Teach, *continued*

Teaching Key Ideas

Identifying Levers Explain that resistance exercises such as weight lifting often involve a simple machine known as a human forearm, which is an example of a third-class lever. The biceps muscle attaches near the elbow, which is the fulcrum. It contracts a short distance to move the forearm a long distance. Have students identify other third-class levers of the human body.

LS Logical/Kinesthetic

Close

Formative Assessment

The main organ systems involved when you flex your arm at the elbow are the _____.

A. muscular, skeletal, immune
(Incorrect. The immune system is not involved.)

B. nervous, muscular, skeletal
(Correct! All three of these systems are involved.)

C. skeletal, excretory, nervous
(Incorrect. The excretory system is not involved.)

D. endocrine, muscular, immune
(Incorrect. The endocrine and immune systems are not involved.)

Answers to Caption Questions

Figure 9: Heart would be expected to contain more slow-twitch muscle because the heart must be able to contract repeatedly without tiring for a person's entire life.





Figure 9 Aerobic exercises, such as jogging and swimming, increase endurance and improve cardiovascular health. Anaerobic exercises, such as weight lifing and jumping, build muscle strength and speed. **Would you expect heart muscle to contain more slow-twitch or fast-twitch muscle fibers?**

Exercise and Muscle

Exercise can effect muscle strength, speed, and endurance. It can result in fatigue and injury. And lack of exercise can cause muscle atrophy.

Strength, Speed, and Endurance Two types of muscle fiber affect strength, speed, and endurance. *Slow-twitch* fibers are resistant to fatigue but produce relatively little force. *Fast-twitch* fibers produce large amounts of force but fatigue quickly. Slow-twitch fibers use aerobic respiration for energy, as long as enough oxygen is available. These fibers can increase their endurance by training for activities such as the marathon in **Figure 9.** Fast-twitch fibers depend on anaerobic respiration. They contain large stores of glucose that are used up quickly. These fibers become stronger or faster in response to short, intense activities. Most muscles contain both fiber types.

Fatigue During strenuous exercise, all of the ATP in muscle cells may be used. When all of the ATP is used, muscles cannot contract. Sometimes, muscles become locked in contraction, and a muscle cramp results. Muscle cramps eventually release as more ATP is generated in the cells.

Injury Muscles can tear if they are stretched too far during exercise. Muscles are also susceptible to overuse injuries. Overuse injuries can result from training that is too intense or that is done with poor technique. One common example is shin splints, a painful overuse injury to the small muscle of the shin. Tendons that are repeatedly stressed can also become inflamed. This is called *tendinitis*.

Atrophy The condition in which muscle mass is lost is called *atrophy*. Atrophy can occur when muscles do not get enough exercise, and in astronauts as a result of weightlessness. Atrophy can also occur as the result of an injury or disease. Examples include spinal cord injury, polio, Lou Gehrig's disease, and muscular dystrophy.

Section 3 Review

KEY IDEAS

1. **Differentiate** between the three types of muscle tissue found in the human body.
2. **Describe** the role of oxygen in aerobic and anaerobic respiration.
3. **Name** the structures that make up skeletal muscle tissue.
4. **Explain** the roles of actin and myosin in muscle contractions.
5. **Identify** six ways that exercise can affect muscles.

CRITICAL THINKING

6. **Analyzing Information** Rigor mortis is a condition in which all of the body muscles become rigid shortly after a person dies. Why does rigor mortis develop?
7. **Connecting Concepts** When muscles lose mass as a result of atrophy, do you think they are losing muscle cells or do you think the cells are becoming smaller?

ALTERNATIVE ASSESSMENT

8. **Research** Isometric exercise involves holding muscles in one position until they become fatigued. It is currently not known why muscles tire even though they are not moving. Use the library or the Internet to find out more about research on isometric exercise and fatigue. Present your findings as a speech or poster.

Answers to Section Review

1. skeletal muscle: consciously controlled, moves the body, striated appearance; smooth muscle: involuntary, makes up walls of digestive organs and blood vessels, smooth appearance; cardiac muscle: involuntary, found in heart, appears striated but has only one nucleus
2. Aerobic respiration requires oxygen to break down fats and glucose, and to make ATP. Anaerobic respiration does not require oxygen.
3. Skeletal muscle is made of cells called muscle fibers. Muscle fibers are made of myofibrils. Myofibrils are made of sarcomeres. Sarcomeres are made of filaments of actin and myosin.
4. The heads of myosin filaments bind to actin filaments and rotate. Actin filaments move inward, causing the sarcomere to shorten and resulting in muscle contraction.
5. Accept any six of the following: increased muscle strength, faster response time, increased muscle endurance, increased cardiovascular endurance, increased muscle mass, fatigue, increased chance of injury.
6. ATP production stops at death. Muscles remain contracted as they were when death occurred.
7. Sample answer: Muscle cells probably become smaller with atrophy because muscle growth occurs by enlarging muscle cells rather than by adding more cells. It would be logical to expect that atrophy would occur the same way.
8. Accept all well-supported and well-presented speeches and posters.