2. Investigate the function of at least five common medications used in treatment of skeletal system.
3. List at least five occupations involved in the health care of skeletal system disorders.
4. Use the Internet to investigate first-, second-, and third-class lever movement of joints.
5. Use the Internet to research the process and techniques used for bone repair after a fracture.
6. Use the Internet to make a poster or pamphlet showing the recommendations for healthy bones, including nutrition and exercise.
7. Use the Internet to investigate and make a poster or pamphlet that describes the methods for improving dental care and cosmetic appearance.

**Bone Health**

WebMD
http://www.webmd.com/osteoeporis/bone-mineral-density

National Institute of Arthritis and Musculoskeletal and Skin Disease (NIAMS)
http://www.niams.nih.gov/Health_Info/Bone/Bone_Health/Exercise/default.asp

**Bone Repair**

Medscape

Medline

**Dental Hygiene**

Academy of General Dentistry
http://www.agd.org/public/anhealth/default.asp?IssId=290&Topic=1123&body

American Dental Association (ADA)
http://www.ada.org/public/topics/whitening_haq.asp

**Muscular System**

**LEARNING OBJECTIVES**

- Define at least 10 terms relating to the muscular system.
- Describe the six functions of the muscular system.
- Identify at least 10 structures of the muscular system and the function of each.
- Describe at least three methods of assessment of the muscular system.
- Describe at least five disorders of the muscular system.

**KEY TERMS**

- **Antagonist** (an-TAG-uh-nist) Muscle that acts in opposition to the action of another muscle, which is its agonist
- **Atrophy** (AT-ro-fee) Wasting away, decrease in size
- **Contraction** (kon-TRAK-shun) Shortening or development of tension in muscle tissue
- **Contracture** (kon-TRAK-chur) Permanent shortening of tendons and ligaments of a joint resulting from atrophy of muscle
- **Dystrophy** (DIS-truh-fee) Muscle disorder resulting from defective or faulty nutrition, abnormal development, or infection
- **Myalgia** (my-AL-jee-uh) Muscle pain
- **Paralysis** (par-AL-iss-uh) Loss or impairment of motor function
- **Posture** (POS-chur) Attitude or position of the body
- **Prime mover** (prime MOO-ver) Muscle that acts directly to bring about a desired movement, agonist
- **Range of motion** (RAY-nuh MO-shun) Active or passive movement of muscle groups to full extent possible, used to prevent contracture
- **Sarcomere** (SAH-roh-mer) Repeating units of muscle fibers with the ability to contract
- **Skeletal** (SKEHL-ee-tal) Pertaining to the framework of the body
**Stimulus** (STIM-yoo-lus) Any agent, act, or influence that produces a change in the development or function of tissues

**Tonus** (TO-nus) Slight, continuous contraction of muscle

**Visceral** (VIS-er-al) Pertainiing to any large interior organ in any one of the cavities of the body

---

**Muscular System Terminology**

Atrophy or wasting of muscle tissue may result from immobility, such as bed rest. (From Sorentino SA. Mosby’s textbook for nursing assistants, ed 7, St. Louis, 2008, Mosby.)

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Prefix</th>
<th>Root</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrophy</td>
<td>Without growth, wasting away</td>
<td>a</td>
<td>troph</td>
<td>y</td>
</tr>
<tr>
<td>Biceps</td>
<td>Muscle with two heads</td>
<td>bi</td>
<td>cepsis</td>
<td></td>
</tr>
<tr>
<td>Blepharospasm</td>
<td>Uncontrolled muscle contraction of the eyelid</td>
<td>dys</td>
<td>trophi</td>
<td>y</td>
</tr>
<tr>
<td>Dystrophy</td>
<td>Faulty growth</td>
<td>fibro</td>
<td>my/o</td>
<td>itis</td>
</tr>
<tr>
<td>Fibromyositis</td>
<td>Inflammation of the muscle tissues</td>
<td>my/o</td>
<td>metrium</td>
<td></td>
</tr>
<tr>
<td>Myalgia</td>
<td>Muscle pain</td>
<td>my</td>
<td>algia</td>
<td></td>
</tr>
<tr>
<td>Myoma</td>
<td>Tumor of the muscle</td>
<td>my</td>
<td>oma</td>
<td></td>
</tr>
<tr>
<td>Myometrium</td>
<td>Muscle of the uterus</td>
<td>my/o</td>
<td>metrium</td>
<td></td>
</tr>
<tr>
<td>Quadriceps</td>
<td>Muscle with four heads</td>
<td>quadri</td>
<td>cepsi</td>
<td>a</td>
</tr>
<tr>
<td>Visceral</td>
<td>Pertaining to the inside</td>
<td>viscer</td>
<td></td>
<td>a</td>
</tr>
</tbody>
</table>

*A transitional syllable or vowel may be added to or deleted from the word parts to make the combining form.*

---

**Structure and Function of the Muscular System**

The human body has more than 600 muscles. The three types of muscle tissue are skeletal, visceral, and cardiac (Table 15-1). Muscles do the following:

- Aid in movement
- Provide and maintain posture
- Protect internal organs
- Provide movement of blood, food, and waste products through the body
- Open and close body openings
- Produce heat (Fig. 15-1)

Muscle contraction is the movement of muscles when stimulated. Tonus is the muscle’s ability to maintain slight, continuous contraction. Muscles can be stimulated electrically, mechanically, or chemically. Muscles are flaccid, or soft, when not contracted. Muscle tissue has several unique characteristics:

- Irritability or excitability is the muscle’s ability to respond to a stimulus such as a nerve or hormone.
- Contractility is the muscle’s ability to shorten forcefully when stimulated.
- Extensibility is the muscle’s ability to stretch and lengthen.
- Elasticity is the muscle’s ability to recoil to its resting length when relaxed.

---

**Abbreviations of the Muscular System**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATP</td>
<td>Adenosine triphosphate</td>
</tr>
<tr>
<td>Bx</td>
<td>Biopsy</td>
</tr>
<tr>
<td>Ca&lt;sup&gt;2+&lt;/sup&gt;</td>
<td>Calcium</td>
</tr>
<tr>
<td>EMG</td>
<td>Electromyogram</td>
</tr>
<tr>
<td>IM</td>
<td>Intramuscular</td>
</tr>
<tr>
<td>LP</td>
<td>Lumbar puncture</td>
</tr>
<tr>
<td>MD</td>
<td>Muscular dystrophy</td>
</tr>
<tr>
<td>MI</td>
<td>Myocardial infarction</td>
</tr>
<tr>
<td>OT</td>
<td>Occupational therapy</td>
</tr>
<tr>
<td>PT</td>
<td>Physical therapy</td>
</tr>
</tbody>
</table>

---

**TABLE 15-1 Types of Muscle Tissue**

<table>
<thead>
<tr>
<th>Muscles</th>
<th>Appearance</th>
<th>Manner of Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skeletal</td>
<td>Striated</td>
<td>Voluntary</td>
</tr>
<tr>
<td>Visceral</td>
<td>Smooth</td>
<td>Involuntary</td>
</tr>
<tr>
<td>Cardiac</td>
<td>Indistinctly striated</td>
<td>Involuntary</td>
</tr>
</tbody>
</table>

---

**Types of Muscle Tissue**

**Skeletal Muscle**

Skeletal muscles make up more than 40% of a person’s body weight. They increase in size and weight with exercise and decrease with inactivity. Muscle size and strength vary among people because of genetic differences and nutritional and exercise habits. Muscles are attached to bones by tendons, which are narrow strips of dense connective tissue. Muscles are named according to their location, related bones, shape, action, or size (Fig. 15-2).

Skeletal muscle tissue looks striated, or banded, under the microscope (Fig. 15-3). Striated muscle is made of bundles of fine fibers. The number of muscle fibers does not increase much after birth. Increase in muscle mass is due to an increase in the size of the fibers. Fascia is a layer of fibrous connective tissue that separates individual muscles.

The basic unit of muscle fibers that causes muscle contraction is called a sarcomere. Sarcomeres are organized units made up of actin and myosin myofilaments. Most skeletal muscles contract under a person’s voluntary control.

Skeletal muscles have three parts (Fig. 15-4):

- The origin is one end of the muscle, attached to the less movable part of the bone.
- The insertion is the other end of the muscle, attached to the more movable part of the bone.
- The action, or body, is the thick, middle part of the muscle.
Skeletal muscles produce movement by pulling bones. Fig. 15-5 shows how skeletal muscles work in pairs; one contracts and pulls while its counter-acting muscle relaxes.

- The prime mover, or agonist muscle, pulls to cause the movement.
- The antagonist muscle relaxes when the agonist contracts.
- Other muscles, called synergists and fixators, help keep the muscle and bone stable during movement.

**Skeletal muscle tissue.**

Skeletal muscles can make seven basic types of body movements (Fig. 15-6). Flexion moves a bone closer to another bone, and extension moves a bone farther from another bone. Rotation is a circular or semicircular motion. Abduction is movement of a body part away from the midline, and adduction is movement toward the midline. Pronation is turning the hand or foot downward or backward, and supination is the opposite of pronation, turning the hand or foot upward or forward.

**Visceral Muscle**

Visceral muscle lines various hollow organs, makes up the walls of blood vessels, and is found in the tubes of the digestive system. Visceral muscle is smooth and has no striations like the bands of the skeletal muscle (Fig. 15-7). Like skeletal muscle, it contracts when stimulated. Visceral muscles are controlled by the autonomic nervous system. One example of a visceral muscle is the sphincter (circular) muscles, which open and close the pupil of the eye.

**Cardiac Muscle**

Cardiac muscle is found only in the heart. It is indistinguishably striated muscle and is under involuntary control (Fig. 15-8). Cardiac muscle has specialized cells that provide a stimulus for contraction. Because of this
“Pacemaker,” the heart continues beating when not stimulated by neural impulses. Chapter 11 provides more information about the heart.

**How Muscles Contract**

When stimulated, a complex chain of molecular actions is responsible for muscle contraction. One theory used to explain this process is the sliding filament theory of muscle contraction. It states that proteins and other molecules in the muscle tissue interact when stimulated, and the resulting molecules are shorter than they were originally, thereby making the tissue contract.

Muscle cells use a form of glucose (glycogen) to provide the energy used for contraction. The glucose is used to fuel the adenosine diphosphate–adenosine triphosphate (ADP-ATP) cycle for energy production in the muscle cells. In the ADP-ATP cycle, ADP combines with a phosphate to store energy as ATP and breaks this bond to release energy for use by the muscle tissue. The ADP-ATP cycle provides the energy necessary to combine the proteins actin and myosin into actomyosin. Calcium is necessary for the reaction to occur. The lactic acid that is produced from the metabolism of glycogen is converted to water and carbon dioxide in the presence of oxygen. If oxygen is in short supply, lactic acid, a by-product of this process, can build up in the muscle and cause soreness. Heat is produced by this action as another by-product.

**Types of Muscle Contraction**

The strength of a muscle contraction depends on the strength of nerve impulses received in the muscle from the brain. Each muscle fiber contracts either completely or not at all. The stimulus must be strong enough to cause the contraction. This is the “all-or-none” law of skeletal muscle contraction. Not all muscle contractions are the same.

- **Isometric contraction** is muscle shortening that produces movement such as skeletal muscle movement during exercise.
- **Muscle tone or tonus** is a state of partial contraction that maintains a person’s posture.
- **Isotonic contraction** does not cause muscle shortening or movement, such as in the motion of pushing against a fixed object like a wall.
- **A twitch** is a quick, jerky contraction of a whole muscle from one stimulus.
- **Tetanic contraction** is more sustained than a twitch and is caused by many stimuli in rapid succession.
- **Tetany** is continued contraction of a skeletal muscle.
- **Fibrillation** is uncoordinated contraction of muscle fibers.
- **Convulsions** are contractions of groups of muscles in an abnormal manner.
- **Spasms** are involuntary, sudden, and prolonged contractions.

**Assessment Techniques**

The muscular system can be assessed in numerous ways. With general inspection, the muscular system is assessed for asymmetry, deformity, swelling, or bruising. With systematic movement of body parts, muscle groups can be assessed for weakness. Reflex tests assess the neurologic functioning of the muscular system. The range of joint motion produced by skeletal muscles can be measured by using a protractor. Blood tests measuring enzymes may indicate muscular system damage. Electromyography (EMG) tests individual muscles through needles inserted into the muscle. A muscle biopsy may be used to assess for tissue disorders. The Gait Abnormality Rating Scale is used to determine the risk of falls in older adults.

** Disorders of the Muscular System**

**Back pain**, a common disorder, usually results from weakened muscles around the spine in the lower back. Recurrent back pain can be caused by a sedentary lifestyle, obesity, poor posture, or muscle tone. Back pain may also result from muscle strain or pressure on the sciatic nerve of the leg. The treatment includes resting, stretching, medication, and exercises to strengthen the muscles. Medication may be used for pain or muscle spasm.

**Case Study 15-1**

Your patient is lying on her back every time you come in the room. During her bath, you notice a red spot on her sacral area. What should you do?

**Answers to Case Studies** are available on the *Evolve website: http://evolve.elsevier.com/Gerdin*

Contraction is a condition in which muscles remain contracted as a joint loses flexibility and ligaments and tendons shorten. **Contractures** result from gradual muscle wasting, called atrophy, because of a lack of movement of the muscles. Contractures can be prevented with range of motion (ROM) exercises. Treatment of severe contractures may involve surgical cutting of ligaments.

**A muscle cramp** is a sudden, involuntary contraction of a muscle producing pain. Cramps usually occur in the legs or feet. Cramps may result from exertion or unknown causes, as with the common cramps that occur at night. Treatment includes stretching and gentle pressure to relieve the pain.
CASE STUDY 15-2 Your friend suddenly has a cramp or "charley horse" in the calf of his leg while you are running. What should you do?

Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Gardin

Muscular dystrophy is a group of genetic diseases involving painful, gradual atrophy of muscle tissue. Duchenne muscular dystrophy, a severe X-linked form, occurs in 1 in every 3000 to 5000 boys. It can be detected with 95% accuracy during pregnancy. Becker muscular dystrophy is a milder form. Severe forms cause total disability, and others cause a mild disability. No cure has been found. Treatment may include medication to slow the progression of the disease, braces, or corrective surgery. Research in gene therapy is being conducted as a treatment for this disorder.

Fibromyalgia (fibro-my-al-je-uh) includes a group of muscle disorders affecting the tendons, ligaments, and other fibrous tissues. Common sites of pain include the neck, shoulders, thorax, lower back (lumbago), and thighs. Fibromyalgia does not cause inflammation. The person with fibromyalgia feels pain and other aches after being exposed to cold, dampness, illness, or minor trauma. Generalized myalgia usually occurs in women. Treatment includes decrease in stress, rest, heat, massage, therapy to stretch the muscles, and exercise.

CASE STUDY 15-3 Your patient has been lying down in bed all day and complains of generalized muscle pain. What should you do?

Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Gardin

Gangrene (gang-green) is caused by Clostridium, a bacterium that kills muscle tissue (Fig. 15-9). Gangrene begins when the bacteria enter an area of muscle tissue that has died. The bacteria destroy the surrounding living tissue. The condition may also result from a blocked blood vessel (thrombosis). The extremities are most often affected, but the gallbladder or intestines may become infected in some cases. Treatment includes removal of dead tissue, antibiotics, and medication against the toxins produced by the bacteria.

Per planum (per-PLAN-uh) also called "flatfoot" or "fallen arches," may be congenital or result from weakened foot muscles. It causes extreme pain. Treatment includes corrective shoes, massage, and special exercises.

Tetanus (TET-uh-nus), commonly called "lockjaw," is caused by a bacterial infection. Muscle spasms may be severe and can result in death. Tetanus can be prevented by vaccination. No cure has been found. Treatment involves preventing complications of muscle spasms and life support.

Trichinosis (trik-ih-NOH-sis) is a parasitic infection caused by eating undercooked pork. The parasites form cysts in muscle tissues, especially the diaphragm and chest muscles. Infection causes pain, tenderness, and fatiguing. The infection can be fatal if it affects the brain or heart. Treatment includes fluids, nutritional support, and medication to relieve pain, reduce fever, and kill the parasites.

Issues and Innovations

Sports Medicine

Many people think of sports medicine as a new health field, but actually it has long existed as a medical specialty. In 1928 the International Sports Medicine Federation was organized. In 1954 the American College of Sports Medicine was formed. It is the primary organization for this specialty in the United States. Sports medicine is involved in all sports and athletics. More than just treating sports injuries, trainers and doctors also direct the healthful development and training of athletes. Chapter 31 provides more information about career opportunities in athletic training.

Athletic injuries include strains, sprains, cuts, bruises, and similar conditions, many affecting the muscular system. Such injuries can be serious and take months to heal. Most sports injuries result from poor flexibility, overtraining, poor training methods, inadequate equipment, or muscle imbalance.

The field of biomechanics, the study of muscles in movement, applies the laws of mechanics and physics to human performance. Other methods of treatment for sports injury include ultrasound and electrical stimulation to increase circulation and promote healing.

Injecting a patient's own blood into an injured area has been shown to promote muscle repair and help regenerate tendon and ligament fibers. This procedure is called platelet-rich plasma therapy.

CASE STUDY 15-4 Your friend tells you that he does not need to stretch before running because he is young. What should you say?

Answers to Case Studies are available on the Evolve website: http://evolve.elsevier.com/Gardin

Fitness Fad

In 2008 the Centers for Disease Control and Prevention reported that more than 20% of the population of every state except Colorado was obese. Six states reported that more than 30% of their population were obese. They define obesity as a body mass index of 30 or more. They report that about half of young people age 12 to 19 do not regularly exercise actively. Regular exercise improves physical fitness and health and also promotes a feeling of well-being. People who exercise on a regular basis feel better about themselves and manage stress and tension more easily.

In the past 10 years, many new health clubs and spas have opened to provide facilities for exercise. When choosing an exercise club, some features to consider include the staff's credentials, how crowded or spacious the facilities are, the cleanliness of the club, and the contract terms.

Becoming too concerned with exercise is possible. For some people, exercise may come to take priority over family, work, and friends. Psychologists believe that this obsession results from the person becoming dependent on the "high" of exercise. This feeling results from a chemical called endorphin (en-DOOR-fin) that is released by the brain during exercise.

A person who has become obsessed with exercise feels he or she needs to work out daily to be even minimally functional. Such an "addicted" person feels withdrawal symptoms such as irritability and depression when not regularly exercising. A sign that a person has a problem is his or her continuing to exercise when ill or injured.

Summary

- Functions of the muscular system include movement, posture, protection of internal organs, transport of blood, and producing heat.
Structures of the muscular system include the skeletal, visceral, and cardiac muscles. Skeletal muscles include the biceps, triceps, quadriceps, deltoid, masseter, and gracili.

Methods of assessment of the muscular system include inspection, electromyogram, and blood and reflex tests.

Disorders of the muscular system include contractures, cramps, dystrophy, polymyositis, and gangrene.

**Review Questions**

1. Describe the six functions of the muscular system.
2. Identify the functional and structural units of the muscular system.
3. Describe three muscular system disorders that are caused by infectious agents.
4. Describe three methods used to assess the function of the muscular system.
5. List three benefits of maintaining a regular exercise program.
6. Use the following terms in one or more sentences that correctly relate their meaning: atrophy, contracture, posture, range of motion, and skeletal.

**Explore the Web**

**Fitness**
CDC
http://www.cdc.gov/NCCDPHP/orp/attigan.htm

**BAM**
http://www.bam.gov/sub_physicalactivity/

**Obesity**
CDC
http://apps.nccd.cdc.gov/PASurveillance/StatsSummary.asp

**Critical Thinking**

1. Investigate and compare the cost of at least three tests used in diagnosing disorders of the muscular system.
2. Investigate the function of at least five common medications used in the treatment of muscular system disorders.

**Digestive System**

**LEARNING OBJECTIVES**

- Define at least 10 terms relating to the digestive system.
- Describe the four functions of the digestive system.
- Identify at least 10 digestive system structures and the function of each.
- Identify the location and function of three accessory organs of the digestive system.
- Identify at least three methods of assessment of the digestive system.
- Describe at least five disorders of the digestive system.

**KEY TERMS**

- Alactasia (a-lak-TAY-zee-uh): Malabsorption or inability to absorb lactose caused by a deficiency of the enzyme lactase
- Bile (BI-uhl): Fluid that helps digest fat in the small intestine; produced by the liver and stored in the gallbladder
- Bulimia (BUH-lim-ee): Excessive binge eating, which may be followed by self-induced vomiting or purging
- Cholecystectomy (ko-le-sis-TEK-to-mee): Surgical removal of the gallbladder
- Chyme (KIME): Thick, semiliquid contents of stomach during digestion
- Defecation (def-uh-KAY-shun): Evacuation of waste or fecal material from the rectum
- Deglutition (dee-gloo-TISH-un): Act of swallowing
- Emetic (EM-uh-sic): Act of vomiting, vomit
- Endoscopy (en-DOS-ko-pe): Visual inspection of a body cavity using a scope
- Enema (EN-uh-muh): Liquid instilled into rectum
- Flatulence (FLAH-uh-lunts): Excessive air or gas in stomach or intestines leading to distension of organs
- Ingestion (ihn-JES-chen): Taking food or medicine into the body through the mouth