**The muscular system makes movement possible.**

**KEY CONCEPT**

Muscles perform important functions.

Every movement of your body—from the beating of your heart, to the movement of food down your throat, to the blinking of your eyes—occurs because of muscles. Some movements are under your control, and other movements seem to happen automatically. However, muscles do more than produce movement. They perform other functions as well. Keeping body temperature stable and maintaining posture are two additional functions of muscles.

**EXPLORE Muscles**

How do muscles change as you move?

**PROCEDURE**

1. Sit on a chair with your feet on the floor.
2. Place your hand around your leg. Straighten one leg as shown in the photograph.
3. Repeat step 2 several times.

**WHAT DO YOU THINK?**

- How did your muscles change during the activity?
- Record your observations.
- What questions do you have about the muscular system?

**VOCABULARY**

- muscular system p. 585
- skeletal muscle p. 586
- voluntary muscle p. 586
- smooth muscle p. 586
- involuntary muscle p. 586
- cardiac muscle p. 586

**MAIN IDEA WEB**

Make a web for the main idea: Muscles perform important functions.

**BEFORE, you learned**

- There are different types of bone tissue
- The human skeleton has two separate divisions
- Joints function in several different ways

**NOW, you will learn**

- About the functions of muscles
- About the different types of muscles and how they work
- How muscles grow and heal

**CHECK YOUR READING**

What are three functions that muscles perform?
Movement

The muscular system works with the skeletal system to allow movement. Like all muscles, the muscles that produce movement are made up of individual cells called muscle fibers. These fibers contract and relax.

Most of the muscles involved in moving the body work in pairs. As they contract, muscles shorten, pulling against bones. It may surprise you to know that muscles do not push. Rather, a muscle on one side of a bone pulls in one direction, while another muscle relaxes. Muscles are attached to bones by stretchy connective tissue.

Maintaining Body Temperature

Earlier you read that processes within the body require certain conditions, such as temperature and the right amount of water and other materials. The balance of conditions is called homeostasis. One of the functions of the muscular system is related to homeostasis. Muscles function to maintain body temperature.

When muscles contract, they release heat. Without this heat from muscle contraction, the body could not maintain its normal temperature. You may have observed the way your muscles affect your body temperature when you shiver. The quick muscle contractions that occur when you shiver release heat and raise your body temperature.

Maintaining Posture

Have you ever noticed that you stand up straight without thinking about it, even though gravity is pulling your body down? Most muscles in your body are always a little bit contracted. This tension, or muscle tone, is present even when you are sleeping. The muscles that maintain posture relax completely only when you are unconscious.

Try standing on the balls of your feet for a few moments, or on one leg. When you are trying to balance or hold one position for any length of time, you can feel different muscles contracting and relaxing. Your muscles make constant adjustments to keep you sitting or standing upright. You don’t have to think about these tiny adjustments; they happen automatically.
Your body has different types of muscle.

Your body has three types of muscle. All three types of muscle tissue share certain characteristics. For example, each type of muscle contracts and relaxes. Yet all three muscle types have different functions, and different types of muscle are found in different locations.

**Skeletal Muscle**

The muscles that are attached to your skeleton are called skeletal muscles. Skeletal muscle performs voluntary movement—that is, movement that you choose to make. Because they are involved in voluntary movement, skeletal muscles are also called voluntary muscles.

Skeletal muscle, like all muscle, is made of long fibers. The fibers are made up of many smaller bundles, as a piece of yarn is made up of strands of wool. One type of bundle allows your muscles to move slowly. Those muscles are called slow-twitch muscles. Another type of bundle allows your muscles to move quickly. These are called fast-twitch muscles. If you were a sprinter, you would want to develop your fast-twitch muscles. If you were a long distance runner, you would develop your slow-twitch muscles.

**Smooth Muscle**

Smooth muscle is found inside some organs, such as the intestines and the stomach. Smooth muscles perform automatic movement and are called involuntary muscles. In other words, smooth muscles work without your knowing it. You have no control over their movement. For example, smooth muscles line your stomach wall and push food through your digestive system. Smooth muscle fibers are not as long as skeletal muscle fibers. Also, unlike skeletal muscles, smooth muscles are not fast-twitch. Smooth muscles contract slowly.

**Cardiac Muscle**

Your heart is made of cardiac muscle. Like smooth muscle, cardiac muscle moves without conscious control. Each cardiac muscle cell has a branched shape. The cells of the heart connect in a chain. These chains form webs of layered tissue that allow cardiac cells to contract together and make the heart beat. Just like the smooth muscle cells, the cardiac muscle cells contract slowly, except in emergencies.

**CHECK YOUR READING**

What does it mean that skeletal muscles are voluntary muscles?

Compare and contrast the three types of muscle described: skeletal, smooth, and cardiac.
The marchers in this band are using all three different types of muscle tissue.

**Muscle Tissue**

**Skeletal muscle** moves the legs of these marchers.

**Smooth muscle** in the air passages of the lungs allows the band members to breathe as they play their instruments.

**Cardiac muscle** allows the hearts of the band members to pump blood as they march to the beat of the music.

**Skeletal muscle** moves the legs of these marchers.

Which movements of these band members are voluntary, and which are involuntary?
Skeletal muscles and tendons allow bones to move.

Skeletal muscles are attached to your bones by strong tissues called tendons. The tendons on the end of the muscle attach firmly to the bone. As the fibers in a muscle contract, they shorten and pull the tendon. The tendon, in turn, pulls the bone and makes it move.

You can feel your muscles moving your bones. Place your left arm, stretched out flat, in front of you on a table. Place the fingers of your right hand just above your left elbow. Bend your elbow and raise and lower your left arm. You are contracting your biceps. Can you feel the muscle pull on the tendon?

The dancers in the photograph are using many sets of muscles. The diagrams show how muscles and tendons work together to move bones. Muscles are shown in red. Notice how each muscle crosses a joint. Most skeletal muscles do. One end of the muscle attaches to one bone, crosses a joint, then attaches to a second bone. As the muscle contracts, it pulls on both bones. This pulling produces movement—in the case of these dancers, very exciting movement.
Muscles grow and heal.

**Developing Muscles** An infant’s muscles cannot do very much. A baby cannot lift its head, because the neck muscles are not strong enough to support it. For the first few months of life, a baby needs extra support, until the neck muscles grow strong and can hold up the baby’s head.

The rest of the skeletal muscles also have to develop and strengthen. During infancy and childhood and into adolescence, humans develop muscular coordination and become more graceful in their movements. Coordination reaches its natural peak in adolescence but can be further improved by additional training.

**Exercise and Muscles** When you exercise regularly, your muscles may get bigger. Muscles increase in size with some types of exercise, because their cells reproduce more rapidly in response to the increased activity. Exercise also stimulates growth of individual muscle cells, making them larger.

You may have experienced sore muscles during or after exercising. During exercise, chemicals can build up in the muscles and make them cramp or ache. The muscle soreness you feel a day or so after exercise is caused by damage to the muscle fibers. The muscle fibers have been overstretched or torn. Such injuries take time to heal, because the body must remove injured cells, and new ones must form.

1. **KEY CONCEPTS**
   - What are the three main functions of the muscular system?
   - Make a rough outline of a human body and label places where you could find each of the three types of muscles.
   - Explain why you may be sore after exercise.

2. **CRITICAL THINKING**
   - **Apply** You are exercising and you begin to feel hot. Explain what is happening in your muscles.
   - **Analyze** Describe what happens in your neck muscles when you nod your head.

3. **CHALLENGE**
   - **Infer** The digestive system breaks down food and transports materials. How are the short length and slow movement of smooth muscle tissues in the stomach and intestines related to the functions of these organs?