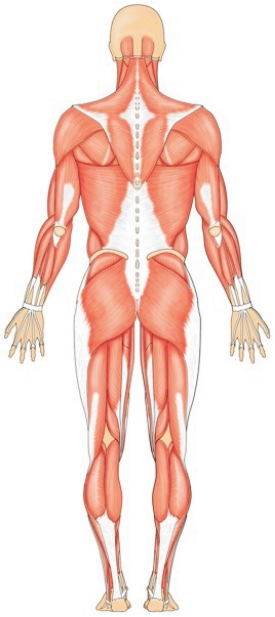
Understand the Components of the Muscular System

YOUR MUSCULAR SYSTEM controls all of your body movement with coordinated teams of muscles. Muscle tissue moves the body, powers internal processes, maintains posture, and produces body heat. There are up to 700 large and small muscles in your body that bulge and ripple under your skin and are arranged in crisscrossing layers.



Objective:

Explain how your muscular system controls your body.

Key Terms:

cardiac	skeletal	striations
involuntary	smooth	thermogenesis
shivering	striated	voluntary

The Muscular System

Tendons—tough fibrous cords of connective tissue—connect **skeletal** muscles to your bones and cause bones to move when muscles contract (shorten).

THREE TYPES OF MUSCLES

There are three types of muscles: voluntary, involuntary, and cardiac.

Voluntary

Muscles you consciously control are **voluntary** skeletal muscles; they are attached to bones. Arm and leg muscles are voluntary and move only when you move them. When you move the big muscle in your arm (biceps), it contracts, and your lower arm moves up. Skeletal muscles have long, thin fibers that are **striated** (striped or streaked). These **striations**, or

bands, are created by the alignment of densely packed muscle fibers. There are more than 600 skeletal bones in your body.

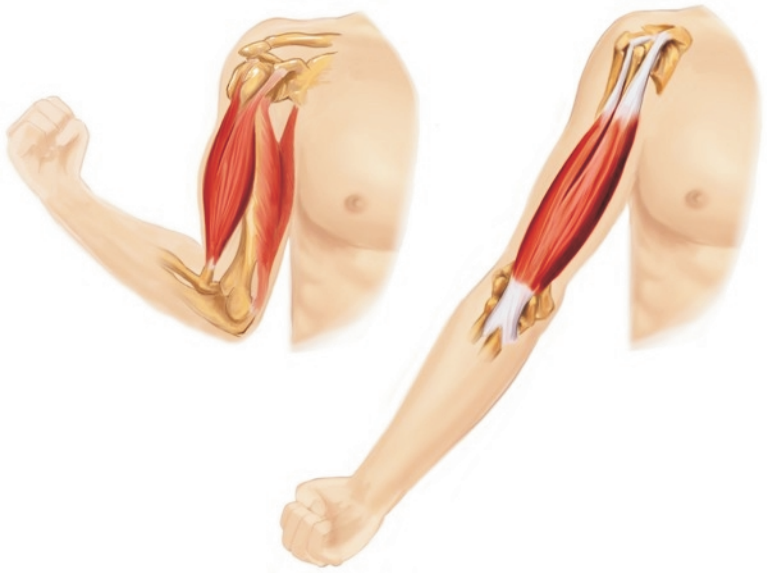


FIGURE 1. Arm muscles are voluntary and move only when you move them.

Involuntary

Involuntary smooth muscles work automatically and are in the walls of your stomach, intestines, blood vessels, and other body organs. They are smooth, without striations. They contract slowly and steadily. Flat sheets of involuntary **smooth** (a muscle that contracts without conscious control) muscles cover your rib cage and control your chest movement as you breathe. Other flat sheets of smooth muscles stretch your stomach when you eat a big meal. Some involuntary muscles contract constantly to maintain body posture. Strong, stabilizing muscles in your neck, inner shoulders, and upper back are in constant activity tensing to steady your head and contracting in coordinated teams to permit neck movements. Upper back muscles that attach to your shoulder blades (scapula) help stabilize your shoulders.

Cardiac

Cardiac muscle is the involuntary muscle of your heart that is striated like skeletal muscle and is found only in your heart. It contracts automatically and constantly. It never tires or rests. It contracts about 70 times a minute and 100,000 times per day. Blood carries oxygen to your cells and muscle fibers. Membranes between the cells in your heart allow electrical impulses to travel rapidly through them so contractions are better coordinated. Each heartbeat, or contrac-

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SCIENCE CONNECTION: Muscles Show Signs of Age

Healthy young skin has resilient fibers made of protein elastin that helps skin return to its original position, as after smiling. With age, elastin breaks down. As a result, the skin's dermis becomes loosely attached to the muscles beneath. Wrinkles appear when the skin can no longer stretch or shrink easily. "Crow's feet" radiate from the corners of the eyes, followed by lines around the brow and mouth, between the eyebrows, on the chin, and on the bridge of the nose.

Facial wrinkles are at right angles to the muscle fibers so they reveal the pattern of facial muscles. Exposure to excessive sunlight and temperatures hastens wrinkling.

tion, pumps blood from your heart to your entire body, carrying nutrients to all your body cells, including your muscle fibers.

The striations in skeletal and cardiac muscles are evenly spaced stripes that run perpendicular (vertical) to the length of the muscle cell. Skeletal muscles have long cells. In contrast, cardiac muscles have short, branching cells. All muscles are made of the same proteins, but the arrangement in striated muscles is more densely organized, making contractions faster and stronger than those in smooth muscles.

TABLE 1. Characteristics and Location of the Three Muscles Types

Tissue	Nervous Control	Cell Appearance	Examples
Skeletal	Voluntary	Striated, long	Biceps
Smooth	Involuntary	Smooth, short	Digestive tract, bladder, and intestines
Cardiac	Involuntary	Striated, short	Heart

NERVOUS SYSTEM

Muscles are dependent on the nervous system to stimulate and integrate your activities. Your brain controls your body and sends messages to every part along nerves that reach into every muscle and touch every muscle fiber. When a message reaches a muscle fiber, the tiny strands inside it move. Strands slide toward each other. The muscle fiber gets shorter, and the whole muscle contracts and moves the body part to which it is attached.

FIBERS

Muscles are made of cells. Each muscle cell is called a fiber. Muscle fiber is thinner than one of the hairs on your head. Hundreds of strands, composed of even thinner strands, make up each muscle fiber. The thinnest strands overlap each other and look crisscrossed like your fingers laced together. Some skeletal muscles are attached to other muscles; some are attached to skin. A typical muscle spans a joint and tapers at each end, attaching to a fibrous tendon that attaches to a bone. Each tendon connects to at least two bones.

FIGURE 2. More than 600 muscles are at work throughout your body.

TEAMWORK

Skeletal muscles can only pull; they can never push. They come in pairs that act in opposition to each other. One muscle (the agonist) pulls the bone in one direction; the opposite muscle (the antagonist) pulls the bone back into position where it relaxes and lengthens. In your upper arm, your biceps muscle is paired with your triceps muscle, which is attached to bones in your lower arm and shoulder.

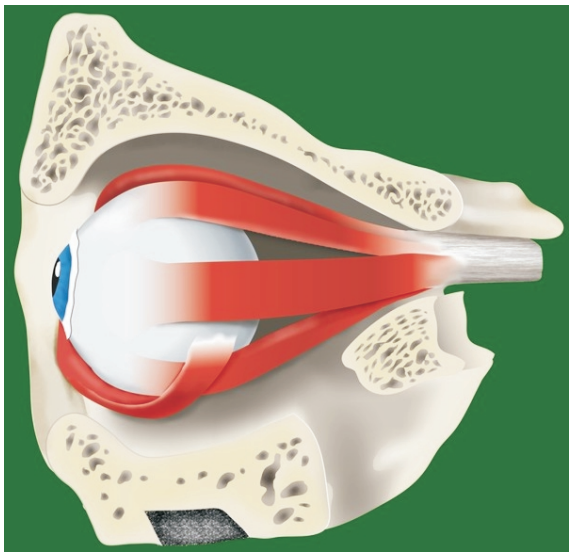

FIGURE 3. Eye muscles move approximately 200,000 times per day.

Facial Muscles

Nearly one-fourth of your skeletal muscles are in your face. They raise your eyebrows and eyelids. Others pull the corners of your mouth into a smile. Six muscles control the movement of each of your eyeballs, allowing you to focus in many directions. These eye muscles move approximately 200,000 times per day.

Sizes and Shapes

Muscles vary in size and shape. They are classified as big, medium, and small. In addition, muscles are arranged in groups. For example, when there is a large muscle, there is a small muscle. Your leg has a combination of all three sizes. Big, fan-shaped muscles in your chest help you move your arms and your shoulders. Twenty small muscles in your hands allow you to make a fist, pick things up, and play the piano.

More than 300 skeletal muscles work together when you take one step. Calf muscles are some of the strongest muscles. They help you walk, run, and jump. The longest skeletal muscles are on the inside of your legs and stretch from your hips to the insides of your knees.

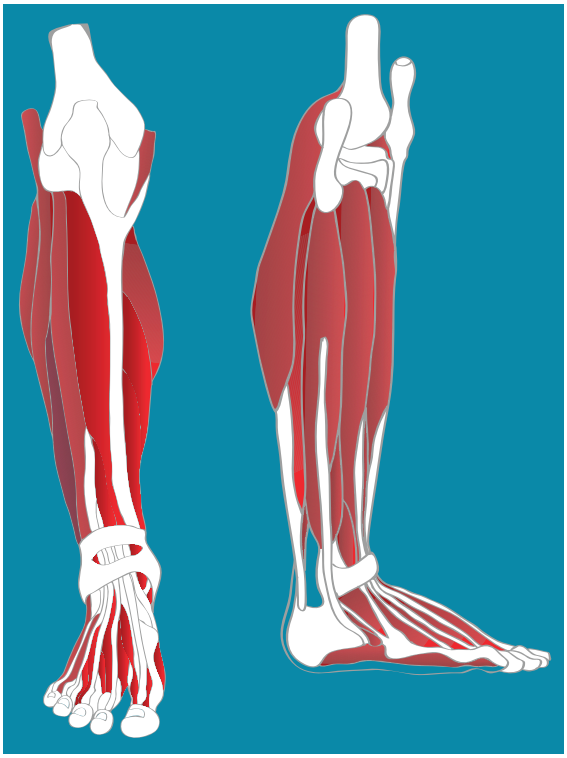

FIGURE 4. More than 300 skeletal muscles work together when you take one step.

Exercise

Skeletal muscles are powerful. Muscles are always contracting and working together. Body motion is generated by the contraction of skeletal muscles and tendons. Exercise makes muscles bigger and stronger. Without exercise, muscles

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SCIENCE CONNECTION: Common Muscle Disorder

Muscle disorders can be strains, tears, or tendonitis (inflammation). A common muscle disorder is carpal tunnel syndrome (CTS), where compression of a nerve in the wrist leads to tingling and pain in the hand, wrist, and forearm. This often weakens a person's grip.

The carpal tunnel is a narrow passageway formed by the carpal ligament on the inside of your wrist and the underlying wrist bones: the carpals. Long tendons run through the passageway from the muscles in the forearm to the bones in the hand and fingers. In carpal tunnel syndrome, the median nerve is compressed by swelling of the tissues around the tunnel.

Causes can include a wrist injury, pregnancy, and rheumatoid arthritis. In some cases, repetitive movements can cause carpal tunnel syndrome. CTS usually affects women between the ages of 40 and 60. Anti-inflammatory drugs, and sometimes surgery, loosen the ligament and bring relief.

shrink and lose strength. The harder muscles work, the more oxygen they need. When you exercise, you breathe faster and more deeply to receive more oxygen. When you experience shortness of breath, your muscles have lost oxygen and are too tired to contract. Your body is signaling that it is time to rest so your muscles can recuperate.

Muscle Tissue

Muscle tissue makes up 50 percent of your body weight. Your body's major movements are controlled by at least 30 pairs of muscles that hoist and stretch together to move, lift, and rotate bones as a group. Male and female bodies are composed of at least 640 muscles. While muscle makes up two-fifths of a man's weight, the smaller muscles in a woman make the proportion of muscle weight five percent less. Smaller muscles can exert less force. Muscles grow only when injury requires them to mend themselves.

BODY HEAT

Muscles generate body heat in a process called **thermogenesis** (the creation of heat). When muscles contract, they burn food for energy, and heat is produced. The more activity, the more heat is produced. The normal body temperature is 98.6°F (37°C). If the body drops beneath this temperature, it becomes cold and often shivers. **Shivering** is caused by rapid muscle contractions. Also, when you are cold, tiny smooth muscles pull on the hairs in your skin, resulting in goose bumps.

Summary:

There are three types of muscles: voluntary, involuntary, and cardiac. Your muscular system has four functions. Muscle tissue moves the body, powers internal processes, maintains posture, and produces body heat. It controls movement with coordinated teams of muscles. Tendons connect muscles to your bones and cause bones to move when muscles contract.

Checking Your Knowledge:

1. Name the four activities that muscles control.
2. What are the three types of muscle tissue?
3. How do muscles differ in appearance?
4. What happens when your muscles run out of oxygen?
5. How does your body control its temperature?

Expanding Your Knowledge:

Consider how your muscles act as levers. Compare the workings of a seesaw with the movement of your arm. The three parts of a lever are the fulcrum, force, and load. What muscles in your arm fulfill these functions?

Web Links:

Functional Anatomy: Tutorials and Quizzes
http://www.getbodysmart.com/ap/muscularsystem/menu/menu.html

The Muscular System
http://www.faqs.org/health/Body-by-Design-V1/The-Muscular-System.html

The Skeletal System
http://www.mnsu.edu/emuseum/biology/humananatomy/skeletal/skeletalsystem.html