3.4 Transport

Student Resources:
Student Edition pages 32–33
Science Notebook 3.4A–B

Materials
- Eggs in containers from Lesson 3.3, paper towels, plastic spoons, large bowls, water, metric measuring tapes, food coloring (*Introduction*)
- Bowl; vinegar; plastic wrap; aerosol air freshener; clear glass container; water; food coloring; straw; bead, same diameter as the straw (Science Notebook 3.4B)

Vocabulary
diffusion (di·'fōō·zhen) the movement of molecules from an area of higher concentration to an area of lower concentration
osmosis (äz·'mō·səs) the diffusion of water through a membrane that allows specific substances to pass through

Supplemental Materials
Science Notebook 3.1B
BLM 3.1B–C

Preparation

Obtain paper towels, a spoon, a bowl with fresh water, a metric measuring tape, and food coloring for each pair of students. (*Introduction*)

Obtain 1 bowl, vinegar, plastic wrap, 1 aerosol can of scented air freshener, 1 clear glass container half full of water, food coloring, 1 straw, and 1 bead. Pour some vinegar into a bowl and cover the bowl with plastic wrap. Cut the straw in half. Make sure the bead is the same diameter as the straw so that it must be pushed instead of rolled through the straw. (Science Notebook 3.4B)

Safety

Check student records for possible allergies.

Warn students that food coloring can stain their clothing.

Objective
Students will discriminate between passive and active transport. They will use an egg to demonstrate osmosis in a cell.

Content
The cell membrane is composed of lipids, proteins, and carbohydrates. Specifically, there are two lipid layers with proteins embedded in the membrane and carbohydrates located on the exterior surface. The cell membrane is also selectively permeable, allowing certain small particles or substances dissolved in water to pass through the membrane via passive transport.

Diffusion is the movement of particles from higher to lower concentration. Osmosis is the movement of water from higher to lower concentration across a membrane. Both diffusion and osmosis are passive forms of transport, meaning they do not require cell energy expenditure. These processes continue until equilibrium is reached. Transport protein molecules form channels through the membrane through which larger particles can pass. Substances that move through these channels must fit the specific size and shape of the protein pores. Since the selective movement through these openings relies on diffusion pressure, this type of facilitated diffusion is called *passive transport*. Sometimes materials must move against the natural flow, or gradient, of high concentrations of substances to low concentrations. In this case, energy is used by the cell and materials then perform what is known as *active transport*. This method utilizes transport proteins also. Larger particles can be engulfed in a process known as *phagocytosis*, also a form of active transport.

Introduction
Direct students to retrieve **Science Notebook 3.1B Egg-speriment Data Collection** and **BLM 3.1B–C Egg-speriment Procedures**. Distribute the materials. Have students follow the directions for Day 4, Step 1. After they record the measurements and observations, ask students to comment on how their predictions from Day 3 compared with the actual results. (**Answers will vary.**) Why did the egg shrink? (**because the higher concentration of water was on the inside of the egg and the salt in the water caused the egg to dehydrate**) What process was this? (**osmosis**) Have students complete Step 2. Direct students to add enough drops of food coloring to turn the water a bright color. Guide them to make a prediction about what will happen. Set the containers with eggs aside.

Directed Instruction
Student Edition page 32
Read the first paragraph to students. Ask why it is important for cells to transport substances across their membranes. (**to get food and water into the cell, to move water and wastes out of the cell**) Explain that the cell is specially designed to move certain substances across its membrane, and is therefore selectively permeable. Some substances can cross without energy being expended by the cell, which is passive transport. When the cell uses energy to transport substances, it is active transport. Read the second paragraph. Explain that when there is a high concentration of food or water outside the cell and a lower concentration inside the cell, substances will pass by **diffusion** through the membrane. However, a membrane is not always necessary for diffusion to take place. For example, odors can diffuse through the air without passing through any membrane, as evidenced by the scent of perfume or a freshly baked pie. On the other hand, for **osmosis** to occur there must be some type of membrane. Direct students' attention to the images and read the captions.

Student Edition page 33
Read the first paragraph. Explain that cell membranes are embedded with protein molecules. These are transport proteins, which serve as a way for particles of a specific size and shape to enter the cell. If a cell needs glucose, it can enter the cell by passing through one of these proteins. Movement is still from high to low concentration, but the channels made by the proteins allow passage for substances that might not have otherwise fit through the membrane. This process, known as *facilitated diffusion*, is still a passive form of transport because no energy is being used by the cell. Have students look at the illustration of the cell membrane and read the caption. Read the second paragraph. Explain that energy is required when cells must move substances from low to high concentration. Ask what type

of transport this is. (**active transport**) Cells often engulf other cells or large particles using active transport. Direct students' attention to the image of phagocytosis and read the caption. Have students read the *Outlook*.

Science Notebook 3.4A Defusing Diffusion

Allow students to work individually or in groups to complete this page.

Science Notebook 3.4B Practicing Transport

Read the directions aloud. Place the bowl of vinegar on a table in front of the room and take the plastic wrap off. Immediately spray the air freshener toward the back of the room. Direct students to raise their right hand as soon as they smell the air freshener and their left hand when they smell the vinegar. After this demonstration, direct them to complete Exercises 1–6. Next, have students watch as you place the container of water on the table and add a few drops of food coloring. While the food coloring diffuses, place the bead into one end of the straw. Gently squeeze that end, moving the bead. Keep squeezing the straw just behind the bead to push the bead through the straw. Draw student's attention back to the water and food coloring. Have them make their observations and then complete the rest of the questions.

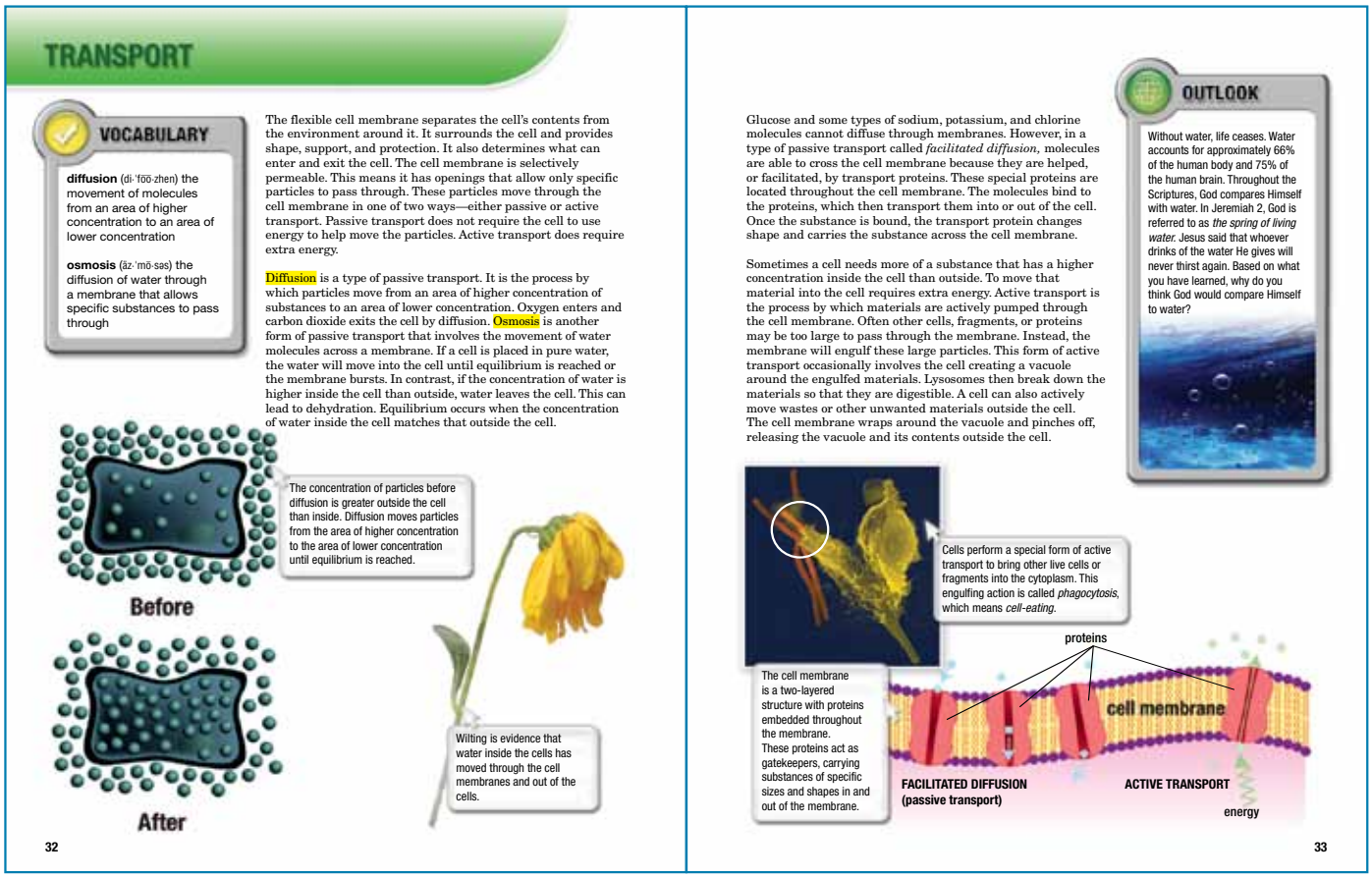
Lesson Review

In what main way is passive transport different from active transport? (**Passive transport does not require the expenditure of any energy from the cell and active transport does.**) Describe two situations in which the cell may need to use active transport. (**The cell may need to move a necessary substance from an area of a lower concentration of substances to a higher one. The cell may need to transport a substance that is too large to fit through the natural opening of the membrane.**)

Notes:

Further Discussion

When the immune system is working properly, it can be more effective than any known drug. Cells actively transport large particles into themselves via endocytosis, a process in which a substance gains entry into a cell without passing through the cell membrane. The human immune system is designed to protect the body from invading cells. Specialized immune cells, called *B-cells*, can recognize foreign substances that would trigger an immune response. When the B-cells detect pathogens or infected cells, they secrete antibodies that tag the foreign substances for destruction. Macrophages respond to the tag and move in to destroy the foreign substances. Macrophages directly attack pathogenic invaders by ingesting them one at a time. The process by which a macrophage ingests bacteria is called *phagocytosis* [ˌfa·gə·sə·'tō·səs]—a type of endocytosis.



13.3 Muscular System

Interaction of Systems

Student Resources:
Student Edition pages 158–159
Science Notebook 13.3A–B

Connect | Construct | Investigate | Extend | Assess

Materials
- Water bottles or cups of water, 2 straws (*Introduction*)
- Raw chicken leg quarter with meat (*Directed Instruction*)
- Stopwatches, hardcover books (Science Notebook 13.3B)

Vocabulary
peristalsis (per·ə·'stȯl·səs) the muscular contractions that move food through the digestive tract
tendon ('ten·dən) the connective tissue that attaches muscle to bone

Supplemental Materials
TM-13.3A

Preparation

Have students bring water bottles to class, or provide cups with a small amount of water in each. In addition, prepare 2 cups and straws filled with a small amount of water for the volunteers to drink out of. (*Introduction*)

Obtain an raw chicken leg quarter and remove the skin. (*Directed Instruction*)

Obtain a stopwatch and a book that is fairly heavy but still manageable for each pair of students. (Science Notebook 13.3B)

Safety

Make sure to wash your hands after handling the raw chicken.

Objective

Students will differentiate between the three types of muscle tissue. They will describe the location and capabilities of each type.

Content

Everyday activities require the coordinated contractions of many muscles in the body. All muscles perform work by contracting, or shortening, in length. When relaxed, they return to their former length. Some of these contractions are voluntary but others are involuntary. The three different kinds of muscles differ in form and function. Skeletal muscles, which attach to bones and other muscles, are responsible for movement of the skeleton. When a muscle contracts, it pulls on the tendon, the tendon pulls on the bone, and the bone moves. Regular stimulation from the nervous system maintains the muscle's size and strength. Routine exercise helps maintain the health of the muscle. Paralysis, followed by shrinking of the muscle, will occur if the nerves to the muscle are destroyed. Smooth muscles line the internal organs and vessels and contract involuntarily in response to being stretched. For example, the movement of food through the digestive tract occurs because of the involuntary contraction of the tract's muscular lining. Blood pressure is controlled when arteries change in diameter to regulate blood flow. Cardiac muscles, which are found only in the heart, involuntarily pump blood out of the heart and through the blood vessels to all cells throughout the body.

Introduction

Allow students to take a drink from their water bottles, or provide small cups of water. Direct them to pay attention to the movement of the water down the esophagus when they swallow. Ask a volunteer to lie down on the floor and take a small sip of water using a straw to avoid spilling. Ask if the water goes down the esophagus. (**Yes.**) How is this possible since gravity pulls downward, not horizontally? (**Answers will vary.**) Have a student stand on his or her head or lay face-up on a table with his or her head hanging down off the table. Tell the student to take a small sip of water using a clean straw. Ask if the water went through the esophagus. (**Yes.**) Does water usually run uphill? (**No.**) Ask for explanations of how this is possible, since water does not normally flow uphill. (**Answers will vary.**)

Directed Instruction

Student Edition page 158

Read the first paragraph. Emphasize that the water the volunteer drank while upside down in the *Introduction* activity moved through the beginning of the alimentary canal because of **peristalsis**. Reinforce that all body movements involve many muscles working together. Read the second paragraph. Remind students that muscle tissue is one of four types of tissue. However, there are three different types of muscle tissue. Direct students' attention to the image of the three types of muscle tissue. Read the caption. Have students contrast the differences.

D Show the chicken leg quarter with the meat on it. Point to the central part of a muscle and ask students what they see. (**belly of the muscle**) Show the **tendon**. Inform students that a tendon is connective tissue that attaches a muscle to a bone. Ask if a tendon is considered a muscle. (**No. It is connective tissue.**) Direct students' attention to the image of the bone, tendon, and muscle. Point out the fibers, the blood vessels, and the tendon. Ask a student what makes a muscle contract. (**a nerve impulse**) Have each student locate his or her Achilles tendon just above the heel. What does it connect? (**the calf muscle to the heel bone**)

? (**The calf muscle is no longer attached to the heel bone and is unable to contract. The leg is unable to hold weight or function correctly.**)

Student Edition page 159

Read the first paragraph. Direct the students' attention to the illustration and read the caption. Have them locate their biceps and triceps. Have them place one hand on their biceps and then raise the forearm to make the muscle bulge. Ask what happens to the biceps. (**It contracts, or shortens.**) Repeat this step, placing a hand on the triceps. What happens to the triceps as the biceps contracts? (**The triceps lengthens.**) Reinforce the idea that muscles only contract and relax and that skeletal muscles

work in antagonistic pairs to move bones. Ask students if this is usually voluntary or involuntary. (**voluntary**) Display **TM-13.3A Muscular System**. Explain that these are the skeletal muscles. Point to the sartorius muscle of the thigh and inform students that this is the longest muscle in the body. Read the names of various muscles as you indicate their location.

Read the next two paragraphs. Explain that both smooth and cardiac muscles are involuntary. Ask why that is so. (**If they were voluntary, people would have to think about food digestion and their heart beating to pump blood. Since they are involuntary, the processes happen without initiating them.**) Read *In the Field.*

Science Notebook 13.3A Muscle Mania

Read the directions and have students complete the exercises. Allow them to view TM-13.3A to locate specific muscles. Review the answers in class or collect for assessment.

Science Notebook 13.3B Muscle Contraction

Distribute one stopwatch and one book to each pair of students. Read the *Question* aloud and have students write their predictions. Give students time to complete the steps. Have them take turns being the timer. Direct them to complete the exercises. Have students share their results. Were the results similar for every student? (**Answers will vary.**)

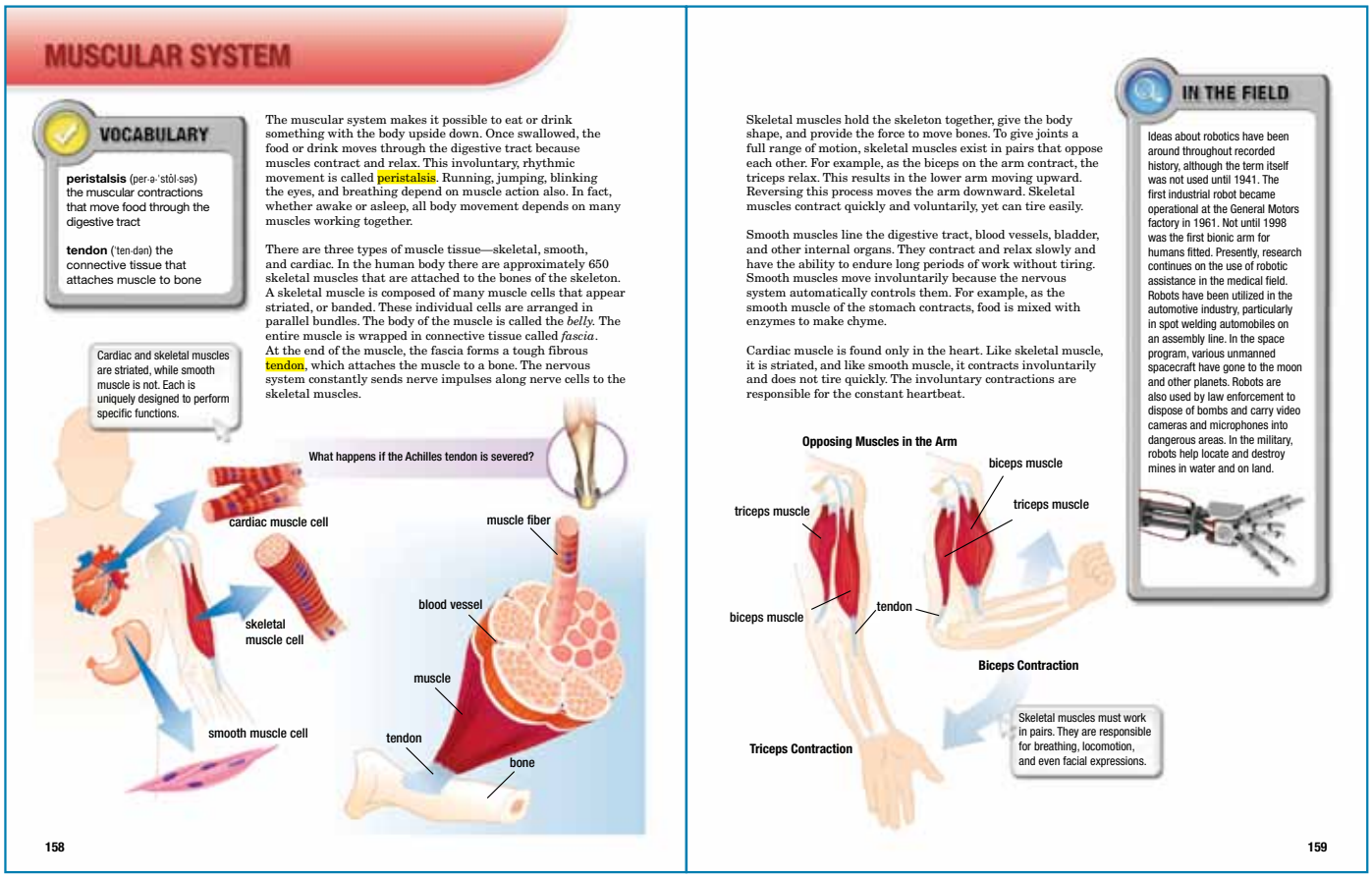
Lesson Review

What does a tendon connect? (**muscle to bone**) What are the three types of muscle tissue? (**skeletal, cardiac, smooth**) Name the type of muscle that moves the skeleton. (**skeletal**) What is the rhythmic movement of the digestive tract called? (**peristalsis**)

Connection

When the capabilities of the heart are analyzed mathematically, it is easy to see its amazing design. The heart pumps blood through a network of blood vessels totaling 97,000 km (60,000 mi) in length. It beats ceaselessly about 100,000 times per day, equaling about 37 million times per year. The human heart beats more than 2.5 billion times during an average lifetime, supplying oxygen and nutrients to the cells and carrying away waste products. The annual adult heart rate can be calculated and verified for accuracy by counting the pulse for 15 sec and then multiplying that number by 4. This gives the heart rate for one minute. Multiply this figure by 60 min, then by 24 hr per day, and lastly, by 365 days per year.

Notes:



Science Notebook Answer Key: Chapter 13

13.1A Notebook Organs to Systems

Place each of the following terms in the appropriate body system category.

kidney, biceps, heart, nerves, mouth, cerebrum, bladder, aorta, ureters, atria, esophagus, bones, ventricles, ligaments, lungs, skull, diaphragm, trachea, plasma, veins, platelets, bone marrow, enzymes, spinal cord, arteries, red blood cells, urine, small intestine, white blood cells, brain stem, capillaries, large intestine, saliva, tendons, stomach, larynx, nose, cerebellum, vertebrae, vocal cords

Human Body Systems					
Circulatory System	Respiratory System	Digestive System	Musculo-skeletal System	Nervous System	Urinary System
heart	lungs	mouth	skull	cerebellum	kidney
ventricles	diaphragm	saliva	vertebrae	cerebrum	bladder
atria	trachea	esophagus	bones	brain stem	ureters
aorta	larynx	stomach	bone marrow	spinal cord	urine
arteries	nose	enzymes	ligaments	nerves	
veins	vocal cords	small intestine	tendons		
capillaries		large intestine	biceps		
plasma					
platelets					
white blood cells					
red blood cells					

13.1B Notebook Organ Fitting

Cut out the organs on **BLM 13.1B Body Organs**. Arrange them in their proper locations onto the body outline below. Keep in mind that this is a front view, so some organs will be placed behind other organs. Glue them into place.

13.3A Notebook Muscle Mania

Read and complete the exercises below.

1. Match the correct type of muscle tissue with the body part. Write *SM* for smooth, *C* for cardiac, and *SK* for skeletal muscle.

SM stomach	SK deltoid	C heart
SK rectus abdominis	SM artery	SM small intestine

2. Identify each muscle or muscle-lined body part according to its muscular movement type, using *V* for voluntary and *IV* for involuntary.

IV stomach	IV heart	IV smooth
V biceps	V skeletal	IV bladder

3. Explain how skeletal muscles work to move the bones.
When one contracts and shortens, the opposite relaxes. This makes the bones move.

4. How is the muscular system dependent on the nervous system?
The nervous system is constantly sending signals to tell the muscles to contract or relax.

5. Peristalsis keeps food and liquids moving through the digestive tract.

6. Muscles are attached to bones by tendons.

7. Even though the diaphragm is a muscle, it is part of the respiratory system because it causes the lungs to fill with air and to deflate.

8. Look at the picture of the skeletal muscle in your textbook. Explain why blood vessels run throughout the bundles of muscle fibers.
Cells need oxygen and other nutrients to perform their functions. Blood vessels bring blood with oxygen and nutrients to the muscle cells. The harder the muscle cells must work, the more oxygen is needed for energy.

9. Explain the importance of muscular tissue in the digestive system.
Food must continually move through the digestive tract. Peristalsis causes this to happen because the organs are made of smooth muscle that does not tire.

13.3B Notebook Muscle Contraction

Question: What happens to skeletal muscle when it contracts repeatedly over a short period of time?

Hypothesize: Answers may vary.

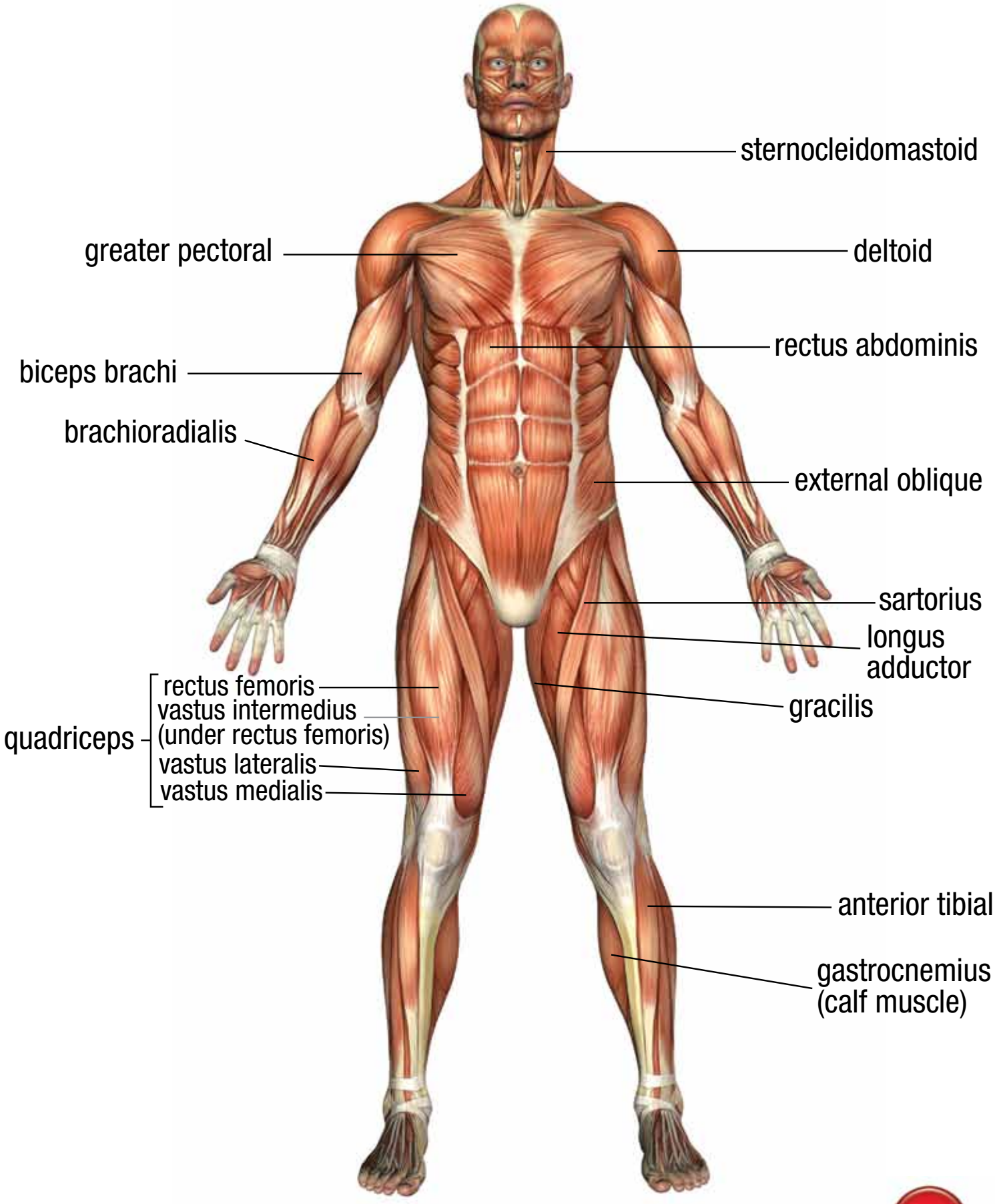
Test It and Record:

1. Designate who will be the first person to time the activity.
2. For the person who is not the timer, place your arm down by your side. Turn your palm so it faces forward.
3. Grip a textbook that is somewhat heavy but still manageable.
4. Keeping your upper arm close to your body, raise and lower the book. Only move your lower arm as if you are pumping it up and down. Do this steadily for three minutes.
5. Count aloud while your partner times you. Have your partner record the number of times you raise and lower the book each minute for three minutes. Raising and lowering the book equals one time.
6. Switch roles and repeat the activity. Answers will vary.

time	number of arm raises
1 minute	
2 minutes	
3 minutes	

Analyze and Conclude:

1. Name the pair of muscles that are being exercised in this activity.
   a. biceps b. triceps
2. Which type of muscle tissue are these? skeletal
3. Is this type of muscle movement voluntary or involuntary? voluntary
4. Based upon your observations, what happens to this type of muscle when it contracts repeatedly over a short period of time? It gets tired and wears out.
5. Would this type of muscle be appropriate for digesting food? Explain.
No. Food needs to digest for hours. If the muscles got tired, the food would stay in one place and rot.
6. Why do you think the heart is not made of this type of muscle?
See Additional Answer Section at end of Answer Key.



Muscular System

TM 13.3A