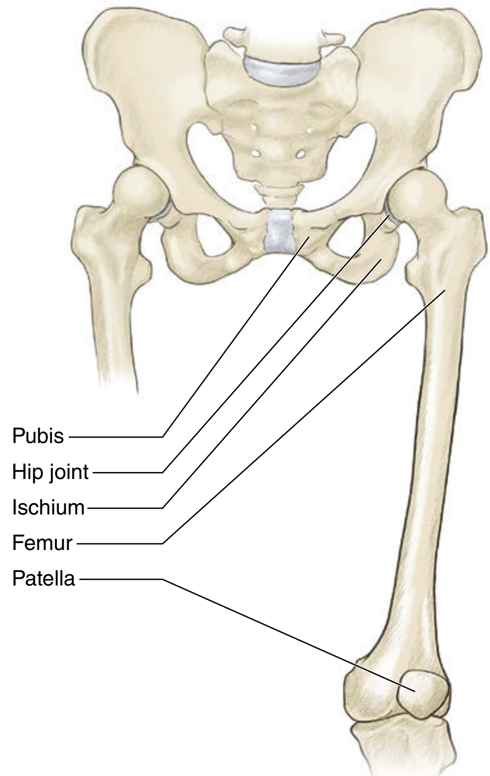


FIGURE 4.1 Bony structures of the upper leg.

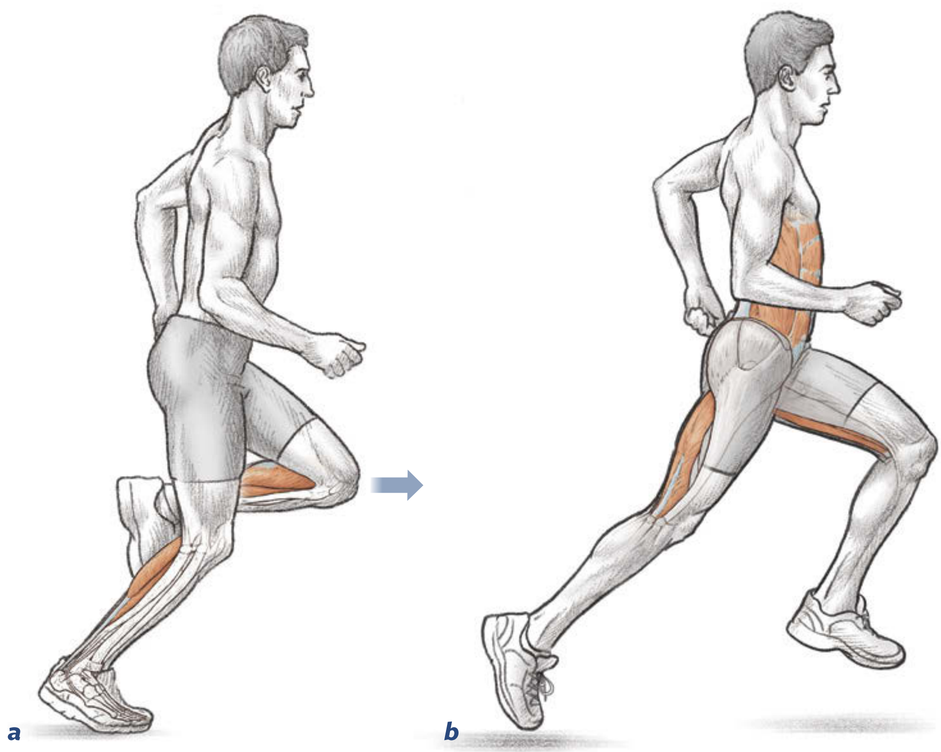


FIGURE 4.2 The gait cycle: *(a)* stance phase; *(b)* swing phase.

The muscles of the lower extremities (figure 4.3) can be broken down into groups based on their actions at each joint, including the hip, knee, foot, and ankle. Motions that occur include flexion, extension, abduction, adduction, rotation, and sometimes a combination of motions to create inversion and eversion at the ankle. Many individual muscles create a single motion about a joint, but a few control motion at two joints.

Flexion at the hip—lifting the thigh—is done by a group of muscles collectively known as the iliopsoas (psoas major, psoas minor, and iliacus). They originate from the deep aspect of the lower anterior spine and pelvis. They attach to a bony prominence on the upper part of the femur called the lesser trochanter. These muscles control a single motion about the hip.

Secondary movers of the hip are in the anterior compartment of the thigh, including the rectus femoris and sartorius. They originate on the pelvis and cross both hip and knee joints, inserting into the patella and proximal tibia, respectively. The rectus femoris facilitates hip flexion and knee extension, or straightening. The sartorius aids in hip flexion but also contributes to knee flexion, or bending. This concept of muscles acting across two joints is essential to understanding the importance of sport-specific exercises to training, which is discussed in chapter 10.

Hip extension, or pushing the thigh back, is controlled by the gluteus maximus. The gluteus maximus is the largest of the gluteal muscles and is mainly responsible for the shape and appearance of the buttocks. From an evolutionary standpoint, the large size of the gluteus maximus is characteristic of an erect stance and an upright gait because it helps one to maintain posture and return to an erect position after bending over.

Hip abduction, or lifting the leg away from the midline of the body, is essentially controlled by the gluteus medius and gluteus minimus. These two muscles originate from the iliac wing of the pelvis and insert into the bony prominence of the femur, the greater trochanter. This is the bone you feel on the side of your hip. These muscles, along with the other abductor (tensor fasciae latae, which runs from the crest of the iliac wing and inserts along the outside of the proximal tibia as the iliotibial band), control hip and pelvis motion through the gait cycle. When you stand still equally on both legs, the weight-bearing center of gravity is in the center of the pelvis. In a single-leg stance, whether walking or running, the body's center of gravity remains more medial than the extremity we are standing on. Therefore, gravity tends to pull us toward the opposite side. Hip abduction on the weight-bearing leg and hip adduction as a coordinated muscle action counteract the body weight to keep the body from falling over the leg in the swing phase of the gait. In this situation, the abductors are pelvic stabilizers that hold the pelvis level and create a stable mechanical axis. This stable platform, with the help of good core control, maintains proper knee and foot biomechanics and helps prevent injury.

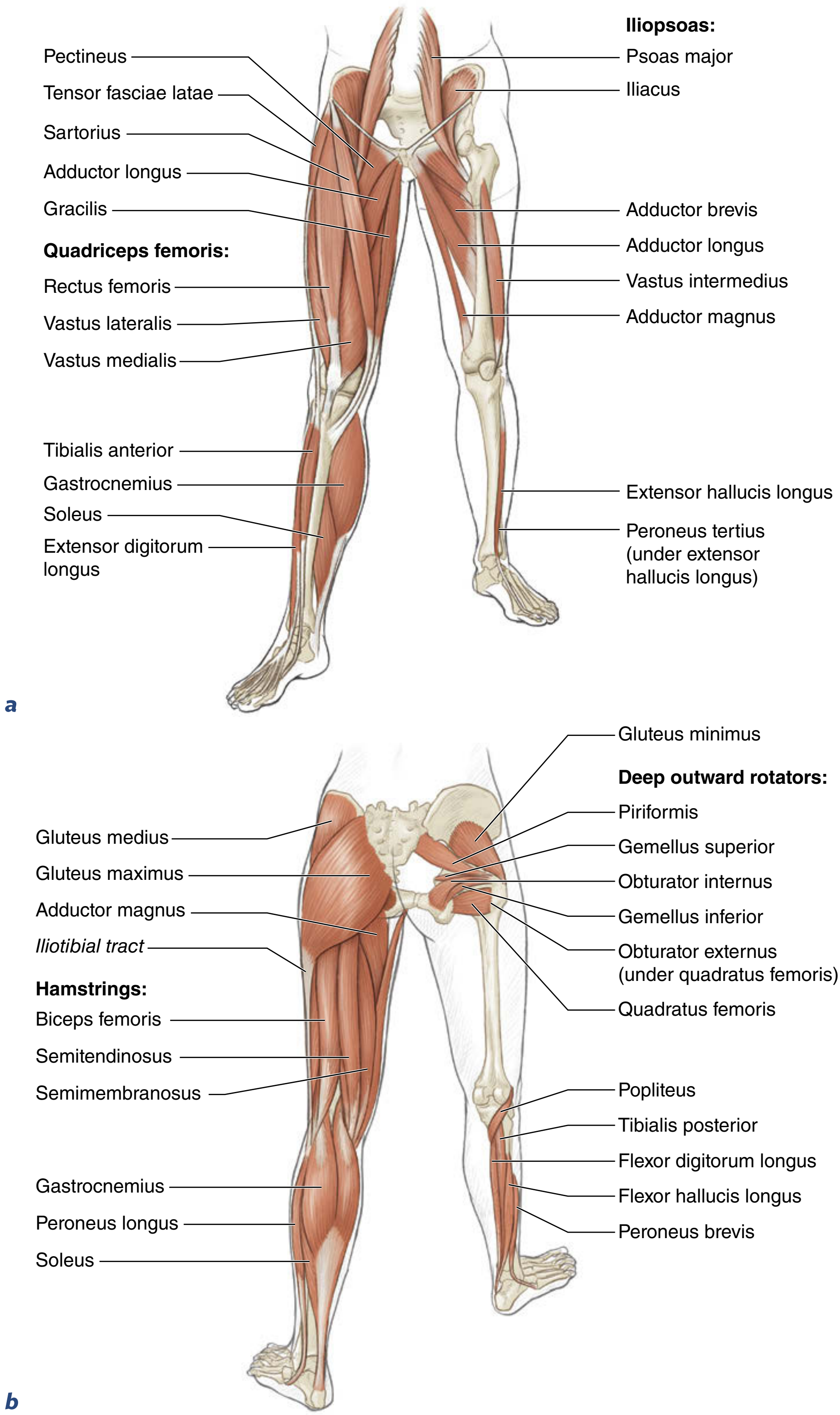


FIGURE 4.3 Muscles of the legs: *(a)* front; *(b)* back.

Hip adduction, pulling the leg toward the midline, is controlled primarily by the pectineus, gracilis, adductor brevis, adductor longus, and adductor magnus. These muscles help maintain a stable pelvis. Each of these muscles has secondary functions as a hip flexor and hip rotator. A common injury in this group is known as a groin strain. Injury to the adductor muscles can cause pain and tightness about the hip. Be aware that other structures in this region can cause similar symptoms. Groin pain can also be caused by an injury to the bones of the hip, including a stress fracture; an injury or tear of the labrum (the fibrous ring that surrounds the hip); or deterioration of the joint cartilage surface, known as arthritis.

Hip external rotation—pointing the toes and knee out—occurs primarily through the posterior hip rotators, including the piriformis, obturator muscles, gemelli, and quadratus femoris. Internal rotation is performed by the gluteus medius and gluteus minimus in conjunction with the adductors.

The bones that make up the knee are the distal femur; the upper tibia, called the tibial plateau; the fibula; and the patella, or kneecap. Articular cartilage of the knee provides a low-friction surface between the femur and tibia (tibiofemoral articulation) and between the patella and femur (patellofemoral joint). The patella and its articulation with the femur provide a mechanical fulcrum that helps generate quadriceps forces. Running and jumping facilitated by quadriceps contraction can produce forces three to five times body weight in the patellofemoral joint.

Knee stability is maintained by a set of four ligaments (figure 4.4). The medial and lateral collateral ligaments provide side-to-side stability. The anterior and posterior cruciate ligaments provide front-to-back stability. The anterior cruciate ligament, or ACL, also provides rotatory stability to the knee and is one of the most frequently injured knee ligaments during pivoting sport activities.

Knee extension, or straightening, is controlled through the anterior thigh muscles of the quadriceps femoris. Four muscles make up the quadriceps femoris: The rectus femoris is surrounded by the vastus intermedius, vastus medialis, and vastus lateralis. The rectus femoris originates at the pelvis, whereas the vastus group originates from the proximal femur. Together they unite at the knee and form a common tendon, the quadriceps tendon, and a layer of tissue surrounding the

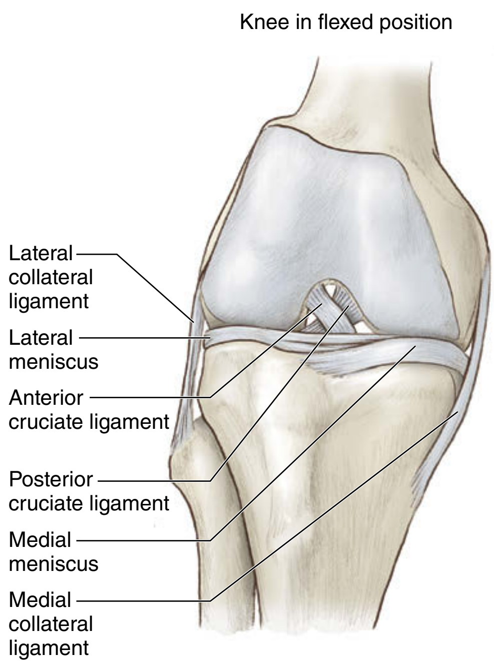


FIGURE 4.4 Knee ligaments and tissues.

patella called the retinaculum. The patellar tendon attaches the patella to the tibia. The retinaculum, quadriceps muscle, quadriceps tendon, patella, and patellar tendon together make up the extensor mechanism of the knee. Its main function is to straighten the knee.

The posterior thigh and knee muscles, collectively referred to as the hamstrings, include the biceps femoris, semitendinosus, and semimembranosus. The biceps femoris has two points of origin, one from a bony prominence of the pelvis, the ischial tuberosity, the bone you sit on, and the other from the back of the shaft of the femur. Both heads combine at the knee and form a common tendon that inserts into the head of the fibula on the lateral aspect of the knee. The primary function of the biceps femoris is to flex, or bend, the knee, but it also acts as a knee lateral rotator. The semitendinosus and semimembranosus, referred to as the medial hamstrings, originate from the pelvis and insert along the medial, or inside, aspect of the tibia. Because the muscles cross two joints, they extend the hip, flex the knee, and medially rotate the leg. Because of their complex muscular actions, they are prone to injury in what is referred to as a hamstring strain. These injuries can be extremely debilitating to the running athlete. The medial hamstrings, along with the sartorius and gracilis, form the pes anserine tendons. They insert along the upper medial border of the proximal tibia. When working together, they function as knee and hip flexors as well as external rotators of the hip and thigh. This motion pattern is essential when walking to help clear the foot as the walker passes from the stance to the swing phase of the gait.

The ankle, which is made up of the distal tibia, distal fibula, and talus (figure 4.5), allows for dorsiflexion (bringing the ankle up) and plantar flexion (pointing the ankle down). The bones below the talus, including the calcaneus (heel bone) and the midfoot bones, allow for complex motions that are

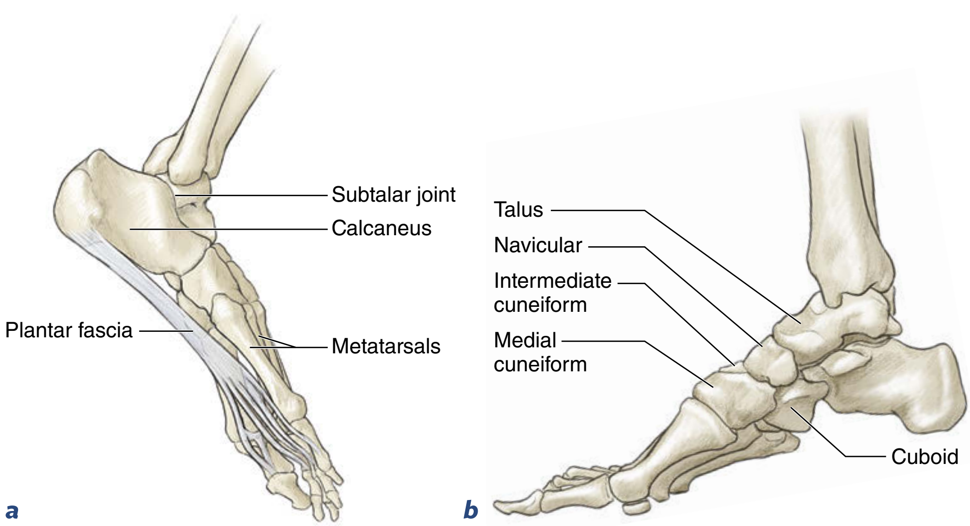


FIGURE 4.5 Bones and tissues of the foot: *(a)* underside showing the plantar fascia; *(b)* medial side.

essential for normal gait. Inversion is defined as plantar flexion and internal rotation of the ankle and foot, and eversion is dorsiflexion and external rotation. Without this series of motions, we would have a very difficult time accommodating uneven surfaces.

Ankle stability is provided by a strong ligament system as well as by contributions from the lateral leg muscles, the peroneus longus and peroneus brevis, which act as dynamic ankle stabilizers. The lateral ligaments of the ankle, including the anterior talofibular and calcaneofibular ligaments, resist inversion forces placed on the ankle. When someone refers to rolling an ankle, which is the most common mechanism of injury, these ligaments are frequently torn.

The deltoid ligament on the medial aspect of the ankle connects the distal tibia, or medial malleolus, to the calcaneus and talus. In more severe sprains, this ligament becomes injured. The last set of strong ankle-stabilizing ligaments connects the distal fibula to the tibia; these are known as the tib-fib ligaments. Injury to these ligaments from rotational forces is called a high ankle sprain because the ligaments are located above the joint level. This injury often takes longer than other sprains to heal.

Muscles of the calf (figure 4.6) control ankle motion. The gastrocnemius, which arises from the distal femur, and the soleus, which originates on the tibia, join near the ankle to form the Achilles tendon, which attaches to the calcaneus, or heel bone. These muscles are responsible for plantar flexion and are the main source of push-off strength. Although the Achilles is the largest and strongest tendon in the body, it is also the site of a spectrum of injuries, including inflammation and rupture.

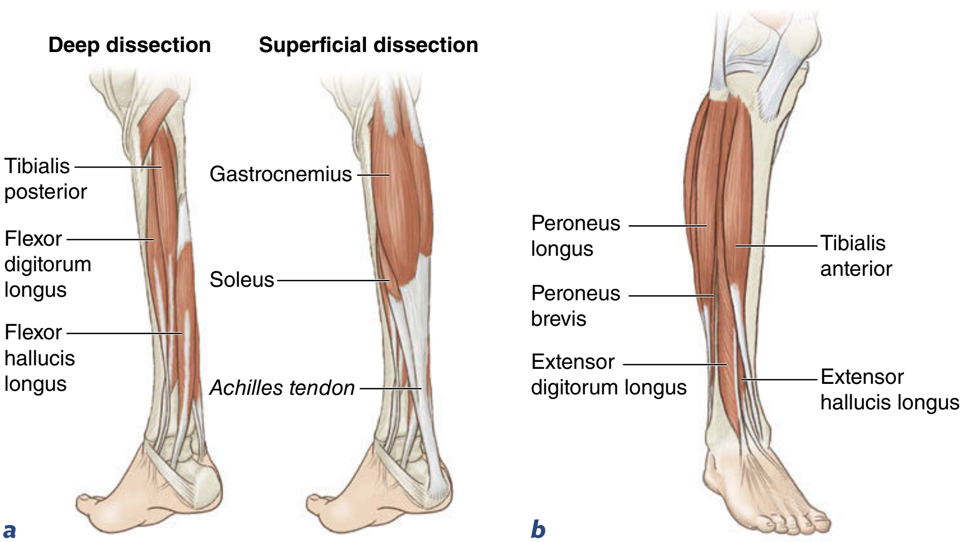


FIGURE 4.6 Muscles of the lower leg and foot: *(a)* back; *(b)* front.

The anterior muscles of the calf, including the tibialis anterior, extensor hallucis longus, and extensor digitorum, produce dorsiflexion of the foot. This essential motion is responsible for clearing the foot as it goes through the swing phase of the gait from toe push-off to heel strike. Without this motion the foot would drop and the toes would drag as the foot swings forward. An injury to the peroneal nerve that innervates this muscle group can cause this problem. This is not a common injury, but it is sometimes a complication of hip replacement surgery.

The last group of muscles is the peroneals, the peroneus longus and peroneus brevis. They originate from the fibula and run down the lateral side of the ankle around the fibula and insert along the foot and toes. Their main function is to evert the ankle. This motion creates dynamic ankle stability. After an ankle sprain and subsequent healing of the ligaments, these muscles require equal attention in rehabilitation to restore complete functional healing.

The foot and ankle are made up of 26 bones, more than 30 joints, and more than 100 muscles, tendons, and ligaments. The extrinsic muscles, those that originate in the lower leg and insert into the foot, have been described. The intrinsic group of muscles of the foot are small and strong and help produce a smooth gait pattern.

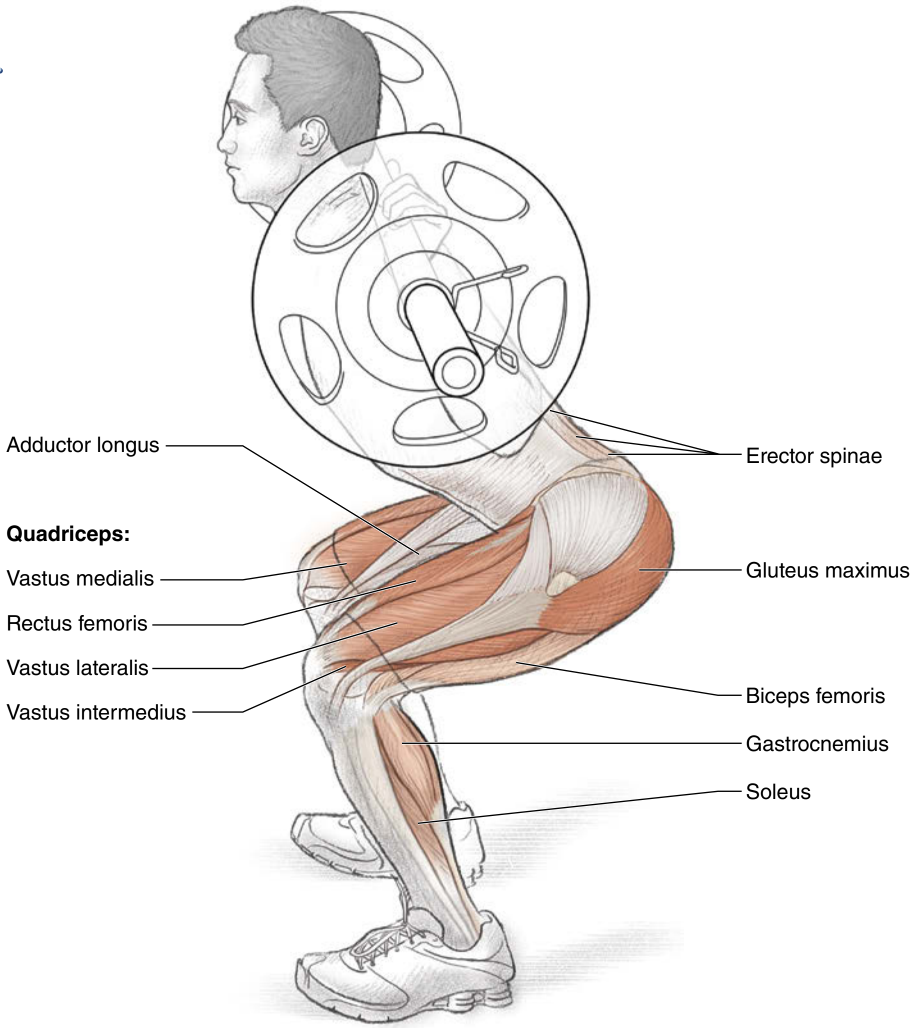
EXERCISES FOR THE LEGS

Triathletes must be strategic when it comes to training their legs to build strength. The time in the annual training season relative to the race season and the current training volumes for cycling and running, among other factors, will influence the amount and quality of resistance training for the legs. The main concern is always adequate recovery and maximizing gains from sport-specific training. Brute strength and power rarely translate to better running or riding results. Sport specificity is a key training principle for all endurance athletes; strength training is a supplement to benefit performance and reduce the risk of injury.

As with other areas of strength training, the legs should be trained to develop strength and muscular endurance. Therefore, consider performing two to four sets of 10 to 15 repetitions for selected exercises in your routine, with about 1 to 2 minutes of rest between sets.

The following exercises are a combination of isolated and sport-specific multijoint movements. Perform them only after an adequate warm-up. This might include 10 to 15 minutes of easy aerobic exercise followed by some stretching, which could include dynamic as well as gentle static stretches. Perform leg strength training two or three times per week during preseason training and one or two times per week during the season for maintenance and injury prevention.

BARBELL SQUAT



SAFETY TIP: Good form is crucial. Maintain a flat back throughout the exercise, and never bounce at the bottom of the movement. Elevate your heels slightly with a board, if necessary, and warm up thoroughly before starting this exercise.

Execution

1. Place a weighted barbell on your upper shoulders and back (not neck), and stand with your feet about shoulder-width apart.
2. Keeping a straight back, bend down to a squat position until your upper thighs are parallel to the floor.

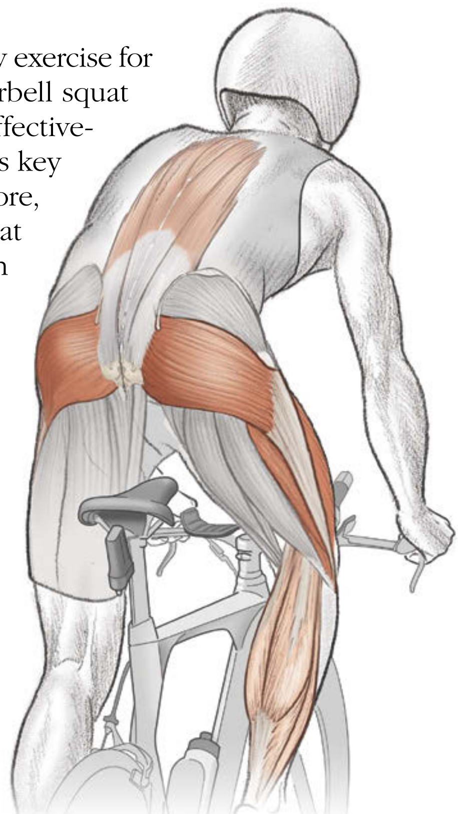
3. Maintaining a straight back and engaged core, activate the muscles in the buttocks and the legs to return to the starting position. Repeat for the required number of repetitions.

Muscles Involved

Primary: Gluteus maximus, quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius)

Secondary: Erector spinae (iliocostalis, longissimus, spinalis), hamstrings (biceps femoris, semitendinosus, semimembranosus), gastrocnemius, soleus, hip adductors (adductor longus, adductor magnus, adductor brevis)

TRIATHLON FOCUS



Long touted as the best overall lower-body exercise for strength development, the traditional barbell squat still reigns supreme when it comes to effectiveness. A multijoint movement that engages key muscles in the legs, buttocks, hips, and core, it's hard to find a lower-body exercise that offers more of a bang for the buck than the squat.

For the triathlon cyclist, stronger quadriceps, hamstrings, and glutes developed through this movement will help generate more power with less fatigue on each pedal stroke, in particular during the powerful downstroke as the leg passes the crank through the 90-degree position.

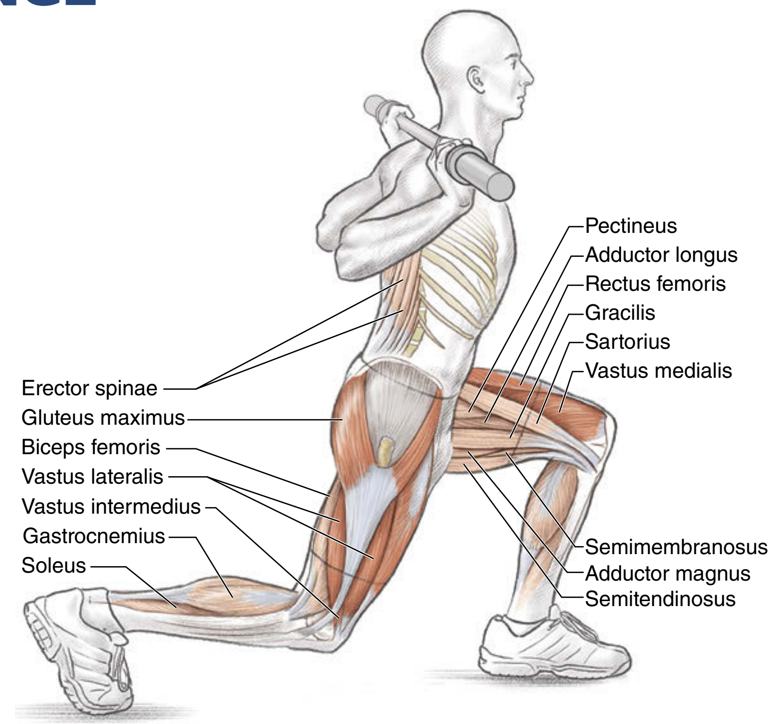
The swimmer will notice a more powerful push off the wall during practices in the pool, as well as more propulsion from the kick. The triathlon runner will be able to push off the ground and drive uphill with more spring in her legs and with more force, even when fatigued coming off a hard bike effort.

VARIATION

Dumbbell Squat

This exercise is performed in a similar fashion to the barbell squat but with dumbbells instead. Simply grasp two evenly weighted dumbbells and hold them down at your sides while performing the squat movement with a flat back.

LUNGE



Execution

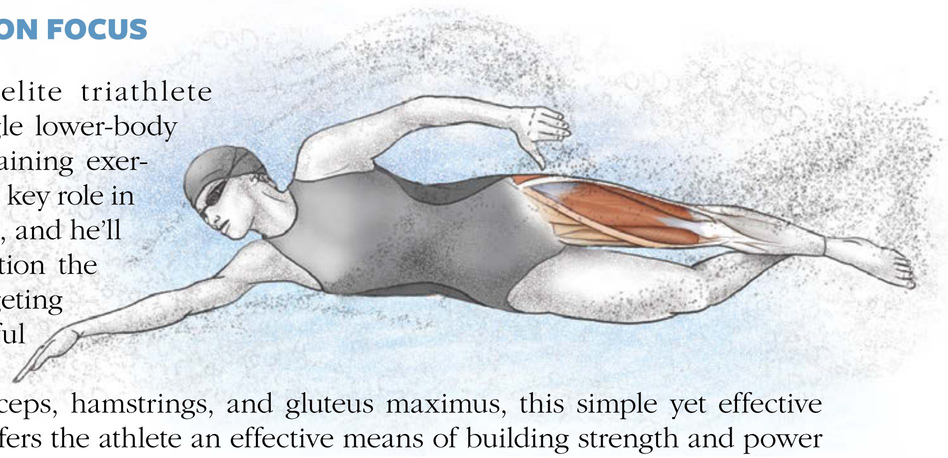
1. Stand with your feet about shoulder-width apart. If you are using added resistance, place a barbell comfortably and evenly on your shoulders, or hold a dumbbell of the same weight in each hand.
2. Keeping your back straight with your head up and looking forward, gently step forward (lunge) until your upper leg is parallel to the ground, your bent knee forming a 90-degree angle with the floor and your patella not coming in front of your toes. The knee of your trailing leg should almost touch the floor. Maintain your posture throughout the movement.
3. After a brief pause, activate the muscles in the quadriceps and glutes of the forward leg while maintaining your balance and posture as you return to the starting position.
4. Repeat this action with the opposite foot leading. Repeat for the required number of repetitions.

Muscles Involved

Primary: Gluteus maximus, quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius)

Secondary: Erector spinae (iliocostalis, longissimus, spinalis), hamstrings (biceps femoris, semitendinosus, semimembranosus), pectineus, gracilis, sartorius, gastrocnemius, soleus, hip adductors (adductor longus, adductor magnus, adductor brevis)

TRIATHLON FOCUS



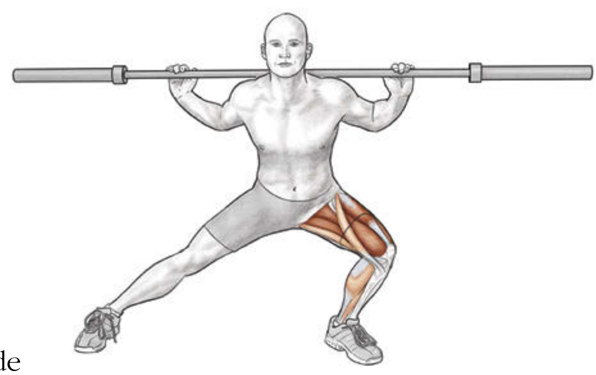
Ask any elite triathlete which single lower-body strength training exercise plays a key role in his success, and he'll likely mention the lunge. Targeting the powerful muscles of the quadriceps, hamstrings, and gluteus maximus, this simple yet effective exercise offers the athlete an effective means of building strength and power for faster cycling and running.

The lunge is a multipurpose lower-body exercise that works not only to increase a triathlete's ability to turn a larger gear on the bike and to charge uphill faster on the run but also functions as a dynamic warm-up and stretching movement recommended before running workouts. In addition, proper execution of the movement enhances proprioception and balance. Finally, as with all exercises that strengthen the glutes, lunges will benefit swimming by contributing to a stronger kick.

Be cautious when performing the lunge, whether using barbells or dumbbells or using only body weight. Proper form dictates that you keep your back straight and that your knee stays behind your toe when stepping out so as not to overstress the patellar tendon.

VARIATION

Lateral Lunge



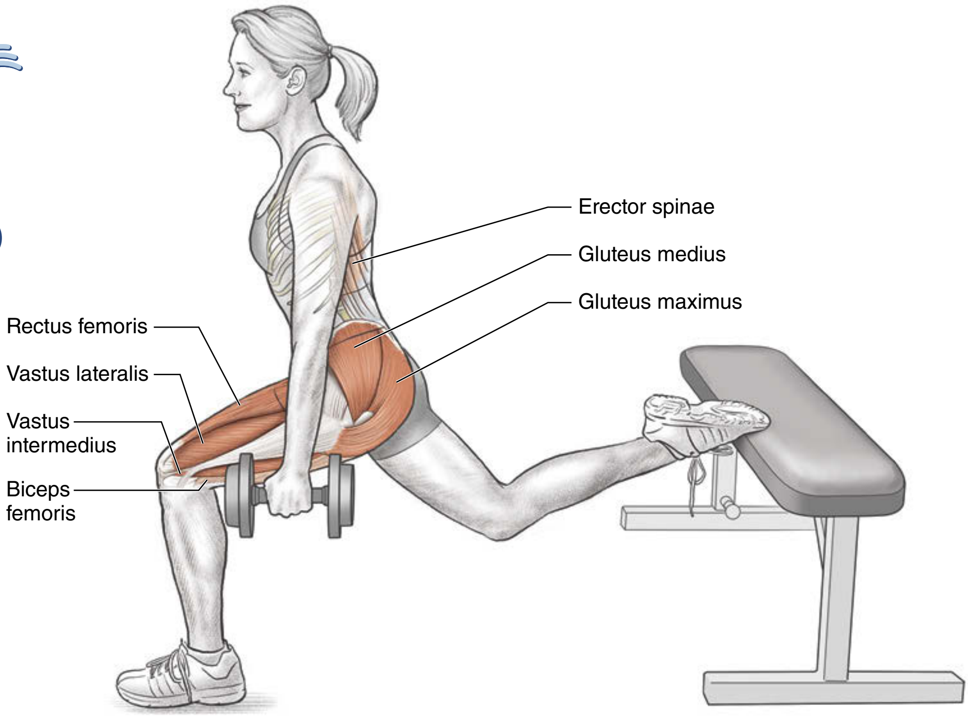
Stand with your feet about shoulder-width apart. For added resistance, place a barbell across your shoulders, or hold a dumbbell in each hand.

Keeping your back straight with your head up and looking forward throughout the exercise, step to the side at approximately a 45-degree angle. Bend your knee until your upper leg is parallel to the ground, creating a 90-degree angle. Keep your knee behind your toes.

After a brief pause, push off with the bent leg to return to the starting position.

Repeat with the opposite foot leading, alternating for the required number of repetitions.

SINGLE-LEG SQUAT



SAFETY TIP: Like double-leg squats, never bounce at the bottom of the movement because this places undue stress on the knee.

Execution

1. Perform this movement with body weight only, or hold a dumbbell in each hand.
2. Stand 2 to 3 feet (0.6 to 0.9 m) in front of a weight bench or other solid support. Reach back with the nonworking leg, placing it on the bench, and find a balanced position.
3. Bend your front knee to lower your body until your thigh is parallel to the ground, activating the muscles of the hips, buttocks, and quadriceps.
4. Straighten your front leg to return to the starting position, and repeat for the required number of repetitions. Switch legs and repeat.

Muscles Involved

Primary: Quadriceps (rectus femoris, vastus medialis, vastus lateralis, vastus intermedius), gluteus maximus, gluteus medius

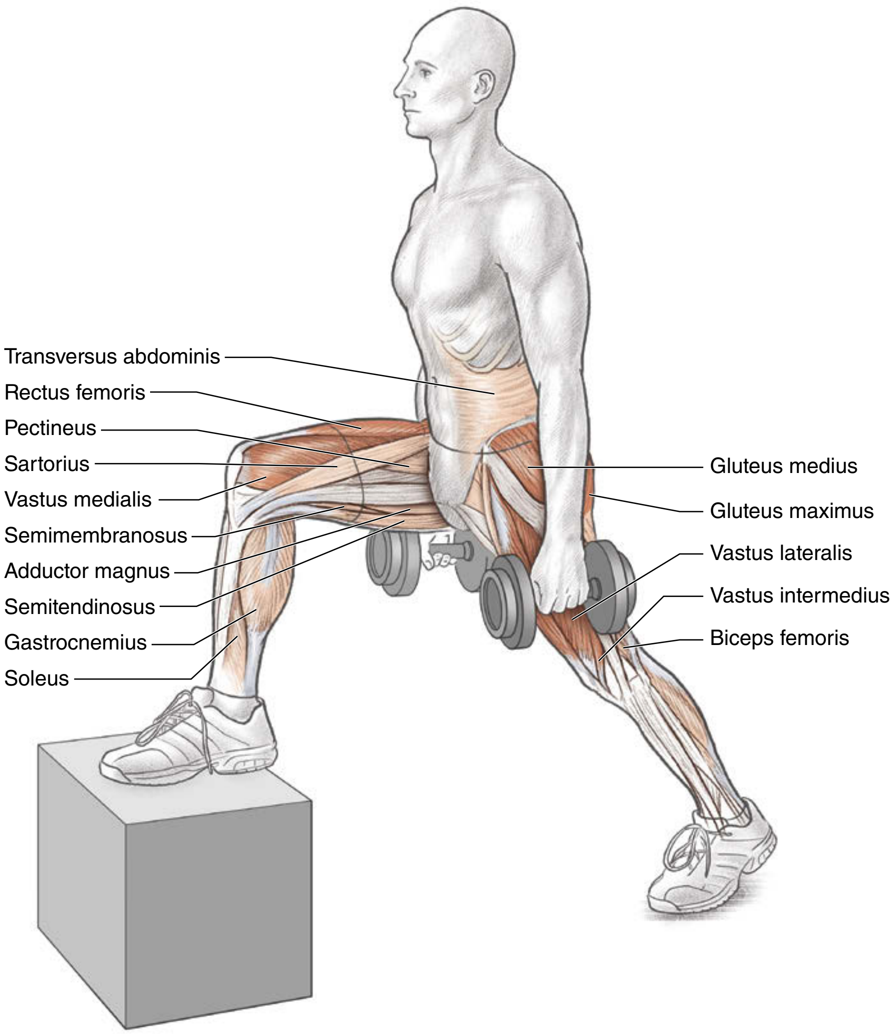
Secondary: Erector spinae (iliocostalis, longissimus, spinalis), biceps femoris, adductor longus, adductor brevis, transversus abdominis, internal oblique, external oblique

TRIATHLON FOCUS

The single-leg squat offers many of the same muscle development benefits as the double-leg squat but with the ability to isolate one leg at a time and focus more on weaknesses and balance.

The broad range of muscles engaged by this exercise makes it ideal for the triathlete, in particular for the sports of cycling and running. The cyclist will improve her ability to produce power throughout the pedaling stroke. The runner will gain greater propulsion, especially when running uphill. Overall, single-leg squats should be a key exercise in a lower-body strength training routine.

DUMBBELL STEP-UP



Execution

1. Use a plyometric or other sturdy box approximately the height of your knee, and stand facing it with a dumbbell in each hand.
2. Step onto the box with the exercising leg, pressing up onto the box until you are standing on it with both feet.
3. Return to the starting position. Perform the same stepping movement with the opposite leg. Repeat for the required number of repetitions.

Muscles Involved

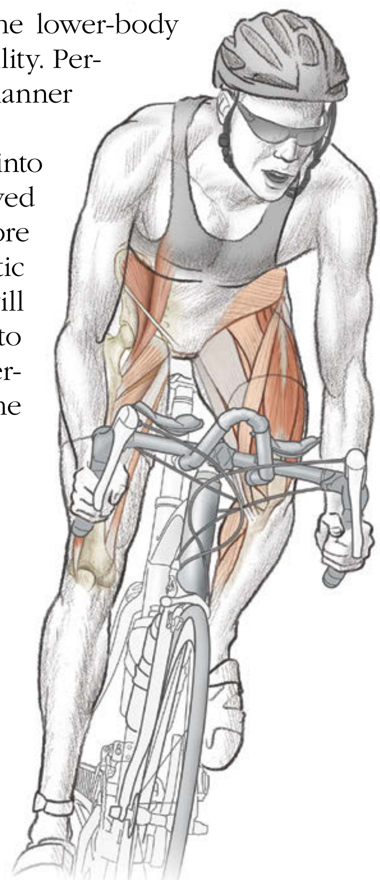
Primary: Quadriceps (rectus femoris, vastus medialis, vastus intermedius, vastus lateralis), psoas major, gluteus maximus, gluteus medius

Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), adductor magnus, adductor brevis, pectineus, sartorius, gastrocnemius, soleus, transversus abdominis

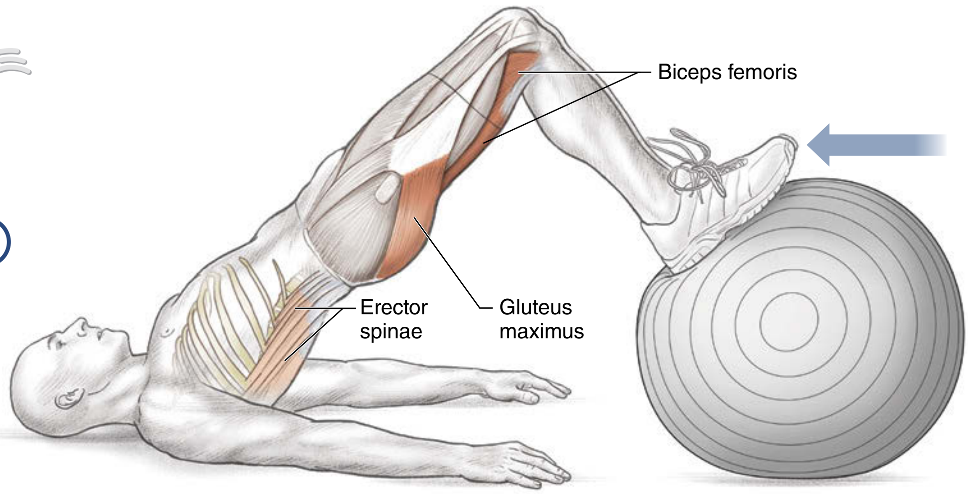
TRIATHLON FOCUS

This is another great exercise for targeting the lower-body muscles as well as increasing balance and stability. Performing this exercise in a slow and controlled manner will further increase its effectiveness.

The triathlete who incorporates this exercise into his strength training routine will notice improved power output on the bike, a stronger and more propulsive kick in the swim, and more energetic bounding uphill on the run. This exercise will also strengthen connective tissues, helping to prevent injury. Increase the intensity of this exercise by either adding more weight or raising the height of the step-up box.



STABILITY BALL HAMSTRING CURL



Execution

1. Using a medium-diameter stability ball, lie on your back with the ball under your heels.
2. Engaging your core, gently lift your hips toward the ceiling so that your body is straight.
3. Pull your heels toward your buttocks until the knee joints form about a 90-degree angle.
4. Straighten your legs back to the starting position, keeping your body straight and supported on the ground with your upper back and on the ball with your heels.

Muscles Involved

Primary: Gluteus maximus, hamstrings (biceps femoris, semitendinosus, semimembranosus)

Secondary: Erector spinae (iliocostalis, longissimus, spinalis)

TRIATHLON FOCUS

This exercise is convenient and effective for the busy triathlete who might not have the time to go to the gym to use strength equipment that targets and isolates the hamstrings and gluteus. In addition, it targets key muscles in the legs as well as those in the core for added bang for your buck.

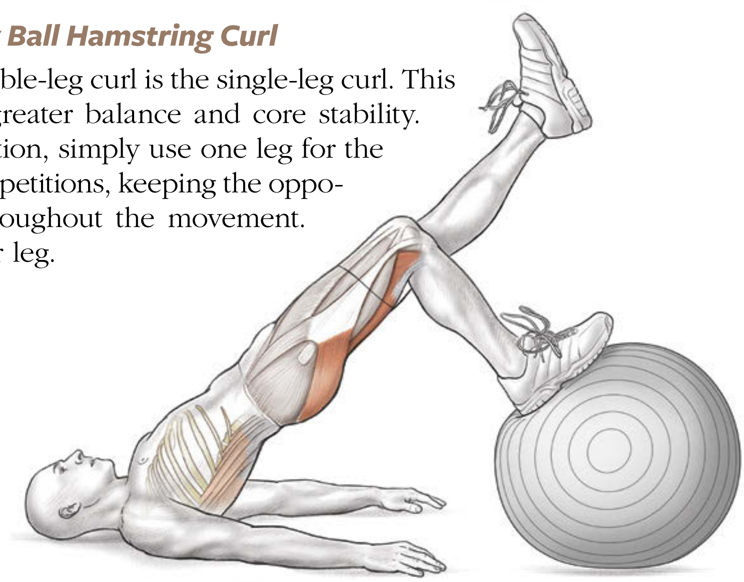
The stability ball hamstring curl will help strengthen muscles used in cycling, particularly when climbing or riding into a headwind when pulling up on the pedals is important. Runners will benefit from having stronger hamstrings and glutes, especially when running into a stiff headwind or when attacking a hill where these key muscle groups are required to perform at an optimal level.

Note that a strong core is required to perform this exercise properly. Read the section on core strengthening exercises in this book.

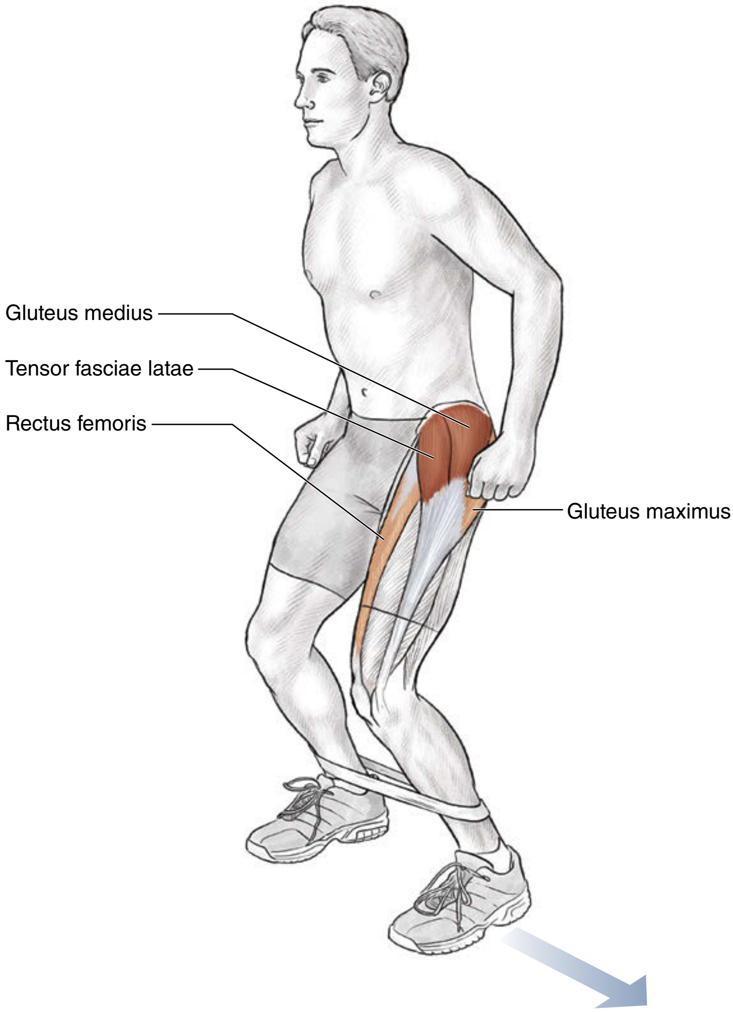
VARIATION

Single-Leg Stability Ball Hamstring Curl

The variation of a double-leg curl is the single-leg curl. This movement requires greater balance and core stability. To perform this variation, simply use one leg for the required number of repetitions, keeping the opposite leg extended throughout the movement. Repeat with the other leg.



BAND LATERAL SHUFFLE



Execution

1. Stand with your knees bent, feet shoulder-width apart, and toes pointed straight ahead.
2. Wrap a resistance band around your ankles. Keeping the trailing leg planted, step to the side with the lead leg while keeping your toes pointed straight ahead.
3. After placing the lead foot on the ground, move the trailing foot.
4. Repeat steps 2 and 3 until you cover a set distance or number of repetitions.

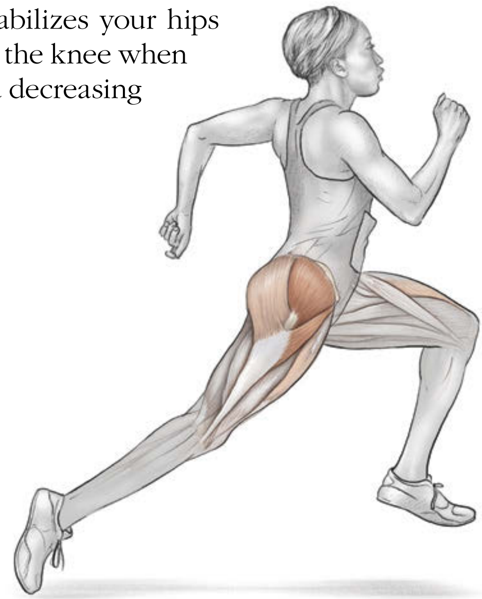
Muscles Involved

Primary: Tensor fasciae latae, gluteus medius

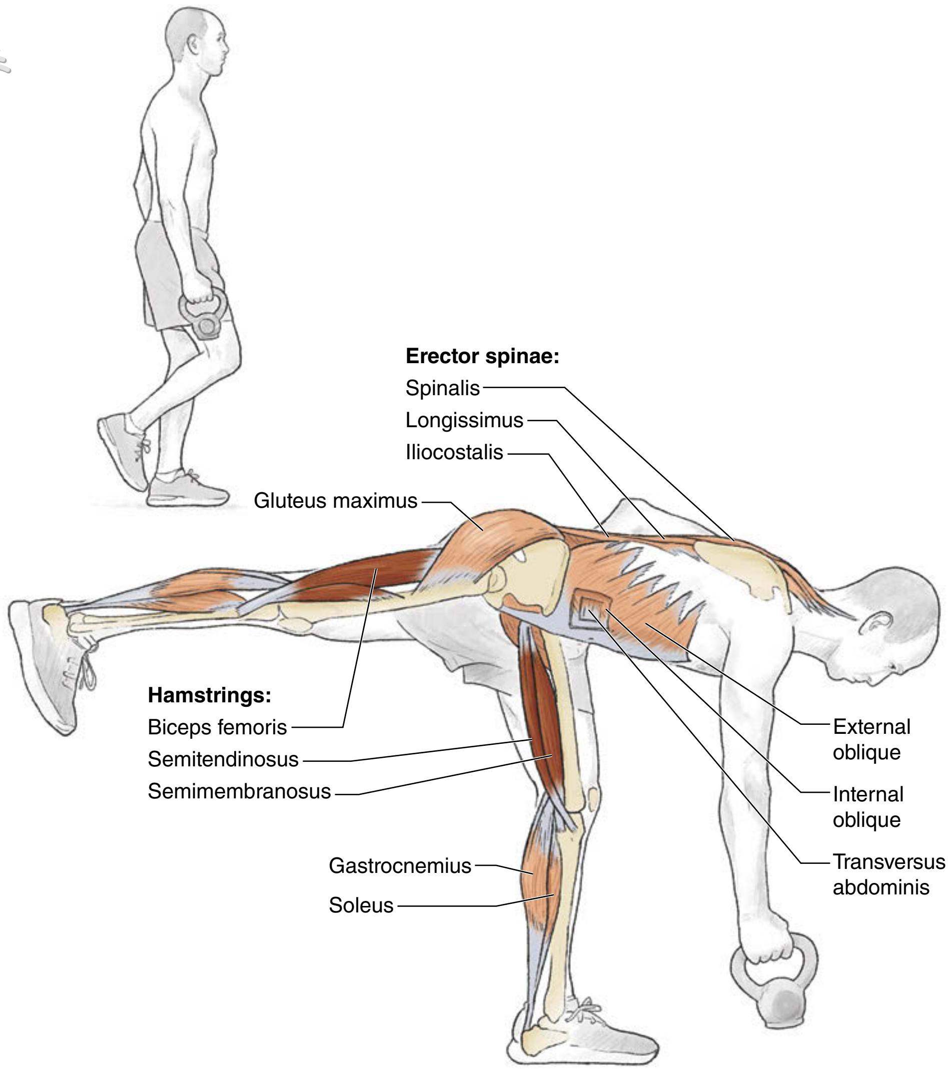
Secondary: Gluteus maximus, rectus femoris

TRIATHLON FOCUS

Strengthening your hip abductors stabilizes your hips and helps promote proper tracking of the knee when running, improving performance and decreasing the risk of injury.



SINGLE-LEG DEADLIFT



Execution

1. Stand on one leg while holding a kettlebell with the opposite-side hand.
2. Keeping your back straight and a soft bend in your knees, begin to lean forward at the waist, performing a stiff-leg deadlift maneuver.
3. As you bend forward, extend your free leg behind you for balance. Continue to flex at the hip until your torso is parallel to the ground.
4. Return to the starting position. Repeat the motion for your set and then perform the same exercise on the opposite side.

Muscles Involved

Primary: Hamstrings (semitendinosus, semimembranosus, biceps femoris)

Secondary: Erector spinae (iliocostalis, longissimus, spinalis), gluteus maximus, gastrocnemius, soleus, external oblique, internal oblique, transversus abdominis

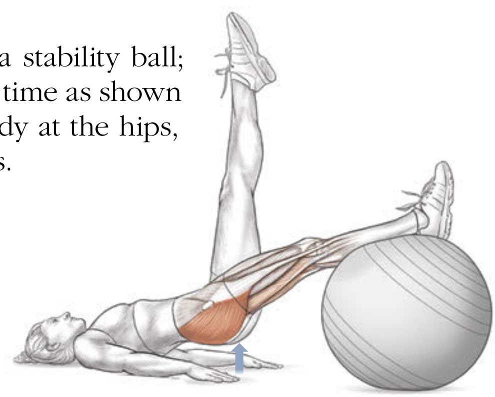
TRIATHLON FOCUS

The single-leg deadlift works many posterior muscles, but primarily the hamstrings. This leads to greater power for riding and running.

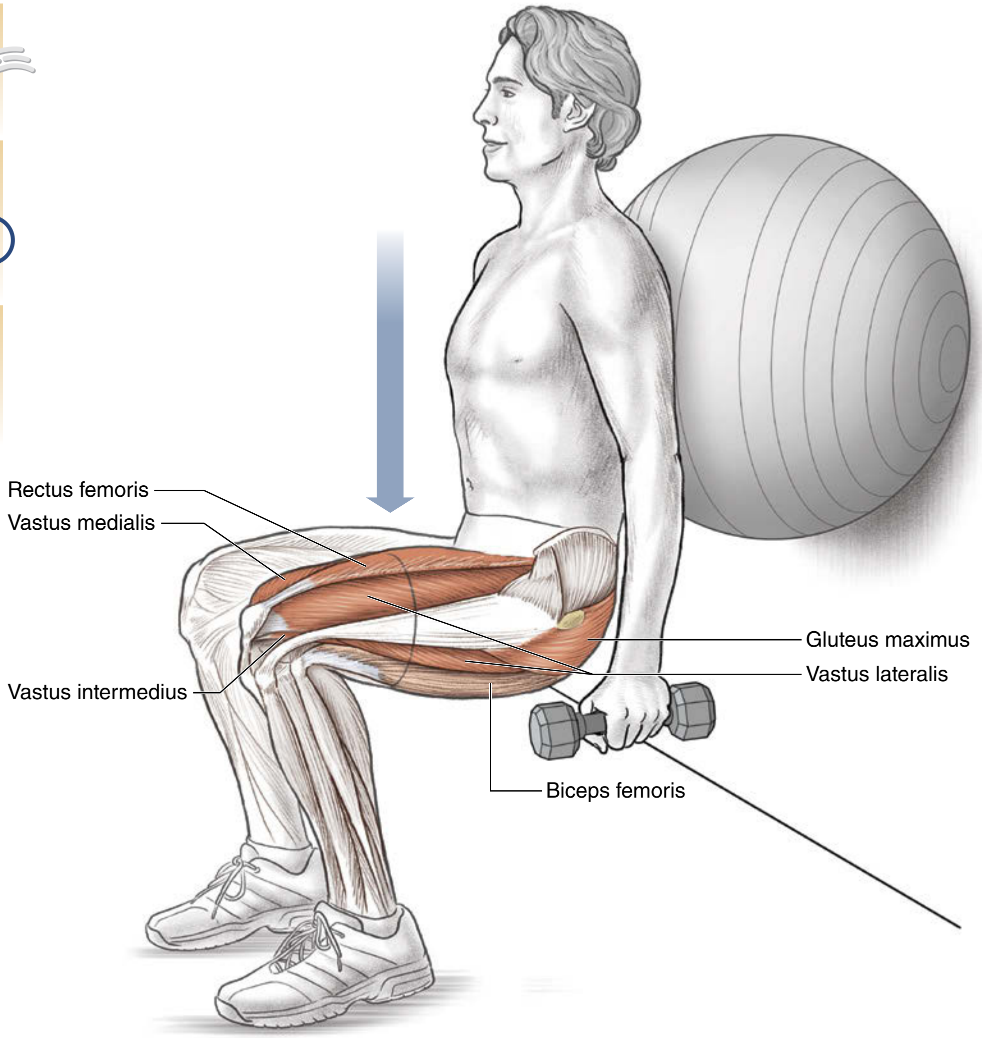
VARIATION

Stability Ball Hip Extension

Lie on your back with both legs on a stability ball; for added difficulty, work one leg at a time as shown in the illustration. Straighten your body at the hips, engaging the glutes to raise your hips.



WALL STABILITY BALL SQUAT



Execution

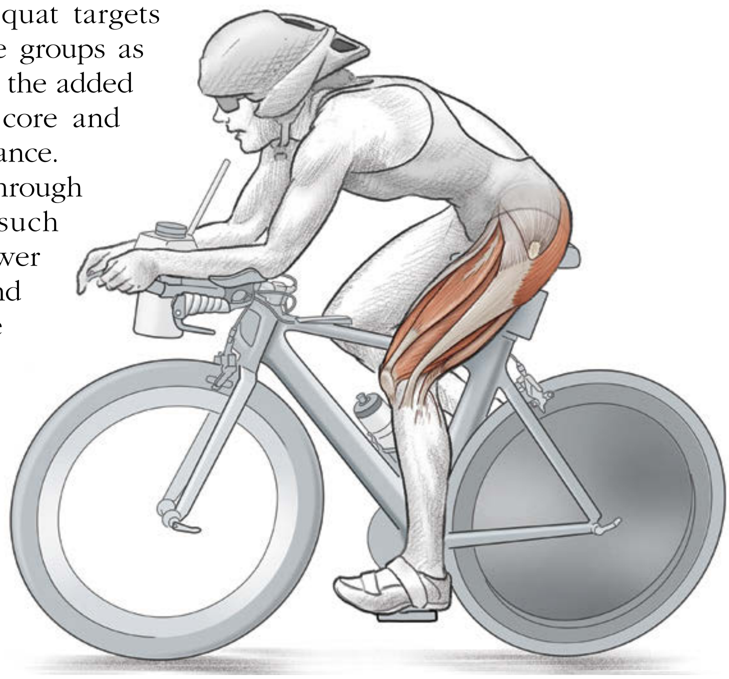
1. From a standing position with your back to a wall and your heels about 3 feet (0.9 m) from the wall, place a stability ball between your lower or middle back and the wall. If you like, add weight by holding a dumbbell in each hand.
2. While pressing back against the ball and maintaining your balance, lower your body to a sitting position, with your legs forming 90-degree angles.
3. Stand up and repeat for the required number of repetitions.

Muscles Involved

Primary: Quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), gluteus maximus

Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), hip adductors (adductor longus, adductor magnus, adductor brevis)

TRIATHLON FOCUS

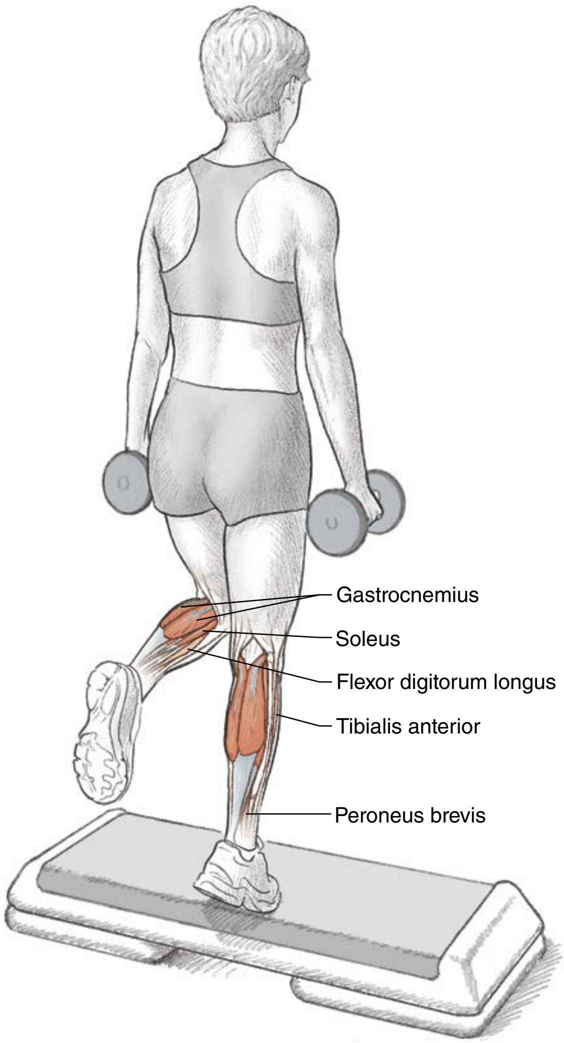


The wall stability ball squat targets many of the same muscle groups as the regular squat but with the added benefit of engaging the core and developing a sense of balance.

Strong legs developed through resistance movements such as this will increase power output for both the bike and the run as well as for the crucial transition from one discipline to the next during a triathlon.

Another benefit to performing exercises such as this is time efficiency—you will be developing the components of core stability and leg strength and endurance all in one simple and very effective exercise.

SINGLE-LEG HEEL RAISE WITH DUMBBELLS



Execution

1. Stand on a stable platform 3 to 5 inches (7.5 to 12.5 cm) high on the ball of one foot (the exercising leg). Hold appropriately weighted dumbbells in each hand or no weight, depending on your fitness level. For many athletes, the weight should be considered challenging to the completion of the desired number of repetitions.
2. Lower your heel toward the ground (dorsiflexion) until you feel a slight stretch in the calf muscles and surrounding region.
3. Slowly extend up (plantar flexion), engaging the muscles of the calf with your knee slightly flexed.
4. Again lower slowly and repeat for the required number of repetitions. Switch legs.

Muscles Involved

Primary: Gastrocnemius, soleus

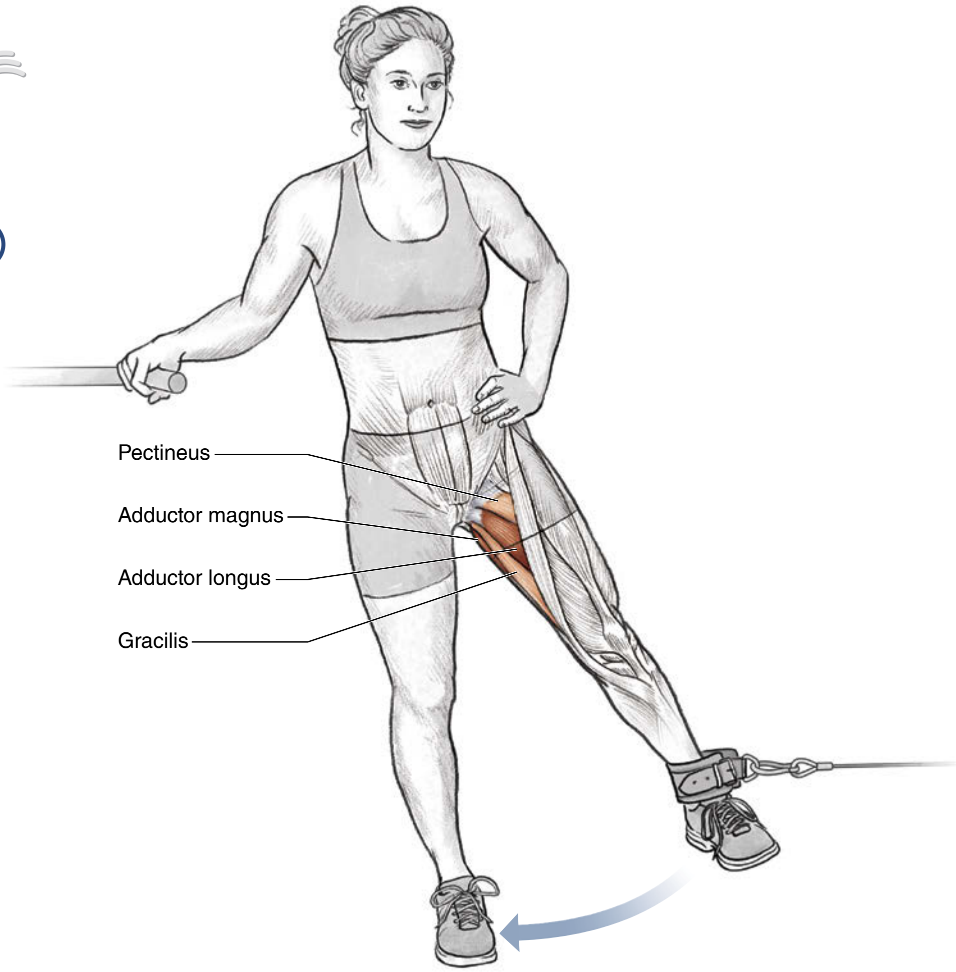
Secondary: Tibialis anterior, peroneus brevis, flexor digitorum longus

TRIATHLON FOCUS

Effective for both injury prevention and performance, this is an important lower-leg isolation exercise for the triathlete that can both prevent injury and enhance cycling and running performance.

While the upper legs and hips provide most of the power in both cycling and running, the lower legs deliver additional power and propulsion. Inadequately strengthened muscles in this area will diminish performance potential as well as increase your risk of injury, most commonly to the Achilles tendon.

CABLE HIP ADDUCTION



Execution

1. Standing with your side to a cable pulley rack, attach a low cable to the ankle closest to the rack.
2. Take one step away from the origin of the cable so the system engages the weights. Hold onto the cable pulley system with your hand for support and stabilization. You should be standing on one foot with the attached ankle drawn out to the side.
3. Keeping your torso stable, draw your connected foot to your stance foot. Hold momentarily, then slowly return to the starting position. Complete the set and then switch sides.

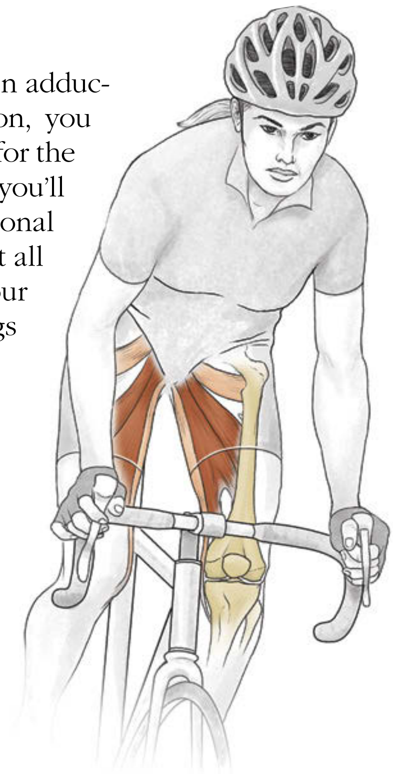
Muscles Involved

Primary: Adductor magnus, adductor longus, adductor brevis

Secondary: Gracilis, pectineus, lower gluteus maximus

TRIATHLON FOCUS

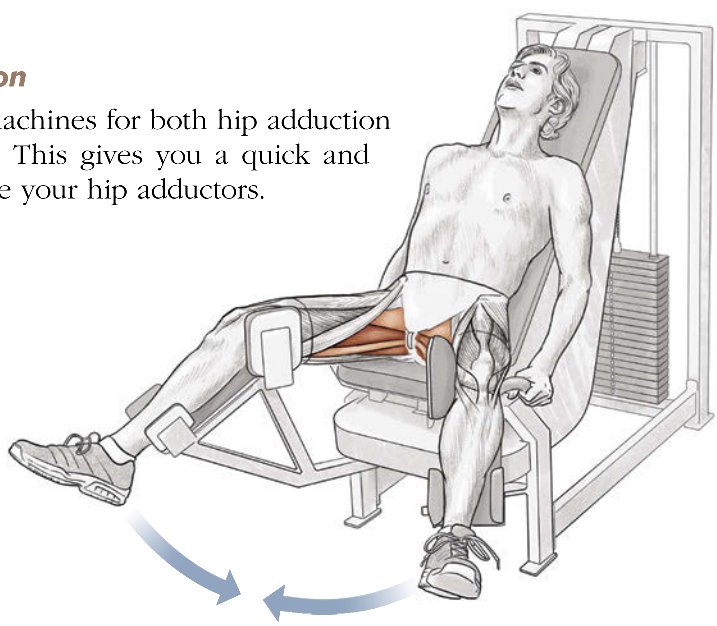
Although you actually won't move your legs in adduction during your pedaling or running motion, you still need to strengthen the adductor muscles for the sake of stability. During hard cycling efforts, you'll want to maintain a clean, streamlined rotational motion of your legs. When running, you want all your energy translated to forward motion. Your adductors help with stability and keep things tracking forward and properly aligned.



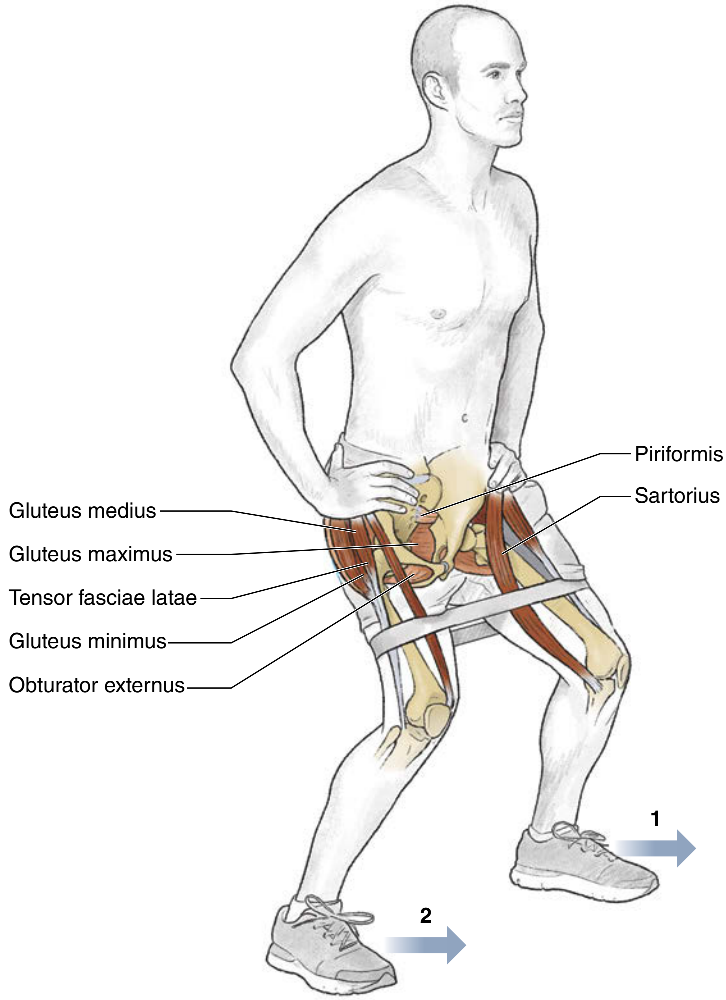
VARIATION

Machine Adduction

Many gyms have machines for both hip adduction and hip abduction. This gives you a quick and easy setup to isolate your hip adductors.



ABDUCTION BAND WALK



Execution

1. Place a resistance band around your thighs just above the knees. (You can also place it around your ankles or feet.)
2. Stand in a quarter-squat position or an athletic stance—knees bent, butt back, back straight. Keep your feet pointed straight ahead.
3. Keeping the same form, step your left leg out to the side. Make sure you keep the knee position fixed and under control—no wobbling inside or out. Keep your feet pointed straight ahead.
4. Follow with your right foot, performing a similar step to the left.
5. Once the set is complete, perform the exercise in the opposite direction (to the right).

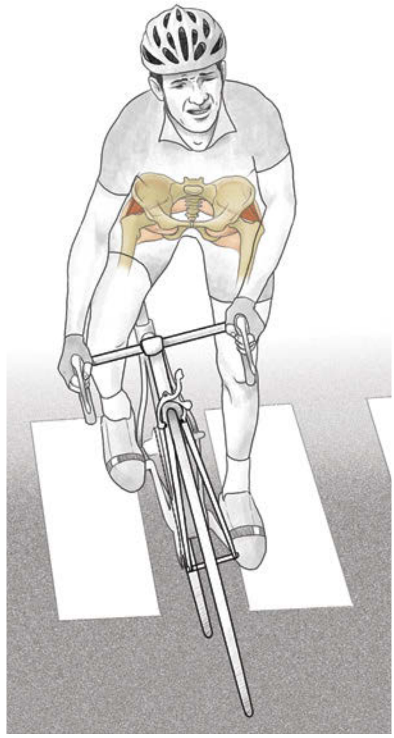
Muscles Involved

Primary: Gluteus medius, gluteus minimus, tensor fasciae latae, sartorius

Secondary: Gluteus maximus, piriformis, obturator externus

TRIATHLON FOCUS

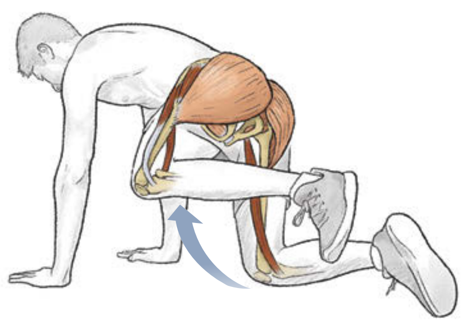
Similar to the hip adductors, the hip abductors play a key role in stabilizing your pedaling and running motions. Strong stabilizers will be especially helpful when you're fatigued and form tends to deteriorate. By training these muscles in the gym, you'll increase the strength of the muscles as well as the volume of blood flow and the number of vascular beds that course throughout the muscle.



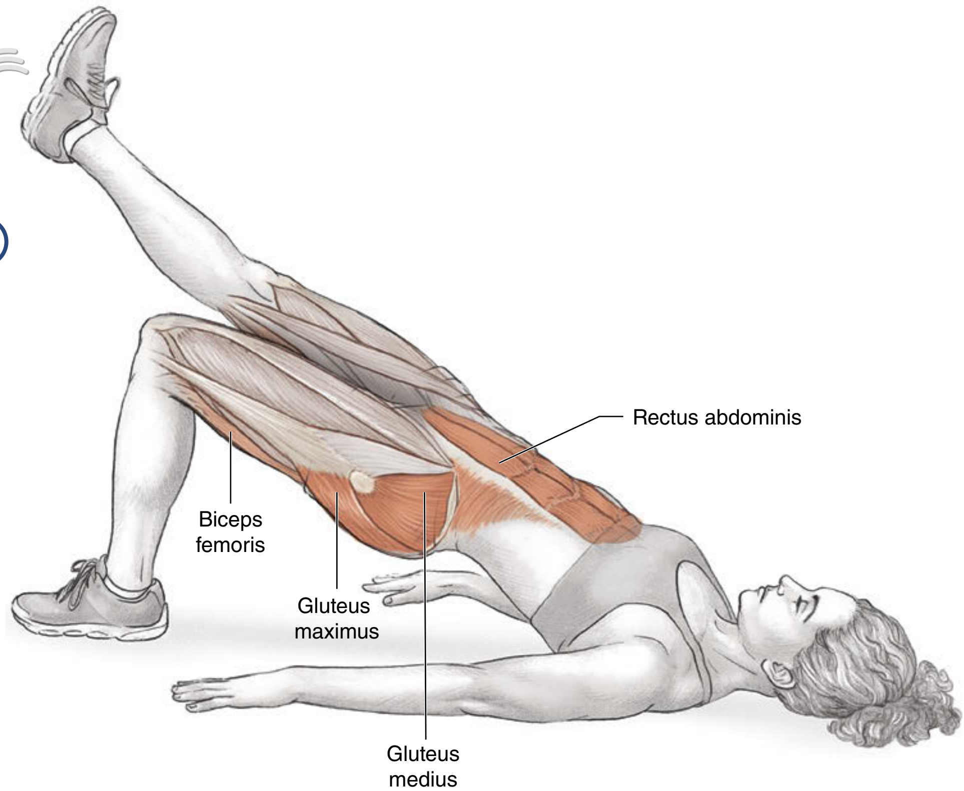
VARIATION

Fire Hydrant

Similar to the hip adductor exercises, you can use a machine or cable to work your hip abductors. However, the fire hydrant is a viable alternative that doesn't require any special equipment, so it is great if you are traveling or at home. Position yourself on your hands and knees. Lift one leg up and out to the side, keeping your knee bent. Focus on activating the hip abductors specifically and you'll see that even this simple exercise can give you a great isolation workout.



BRIDGE WITH LEG KICK



Execution

1. Lie supine (on your back) with both knees bent.
2. Lift your hips into the air as high as you can, simultaneously squeezing your glutes and keeping your scapulae on the floor.
3. Once you are in the bridge position, extend one lower leg straight out and hold for 5 seconds.
4. Lower the leg, then kick and hold with the opposite leg.

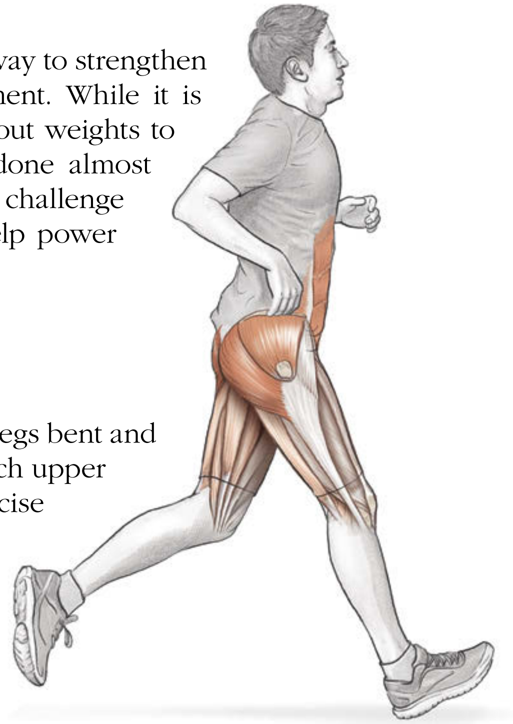
Muscles Involved

Primary: Gluteus maximus, gluteus medius, gluteus minimus, rectus abdominis, transversus abdominis

Secondary: Hamstrings (semitendinosus, semimembranosus, biceps femoris)

TRIATHLON FOCUS

Bridges (and variations) are a viable way to strengthen hip extensors, even without equipment. While it is harder to overload the muscles without weights to add resistance, the bridge can be done almost anywhere and is an effective way to challenge the glutes and hamstrings, which help power output when running and riding.

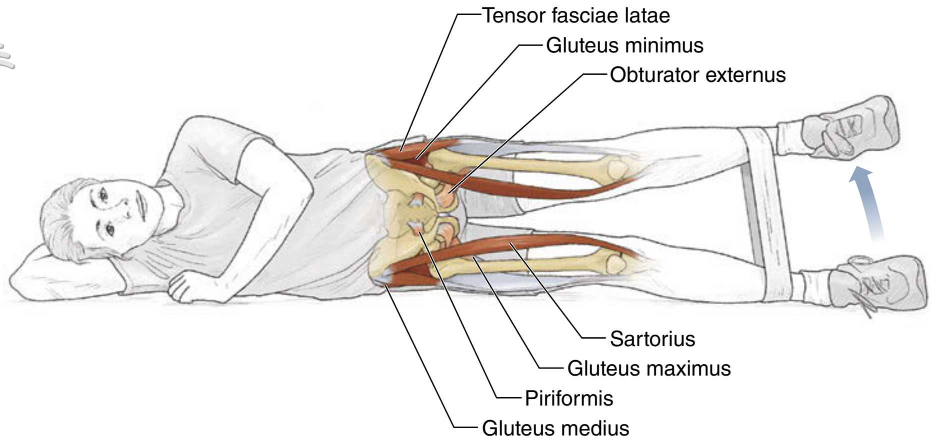


VARIATION

Weighted Bridge With Leg Kick

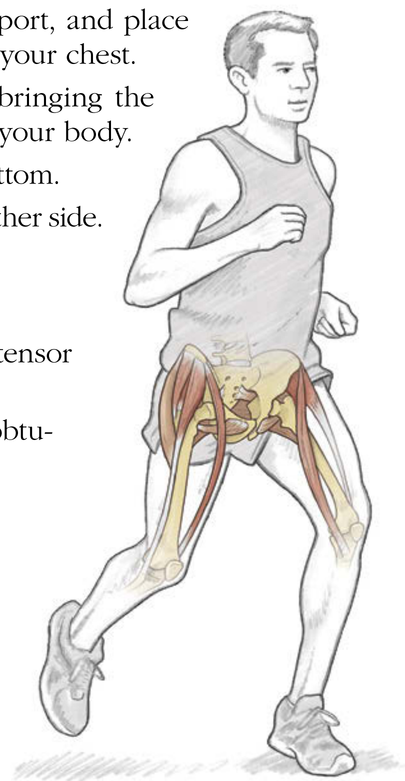
Assume the bridge position with the legs bent and a dumbbell resting on the front of each upper thigh (anterior hip). Perform the exercise in the usual manner with the dumbbells increasing the resistance.

SIDE LEG RAISE



Execution

1. Lie down on your right side on a mat, with your hips stacked, your body in a straight line, and a resistance band around your ankles.
2. Place your arm under your head for support, and place your left hand on the ground in front of your chest.
3. Slowly raise your left leg off the right, bringing the legs as high as you can without rotating your body.
4. Slowly lower and pause briefly at the bottom.
5. Repeat 10 to 12 times, then switch to the other side.



Muscles Involved

Primary: Gluteus medius, gluteus minimus, tensor fasciae latae, sartorius

Secondary: Gluteus maximus, piriformis, obturator externus

TRIATHLON FOCUS

As with other exercises that focus on your abductors, the side leg raise is an effective way to add lateral stability when riding and improve your running form.

5

BACK AND NECK

Neck and back pain will affect approximately 60 to 80 percent of people in the United States during their lifetimes. So why do we spend so little time trying to keep our necks and backs healthy and strong? Throughout our lives we have heard phrases such as "watch your back" or that someone's got her "back against the wall." These simple words emphasize the potential vulnerability of the area. The perceived fear of exercising the neck and back has led us to ignore a prime area where we could dramatically decrease the chance of injury and disability.

The physical demands we put on our bodies during triathlons place us at risk for injury. Whether that injury is caused by poor technique, fatigue, equipment issues, or a mishap or crash, endurance training and racing place highly repetitive stresses on all our tissues, which can lead to breakdown, accidents, and injuries. A lack of body rotation while swimming forces the athlete to use excessive rotation of the head, which can unduly stress the neck and produce pain and stiffness. Improper bike fit, poor riding position, or even just spending too many hours in the saddle can lead to neck and lower-back pain. Running places high-impact forces on the spine and its supporting tissues. Couple this with worn-out running shoes and even minor issues with running form, and back and neck issues can soon follow. This group of injuries can be described as strains or mechanical pain. Neck and back strains can be caused by an injury to one or more structures of the spine, including bones, tendons, ligaments, discs, and muscles. This should be distinguished from neurological or radicular pain, in which nerve irritation produces a constellation of symptoms, including pain that is felt more in the leg and arm than in the back or neck.

To better understand the importance of the neck and back and their relationship to health and function, we will discuss each anatomical component separately and argue that an ounce of prevention with a well-designed strength and flexibility training program can lead to a pound of injury prevention and performance improvement.

BONY STRUCTURES OF THE BACK AND NECK

The core structures of the neck and back are the bones that make up the spinal column. The spine is composed of 33 vertebrae: 7 cervical (C1–C7), 12 thoracic (T1–T12), 5 lumbar (L1–L5), 5 fused sacral vertebrae that form the sacrum, and 4 coccygeal bones that form the tailbone (figure 5.1).

Each vertebra has two essential components: an anterior segment (the vertebral body) and a posterior part (the vertebral or neural arch). Each vertebral body is stacked on another to form the spinal column (figure 5.2). Intervertebral discs separate the vertebral bodies, except for the sacrum and coccygeal

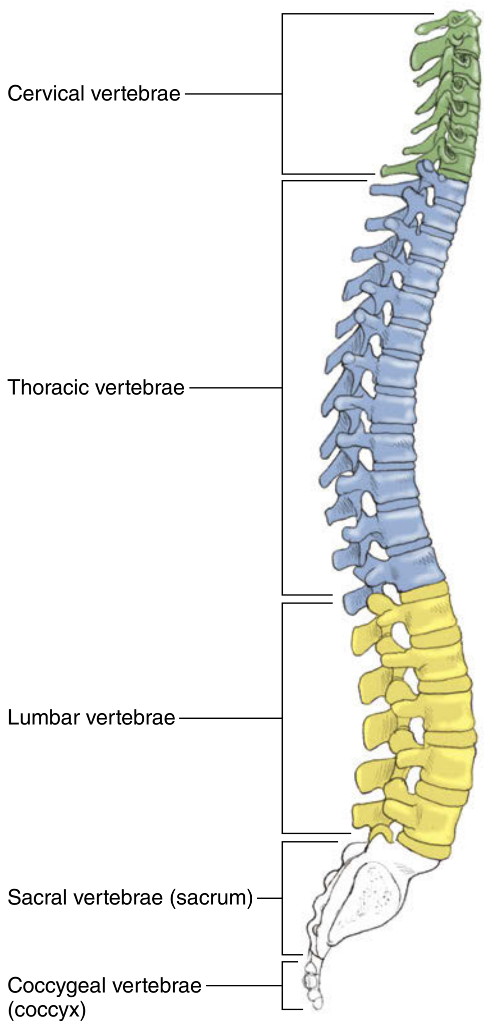


FIGURE 5.1 Regions and curves of the spine, view of right side.

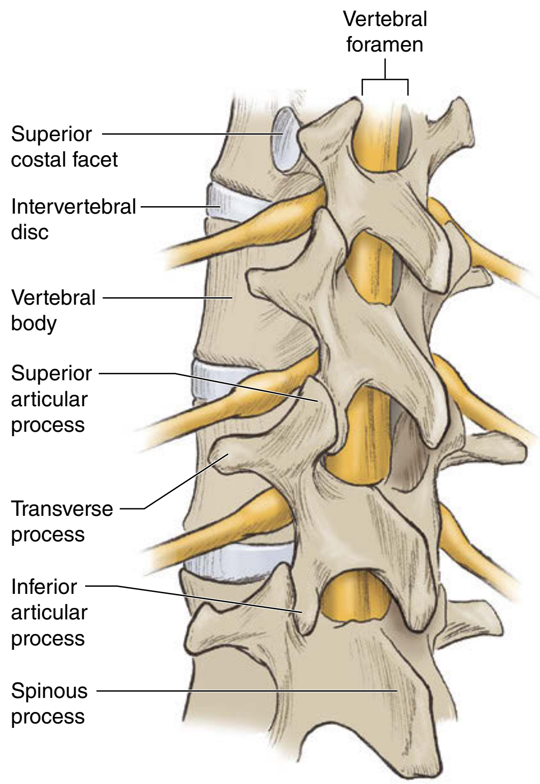


FIGURE 5.2 Vertebrae along the spine.

bones. The vertebral arches attach to one another via two joints, one on each side, called the facets. A series of ligaments that run the length of the spinal column help connect each segment, creating a support column that holds the head and trunk upright and protects the spinal cord and its nerve roots.

An intervertebral disc and its adjacent vertebrae create a motion segment. By themselves they have little motion, but as you stack multiple segments on top of each other, a flexible column is created. At the core of this motion is the intervertebral disc. Think of it as a jelly donut that has a fibrous ring (annulus fibrosus) surrounding a jelly-like substance in its center (nucleus pulposus) (figure 5.3). Ninety percent of the nucleus is composed of water, creating an incompressible pillow.

The disc performs two functions, motion and shock absorption. Motion of the spine occurs from the interplay between the annulus fibrosus and the nucleus pulposus. Vertical pressure exerted on the spine with impact loading is resisted by the relatively incompressible nucleus pulposus contained within the fibrous ring. Athletes as young as their 20s and 30s can experience degenerative changes in discs and facet joints. A loss of water in the nucleus pulposus and breakdown of the collagen fiber structure of the annulus fibrosus can decrease the shock absorption ability of the vertebrae and place discs at risk of herniation. In this condition, the jelly escapes the confines of the fibrous ring and potentially presses on the spinal cord or on one of its nerves, causing pain that can radiate down a leg or arm, depending on the disc level. Deterioration of the facet joints, including loss of the cartilage lining, and stiffness or fibrosis of the surrounding ligaments can cause pain and a loss of motion about the spine.

The normal spine has an S-shaped curve when viewed from the side (see figure 5.1) and looks straight when viewed from the front. These curves develop in childhood. We are born with a C-shaped spine, called kyphosis. (The upper back looks posteriorly convex when viewed from the side.) As a baby starts to crawl and lift her head, cervical lordosis develops. (The upper back looks anteriorly convex when viewed from the side.) With continued muscular development and the onset of walking, more weight is distributed onto the spine, and lumbar lordosis is created. The mature S-shaped spine allows for balance, flexibility, and an even distribution of weight.

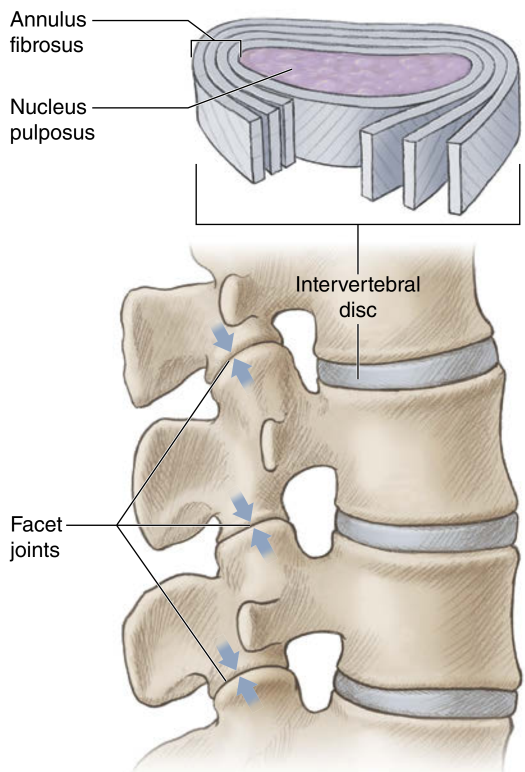


FIGURE 5.3 Facet joints and intervertebral discs, with a detail of an intervertebral disc.

MUSCLES OF THE BACK AND NECK

Everything described so far is a passive structural element of the spine. But what makes it move? A group of deep, strong muscles in the back including the erector spinae (figure 5.4), multifidus (figure 5.5), and intertransversarii muscles control the movements of the lower and middle spine.

Upper-back and cervical motion are controlled by similar muscles but also by a large group of smaller neck muscles (figure 5.6), including the sternocleidomastoid, scalenes, and splenius capitis, to name a few.

Other muscles on the back that contribute to motion about the spine include the trapezius, the latissimus dorsi, and the deep scapular rotator, the levator scapulae.

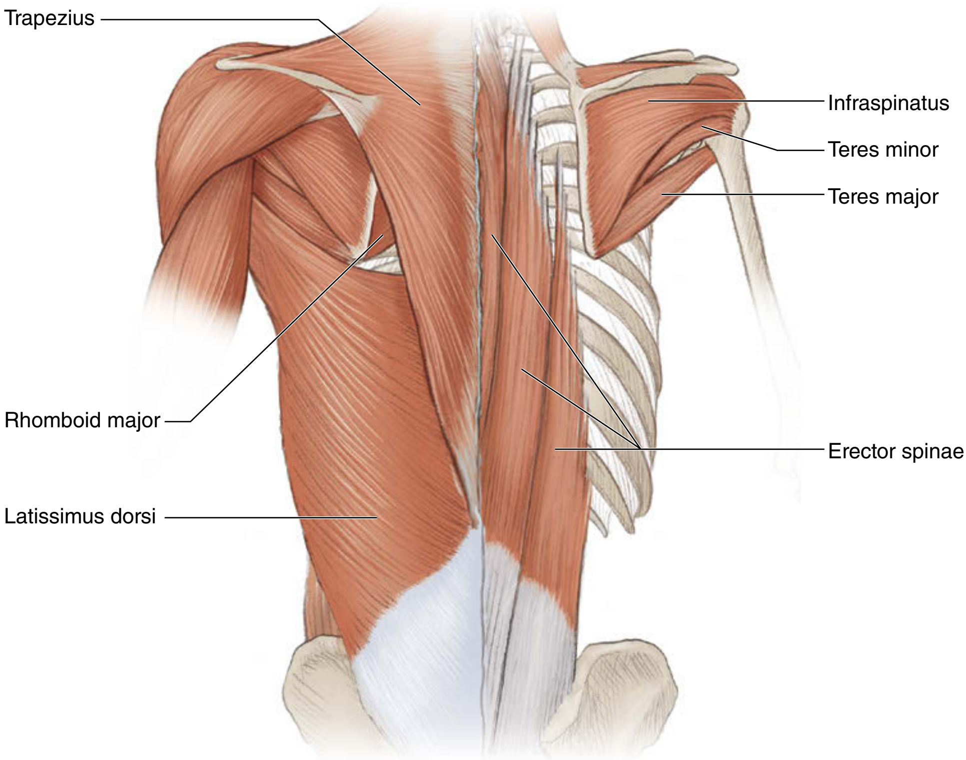


FIGURE 5.4 Muscles of the back: trapezius, rhomboid major, latissimus dorsi, infraspinatus, teres minor, teres major, and erector spinae.

Motions that occur about the spine are flexion and extension (bending forward and backward); side bending, or lateral flexion; and rotation. In the cervical spine the majority of rotation occurs at the uppermost vertebral bodies, C1 and C2; flexion and extension occur at the lower cervical vertebrae, C5 and C6. In the lumbar spine, rotation is somewhat evenly distributed among all vertebrae, but flexion and extension occur in the L3–L4 and

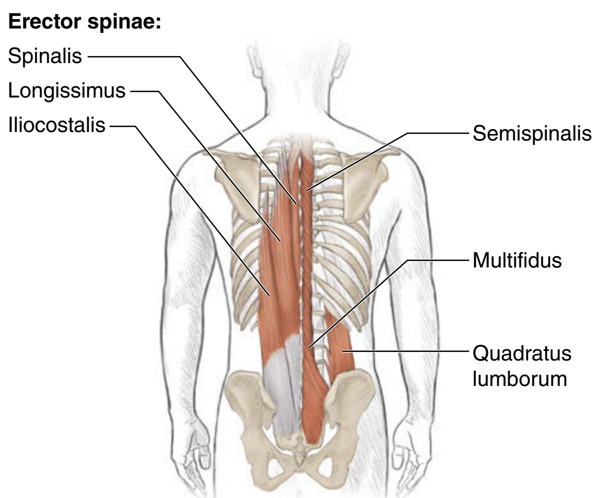


FIGURE 5.5 Deeper back muscles, including the multifidus and semispinalis.

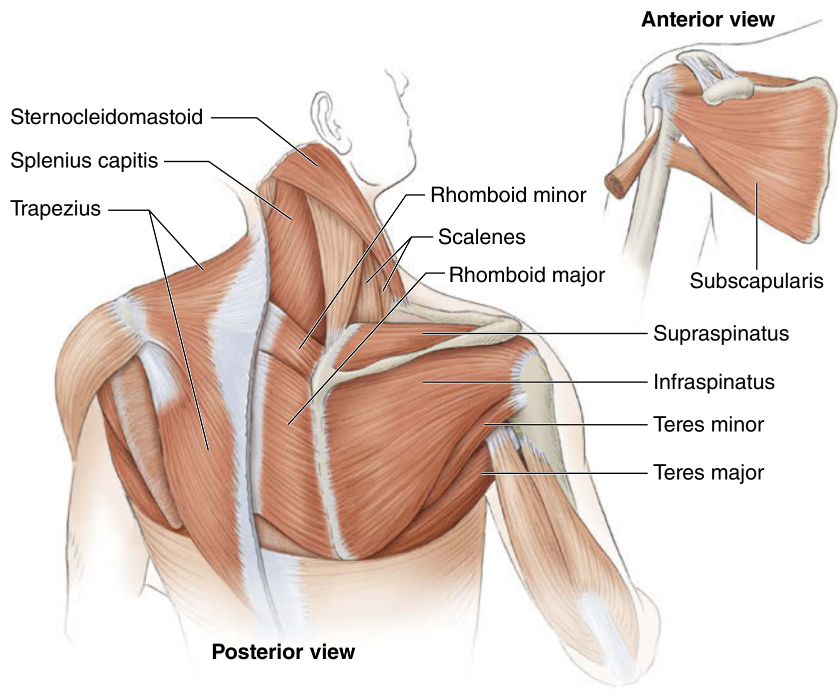


FIGURE 5.6 Muscles of the neck, upper back, and rotator cuff.

L4–L5 regions. Most degenerative changes occur at these sites due to their increased mobility.

Flexion of the spine occurs through the action of the anterior muscles of the abdomen and rectus abdominis. Extension of the spine is performed by a muscle group called the erector spinae. It is made up of three separate muscles—the iliocostalis, longissimus, and spinalis—that run vertically along the spine from the sacrum to the cervical region. Some of the fibers are also continuous with the gluteus maximus. Their main function is to stabilize and extend the spine.

Lateral spine rotation and side bending are performed by the oblique muscles of the abdomen in conjunction with isolated contraction of the erector spinae group. The intertransversarii muscles are small muscles that run between the transverse processes of each vertebra. Their location on the spine also assists in lateral flexion of the spine.

The multifidus muscle is a very thin, deep muscle of the back that runs from the sacrum up into the cervical region in the groove next to the spinous process (that bony prominence you can feel on your back) of each vertebra. The main function of the multifidus is to stabilize each joint segment of the spine.

In the cervical region, the sternocleidomastoid on each side of the neck is responsible for rotation and side bending. The scalene muscles, three on each side, perform lateral bending of the head. Both muscle groups also facilitate respiration, an important function in exercise. The trapezius, by virtue of its attachments to the base of the skull, scapula, and spine, links the neck to the rest of the body and assists with extension, rotation, and neck bending.

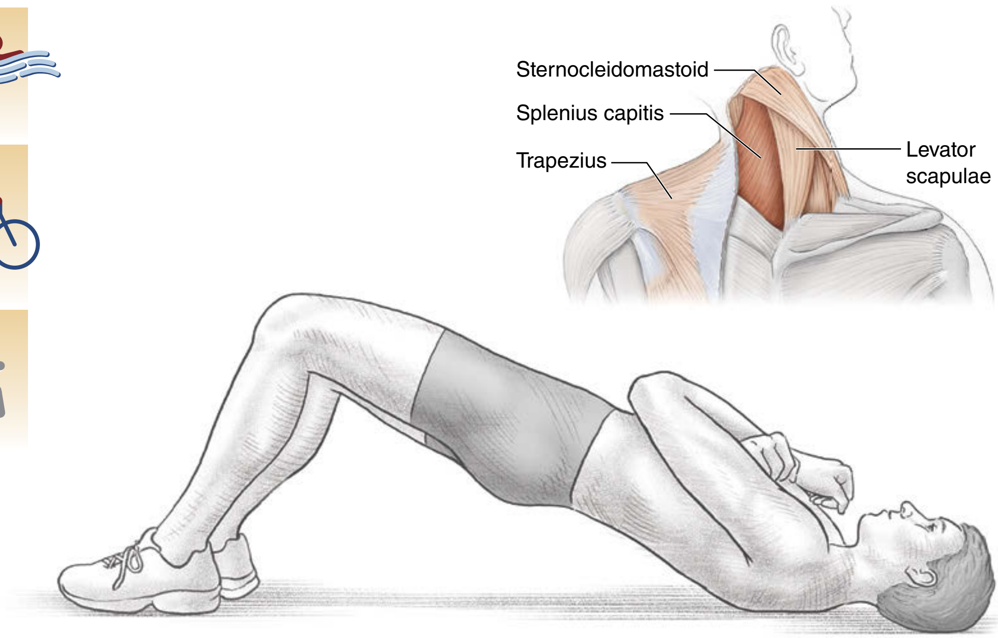
EXERCISES FOR THE BACK AND NECK

For muscular endurance and strength development, strive to complete one to three sets of 10 to 15 repetitions for the exercises in this chapter. To maximize the benefit of each set, choose a weight that challenges you to complete the final repetitions but does not compromise form (and therefore safety). Research shows that resting 3 to 5 minutes between sets might be best for maximum strength development, and shorter rest intervals of up to 60 seconds elicit greater gains in muscular endurance. This depends on the intensity of the exercise and the relative difficulty of completing each set without going to failure. In most cases it is recommended that triathletes target a rest interval of 1 to 2 minutes between sets of moderate intensity.

The muscles of the back and neck are often ignored during training but physically taxed during racing and even during normal activities of daily living, such as sitting behind a desk hunched over a computer. To prevent injury to the low-back and cervical region, you need to engage in strength training of this area as well as overall core and abdominal training.

The back especially requires an adequate warm-up period before you begin a strength training program. Because the back is a link to the upper and lower extremities, activities such as rowing or using an elliptical trainer are great for warming up. Increasing heart rate brings blood flow to all regions of the body. As core temperature rises, muscles, tendons, and ligaments are more receptive and compliant to the stresses placed on them. A proper warm-up period should entail low-level exercise in which you can easily hold a conversation, your heart rate is in the lower aerobic range, and you break a light sweat. Once this is accomplished, begin strength training. The exercises that follow will help develop a strong and healthy back and neck.

FLOOR BRIDGE



SAFETY TIP: This exercise requires extreme caution. Be sure your neck muscles are warmed up before performing this exercise. Don't attempt to engage the neck muscles beyond your comfort level. Never extend back to the top of your head or extremely arch your neck.

Execution

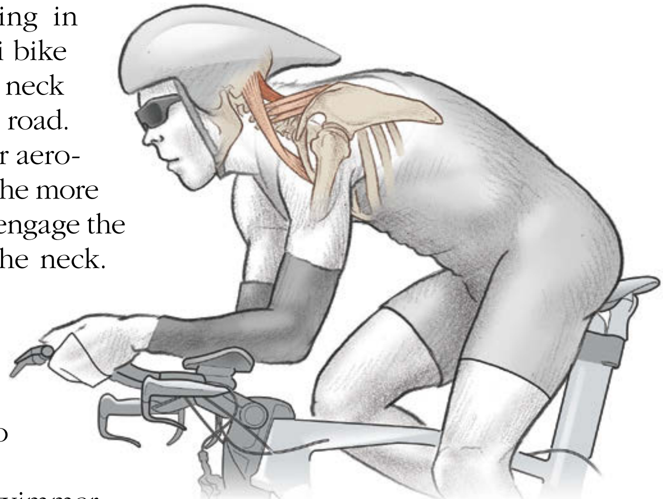
1. Start by lying on your back on the floor, with your knees bent and feet flat.
2. Gently press back on the floor with your head as you slowly raise your body and shoulders, engaging the muscles in the back of the neck. This should take 3 to 4 seconds.
3. Slowly roll back to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Splenius capitis

Secondary: Trapezius, levator scapulae, erector spinae (iliocostalis, longissimus, spinalis), posterior sternocleidomastoid

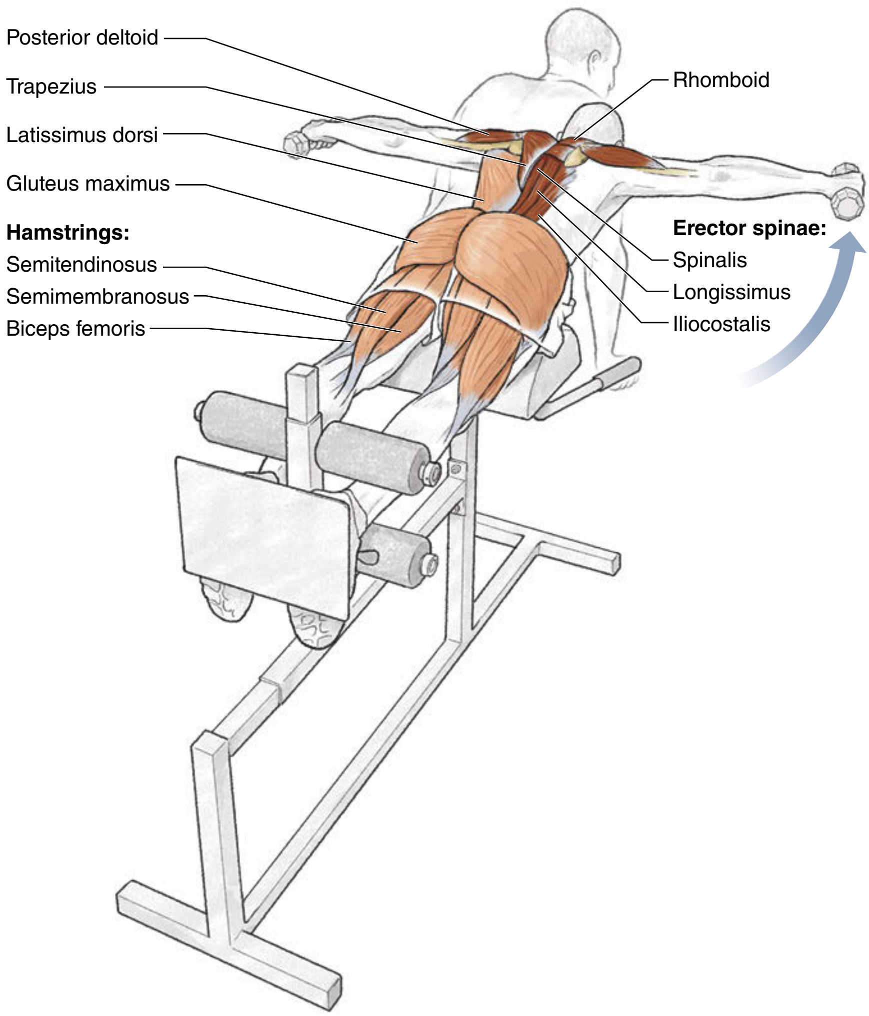
TRIATHLON FOCUS



The very nature of riding in the aero position on a tri bike forces you to extend your neck upward as you look at the road. The more aggressive your aerodynamic riding position, the more you need to look up and engage the muscles in the back of the neck. After a few hours in the saddle, your 10-pound (4.5 kg) head gets pretty heavy, and neck fatigue and stiffness can begin to settle in.

For the open-water swimmer, sighting the buoys requires frequent head-up, lifeguard-style strokes to maintain a proper course. This also places a lot of stress on the back of the neck. Supplementary strength training such as the floor bridge will help alleviate neck fatigue and soreness.

STATIC BACK EXTENSION WITH REVERSE FLY



Execution

1. Lie facedown with your hips resting on the lumbar extension bench and your ankles underneath the support.
2. Hold a light weight plate or dumbbell in each hand.
3. This is a static lower-back exercise. There is no movement of the back once in position. Extend your lower back and keep your spine parallel with the ground.

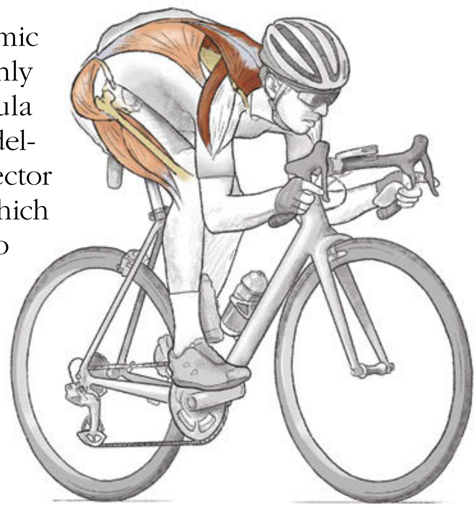
4. With your arms hanging down toward the floor, perform a reverse fly movement. Pull your scapula together as you sweep your arms out and up. You end in a T position with your back still extended.
5. Return your arms to the down-hanging position. Repeat the arm movement without moving your lower back.

Muscles Involved

Primary: Erector spinae (iliocostalis, longissimus, spinalis), rhomboids, trapezius, posterior deltoid

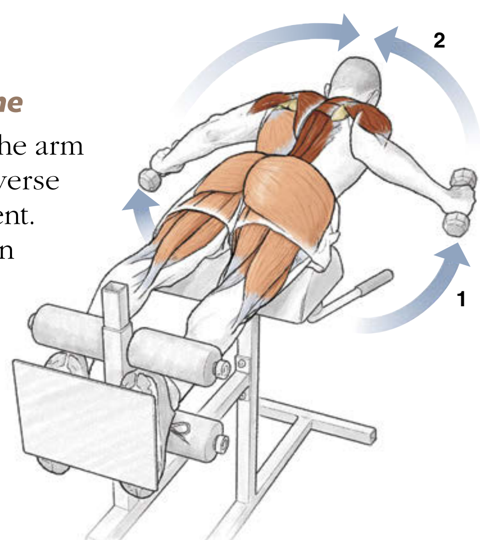
Secondary: Latissimus dorsi, gluteus maximus, hamstrings (semitendinosus, semimembranosus, biceps femoris)

TRIATHLON FOCUS



This is a static lower-back and dynamic upper-back exercise. It will work not only the muscles used to move the scapula (rhomboids, trapezius, and posterior deltoid), but it will also strengthen the erector spinae. This is applicable to riding, in which you spend extended periods in an aero position, with little movement of your spine, which can lead the lower back to spasm. This exercise strengthens your lower back for endurance and not just pure strength. Clearly, endurance is what your lower back needs as you set out on longer and more strenuous rides.

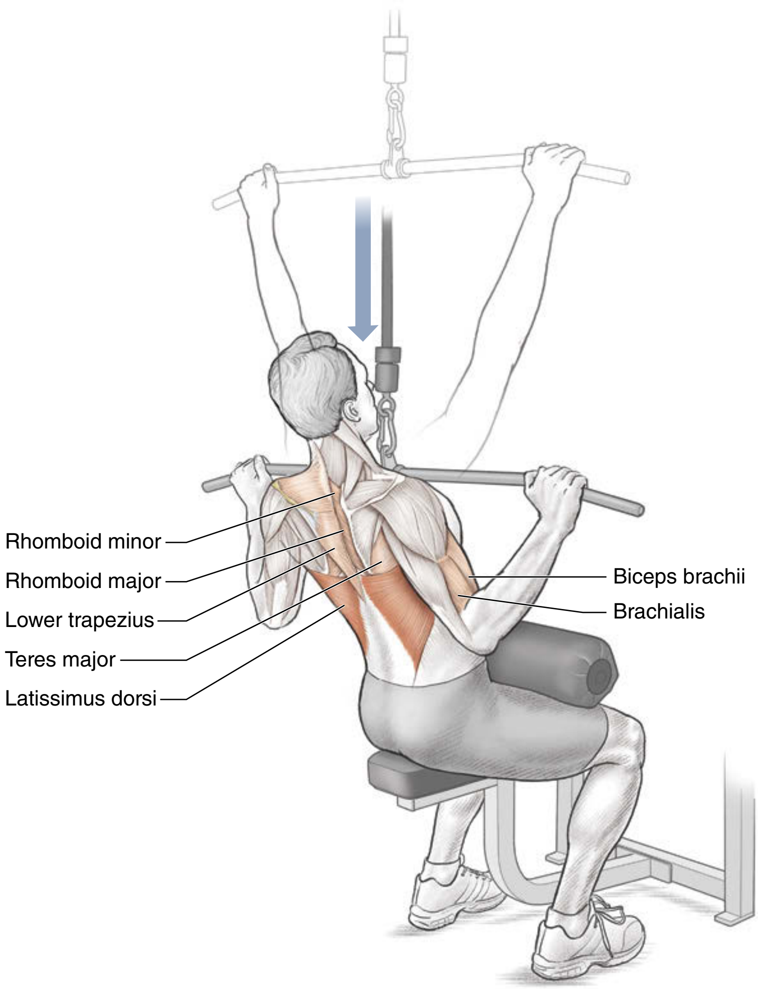
VARIATION



Static Back Extension With A-Frame

Try this same exercise but change up the arm movement. Rather than doing a reverse fly, try to add in an A-frame movement. Perform steps 1 through 3 described in this exercise. But rather than performing a fly movement, complete the A-frame arm movement. The key with this exercise is keeping your lower back extended and improving your endurance with the movement over time.

LAT PULL-DOWN



SAFETY TIP: Old-school bodybuilding books depict this exercise with the bar lowered to the upper back. Although this might be effective for some athletes, it also places undue stress on the shoulders, making this technique ill advised.

Execution

1. Sit down at a lat pull-down machine so your legs are under the support pads, bracing your body. With your arms at full extension, grab the bar with an overhand grip (palms facing out), hands a little wider than shoulder-width apart.
2. Start each repetition by pulling the bar toward your upper chest, in a slow and controlled motion, until the bar is under your chin.
3. Slowly return the bar to starting position, with your arms fully extended. Repeat for the required number of repetitions.

Muscles Involved

Primary: Latissimus dorsi

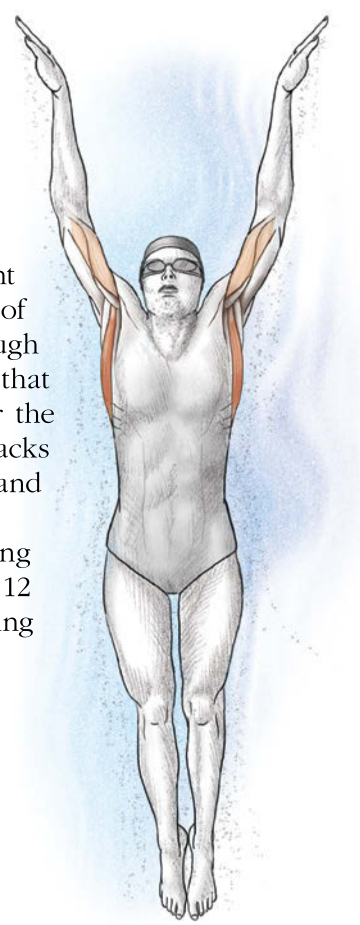
Secondary: Lower trapezius, rhomboid major, rhomboid minor, teres major, biceps brachii, brachialis

TRIATHLON FOCUS

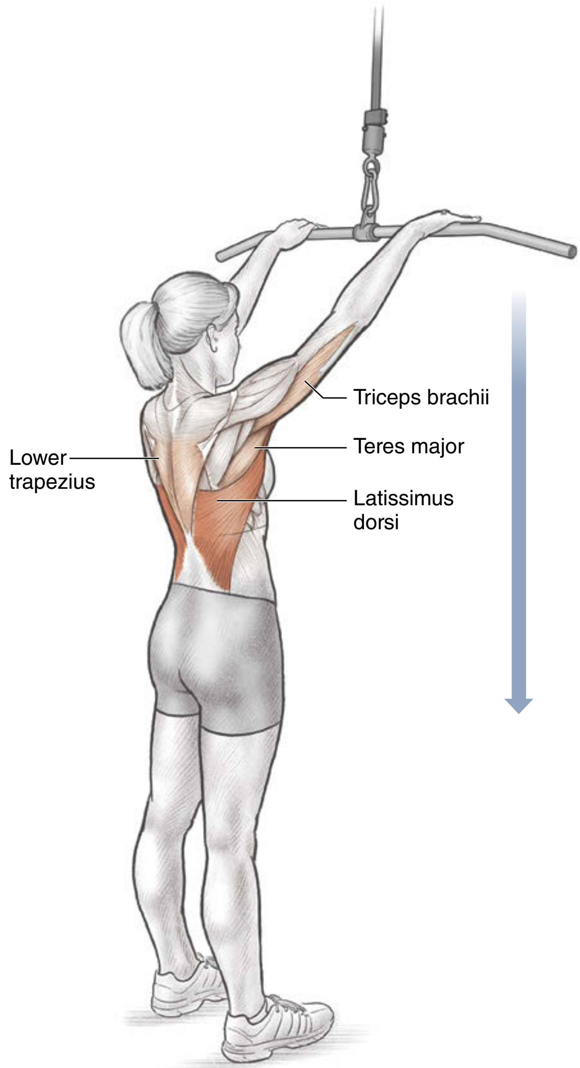
Similar in focus to the pull-up, the lat pull-down has the advantage of offering variable resistance and is a great alternative and starting point for athletes who cannot perform repetitions using their body weight or for very strong athletes who require loads that only a weight stack can offer.

As with the pull-up, this exercise is a multijoint mover that develops most of the pulling muscles of the upper body and benefits the triathlete through increased strength, stability, and endurance in that muscle region. The most direct application is for the swimming leg, but triathletes with strong upper backs will also notice positive results for the cycling and running legs as well.

We recommend that athletes start developing strength with this exercise, performing sets of 10 to 12 repetitions with a challenging weight before moving on to the more difficult pull-up exercise.



STANDING STRAIGHT-ARM PULL-DOWN



Execution

1. Standing with a straight back, face the pulley machine.
2. Bending your arms ever so slightly, place your palms on the top of the bar to start the movement.
3. Maintaining the proper elbow position (high and flexed slightly), press the bar down in an arching movement to your upper thighs, almost touching them. Focus on engaging the latissimus dorsi muscles in the back throughout the movement.
4. Slowly return the bar to the starting position, and repeat for the required number of repetitions.

Muscles Involved

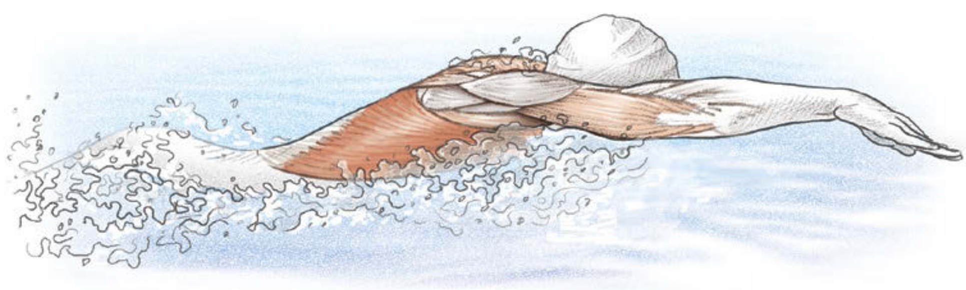
Primary: Latissimus dorsi, pectoralis major

Secondary: Lower trapezius, teres major, triceps brachii

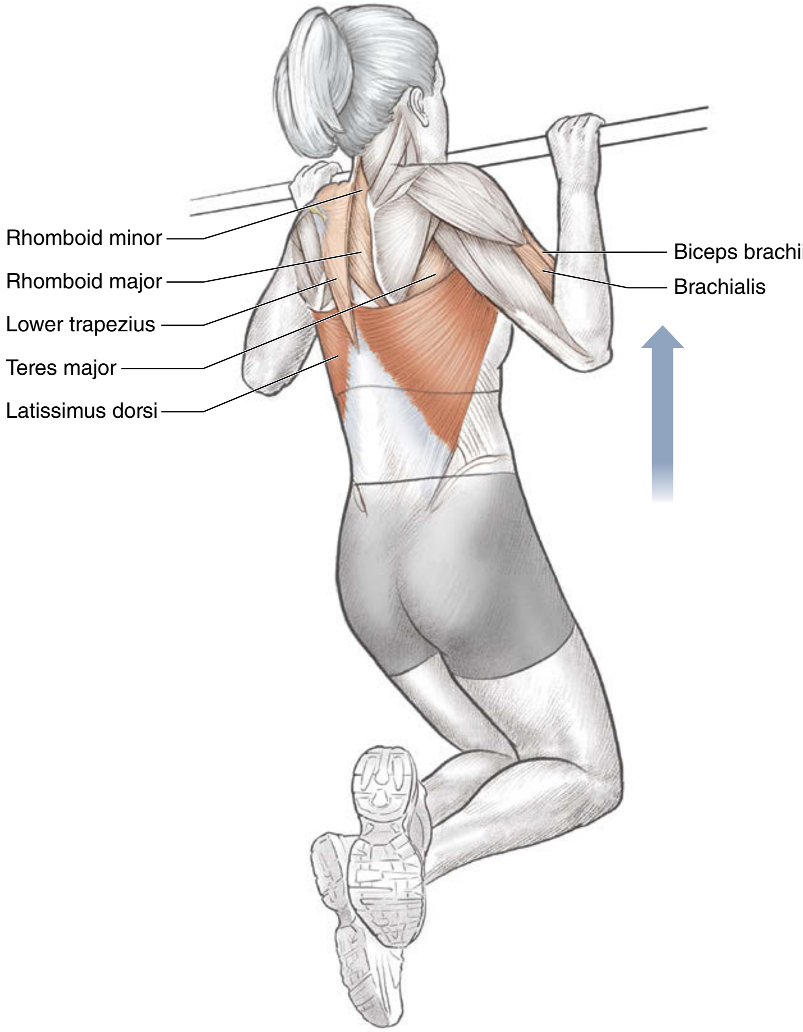
TRIATHLON FOCUS

This exercise primarily benefits the swimming leg of the triathlon and can be incorporated into a triathlete's dryland resistance training routine. The overhead starting position closely mimics the initial pulling phase of the freestyle swim stroke, initiated after the hand enters the water with a catch. It then targets each muscle group as they'll be activated in the actual swim stroke up until the recovery phase.

When performing this exercise, focus on engaging the latissimus dorsi through most of the movement, with a slight shift in emphasis to the triceps brachii near the end of the movement. Keep the body still and avoid any jerking movements, which is cheating and negates the full effect of the exercise.



PULL-UP



SAFETY TIP: Lower yourself slowly and in a controlled manner to reduce the stress on your shoulders.

Execution

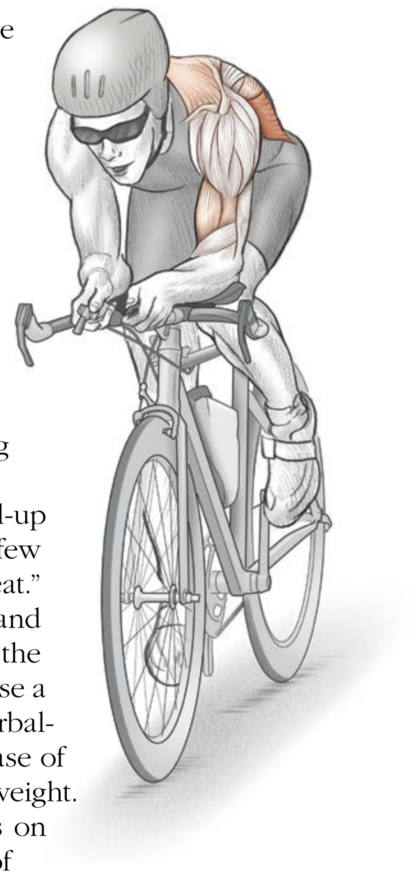
1. Hold the pull-up bar with an overhand grip, palms facing forward.
2. Bend your knees and cross your ankles for lower-body stability and to prevent rocking back and forth.
3. From a fully extended hanging position, pull your body up, bringing your upper chest to the bar.
4. Lower yourself slowly, and repeat for the required number of repetitions.

Muscles Involved

Primary: Latissimus dorsi

Secondary: Lower trapezius, rhomboid major, rhomboid minor, teres major, biceps brachii, brachialis

TRIATHLON FOCUS

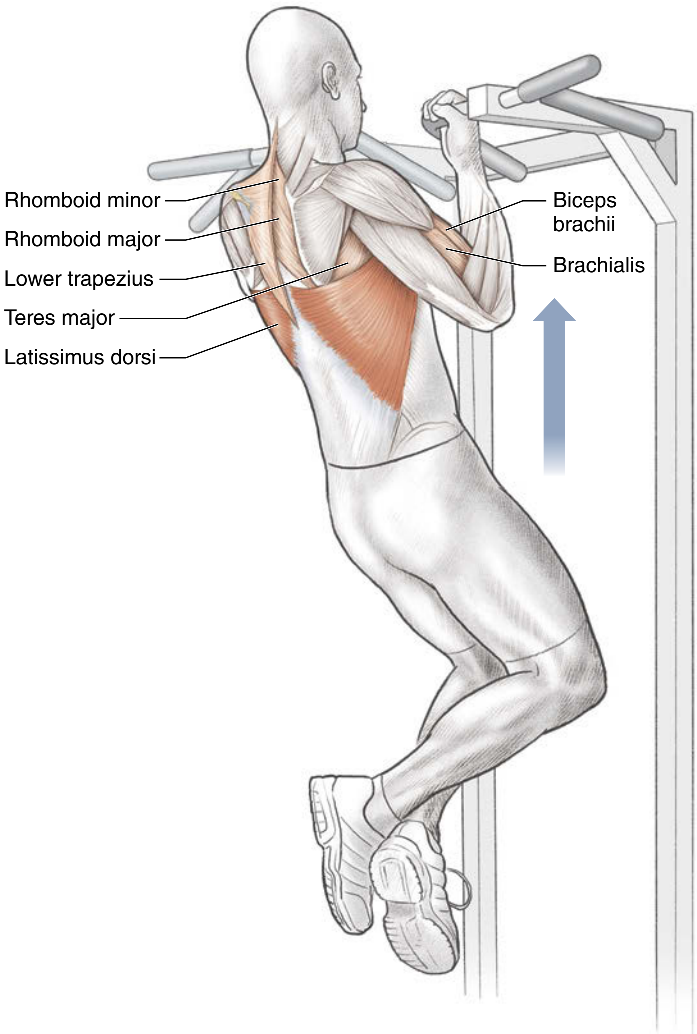


You've probably dreaded performing pull-ups since you were in high-school gym class. However the pull-up is one of the most effective and all-encompassing upper-body exercises you can do to improve your pulling strength and develop your back muscles.

The most direct application for the triathlete is in swimming because this exercise targets muscles used in each phase of the freestyle swim stroke. Cyclists will enjoy the enhanced stability they feel when riding in the aero bars or out of the saddle, while runners will be able to generate additional momentum with the arms when driving up a steep hill.

Consistency is the key to increasing your pull-up count. If at first it's difficult for you to complete a few repetitions, there are many acceptable ways to "cheat." Have someone assist you by holding your feet and helping you up, use bands extending from around the bar to your feet to effectively decrease the weight, use a machine designed to give you assistance by counterbalancing, or even try a light jump for the positive phase of the exercise and lower slowly with your full body weight. Once you can perform sets of 12 to 15 repetitions on your own, consider adding weight in the form of either a dumbbell held between your crossed feet or a weighted vest.

CHIN-UP



SAFETY TIP: Don't lower your body quickly to full extension because this places undue stress on your shoulders. Lower your body slowly and under control. Also, don't allow your legs to swing because this is a form of cheating.

Execution

1. Grab the chin-up bar with your palms facing you. Bend your knees and cross your ankles to stabilize your lower body.
2. From a fully extended position, gently raise your body, pulling your upper chest to the bar with the goal of pulling your chin over the bar for each repetition.
3. Lower to the starting position slowly and under control. Repeat for the required number of repetitions.

Muscles Involved

Primary: Latissimus dorsi

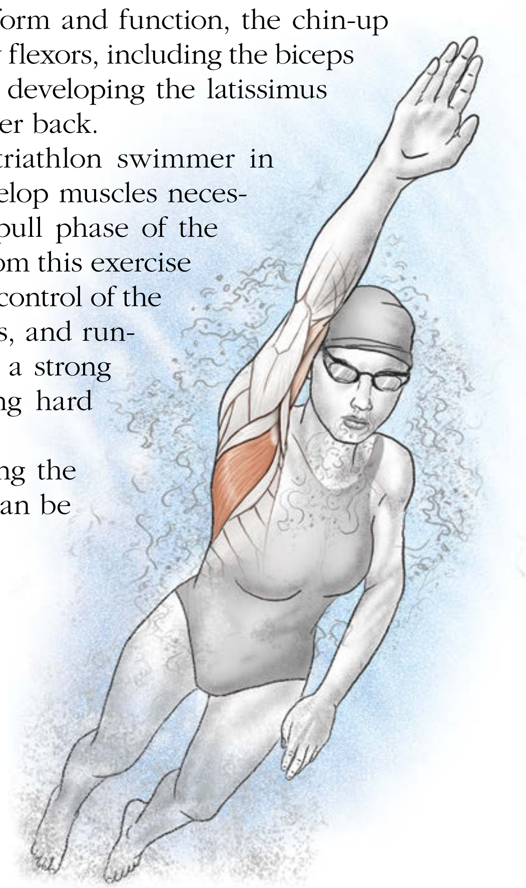
Secondary: Biceps brachii, brachialis, lower trapezius, rhomboid major, rhomboid minor, teres major

TRIATHLON FOCUS

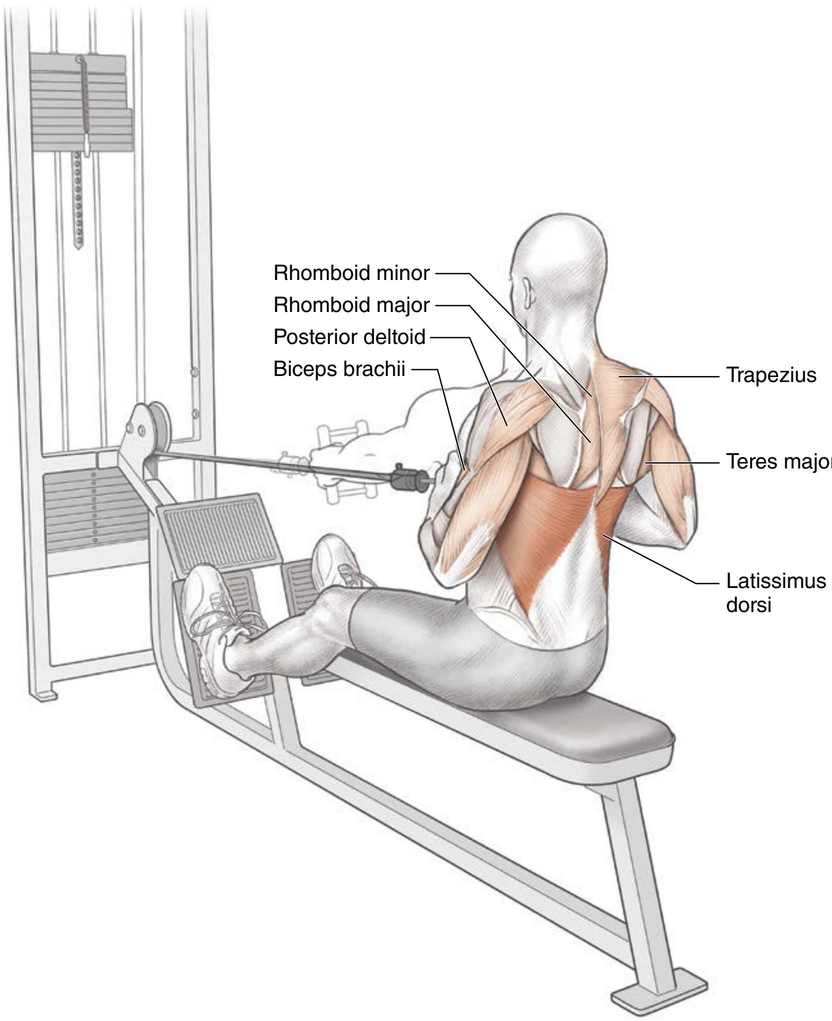
A close cousin to the pull-up in form and function, the chin-up does more to emphasize the elbow flexors, including the biceps brachii and brachialis, while also developing the latissimus dorsi, the large muscle in the upper back.

Specific to the needs of the triathlon swimmer in particular, this exercise helps develop muscles necessary for a strong and consistent pull phase of the freestyle stroke. Cyclists benefit from this exercise by exhibiting greater stability and control of the bike when riding on the aero bars, and runners will like the additional push a strong upper back and arms offer during hard uphill charges.

The same methods of modifying the resistance outlined for a pull-up can be used for the chin-up.



SEATED DOUBLE-ARM MACHINE ROW



Execution

1. Sit on a seated low-row machine with cables and pulleys, brace yourself, and grasp the handles to initiate the exercise movement.
2. Keeping your back straight and perpendicular to the floor, reach forward with the weighted handles to an extended arm position. Notice the stretching of your latissimus dorsi, rhomboids, and posterior deltoid.
3. Pull the handles into your lower chest, engaging the latissimus dorsi while squeezing your shoulder blades together. Remember to keep your spine erect.
4. Extend back to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Latissimus dorsi

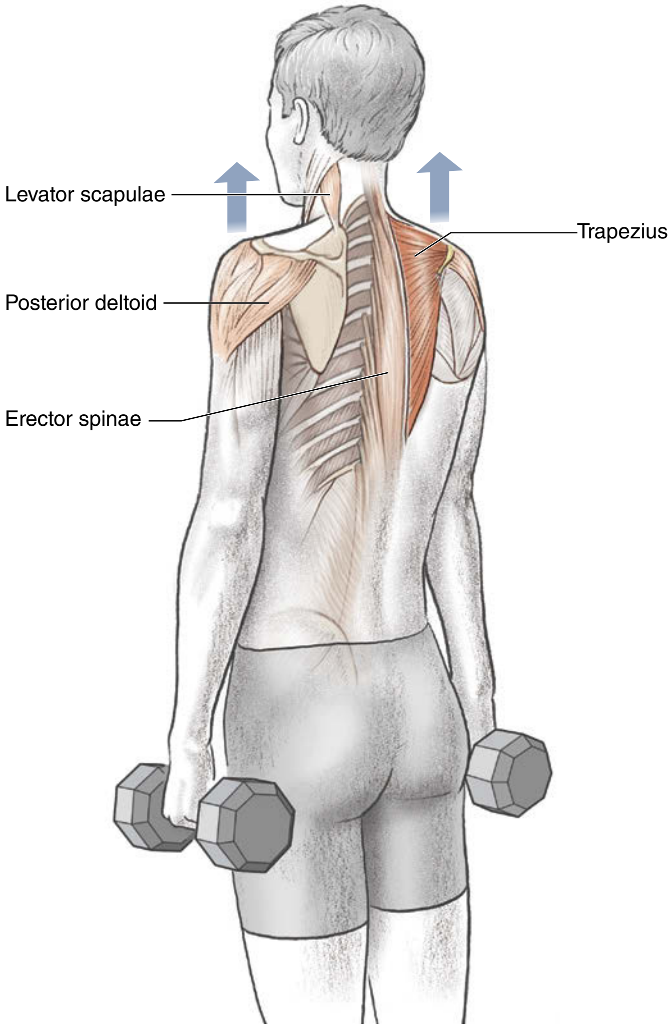
Secondary: Trapezius, rhomboid major, rhomboid minor, teres major, posterior deltoid, biceps brachii

TRIATHLON FOCUS

Again, this upper-back exercise develops key muscle groups used in open-water swimming and is essential for the serious triathlete to perform in training. It does an outstanding job of strengthening the scapular stabilizers, which leads to a strong base of support for the entire shoulder girdle.

Although the movement itself is not specific to freestyle swimming, the work done and the muscles targeted will help generate more force during the pulling phase of the stroke. The cyclist will experience greater control of the bike, especially when her hands are on the cow horns and she is pulling hard during steep and difficult climbing efforts.

DUMBBELL SHRUG



Execution

1. Stand with your spine erect. Hold a dumbbell in each hand.
2. Pull your shoulders up to your ears (shrug them), keeping your arms straight.
3. Return to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Trapezius

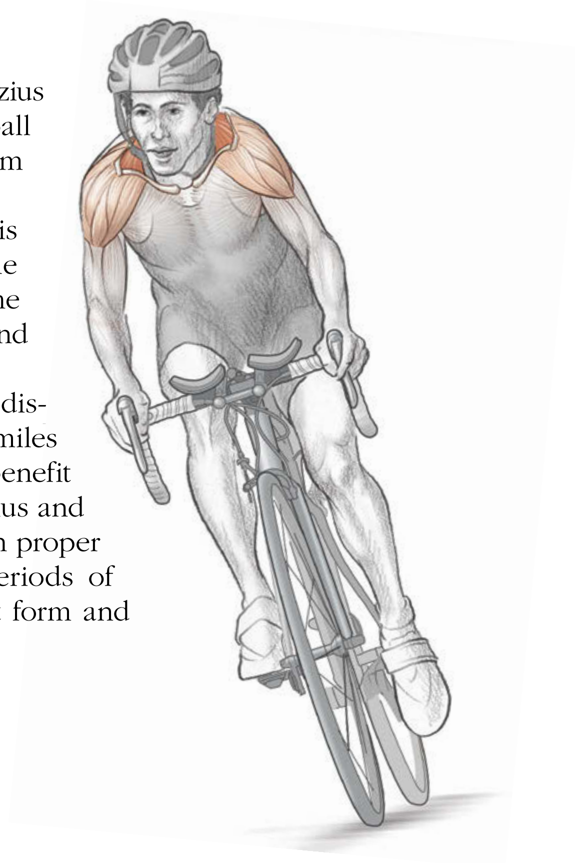
Secondary: Posterior deltoid, levator scapulae, erector spinae (iliocostalis, longissimus, spinalis)

TRIATHLON FOCUS

Although triathletes don't need huge trapezius muscles (or necks) like American football players do, it's still a good idea to perform shrugs in a strength training routine.

In cycling, the muscles targeted in this exercise will be particularly noticeable when the athlete is climbing out of the saddle during moderate to steep climbs and during intense sprint efforts.

The runner, especially the Ironman-distance triathlete who endures miles and miles of running in training and racing, will benefit from shrugs by strengthening the trapezius and surrounding muscle groups that maintain proper upper-arm positioning for extended periods of time, when fatigue can negatively affect form and technique.

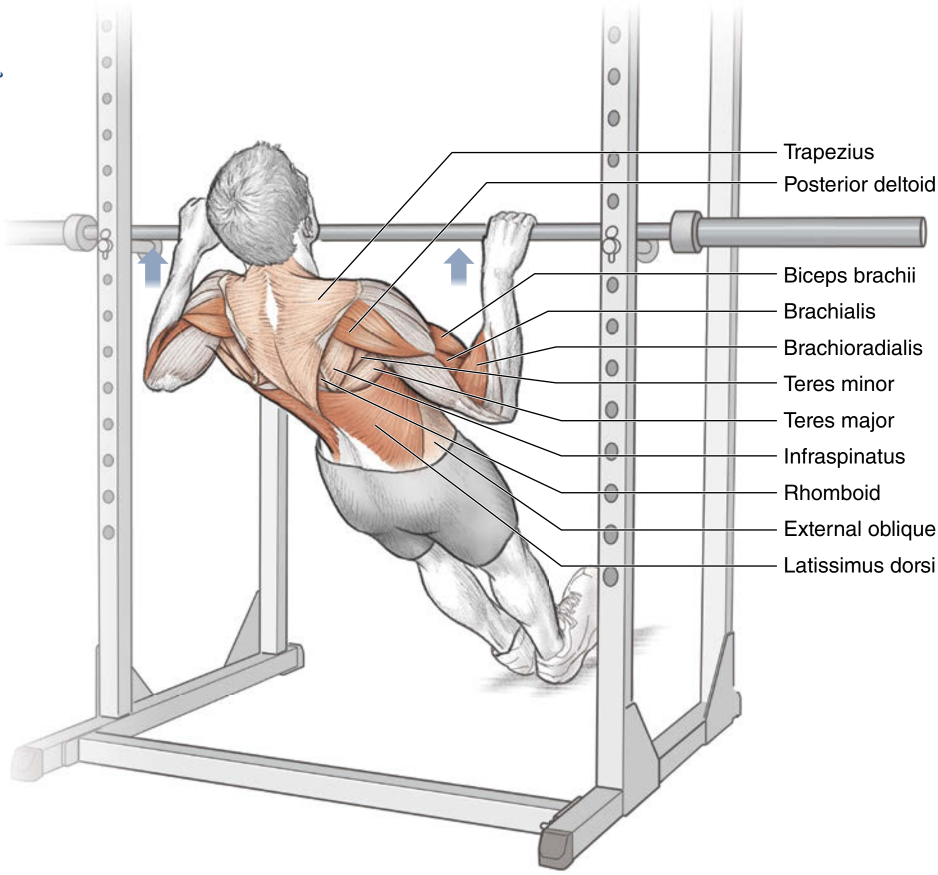


VARIATION

Barbell Shrug

This exercise can also be effectively performed by using a barbell in place of dumbbells. Hold the barbell in an overhand grip.

BARBELL PULL-UP



Execution

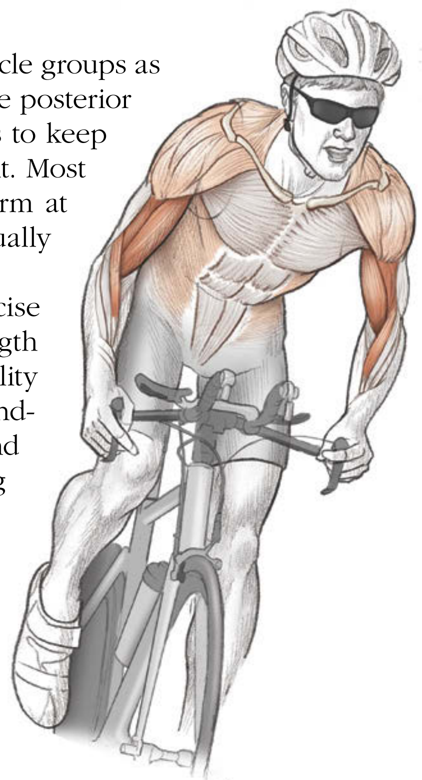
1. Use a Smith machine or other low bar set at approximately waist height.
2. Position your body under the bar. Grasp the bar in an overhand grip, hanging with your body straight and your arms fully extended. Your body should be at an approximately 45-degree angle to the floor.
3. Pull your chest up to the bar, trying to touch the bar near your sternum.
4. Lower your body, and repeat for the required number of repetitions.

Muscles Involved

Primary: Latissimus dorsi, biceps brachii, brachialis, brachioradialis, posterior deltoid

Secondary: Rhomboid major, rhomboid minor, teres major, teres minor, infraspinatus, external oblique, trapezius

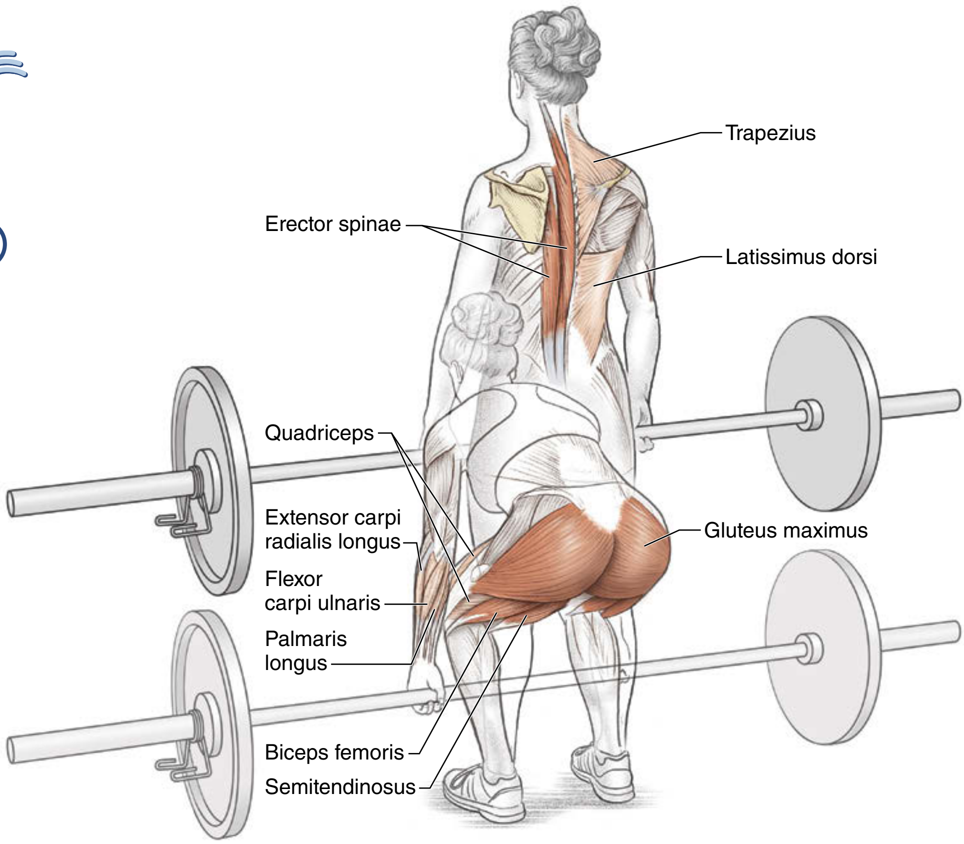
TRIATHLON FOCUS



This exercise targets many of the same muscle groups as the pull-up, with a stronger emphasis on the posterior deltoid. The key for successful execution is to keep the body straight throughout the movement. Most people find this exercise difficult to perform at first. Be patient because results will eventually come.

The triathlete will benefit from this exercise in many ways, including greater back strength for improved swimming and enhanced stability and climbing leverage on the bike when standing. Runners will notice improved posture and less fatigue in the back muscles during long endurance runs.

DEADLIFT



SAFETY TIP: Take care to perform this exercise in the correct manner; keep the back straight while looking up and forward throughout the range of motion.

Execution

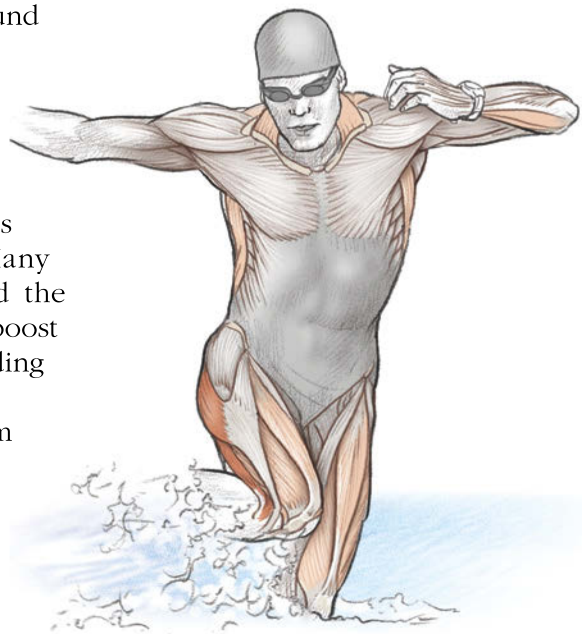
1. Placing your feet about shoulder-width apart, bend at the knees and grasp the barbell with an overhand grip. Be sure the barbell is loaded with the appropriate weight.
2. With your back flat and spine straight, look ahead and keep your chin up.
3. Lift the weight off the floor as you rise to a full standing position, gently allowing the barbell to brush against your shins. Keep your back straight, and focus on activating the strong muscles of your quadriceps, buttocks, hamstrings, and low back.
4. Slowly lower the weight in the same fashion until it settles on the floor. Do not bounce the weight. Repeat for the required number of repetitions.

Muscles Involved

Primary: Erector spinae (iliocostalis, longissimus, spinalis), gluteus maximus, hamstrings (biceps femoris, semitendinosus, semimembranosus)

Secondary: Trapezius, latissimus dorsi, quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), forearms (extensor carpi radialis longus, flexor carpi ulnaris, palmaris longus)

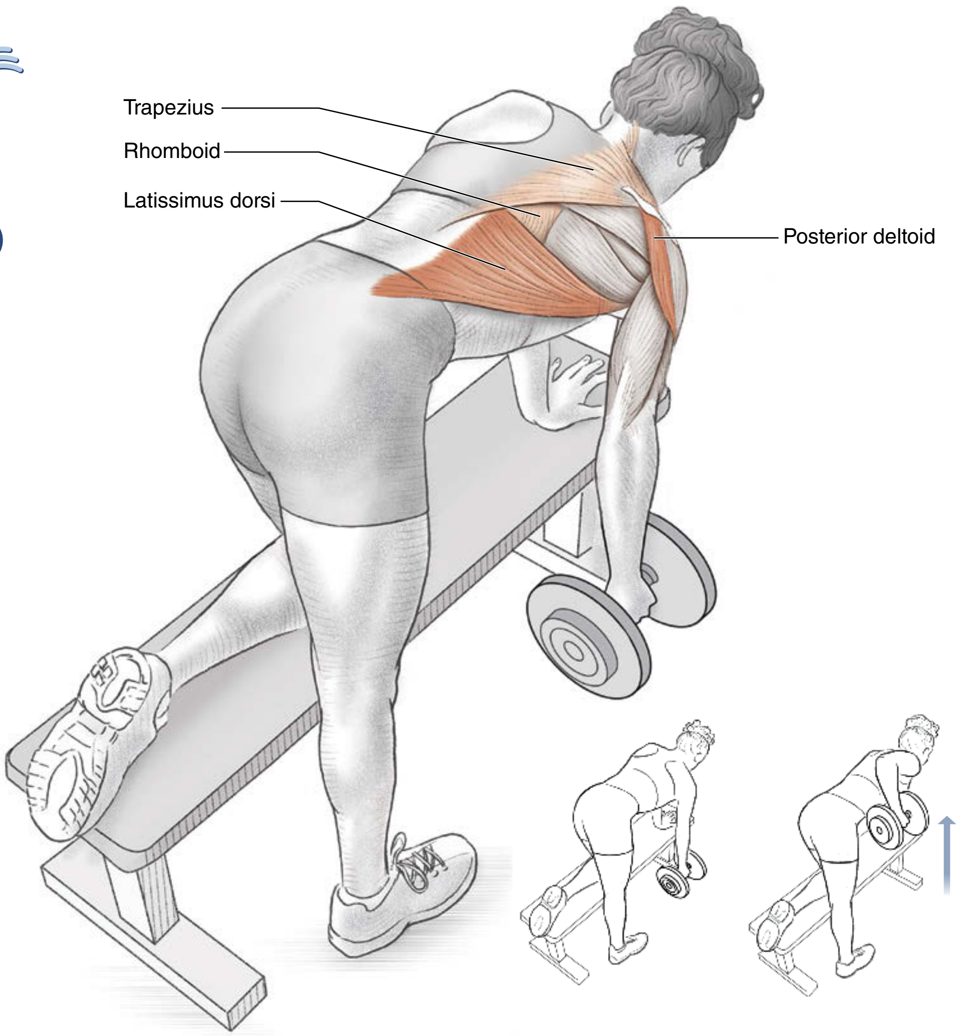
TRIATHLON FOCUS



The deadlift is a great all-around exercise that elicits full-body strength gains because of the many large muscle groups engaged during the movement. In particular, this exercise targets the erector spinae, gluteus maximus, and hamstrings. Many strength coaches also applaud the deadlift movement as a way to boost the production of muscle-building hormones.

Triathletes will benefit from performing the deadlift by developing greater lower-body, core, and back strength and endurance, especially during longer-distance race events. It is not uncommon for long-course triathletes to experience issues with low-back fatigue caused by bending over on the bike and pounding the pavement during long runs. Furthermore, long-distance open-water swimming can cause a tremendous amount of low-back fatigue if the athlete is not properly conditioned. A regular schedule of deadlift training will minimize, if not alleviate, many of these issues.

SINGLE-ARM DUMBBELL ROW



Execution

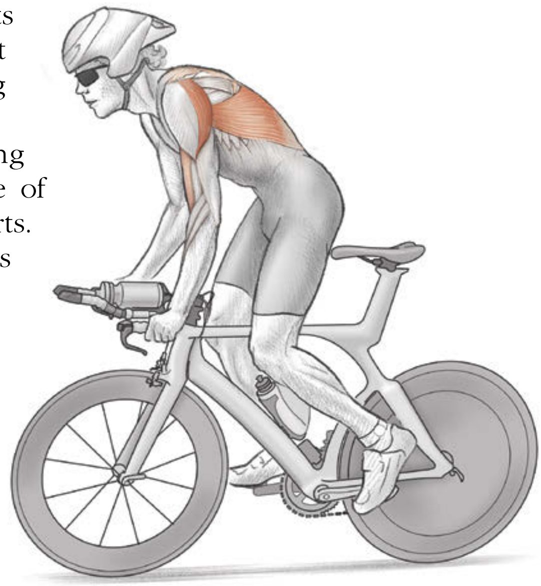
1. Kneel on a bench on one knee. Place your hand on the bench on the same side to support your weight. Bend down to pick up a dumbbell off the floor, and then let the weight hang vertically.
2. Keeping your back flat and your head in a neutral position, use the muscles in your back to pull the dumbbell up until your hand reaches the side of your lower chest.
3. Return the dumbbell to the starting position, and repeat for the required number of repetitions for that arm. Switch arms and repeat.

Muscles Involved

Primary: Posterior deltoid, latissimus dorsi

Secondary: Trapezius, rhomboid major, rhomboid minor, biceps brachii

TRIATHLON FOCUS



The single-arm dumbbell row targets the posterior deltoid, an important muscle to develop for the swimming and cycling legs of triathlon.

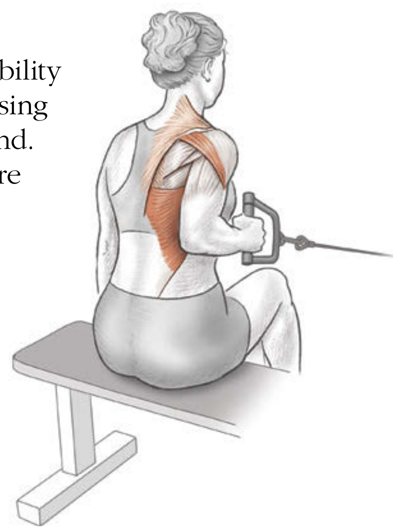
Open-water freestyle swimming requires high arm recovery because of rough waters and crowded wave starts. Having a strong rear deltoid lessens fatigue and improves the athlete's stroke cycles in difficult open-water swimming conditions.

Cyclists require strong rear deltoids primarily when grabbing the base bars for hard climbing and sprinting. The single-arm dumbbell row activates many of the same muscle groups involved when aggressively rocking the bike back and forth during hard, out-of-the-saddle efforts.

VARIATION

Single-Arm Cable or Elastic Band Pull

Sit on a weight bench as shown or on a stability ball. Perform the one-arm rowing motion using a horizontally oriented cable or elastic band. This variation offers the added benefit of core stabilization.



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6

CHEST

No discussion about the upper extremity can be complete without an understanding of how the chest musculature affects the motion and stability of the shoulder. The pectoralis major, pectoralis minor, and serratus anterior as a muscle group make up some of the most visible muscles in the body. From late-night infomercials to bodybuilding magazine covers, the front of the chest has come to represent strength and power.

For the triathlete, size does not matter, and in fact it is often a concern with weight training. As discussed in previous chapters, shoulder motion is accomplished through the intricate coordination of many muscles. Strong and healthy chest muscles form just another link in the chain to help develop efficiency, improve performance, and prevent injuries to the shoulder.

BONY STRUCTURES OF THE CHEST

The bony anatomy of the chest consists of the anterior ribs, sternum, and clavicle. The clavicle is the only bony attachment of the arm and shoulder to the rest of the body. The clavicle is bound to the sternum by the strong sternoclavicular joint. In conjunction with the pectoralis muscle, the clavicle anchors the arm and shoulder to the chest wall. It is through the contraction of the pectoralis muscle and the mechanical strut action of the clavicle that we push objects away from the chest.

The ribs, as expected, protect internal structures such as the lungs and heart. The intercostal muscles that lie between the ribs work with the diaphragm with the assistance of the pectoralis major and serratus anterior muscles to allow us to breathe deeply as needed during exercise.

MUSCLES OF THE CHEST

The pectoralis major (figure 6.1) is a large, fan-shaped muscle that has two points of origin. The clavicular head, or upper portion, arises from the medial clavicle and the upper portion of the sternum, called the manubrium. The sternal head, or lower portion, originates from the sternum and upper ribs. Muscle fibers from both origins then converge and run laterally outward to form a tendon that attaches to the medial, inner portion of the upper humerus.

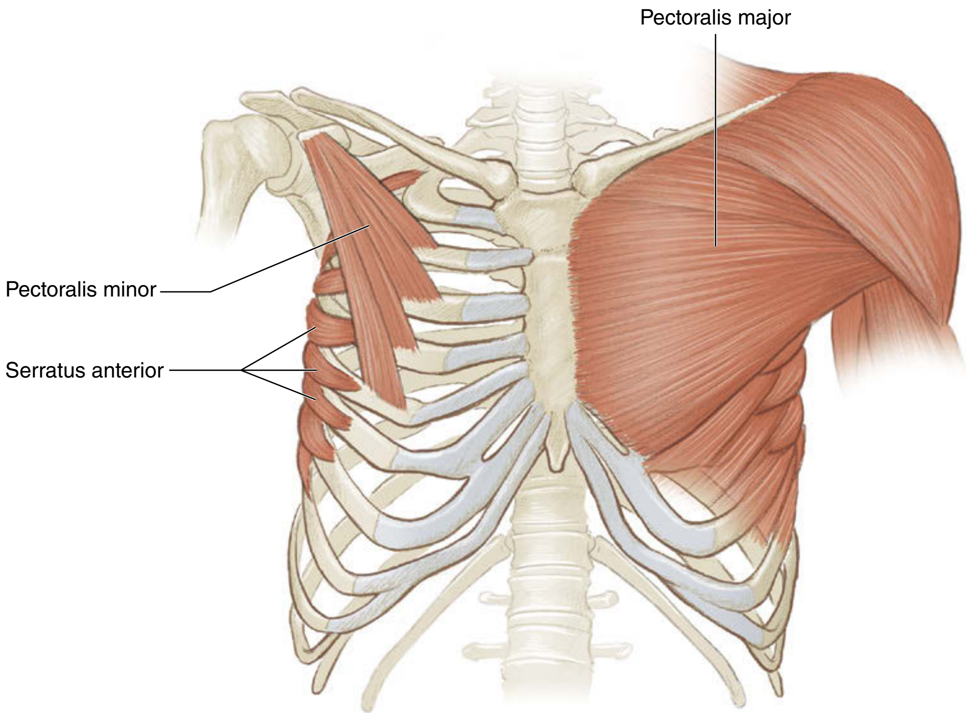


FIGURE 6.1 Muscles of the chest.

Although rare, injuries to this tendon can occur during high-intensity activities such as powerlifting and American football. Unfortunately, many of these injuries require surgical intervention to restore anatomy and preserve function. The main actions of the pectoralis major are flexion, adduction, and internal rotation of the arm and shoulder. In swimming, the pectoralis major, with the help of the latissimus dorsi, helps initiate the pull. During cycling in the aerobars or on the hoods, the pectoralis major helps support the upper body, and in running it assists in fluid arm motion.

The pectoralis minor, which is a smaller muscle, lies beneath the pectoralis major. It takes its origin from the anterior upper ribs and inserts into the medial border of the scapula and a bony projection from the scapula called the coracoid process. Its function is to help control the scapula, stabilizing it against the thoracic wall during arm elevation.

The serratus anterior, known as the boxer's muscle, is a deep muscle group that originates from the upper ribs on each side of the chest and inserts along the entire length of the medial scapula. Its function, stabilization of the scapula, is similar to that of the pectoralis minor. It helps pull the scapula forward during the recovery and initial catch phases of swimming. During breathing, the serratus anterior also assists in chest expansion.

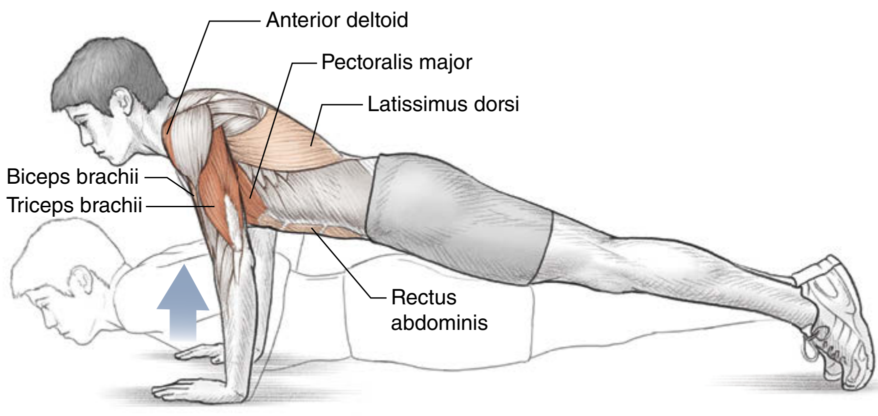
EXERCISES FOR THE CHEST

Common strength training exercises that many athletes learn early in their careers, including the bench press, military press, and dip, preferentially strengthen the front of the shoulder and chest. If these exercises are done exclusively, this can create a muscle imbalance that causes the shoulders to roll forward, and subsequently it may cause stiffness in the front of the shoulders. In swimming, this contracted position may cause the rotator cuff to overwork, leading to a spectrum of injuries, including shoulder impingement. Symptoms commonly include shoulder pain and limited motion. In cycling, weak chest and upper-extremity muscles plus a rounded shoulder position put the neck and upper back at risk for a soft-tissue injury, called a strain. Symptoms of this type of strain may manifest as difficulty staying in the aerobars and even difficulty keeping the head up when riding for extended periods. In running, a rounded shoulder position can cause a constriction of the chest wall, limiting chest expansion and proper breathing, and an abnormal arm motion, such as swinging across the body, which can decrease running efficiency.

The following exercises, which include the simple (but challenging) push-up and dip, need to be balanced with exercises that target scapular rotators, fine-tune coordinators, and the power muscles of the back. Increased emphasis on the less sexy, showy muscles, including those of the back and rotator cuff, will pay large dividends in injury prevention. A simple ratio of two-to-one back-to-chest strength training will help keep you healthy.

For the triathlete, the power-to-weight ratio is a key factor in performance, especially in cycling and running, since gravity and wind resistance play a key role in affecting speed. Therefore, building muscular strength and endurance without packing on additional weight is a goal. For most of the exercises in this chapter, perform two or three sets of 10 to 15 repetitions with strict form. Select weights that enable you to finish the required number of repetitions but with considerable effort for the last few repetitions. As you become more experienced in strength training, you may choose to perform one set to exhaustion, a point at which another repetition would be nearly impossible without assistance from a spotter or compromises to form and safety. This is an advanced training technique that should be used only by experienced athletes during certain phases of their annual training cycle in order to prevent overtraining and reduce the risk of injury.

PUSH-UP



Execution

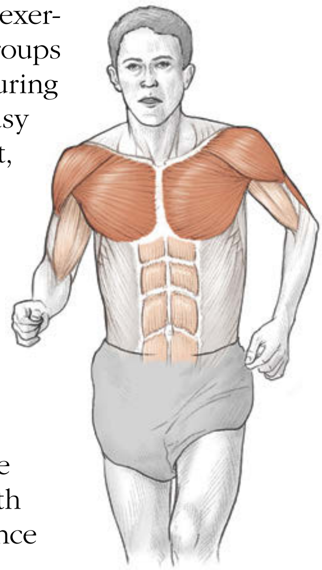
1. Start in a prone position, with hands slightly wider than shoulder width and fingers pointed forward.
2. With your core engaged, lower your torso until it lightly touches the ground. Maintain a flat back and a neutral head position.
3. With an explosive yet controlled motion, press up to the starting position, keeping elbows slightly bent upon completion. Repeat for the required number of repetitions.

Muscles Involved

Primary: Pectoralis major, triceps brachii, anterior deltoid

Secondary: Biceps brachii, latissimus dorsi, rectus abdominis

TRIATHLON FOCUS



One of the most effective and popular upper-body exercises available, the push-up targets key muscle groups in the torso and upper arms that are engaged during swimming, cycling, and running. Because it is easy to do and doesn't require any additional equipment, the basic push-up is convenient and can be performed practically anywhere. The downside is that unlike exercises using weights, it's hard (but not impossible) to manipulate the resistance of a push-up, so for some it's too easy and for others it's too challenging.

Swimmers will benefit by developing stronger chest muscles, especially the pectoralis major and the triceps brachii muscles that are essential to the execution of the freestyle stroke. Enhanced strength in these muscle groups can result in greater endurance and power to pull the body through the water.

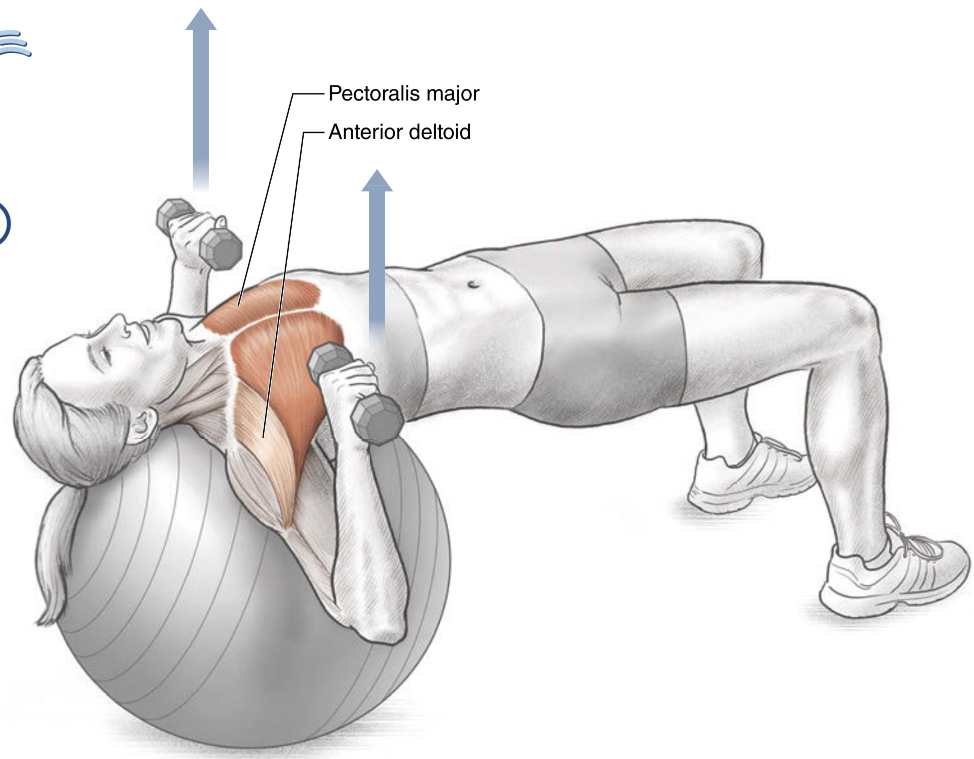
Pure cyclists and runners, with a few exceptions, are notoriously weak in the upper body. However, triathletes tend to be stronger because of the swim leg, and the strength developed by performing push-ups can help the triathlete to stabilize herself better on the bike when climbing hills out of the saddle. The runner will benefit by experiencing less upper-body fatigue during hard uphill run intervals and will be able to drive the arms with greater force in case he needs to sprint to the finish line.

VARIATION

Push-Up From the Knees

Many triathletes new to upper-body strength training, and to push-ups in particular, will need to modify the push-up by starting from their knees instead of their toes. This makes the exercise easier to perform and enables the weaker athlete to focus on form while developing strength. Once you can perform a few sets of 12 to 15 repetitions from the knees, it's time to begin incorporating reps from the toes.

DUMBBELL STABILITY BALL CHEST PRESS



Execution

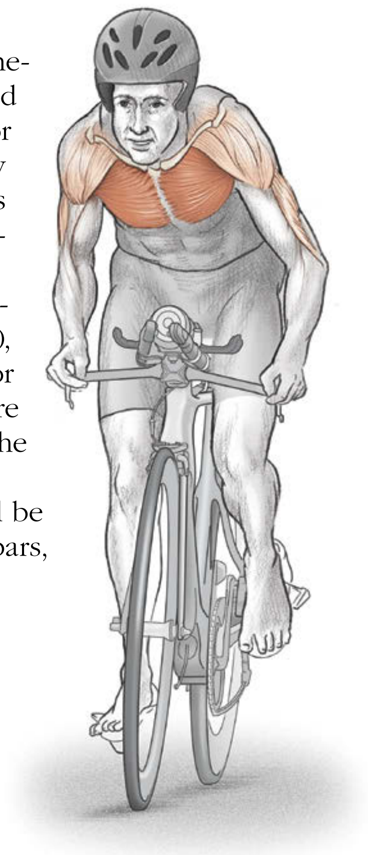
1. Sitting on a stability ball with a dumbbell of appropriate weight in each hand, slide your back down onto the ball until your upper back is firmly in place and you feel stable.
2. With your legs slightly wider than shoulder width for increased stability, your hips straight in line with your shoulders and head, and your arms extended, slowly lower the dumbbells to chest level.
3. Press up, returning to the starting position while being careful to maintain balance on the unstable surface of the ball.

Muscles Involved

Primary: Pectoralis major

Secondary: Anterior deltoid, triceps brachii

TRIATHLON FOCUS

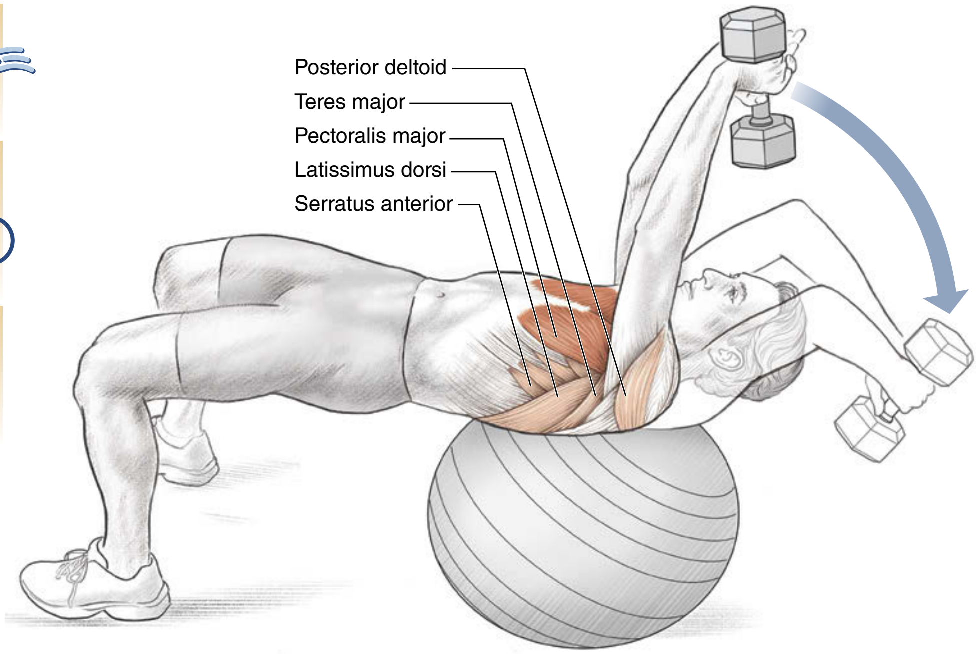


This movement offers many of the same benefits as other pressing exercises, engaging and strengthening the muscles of the chest, anterior shoulder, and triceps. With the use of a stability ball, this variation offers the additional benefits of developing a sense of balance and strengthening the core.

Because this exercise requires weight stabilization and balance with each arm (user dependent), it benefits the weaker, nondominant side. For open-water swimming, this can lead to a more balanced and symmetrical pulling phase of the freestyle swim stroke.

For the cyclist, this individual arm focus will be apparent when pulling up hard on the base bars, or cow horns, when climbing a steep hill.

DUMBBELL PULLOVER



Execution

1. Using a stability ball to activate core muscle groups, hold a dumbbell with both hands.
2. Slide down so that your upper back is supported by the ball, with your back flat and your feet about shoulder-width apart.
3. Lower the dumbbell with your elbows slightly bent until it's even with your head. Focus on activating the muscles in your chest and upper back as you return the dumbbell to the starting position.

Muscles Involved

Primary: Pectoralis major

Secondary: Latissimus dorsi, teres major, pectoralis minor, posterior deltoid, serratus anterior, rhomboid major, rhomboid minor

TRIATHLON FOCUS

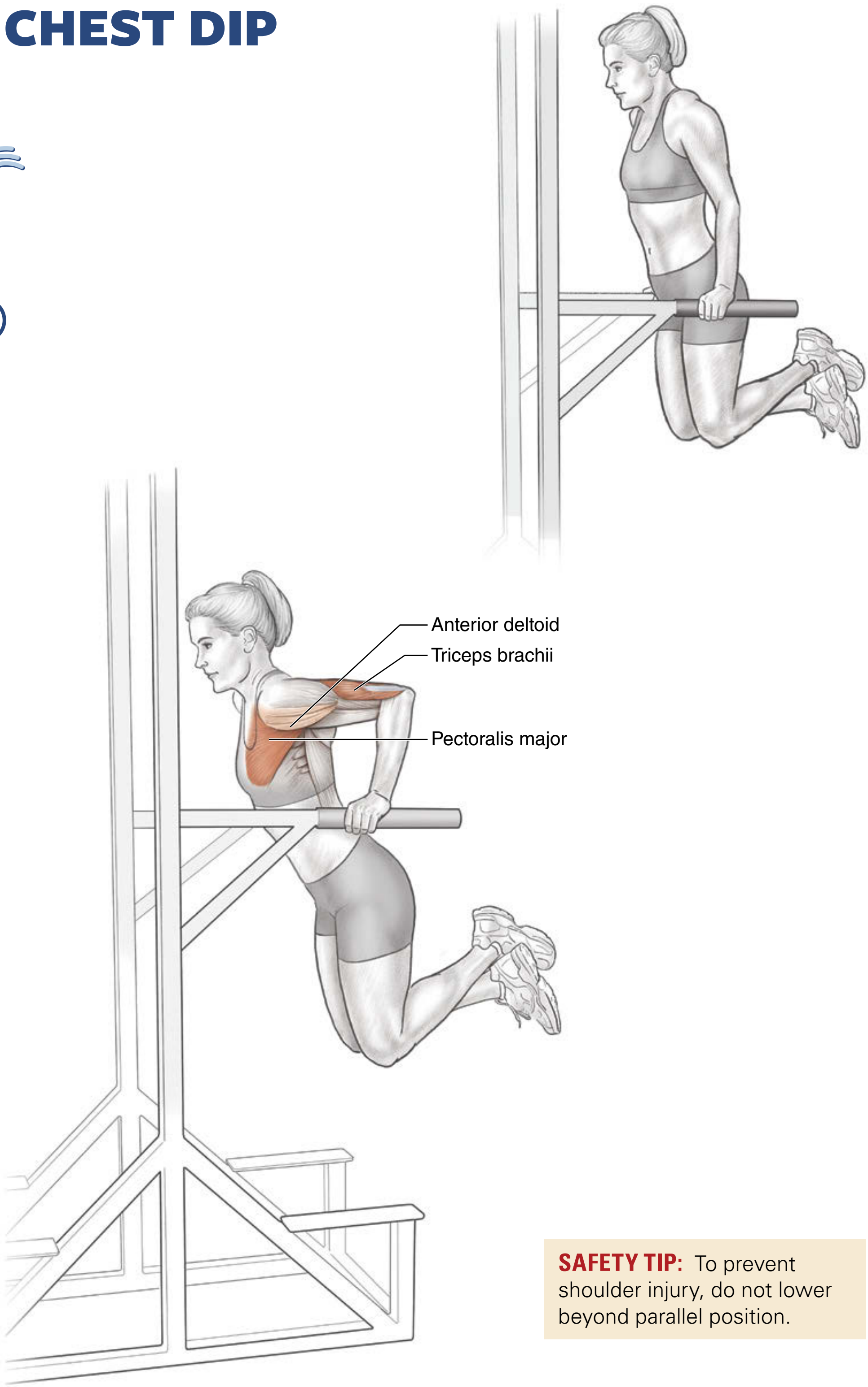
This basic exercise offers a variety of benefits for the triathlete. For swimming, it targets muscle groups used in the pulling phase of the stroke. For cycling, it develops the muscles used when stretched out in the aero position when cycling with aerobars. The runner will benefit from being able to generate more propulsive force with the upper body when pumping her arms to tackle steep climbs or when sprinting to the finish line. For the runner, this enhanced upper-body balance and improved ability to drive with the arms will help during running surges late in a race or when charging uphill.

VARIATION

Bench Dumbbell Pullover

When first attempting the pullover movement, some athletes should use a stable surface such as a bench instead of the stability ball. Essentially, the exercise is performed in the same manner as with a stability ball but without the need to engage core muscle groups for enhanced stability, enabling the athlete to focus on the target muscle groups.

CHEST DIP



SAFETY TIP: To prevent shoulder injury, do not lower beyond parallel position.

Execution

1. Using a dip bar or parallel bars, start with your arms supporting your weight, with elbows slightly bent.
2. Lower your body slowly until your upper arms are parallel to the floor, while leaning your torso slightly forward to better activate the chest muscles.
3. Press up to the starting position, keeping the arms slightly bent at completion. Repeat for the required number of reps.

Muscles Involved

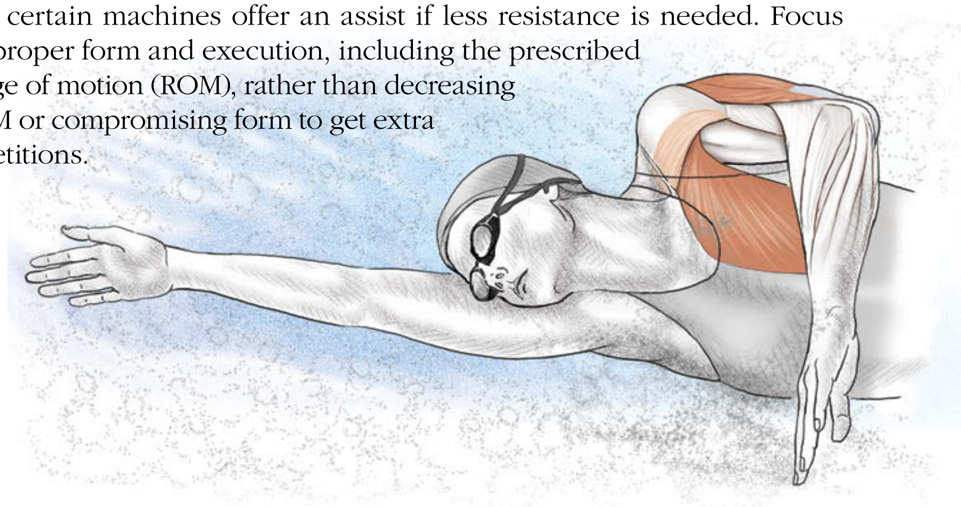
Primary: Pectoralis major, triceps brachii

Secondary: Anterior deltoid

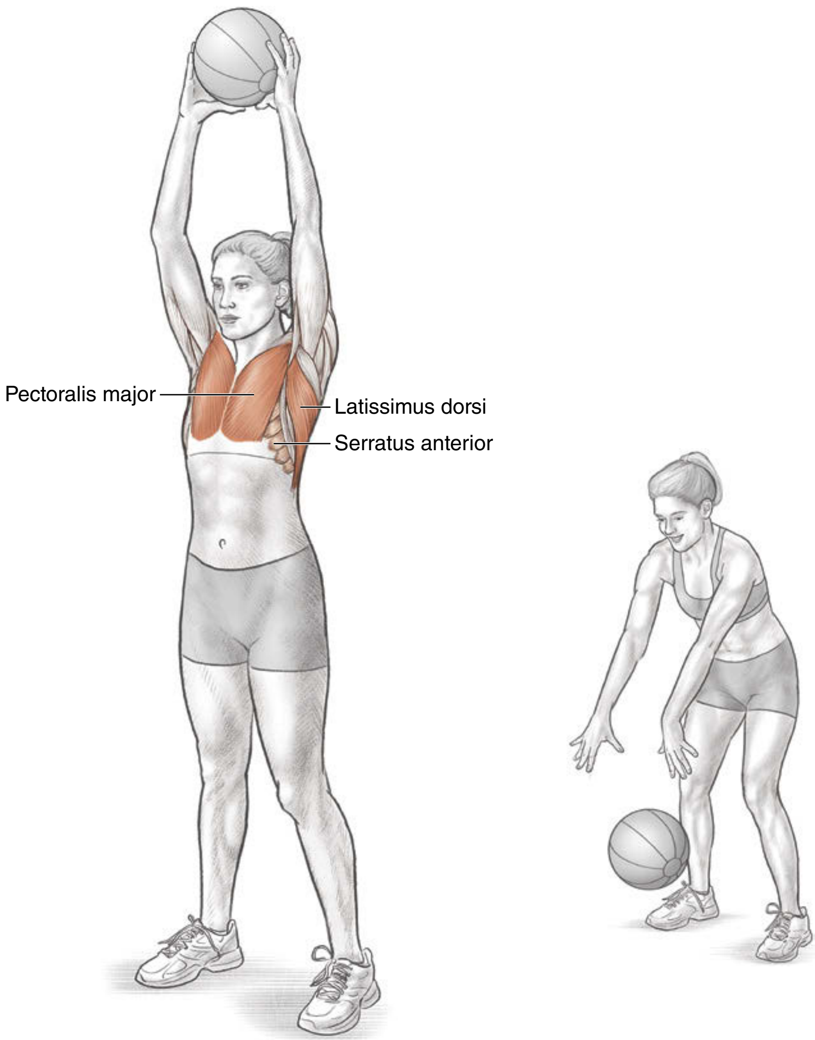
TRIATHLON FOCUS

The dip is a basic movement that offers a lot of bang for the buck when it comes to increasing upper-body strength and endurance. For the triathlete during the swim leg, the dip targets muscles that are critical for successful freestyle swimming, including the pectoralis major and the triceps brachii. For cycling, the dip will enable the triathlete to ride longer and more comfortably in the aerobars, and it will provide the athlete with an enhanced ability to climb in the standing position over short, steep hills.

As with the push-up (or any other body-weight exercise), manipulating the resistance can be a challenge. Extra weight can be added with a vest or belt, and certain machines offer an assist if less resistance is needed. Focus on proper form and execution, including the prescribed range of motion (ROM), rather than decreasing ROM or compromising form to get extra repetitions.



STANDING DOUBLE-ARM MEDICINE BALL THROW-DOWN



Execution

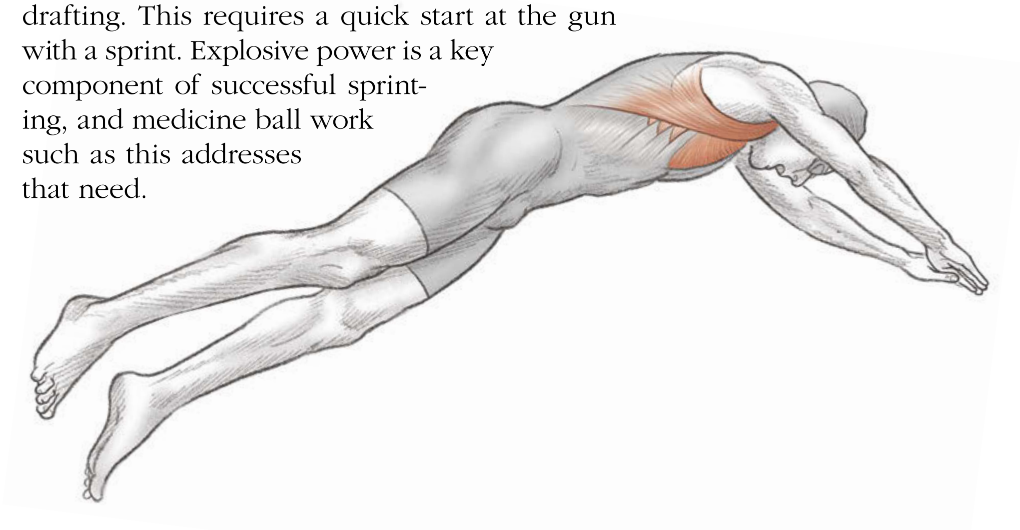
1. Choose a medicine ball of an appropriate weight. While standing on concrete or another hard surface, hold the ball with arms almost straight over your head.
2. With an explosive effort, throw the ball down to the ground roughly 12 to 15 inches (30 to 38 cm) in front of your toes.
3. Catch the ball as it bounces back up. Return to the starting position with the ball over your head, and repeat the movement for the required number of repetitions.

Muscles Involved

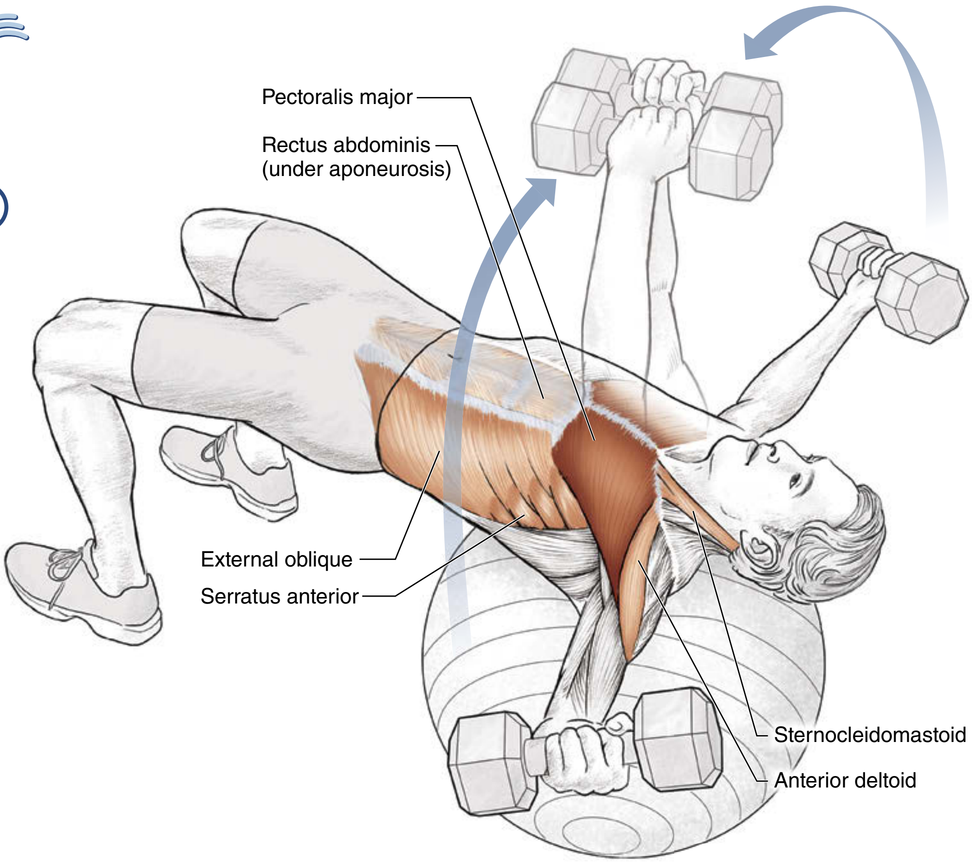
Primary: Pectoralis major, latissimus dorsi
Secondary: Serratus anterior

TRIATHLON FOCUS

This is an ideal exercise for the triathlete focused on freestyle swimming. Successful open-water swimming requires that the athlete establish good position with other swimmers of similar ability so as to conserve energy by drafting. This requires a quick start at the gun with a sprint. Explosive power is a key component of successful sprinting, and medicine ball work such as this addresses that need.



STABILITY BALL DUMBBELL FLY



Execution

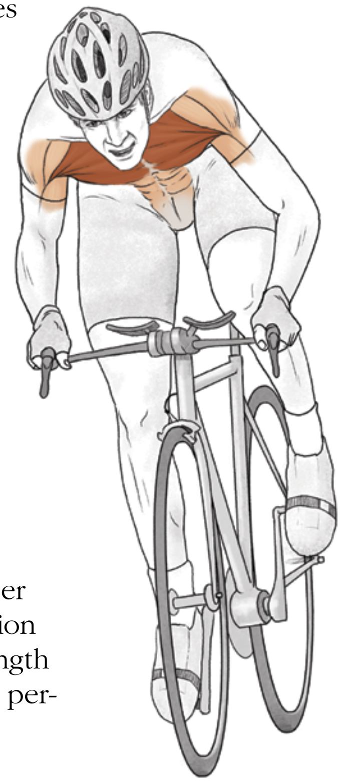
1. With a dumbbell of the appropriate weight in each hand, sit on a stability ball and slide down on your back until your upper back is firmly balanced, with your feet flat on the floor and shoulder-width apart. Your back and neck should be straight.
2. Start with both dumbbells extended over your head, elbows slightly bent, and palms facing each other. Lower the dumbbells out to your sides. Focus on allowing the chest and anterior deltoid muscles to do the work.
3. As if hugging a large tree trunk, return to the starting position with a slow and controlled motion. Repeat for the required number of reps.

Muscles Involved

Primary: Pectoralis major

Secondary: Anterior deltoid, rectus abdominis, sternocleidomastoid, external oblique, internal oblique, serratus anterior

TRIATHLON FOCUS



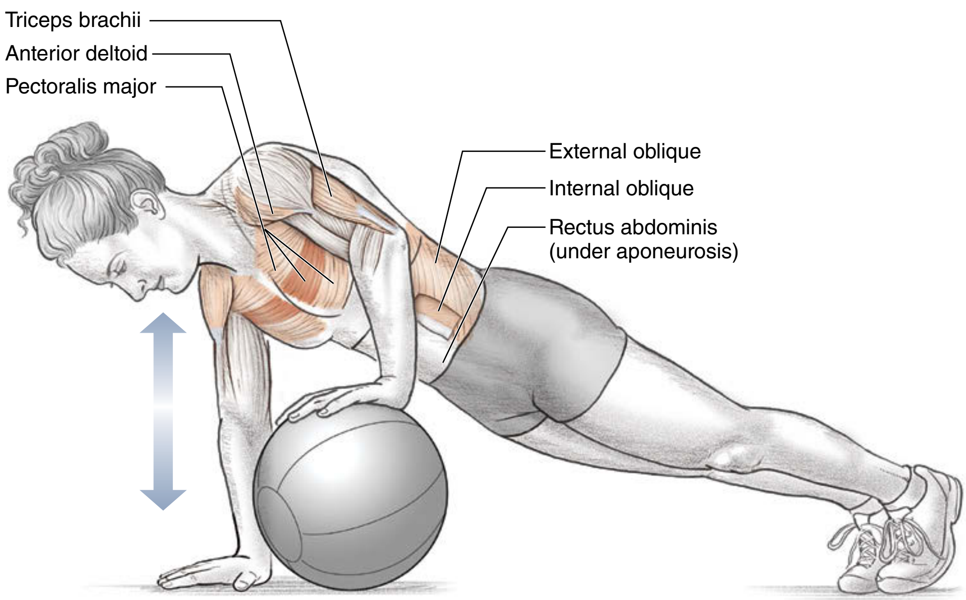
Triathletes need to strengthen key upper-body muscles for stronger open-water swimming and greater stability on the bike when time trialing, especially over challenging hilly courses. The stability ball dumbbell fly offers a fantastic pectoralis major movement as well as the added benefit of increasing core strength and balance. For swimmers, this translates to a stronger and more explosive pull phase in the freestyle stroke. For cyclists, it enhances the ability to whip the bike back and forth in the case of an explosive climb or to sprint in order to break away from a pack or drop a competitor who might be intentionally drafting off your wheel.

VARIATION

Incline Dumbbell Fly

Targeting a little more of the anterior deltoid and upper pectoral, the incline dumbbell fly is a slight variation recommended primarily for the more advanced strength training triathlete. The incline dumbbell fly may be performed on an incline bench or a stability ball.

MEDICINE BALL PUSH-UP



Execution

1. With one hand on a medicine ball and the other on the floor, start in standard push-up position. Keep your body straight and your head in neutral position.
2. Lower your body until your chest almost touches the floor. Keep your body straight and your back flat.
3. Return to the starting position. The elbow of the hand on the medicine ball should be slightly bent; the other arm straightens almost completely but does not lock at the elbow. Switch hands so the other hand is on the medicine ball, and perform this same sequence with the opposite arm. Instead of alternating hands, you may choose to perform a complete set with one arm then switch to the other.

Muscles Involved

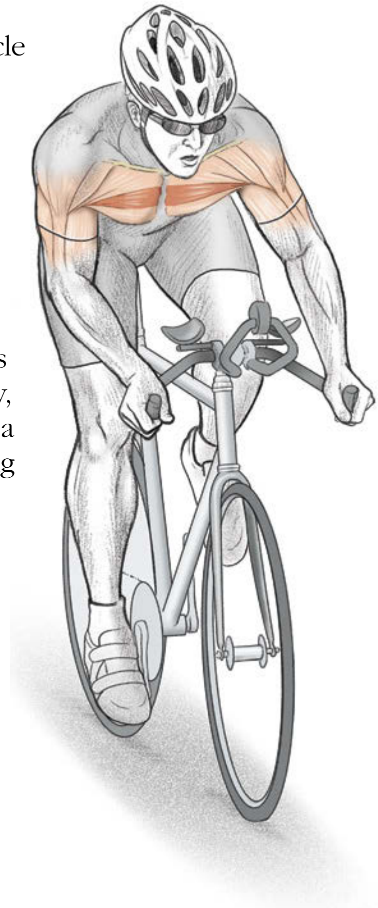
Primary: Middle pectoralis major

Secondary: Triceps brachii, anterior deltoid, rectus abdominis, internal oblique, external oblique, serratus anterior

TRIATHLON FOCUS

This variation of the push-up engages core muscle groups and targets the upper body. This pushes muscles in a slightly different manner, which helps with balanced muscle development and adds variety to the resistance training program.

Like the traditional push-up, this exercise strengthens the freestyle swim stroke by enhancing the strength and endurance of the pectoralis major, anterior deltoid, and triceps brachii. For cycling and time trialing especially, stronger chest muscles and triceps provide a stronger foundation on the bike for generating more power when riding in the aero position.



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7

SHOULDERS

The complex anatomy of the shoulder makes it one of the largest and most functional joints in the body. The shoulder, which is made up of three bones (the humerus, scapula, and clavicle) along with numerous muscles, tendons, and ligaments, positions the arm in space, creating structural support and generating power for all athletic activities.

Eighteen separate muscles either arise from or insert into the scapula, or shoulder blade. The muscle coordination involved in arm elevation and activities such as swimming, biking, running, and training is as involved as any complex machine. The muscles create shoulder motion that takes place at two distinct joints. The glenohumeral joint is formed between the top of the arm bone and the scapula, and the scapulothoracic joint is formed by the scapula as it sits on the back of the chest, or thoracic area. If one segment breaks down, the rest of the system has to compensate for the injured part, which could cause pain and dysfunction. The repetitive nature of triathlon sports, most notably swimming, makes the shoulder a prime area for potential overuse and injury. A complete understanding of the interactions between the anatomical structures and the benefits of strength training can help athletes to train safely and prevent injuries.

BONY ANATOMY OF THE SHOULDER

The shoulder is made up of three bones: the scapula, clavicle, and humerus (figure 7.1). The humerus, as discussed in chapter 8, is a long bone with an upper end shaped like a ball that makes an articulation, or joint, with the shallow socket of the scapula (the glenoid). It is like a golf ball sitting on a tee. This configuration allows for tremendous mobility of the shoulder.

The scapula, or shoulder blade, which sits on the posterior chest wall, has a triangular shape. The acromion is a bony projection from the scapula that forms its top border. It can easily be felt as the bony prominence on top of the shoulder. It functions as a bony arch to protect the rotator cuff muscles and tendons that run below it.

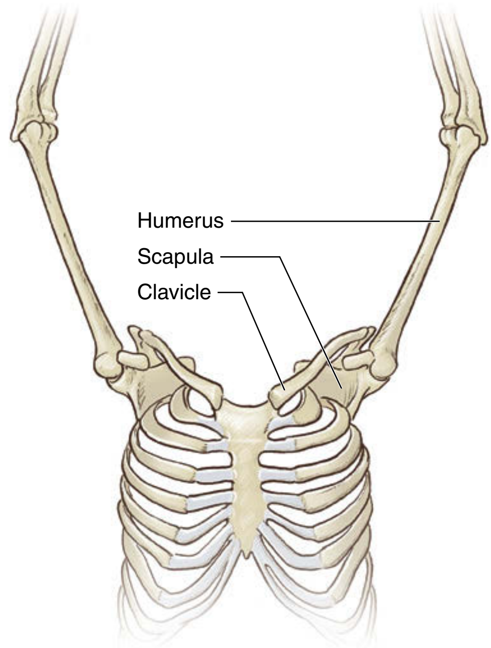


FIGURE 7.1 Bones of the shoulder: scapula, clavicle, and humerus.

The clavicle, or collarbone, is a long bone that lies horizontally across the front of the chest. Via the acromioclavicular joint, the clavicle attaches the scapula to the sternum, or breastbone. The clavicle functions as the sole bony attachment and mechanical strut from which the shoulder and arm are suspended. It helps keep the arm supported away from the body to allow maximum range of motion.

LIGAMENTS OF THE SHOULDER

The golf ball and tee analogy for the shoulder joint, or glenohumeral articulation, helps us understand how mobile the shoulder can be, but this potentially unstable configuration also means the ball can fall off the tee. It is called a dislocation when the ball falls off and a subluxation when it starts to roll off but then rolls back into place. Often acute trauma, such as a fall from the bike, can cause a dislocation, but repetitive injury from swimming may lead to subluxations, which may be recurrent or chronic. Muscle coordination about the shoulder, a soft-tissue envelope around the joint, and an intact ligament system prevent this from happening.

A tough fibrous-tissue capsule surrounds the shoulder joint, like a balloon with the air sucked out, holding the ball on the tee. Thickenings of this tissue form a ligament system, connecting bone to bone, that also provides stability. These ligaments attach to a ring of tissue called the labrum that surrounds the glenoid. It helps deepen the socket and provides further resistance to the ball's falling off the tee.

MUSCLES OF THE SHOULDER

The muscles of the shoulder girdle can be divided into three groups: major movers, fine-tune coordinators, and scapular stabilizers. Six primary movements are created by the coordinated actions of muscles from each group working together:

Flexion: arm elevation in front of the body

Extension: arm motion behind the body

Abduction: arm elevation away from the body (to the side)
Adduction: arm movement toward the body (from the side)
Internal rotation: rotation of the arm toward and across the body
External rotation: rotation of the arm away from the body

Major Movers

The major movers include the deltoid, latissimus dorsi, and pectoralis major.

The deltoid (figure 7.2) is made up of three distinct heads. The anterior, middle, and posterior heads originate at the clavicle, acromion, and spine of the scapula and insert as a single tendon onto the upper end of the humerus. When all fibers contract simultaneously, the deltoid is the prime mover for abduction.

The latissimus dorsi (figure 7.3) is the broad muscle of the back. It originates at the lower back and rib region, runs under the armpit, or axilla, and inserts on the medial, or inside, aspect of the proximal humerus. It acts as a shoulder extensor and adductor. It also serves as an internal rotator in conjunction with the pectoralis. Swim propulsion depends on technique and the strength of this muscle.

The pectoralis major and smaller pectoralis minor are fan-shaped muscles that lie on the anterior chest, arising from the clavicle, sternum, and upper ribs. They attach to the medial part of the upper end of the humerus. Their primary actions include arm flexion, adduction, and internal rotation. The strength of the pectoralis is a factor in swimming speed. The pectoralis major and pectoralis minor are covered in more detail in chapter 6.

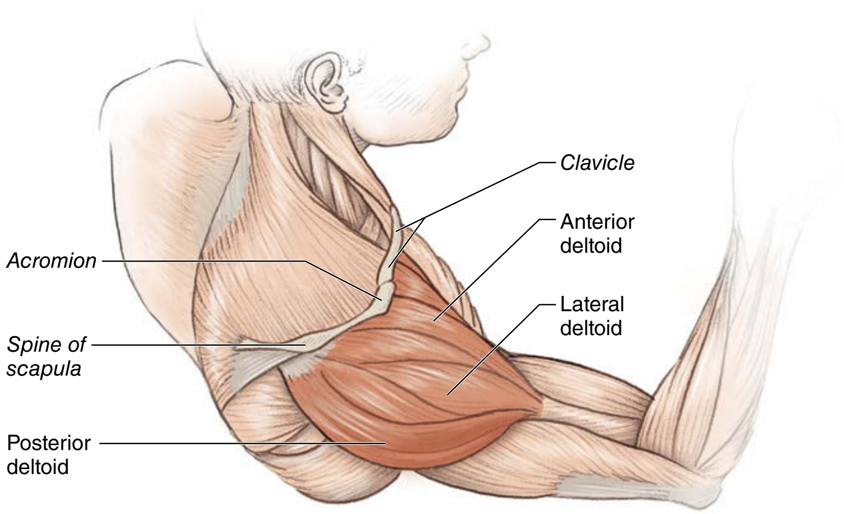


FIGURE 7.2 Deltoid muscle.

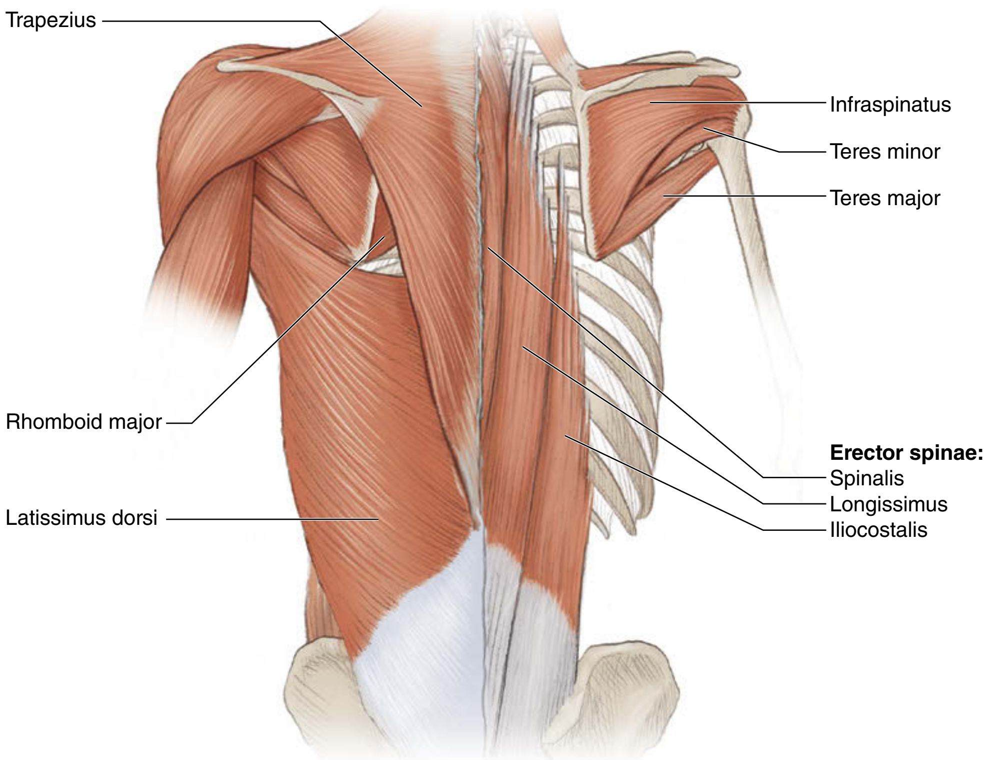


FIGURE 7.3 Back muscles, including the latissimus dorsi.

Fine-Tune Coordinators

The fine-tune coordinators make up the rotator cuff (figure 7.4). The rotator cuff is a group of four small muscles (the subscapularis, supraspinatus, infraspinatus, and teres minor) that originate from the scapula and together form a tendinous cuff that surrounds the head of the humerus. The subscapularis functions as an internal rotator of the shoulder. The supraspinatus, as it lies on top of the scapula, helps with abduction. The infraspinatus and teres minor assist with external rotation.

As the deltoid begins to move the arm, the rotator cuff muscles contract in a coordinated fashion to compress the humeral head onto the glenoid, thus holding the ball on the tee. Repetitive activities or trauma from a fall may injure the cuff tendons, leading to a spectrum of conditions, including impingement syndrome, bursitis, rotator cuff tendinitis, and rotator cuff tears, which cause pain and disability.

Scapular Stabilizers

This group of muscles includes the trapezius, rhomboid major, rhomboid minor, serratus anterior, levator scapulae, and pectoralis minor. These muscles

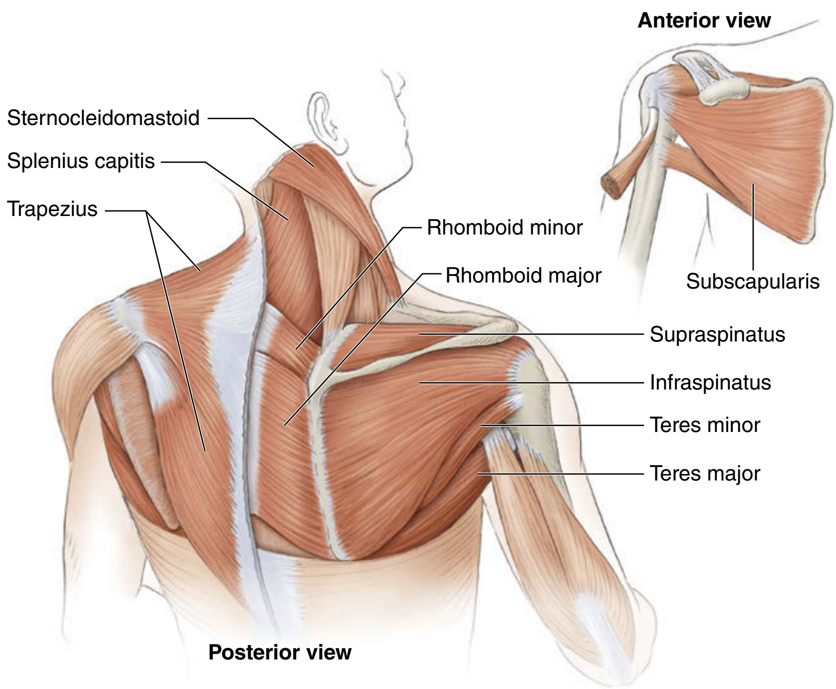


FIGURE 7.4 Rotator cuff and scapula muscles.

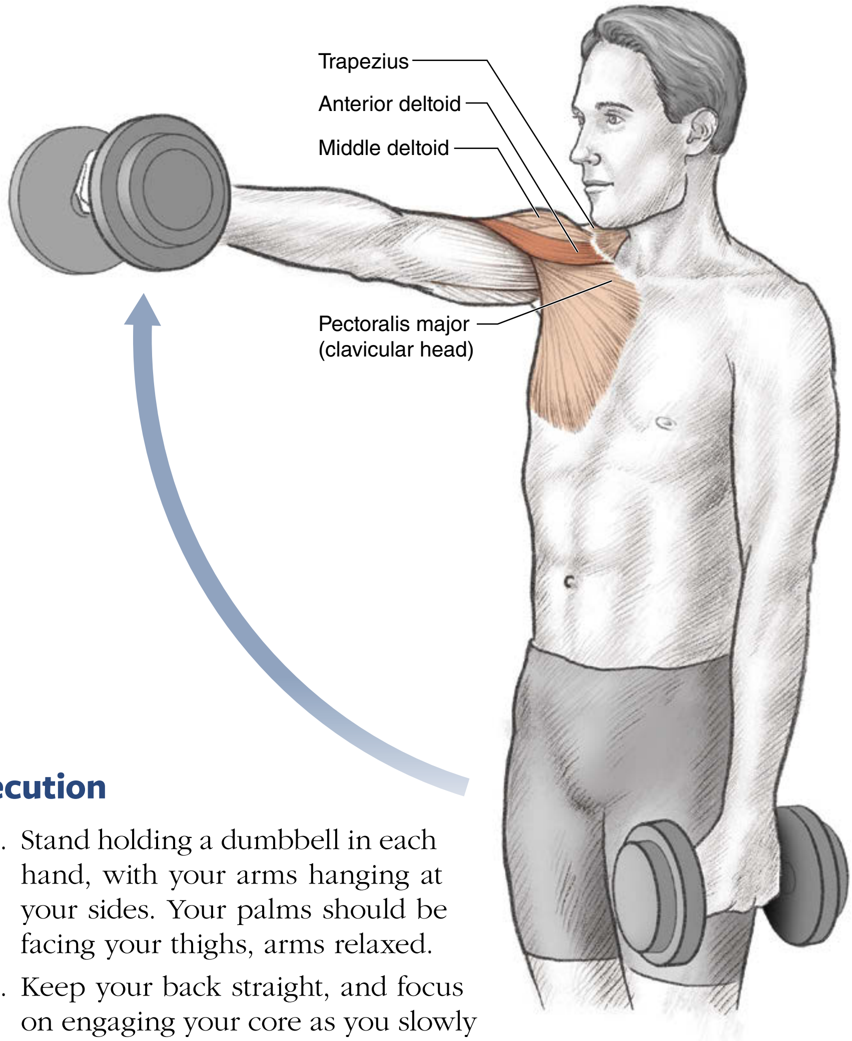
are responsible for scapular movement. As the humerus moves, the scapula follows with the motions of elevation, depression, retraction, and protraction. The combination of scapular motion on the posterior rib cage and motion at the shoulder joint is what allows us to put our arms in such a wide variety of positions.

For shoulder motion to occur, the different pieces of the complex shoulder anatomy must coordinate. This highlights the importance of having a strong and well-conditioned shoulder joint. The exercises that follow emphasize these muscle groups.

EXERCISES FOR THE SHOULDER

The shoulder complex is relatively delicate and requires special care and deliberation when training. Place special focus on performing movements with good technique. Heavy weights and low repetitions are not ideal for most endurance athletes. Typically the ideal target is three or four sets of 10 to 15 repetitions, with 60 to 90 seconds of rest between sets. The weight chosen for each set should be challenging but should not require deviation from perfect form. You should be able to complete the targeted number of repetitions before increasing the weight. As always, warm up the shoulder properly before initiating any resistance training routine.

FORWARD DUMBBELL DELTOID RAISE



Execution

1. Stand holding a dumbbell in each hand, with your arms hanging at your sides. Your palms should be facing your thighs, arms relaxed.
2. Keep your back straight, and focus on engaging your core as you slowly raise one dumbbell directly in front of your body.
3. As the dumbbell rises, slightly bend your elbow and rotate your hand so your palm faces the floor at the top of the movement.
4. Lower the dumbbell slowly and under control as you begin the movement with the opposite arm.

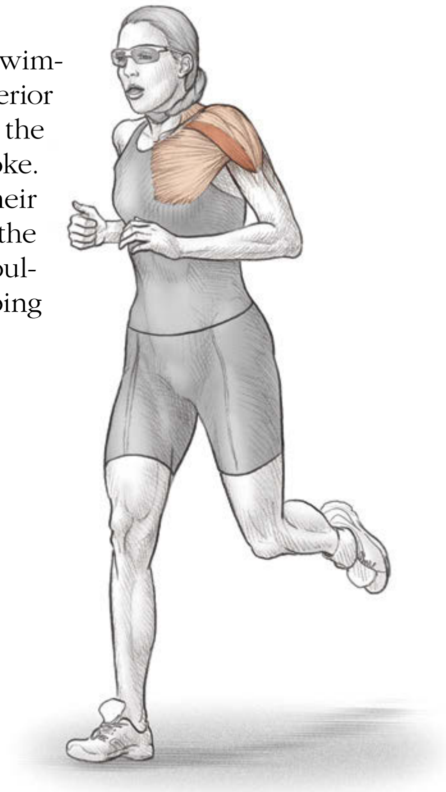
Muscles Involved

Primary: Anterior deltoid

Secondary: Pectoralis major, middle deltoid, trapezius

TRIATHLON FOCUS

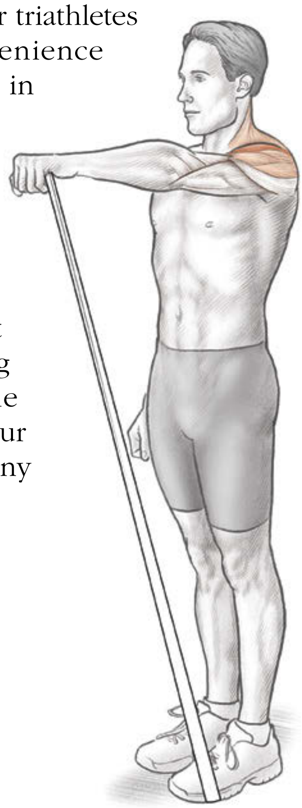
The anterior deltoid plays an important role in swimming, cycling, and running. In swimming, the anterior deltoid is indirectly engaged in the catch and in the first part of the pulling phase of the freestyle stroke. Cyclists use this muscle group to help stabilize their position when standing to climb while grasping the base bars. Runners leverage the front of the shoulder when driving with the arms to aid in climbing steep hills.



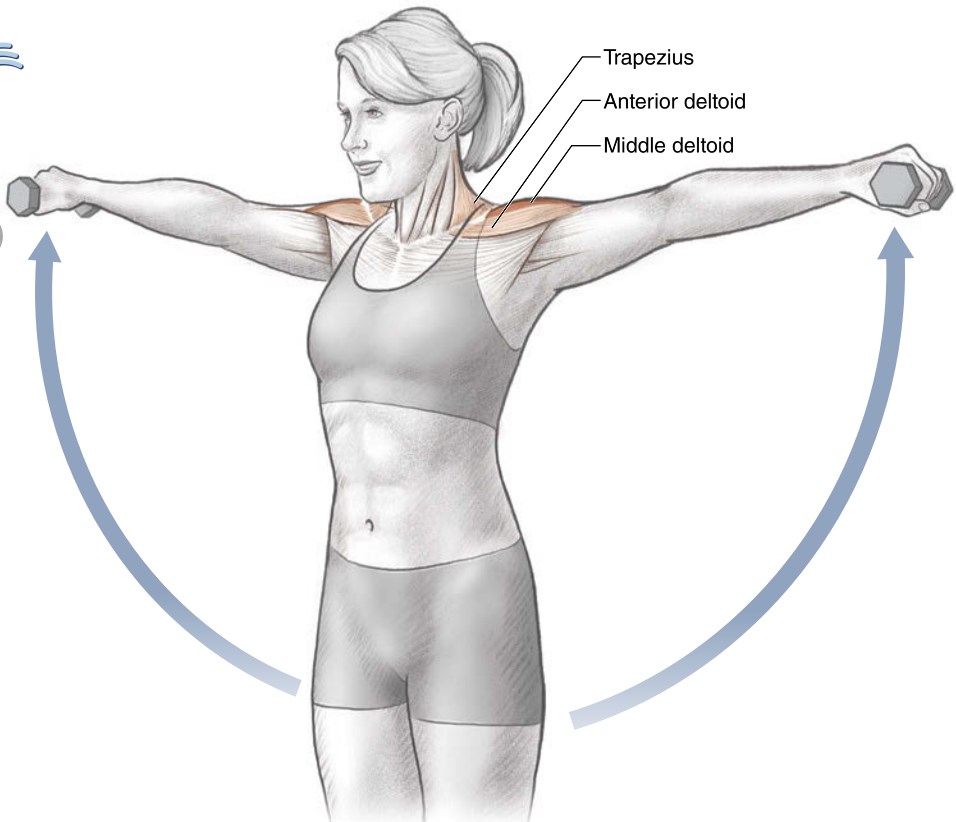
VARIATION

Forward Deltoid Raise With Tubing

Stretch tubes are ideal for triathletes because of their convenience and ease of application in performing a variety of upper-body movements, including the forward deltoid raise. Vary the resistance according to your needs by choosing the correct tube weight or by varying your distance from the anchor, which can be your foot as illustrated or any stationary object.



LATERAL DUMBBELL DELTOID RAISE



Execution

1. Stand holding a dumbbell in each hand down at your sides, with your palms facing your thighs.
2. Slightly bending your arms at the elbows, raise your arms laterally in a slow and controlled motion until they are even with your shoulders. Keep your palms facing the ground.
3. Lower the dumbbells to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Middle deltoid

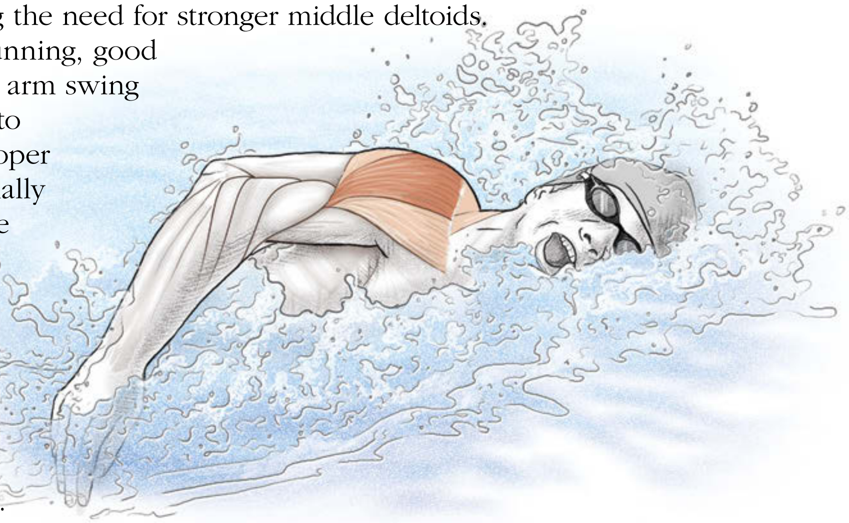
Secondary: Anterior deltoid, posterior deltoid, supraspinatus, trapezius

TRIATHLON FOCUS

The middle deltoid, like the anterior deltoid, plays more of a supporting role than a primary role for all shoulder movement patterns involved in swimming freestyle, cycling, and running.

The swimmer relies heavily on this muscle group during the recovery phase of the freestyle stroke. Premature fatigue of this muscle group when swimming open-water distance freestyle, especially when swimming head-up to sight buoys and to navigate the course, can cause asymmetry in the stroke. This sloppiness can slow a swimmer's time. Additionally, long-sleeved wetsuits tend to be tight around the shoulder, creating even more fatigue and emphasizing the need for stronger middle deltoids.

During running, good posture and arm swing are needed to maintain proper form, especially when fatigue starts to settle in. Focus on developing the middle deltoid to strengthen form overall.

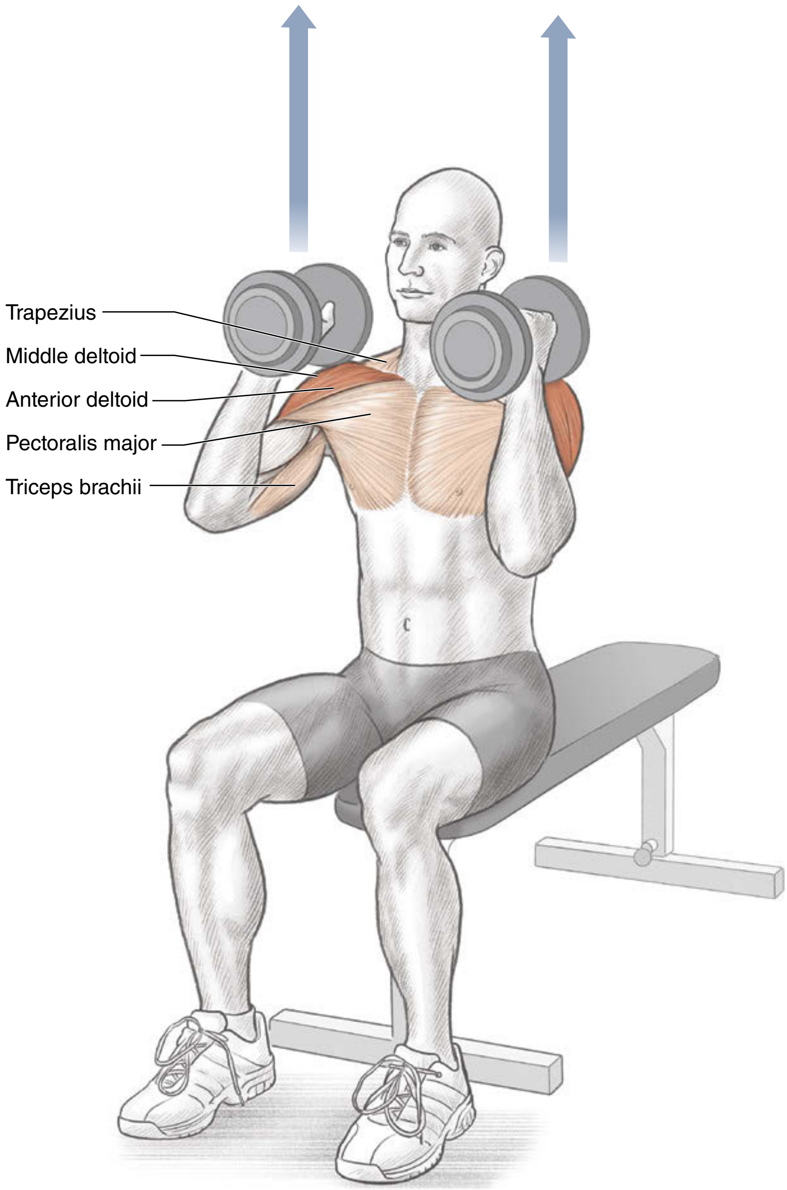


VARIATION

Lateral Deltoid Raise With Tubing

Elastic tubing is the ideal alternative to dumbbells. Perform the movement in the same way you do with dumbbells, varying the resistance of the band to suit your needs.

DUMBBELL SHOULDER PRESS



Execution

1. Sit on a bench with your back straight. Hold two dumbbells of the same weight on your shoulders, palms facing your body.
2. Press the dumbbells straight overhead until your elbows are almost locked out. Rotating the palms during this movement may help prevent impingement of the biceps tendon.
3. Lower the dumbbells slowly back to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Anterior deltoid, middle deltoid

Secondary: Pectoralis major, posterior deltoid, trapezius, supraspinatus, triceps brachii

TRIATHLON FOCUS

People are weakest when it comes to overhead resistance exercises. The dumbbell shoulder press is an effective exercise that engages several important muscle groups at the same time, including the middle deltoid, anterior deltoid, and triceps brachii.

This exercise will help swimmers to extend and reach, which helps to create a streamlined body position and maximizes strokes per length.

Strong shoulders will also help a runner add propulsion, especially while sprinting.

Cyclists will benefit from this movement by building overall shoulder strength as well as trapezius and upper-arm strength. This is especially important for the long-distance triathlete who spends a lot of time with his arms in the aero position and with his neck bent slightly, looking up the road.

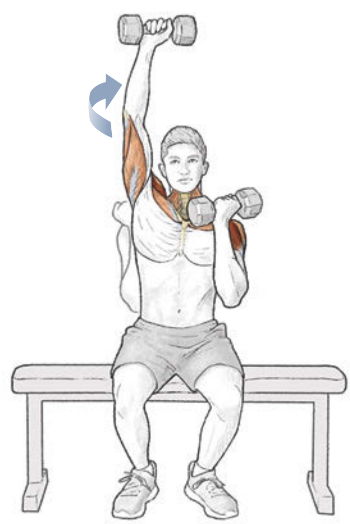
VARIATIONS

Stability Ball Shoulder Press

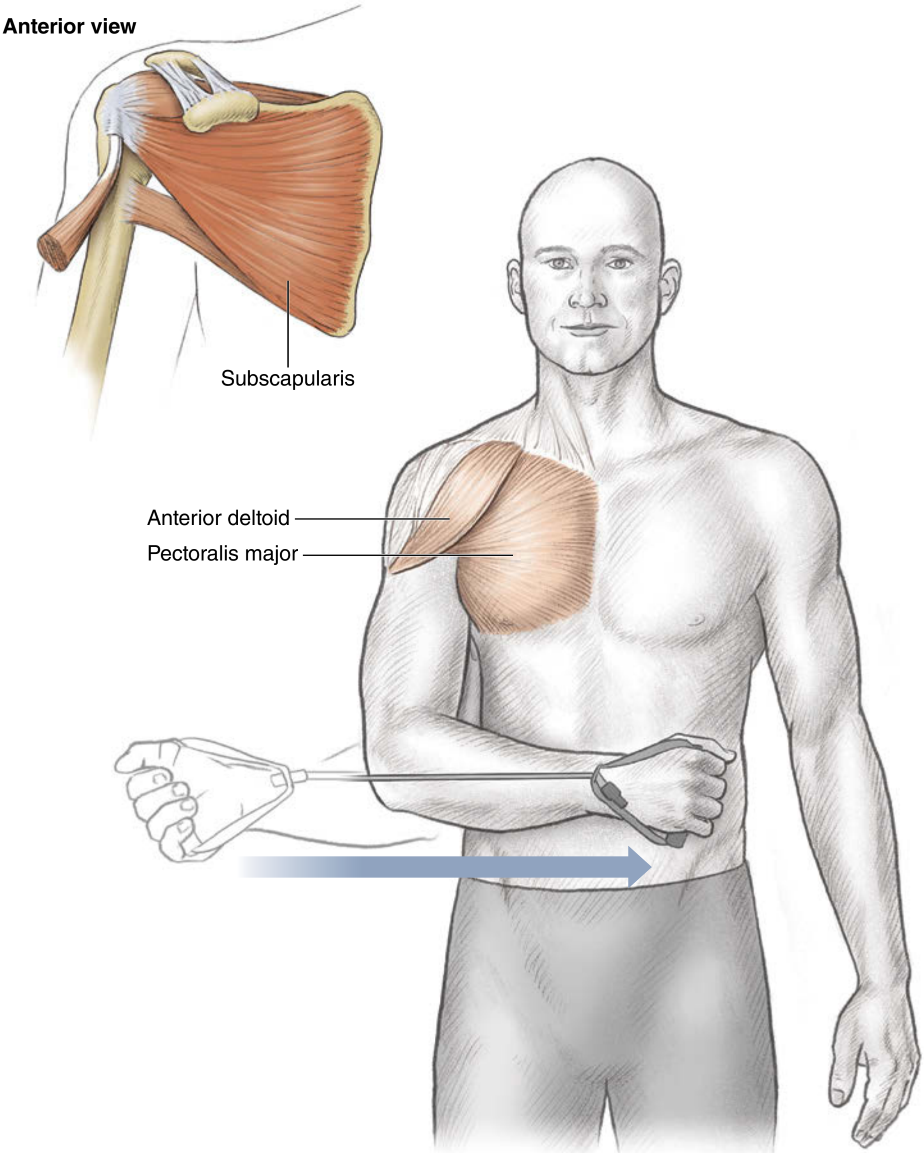
This movement can also function as a core strengthening and balance exercise. Simply by performing the presses using a stability ball instead of a bench, you'll be able to gain those important benefits.

Arnold Press

Hold a dumbbell in each hand, with palms facing you, as you would at the finish position of a biceps curl. Rather than pushing straight up, as in a conventional shoulder press, initiate the exercise by moving your arms out to the sides as you twist your hands to face forward. Finish with elbows fully extended, dumbbells raised high overhead, with palms forward.



INTERNAL ROTATION WITH TUBING



Execution

1. Choose exercise tubing of an appropriate resistance for your fitness level. Secure the tubing to an anchor at elbow height, and stand approximately 4 feet (1.2 m) away from the anchor. Hold the handle with the arm closest to the anchor, and bend the elbow 90 degrees. Place a small, folded towel between the upper arm and middle torso. Holding the elbow in this position will reinforce proper rotation technique.
2. Keeping the forearm parallel to the floor and the upper arm stable, rotate your hand across the front of your body until your hand touches your torso.
3. Return slowly to the starting position, and repeat for the required number of repetitions.

Muscles Involved

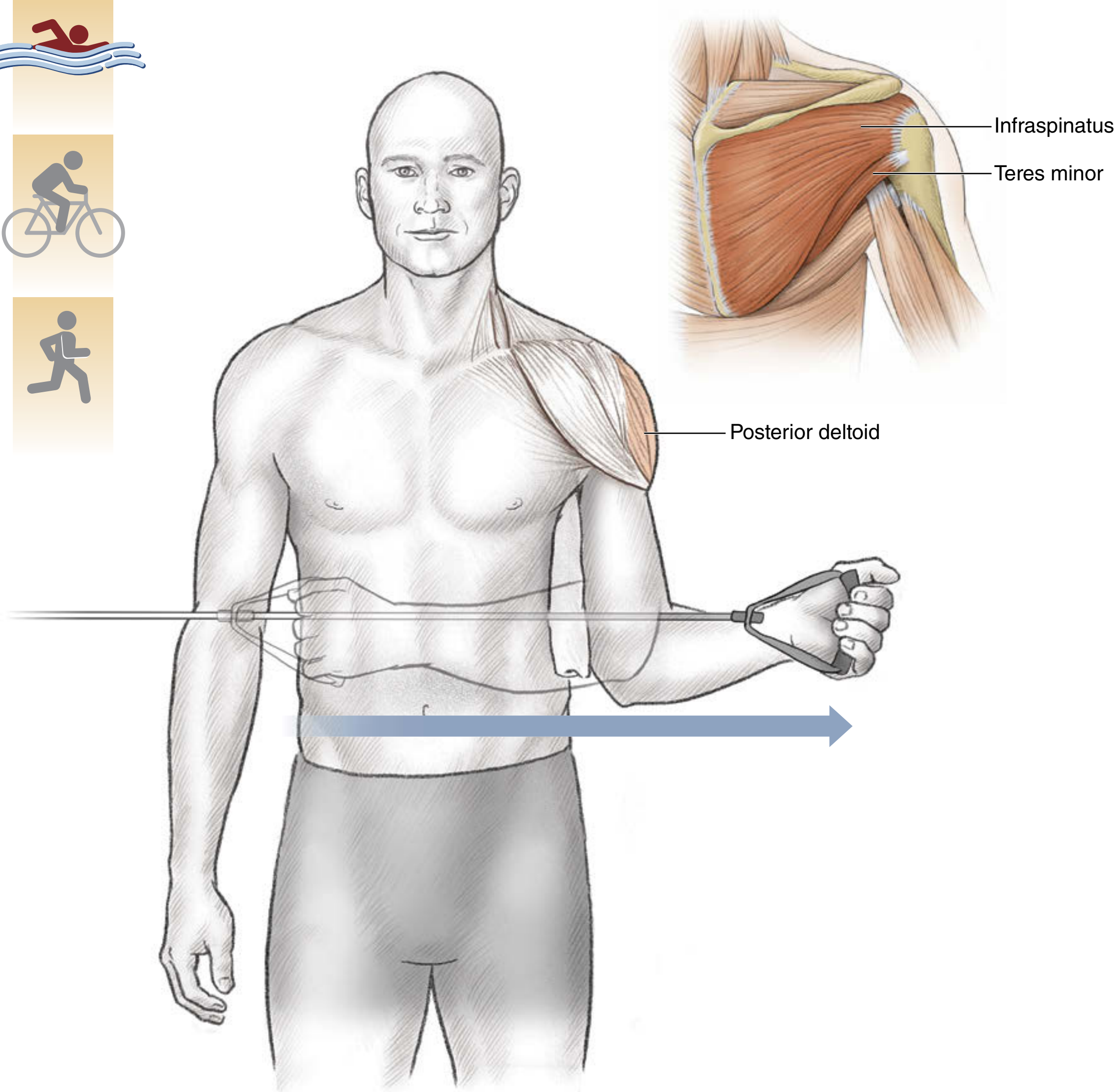
Primary: Subscapularis

Secondary: Pectoralis major, anterior deltoid, latissimus dorsi

TRIATHLON FOCUS

This exercise is included in this section because of its importance in maintaining rotator cuff health, with the goal of preventing shoulder-related overuse injuries often encountered by masters swimmers and triathletes. As one of four rotator cuff muscles, the subscapularis is the muscle responsible for internal rotation of the arm. Together with the shoulder capsule and ligament system, the subscapularis acts as a shoulder stabilizer, helping to keep the ball on the tee. Although other larger muscles perform similar actions of internal rotation, the subscapularis should be targeted with supplemental strength training in order to reduce the risks associated with repetitive motion movements such as swimming freestyle for distance events.

EXTERNAL ROTATION WITH TUBING



Execution

1. With exercise tubing of the appropriate resistance, stand approximately 4 feet (1.2 m) away from an anchor for the tube, set at elbow height. Bend the arm at 90 degrees, holding the tube with the arm farthest from the anchor. Place a small, folded towel between the upper arm and middle torso. Holding the elbow in this position will reinforce proper rotation technique.
2. Keeping the forearm parallel to the floor and the upper arm stable, rotate your hand across and away from the front of your body.
3. Return slowly to the side, and repeat for the required number of repetitions.

Muscles Involved

Primary: Infraspinatus, teres minor

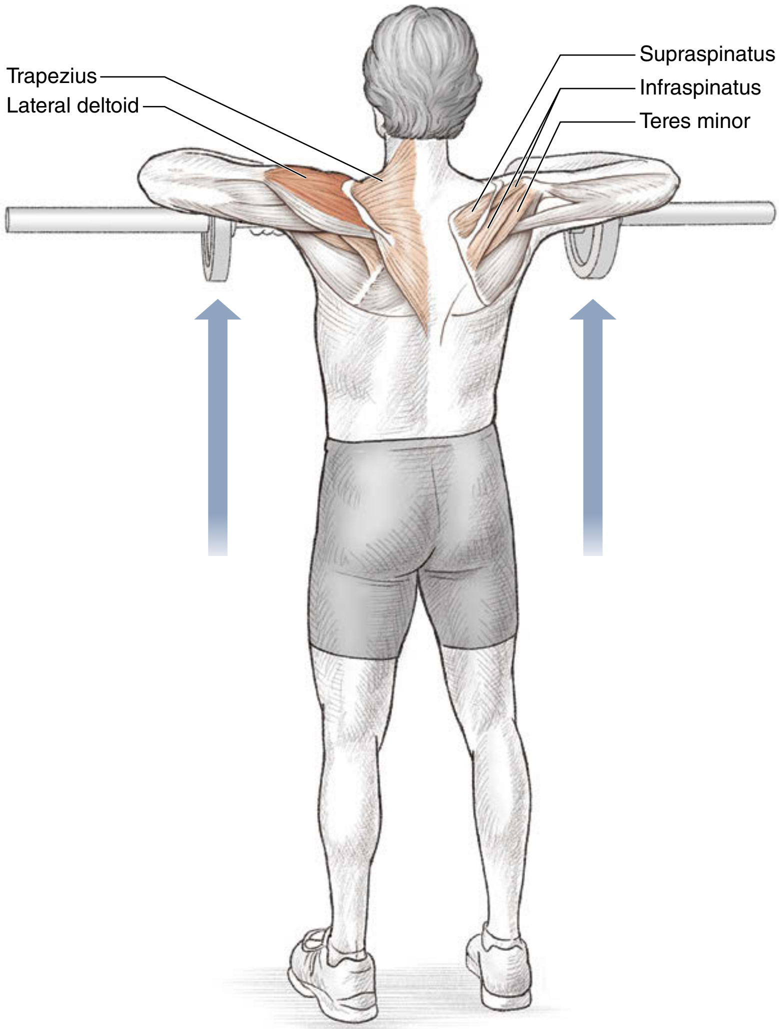
Secondary: Posterior deltoid

TRIATHLON FOCUS

Similar to the internal rotation with tubing exercise, this exercise is included in this section because of its importance in preventing shoulder-related overuse injuries often encountered by masters swimmers and triathletes. External rotation of the arm is an essential movement pattern in swimming.

Fatigue of this group of muscles can cause dyskinesia (abnormal motion about the shoulder and scapula), which leads to injury. These strength training exercises increase the durability of this group of muscles, which in turn helps reduce the chance of injury.

UPRIGHT ROW



Execution

1. Stand holding a barbell in front of you, resting the barbell against your thighs with your arms straight.
2. Pull the weight up vertically along your torso until it reaches your upper chest near the base of your neck. Focus on keeping your elbows high and engaging the various shoulder muscles during the movement.
3. Return to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Anterior deltoid, lateral deltoid

Secondary: Infraspinatus, supraspinatus, teres minor, trapezius

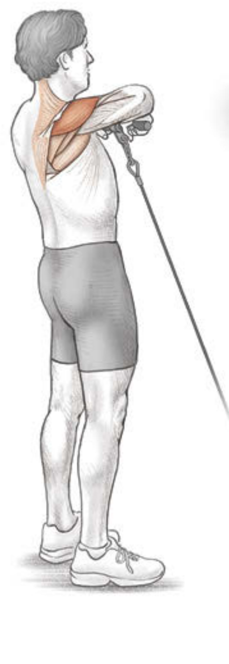
TRIATHLON FOCUS

Each discipline of triathlon relies on strong shoulders, and the upright row is an excellent multijoint exercise that focuses on this area of the body. From the swimmer's perspective, strong shoulders mean stronger pulls through the water and less fatigue during the recovery phase of the stroke when the swimmer is wearing a long-sleeved wetsuit.

The cyclist will enjoy having stronger shoulders when rocking the bike back and forth while out of the saddle and climbing. Strong shoulders also prevent fatigue when riding for countless hours on the aerobars.

The runner will be able to maintain a strong rhythm and balance, driving with the arms when attacking a climb or sprinting to the finish. The upright row addresses practically all of these important aspects.

VARIATION



Upright Row With Dumbbells, Cables, or Elastic Bands

The upright rowing movement can be performed effectively using dumbbells, cables, or elastic bands.

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8

ARMS

The three disciplines of triathlon—swim, bike, and run—require a balanced use of both lower and upper extremities. The upper extremity is composed of the upper arm, including the humerus; the lower arm, or forearm; the hand; and all muscular attachments. The shoulder, which plays an integral role in upper-extremity function, is discussed in chapter 7.

The arm is suspended from the shoulder by a single bony attachment to the axial skeleton, or trunk, through the clavicle to the chest and sternum. This lack of bony support explains the freedom of motion the arm and shoulder have compared with the lower extremities. Through the coordinated actions of the muscles and the structural support of the ligaments, a triathlete can create a strong anchor to generate propulsion while swimming, maintain strong upper-body support for better aerodynamic positioning on the bike, and help counterbalance the lower-extremity motion during running, creating a smooth and efficient running form.

Weaknesses of any muscles of the arm and forearm may not significantly affect running or biking, but they can cause significant changes in swim technique that can lead to injury. Sport-specific strength training can help reduce the chance of repetitive overuse injuries.

The anatomy of the arm can be divided into bones, joints, and muscles.

BONES OF THE ARM

The humerus is the long bone of the upper arm that links the shoulder to the elbow. It gives shape to the arm and is the attachment site for major muscle groups that provide upper-extremity motion and function.

The forearm consists of two bones: the radius and the ulna. The complex architecture at the ends of each bone and the bow shape of the radius allow complementary motion patterns at the elbow and wrist, including flexion and extension (bending and straightening) and supination and pronation (rotating the hand palm up and palm down). Without these motions, swimming would be impossible.

The wrist and hand are made up of numerous bones that have complex interactions through joints, ligaments, muscles, and their tendon attachments to allow dexterity and a high level of hand function.

JOINTS OF THE ARM

The upper extremity has two major joints: the glenohumeral and the elbow. The top portion of the humerus looks like a rounded ball. It sits on the glenoid, or socket, of the scapula. This makes up the bony anatomy of the shoulder. Like all synovial joints, the two ends of the bone are covered with articular cartilage that allows smooth, low-friction motion. They then are covered by a capsule with an inner lining of synovium that produces synovial fluid, which lubricates and nourishes the joint cartilage. This unconstrained joint, like a golf ball sitting on a tee, allows the arm to have significant mobility and range of motion.

The bony architecture of the elbow joint is made up of the distal (far) end of the humerus and the proximal (near) portions of the ulna and radius. Each forearm bone makes a simple hinge joint with the humerus. The humeroulnar articulation allows for flexion and extension, and the humeroradial joint allows for forearm supination and pronation. These simple motions coupled with the articulation between the radius and ulna allow a complex range of motion around the elbow.

MUSCLES OF THE ARM

As discussed in chapter 7, a group of muscles in the shoulder, including the rotator cuff, initiate and control shoulder motion. With respect to the upper arm, the pectoralis major and latissimus dorsi insert at the upper end below the level of the rotator cuff on the front of the humerus. When the muscles act independently, they perform primarily arm flexion and extension, respectively. When the muscles act together, they are very powerful adductors and internal rotators of the arm. These motions are essential in the catch and pull phase of swimming.

The biceps brachii has its origin in two areas of the scapula, the long head at the top of the glenoid and the short head from the coracoid process. These heads join in the middle of the arm along with the brachialis, which originates from the middle to upper end of the humerus, and the brachioradialis, from the distal end of the humerus (figure 8.1). These muscles cross the elbow and perform the motions of both elbow flexion and forearm supination.

The posterior aspect of the humerus is the origin of the medial and lateral heads of the triceps brachii muscle (figure 8.2). The triceps tendon inserts into the tip of the ulna, or olecranon process. The simple hinge joint of the humeroulnar articulation allows the triceps to extend and straighten the elbow.

Another muscle worth mentioning is the pronator teres. This important muscle arises from the medial aspect of the distal humerus and ulna to allow pronation of the forearm and to balance the biceps during forearm supination.

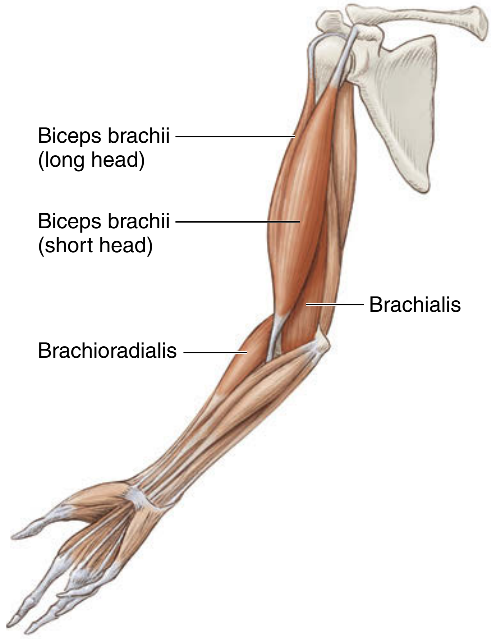


FIGURE 8.1 Biceps brachii, brachialis, and brachioradialis muscles.

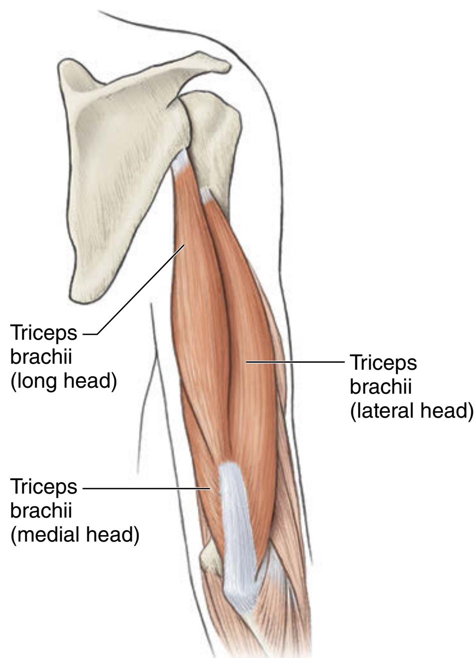


FIGURE 8.2 Triceps brachii muscle.

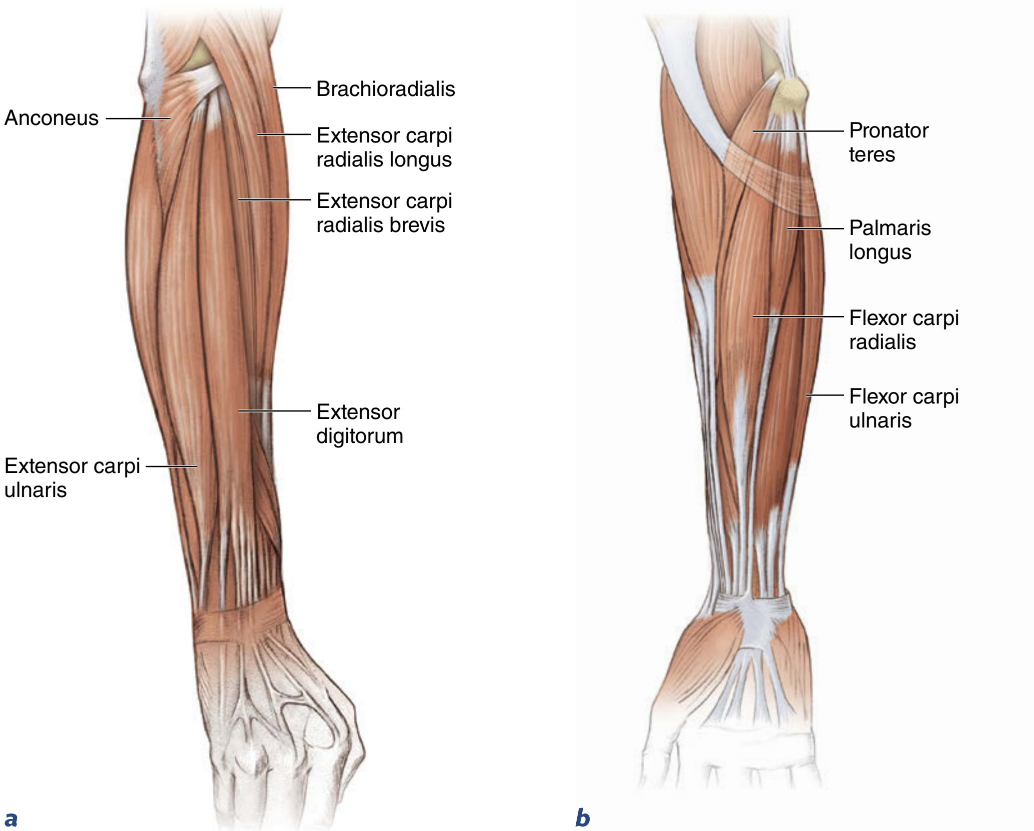


FIGURE 8.3 Forearm muscles: *(a)* outside; *(b)* inside.

The muscles of the forearm (figure 8.3) and hand represent a complex area of anatomy and function. Many activities in life as well as in triathlon—from the swim catch, bike handling, and relaxed proper running form—rely on strong, conditioned forearm musculature.

The forearm can be divided into the flexor group of muscles on the palm side and the extensors on the opposite, or dorsal, surface. The extensor group includes the extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris of the wrist and the extensor digitorum, extensor digiti minimi, extensor indicis, extensor pollicis longus, and extensor pollicis brevis of the fingers. This group of muscles originates from the outside of the distal humerus, called the lateral epicondyle.

On the palm side of the forearm is the flexor group, which includes the flexor carpi radialis, palmaris longus, and flexor carpi ulnaris of the wrist and the flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus of the fingers. This group of muscles originates from the inside prominence of the medial distal humerus, called the medial epicondyle.

EXERCISES FOR THE ARMS

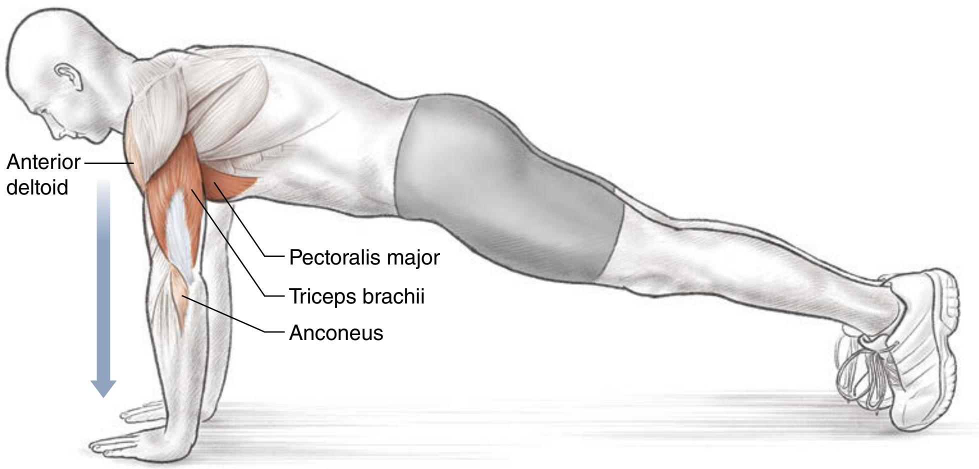
The arm exercises in this chapter build muscular strength and endurance while reducing the risk of injury specific to swimming, cycling, and running. Of course, many other arm exercises are available; it's up to the athlete or coach to select the options appropriate for the athlete's needs.

Because arm exercises are typically done after exercises for the muscles of the chest, back, and shoulders, a separate warm-up is not usually necessary, though it should be done if arm exercises are performed first. A series of dynamic stretches and the use of light resistance are recommended before jumping into your training routine. For example, it is common to see swimmers on deck performing various arm swings as a way to stretch as well as using tubing or light dumbbells in triceps extensions and biceps curling movements to warm up before training.

Training the arms for triathlon performance is similar to training other body parts in that the set and repetition scheme should be geared to developing strength and endurance and not to build too much unnecessary mass. (Remember, cycling and running are both affected by the athlete's power-to-weight ratio.) Therefore, we recommend one to three sets of 10 to 15 repetitions for most of the exercises in this chapter.

Because recovery is so important when training for three sports, as in triathlon, overdoing any single component can have a negative effect on other areas. When you strength train other upper-body parts, such as the chest, shoulders, and upper back, the arms are used as well and receive a training effect. In fact, in triathlon activities, you rarely (if ever) use your biceps and triceps without using the aforementioned muscles of the back, chest, or shoulders. Be careful not to overtrain the arms by adding too many arm-specific exercises to your routine. Keep an eye on the gauges or work with a coach to make sure you're following the proper training program.

CLOSE-GRIP PUSH-UP



Execution

1. Lying facedown, place your hands slightly less than shoulder-width apart, with your fingers pointing forward.
2. Extend your body so that your spine is straight. Support your lower body on your toes with straight and locked legs. Keep your head in a neutral position, aligned with your spine.
3. Lower your body slowly and under control until your chest is 1 to 2 inches (2.5 to 5 cm) from the ground. Keep your upper arms close to your body.
4. Press up slowly and under control, maintaining a straight body position, until your elbows are almost locked. Repeat for the desired number of repetitions.

Muscles Involved

Primary: Triceps brachii, pectoralis major

Secondary: Pectoralis minor, anterior deltoid, anconeus

TRIATHLON FOCUS

The push-up is considered the king of upper-body strengthening exercises. Push-ups are easy to perform, don't require any equipment, and are very effective at producing results, enhancing both strength and endurance in the upper-body musculature.

By varying the hand position of the push-up movement, the athlete can focus on activating slightly different muscle groups. In this example of the close-grip push-up, the emphasis is on the triceps brachii, a muscle used extensively in swimming and cycling. In the freestyle swim stroke, much of the athlete's forward propulsion is created in the final extension phase of the stroke. Here, a strong triceps will be able to propel the hand through the water with more force, resulting in a faster swim pace.

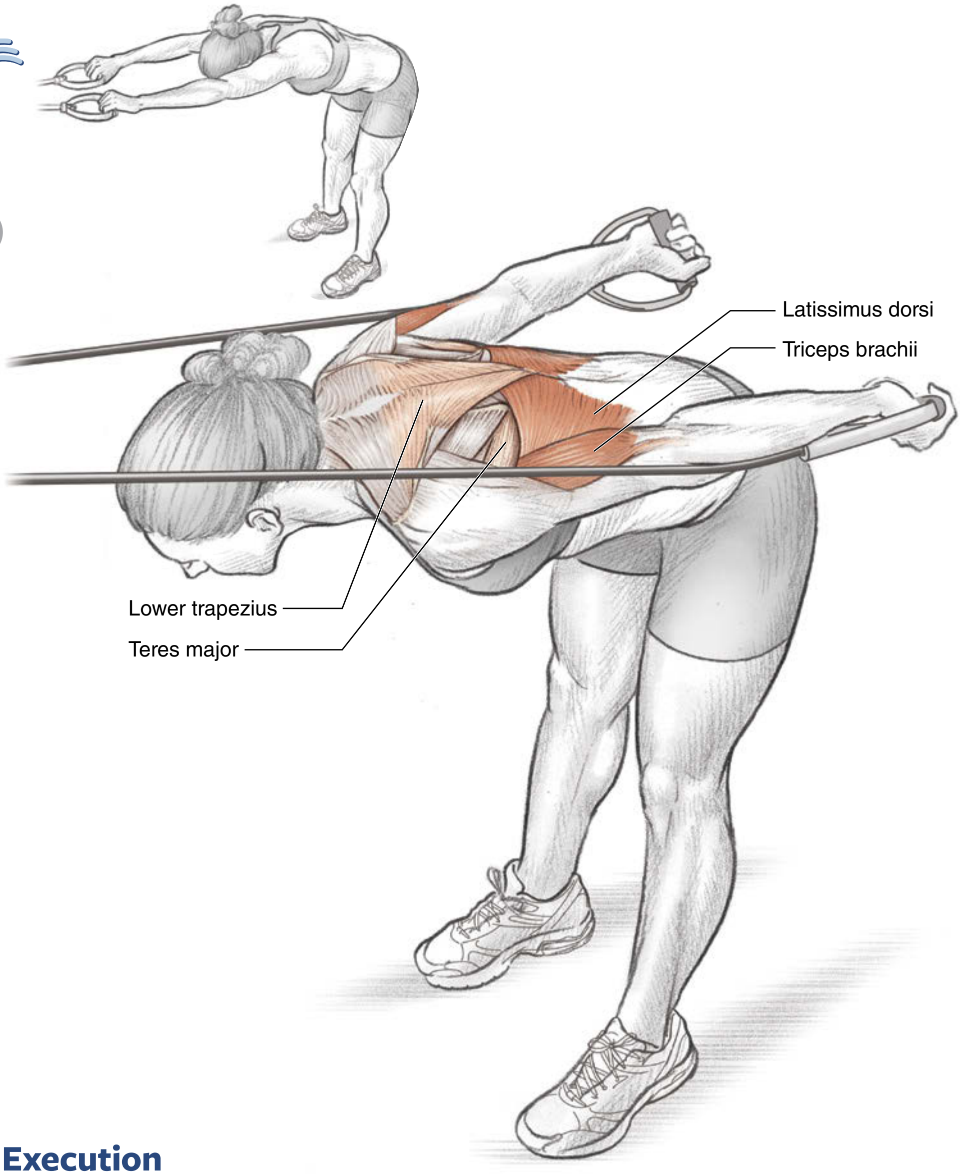
Building arm strength can help make bicycle riding safer by enhancing handling and stability. Cycling hand positions vary according to the terrain and objectives. Strong triceps help the rider to support her body weight when riding on the hoods or the drops and when riding out of the saddle, and they help stabilize the upper body more when riding on the aerobars.

VARIATION

Push-Up From Knee Position

Close-grip push-ups isolate the triceps, making this exercise difficult for some people. One variation that makes this exercise easier for beginners is to perform the movement from the knees. Be sure to keep the same body position, with a straight spine and a neutral head position. Once you can perform the desired number of repetitions from the knees, gradually move to performing reps from your toes. It's better to properly execute the modified version than to sacrifice form, safety, and effectiveness with a poorly done nonmodified version.

BENT-OVER FREESTYLE PULL WITH BAND



Execution

1. Choose a band resistance suitable for your current fitness level. Anchor the band to an immovable object such as a piece of weight equipment or a doorjamb. The band should be near waist height. Grasp the handles or the ends of the band with your palms facing behind you.
2. Step back from the anchor in order to create some tension in the band. Stand with your feet shoulder-width apart and knees slightly bent.
3. Bend over at the waist so your upper body is almost parallel to the ground. Stretch your arms above your head, as if you were entering the water in the first phase of the freestyle swim stroke.

4. Using both arms simultaneously, pull back on the handles with your elbows slightly up (high elbows) and bent, activating the chest and upper-back muscles.
5. When the hands reach the waist, extend the forearms back against the increasing resistance of the stretched band, focusing on the triceps and almost locking the elbows in a fully extended position.
6. Return in a controlled manner against the resistance of the elastic band and repeat. Complete three to five sets of 10 to 15 repetitions.

Muscles Involved

Primary: Latissimus dorsi, pectoralis major, triceps brachii

Secondary: Lower trapezius, teres major

TRIATHLON FOCUS

This is a key dryland exercise used by swimmers. Convenient and specific to the freestyle swim movement, the bent-over freestyle pull with band should be a staple exercise for the busy triathlete who is challenged to find enough time to get to the pool as well as for the triathlete who wishes to supplement his swim training with band work.

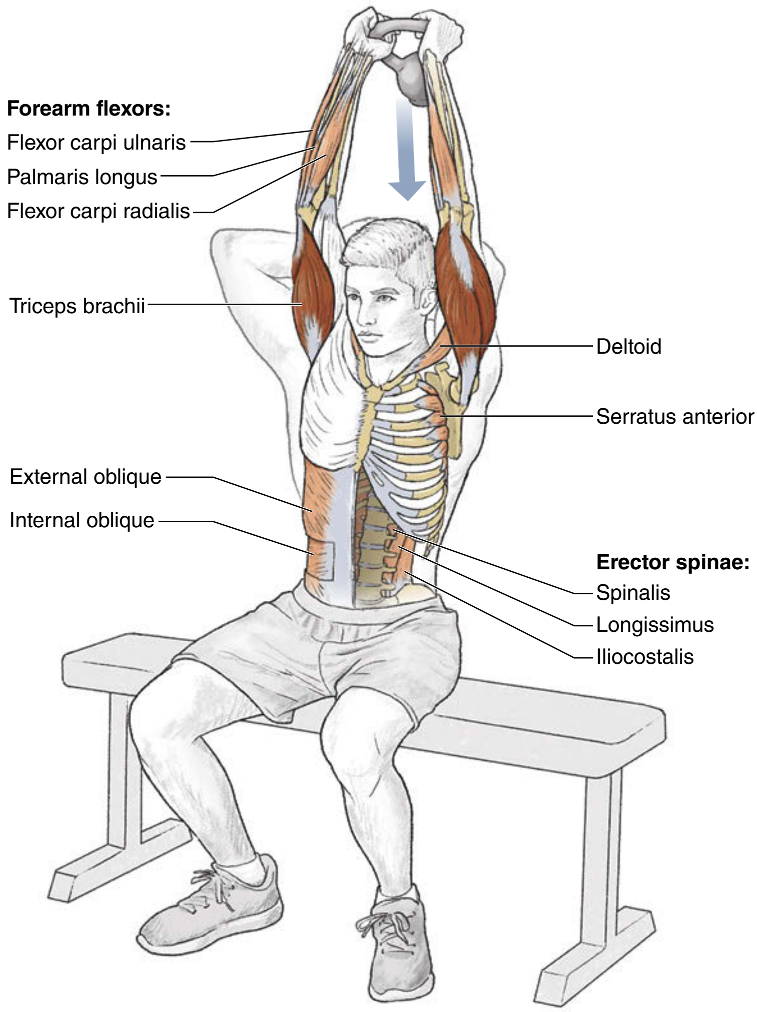
The key muscles engaged in this movement include those of the upper back and chest as well as the triceps in the arms. The ability to mimic the movement pattern found in an effective freestyle swim technique—including an early vertical forearm, high elbow, and explosive final extension of the triceps—against the increasing resistance of the band helps enhance swim efficiency while also boosting swim-specific strength and endurance.

VARIATION

Single-Arm Pull

Instead of pulling with both arms at the same time, a simple variation is to pull with one arm at a time. Focusing on one arm allows you to practice your swim cadence with proper body rotation.

SEATED KETTLEBELL EXTENSION



Execution

1. Sitting upright, hold the kettlebell extended over your head in both hands. Contract your core with a slight arch to your lower back.
2. With control, slowly lower the kettlebell, bending at the elbows, lowering the kettlebell behind your head.
3. Extend your elbows until they are straight, returning the kettlebell to the original overhead position.

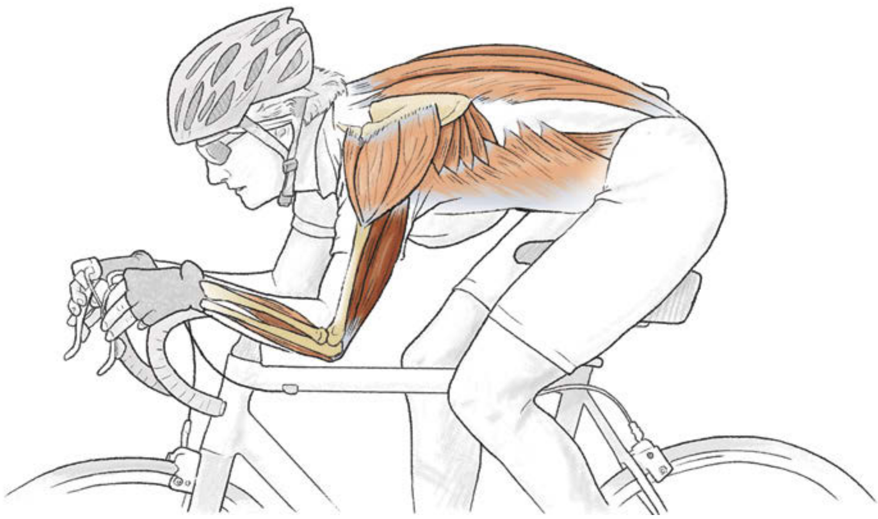
Muscles Involved

Primary: Triceps brachii

Secondary: Deltoids, erector spinae (iliocostalis, longissimus, spinalis), forearm flexors (flexor carpi ulnaris, flexor carpi radialis, palmaris longus), serratus anterior, internal oblique, external oblique

TRIATHLON FOCUS

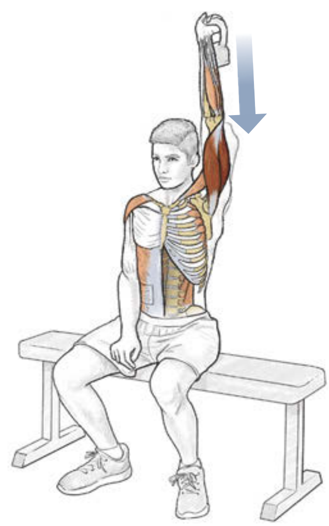
If lack of triceps muscular strength and endurance prevents you from maintaining your position on the aero bars, it will hurt your aerodynamics and ultimately slow you down. A perfect position in a wind tunnel isn't so perfect without the ability to hold the position. Strong triceps are an important ingredient in holding a rider steady on the aerobars. Developing the triceps is also especially helpful at the back end of the freestyle swim stroke.



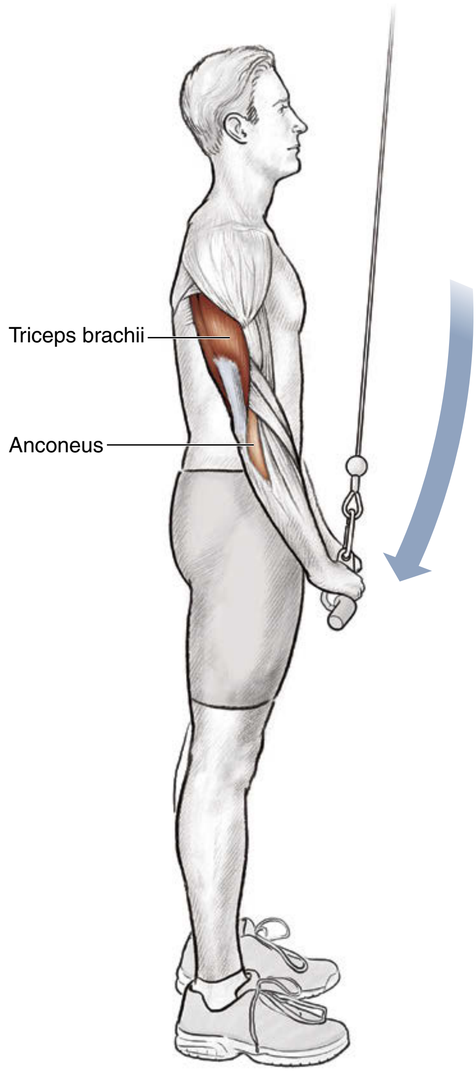
VARIATION

Single-Arm Seated Triceps Extension

Set up the exercise the same way, except you'll hold a lighter kettlebell or dumbbell in one hand. This will not only focus on your lateral triceps but also engage your core due to the asymmetry.



CABLE TRICEPS PUSHDOWN



Execution

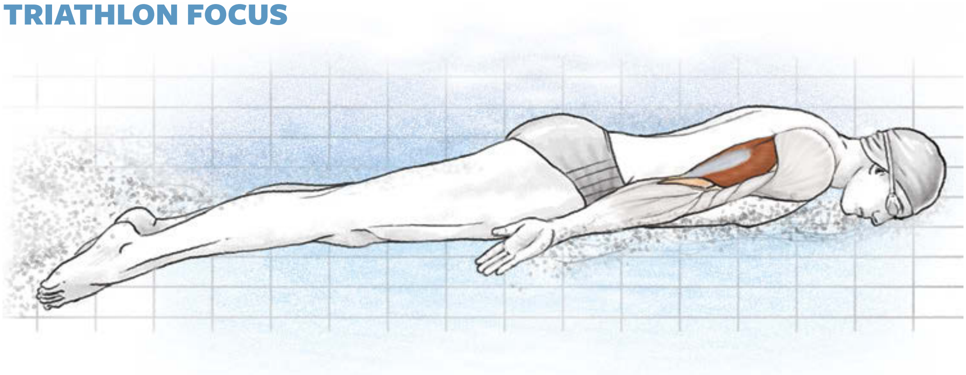
1. Stand facing a pulley with a short bar attached high. Grasp the bar at chest level using an overhand grip so that your hands are slightly less than shoulder-width apart.
2. Keeping your elbows tight at your sides, press down, extending the elbows until they are almost locked.
3. Return to the starting position, making sure to control the weight.

Muscles Involved

Primary: Triceps brachii

Secondary: Anconeus, wrist and finger flexors

TRIATHLON FOCUS



Although this exercise is effective at targeting the triceps brachii and will produce benefits across all four strokes, it is particularly valuable to breaststrokers because it mimics the final portion of the underwater pull performed off the start and at each turn wall.

When performing the exercise, you should maintain an upright posture and try to generate the force needed to move the weight solely by tightening your triceps brachii. Because swimmers have a predisposition to a rounded-shoulder posture, you can easily develop the bad habit of leaning into the cable and cheating by bouncing your upper body at the start of each repetition.

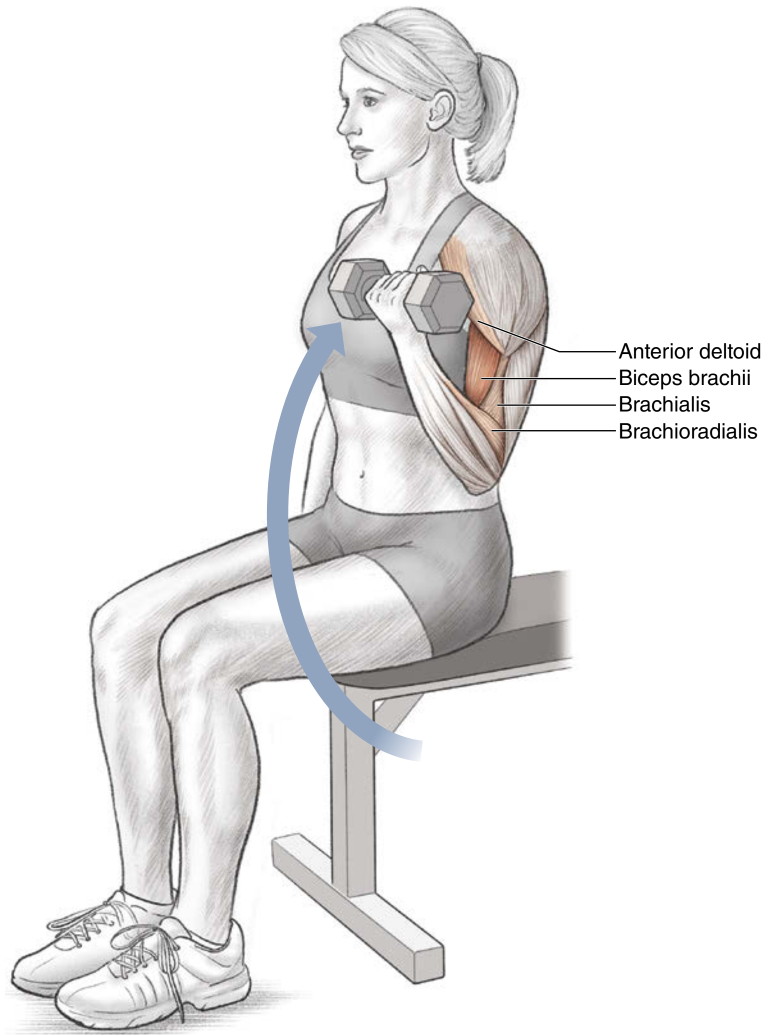
VARIATION

Standing Double-Arm Triceps Pushdown With Rope

In the starting position, your hands are at your midline.

As the elbows are extended, the hands pull the ends of the ropes outward so that when the elbows are almost locked, the hands are shoulder-width apart. The added lateral movement focuses on the lateral head of the triceps brachii.

DUMBBELL CURL



SAFETY TIP: To maximize the benefit of the exercise, stabilize your upper body. Avoid rocking and throwing the weight.

Execution

1. Stand erect or sit on a weight bench as shown. Grab dumbbells of an appropriate weight for your fitness level, one dumbbell in each hand. Lower your arms to your sides, palms turned in.
2. With your left arm, curl the weight slowly toward the shoulder, rotating the wrist so the palm is facing the shoulder.
3. Lower the dumbbell to the extended position, and repeat with the right arm for the required number of repetitions.

Muscles Involved

Primary: Biceps brachii

Secondary: Brachialis, brachioradialis, anterior deltoid, forearm flexors

TRIATHLON FOCUS

Triathletes need strong biceps to stabilize their position on the bike, to swim with greater efficiency, and to drive with their arms when running uphill or sprinting to the finish.

Having strong biceps is of particular importance during the bike leg and time trials. When riding in the aero position, triathletes engage the biceps by pulling up hard on the bars, using the bars as an anchor for leverage and stabilization.

For the runner, especially the long-distance triathlete participating in half-Ironman and Ironman races, strong biceps with enhanced endurance can contribute to faster times by enabling the athlete to maintain proper running form and biomechanics.

VARIATION

Stability Ball Dumbbell Curl

One popular variation is to perform the curl while seated on a stability ball. This engages the core muscle groups in addition to the biceps.

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9

CORE

"To core or not to core" is not the question but the answer. Core stability and function enable our bodies to move through time and space. Whether we are getting up from a chair, picking up a cup of coffee, or running the last leg of a triathlon, our core musculature provides the foundation for stability and movement. Mobilizing the core is an instantaneous process that is controlled through our autonomic central nervous system. This is an involuntary system that works more like reflexes than like deliberate motor movements. We are typically unaware of core muscle activity, but when core weakness leads to injuries to the back and lower extremities, it becomes quite evident.

The core can be defined as the region of the body that includes the bones of the hips, pelvis, and lower spine in conjunction with the muscles of the abdominal wall, pelvis, lower back, and diaphragm, which function together to stabilize the body as the lower and upper extremities move during activity. This lumbopelvic–hip complex is composed of both passive and active elements. The passive elements—including bones and ligamentous support of the lower spine, pelvis, and hip joint—are very strong and provide form and structure to the body. The active core muscles are the superficial and deep spinal extensor muscles, or paraspinals; abdominal muscles; pelvic floor muscles; and hip girdle muscles. Coordinated contraction of the abdominal muscles against the solid abdominal organs forms a ball-like core region that functions as a stabilizing platform for the spine and helps to maintain an upright posture. Let's examine each individual component.

BONY STRUCTURES OF THE CORE

The bony anatomy of the core consists of the upper portion of the femurs, or thighbones, each of which forms a ball-and-socket joint with the cup formed in the pelvis, called the acetabulum (figure 9.1). Unlike the shoulder joint, the hip joint is very stable. A strong ligamentous support surrounds the joint, creating what is referred to as a constrained joint. This design allows for motion, weight transmission, and stability. Dislocation of the hip is an uncommon occurrence and is usually caused by significant trauma.

The pelvis is made up of six bones: the ilium, ischium, and pubis, one on each side. These bones are tightly bound together, forming a circular platform with the sacrum at the back of the pelvis to protect internal organs and support the lower extremities. Weight-bearing forces that occur with impact loading or pushing activities pass through the hip joints and are distributed over the pelvis and dissipated to the spine.

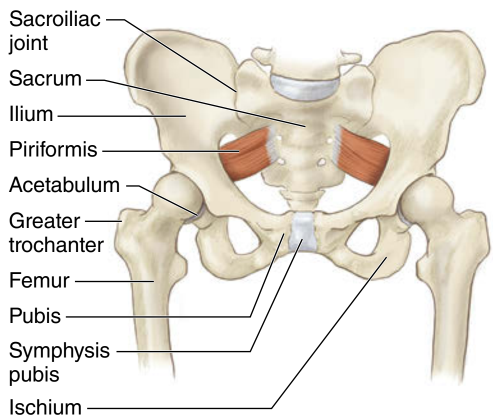


FIGURE 9.1 Bony structures of the pelvis.

MUSCLES OF THE CORE

The top portion of the ilium, the iliac crest, serves as the origin of the hip abductor musculature, including the tensor fasciae latae, gluteus medius, and gluteus minimus (figure 9.2). These muscles pull the leg away from the midline of the body and help stabilize the pelvis. The gluteus maximus originates from the back of the iliac crest and sacrum. It inserts into the posterior portion of the upper femur and is the main hip extensor. The front of the pelvis, the pubis, is the origin of the adductor group of muscles, those that pull the leg toward the midline of the body, discussed in more detail in chapter 4. The ischium is the origin for the hamstring muscles and is referred to as the sit bone because this is actually what we sit on and why a good fit for a bike seat is so important. We all know what it is like when that fit isn't right!

The muscular anatomy of the core can be divided into groups based on the motions they produce or resist. The large superficial muscles of the hip and

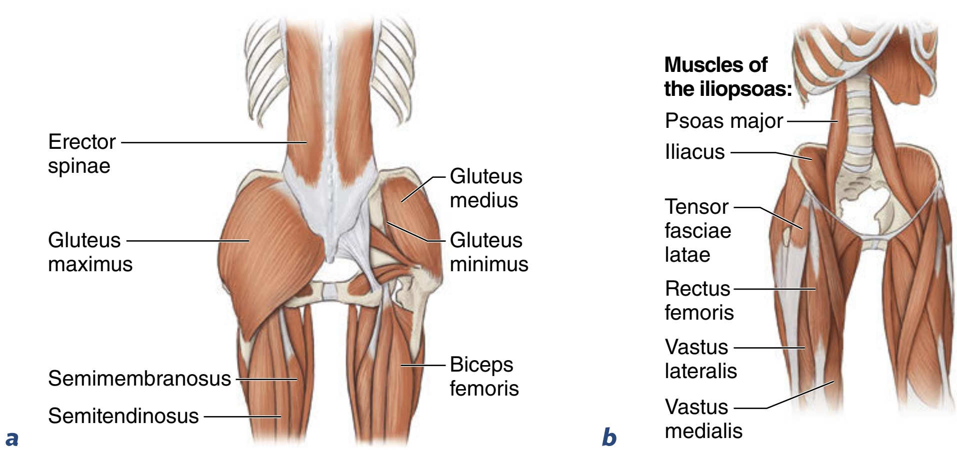


FIGURE 9.2 Muscles of the lower core and upper leg: *(a)* back; *(b)* front.

trunk are best suited to provide core stability, but smaller muscles referred to as intrinsics play a significant role and should not be disregarded.

When acting in isolation, the rectus abdominis (figure 9.3*a*) and transversus abdominis (figure 9.3*b*) of the abdominals initiate and produce trunk flexion (bending forward). The erector spinae and multifidus of the back (figure 9.4) and the gluteus maximus and hamstrings of the hips and legs cause hip and trunk extension, or backward bending. Coordinated co-contraction stabilizes the trunk. Force generation through the gluteus maximus to the lower extremities allows for activities such as running and jumping.

Muscles that control motion from side to side include the gluteus medius, gluteus minimus, and quadratus lumborum. In isolation, the gluteus medius and gluteus minimus abduct the leg away from the body. When the leg is planted on the ground during walking or running, these muscles hold the pelvis level and maintain lower-extremity alignment. The quadratus lumborum is very active during all upright motion and is a chief stabilizer of the spine. Weaknesses

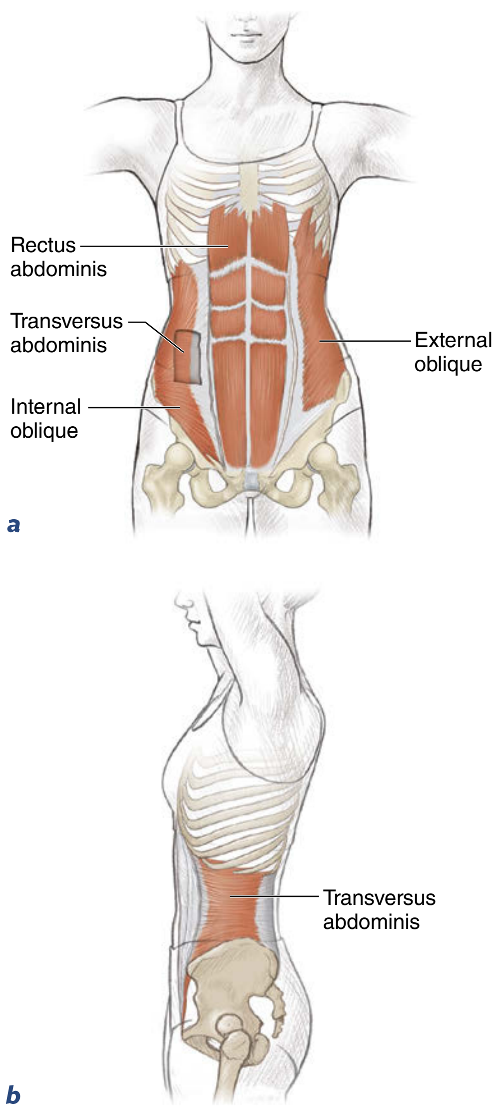


FIGURE 9.3 Abdominal muscles: *(a)* front view, showing the rectus abdominis and external and internal obliques; *(b)* side view, showing the transversus abdominis.

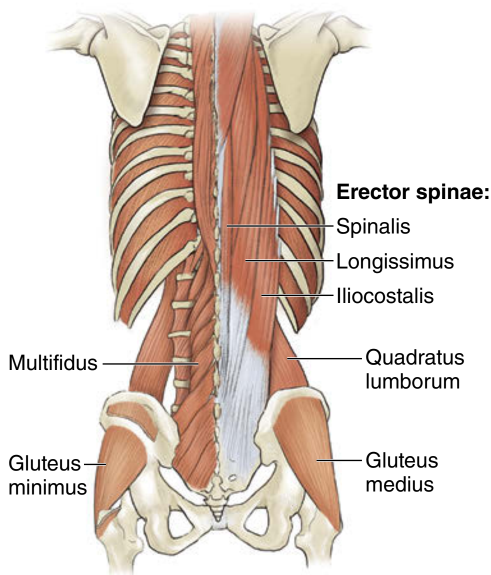


FIGURE 9.4 Core muscles of the back.

in these areas often result in the development of overuse injuries in the lower extremity seen in runners.

The group of hip adductors, those that pull the leg toward the midline of the body, include the adductor magnus, adductor longus, adductor brevis, and pectineus. These adductors, along with the hip external rotators, superior and inferior gemelli, quadratus femoris, obturator externus, and obturator internus, play a secondary role in core stability. These muscles are covered in more detail in chapter 4.

THE CORE'S IMPORTANCE FOR TRIATHLETES

Triathletes train and race in three very different sports. Improvement in cardiorespiratory fitness is a given with aerobic exercise—the heart doesn't know or care whether you are running, biking, or swimming. The musculoskeletal system, on the other hand, may need more guidance on how to stay strong and healthy. The physical demands, including stresses on the joints, muscles, tendons, ligaments, and bones, during triathlon training and racing are unique. Especially with endurance activities, prolonged stress can lead to potential fatigue and biomechanical failure, which is commonly seen in overuse injuries. This may lead to missed days of training and decreased performance. Of equal if not greater importance is the value of core stability in building a strong foundation that helps develop biomechanical efficiency, create power, resist fatigue, and prevent injury.

Core stability and thus function can be improved through both open- and closed-chain kinetic exercises as described later in this chapter. *Kinetic chain* is a term that describes a series of events in the musculoskeletal system that allow for movement and power generation. These actions require a coordinated process that relies on strength, flexibility, and range of motion in all parts of the body. Joint motion and subsequent power generation come from an initial contraction of the core muscles. This acts as the foundation on which all other activity occurs. In swimming, the catch phase and subsequent arm pull are aided by the contraction of the core muscles. This provides the anchor for the latissimus dorsi and shoulder and arm muscles to pull against to produce forward motion. During biking, if it were not for a stable pelvis and spine, an athlete could not maintain balance and produce force by pressing down and pulling up on the pedals. Similarly, as the runner transfers weight from one leg to the other, a stable pelvis and spine help to absorb shock, produce force, and prevent injuries by maintaining proper running mechanics.

ASSESSING CORE STRENGTH

How can we test our own core? There are a few tests that many clinicians, physical therapists, and other allied health professionals may use to assess core strength. Unfortunately, a single assessment may not be truly accurate in assessing core stability and weakness, but repeated evaluation and improvement define success.

Single-leg squatting is a common test for core function while running. Running is a single-leg activity that requires one to perform approximately 1,700 steps per mile. That is 10,540 single-leg squats per 10K run. Now put yourself in front of a mirror and start doing shallow single-leg squats. As your core weakens—especially your hip abductors, external rotators, and the multifidus—one side of your pelvis may begin to drop. As this occurs, the force transmitted to your hip, knee, and ankle can exceed the threshold of injury. Most commonly, a runner will develop knee pain called patellofemoral syndrome or runner's knee. So, a simple evaluation technique is to look at yourself in a mirror and see how easy it is to do multiple single-leg squats. Is your pelvis level? Does your knee, when seen from the front, bend straight up and down, or does it start to bend inward? Is this movement difficult to perform? Is one side easier than the other? Do you feel pain? Lots to think about, but a simple way of assessing core function.

Another method is to see how long you can maintain a side plank. It may be much more difficult than you think. This requires the engagement of many more core muscles, and it is both a great way to assess strength and a great exercise to build core strength. Working up to three sets of 60 seconds each demonstrates good muscular endurance.

EXERCISES FOR THE CORE

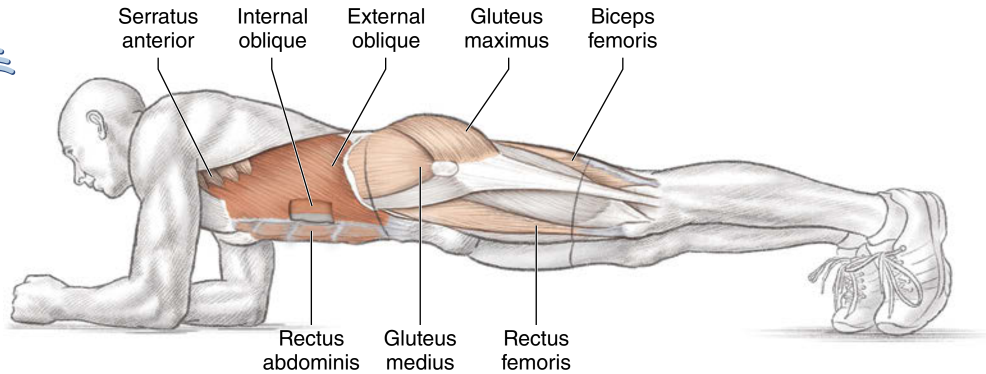
The core is often thought of as simply the muscles in the abdominal region, sides, and lower back. In fact, the core involves these areas plus other supporting muscles such as the glutes and lats. A coordinated, finely tuned effort from these muscles supports the spine and creates a foundation for balanced movement.

Although it's not uncommon to hear someone boast of how many sit-ups he can do at one time, the muscles of the core are like any other muscle in the body, and they adapt similarly to training stresses. Therefore, most of the core exercises described in this book are meant to be done 2 or 3 days per week, for two or three sets of 10 to 15 challenging repetitions.

To maximize core stability, you need to develop core strength. This is done by performing specific exercises that activate core muscles with sport-specific actions in mind. A basic abdominal crunch does not simulate the activities performed in triathlon. However, holding a position such as a plank can simulate riding in the aerobars. The longer you can stay there, the more aerodynamic you will be and the less fatigue you'll feel coming off the bike and starting the run.

The following exercises are done using your own body weight to produce strength and endurance. As strength improves, try to hold each position for a greater amount of time or to perform more repetitions. These exercises will help you to develop a strong functional core that can lead to injury-free training and racing.

PLANK



Execution

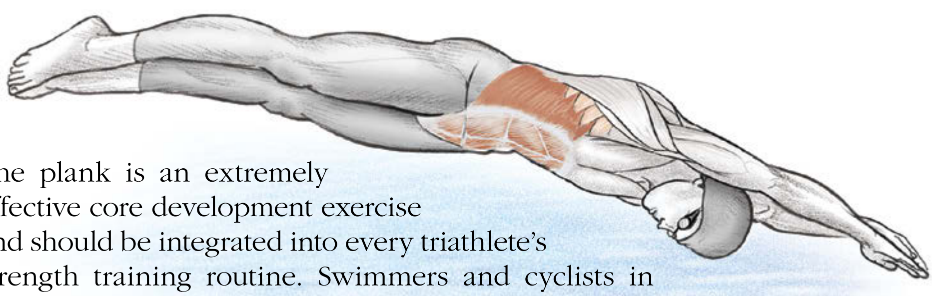
1. Start in a prone position, facedown and back straight, with weight rested on forearms and toes.
2. Engaging the entire core area and keeping the body flat, hold this position for 15 to 30 seconds, depending on your level of fitness.

Muscles Involved

Primary: Rectus abdominis, external oblique, internal oblique, transversus abdominis

Secondary: Serratus anterior, rectus femoris, gluteus maximus, gluteus medius, hamstrings (biceps femoris, semitendinosus, semimembranosus)

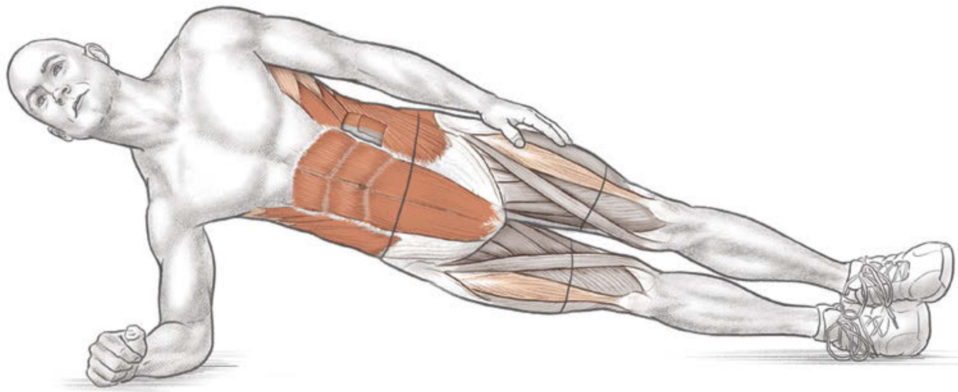
TRIATHLON FOCUS



The plank is an extremely effective core development exercise and should be integrated into every triathlete's strength training routine. Swimmers and cyclists in particular require stronger muscles that stabilize the body when in a horizontal plane, including freestyle swimming and laying out on aerobars.

The key to performing the plank is to keep the body rigid and the head in a neutral position. If the hips begin to drop, you'll need to focus on bringing them back into line or discontinue the exercise until your endurance improves. It's recommended that you start with 15 seconds in each position (front facing and side facing) and work up to holding each position for up to 1 minute. There are countless variations on the plank, and adding dynamic movements is a great way to make the exercise more challenging and effective as you progress.

VARIATION

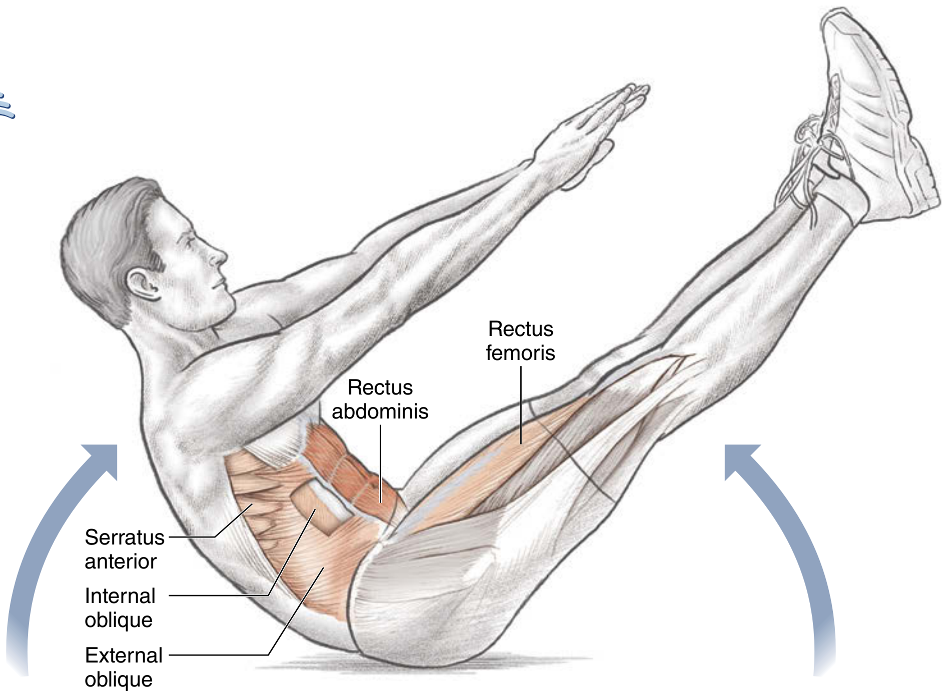


Side Plank

Begin as if doing a standard plank. Rotate to face left, supporting yourself on your right forearm and the side of your right foot. Stack your left leg on top of the right. Keep your left arm at your side, or for added difficulty, point it straight up. Hold this position for 15 to 30 seconds to start, eventually working up to 60 seconds.

Return to the forward position, then rotate to the other side, using the same technique just described. If you are more advanced, hold the forward position for 15 to 30 seconds before rotating to the other side.

V-SIT



Execution

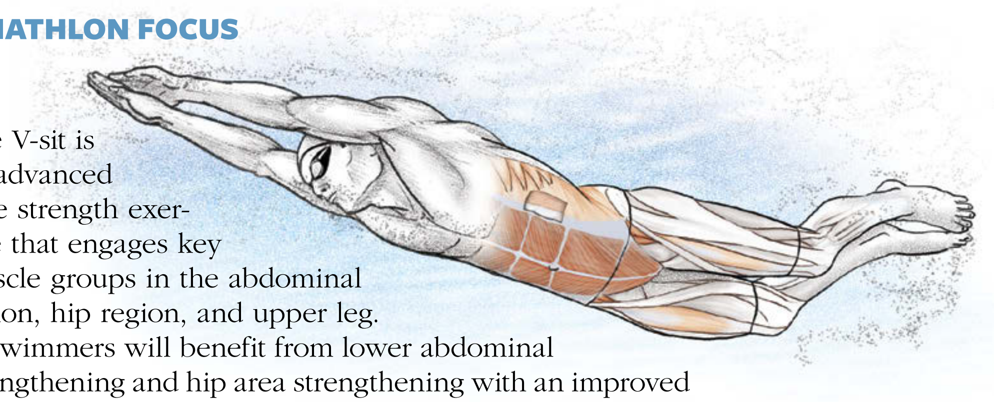
1. Start by lying flat on your back on a mat or other soft surface.
2. Simultaneously raise your upper body and your legs, bending at the hips, forming a V shape.
3. Return to the start position, and repeat the movement for the required number of repetitions.

Muscles Involved

Primary: Rectus abdominis

Secondary: External oblique, internal oblique, transversus abdominis, serratus anterior, rectus femoris, iliopsoas

TRIATHLON FOCUS



The V-sit is an advanced core strength exercise that engages key muscle groups in the abdominal region, hip region, and upper leg.

Swimmers will benefit from lower abdominal strengthening and hip area strengthening with an improved kicking motion. Cyclists will be more comfortable during extended time in the aero position while also benefitting from strengthened hip flexor and rectus femoris muscles, which are important for pulling up or unweighting the pedals during the 7 to 11 o'clock phase of the pedal-stroke cycle.

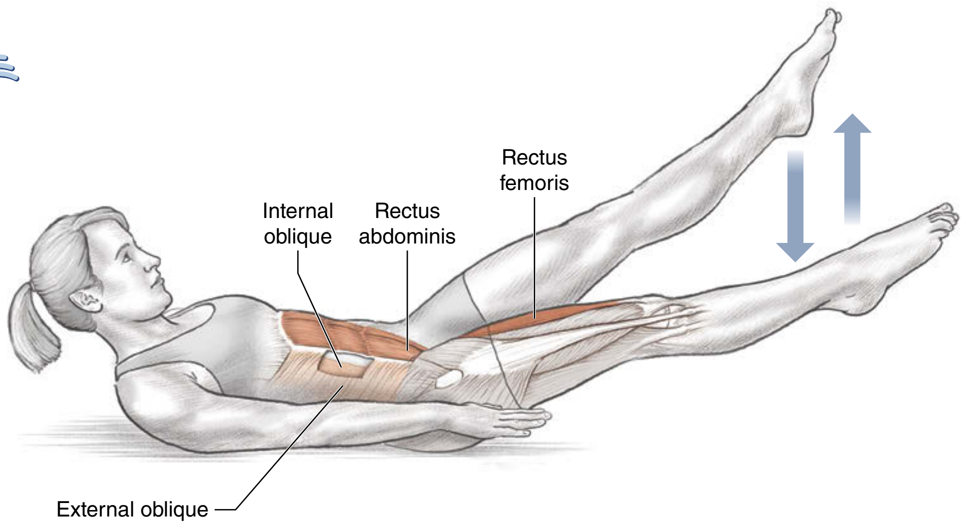
Add intensity to this exercise by lowering the legs and upper body almost to the ground, but not all the way, maintaining constant muscle activation.

VARIATION

V-Sit With Weights

Add intensity to the V-sit by holding a medicine ball or other weight at the chest and then extending it toward the legs during each repetition.

FLUTTER KICK



Execution

1. Start by lying on your back with your toes pointed and your arms at your sides.
2. Gently lift your shoulders and hands slightly off the ground, engaging your core, while also bringing your feet 12 to 16 inches (30 to 40 cm) off the ground, keeping your toes pointed.
3. From this position, kick your legs up and down (flutter kick). Focus on keeping your toes pointed.
4. Perform these kicks for 15 to 30 seconds, working toward the goal of 60 seconds, resting 30 to 60 seconds between sets.

Muscles Involved

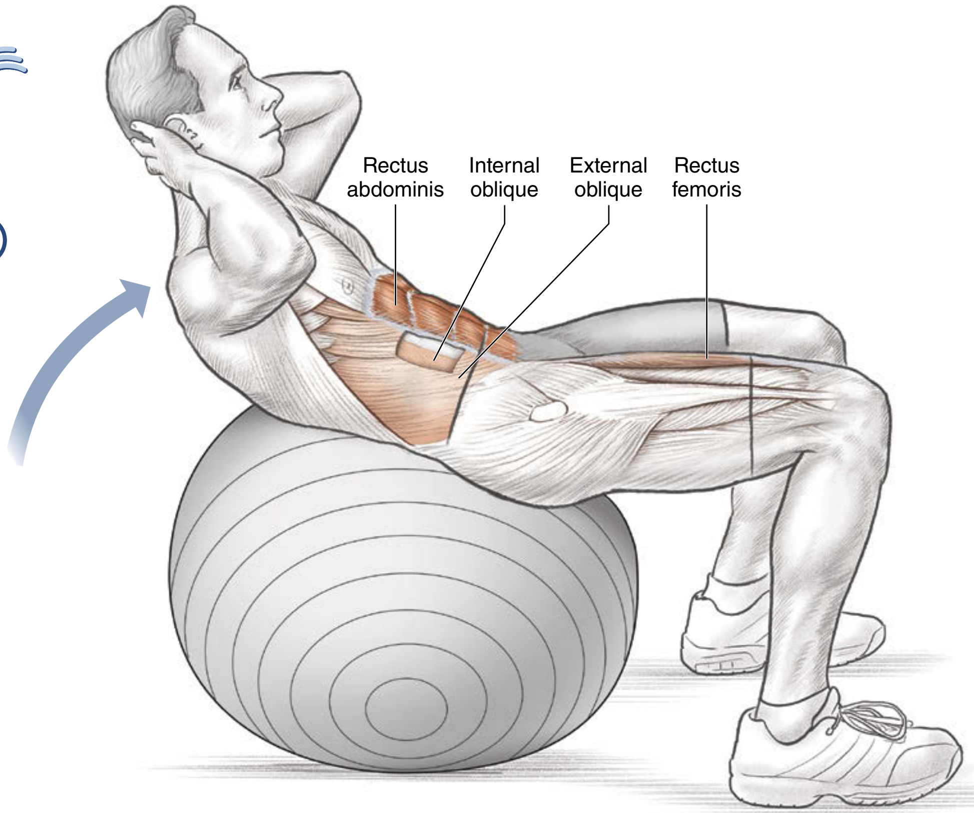
Primary: Rectus abdominis, rectus femoris

Secondary: External oblique, internal oblique, transversus abdominis, iliopsoas

TRIATHLON FOCUS

The flutter kick activates key muscle groups, including the lower rectus abdominis and the rectus femoris, used when kicking during the freestyle swim stroke. In addition, performing this exercise and pointing your toes can improve ankle flexibility. A key to performing this exercise is to focus on keeping the lower back flat with the help of the abdominal musculature. Keep your toes pointed as well, which promotes greater ankle flexibility and better foot position for more propulsive kicking during the freestyle stroke cycle.

STABILITY BALL CRUNCH



Execution

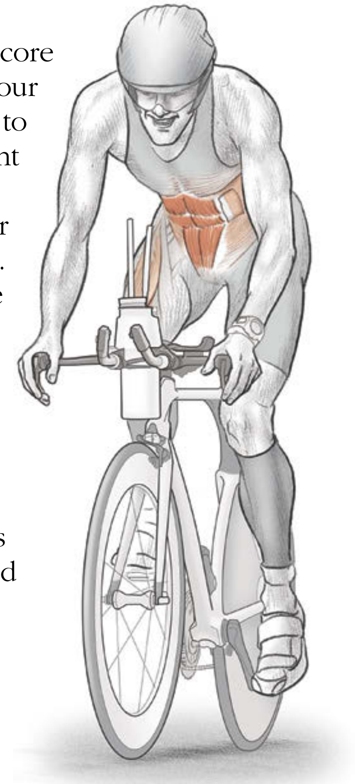
1. Start this exercise with the stability ball positioned in the middle of your back. Plant your feet on the floor about shoulder-width apart.
2. Support your head with your hands in a neutral position, but don't pull your head up with your hands because this places undue strain on your neck.
3. Raise your chest and shoulders toward the ceiling. Focus on isolating and engaging your abdominal muscles. Hold the crunch for a few seconds when you near full contraction.
4. Lower slowly to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Rectus abdominis

Secondary: External oblique, internal oblique, transversus abdominis, rectus femoris

TRIATHLON FOCUS



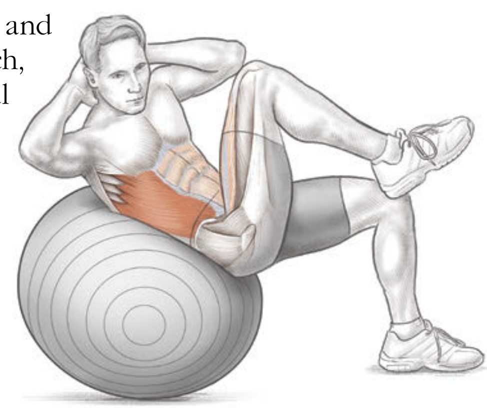
The stability ball crunch is a safe and effective core strengthening exercise that should be a staple in your triathlon core strength training program. It's easy to perform and can be adjusted to suit your current fitness level.

Always focus on proper form and on isolating your abdominal muscles when you perform this exercise. Keep your feet flat and your quads parallel to the ground as you balance yourself on the ball.

Working on the core offers an indirect boost to swimming, cycling, and running performance by enhancing the strength and stability of muscles responsible for balance. That provides the foundation for all movement. The stability ball crunch is effective in building strength and endurance. It is recommended for all athletes, not just those engaged in swimming, cycling, and running.

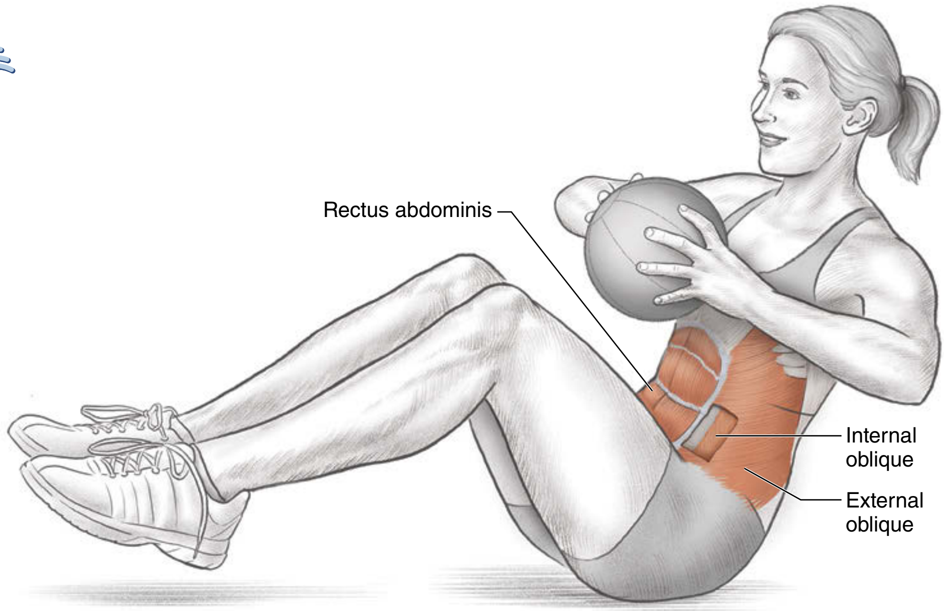
VARIATION

Stability Ball Crunch With Trunk Rotation



By incorporating a twisting motion and alternating side to side with each crunch, you'll target the internal and external obliques, enhancing your ability to rotate the torso.

RUSSIAN TWIST



Execution

1. Sitting on the ground with your knees bent, hold an appropriately weighted medicine ball, one that enables you to perform 10 to 15 repetitions with considerable effort, to your chest with both hands.
2. Gradually lean back so that your torso forms approximately a 45-degree angle to the floor. Raise your feet 3 to 6 inches (7.5 to 15 cm) off the ground.
3. Using only your trunk muscles, rotate from side to side. Repeat this movement for 10 to 15 repetitions.

Muscles Involved

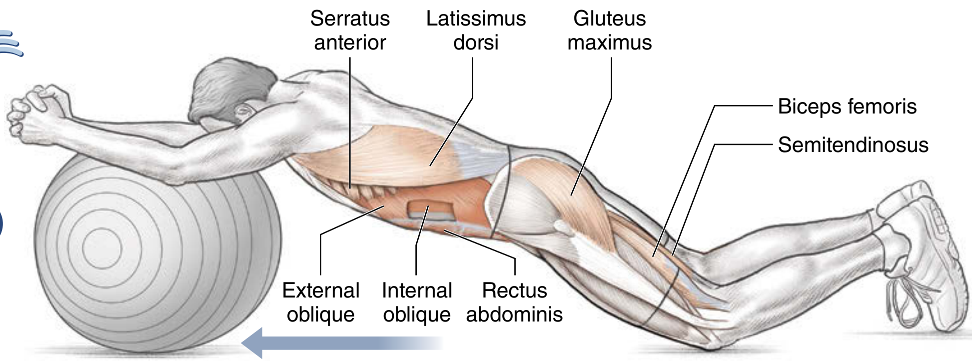
Primary: Rectus abdominis, external oblique, internal oblique

Secondary: Psoas major

TRIATHLON FOCUS

The Russian twist is an excellent exercise for targeting the obliques and enhancing your ability to rotate at the hips. This is especially important in freestyle swimming since core strength is critical for maintaining a streamlined position in the water. As the leading hand enters the water and reaches before the catch, the core is engaged as the pulling motion is initiated, helping to whip the hips into proper alignment for maximum acceleration and streamlining.

STABILITY BALL PRAYER ROLL



Execution

1. Start on your knees while resting your forearms on a stability ball.
2. Slowly push the ball away, using your forearms to support your weight until you achieve an outstretched position suitable for your current level of fitness.
3. After a brief pause, roll the ball back to the starting position. Repeat for 10 to 15 repetitions.

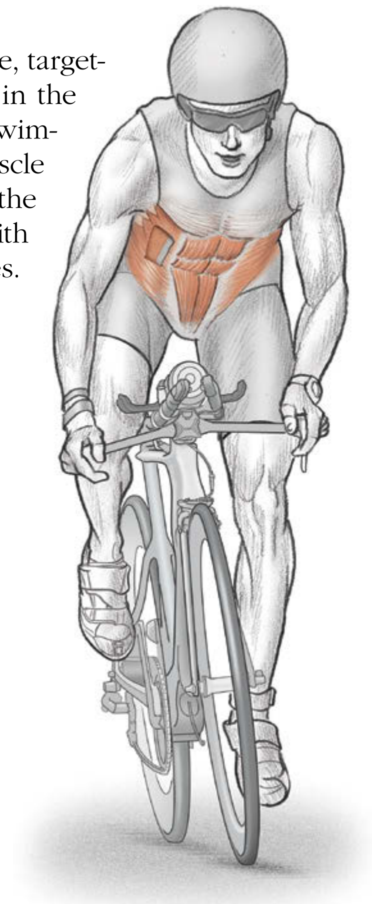
Muscles Involved

Primary: Rectus abdominis, external oblique, internal oblique, transversus abdominis

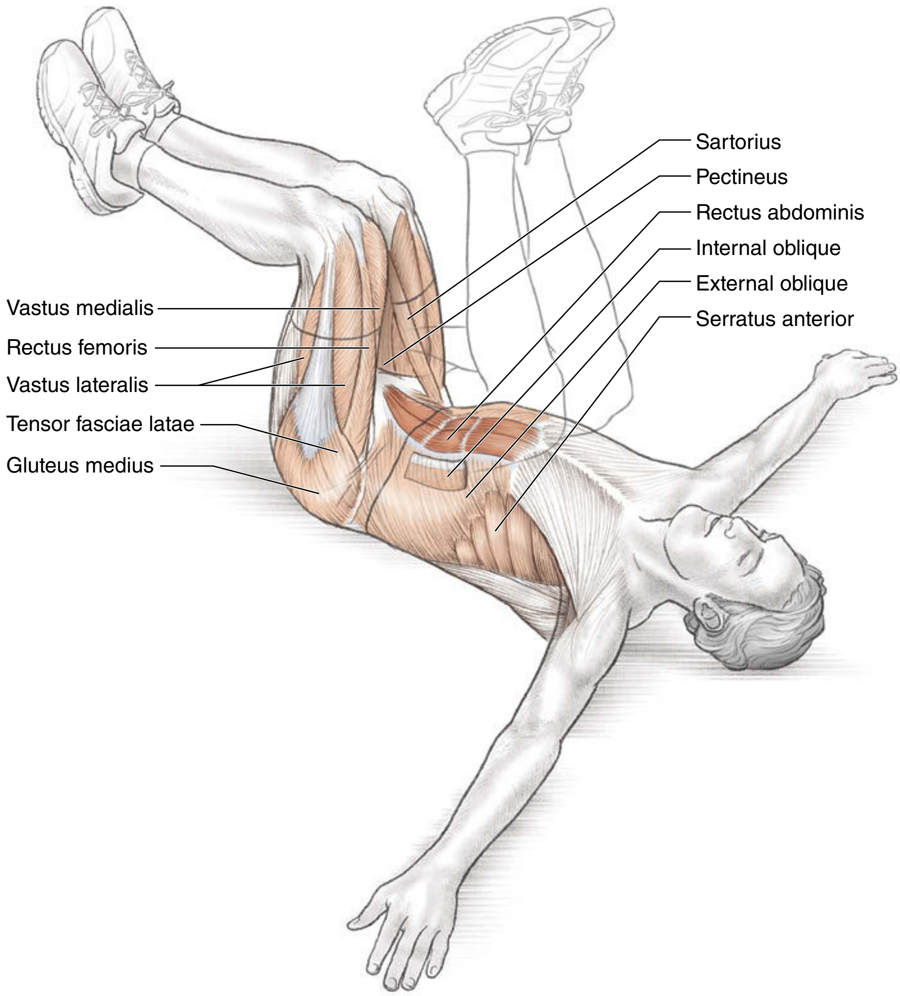
Secondary: Latissimus dorsi, serratus anterior, gluteus maximus, hamstrings (biceps femoris, semitendinosus, semimembranosus)

TRIATHLON FOCUS

This is a very effective core strengthening exercise, targeting muscles in the abdominal region as well as in the upper and lower back. Its application to freestyle swimming is clear because it addresses many of the muscle groups used in the underwater pulling phase of the stroke. It will also help triathletes to ride longer with greater comfort in the aero position on their bikes.



REVERSE CRUNCH



Execution

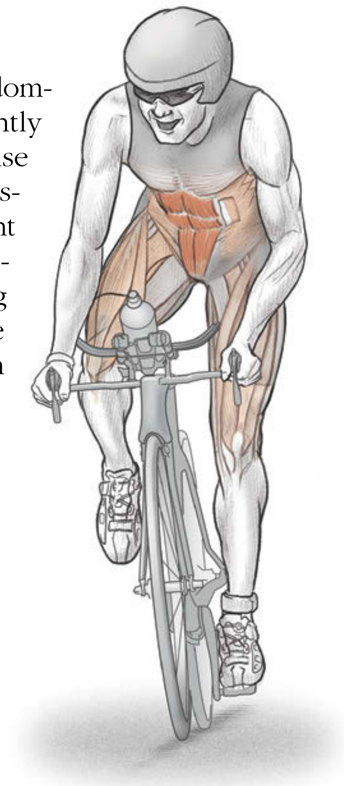
1. Lie on your back with your upper legs perpendicular to the ground and your lower legs parallel to the ground.
2. Stabilize your upper body by stretching your arms out to your sides, palms flat on the ground.
3. Focus on engaging the lower abdominal muscles as you lift your pelvis off the floor, bringing your knees toward your chest.
4. Lower your pelvis to the starting position. Repeat for the required number of repetitions.

Muscles Involved

Primary: Rectus abdominis

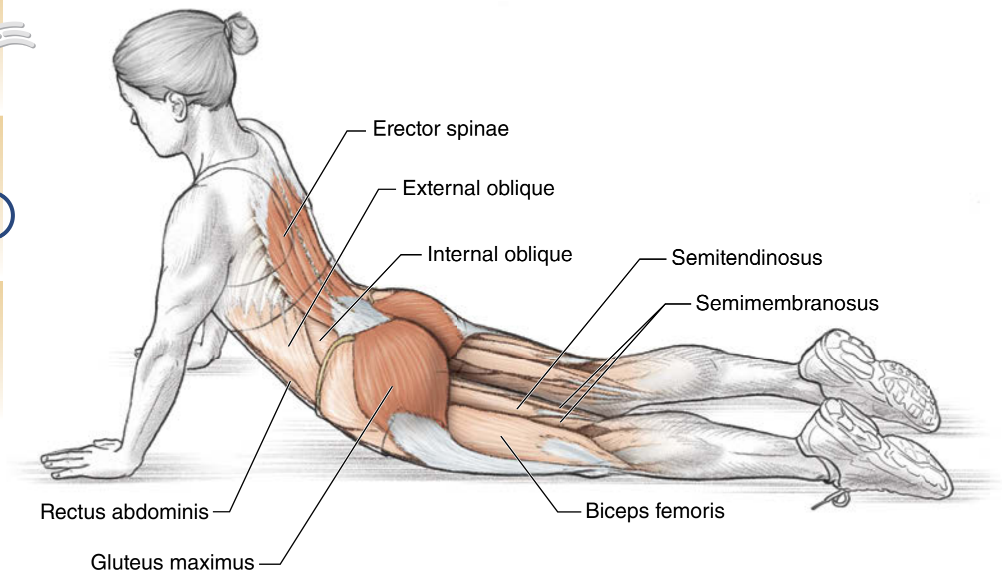
Secondary: External oblique, internal oblique, transversus abdominis, serratus anterior, quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), hip flexors (including the gluteus medius, tensor fasciae latae, sartorius, pectineus)

TRIATHLON FOCUS



It is important for triathletes to develop the lower abdominal muscles because these muscles are constantly engaged in each of the three disciplines. This exercise offers a safe and effective way to strengthen these muscles by isolating the area for maximum engagement while limiting the likelihood of cheating during execution. From the freestyle kick in open-water swimming to hard uphill charges both on the bike and on the run, strong core muscles will help you to maintain proper form while you push toward the finish line.

BACK EXTENSION PRESS-UP



Execution

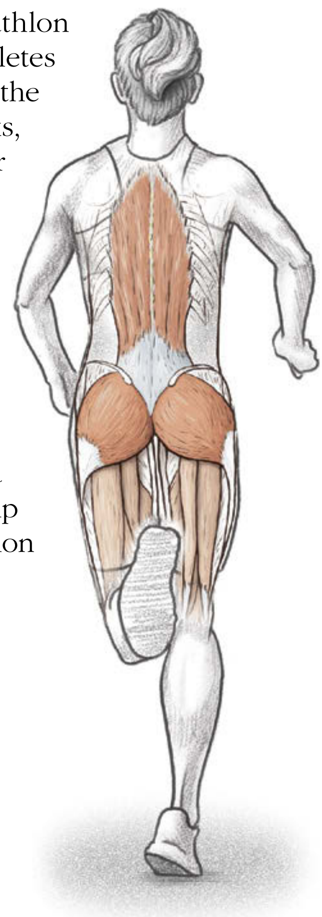
1. Start on the ground in the push-up position, facedown and back flat.
2. Slowly push up with the arms until only your torso is off the ground. Your legs stay flat on the floor.
3. Hold this position for 10 to 15 seconds. Focus on activating the muscles of the lower back and glutes.
4. Return to the starting position, and repeat for the required number of repetitions.

Muscles Involved

Primary: Erector spinae (iliocostalis, longissimus, spinalis), gluteus maximus

Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), rectus abdominis, external oblique, internal oblique

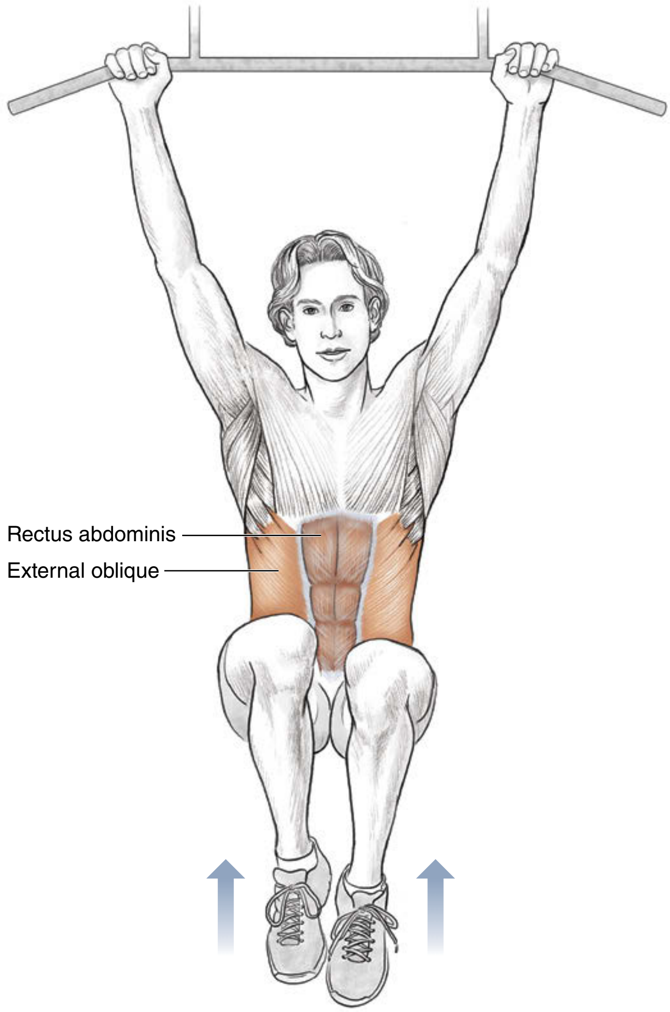
TRIATHLON FOCUS



Core strengthening exercises are critical for triathlon success in many ways. Unfortunately, many athletes overemphasize the abdominal region and neglect the important muscles in the lower back and buttocks, ultimately leading to muscular imbalances and further increasing the risk of injury during repetitive-motion activities.

The back extension press-up is a simple exercise that offers a huge return on investment in terms of developing those key back muscles to stabilize the pelvic region. This is especially important for the running leg of the triathlon because a misaligned pelvic region can adversely affect the runner's gait, leading to other biomechanical inefficiencies and potential injury. Lower-back strength will also help you maintain an aerodynamically desirable position on the bike.

HANGING KNEE RAISE



NOTE: You can also do this with straight legs rather than bending at the knee.

Execution

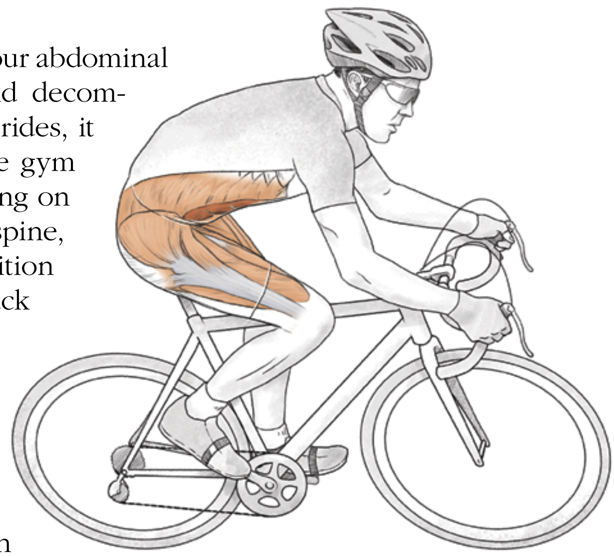
1. Hang from the pull-up bar using a palm-forward grip.
2. Simultaneously lift both knees toward your chest. Use a controlled movement rather than swinging and using momentum. Your thighs should move higher than horizontal to the floor. A person standing in front of you should be able to see the underside of your butt.
3. Slowly and with control, lower your legs and extend the knees.

Muscles Involved

Primary: Rectus abdominis

Secondary: External oblique, internal oblique, transversus abdominis, sartorius, iliopsoas, rectus femoris, tensor fasciae latae, pectineus, adductor brevis, adductor longus

TRIATHLON FOCUS



This exercise not only works your abdominal muscles but also stretches and decompresses your spine. After long rides, it always feels good to get in the gym and perform this exercise. Sitting on the saddle compresses your spine, and the forward-leaning position on the bike can tighten your back muscles. Before and after a set of hanging knee raises, you should hang with your legs dangling for a few moments to let the ligaments and muscles get a good stretch. As you lift your legs, you'll feel the strain on your abdominal muscles. This exercise will give you a great workout to help balance the power of your lower back. You'll also be training your smaller stabilizers if you keep your body under control during the exercise—this means no swinging as you lift and lower your legs. In addition, you'll be working your forearms and grip strength by hanging from the bar. If you have trouble holding onto the bar for the entire set, try using arm slings. Slip your hands and elbows through the slings and let your body weight rest on the backs of your upper arms.

VARIATION

Lateral Hanging Knee Raise

Instead of raising your legs straight up in front, try doing a set in which you alternate raising your knees to one side and then the other. This will place added emphasis on your oblique muscles. For an even greater challenge, you can add a medicine ball between your feet. This can be performed on both the hanging knee raise and the lateral hanging knee raise.

10

WHOLE-BODY TRAINING

Over the last few chapters we have outlined a series of exercises intended to strengthen specific groups of muscles that triathletes should develop. One advantage of such training is that athletes can overload the intended muscles with each movement. But in real life and in triathlon, movements rarely come from isolated muscle contractions. Instead, they involve a coordinated series of muscle interactions, usually across multiple joints to create fluid motion. This whole-body involvement occurs throughout a triathlon. A crucial contributor to whole-body motion is the stable platform provided by strong core muscles that support force generation, balance, and efficient motion. The exercises in this chapter engage both core muscles and other muscle groups that help triathletes to develop sport-specific strength and to improve their performance.

It is important to note that many coaches prefer sport-specific strength development over other methods. Examples of this include swimming with hand paddles and drag suits; doing hill repeats on the bike while using a high resistance and low cadence; running stairs; running steep hill repeats; or using a resistance device, such as a parachute or an elastic cord held by a coach. Each of these serves to build strength that is specific to the movement pattern of each discipline and is beneficial to that activity specifically. Training with these methods needs to be done carefully for actions that require precision. However, when coupled with skill work, they can be effective.

Resistance training with the use of weights or body weight develops strength. Generating motion and force across multiple joints and performing multiple repetitions can also stress and improve the cardiorespiratory system. Secondary effects of this type of training also enhance the neuromuscular system. Neural pathways that control muscular contractions become more efficient and result in increased efficiency of motion, which can ultimately lead to decreased energy consumption. You feel this effect as you train and get into better shape. Workouts become easier, and you become stronger and faster. This process is referred to as neuromuscular adaptation. Unfortunately, as the body gets used to each exercise, strength development and neuromuscular improvements can plateau. Periodization with training, as discussed in chapter 3, helps break the pattern of repetitive activity and allows for continued improvement while also helping to prevent injuries.

MULTIJOINT EXERCISES

The exercises described in this chapter are divided into multijoint and plyometric activities. Multijoint exercises engage two or more groups of muscles that cross more than one joint. Motion about a joint often involves a pair of muscles that work synergistically—that is, they produce greater force together than they can produce separately. This is referred to as an agonist and antagonist pair. This type of muscle interaction also helps with joint stabilization and mechanics, and this helps to protect the joint throughout the range of motion. An agonist is a muscle that causes specific movement, such as flexion, which is defined as bending the joint, or extension, straightening the joint. The antagonist muscle would cause the opposite motion. In the arm, as the biceps brachii contracts and bends the elbow, the triceps brachii relaxes and lets that motion occur. Similarly, when the elbow is straightened, or extended, the opposite occurs. This motion seems simple, but as you involve multiple joints and muscles, this basic contraction–relaxation mechanism becomes more complex.

To better understand this complex motion, you need to understand some basic concepts of muscle contraction and interaction during joint motion and some concepts of muscle training. Muscles contract, or create tension, by staying the same length (isometric contraction), shortening (concentric contraction), or lengthening (eccentric contraction). Basic weight training uses the principles of open-chain and closed-chain exercises. (More advanced techniques are available but often require specialized equipment.) In open-chain exercises, force and motion are generated across a joint so the distal portion of the extremity—the hand or foot—is moving and free in space. Examples include leg extensions and biceps curls. A closed-chain exercise occurs when the distal portion of the foot or hand is fixed to the ground, as it would be during a squat or a push-up. Open- and closed-chain exercises differ in the interplay between the agonists and antagonists. Throughout the motion of the lunge (closed chain), there is a co-contraction of both agonists and antagonists. This reduces the force and stress on the joints, possibly preventing injury. Closed-chain exercises tend to offer increased functional benefits. Open-chain kinetic exercises isolate individual muscle groups and are best for muscle-specific strength gains. In training and racing, combinations of isometric, concentric, and eccentric contractions occur in all muscles, depending on the angle of the joints involved.

PLYOMETRIC EXERCISES

Plyometric exercises, a combination of eccentric and concentric explosive muscular contraction, are designed to produce fast, powerful movements. These exercises have been shown to improve sport performance, including gains in power and speed. When a muscle is loaded or stretched and then forced to rapidly contract and produce motion, a plyometric action is produced. This elastic recoil mechanism is demonstrated in the double-leg power jump. When they contract concentrically, muscles have a maximum potential for force generation. Eccentric loading of a muscle, referred to as preloading, creates a state in which force production can be increased past this point. The extent of stretch and the speed with which the muscle is loaded are two major factors that affect the extent to which the muscle can produce force. A shorter time between the eccentric and concentric contractions will also increase force production. When you perform a double-leg power jump, the muscles of the lower extremities are stretched as you come down and squat. The transition to jumping and the subsequent muscular contraction that enables you to leave the ground complete the actions of the elastic recoil mechanism. Sensory nerve fibers within muscle are also activated and trained as the elastic recoil occurs. It is this type of exercise training that helps increase efficiency between the brain and muscles.

Used judiciously, plyometric exercises have been shown to reduce lower-extremity injuries when combined with other exercises, including strength training, balance training, and stretching. Additionally, because of the aforementioned neuromuscular benefit, plyometrics can help increase efficiency and economy in triathletes. There is a potential for increased injury, though, because of the large forces generated during these activities. Plyometric exercises should be performed only after an initial program of strength and flexibility training has been completed. A proper warm-up is essential before performing these exercises.

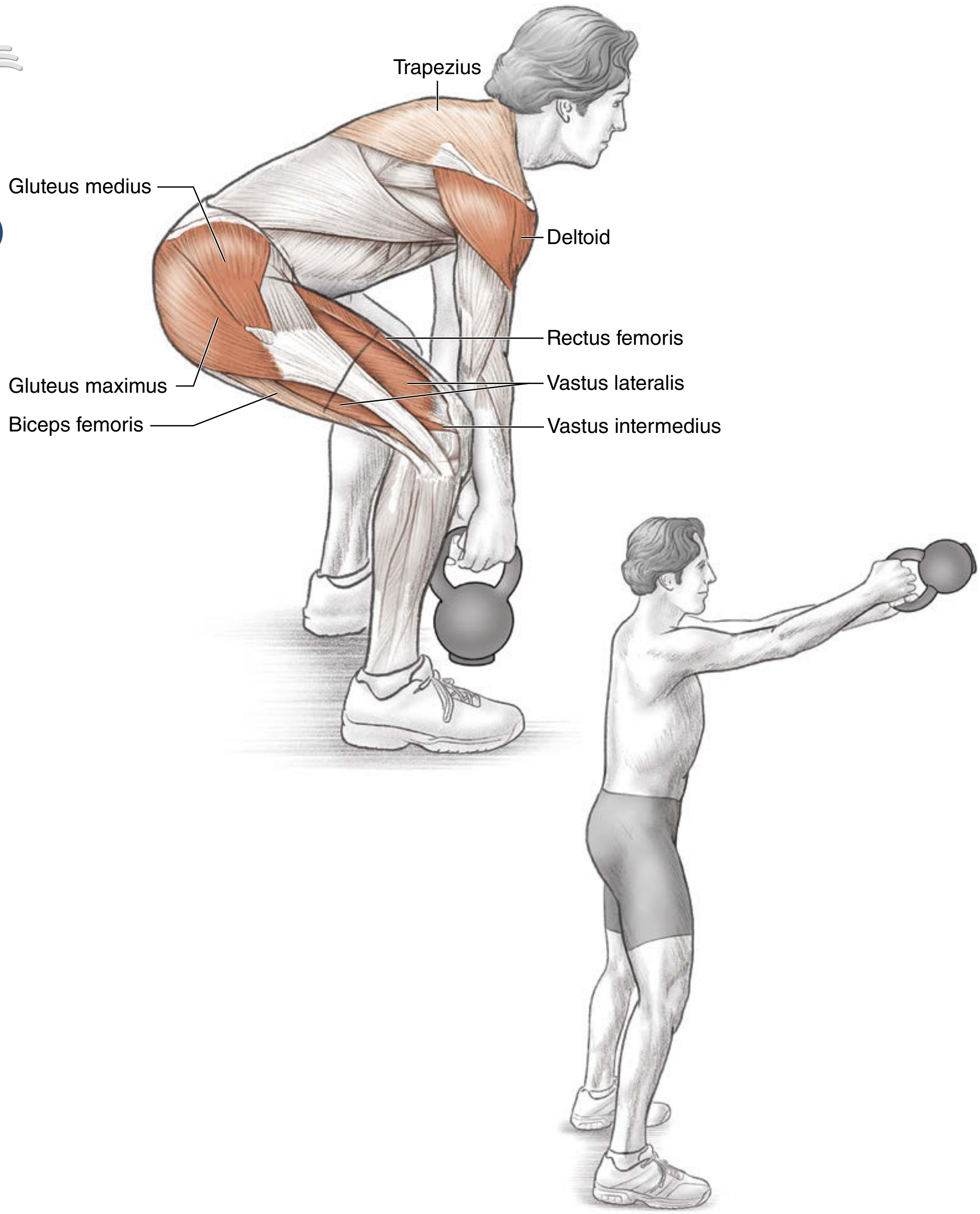
EXERCISES FOR THE ENTIRE BODY

These exercises are considered to be effective for full-body training. Proper execution of each exercise in a strategically designed training program specific to the needs of the competitive triathlete is the key to success.

Because of the nature of full-body training, which tends to be very active and at times requires explosive output, a proper warm-up routine is highly recommended, including a series of dynamic stretches.

With regard to sets and repetitions, many coaches prescribe a time frame in which the athlete performs as many repetitions as possible with proper technique. This encourages the athlete to push his limits as well as notice progress and improvements in fitness. Using the burpee as an example, perform as many repetitions as possible within 30 seconds or a set of 10 to 15 repetitions. Ultimately, it's up to the coach and the athlete to determine which method works best. In either case, it's recommended that the athlete complete two to four sets of 10 to 15 repetitions with 1 to 2 minutes of rest between sets.

KETTLEBELL SWING



SAFETY TIP: While at first glance the swing appears to be initiated by the upper body, it's actually your lower half that should be doing most of the work. Don't try to "muscle up" the kettlebell with your arms and shoulders.

Execution

1. Starting in a squat position with a flat back, grasp a kettlebell resting on the floor between your legs.
2. From the squat position, drive your hips forward and rise to an upright stance while swinging the kettlebell out in front of you.
3. Keeping your arms straight, bring the kettlebell to just above shoulder height.
4. Keeping your back straight, bend from the hips and let the kettlebell swing back down between your legs and out behind you.

Muscles Involved

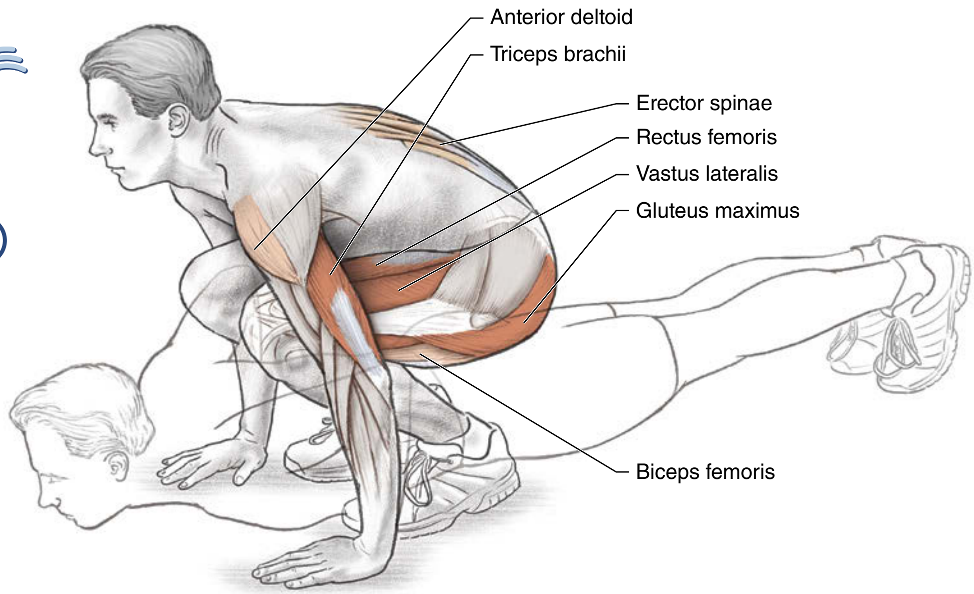
Primary: Quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), gluteus maximus, gluteus medius, gluteus minimus, erector spinae (iliocostalis, longissimus, spinalis), deltoid, rectus abdominis

Secondary: Gracilis, hip adductors (adductor brevis, adductor longus, adductor magnus), pectineus, hamstrings (semitendinosus, semimembranosus, biceps femoris), trapezius, pectoralis major, palmaris longus, flexor carpi radialis, flexor carpi ulnaris

TRIATHLON FOCUS

Because of the emphasis on the glutes and hamstrings, the kettlebell swing can be helpful in developing power on the run and the ride. Because the power is initiated from the bottom of a squat position, it is particularly applicable for riding in a low, aerodynamic position.

BURPEE



SAFETY TIP: Exercise caution when performing the ballistic jumping motion. Knees should be slightly bent at the point of impact.

Execution

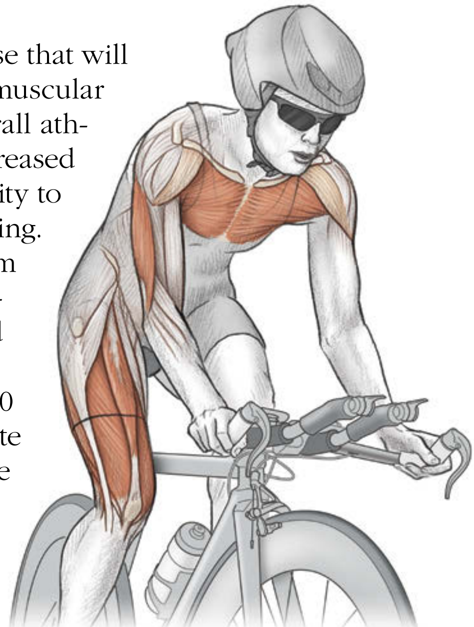
1. Start in a standing position with your feet shoulder-width apart. Place your hands on the ground.
2. Kick your legs out and assume a push-up position with a flat back. Lower yourself and perform a push-up while keeping your body straight. Forcibly push back up.
3. Draw your feet underneath your body and then explosively jump into the air as you extend your arms straight over your head.
4. Land on the ground with knees slightly bent. Perform the movement again for the required number of repetitions.

Muscles Involved

Primary: Quadriceps (rectus femoris, vastus lateralis, vastus intermedius, vastus medialis), gluteus maximus, pectoralis major, triceps brachii

Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), erector spinae (iliocostalis, longissimus, spinalis), anterior deltoid

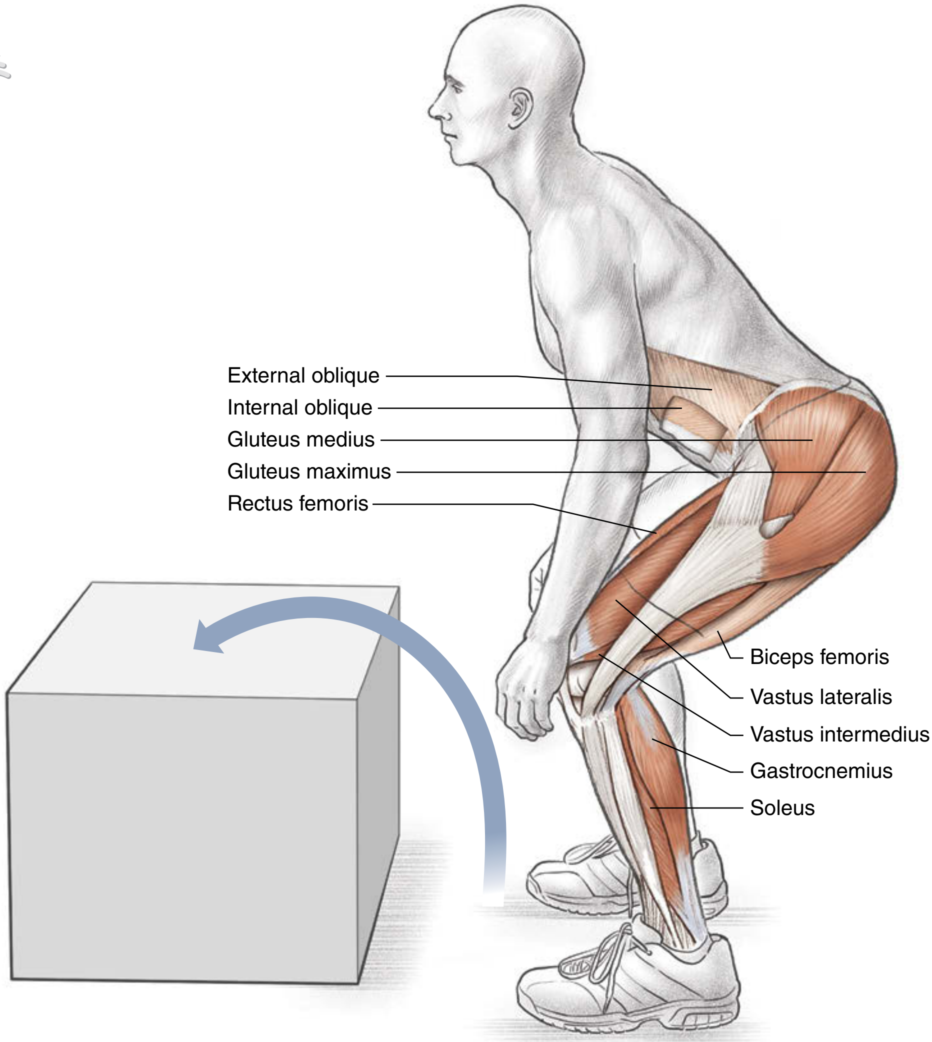
TRIATHLON FOCUS



The burpee is a great all-around exercise that will develop both cardiorespiratory and muscular strength and endurance as well as overall athleticism. Swimmers will benefit from increased upper-body strength as well as the ability to push more forcibly off the wall in training. Cyclists and runners will benefit from enhanced leg strength and power resulting from the jumps, as well as increased overall dexterity and quickness.

As athletes quickly discover, a set of 10 to 15 repetitions will elicit a high heart rate and significant fitness gains when done with some consistency in a structured dryland training program.

BOX JUMP



Execution

1. Place a plyometric box, approximately knee height, firmly on the ground. Stand 6 to 8 inches (15 to 20 cm) from the box.
2. Launch yourself with a powerful jump onto the box. Land with your legs slightly bent.
3. Stand up straight on top of the box to finish the movement.
4. Step down to the starting position. Repeat for the required number of repetitions.

Muscles Involved

Primary: Quadriceps (rectus femoris, vastus medialis, vastus intermedius, vastus lateralis), gluteus maximus, gluteus medius, gastrocnemius, soleus

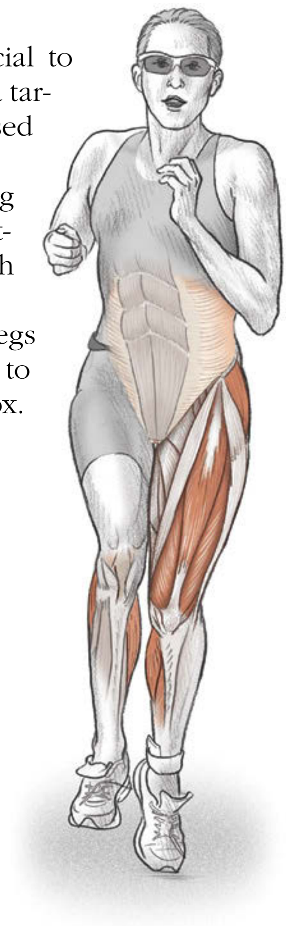
Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), external oblique, internal oblique, transversus abdominis, erector spinae (iliocostalis, longissimus, spinalis)

TRIATHLON FOCUS

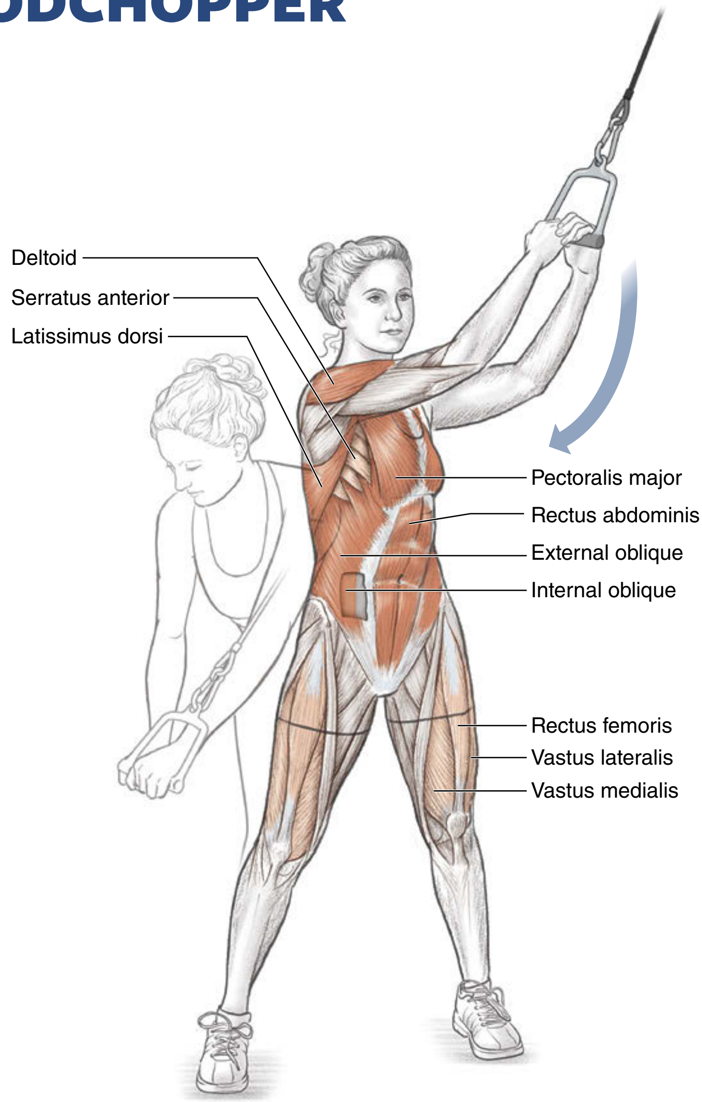
Box jumps develop explosive power that is beneficial to cyclists and runners. Jumping up on the box provides a targeted challenge because the box height can be increased as jumping fitness and power improve over time.

Cyclists will benefit from this exercise by realizing more explosive power on climbs and in sprinting situations. Runners will develop the ability to drive with more power and speed up steep inclines.

Cheating in this exercise involves tucking the legs excessively to get to the box. If you find it necessary to tuck your legs, consider reducing the height of the box.



WOODCHOPPER



Execution

1. Stand sideways to a high-pulley machine, with your feet slightly wider than shoulder-width apart.
2. Grasp the handle with both hands.
3. Initiate the movement with the arm, shoulder, and chest muscles, pulling the handle diagonally down across your body.
4. Engage the core muscles while simultaneously bending your knees as you pull the handle toward the ground.
5. Slowly control the return to the starting position. Repeat for the required number of repetitions.

Muscles Involved

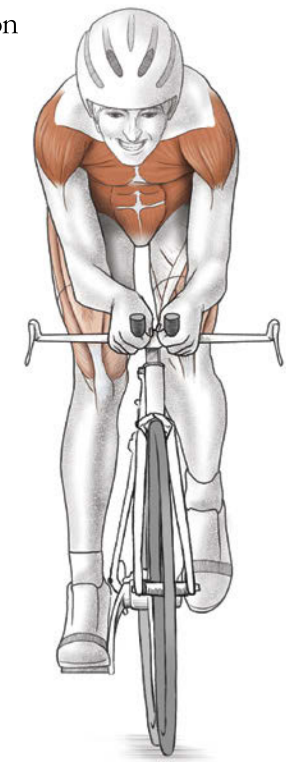
Primary: Rectus abdominis, internal oblique, external oblique, deltoid, latissimus dorsi, pectoralis major

Secondary: Quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), gluteus medius, gluteus maximus, gluteus minimus, teres major, serratus anterior

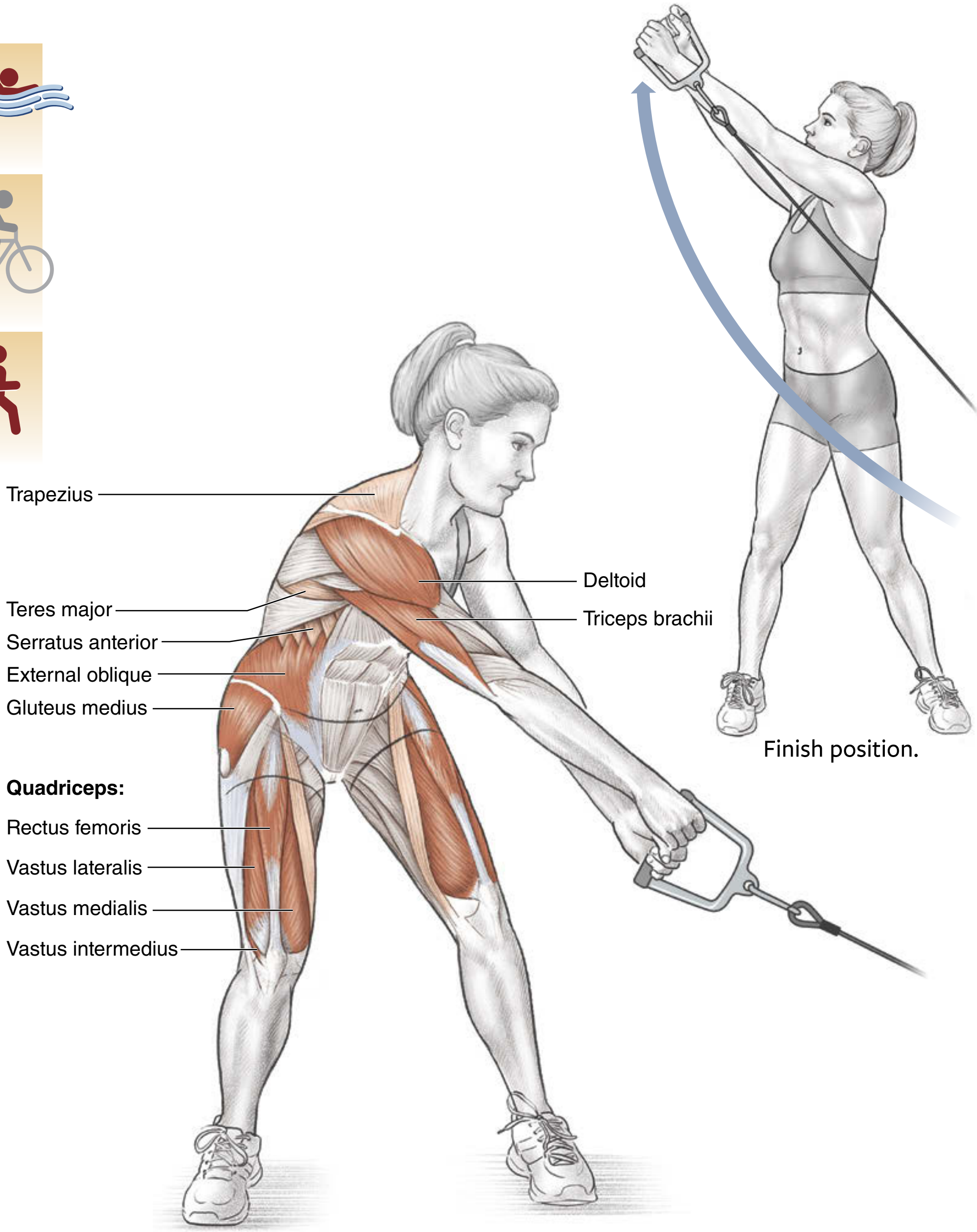
TRIATHLON FOCUS

Multisport athletes require a strong core and coordination between upper-body and lower-body muscle groups. The woodchopper provides a dynamic full range of motion that engages several critical muscle groups while also promoting overall body coordination. Done properly and as part of a high-intensity workout, the exercise will boost heart rate during its execution.

Specific to the needs of the competitive triathlete, this exercise promotes greater core stability and endurance, especially useful for long-distance racing. The core strength you'll gain from the woodchopper will also add stability on the bike and during the run, minimizing wasted movement.



REVERSE WOODCHOPPER

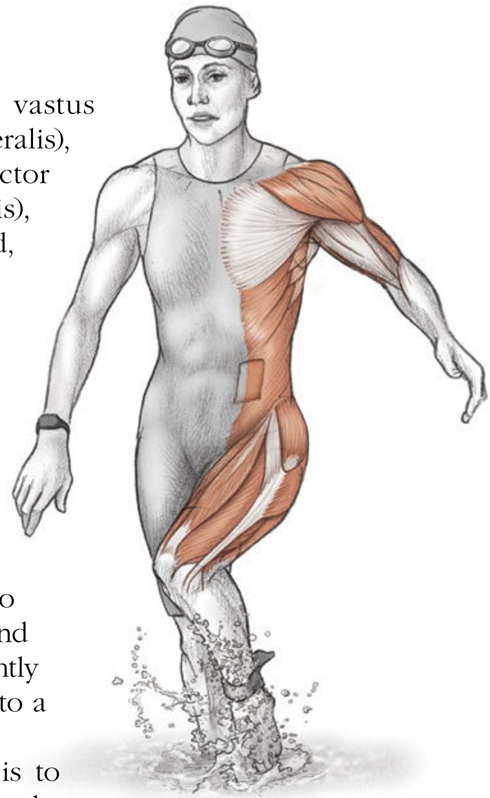


Finish position.

Execution

1. Stand side-on to and about 3 feet (0.9 m) away from a low-cable pulley machine, with your feet slightly wider than shoulder-width apart.
2. Slightly bend your knees into a half-squat position, and grab the pulley handle with both hands.

3. In a coordinated motion, raise the pulley handle diagonally across the body and over the opposite shoulder while standing straight.
4. Lower slowly to the starting position. Repeat for the required number of repetitions.



Muscles Involved

Primary: Quadriceps (rectus femoris, vastus medialis, vastus intermedius, vastus lateralis), gluteus maximus, gluteus medius, erector spinae (iliocostalis, longissimus, spinalis), external oblique, internal oblique, deltoid, triceps brachii

Secondary: Hamstrings (biceps femoris, semitendinosus, semimembranosus), serratus anterior, teres major, trapezius, supraspinatus, rhomboid minor, rhomboid major

TRIATHLON FOCUS

This movement is particularly useful for swimmers as a dryland exercise, but it can also benefit runners in building core, upper-arm, and leg strength. Runners are advised to bend slightly more at the knee to engage the quadriceps to a higher extent.

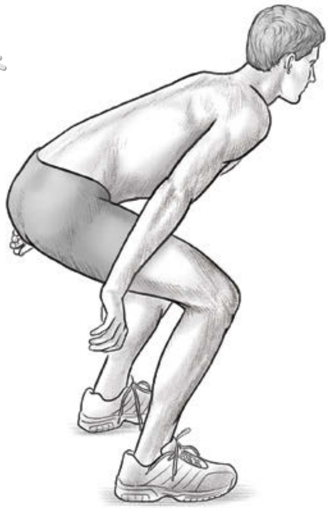
One important technique consideration is to engage the core muscle groups by focusing on the path the hand takes as it moves diagonally across the body. This will ensure maximum use of this important area.

VARIATION

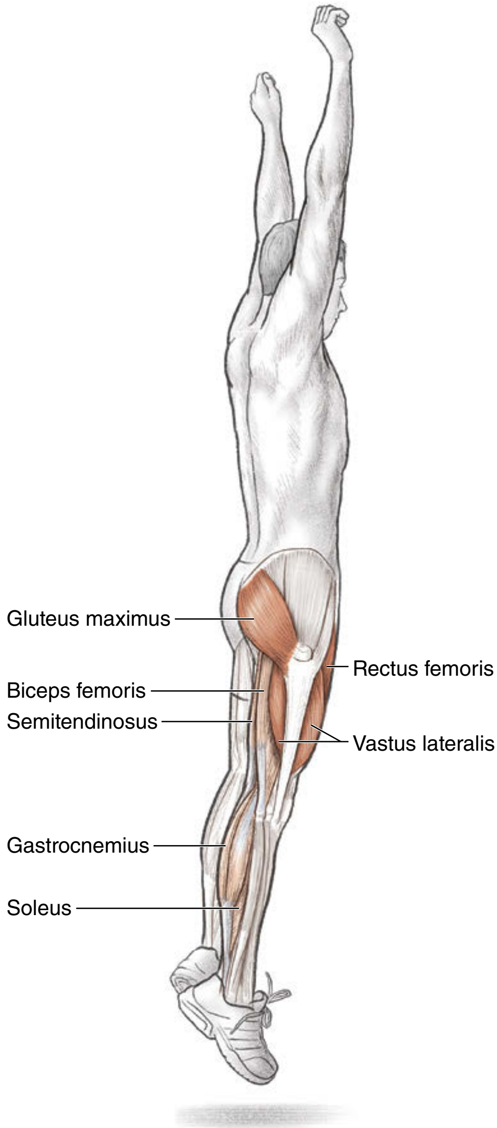
Diagonal Medicine Ball Lift

Using a medicine ball, initiate the movement much the same way as you would with a low-pulley cable machine. Emphasize power by explosively tossing the medicine ball over your shoulder to a partner with each repetition.

DOUBLE-LEG POWER JUMP



Start position.



Execution

1. With your feet slightly wider than shoulder-width apart, squat down with your knees bent at approximately 45-degree angles.
2. With explosive force, using the upward momentum of your arms and the power generated from your quadriceps, jump straight up and slightly forward to your maximal height.
3. Land and return to the original squat position. Repeat for the required number of repetitions.

Muscles Involved

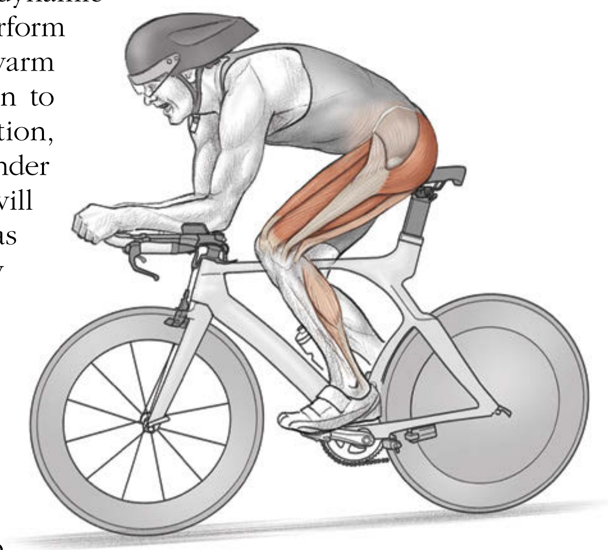
Primary: Gluteus maximus, quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius)

Secondary: Erector spinae (iliocostalis, longissimus, spinalis), hamstrings (biceps femoris, semitendinosus, semimembranosus), soleus, gastrocnemius, hip adductors (adductor longus, adductor magnus, adductor brevis)

TRIATHLON FOCUS

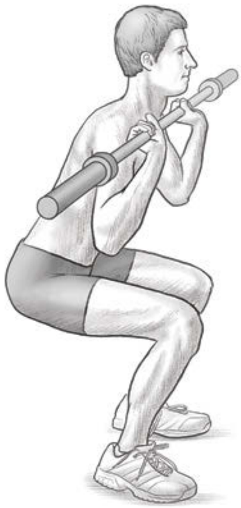
The ability to produce explosive power is a key to success in all sporting activities, including endurance-focused cycling and running. The power jump is simplicity at its finest, producing huge gains in explosive leg power without the need for fancy or expensive exercise equipment.

Because this is a highly dynamic exercise, it's important to perform the power jump with very warm muscles. Pay special attention to the landing on each repetition, which should be soft and under control. Athletes of all levels will benefit from increased power as well as the cardiorespiratory gains this challenging exercise has to offer.

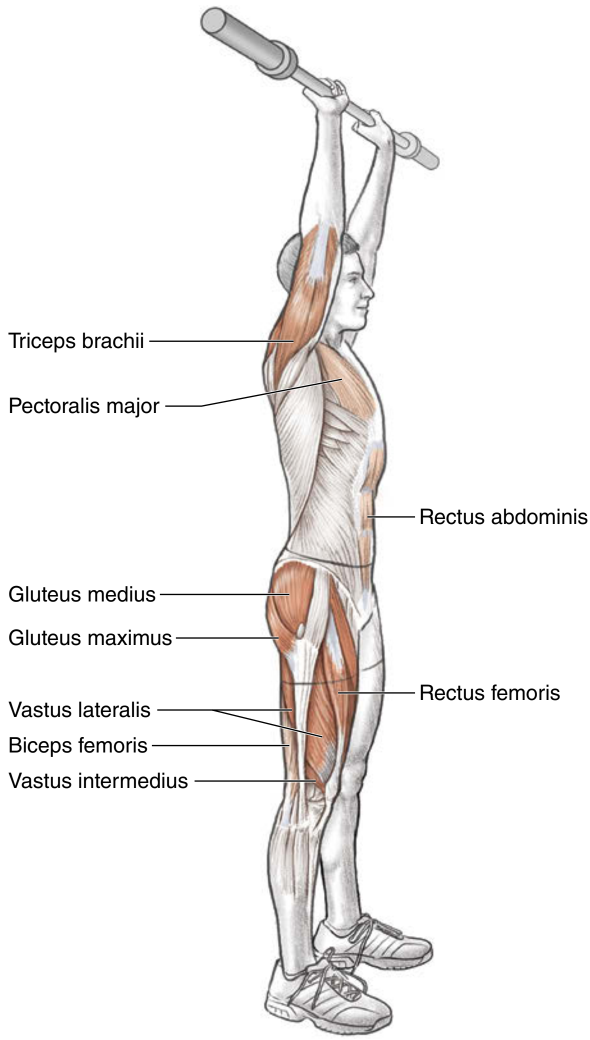


For the competitive triathlete, enhanced power through doing power jumps can improve short-burst speed for climbing steep hills on the bike and powering up the hills on the run.

SQUAT PRESS



Start position.



SAFETY TIP: Maintain proper technique to prevent injury and maximize effectiveness. Keep the back straight, and keep your chin up throughout the movement. If fatigue begins to negatively affect form, stop and rest or move to another activity.

Execution

1. Stand erect with feet shoulder-width apart. Grasp a barbell across your upper chest, with your palms turned out.
2. Bend to a squatting position, with your upper quadriceps almost parallel to the ground.
3. Extend up into a standing position. From there, press the weight over your head, and then lower it in a controlled manner.
4. Lower back to the squat position. Repeat for the required number of repetitions.

Muscles Involved

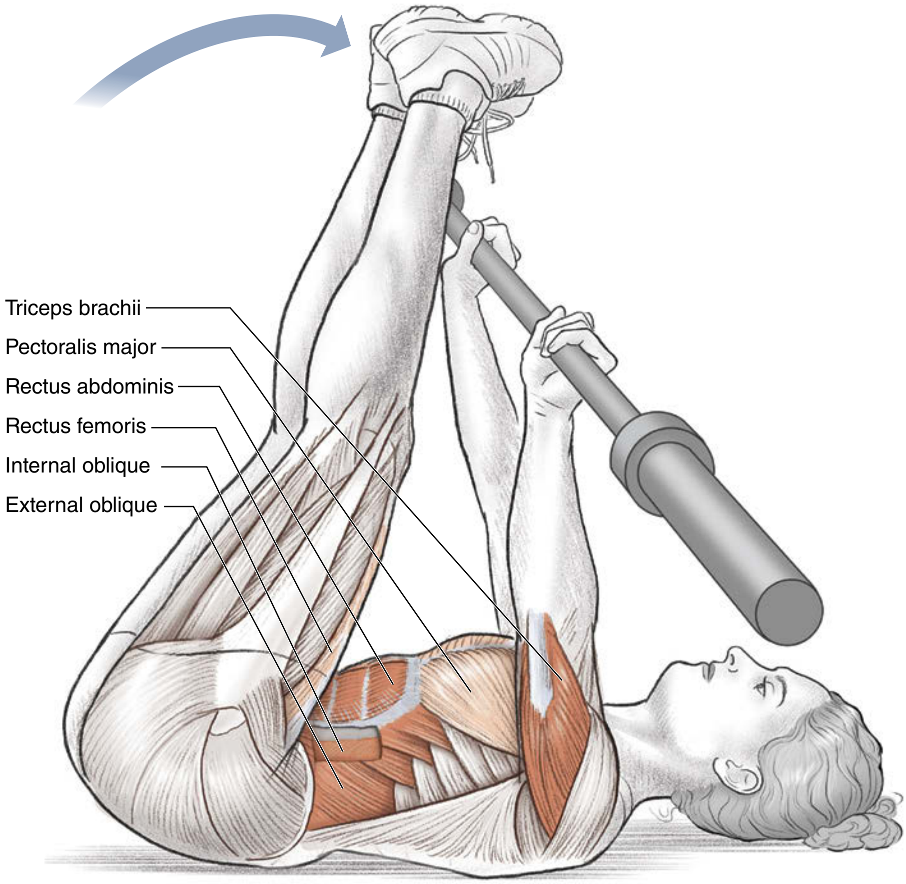
Primary: Quadriceps (rectus femoris, vastus lateralis, vastus medialis, vastus intermedius), gluteus maximus, gluteus minimus, gluteus medius, anterior deltoid, triceps brachii

Secondary: Hip adductors (adductor longus, adductor magnus, adductor brevis), hamstrings (biceps femoris, semitendinosus, semimembranosus), erector spinae (iliocostalis, longissimus, spinalis), trapezius, rectus abdominis, upper pectoralis major

TRIATHLON FOCUS

This whole-body exercise combines the effectiveness of the squat with that of the shoulder press, making for a demanding and result-producing movement. Multisport athletes will benefit from enhanced leg and shoulder strength for improved swimming, cycling, and running performance at all levels. Furthermore, the combination of two major muscle group exercises makes for more effective and efficient use of time while also enhancing coordination.

FLOOR WIPER



Execution

1. Lie flat on your back on the floor.
2. Hold a barbell over your chest, with your arms fully extended.
3. Raise your legs, keeping them as straight as possible, although you may need to bend your knees slightly.
4. While keeping your upper body stable, lower your legs to one end of the bar, and then sweep them to the other end of the bar in a wiping motion.
5. Repeat for the required number of repetitions.

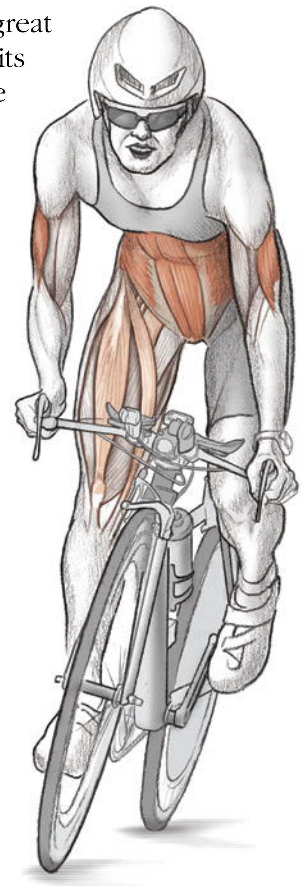
Muscles Involved

Primary: Rectus abdominis, external oblique, internal oblique, triceps brachii

Secondary: Pectineus, sartorius, iliopsoas, rectus femoris, pectoralis major

TRIATHLON FOCUS

The floor wiper is a challenging exercise that does a great job of engaging the core muscle groups. This benefits triathletes by increasing their ability to rotate with force and authority. This is especially useful in freestyle swimming, in which coordinated body rotation is so important, and when climbing or sprinting hard on the bike. It is also an effective exercise for runners, who will benefit from the added core stability. This exercise will test even the most conditioned athlete and will take her core fitness to the next level.



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11

INJURY PREVENTION

No discussion of training programs would be complete without examining their pros and cons. For all the good that we have proposed in the previous chapters, there are inherent risks with trying to get stronger and faster. The body is designed to respond to exercise stress by

- enhancing the cellular mechanism to sustain aerobic and anaerobic metabolism;
- improving the cardiorespiratory system to supply oxygen and nutrients to tissues;
- increasing muscular cell size and strength; and
- strengthening the tissues of tendons, ligaments, and bones to support the athletic loads placed on them.

Athletes can reach a point at which this enhancement is disrupted, which may cause injury. Nothing is more frustrating than getting hurt while performing an exercise that is intended to make you a better athlete. Injuries may be initiated by tissue failure in the form of tearing, either at a microscopic level or at a visible, or macroscopic, level. This causes a cascade of actions, including localized bleeding from damaged vessels and recruitment of cells that promote healing. This healing process can take anywhere from 4 to 6 weeks to complete. Some tissues may take longer to heal, depending on such factors as the magnitude of the injury and the promptness of treatment. Healing may take much longer if an injury becomes chronic.

TYPES OF INJURY

Trauma is defined as a significant force applied to normal tissue, caused by events such as falling from a bike. Traumas can cause injuries of varying severity. A simple bruise, or contusion, from soft-tissue injury can cause localized bleeding and swelling. More significant force can lead to a broken (fractured) bone. This is often accompanied by a visible deformity, as with a clavicle fracture.

Triathlon participation is somewhat unusual in that we train in more than one sport. If we stay upright on the bike, traumatic injuries are rare. However, because of the nature of endurance sports and the repetitive stresses we place on our tissues, overuse injuries are more common for triathletes than for those who participate in many single sports.

An overuse injury can be defined as failure of tissue—including muscles, tendons, ligaments, and even bone—at less than maximal force. Think of a paper clip, a relatively strong piece of metal. If you were to take it and start bending it repetitively with only a small amount of force, eventually it would break. Collagen, which makes up 70 percent of the dry weight of the body and is the main constituent in all of our tissues, is vulnerable to this type of failure. If you pull hard enough on a rope, some of its fibers will tear, and if you pull hard for long enough, the rope may break. All of our tissues have cellular mechanisms that constantly defend against and try to repair such injuries.

Exercise can challenge the equilibrium between strengthening tissues and repairing their structural breakdown. As you push the envelope of training—trying to catch up on a workout schedule, increasing running volume or intensity too quickly, or swimming with paddles when your arms are tired—the risk of injury increases. Similarly, small but repeated movements, such as thousands of pedal strokes on an ill-fitting bike, can lead to injury. Many things can lead us down the wrong path. One advantage of training for a triathlon is that we can diversify our workouts. We can de-emphasize one discipline while increasing work in another, allowing us to rest and heal an area that may be at risk for injury or already slightly injured.

PREVENTION AND RECOGNITION OF INJURIES

Rest, which triathletes tend to resist, and proper sleep, which can be a precious commodity, are integral to the healing process This is when the body heals itself and gets stronger. We discussed this in the context of periodization, which may involve taking a day or a few weeks off from working out or reducing the intensity or volume of your workouts. Obtaining the appropriate amount of sleep to allow hormonal processes to heal injured tissues is an important part of injury prevention that is often overlooked. Other prevention techniques include stretching if the athlete's range of motion is limited or reduced and specific strengthening to help maintain joint efficiency and muscular balance.

Injuries are not an act of nature. They indicate that the athlete has reached a breakdown point at which exercise no longer produces a positive response. The body has been pushed past its reparative capabilities, and it begins to develop signs and symptoms of injury. One of these is pain. We all have experienced discomfort when working out, but when is it bad to try to push through the discomfort? Pain can be defined as an unpleasant sensation that is often associated with damage to the body. We may hear that "pain is just weakness leaving the body," or "no pain, no gain." It's fun to say such things to psych ourselves up for training, but taking them too seriously can lead us down the path of chronic injury.

Any discomfort may be an early warning sign of injury. Discomfort that begins with an activity but goes away as you warm up may be something you can train through with appropriate modifications. However, discomfort that continues through the activity should be a clear warning sign that something is not right, and you should stop that activity. Discomfort that persists after the activity, does not respond to basic RICE treatment (rest, ice, compression, elevation), and affects other functions should be treated and, if necessary, evaluated by a sports medicine specialist.

Recognizing that something is wrong is the first step in treating an injury. Maturity and experience are helpful in this regard. A qualified coach or trainer can help you to develop appropriate workouts, and a well-designed training plan can minimize the risk of injury. But a perfectly designed program is only as good as its user. As a triathlete, your goal is to gain strength, not to demonstrate strength. So check your ego at the door, and make sure you execute every single repetition with perfect form. Keeping a training log is also important so you can look back and see if a specific workout or series of workouts led to injury.

Overuse injuries are difficult to recognize. Often there is no single event that causes them. Many of these injuries lack some of the signs of acute injury, such as bleeding, swelling, and tenderness. They just cause discomfort and pain when you want to swim, bike, or run. Over time the discomfort becomes debilitating.

TREATMENT

Treatment of injuries relies on a simple principle: Treat the cause as well as the effect. Mistakes in training plans can be adjusted and corrected. Equipment or technique issues such as poor swim stroke mechanics, improper bike fit, and worn-out running shoes should be considered. Nutrition can also play a role in injury prevention and treatment. Diets deficient in protein and carbohydrate fail to address the nutritional demands placed on the body during strenuous exercise. An example of this is the female athlete triad, in which eating disorders, lower-than-optimal body weight, and abnormal menstruation lead to the development of stress-related injuries to bone, including stress fractures.

The RICE approach, which stands for rest, ice, compression, and elevation, applies to the basic treatment of any injury. If rest is a bad word to you, try *relative rest*, during which you perform alternative activities (cross-train) that cause no discomfort.

Use ice on an acute injury of any type for the first 36 to 48 hours. After that it can be very useful for pain control. Apply ice to the affected area for 10 to 15 minutes every 2 to 3 hours. Protect the skin with a piece of light fabric to prevent complications associated with ice, including skin burn. You may apply heat after the first 48 hours when stiffness may be present. Application principles are similar. No scientific literature supports alternating the two treatments; therefore, it is not recommended.

Compression is helpful to control swelling. In an acute situation, compression helps control bleeding and thus swelling. Wrapping the affected area comfortably with an elastic bandage can be effective for as long as tolerated. When using an elastic bandage, it is important to remember not to wrap too tightly. Think about stretching the wrap about 10% past its resting length, a gentle stretch. Always cover the whole area. In the case of a leg injury, start at the toes and work up to a few inches above the affected area. Lower-extremity swelling can also be addressed with the use of compression socks. Knee-length and thigh-length socks can be used, depending on the site of swelling. These can be worn for as long as desired.

Elevation is helpful for extremity injuries because it also helps control swelling. Be sure to place the affected area above the level of the heart to allow the swelling to drain.

STRETCHES FOR INJURY PREVENTION AND TREATMENT

Injury prevention requires a well-designed training plan with periods of rest and guidance on nutrition for preworkout, in-workout, and postworkout consumption. Another important piece of the puzzle is a stretching program. Exercise places a great deal of stress on the tissues, which can lead to stiffness. This may lead to a loss of motion about the joint, and it may cause a change in biomechanics, which can lead to injury. From a performance point of view, the role of flexibility in a healthy runner with normal range of motion (ROM) is often overstated; in fact, increases in flexibility in runners are associated with a decrease in speed if taken too far. But if ROM is inhibited, it should be addressed.

Ideally, stretches should be performed after a workout, or at least after a short warm-up. Cold muscles are less pliable and more susceptible to injury. There is a lack of scientific evidence for the ideal duration of stretching, but for static stretching, 15 to 30 seconds is a safe recommendation. Stretching is definitely not a “if some is good, more is better” activity, so never stretch to the point of pain.

Dynamic Stretching

Dynamic stretching is a popular form of stretching among athletes and is recommended before engaging in training activities. Static stretching means to stretch and hold a position; dynamic stretching includes a gentle and progressive movement pattern through a comfortable range of motion that does not exceed that of a static stretch. Going beyond that range would be considered a ballistic stretch, which is not recommended. Dynamic stretching offers many benefits, such as increasing range of motion, increasing temperature, improving blood and oxygen flow to areas specific to the training activity, enhancing the nervous system and motor ability in preparation for training, and preventing training-related injuries.

Dynamic stretching is simple but requires caution. Begin with a short range of motion. As you warm up, increase the range of motion toward your maximum level. The walking lunge and carioca are two examples of dynamic stretches popular among triathletes and runners. For the walking lunge, stand with your feet shoulder-width apart, and step forward with the leading foot to assume a lunge position. While supporting your body weight on your leading foot, stand erect again and step forward with the opposite foot. Repeat this series of walking lunges for 10 steps with each leg and then repeat. The carioca is a good dynamic stretch that targets the hips and other areas of lateral movement. Stand with feet shoulder-width apart and knees slightly bent. Cross the left foot over and in front of the right foot. Repeat with the right foot crossing the left foot in a lateral movement, gently twisting at the hips. Travel for 30 to 50 feet (10 to 15 m) in one direction and then the other.

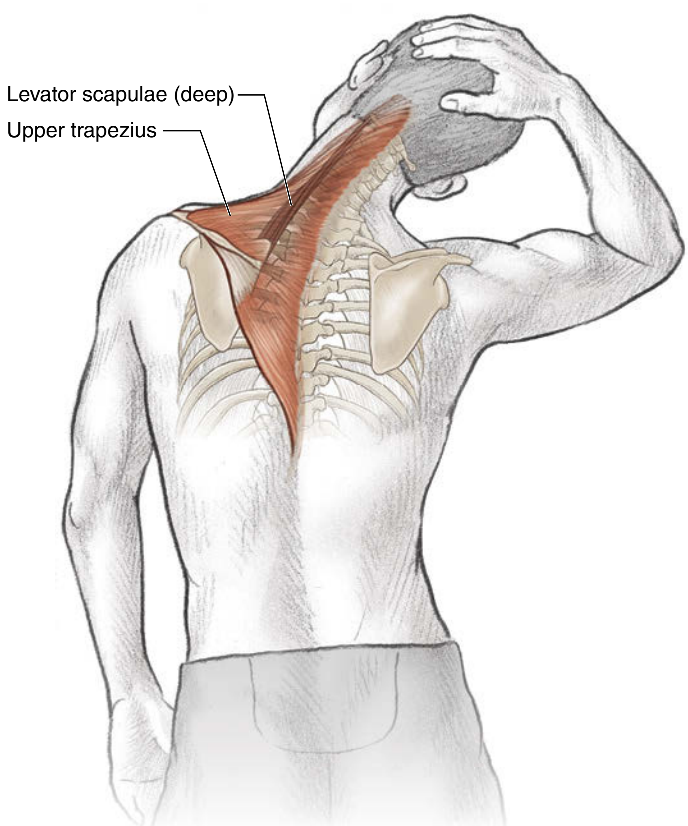
The addition of dynamic stretching to your training will pay off by reducing your risk of injury and improving your training performance.

Basic Stretching

The basic stretches that follow are specific to the muscles used in triathlon training. They should be considered essential to the prevention of overuse injuries that are common to triathletes. Use gentle motion until an easy stretch is felt. Hold the position for 15 to 30 seconds, and repeat two or three times. Bouncing, what was once referred to as ballistic stretching, can be detrimental and is not recommended.

Spend some time doing these gentle stretches. They feel good, help improve range of motion, and help you recover from injury.

SIDE NECK STRETCH



Execution

1. Sit or stand straight. Place one hand over your head toward the opposite ear.
2. Gently pull your hand to the side. Keep looking forward, and feel a stretch in the lateral neck region on the opposite side of the hand on your head.
3. Allow that shoulder to gently drop to help accentuate the stretch.
4. Hold this position for 15 to 30 seconds. Repeat three times on each side.

Muscles Involved

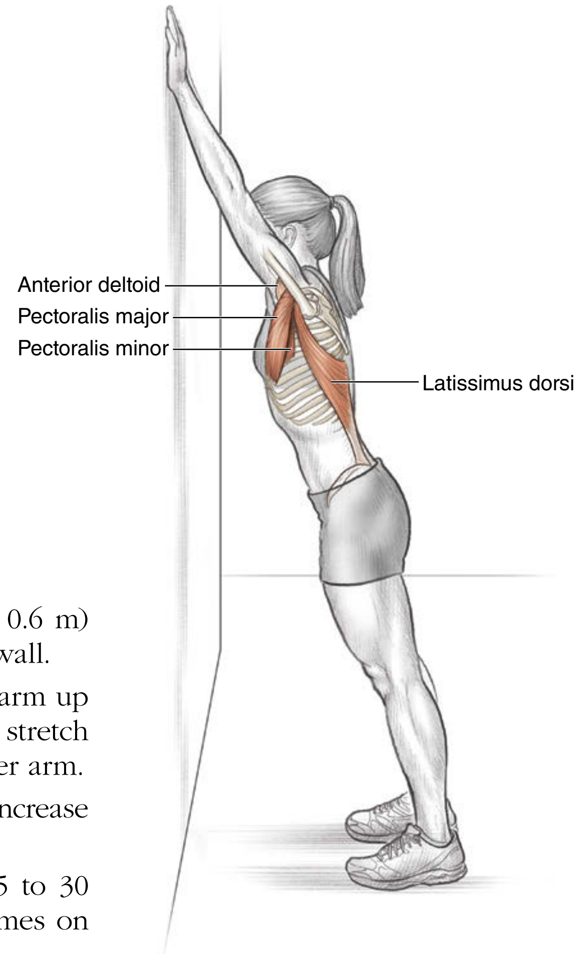
Primary: Upper trapezius

Secondary: Scalenes, levator scapulae

TRIATHLON FOCUS

A triathlete's head position changes constantly depending on the discipline. This requires a flexible neck. Open-water freestyle swimming requires the ability to sight buoys. Swimmers must look up often and switch their breathing from side to side. Cyclists must often ride in an aerodynamic tuck, which can create fatigue and strain along the back of the neck. Runners must have the neck strength and flexibility to maintain a neutral head and back position for maximum proficiency.

ARM ON WALL FORWARD STRETCH



Execution

1. Stand 1 to 2 feet (0.3 to 0.6 m) away from and facing a wall.
2. Walk the fingers of one arm up the wall until you feel a stretch along the chest and upper arm.
3. You may lean forward to increase the stretch.
4. Hold this position for 15 to 30 seconds. Repeat three times on each side.

Muscles Involved

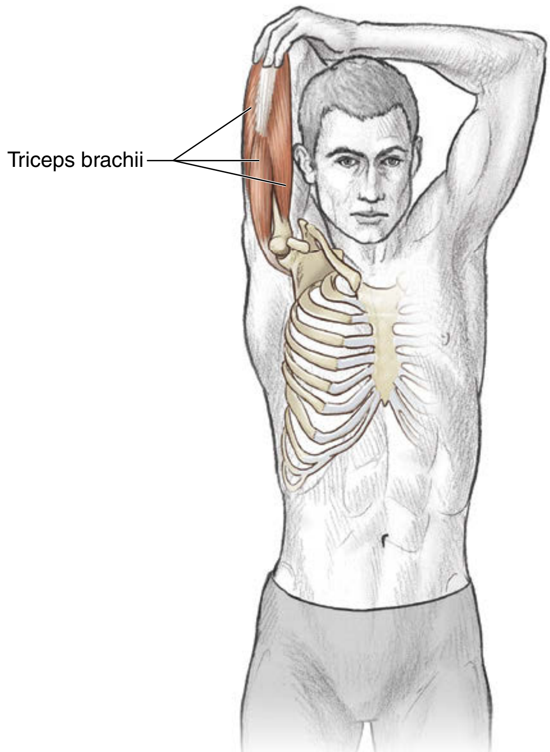
Primary: Pectoralis major, pectoralis minor, latissimus dorsi

Secondary: Anterior deltoid

TRIATHLON FOCUS

Open-water distance freestyle swimming requires the triathlete to take long, steady strokes, maximizing efficiency and distance per stroke. Flexibility training for the chest and upper back improve reach and help athletes to achieve optimal body rotation and glide.

TRICEPS STRETCH



Execution

1. From a standing position, place one hand on the upper back of the opposite shoulder.
2. With the elbow bent toward the ceiling, use your other hand to pull the elbow toward your head.
3. Hold this position for 15 to 30 seconds. Repeat three times on each side.

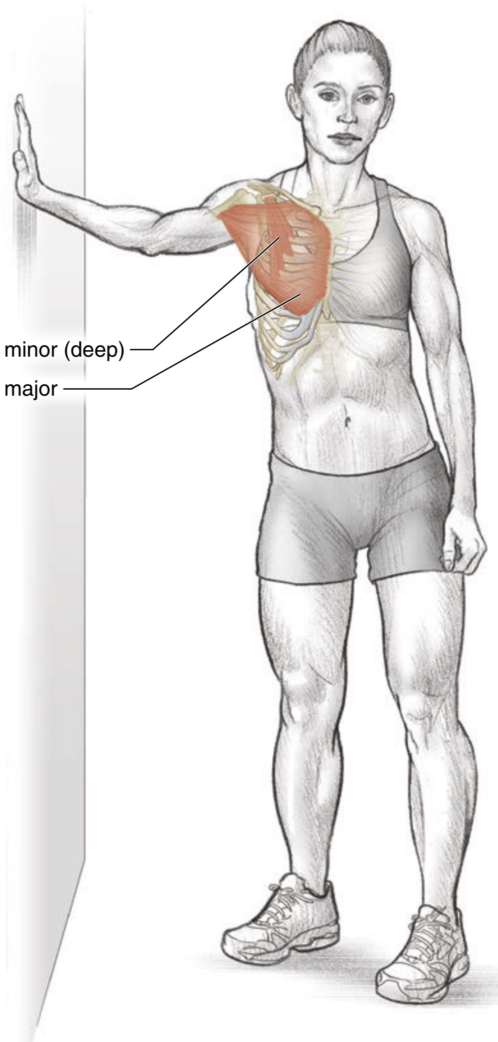
Muscles Involved

Primary: Triceps brachii

TRIATHLON FOCUS

Open-water freestyle swimming engages the triceps in a key propulsive phase of the swim stroke. Cyclists use the triceps extensively when climbing aggressively out of the saddle.

CHEST STRETCH



Execution

1. Stand in a doorway or next to a wall.
2. Place the hand of the arm to be stretched on the wall or doorjamb.
3. Rotate your body away from the hand, and feel the stretch in the front of the shoulder.
4. Hold this position for 15 to 30 seconds. Repeat three times on each side.

Muscles Involved

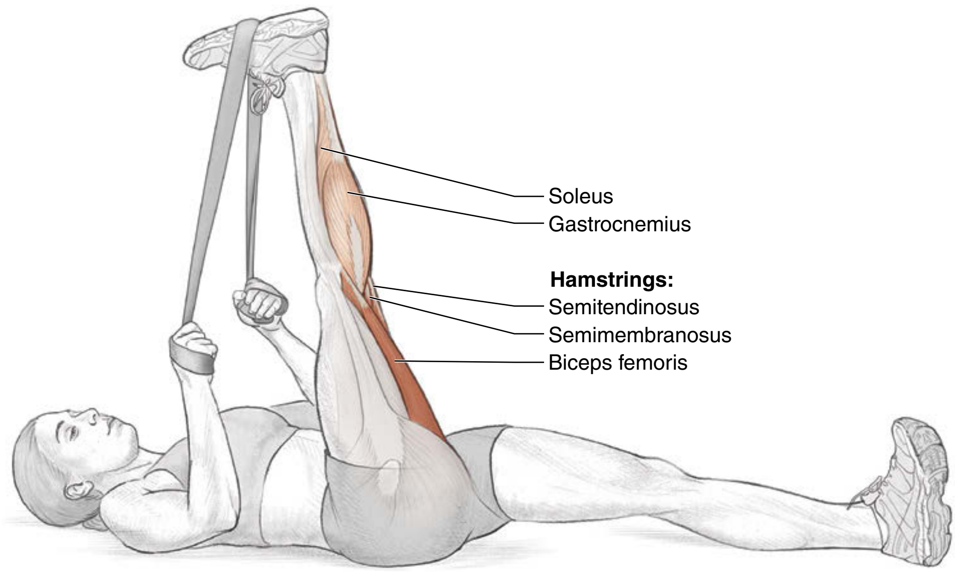
Primary: Pectoralis major

Secondary: Pectoralis minor

TRIATHLON FOCUS

Stretching the chest has benefits for every activity in a triathlon. Swimmers realize greater arm extension and can get long and streamlined during each stroke. Cyclists enjoy an enhanced ability to ride out of the saddle when grasping the drops or the base-bar handles. Runners can drive with their arms when charging up steep inclines.

LYING HAMSTRING STRETCH



Execution

1. Lie supine with shoulders on the floor and legs straight out, toes pointed up. Place a resistance band, a rope, or a towel around your right foot.
2. Gently pull on the ends of the resistance band to lift the right leg straight up.
3. Hold the stretch at the highest point for 15 to 30 seconds, applying subtle pressure with the band.
4. Return to the starting position and switch legs. Repeat the stretch on the opposite leg.

Muscles Involved

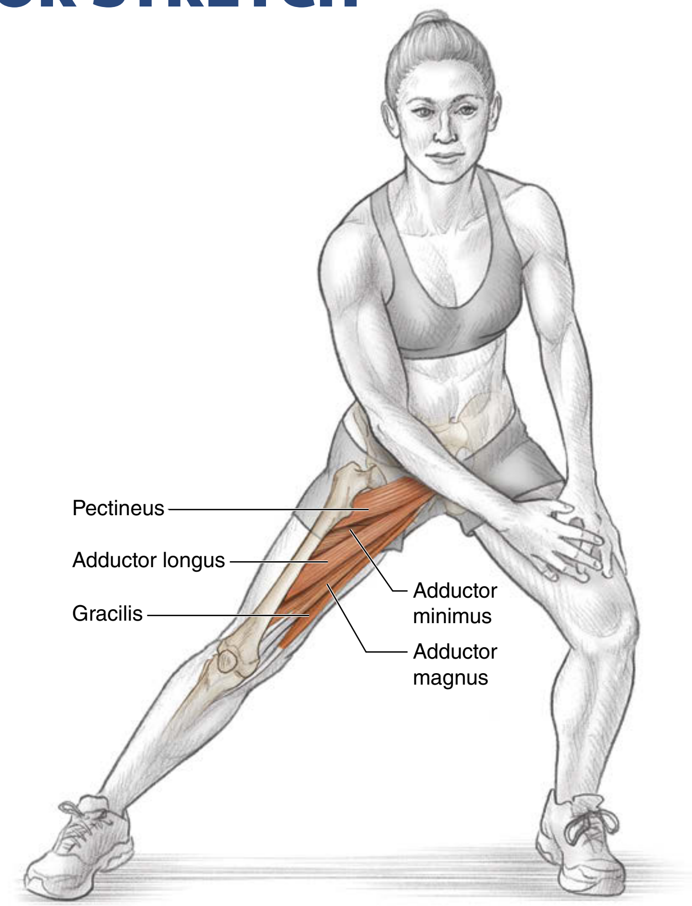
Primary: Hamstrings (biceps femoris, semitendinosus, semimembranosus)

Secondary: Popliteus, gastrocnemius, soleus

TRIATHLON FOCUS

The hamstrings (the biceps femoris, semitendinosus, and semimembranosus) play a major role in hip extension on the bike and run, and they are often quite tight in triathletes. There is a correlation between hamstring tightness and lower-back pain. Improving hamstring flexibility will reduce the chance of injury to the lower back and can improve performance.

ADDUCTOR STRETCH



Execution

1. Stand with feet slightly wider than shoulder-width apart.
2. Keeping the right leg straight, bend your left knee. Use your hands for support. Lean to the left.
3. You should feel a stretch in the right inner thigh.
4. Hold this position for 15 to 30 seconds. Repeat three times on each side.

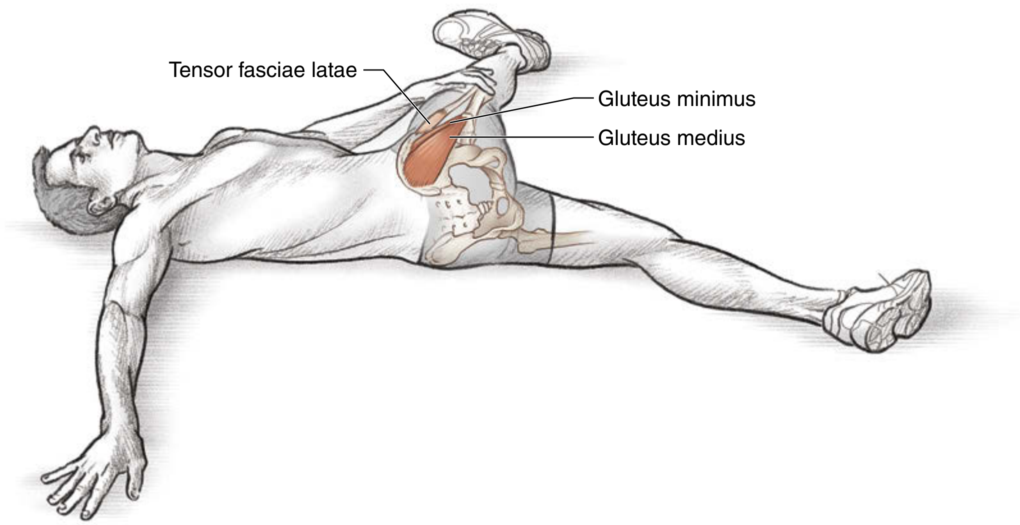
Muscles Involved

Primary: Adductor longus, adductor magnus, adductor minimus, gracilis, pectineus

TRIATHLON FOCUS

Greater flexibility in the adductors helps improve cycling and running form while reducing the risk of injury. Off-road triathlon events that include trail running will be sure to place additional stress on this area.

HIP ROTATION STRETCH



Execution

1. Lie on the floor on your back, legs straight.
2. Bring the right leg over the left leg, keeping the legs straight or only slightly bent.
3. Use your left hand to pull the right knee across your body.
4. You should feel the stretch in the buttocks and posterior hip.
5. Hold this position for 15 to 30 seconds. Repeat three times on each side.

Muscles Involved

Primary: Gluteus medius, gluteus minimus

Secondary: Tensor fasciae latae

TRIATHLON FOCUS

For the triathlete, enhanced hip-region flexibility can help prevent a number of lower-body issues related to the twisting and turning a triathlete does during open-water swimming, transitions, and aggressive running.

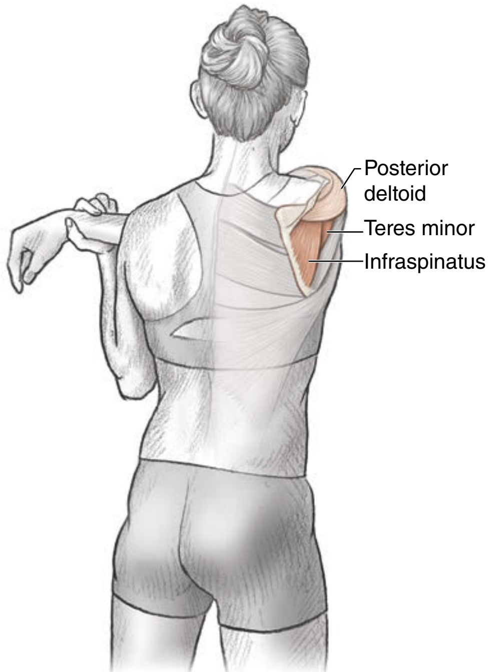
Therapeutic Stretching

This series of therapeutic stretching exercises is intended to help manage symptoms associated with a variety of overuse injuries that occur with triathlon participation. The stretching technique includes gentle motion until an easy stretch is felt. Hold the position for 15 to 30 seconds, and repeat two or three times. Bouncing, once referred to as ballistic stretching, can be detrimental and is not recommended. If you experience pain or discomfort while doing the stretch, ease back and apply less pressure. A sense of pulling is appropriate, but that must be distinguished from pain. If pain persists and a stretch cannot be performed without discomfort, professional assistance may be necessary.

CROSS-BODY ARM STRETCH

Execution

1. From a standing or seated position, take the affected arm and cross it horizontally over the chest.
2. Place the other hand on the elbow, and gently assist the stretch across the body.
3. You will feel a pulling sensation on the back of the shoulder.
4. Hold this position for 15 to 30 seconds. Repeat three times on each side.



Muscles Involved

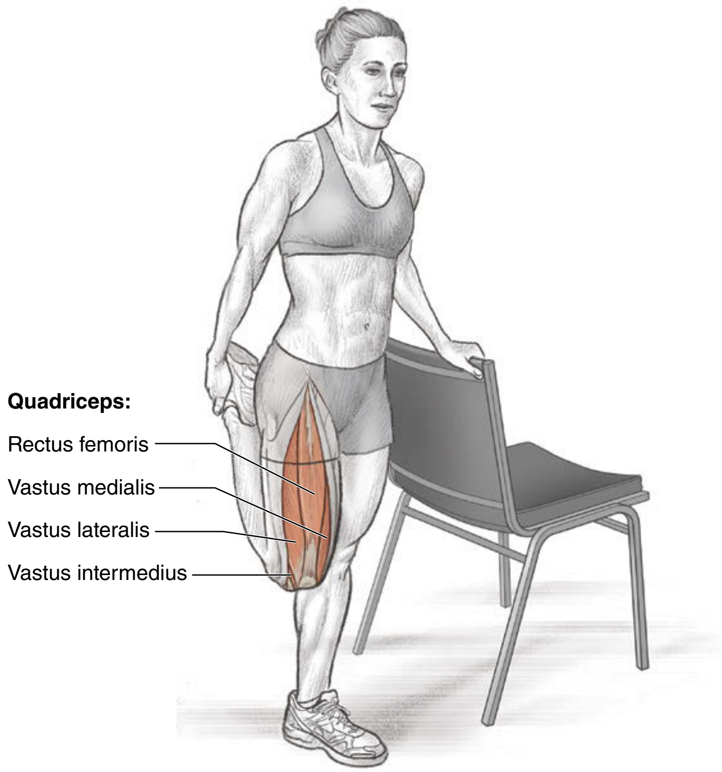
Primary: Infraspinatus, teres minor

Secondary: Posterior deltoid, triceps brachii, posterior joint capsule

TRIATHLON FOCUS

The rotator cuff, discussed in chapter 7, helps control shoulder motion. Overhead activities such as swimming can cause an overuse or microscopic injury to the tendons of the rotator cuff and the adjacent tissues, including the bursa. Poor swim technique, such as crossing the arm over the midline on hand entry, or participating in a harder-than-normal swim workout, can cause such an injury. The bursa can become irritated and inflamed if the rotator cuff is not functioning smoothly. This stretch can help reduce pain and stiffness in the shoulder joint. Stretching the capsule and rotator cuff tendons, along with rotator cuff strengthening exercises such as those listed in chapter 7, can also help reduce pain and increase function. Muscle imbalances and poor posture can exacerbate a shoulder condition. Exercises to improve posture and maintain shoulder biomechanics, including those that strengthen the posterior muscles of the shoulder and back, can help prevent impingement from occurring. See chapter 5 for the lat pull-down.

QUADRICEPS STRETCH



Execution

1. Using a wall or steady piece of furniture for support, bend your right leg and try to grab your ankle. If this is difficult, loop a towel around your ankle. Keep your knees together. Do not arch your back.
2. Gently bring your heel toward your buttocks. Push your hips forward to accentuate the stretch. You should feel a stretch in the front of your thigh (quadriceps) muscle.
3. Hold the stretch for 15 to 30 seconds. Repeat with the other leg.

Muscles Involved

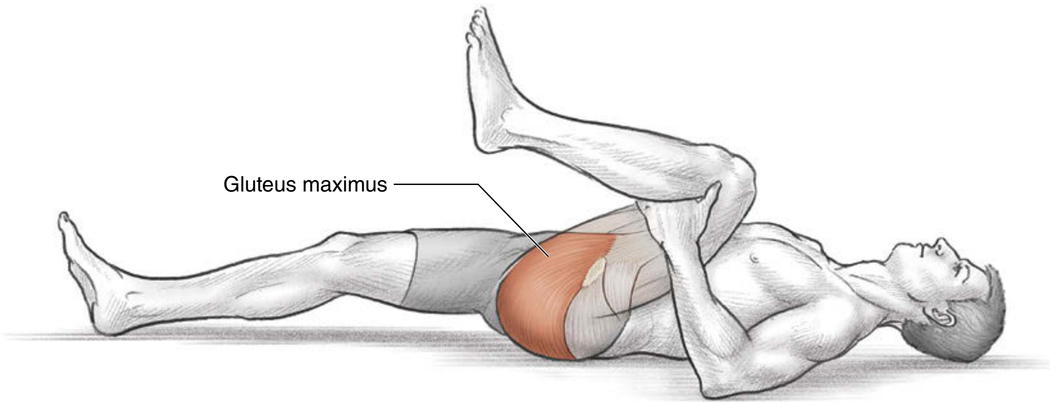
Primary: Quadriceps (rectus femoris, vastus medialis, vastus lateralis, vastus intermedius)

TRIATHLON FOCUS

Running and cycling place large forces on the joints of the lower extremities, especially the knee. The patella, kneecap, and peripatellar tissues are exposed to approximately three to five times body weight with such activities. Forces on your tissues that exceed the body's ability to tolerate them can cause injury and pain. Often there is no single identifiable cause, but repetitive microscopic trauma can result in an overuse injury. Changes in training such as increased volume, intensity, or duration can be contributing factors. Worn-out or ill-fitting running shoes or a drastic change in footwear can also increase stresses on the knees. Anterior knee pain, which is often characterized as diffuse and under the kneecap, is just one of the symptoms caused by this condition, often referred to as runner's knee. Activities of daily living such as stair walking and sitting with the legs bent (e.g., sitting for a long time at the movies) can cause similar symptoms.

The quadriceps muscles and the tissues around the knee often become tight. Stretching the quadriceps will restore flexibility and improve knee symptoms. Improving your core stability and strengthening your lower extremities can help address muscular imbalances that lead to altered biomechanics and result in symptoms of runner's knee. Strength exercises found in chapter 5, including the floor bridge, and chapter 4, such as the wall stability ball squat, are essential for the process of rehabilitation.

SINGLE LEG TO CHEST STRETCH



Execution

1. Lie on your back.
2. With your hands behind your left leg, gently pull your left knee to your chest until you feel a comfortable stretch in the low back and buttocks.
3. Hold this position for 15 to 30 seconds. Repeat three times on each leg.

Muscles Involved

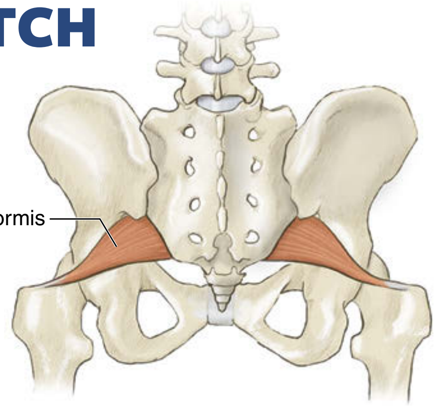
Primary: Gluteus maximus

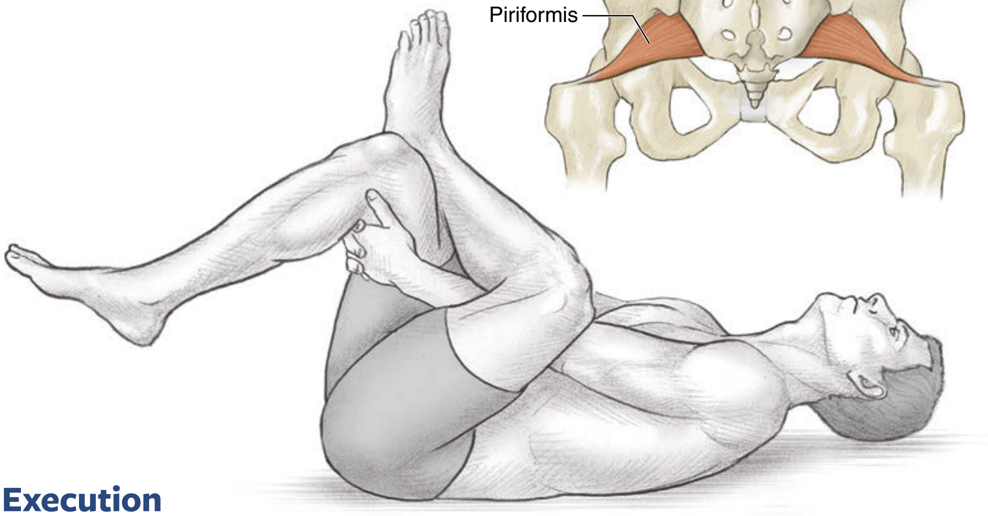
Secondary: Erector spinae (iliocostalis, longissimus, spinalis)

TRIATHLON FOCUS

Injuries to the muscles of the lower back are common in both athletic and nonathletic people. Improper bike fit, including an overly aggressive aerodynamic position, and even basic running can strain the muscles, tendons, and ligaments of the lower back. Mechanical low-back pain is different from radicular or neurological pain, which is caused by nerve irritation, most commonly from a herniated disc. Localized back pain and stiffness are two of the most common symptoms of a mechanical muscle strain. Leg pain, numbness, weakness, or tingling of the leg can be signs of a herniated disc. The muscles of the lower back and legs, including the erector spinae, multifidus, and hamstrings, can become tight. Gentle stretching of the lower back can help increase flexibility and ease symptoms.

PIRIFORMIS STRETCH





Execution

1. Lie on your back, and cross your left ankle over your right thigh.
2. Using your hands, pull your right thigh up while bending the right hip. You should feel a stretch in the left buttocks.
3. If able, use the left hand or elbow to push your left knee out. This may accentuate the stretch.
4. Hold the stretch for 15 to 30 seconds and switch legs.

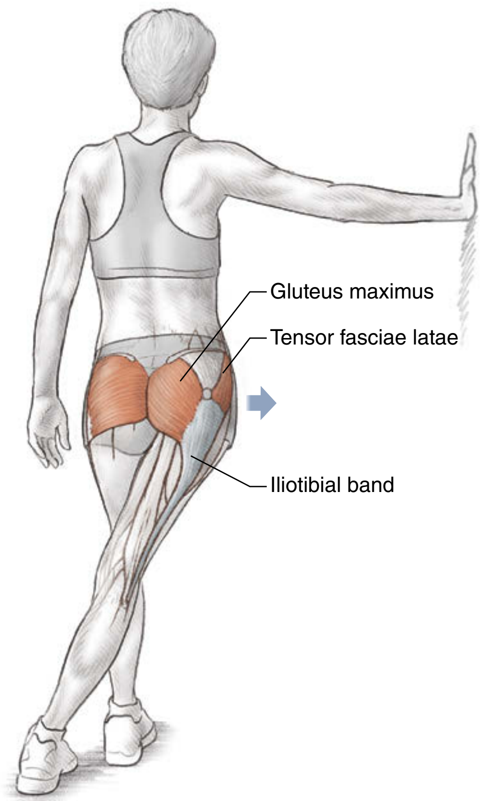
Muscles Involved

Primary: Piriformis

TRIATHLON FOCUS

The piriformis muscle is exposed to significant stress during running. Repetitive forward motion can cause muscle imbalances from overdeveloped hip flexors and relatively weak hip abductors and adductors. This can cause the piriformis to contract and shorten. The sciatic nerve or large groups of nerve roots that run down the leg can be compressed as they pass under the piriformis muscle and tendon in the deep buttock. This can cause pain, tingling, and numbness down the leg. Although buttock pain is caused by many conditions, including hamstring strains and sciatica, piriformis syndrome can be an elusive diagnosis. Tightness of this muscle also occurs after sitting in the saddle for a long time. Prevention and treatment of injury with appropriate stretching is time well spent. Strength training of the abductors and adductors can also be therapeutic. See chapter 4 for abduction band walk and machine adduction.

ILIOTIBIAL BAND STRETCH



Execution

1. Stand next to a wall. Place the right hand on the wall for support.
2. Cross the right leg behind the left leg.
3. Without bending forward, lean both hips into the wall.
4. Hold this position for 15 seconds. Repeat three times on each side.

Muscles Involved

Primary: Iliotibial band, tensor fasciae latae, gluteus maximus

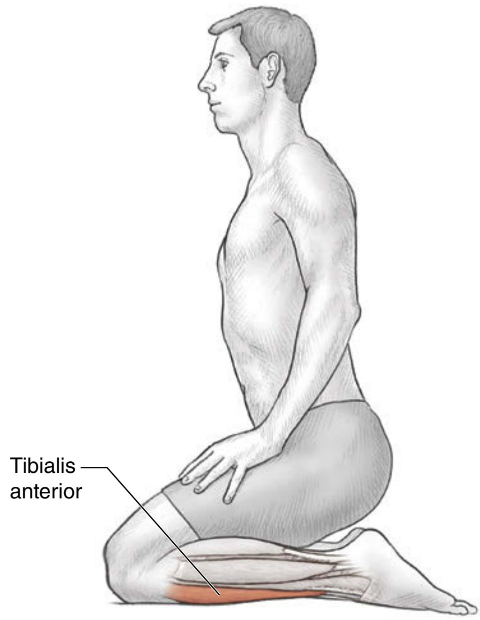
TRIATHLON FOCUS

In iliotibial band friction syndrome, pain and stiffness on the outer aspect of the knee during running can be the hallmark of trouble to come. The iliotibial, or IT, band originates about the hip and tensor fasciae latae, extends down the thigh, and attaches to the knee. The IT band makes two potential contact points at the hip (the greater trochanter) and knee (the lateral epicondyle). At each contact point, a bursal sac helps provide smooth motion over the bony prominences. Injury, irritation, or tissue tightness can increase friction that can cause inflammation and subsequent pain about the knee; disabling discomfort can occur if symptoms are left untreated. Stretching the iliotibial band is an essential part of any preventive or treatment plan. Additional strength training for the hip abductors and core may reduce the risk of developing IT band friction syndrome.

TIBIALIS ANTERIOR STRETCH

Execution

1. Kneel on both legs on a soft surface for comfort.
2. Point your toes so that the tops of the feet and legs rest on the ground.
3. Use your hands to push the legs closer to the ground, or if it is comfortable, you can sit on your heels.
4. Hold this position for 15 to 30 seconds. Repeat three times.



Muscles Involved

Primary: Tibialis anterior

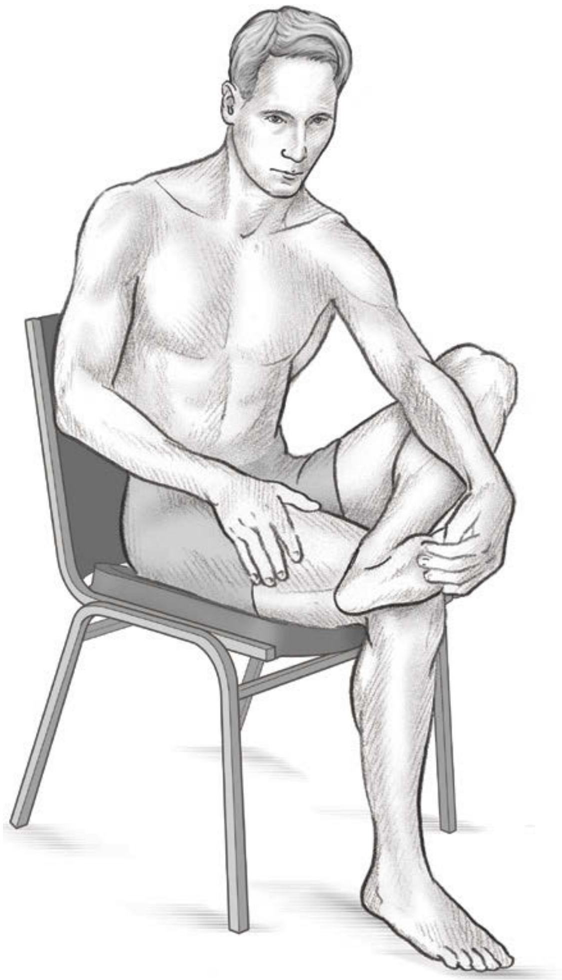
TRIATHLON FOCUS

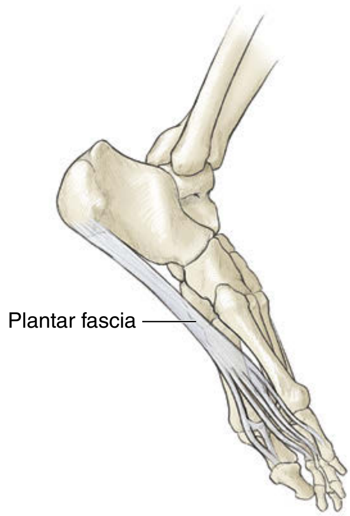
Running requires complex motion about the ankle and foot. The tibialis anterior produces ankle dorsiflexion and allows the runner to clear the foot as she swings the leg forward. As the runner's foot makes contact with the ground, its relative flexibility enables it to absorb shock and accommodate changes in the surface.

The tibialis posterior muscle and tendon along with the calf muscles help absorb the impact and prepare for the push-off phase of gait. As the ankle and foot roll forward to push off, the posterior tibialis contracts, causing its tendon to lock the ankle and foot and create a strong platform that transmits force for push-off. The tibialis posterior inserts along the shaft of the inner aspect of the tibia. Its tendon runs down the lower leg and wraps around the inner ankle to insert on the foot. Because this muscle is essential for running, repetitive stress at the site of muscle insertion, the periosteum, can cause tearing and inflammation.

Tightness of the tibialis anterior, which commonly occurs with running, can cause abnormal stress on the tibialis posterior. This can cause diffuse discomfort along the inner tibia at the beginning of a run. Stretching of both the calf muscles and the tibialis anterior can help alleviate this problem.

FOOT STRETCH





Execution

1. Sit in a chair. Cross one foot over the other knee.
2. Using the hand, gently pull the toes up. The ankle may also move.
3. Hold for 15 to 30 seconds. Repeat three times for each foot.

Muscles Involved

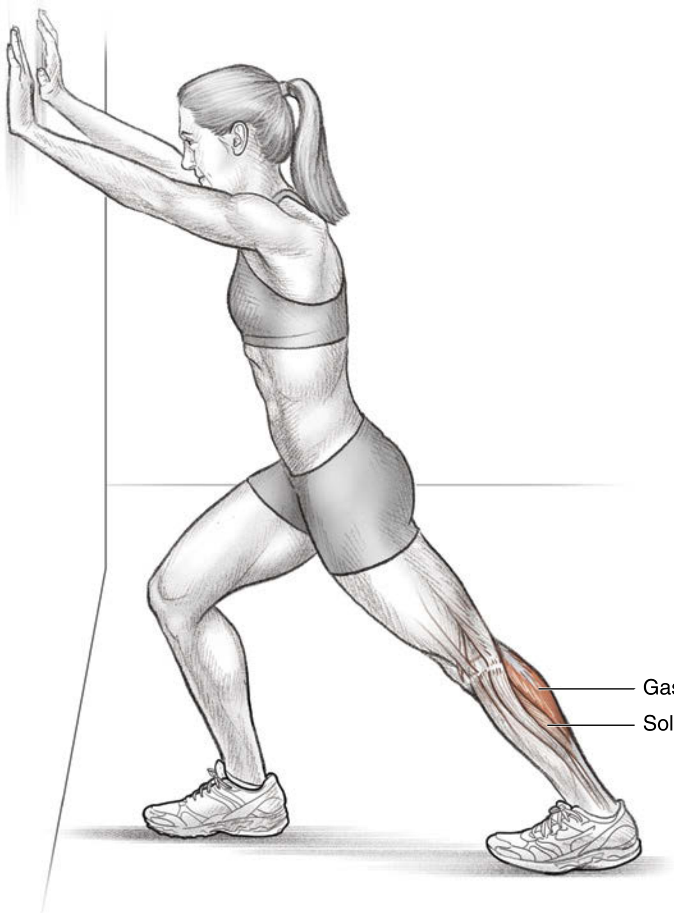
Primary: Plantar fascia

Secondary: Intrinsic muscles of the foot

TRIATHLON FOCUS

Heel pain can be the bane of an athlete's existence. Walking, sitting, even getting out of bed can be problematic. Microscopic injury to the insertion of a layer of tissue at the bottom of the foot into the heel, the plantar fascia, can be disabling. Repetitive impact loading from running, wearing worn-out shoes, or just having bad luck can cause plantar fasciitis to rear its ugly head. Improperly referred to as heel spurs, this condition takes a great deal of tender loving care to treat. This stretching exercise is just one of many techniques to reduce symptoms and allow for proper healing. Other treatments include ice, heel inserts, night splints, physical therapy, orthotics, new shoes, and medication.

CALF STRETCH



Execution

1. Face a wall or a stable piece of furniture. Use the hands for support.
2. Place the right leg close to the wall and the left leg comfortably 1 to 2 feet (0.3 to 0.6 m) behind.
3. Keep the back leg straight and the heel firmly on the ground. Hips should be straight and facing the wall.
4. Gently lean the hips toward the wall until you feel a gentle pull in the calf of the back leg.
5. Hold this position for 15 to 30 seconds. Repeat three times for each leg.

Muscles Involved

Primary: Gastrocnemius

Secondary: Soleus, flexor hallucis longus, flexor digitorum longus

TRIATHLON FOCUS

Injury to the Achilles tendon, the largest tendon in the body, can cause symptoms of stiffness around the ankle as well as pain with motion. For the unfortunate athlete who sustains a complete rupture of the Achilles tendon, there are often no warning signs. Inflammation around the area with swelling and possibly the development of a hard bump on the tendon can disrupt athletic activities. The calf muscles—the gastrocnemius and soleus—together form the Achilles tendon. Injury to this region should be addressed with appropriate stretches such as this one. Strength training exercises described in chapter 4, such as the single-leg heel raise with dumbbells, can help treat and prevent muscle and tendon injury.

EXERCISE FINDER

LEGS AND HIPS

BACK AND NECK

CHEST

SHOULDERS

ARMS

CORE

WHOLE-BODY TRAINING

INJURY PREVENTION

ABOUT THE AUTHORS

Courtesy of Mariela Melamed.

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Klion has participated in 11 Ironman triathlons, including Hawaii Ironman 2000 and 2001. He has completed 15 marathons in addition to many ultradistance running and biking races. He serves as the medical director for the New York City Triathlon. He has published numerous articles on sports medicine issues and has appeared on both regional and national radio and television programs. He is active in the triathlon and endurance community, providing lectures about sports-medicine-related issues to local clubs and groups.

Jonathan Cane

Jonathan Cane, better known as Coach Cane, has been coaching endurance athletes for over 30 years. He is the cofounder and head coach of City Coach, a running and triathlon coaching company, where he coaches athletes ranging from beginners to world champions and world record holders. He holds a master's degree in exercise physiology from Adelphi University. In addition to his work with City Coach, he has coached for Nike, JackRabbit, and Under Armour.

Cane is the coauthor of *The Complete Idiot's Guide to Weight Training* and has written for *MetroSports Magazine*, *NY Runner*, and *Triathlete Magazine*. He has been a featured speaker for Nike, New York Road Runners, Chelsea Piers Triathlon Club, Hospital for Special Surgery, and more.

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