

Lab

The Muscular System

Background Information

Muscle tissue consists of groups of cells that are specialized for **contraction**. In the body, muscle tissue is usually organized into organs called muscles. Muscles contain connective tissue, nerves, and blood vessels in addition to muscle cells. Although the term muscle often refers to an entire organ, it is also frequently used to refer to muscle tissue alone. There are three different types of muscle tissue in the bodies of humans and other vertebrates: **skeletal, smooth, and cardiac**.

Skeletal muscles are attached to the bones, cover the skeleton, give shape to the body, and make movement possible. The individual cells in skeletal muscle are often called **fibers** rather than cells because they are long and thin and quite different in structure from typical cells. Skeletal muscle fibers are larger than most cells (as much as 40 centimeters in length), contain many nuclei, and have many transverse stripes that are visible when the fibers are viewed under a microscope. Because of these stripes, or **striations**, skeletal muscle is called striated muscle. Skeletal muscle is also known as voluntary muscle because it is under conscious control.

Smooth muscle is very prominent in the walls of the stomach, intestine, and urinary bladder. Smooth muscle also occurs in the walls of blood vessels, in glands, and in the skin. The cells of smooth muscle are spindle-shaped, have individual nuclei, and are not striated. Smooth muscle is also called involuntary muscle because it is not under conscious control.

Cardiac muscle is found only within the walls of the heart. Like smooth muscle, cardiac muscle is not under conscious control and it is a type of involuntary muscle. Like skeletal muscle, cardiac muscle is striated. The cells in cardiac muscle are striped. Cardiac muscle cells contain one nucleus and form branching fibers with adjacent cardiac muscle cells.

In this investigation, you will observe prepared slides of three types of muscle cells.

Problem

How is the human muscular system organized?

Materials (per group)

Prepared slides of skeletal, smooth, and cardiac muscle

Microscope

Procedure**Part A. Examining Three Types of Muscle Cells**

1. Observe a prepared slide of skeletal muscle under the low-power objective of the microscope.
2. Switch to high. CAUTION: When switching to high power objective, always look at the objective from the side of the microscope so that the object does not hit or damage the slide.
3. Count the number of nuclei that are contained within one skeletal muscle fiber. Note whether this cell has striations (stripes). Observe the cell shape. Classify skeletal muscle as voluntary or involuntary. Record the information in the appropriate place in the Data Table.
4. In the appropriate place in Observations, sketch a few of the skeletal muscle fibers that you observed under high power. Label the nucleus, cell membrane, cytoplasm, and striations. Record the magnification of the microscope.

5. Observe a prepared slide of smooth muscle under low power. Switch to high power and observe the number of nuclei within one cell, the cell shape, and the presence or absence of striations. Classify smooth muscle as voluntary or involuntary. Record the information in the appropriate place in the Data Table.
6. In the appropriate place in Observations, sketch a few of the smooth muscle cells that you observed under high power. Label the nucleus, cell membrane, and cytoplasm. Record the magnification of the microscope.
7. Observe a prepared slide of cardiac muscle under low power. Switch to high power and observe the number of nuclei in one cell, the cell shape, and the presence or absence of striations. Classify cardiac muscle as voluntary or involuntary. Record the information in the appropriate place in the Data Table.
8. In the appropriate place in Observations, sketch a few of the cardiac muscle cells that you observed under high power. Label the nucleus, cell membrane, cytoplasm, and striations. Record the magnification of the microscope.

Part B. Examining the Muscles of the Human Torso

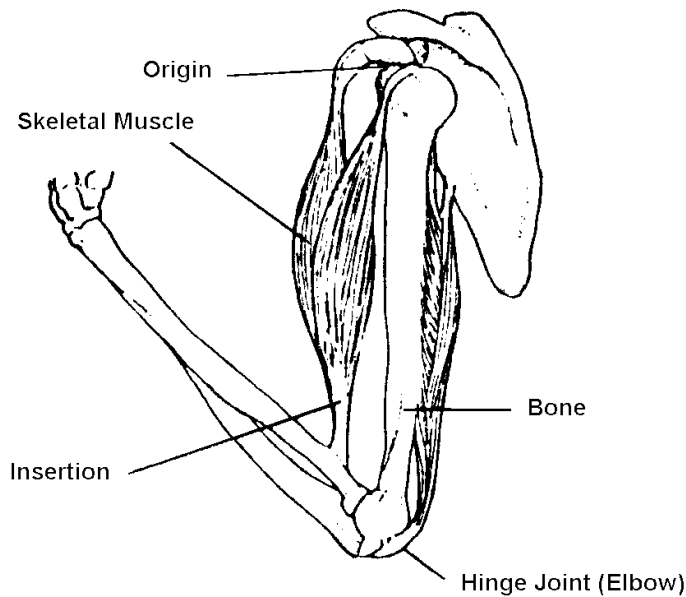
1. Use your textbook to identify the following groups of muscles. After locating these muscles on yourself or your partner, label the human torsos in Observations.
 - a. **Deltoid muscle** inserts on the humerus and originates on the clavicle. When the arm is at rest, the deltoid is the outer muscle along the upper third of the humerus. When the arm is raised, the deltoid is the hard mass of muscle above the shoulder joint. The short, thick deltoid raises the arm to a horizontal position or slightly higher.
 - b. **Pectoralis muscle** is the large, triangular muscle covering the upper part of the chest. It inserts on the humerus and originates from the clavicle, upper ribs, and sternum. If your arm is fixed, such as during climbing, the pectoralis helps pull the chest upward. The pectoralis muscles are the "breast" of poultry and are the main flight muscles of birds.
 - c. **Trapezius muscle** inserts on the clavicle and along the scapula and originates along the upper dorsal midline. It aids in lifting with the arms or carrying loads on shoulders; braces and shrugs the shoulders.
 - d. **Latissimus muscle** is a large sheet of muscle in the back. It inserts on the upper part of the humerus, and originates along the mid-dorsal line. The latissimus muscle moves the arm downward and is the primary muscle used in a swimming stroke or in bringing the arm forcibly downward.
 - e. **Triceps muscle** inserts on the ulna and originates from scapula and humerus. The triceps extends the arm at the elbow and is the primary muscle for doing a pushup.
 - f. **Biceps muscle** inserts on the radius and originates on the scapula. The biceps flexes the arm at the elbow and is the primary muscle for doing a pull up.
 - g. **Masseter muscle** is the main muscle that clenches the jaw. You can feel this muscle at your temples and on either side of your cheekbone (zygotic arch).
 - h. **Frontalis muscle** is used to raise the skin of the forehead in an upward motion. It originates near the top of the cranium and inserts on the inner skin of the forehead.
 - i. **Hamstring muscles** are a set of three muscles on the back of the thigh that bend the leg at the knee. Originate on the pelvic bones and femur and insert on the fibula. You can feel the hamstring's tendons at the back of your knee joint when you bend your knee while standing on the other leg. Hamstrings are so named because butchers use these tendons to hang up hams.
 - j. **Quadriceps muscles** are large muscles on the anterior part of the thigh that originate on the pelvic bones and inserts on the tibia. The quadriceps extend the knee and enable you to stand from a squatting position. They also provide much of the power for kicking a ball.

- k. **Gastrocnemius muscle** is the calf muscle. It originates on the femur and inserts (by the Achilles tendon) on the heel bone (one of the metatarsals). The gastrocnemius enables you to stand on tiptoe and extend your foot.

 - l. **Gluteus muscles** are large, powerful muscles in the posterior pelvic region. They insert on the femur and originate from the pelvic bones. The glutens support the pelvis and trunk on the femur (you can show this by standing on one leg and feeling the muscle). They are used in climbing, cycling, jumping, and regaining an erect position after bending forward.

 - m. **Abdominals** are a set of muscles below the chest that flatten and compress the abdomen. Abdominals bend the body forward and from side to side; also used to urinate and defecate.
2. Examine Figure 1, which shows the muscles and bones of the human arm. The elbow joint, which is a hinge joint, is similar to the joint in the chicken wing. On Figure 1, locate the tendons that attach the muscles to the bones. As a muscle contracts, the attachments either remain stationary or move. The attachment end that moves a bone is called the **insertion**. The attachment end that remains stationary, anchoring the muscle, is called the **origin**.

Figure 1



Observations

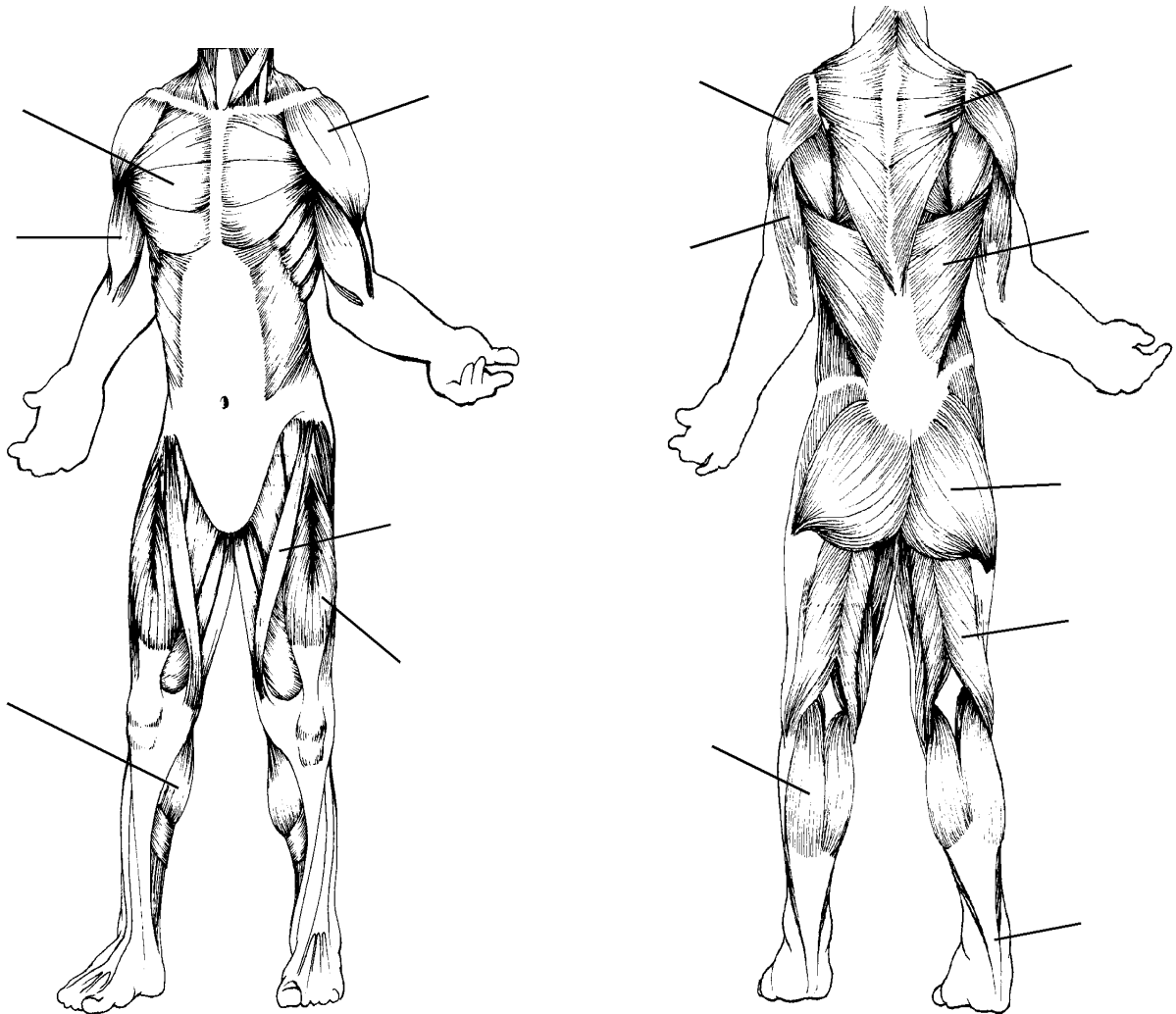
Data Table

Type of Muscle Cell	# of Nuclei per Cell	Striations	Cell Shape	Voluntary or Involuntary
Skeletal				
Smooth				
Cardiac				

Drawings of the Three Different Muscle Types

Skeletal Muscle	Smooth Muscle	Cardiac Muscle

Human Torsos



Analysis and Conclusions

1. a) How are skeletal muscle tissue and cardiac muscle tissue similar?

b) How are they different?
2. How does smooth muscle tissue differ from the other two types of muscle tissue?

3. Where in the body is each of the three types of muscle tissue found?

Skeletal muscle tissue _____

Smooth muscle tissue _____

Cardiac muscle tissue _____

4. Does the human body have more bones or more muscles?
5. How might injury to one of the muscles in an antagonistic muscle pair affect movement?

Critical Thinking and Application

1. What effect will the tearing of a tendon have on its corresponding muscle?
2. Suppose smooth muscle instead of skeletal muscle could be attached to the skeleton. How might the movement of the skeleton be affected?
3. Why would a bird be unable to fly if there was some damage to a nerve in the wing?
4. What are the two muscle filaments that work together to shorten a sarcomere called?