Chapter 3
The Muscular System

Chapter Objectives
Upon completion of this chapter, you should be able to
1. identify and define medical terms associated with the major structures and functions of the muscular system;
2. recognize, define, spell, and pronounce terms related to the pathology, diagnosis, and treatment of muscular system diseases and conditions; and
3. identify medical careers associated with the diagnosis and treatment of muscular system diseases and conditions.

Case Study
Khalil Larkins, an 18-year-old senior at Wolfridge High School, was running the 100-meter dash for his qualifying time. As he left his starting block, he heard a “pop” and instantly felt a sharp pain in the upper back part of his left leg. He struggled as he limped off the track. His teammates helped him to the treatment area, where his trainer could assess him. After a quick evaluation, the trainer placed ice on Khalil’s left hamstring, the muscle in the posterior upper leg. Khalil was instructed to stay off his left leg and was given a pair of crutches to use until he could be examined by a physician.

The next morning, Khalil’s pain had not subsided, and now there was swelling, bruising, and tenderness at the injury site. Khalil continued to use his crutches to move around, and when it was convenient, he iced the back part of his upper left leg. The following day, Khalil saw Dr. Schumacher for his initial assessment. Dr. Schumacher was an orthopedist (OR-thoh-PEE-dist), or a medical specialist who treats conditions and injuries of the musculoskeletal (MUS-kyoo-loh-SKEL-uh-tuhl) system, which is made up of the muscular and skeletal structures and tissues of the body.

Dr. Schumacher determined that Khalil had a strained, or pulled, hamstring in his left leg.

Your Turn
What kinds of treatments do you think Dr. Schumacher recommended for Khalil’s hamstring strain? What facts in the case study led you to this answer? As you read through this chapter, you will learn medical terms that will help you understand the basic structures and functions of the muscular system, as well as common diseases and conditions, diagnostic tests and procedures, and surgical and therapeutic treatments. You will refer back to this case study when you interpret Khalil’s medical record in the Chapter Review.

Medical Word Parts

The muscular system is made up of many unique structures and parts, all of which have specific names in the healthcare and medical fields. Mastery of the combining forms, prefixes, and suffixes listed in the tables that follow will help you understand medical terms pertaining to the muscular system.

Combining Forms
The combining forms that follow are common in medical terms used to describe muscular system conditions, diagnostic and surgical procedures, and therapeutic treatment methods.

<table>
<thead>
<tr>
<th>Combining Form (Root Word plus Combining Vowel)</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>articul/o</td>
<td>joint</td>
</tr>
<tr>
<td>card/o, cardi/o</td>
<td>heart</td>
</tr>
<tr>
<td>duct/o</td>
<td>to lead; to carry</td>
</tr>
<tr>
<td>elect/o</td>
<td>electricity</td>
</tr>
<tr>
<td>fasci/o</td>
<td>fibrous band; fascia</td>
</tr>
</tbody>
</table>

(Continued)
The Muscular System

Chapter 3

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Of your body weight. Your body has more than 630 muscles that help you perform different kinds of movement.

On average, muscles make up 40 to 45 percent of your body weight. Your body has more than 630 muscles that help you perform different kinds of movement.

Introduction to Medical Terminology

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(Continued)

suffixes follow that are common in medical terms used to describe health conditions, diagnostic tests and procedures, and therapeutic treatments related to the muscular system. You will encounter many of the same suffixes in your study of other body systems.

Suffixes

The suffixes that follow are not specific to muscular system terminology. These universal prefixes are used in many other medical terms, as you will see in your study of medical terminology and other body systems.

Prefixes

The prefixes that follow are specific to muscular system terminology. These universal prefixes are used in many other medical terms, as you will see in your study of medical terminology and other body systems.

Muscle Tissue Types

Muscle is a type of body tissue made up of bundles of fibers (long, slender cells) that are held together by connective tissue. When nerves stimulate muscle fibers, the fibers contract (become shorter and thicker), causing body movement.

Muscles that are stimulated to move through conscious control are called voluntary muscles. The phrase “conscious control” does not mean that your brain has to think about, or plan, every muscular action before it is performed. Rather, voluntary muscular activity is an action that you can control through the force of your will (for example, swallowing). Much voluntary muscular activity happens when you are giving little, if any, thought to the actions that are performed by your body. By contrast, muscles that are not stimulated to move through conscious control are called involuntary muscles. You cannot force yourself to move these muscles through willpower (for example, the heart beating).

Voluntary and involuntary muscles in the body come in three types: skeletal muscle, smooth muscle, and cardiac muscle.

Skeletal muscle, also called striated (strih-AH-ted) muscle, is voluntary muscle that is attached to bone and can be contracted or relaxed through conscious control. Striated muscle has a distinctively striped appearance and is composed of muscle fibers. Skeletal muscle fibers are long, slender cells grouped and held together with connective tissue and covered with fascia (FASH-ee-uh), a band or sheet of fibrous tissue that encloses a muscle or group of muscles. Skeletal muscle is found in the scalp, face, mouth, pharynx (throat), larynx (voice box), neck, chest, vertebral column, arms and hands, abdomen, back, and legs and feet.

Smooth muscle, also called visceral (VIS-uh-ruhl) muscle, is a type of involuntary muscle, meaning it is not controlled by conscious thought processes. Smooth muscle surrounds internal organs and is found throughout your respiratory tract, stomach, intestines, and urinary tract. Smooth muscle contracts and relaxes to move contents through body system passageways. This involuntary movement, known as peristalsis (PEER-ih-stahl-sis), enables blood to travel through arteries and veins, food to move through the stomach and intestines, and a fetus to be expelled through the birth canal.

Prefixed Meaning

tabi/o fiber

tabi/o fiber

tabi/o fiber

tabi/o fiber

tabi/o fiber

in- in; into; not

par, para- near; beside; alongside; beyond; abnormal

quadri- four

tachy- fast

tri- three

Suffix Meaning

-tomy process of cutting; incision

-tonia tone; tension

trophy condition of growth or development

Prefix Meaning

-ac, -al, -ar, -ic pertaining to

-algia pain

-asthenia weakness

-cele hernia; swelling; protrusion

ceps heads (attachments)
dynia pain

ectomy surgical removal; excision
esthesia sensation

-logy study of

-gram record; image

-graphy process of recording

-tonia tone; tension

-tron process; state; condition

-tis inflammation

-logy study of

-lysis breakdown; separation; loosening

-malacia softening

-oma tumor; mass

-paresis weakness

-penia deficiency

-plasty surgical repair

-plegia paralysis

-plegia pertaining to paralysis

-rhexis rupture

-scope instrument used to view

-scopie visual examination using a scope

-softening

-tumor; mass

-deficiency

-repair

-paralysis

-rupture

-view

-view

-view

-view

-view
Cardiac muscle, also called myocardial (MY-oh-KAR-dee-uhl) muscle, is found only in the heart. Like smooth muscle, cardiac muscle is unconsciously controlled. As cardiac muscle involuntarily contracts, it pumps blood from the heart into blood vessels.

**Fascinating Fact**

You probably have heard the saying, "It takes more muscles to frown than it does to smile." Did you know that you have more than 30 facial muscles that produce a range of subtly different expressions including happiness, sadness, surprise, anger, fear, disgust, and astonishment?

**Muscle Tissue Properties**

Muscle tissue has many unique properties. It is the only tissue in the body that has the following physiological characteristics:

- **Automaticity** (AW-toh-muh-TIH-ih-tee)—the ability of a muscle to contract without the involvement of a nerve supply. Automaticity is a property of visceral, smooth, and cardiac muscles.
- **Contractility** (KAHN-trak-TIL-ih-tee)—the ability of a skeletal muscle to contract (shorten); for example, the biceps muscle contracts when the arm is flexed.
- **Excitability** (also called irritability)—the ability of a skeletal muscle to receive and respond to a nerve impulse by contracting. For example, nerves send a message to the heart muscle, and the heart pumps blood through the vessels throughout the body.
- **Extensibility** (eks-TENS-ih-BIL-ih-tee)—the ability of the skeletal muscles to be stretched. Extensibility is evident in the hamstrings and calf muscles during a toe touch, for example.

**Skeletal Muscle Organization**

The basic structure of muscles includes several connective tissue layers (Figure 3.4). The inner layer, or endomysium (EN-doh-MIZ-e-um), is a fine sheath of areolar connective tissue around each muscle fiber. **Areolar** tissue consists of loosely woven fibers and many blood vessels. The **Perimysium** (PEER-ih-MIZ-e-um) is a sheath of connective tissue that surrounds bundles of muscle fibers called **Fasciae** (FAS-ih-kuhlz). The outer layer, or epimysium (EPih-MIZ-e-um), is a dense, fibrous connective tissue that surrounds the entire muscle. All of these structures are surrounded by **fascia** (FASH-ee-uh), fibrous connective tissue that binds muscles into functional groups.

**Muscle Origin and Insertion**

Skeletal muscle plays a vital role in directional movements of the skeleton. The connecting parts of each muscle are specific to that muscle and the bone to which the muscle is connected. Skeletal muscle is attached to bone at both ends of the muscle.

Typically, during contraction, one end of a muscle remains fixed in its position, and the other end of the muscle moves. The origin of a muscle is the attachment site that does not move when the muscle contracts; the insertion is the attachment site that moves during muscular contraction. Figure 3.2 illustrates examples of origin and insertion points in the shoulder and forearm.

Most skeletal muscle is attached to bone by **tendons** (non-cartilage). A tendon is a band of fibrous tissue that connects muscle to bone (Figure 3.3). The Achilles tendon, for example, attaches the gastrocnemius (GAS-trok-NEE-mee-us) muscle on the calf of the leg to the calcaneus (kal-KAY-nee-us), or heel bone.

Tendons are different from ligaments. As you learned in Chapter 2: The Skeletal System, a **ligament** is a fibrous cord of tissue that attaches bone to bone. Ligaments usually impart stability by holding structures together (Figure 3.3).
groups and envelops other structures in the body, such as bones, nerves, and blood vessels.

The muscular system has its own blood and nerve supply. Muscles have arteries, veins, and capillaries due to their remarkable energy needs and the metabolic waste they generate as a product of contraction.

**Fascinating Fact**
The eye muscles are the most active muscles in the body. Scientists estimate that these muscles may move more than 100,000 times a day.

### Directional Motion

Three factors make the muscular system capable of moving the body: muscle type, muscle excitability (stimulation of a muscle by a nerve impulse), and opposition between agonist (AG-uh-nist) and antagonist (an-TAG-uh-nist) muscle pairs (Figure 3.5).

Agonist and antagonist muscle pairs work in opposition to create body movement. In these pairs, the agonist is the muscle that causes the primary movement. The antagonist is the muscle that works against this movement. For example, when you flex your arm, your biceps muscle functions as the agonist. When you straighten your arm, the biceps muscle becomes the antagonist while the triceps muscle functions as the agonist to achieve primary muscular movement. For this reason, agonist muscles are referred to as “prime movers.”

Many types of muscular movement have a directional opposite; therefore, the directional motions produced by agonist and antagonist muscles are typically categorized in pairs, as described in the table that follows, with a couple of exceptions. These movements are described from the perspective of anatomical position.

#### Directional Movements

<table>
<thead>
<tr>
<th>Movement</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>abduction</strong></td>
<td>Movement of a body part away from the midline of the body.</td>
<td>Triceps relaxed (antagonist) in biceps (agonist)</td>
</tr>
<tr>
<td><strong>adduction</strong></td>
<td>Movement of a body part toward the midline of the body.</td>
<td>Triceps relaxed (antagonist) in biceps (agonist)</td>
</tr>
<tr>
<td><strong>inversion</strong></td>
<td>The turning inward of the sole of the foot.</td>
<td>Triceps relaxed (antagonist) in biceps (agonist)</td>
</tr>
<tr>
<td><strong>eversion</strong></td>
<td>The turning outward of the sole of the foot.</td>
<td>Triceps relaxed (antagonist) in biceps (agonist)</td>
</tr>
</tbody>
</table>

**Challange**
Nerve impulses are vital to the directional motion of the body. When nerve impulses are impaired, a condition called paralysis (puh-RAL-i-see) can occur. Paralysis prevents muscular movement. The term neuromuscular (NEW-roh-MUS-kyoo-ler) is used to describe or define the relationship between nerves and muscles in the body.

**Directions:** On a separate sheet of paper, dissect the word neuromuscular into its individual word parts. Identify each word part (combining form, prefix, or suffix). Then define each word part and the term as a whole.
### Directional Movements

<table>
<thead>
<tr>
<th>Direction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>elevation</strong></td>
<td>Raising of a body part.</td>
</tr>
<tr>
<td><strong>depression</strong></td>
<td>Lowering of a body part.</td>
</tr>
<tr>
<td><strong>flexion</strong></td>
<td>The movement of two body surfaces toward each other, as in the act of bending.</td>
</tr>
<tr>
<td>flex/o = to bend</td>
<td>-ion = process; state; condition</td>
</tr>
<tr>
<td><strong>extension</strong></td>
<td>The straightening of a limb after it has been flexed.</td>
</tr>
<tr>
<td>ext/o = out away from</td>
<td>-en = process; state; condition</td>
</tr>
<tr>
<td><strong>hyperextension</strong></td>
<td>The act of bending a joint or limb beyond normal extension or range of motion.</td>
</tr>
<tr>
<td>hyper- = above normal</td>
<td>-en = process; state; condition</td>
</tr>
<tr>
<td><strong>dorsiflexion</strong></td>
<td>Movement of the sole of the foot upward (flexed toward the lower leg).</td>
</tr>
<tr>
<td>dors/o = back</td>
<td>-en = process; state; condition</td>
</tr>
<tr>
<td><strong>plantar flexion</strong></td>
<td>Motion of the plantar surface (sole of the foot) away from the midline of the body.</td>
</tr>
<tr>
<td>plant/o = sole of the foot</td>
<td>-an = process; state; condition</td>
</tr>
</tbody>
</table>

### Major Muscles and Their Functions

The human body is made up of many muscles, all with specific functions and names. People in the fields of healthcare and medicine need to be familiar with the major muscles of the body. The major muscles of the body are listed in the following table, along with brief descriptions of their main functions.

**Fascinating Fact**
The term hamstring derives its name from eighteenth-century English butchers, who used string to hang slaughtered pigs (ham) by the muscles in the back of the knees.

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Location</th>
<th>Primary Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>frontalis</td>
<td>forehead</td>
<td>Raises eyebrows; wrinkles forehead.</td>
</tr>
<tr>
<td>trapezius</td>
<td>upper back and neck</td>
<td>Extends neck; elevates, adducts, and rotates scapula.</td>
</tr>
<tr>
<td>deltoid</td>
<td>external shoulder</td>
<td>Abducts, flexes, extends, and rotates arm.</td>
</tr>
<tr>
<td>pectoralis major</td>
<td>chest</td>
<td>Flexes, adducts, and rotates arm.</td>
</tr>
<tr>
<td>biceps brachii</td>
<td>posterior upper arm</td>
<td>Extends forearm.</td>
</tr>
<tr>
<td>latissimus dorsi</td>
<td>midback and lower spine</td>
<td>Extends, adducts, and rotates arm.</td>
</tr>
<tr>
<td>abdominal muscles</td>
<td>ribs to pubic bone</td>
<td>Flex and rotate trunk.</td>
</tr>
<tr>
<td>gluteus medius</td>
<td>medial muscle of buttocks;</td>
<td>Adducts and rotates thigh.</td>
</tr>
<tr>
<td>gluteus maximus</td>
<td>outer surface of pelvis</td>
<td></td>
</tr>
<tr>
<td>sartorius</td>
<td>anterior thigh (crosses thigh obliquely)</td>
<td>Flexes and rotates thigh; flexes leg.</td>
</tr>
<tr>
<td>biceps femoris (hamstring)</td>
<td>posterior thigh</td>
<td>Extends thigh; flexes and rotates leg.</td>
</tr>
<tr>
<td>rectus femoris (quadriceps)</td>
<td>anterior thigh</td>
<td>Flexes thigh; extends leg.</td>
</tr>
<tr>
<td>gastrocnemius</td>
<td>prominent muscle in posterior calf</td>
<td>Flexes foot and leg.</td>
</tr>
<tr>
<td>tibialis anterior</td>
<td>anterior lower leg</td>
<td>Dorsiflexes and inverts foot.</td>
</tr>
</tbody>
</table>

(Continued)
Diseases and Conditions

Perhaps you or someone you know has experienced carpal tunnel syndrome, uses a wheelchair due to paralysis, or has been diagnosed with a chronic disease such as muscular dystrophy. In this section, you will learn about common characteristics of diseases and conditions that affect the muscular system.

<table>
<thead>
<tr>
<th>Disease/Condition</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>adhesion</td>
<td>Normally, the formation of a fibrous band of tissue that holds two parts or surfaces together, as in the healing of a wound. In a disease condition, the formation of a fibrous band of tissue that holds two surfaces together due to inflammation or trauma (Figure 3.6).</td>
</tr>
<tr>
<td>ataxia</td>
<td>Inability to coordinate voluntary muscle activity; characterized by shaky, unsteady movements.</td>
</tr>
<tr>
<td>atrophy</td>
<td>Wasting away or shrinkage of muscle size.</td>
</tr>
</tbody>
</table>

**Figure 3.6** Abdominal adhesion. Endoscopic view of a patient’s abdomen with adhesions between the omentum (bottom left) and the abdominal wall (top). The omentum is a membranous sac that hangs down from the stomach, covering the intestines. Adhesions are growths of fibrous (scar) connective tissue formed as a response to tissue trauma. They often result from abdominal surgery. If the adhesions cause severe pain or obstruct part of the bowel, they are removed surgically.

**STUDENT CHALLENGE**

How is the flexibility in your upper and lower extremities? In the passive range-of-motion (ROM) exercises that follow, you and a classmate will take turns being the patient and the physical therapist. Record your answers to the following questions as you work through each exercise.

1. In which passive ROM exercises did you demonstrate more joint flexibility?
2. Which exercises do you think might help you to strengthen certain joints and muscles?

**Directions:**

a. “Snow Angel Arms”—In a sitting position, keep your left arm straight at your side; then move the arm straight out while your classmate supports your left elbow and wrist. Repeat these steps with your right arm as your partner supports your right elbow and wrist.

b. “Brush Your Hair”—As your classmate supports your elbow and wrist, bend your left or right arm at the elbow and bring your arm over your head.

c. “Let’s Go Bowling”—Begin with your arm straight at your side; then move the arm slightly behind your back while your partner supports your elbow and wrist.

d. “Open the Door”—As your classmate supports your elbow, place one hand in the palm of his or her other hand and rotate your forearm upward. Then rotate it downward, as if turning a doorknob.

e. “Come Here”—Begin with your elbow supported on a desk, a table, or the arm of a chair. As your classmate provides support above and below your wrist, flex your palm toward the ventral (interior) side of your forearm. Then extend the back of your hand toward the top of your forearm.

f. “Wave Goodbye”—Begin with your elbow supported on a flat surface. As your classmate provides support above and below your wrist, turn your hand toward your thumb; then turn your hand toward your pinky finger.

g. Finger Curls—With your elbow supported on a flat surface, place the palms of your hands in the palms of your classmate’s hands. Next, curl your fingers around your classmate’s fingers; then straighten your fingers.

h. Thumb and Finger Touches—As your partner supports your elbow on a flat surface, touch the tip of each of your fingers with the tip of your thumb.

i. Finger Spreads—As your partner supports your elbow on a flat surface, spread each of your fingers away from the midline of your hand.

j. “Snow Angel Legs”—Lie in a supine (flat on your back) position. As your classmate provides support beneath your left knee and ankle, move your left leg straight out to your side; then move it back to its “starting” position. Repeat the exercise with your right leg.

k. “Bicycle”—Lie in a supine position. With one leg straight and your classmate providing support beneath the knee and ankle of your other leg, bend the supported leg at your knee. Then straighten your leg and lower it to its original position.

l. “The Twist”—Lie in a supine position on a mat. With one leg straight and your partner providing support beneath the knee and ankle of your other leg, rotate your entire supported leg inward; then rotate it outward.

m. Ankle Circles—With your leg on a mat, and your classmate providing support above and below your ankle, rotate your foot in a circle to the right; then rotate it in a circle to the left.

NOTE: For the exercises that follow, you and your classmate should wear gloves.

n. Toe Curls—Lie with your legs straight on a mat. With your classmate providing support at your ankle, she or he curls your toes inward and then straightens them.

o. Toe Spreads—As you lie with your leg on a mat, your partner moves each of your toes away from your middle toe and then back toward your middle toe.
<table>
<thead>
<tr>
<th>Disease/Condition</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>carpal tunnel syndrome (CTs)</strong></td>
<td>Disorder marked by pain, burning, and itching or tingling due to an inflamed median nerve and tendons in the wrist; commonly associated with repetitive activity and/or overuse injury.</td>
</tr>
<tr>
<td><strong>contracture</strong></td>
<td>Permanent tightening of skin, muscles, tendons, ligaments, and fascia (a band or sheet of fibrous tissue that encloses muscle tissue); most commonly due to lack of use or immobilization.</td>
</tr>
<tr>
<td><strong>Duchenne muscular dystrophy (DMD)</strong></td>
<td>Progressive disease that weakens the muscles of the shoulder and pelvic girdle. DMD is a sex-linked recessive trait that affects mostly males.</td>
</tr>
<tr>
<td><strong>dystasia</strong></td>
<td>Partial ataxia; a mild form of ataxia (lack of muscular coordination that produces shaky, unsteady movements).</td>
</tr>
<tr>
<td><strong>fasciitis</strong></td>
<td>Inflammation of a fascia (a band or sheet of fibrous tissue that encloses a muscle or group of muscles).</td>
</tr>
<tr>
<td><strong>flaccidity</strong></td>
<td>Condition or state in which muscles are flabby, relaxed, or have defective or absent tone. Tone is the normal tension present in muscles in a resting state.</td>
</tr>
<tr>
<td><strong>hemiparesis</strong></td>
<td>Weakness or slight paralysis on one side of the body. Total paralysis on one side of the body.</td>
</tr>
<tr>
<td><strong>hemiplegia</strong></td>
<td>Excessive growth or abnormal enlargement of a muscle (Figure 3.7 on the next page).</td>
</tr>
<tr>
<td><strong>hypertrophy</strong></td>
<td>Genetic disease characterized by progressive muscular weakness and skeletal muscle deterioration (Figure 3.9).</td>
</tr>
<tr>
<td><strong>hypotonia</strong></td>
<td>Loss of muscle tone.</td>
</tr>
<tr>
<td><strong>impingement syndrome</strong></td>
<td>Condition that occurs when tendons of the shoulder become impinged, or compressed, by the bones of the shoulder (Figure 3.8).</td>
</tr>
<tr>
<td><strong>muscular dystrophy (MD)</strong></td>
<td>Genetic disease characterized by progressive muscular weakness and skeletal muscle deterioration (Figure 3.9).</td>
</tr>
<tr>
<td><strong>myalgia or myodynia</strong></td>
<td>Muscle pain.</td>
</tr>
<tr>
<td><strong>myasthenia gravis</strong></td>
<td>Chronic autoimmune disease characterized by voluntary muscle weakness that worsens after activity and improves after rest.</td>
</tr>
</tbody>
</table>

**Figure 3.7** At left, a normal heart; at right, a heart affected by muscular hypertrophy.

**Figure 3.8** When the bones of the shoulder compress the shoulder tendon, the result is impingement syndrome.
Disease/Condition  Definition

myocele  Herniation or protrusion of muscle through a tear in the fascia.

myolysis  Degeneration or deterioration of muscle tissue.

myoma  Tumor of the muscle.

leiomyoma  Benign tumor of smooth muscle, such as that found in the heart, bladder, or uterus.

myomata (continued)  Definition

leiomyosarcoma  Malignant tumor of smooth muscle.

rhabdomyoma  Benign tumor consisting of striated muscle that occurs on or in the smooth muscle of the heart (Figure 3.9).

rhabdomyosarcoma (RMS)  Malignant tumor of skeletal muscle.

myomalacia  Abnormal softening of muscle tissue.

myoparesis  Weakness or mild muscular paralysis.

myorrhesis  Rupture or tearing of a muscle.

myositis  Inflammation of a muscle.

paraplegia  Paralysis of both legs and, often, the lower trunk.

paresthesia  Abnormal sensation that typically is not painful, such as tingling, numbness, itching, prickling, or burning. An example of a common form of temporary paresthesia is when your foot “falls asleep,” causing a “pins and needles” sensation after you have sat on it too long.

paraspinous  Pain occurring in the region of the spinous processes.

myopia  Weakness or mild muscular paralysis.

myostis  Inflammation of a muscle.

paraplegia  Paralysis of both legs and, often, the lower trunk.

paresthesia  Abnormal sensation that typically is not painful, such as tingling, numbness, itching, prickling, or burning. An example of a common form of temporary paresthesia is when your foot “falls asleep,” causing a “pins and needles” sensation after you have sat on it too long.

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**Disease/Condition** | **Definition**  
---|---  
plantar fasciitis | Inflammation of the plantar fascia (the thick band of tissue in the sole of the foot between the heel bone and the toes), resulting in heel pain.  
quadriplegia | Paralysis of all four extremities.  
rigor or rigidity | Muscular stiffness/stiff muscle, as in *rigor mortis* (Latin *rigor* = “stiffness”; *mortis* = “of death”). Stiffness that occurs in dead bodies due to chemical changes in the muscles.  
sarcopenia | Loss of muscle mass, strength, and function as a result of aging.  
shin splint | Painful condition caused by muscle tearing away from the tibia.  
spasm | Involuntary sudden movement or convulsive muscular contraction. Such a movement is described as spastic.  
sprain | The stretching or tearing of a ligament, which connects bone to bone.  
strain | The stretching or tearing of a muscle or tendon, the latter of which connects muscle to bone; pulled muscle or pulled tendon.  
tenalgia or tenodynia | Pain in the tendon.  
tendinitis or tendonitis | Inflammation of a tendon.  
tetany | A state of sustained muscular contraction.

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**Inquiring Minds**

A trained individual conducting a postmortem exam can estimate the time of a person’s death by studying a few revealing facts, such as body temperature and the presence (or absence) of body stiffness, called *rigor mortis*. (The term *postmortem* comes from the Latin words *post*, which means “after,” and *mortem*, meaning “death.”) Use of a rectal thermometer is the most accurate method of assessing the temperature of a corpse. The normal body temperature of a living person is 98.6 degrees Fahrenheit (F), and normal rectal temperature is 99.6 degrees F. In a temperature-controlled environment, the body temperature of a deceased person drops an average of 1.5 degrees F per hour. Rigor mortis sets in approximately 2 to 4 hours after death, peaks around 12 to 18 hours postmortem, and usually fades 24 to 36 hours after death. At this stage, decomposition (decay) begins to occur. Imagine that you are a forensic pathologist, a medical professional who determines cause of death by examining corpses. You establish that the rectal temperature of a corpse at midnight was 95 degrees F. You also note that rigor mortis was present. Based on these facts, what do you estimate to be the time of death? What medical terms would you, as a forensic pathologist, need to know to communicate your observations? Summarize your observations and share with a partner using the appropriate medical vocabulary.

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**Diagnostic Tests and Procedures**

A diagnostician uses different kinds of tools and methods to aid in pinpointing the causes of patients’ health problems. Following are some of the most common tests and procedures used to diagnose diseases and conditions of the muscular system.

**Test/Procedure** | **Definition**  
---|---  
biopsy | The removal of a small piece of living tissue for microscopic examination (Figure 3.11).  
computerized tomography (CT) | Process in which radiographic images of a specific section of the body are taken from multiple angles. The images are then analyzed using a computer to identify muscular injury or disease. CT scans provide more detailed imagery than standard X-rays.
**deep tendon reflexes** (DTR)

- **Definition**: Evaluation of involuntary muscular responses with a reflex hammer (Figure 3.12). Patients under heavy sedation or in a deep coma do not exhibit these reflexes.

**electromyogram (EMG)**

- **Definition**: A graphic recording of the contraction of a muscle as a result of electrical stimulation (Figure 3.13 on the next page).

**goniometry**

- **Definition**: The measurement of range of motion in a joint.

**magnetic resonance imaging (MRI)**

- **Definition**: A noninvasive scanning test that involves use of an electromagnetic field and radio waves to visualize soft-tissue structures.

**nuclear medicine imaging (NMI)**

- **Definition**: Diagnostic imaging technique in which a radioactive substance and a special camera are used to visualize structures and functions in the body. The radioactive substance is injected into or swallowed by the patient.

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**Fascinating Fact**

The term goniometry comes from the Greek gonia ("angle") and metron ("measure"). More precisely, goniometry is the measurement of the angles produced by joints during range-of-motion activity.
### Surgical Procedures and Therapeutics

Once a muscular condition or disease has been diagnosed, a treatment plan can be developed and implemented. For example, when an EMG (electromyogram) reveals symptoms of muscle weakness, physical therapy may be the recommended treatment.

Following is a list of common surgical and noninvasive treatments for diseases and conditions of the muscular system.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>myoplasty</td>
<td>Surgical repair of a muscle through plastic surgery.</td>
</tr>
<tr>
<td>physical therapy</td>
<td>Treatment to rehabilitate a patient disabled by illness or injury. Common methods include exercise, hydrotherapy (water therapy), shown in Figure 3.14: ultrasound, and diathermy (DIGH-uh-HER-mee), or deep heating of body tissues using a high-frequency electrical current. Exercises performed to improve or maintain joint mobility and flexibility. Active ROM exercises are those that can be performed on your own. Assisted ROM exercises require minor assistance due to mild weakness, pain, or stiffness. Passive ROM exercises are performed by a physical therapist on a person who requires total assistance to do the exercises.</td>
</tr>
<tr>
<td>range-of-motion (ROM) therapy</td>
<td><strong>Figure 3.14</strong> Hydrotherapy is often recommended for patients with arthritis because the buoyancy of the water means less weight-bearing impact on the joints.</td>
</tr>
</tbody>
</table>

### Therapeutic Drug Treatments

Injuries and conditions of the muscular system often require treatment with medications. The following list includes common drugs and their pharmacodynamics (actions in the body).

<table>
<thead>
<tr>
<th>Drug</th>
<th>Effect on the Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>analgesic</td>
<td>A drug that relieves pain; includes nonprescription pain relievers, such as aspirin, and prescription pain relievers, such as hydrocodone.</td>
</tr>
<tr>
<td>anti-inflammatory</td>
<td>A drug that reduces inflammation.</td>
</tr>
<tr>
<td>antispasmodic or anticholinergic</td>
<td>A drug prescribed to suppress smooth muscle contractions of the bladder, stomach, or intestine.</td>
</tr>
<tr>
<td>narcotic</td>
<td>A drug that, in moderate doses, depresses the central nervous system, relieves pain, and induces sleep. Taken in excess, narcotics produce unconsciousness, stupor, coma, and possibly death.</td>
</tr>
<tr>
<td>nonsteroidal (NSAID)</td>
<td>A group of drugs with analgesic, anti-inflammatory, and antipyretic (fever-reducing) properties. Aspirin, ibuprofen, and naproxen are common over-the-counter (OTC) NSAIDs. This group of drugs is set apart from other drugs that have the same properties because they are nonsteroidal. Steroidal drugs have narcotic effects and may result in addiction.</td>
</tr>
</tbody>
</table>
Common Medical Abbreviations

The following medical abbreviations are commonly used in reference to the muscular system. These abbreviations provide a shorthand method of communication among healthcare professionals concerning pathological conditions, diagnostic tests, surgical procedures, and therapeutic treatments. These abbreviations can be found in this chapter and in the medical record activity that follows.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>amb</td>
<td>ambulate (walk)</td>
<td>NMI</td>
<td>nuclear medicine imaging</td>
</tr>
<tr>
<td>CAT</td>
<td>computerized axial tomography</td>
<td>NSAID</td>
<td>nonsteroidal anti-inflammatory</td>
</tr>
<tr>
<td>CFT</td>
<td>certified fitness trainer</td>
<td>OTC</td>
<td>over-the-counter</td>
</tr>
<tr>
<td>c/o</td>
<td>complains of; complaining of</td>
<td>PCN</td>
<td>penicillin</td>
</tr>
<tr>
<td>CPR</td>
<td>cardiopulmonary resuscitation</td>
<td>PCP</td>
<td>primary care physician</td>
</tr>
<tr>
<td>CT</td>
<td>computed tomography; computerized tomography</td>
<td>PFT</td>
<td>personal fitness trainer</td>
</tr>
<tr>
<td>CTS</td>
<td>carpal tunnel syndrome</td>
<td>PRN, p.r.n.</td>
<td>as needed (from the Latin pro re nata)</td>
</tr>
<tr>
<td>DMD</td>
<td>Duchenne muscular dystrophy</td>
<td>Pt, pt.</td>
<td>patient</td>
</tr>
<tr>
<td>DTR</td>
<td>deep tendon reflex</td>
<td>PT</td>
<td>physical therapy</td>
</tr>
<tr>
<td>EMG</td>
<td>electromyogram</td>
<td>Q2–3H</td>
<td>every two or three hours</td>
</tr>
<tr>
<td>h</td>
<td>hour(s)</td>
<td>Q8H</td>
<td>every eight hours (from the Latin quaque octava hora)</td>
</tr>
<tr>
<td>Hx, hx</td>
<td>history</td>
<td>R</td>
<td>right</td>
</tr>
<tr>
<td>IM</td>
<td>intramuscular</td>
<td>RICE</td>
<td>rest, ice, compression, elevation</td>
</tr>
<tr>
<td>L</td>
<td>left</td>
<td>RMS</td>
<td>rhabdomyosarcoma</td>
</tr>
<tr>
<td>MD</td>
<td>muscular dystrophy</td>
<td>ROM</td>
<td>range of motion</td>
</tr>
<tr>
<td>mg</td>
<td>milligram(s)</td>
<td>wt</td>
<td>weight</td>
</tr>
<tr>
<td>MRI</td>
<td>magnetic resonance imaging</td>
<td>y/o</td>
<td>years old; year-old (as in 18-year-old)</td>
</tr>
<tr>
<td>N/A</td>
<td>not applicable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Careers to Consider

If you pursue any of the following careers, you will interact on a regular basis with patients who have conditions or diseases of the muscular system. For more detailed information on the career opportunities discussed in this section, visit the US Bureau of Labor Statistics website.

Certified Fitness Trainer

A certified fitness trainer (CFT) serves as a leader and instructor in exercise programs and helps people achieve and maintain a healthy lifestyle. This career path demands a passion for being physically active, healthy, and fit. CFTs must have excellent communication skills and a talent for encouraging and motivating others.

Certified fitness trainer programs take, on average, six months to complete. These programs teach a well-rounded curriculum that includes coursework in exercise programs, nutrition, anatomy and physiology, and psychology. Admission to a CFT program generally requires a high school diploma and current certification in first aid and cardiopulmonary resuscitation (CPR).

Exercise Physiologist

Exercise physiologists develop individualized exercise plans based on their clients' needs, and they design exercise programs to help athletes achieve specific goals.

To prepare for a career in this field, candidates must have at least a bachelor’s degree in exercise physiology. With further education and successful completion of the Exercise Physiologist Certified (EPC) exam, administered by the American Society of Exercise Physiologists (ASEP), a person can obtain board certification. Exercise physiologists are employed in a variety of environments, including healthcare facilities, fitness centers, colleges and universities, athletic or military training facilities, and rehabilitation centers.

Sports Medicine Physician

A sports medicine physician treats and prevents sports-related injuries of the bones, joints, and muscles. These healthcare professionals are qualified to diagnose and treat patients, prescribe medication and therapy, and perform surgery. They attend an accredited medical school to obtain a Medical Doctor (MD) degree or a Doctor of Osteopathic Medicine (DO) degree. Both types of physicians must complete residency programs and obtain a license to practice. Sports medicine physicians may work exclusively for an athletic team, for a university sports program or fitness center, in a private practice, or with a group of physicians.
Chapter 3 Review

Anatomy and Physiology

Directions: Provide the correct term(s) for each question that follows.

1. What type of body tissue is made up of bundles of fibers held together by connective tissue?
2. What are the three types of muscle tissue in the body? Give an example of each.
3. What term is used to describe muscles that are controlled consciously?
4. What term is used to describe muscles that cannot be consciously controlled?
5. Which property describes the ability of muscle to shorten (for example, the biceps muscle when flexed)?
6. Which property describes the ability of skeletal muscle fibers to resume their resting length when a stretching force is removed?
7. Identify the term for the attachment site of a muscle that does not move when the muscle contracts.
8. What is the name for the attachment site of a muscle that moves during muscular contraction?
9. Identify the term for the attachment site of a muscle that connects muscle to bone?
10. What is the term for the band of fibrous tissue that connects bone to bone?

Word Construction

Directions: Using word parts and meanings presented in the chapter, build the medical term described in each definition that follows.

1. surgical repair of a muscle
2. pertaining to muscle
3. process of leading toward
4. pertaining to the sole of the foot
5. the study of movement
6. paralysis of half (of the body)
7. without growth or development
8. three heads (a muscle with three heads or attachments)
9. pertaining to paralysis of four (extremities)
10. process of leading away from
11. process of bending
12. inflammation of the tendon

Word Surgery

Directions: Dissect each medical term into its word parts. Identify the word-part types (prefix, combining form, or suffix), and write the meaning(s) of each word part. Then write a definition of the term.

Example: muscular
Dissection: muscul/o - ar
-muscul/o (combining form) = muscle
-ar (suffix) = pertaining to
Definition: pertaining to muscle


Matching

Directions: Match the combining form (root word and combining vowel) to the correct meaning.


1. a. heart muscle
2. b. coordination; order
3. c. muscle
4. d. tendon
5. e. rod-shaped
6. f. movement
7. g. stretched; strained
8. h. straight; normal
9. i. tone; tension
10. j. smooth
11. k. flesh
12. l. joint
13. m. to bend
14. n. fiber
15. o. sole of the foot

Spelling

Directions: Identify the correctly spelled medical term in each numbered item.

1. fasciitis
2. hypertonnia
3. myalgea
4. dorsafllexion

Example: fasciitis
-dissection: fasciti/s
-fasciitis
-hypertonnia
-hypertonia
-myalgea
-myalgia
-dorsafllexion
-dorsafllexion
### Chapter 3 Review

#### Pronunciation
Directions: Pronounce each term below, then write the correct spelling.

1. FASH-ee-uh
2. MUS-kyoo-ler
3. QUAH-drih-PLEE-jik
4. high-PER-truh-fee
5. TRIGH-seps
6. DOR-sih-FLEK-shun
7. HEM-ih-PLEE-jee-uh
8. fas-ee-IGH-tis
9. MIGH-uhs-THEE-nee-uh
10. HEM-ee-puh-REE-sis
11. MIGH-oh-KAR-dee-um
12. migh-AH-lih-sis

#### Search the Source
1. There are more than 30 different forms of muscular dystrophy, but Duchenne muscular dystrophy tops the list. Working with a partner, visit the National Institutes of Health (NIH) website and research the facts about DMD. What is it? What are the common signs and symptoms? How does DMD develop? What is its prevalence?
2. A sprain and a strain are similar types of injuries but involve different body parts. Visit the NIH website and research the facts about both types of injuries. What are the leading causes of each injury? How is each injury treated?

#### Matching Terms of Directional Motion
Directions: Match each directional movement to the correct definition.

1. abduction
2. adduction
3. rotation
4. circumduction
5. flexion
6. extension
7. supination
8. pronation
9. elevation
10. depression

### Chapter 3 Review

#### Identifying Abbreviations
Directions: Write the correct abbreviation for each medical term or phrase.

1. electromyogram
2. muscular dystrophy
3. years old; year-old
4. physical therapy
5. computerized axial tomography
6. carpal tunnel syndrome
7. primary care physician
8. nonsteroidal anti-inflammatory drug
9. computed tomography; computerized tomography
10. rest, ice, compression, elevation
11. nuclear medicine imaging
12. carpal tunnel syndrome
13. history
14. Duchenne muscular dystrophy
15. complains of; complaining of
16. intramuscular

#### Interpreting Abbreviations
Directions: Write the correct medical term or phrase for each abbreviation listed.

1. mg
2. DTR
3. amb
4. IM
5. L
6. wt
7. PCN
8. NSAID
9. ROM
10. PRN
11. EMG
12. h
13. R
14. RICE
15. PT
16. CT

#### Medical Record Practice

Following is a physical therapy report for Khalil, the 18-year-old high school senior who was introduced in the Case Study. Read Khalil’s medical record. Then, on a separate sheet of paper, write a definition for each highlighted term and abbreviation.

---

**HERMAN ORTHOPEDIC CLINIC**

987 Medical Drive, Hospital City, US 12345

PHONE: (xxx) xxx-4321      FAX: (xxx) xxx-2910

**PHYSICAL THERAPY NOTE**

**PT NAME:** Khalil Larkins

**ID NO:** 86523497

**DATE:** 03/20/20xx

**PCP:** Dr. Evan Schumacher

**Subjective Data:**
Pt. is an 18 y/o male c/o pain, swelling, and tenderness to L hamstring area.

**Past Medical Hx:**
No prior surgeries.

**Social Hx:**
No alcohol or drug use.

**Current Limitations:**
Unable to amb and bear wt on L leg.

**Limitation before Injury:** N/A

**Medications:** Ibuprofen 800 mg Q8H PRN for pain.

**Allergies:** PCN

**Current Pain Level:** 8 on a 1–10 pain scale.

**Pt Goal:** Pain free, return of full ROM and strength.

**Objective Data:**

**Injury Involved:** L hamstring strain.

**Treatment Recommendations:**
1. Rest the injury.
2. Ice to injured site Q2–3H.
3. Compression bandage to minimize bleeding into the tissue.
4. Elevation of the injury to decrease swelling.
5. Continue RICE treatment for the next 48 h.
6. Use crutches for next 48 h.
7. After 48 h, alternate ice and heat.
8. Return to PT department for initial stretching and strengthening exercises in 72 h.