19C Section Objectives

- ✓ Discuss the major functions of the skeletal system.
- ✓ Differentiate between bone and cartilage.
- ✓ Explain how the skeleton develops and grows.
- ✓ Describe the typical structure of bone.
- ✓ Differentiate between ligaments and tendons.
- ✓ Identify the major bones of the human skeleton.
- ✓ Compare five kinds of joints in the skeleton and give examples of each.
- ✓ Distinguish the types of broken bones and discuss how bones heal.

Functions of the Skeletal System

- Framework for support and movement
- Protection
- Storage of minerals
- Production of blood cells

Dead Bones

In Ezekiel 37:1–14 God, Who designed human bones as living material, compared Israel to dead bones and promised to make them live again. He promised that He would restore the Israelites to their land: "and I shall place you in your own land" (v. 14). God has kept His promises to Israel in the past, and He will continue to do so in the future. We can trust Him to keep all of His promises.

19C The Skeletal System

A structure as large as your body must have some means of support. If you were supported by an exoskeleton, like an insect's or a lobster's, you would have to move in a hard, thick, heavy coating that would make a suit of medieval armor seem lightweight and graceful. Instead, your *skeletal system* is an endoskeleton. The lightweight strength of the endoskeleton's bones, along with the flexibility of its various types of joints, permits your muscles to move your body easily.

19.6 The Functions of the Skeleton

The skeleton provides the supporting framework for the body. Without bones you could not stand or sit upright. Your muscles would have no firm structures to move, and your body would have no definite shape.

The skeleton also protects the body's organs. Your skull protects your brain, eyes, and inner ears. Your rib cage protects your lungs and heart. Your vertebrae (VUR tuh BRAY) protect your spinal cord.

The skeleton also stores minerals. Bone tissue contains calcium and phosphorus, which give bones their strength. Studies show that the average woman acquires most of her skeletal mass by age 18 and the average man by age 20. That is why it is critical to get lots of calcium in your diet while you are young to build strong bones. This is an important way that we can take care of the bodies God has given us.

Bones also produce blood cells. The red bone marrow found inside many bones makes almost a billion new blood cells every day.

19.7 The Parts of the Skeleton

When you think of the skeletal system, you probably think of a skeleton you have seen in a museum or classroom. The bones in your body, however, are much different from dead, dry bones. Your bones contain living bone cells, blood vessels, and nerves. Two main types of tissue—cartilage and bone—make up the skeleton.

Cartilage

Cartilage is a type of connective tissue. It is softer and more flexible than bone because its nonliving material contains very little calcium and phosphorus. Blood vessels never pass through cartilage. Nutrients from blood in vessels on the surface of cartilage pass easily through the soft, nonliving material to the cartilage cells.

Cartilage covers the ends of many of your bones, helping them slide smoothly against one another and providing a cushion for the hard ends of the bones. Cartilage also provides flexibility where it is needed, such as in the tip of your nose and your ears.

When you were a tiny embryo, your entire skeleton was composed of cartilage and similar tissues. As you developed, these tissues gradually changed to bone. The bones of your head did not fuse to form your solid, bony skull until you were about two years old. Some parts of your skeleton, such as the tip of your nose, your outer ears, and part of your kneecaps, never change to bone.

Near the ends of the long bones of your body are cartilage plates. As you grow, the cells in these cartilage plates divide and change into bone tissue, making these bones longer. During your high-school years and possibly even a few years after that, most of these cartilage plates will change completely to bone. When they do, you will stop growing.

Bone

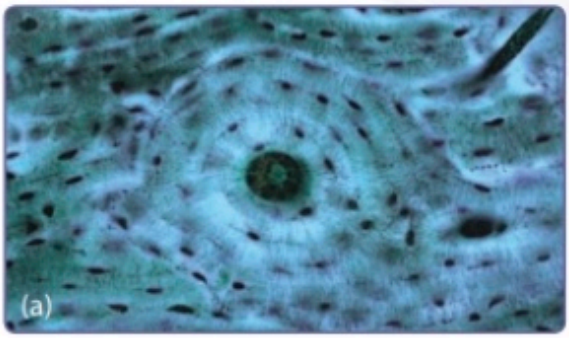
Bone is also a type of connective tissue. It consists of living bone cells and the nonliving material they secrete. This nonliving substance is made of calcium, phosphorus, and microscopic fibers; it forms circular layers around the tiny blood vessels in bones. Each circular layer has bone cells between it and the next layer. The blood vessel supplies nutrients to the bone cells. A blood vessel, the layers of nonliving material around it, and the living bone cells found between the layers make up an **osteon**. Hard, strong bone sections consist of many osteons side by side.

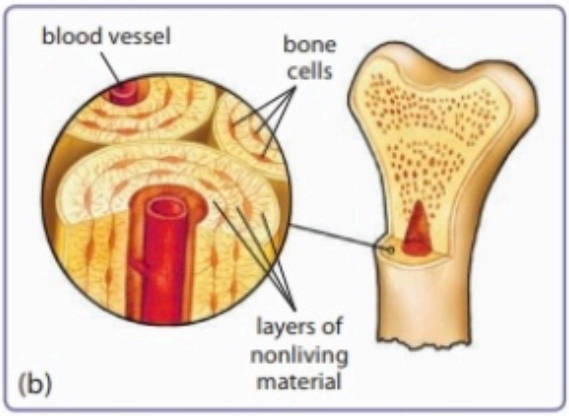
Bones have different sizes and shapes. Figure 19-10 shows the major bones of the human body. Bones are also similar in several ways. Very few bones are solid. Many bones have a hard, solid outer layer with spongelike spaces on the inside. This type of bone, although it is named *spongy bone*, is actually quite rigid.

Many bones contain a long, central chamber called a *marrow cavity*. Marrow cavities and the spaces in spongy bone are filled with **bone marrow**. There are two types of bone marrow. *Red bone marrow* is a soft tissue that makes blood cells. As a person grows older, much red bone marrow is gradually replaced with *yellow bone marrow*, a fatty tissue.

A bone's surface is usually covered with a tough, white tissue called the *periosteum* (PEHR ee AHS tee um). As you grow, the periosteum forms new bone tissue. Joined to the periosteum are ligaments and tendons. **Ligaments** are tough, flexible bands of connective tissue that attach bones to other bones at joints. **Tendons** are bands of connective tissue that connect muscles to bones.

The outer surface of a bone is not always smooth and solid. There are openings and grooves in bones that serve as passageways for blood vessels and nerves. Projecting parts and rough humps on many bones provide places for tendons and ligaments to attach.

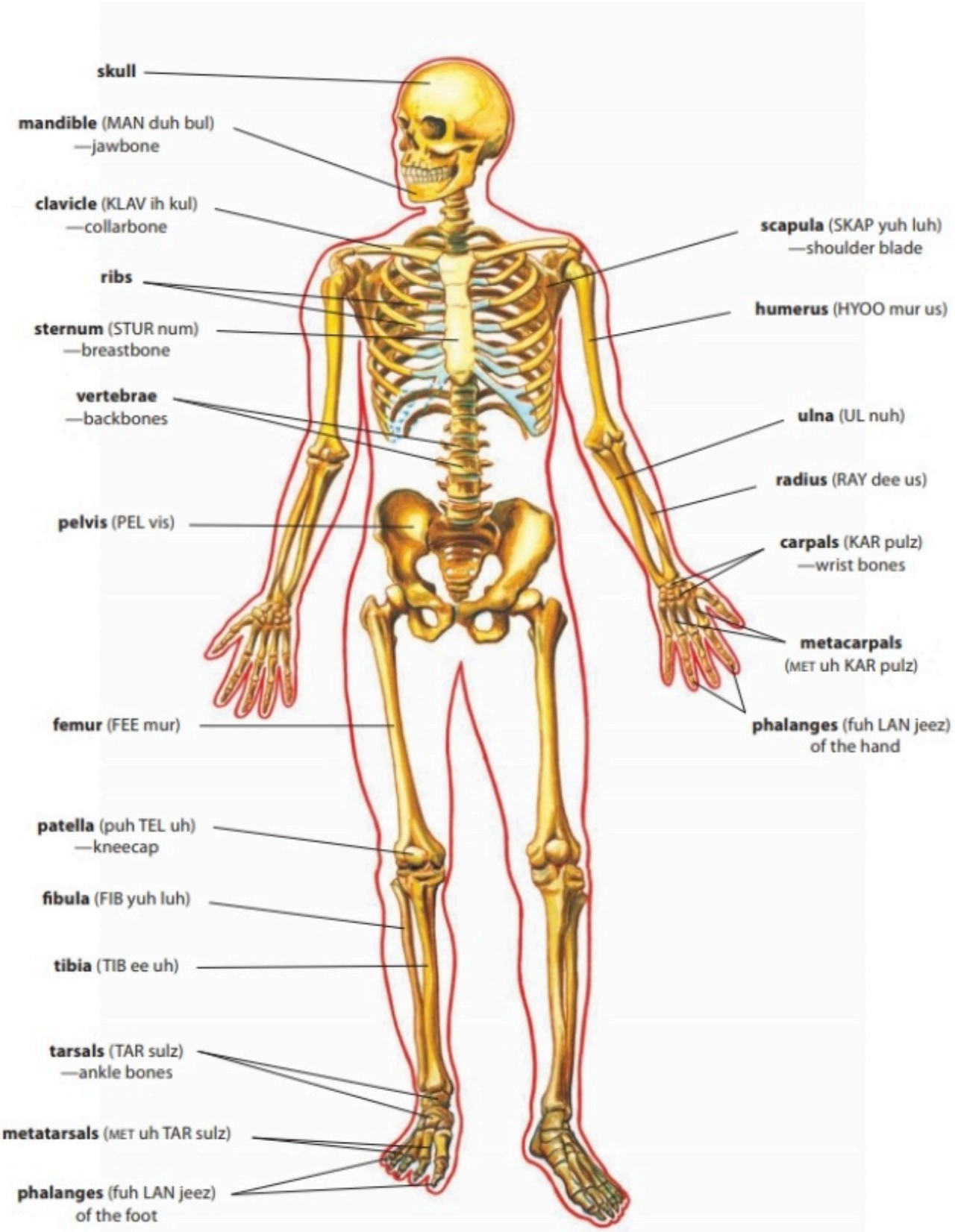




19-8 A photomicrograph of an osteon (a) and a diagram of an osteon (b)

19-9 Human skeletal and connective structures. Can you name the four bones shown in this diagram?

periosteum: peri- (Gk. *peri*—around) + -osteum (Gk. *osteon*—bone)



19-10 Human skeletal system

19.8 The Joints of the Skeleton

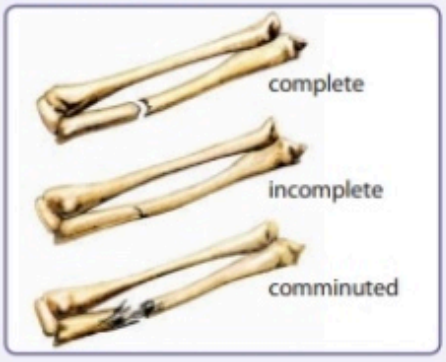
A **joint** is a place where two or more bones meet. The bones of most joints are held together by ligaments. Different joints permit different types of movement, depending on the shapes of the bones in the joint.

- *Hinge joints.* Elbow and knee joints are called hinge joints because they bend in only one direction, like a door hinge.
- *Gliding joints.* The joints between the vertebrae of the back are gliding joints, which allow the vertebrae to slide and twist in almost any direction.
- *Ball-and-socket joints.* The ball-and-socket joints of the shoulder and hip provide free rotating movement within a limited area.
- *Pivot joints.* The joint between the radius and ulna of the forearm near the elbow is a pivot joint. Circular movement occurs between these bones whenever the arm twists.

Facets of Life Science: Broken Bones

Scientifically speaking, a broken bone is a *fractured bone*. The type of break that occurs determines what type of fracture it is. When a bone breaks completely in two, the break is called a *complete fracture*. An *incomplete fracture* occurs when there is only a crack, not a break, in the bone. Bones that break cleanly in one place are *simple fractures*; fractures that splinter the bones are called *comminuted* (KAHM uh NYOO tid) *fractures*.

Fractures heal properly only if they are set properly. Physicians set fractures by aligning the pieces of bone in their proper positions. If necessary, they secure the pieces with a cast on the outside or metal screws and plates on the bone itself. Sometimes traction (pulling on the end of a bone) is also required to keep the bone in place as the fracture heals.



A broken bone begins to heal as its cells produce fibers and secrete jellylike substances into the cracks of the fracture. This material is the same cartilage-like material from which the bone formed in the first place. It fills the cracks much like glue. As minerals (especially calcium and phosphorus) are deposited in this "glue," it gradually hardens into bone.

Most fractures heal in several weeks to several months, depending on the type of fracture. However, fractures that move after they have been set take longer to mend. Moving at the fracture site unsets the "glue," forcing the bone to secrete more of the gluelike material and start the hardening process all over again. Large lumps of bone sometimes form at such a fracture site.

The fractures of children and teenagers heal much faster than the fractures of older people. The bone cells of an elderly person are slower to manufacture the gluelike material needed for healing fractures. Fractures that heal in a few weeks in children and teenagers can sometimes take years to heal in an elderly person.

The longer a person lives, the more brittle his bones are likely to become. Why? The body removes minerals from the bones, making them thinner and much easier to break. If this condition becomes severe, it is called *osteoporosis* (AHS tee oh puh RO sis). Getting enough calcium in the diet and participating in weight-bearing exercises help prevent osteoporosis. There are also medications that people with low bone density can take to slow the removal of calcium from their bones.

Broken bones are maintained in proper alignment with a cast or plates and screws.

Thinking Critically: A Medical Mystery

Jane is a 68-year-old white female who has come to your clinic because of pain in her lower back. Because lower back pain can be caused by many different conditions, you know that you must obtain more information before making a diagnosis. Use the key below to obtain more information about Jane and make a diagnosis. Read the information with each number, and then decide what test to run next or what information to obtain next. (None of the choices are right or wrong; they are simply paths you can take to obtain more information to help you make a diagnosis.) Then answer the questions that follow.

Key

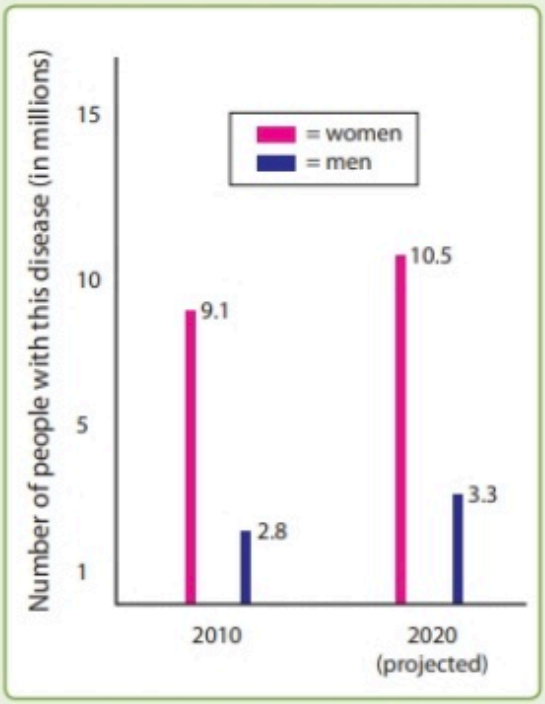
1. a. To ask Jane about her personal health history, go to 2.
   b. To ask Jane about her family health history, go to 3.
2. Jane says that she has never had any severe medical problems. About four years ago, she was diagnosed with vitamin D deficiency. Her doctor recommended that she take daily multivitamins, but she has not been faithful in doing so. Jane has smoked since she was in her 30s. She also tells you that she is concerned because she has lost about one inch of her height over the past two years.
   a. To ask Jane about her family health history, go to 3.
   b. To begin running tests on Jane, go to 4.
3. Jane says that her mother died at 73. She had suffered two broken hips in the five years before her death, but she had never had any diagnosis of disease. Her father had one heart attack at 67 and died two years later of natural causes.
   a. To ask Jane about her personal health history, go to 2.
   b. To begin running tests on Jane, go to 4.
4. a. To run a complete blood count (CBC) test, go to 5.
   b. To run a bone density test, go to 6.
   c. To run a vitamin deficiency test, go to 7.
5. You decide to run a CBC test on Jane. A higher-than-normal number of white blood cells in Jane's blood could indicate an infection. Either a low red blood cell count or low hemoglobin could indicate anemia. However, your tests show that Jane's blood cell count is normal.
   a. To run a bone density test, go to 6.
   b. To run a vitamin deficiency test, go to 7.
   c. To make a tentative diagnosis, go to Question 1 below.
6. You decide to run a bone density test on Jane. A score of −1.0 or above is normal. Scores between −2.5 and −1.0 indicate mild bone loss. Scores below −2.5 indicate osteoporosis. Jane's bone density score comes back as −2.9.
   a. To run a complete blood count (CBC) test, go to 5.
   b. To run a vitamin deficiency test, go to 7.
   c. To make a tentative diagnosis, go to Question 1 below.
7. You decide to run a vitamin deficiency test on Jane. The results show that most vitamins are in the normal range. Vitamin B_1, however, is slightly low, and vitamin D is moderately low.
   a. To run a complete blood count (CBC) test, go to 5.
   b. To run a bone density test, go to 6.
   c. To make a tentative diagnosis, go to Question 1 below.

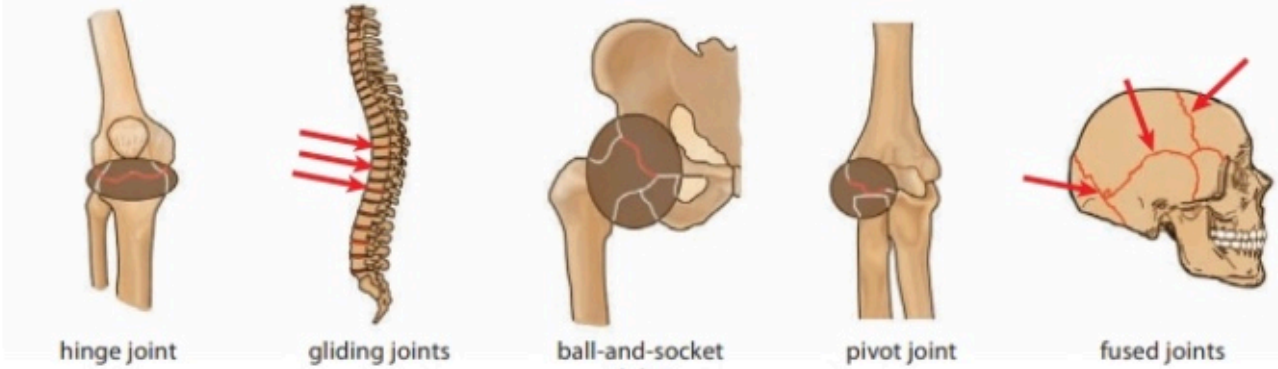
Questions

1. What was the purpose of running the CBC test? What was the purpose of running a bone density test? What was the purpose of the vitamin deficiency test?
2. What is your tentative diagnosis of Jane's condition?
3. What factors (if any) in Jane's personal health history put her at risk for this condition?
4. What factors (if any) in Jane's family health history put her at risk for this condition?
5. What clues during your evaluation of Jane led you to make this diagnosis?
6. What can Jane do to prevent further progression of the disease?

The graph below shows the number of people in the United States with this disease in 2010 and the projected number for 2020.

7. Is this disease more common in men or women, or is there no distinction?
8. What is expected to happen to the incidence of this disease by the year 2020?





19-11 Find each of these types of joints on your body and notice the different types of movement they allow.

- *Fused joints.* Fused joints, such as those between the bones of the skull, do not allow any movement since the bones have become permanently fused together.

Joints sometimes become inflamed, a condition known as *arthritis*. Inflammation usually causes pain around the joint, especially during movement. The most common type of arthritis is caused by disintegration of the cartilage surrounding the joint. Severe arthritis can prevent a person from using the affected joints normally.

Joints are very common prosthetics. For example, some people need to have one of their hips or knees replaced. Physicians need to know how the hip and knee joints work in order to have a replacement made and installed.

Health Hint—Sprains

A *sprain* is an injury to the ligaments or tendons around a joint. Sprains cause the ligaments and tendons to stretch or even tear. This causes pain and inability to use the sprained area normally.

Doctors usually advise people not to participate in strenuous activity while recovering from a sprain. Too much activity could cause permanent damage to the joint. However, too little activity could cause the ligaments and tendons to heal improperly. This could permanently limit the person's use of the joint. Bad sprains may require medical attention.

19C Section Review

1. List four functions of the skeletal system.
2. What two minerals are especially important in giving bones their strength?
3. A unit of bone consisting of a blood vessel and the layers of hard material around it is called a(n)
   a. ligament. c. osteon.
   b. papilla. d. tendon.
4. What part of a bone produces blood cells?
   a. periosteum c. cartilage
   b. comminuted joints d. red bone marrow
5. The structures that attach bones to other bones at joints are called _____.
6. What is the scientific name for the thigh bone?
7. Name a bone that is inferior to the pelvis and a bone that is posterior to the sternum.
8. Besides bone, what other tissues are important to the skeletal system?
9. Give examples of the following types of joints: hinge, gliding, ball-and-socket, pivot, and fused.
10. (F) A disease in which calcium is removed from the bones more quickly than it can be replaced is called _____.

19D Section Objectives

- ✓ Differentiate between voluntary and involuntary muscle; between striated and nonstriated muscle; and between skeletal, smooth, and cardiac muscle.
- ✓ Explain how muscles move.
- ✓ Describe three functions of the muscular system.

19D The Muscular System

Your body moves when your muscles contract. Since contracting involves becoming shorter and thicker, your muscles can move your body only by pulling, never by pushing. Muscles, however, cannot move the body by themselves. Muscles, nerves, bones, joints, and other structures work together to move the body.

Prosthetic limbs must be designed to work well with the recipient's skeletal, muscular, and nervous systems. Some prosthetic limbs use the electrical impulses from the nerves in the residual limb (the part that was not amputated) to control the movement of the prosthesis. In this way the prosthesis can replicate the movement and action of the original limb. But even a good prosthesis cannot compare with the amazingly complex muscles that God has designed to work together in our bodies.

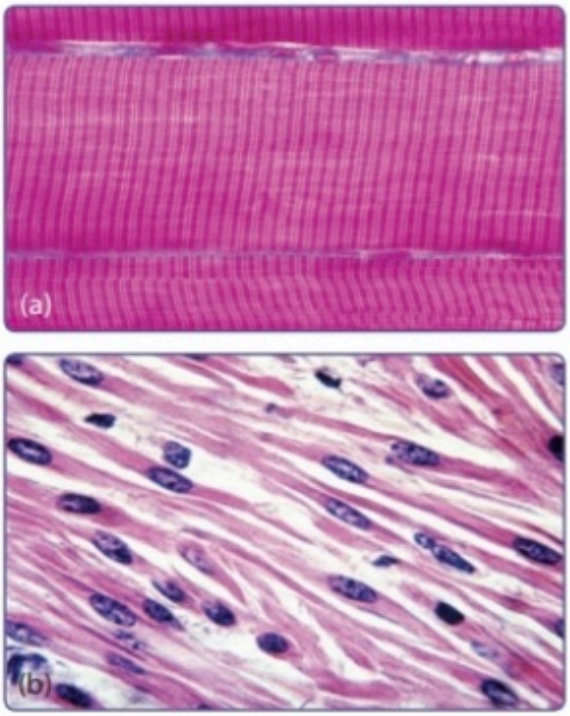
19.9 Types of Muscles

Your *muscular system* contains about 600 muscles to move the various parts of your body. Muscles can be classified as either voluntary or involuntary.

Voluntary Muscles

Muscles that you can control at will are called **voluntary muscles**. The muscles that move your skeleton, called **skeletal muscles**, are voluntary muscles. Skeletal muscles are usually attached to bones.

A view of skeletal muscle tissue through a microscope shows a pattern of dark and light bands called striations (STRY AY shunz). Striations appear where layers of different kinds of protein molecules meet. As the muscle contracts, the protein molecules move past each other, and the striations appear to move. Because of these striations, skeletal muscle is called **striated muscle**.



19-12 Microscopic views of striated muscle tissue (a) and smooth muscle tissue (b)

Involuntary Muscles

Muscle tissue that you cannot control at will is **involuntary muscle**. The muscles of the heart, stomach, intestines, blood vessels, and other internal organs are involuntary muscles. The nervous system automatically controls involuntary muscles. Your heart continues to pump blood and your stomach continues to churn food even when you are asleep or unconscious.

Involuntary muscles generally contract more slowly than voluntary muscles, but they can function longer before tiring. Most involuntary muscles do not have striations and are called **smooth muscles**. The heart muscle is the exception. Its muscle tissue, called **cardiac muscle**, is both involuntary and striated.

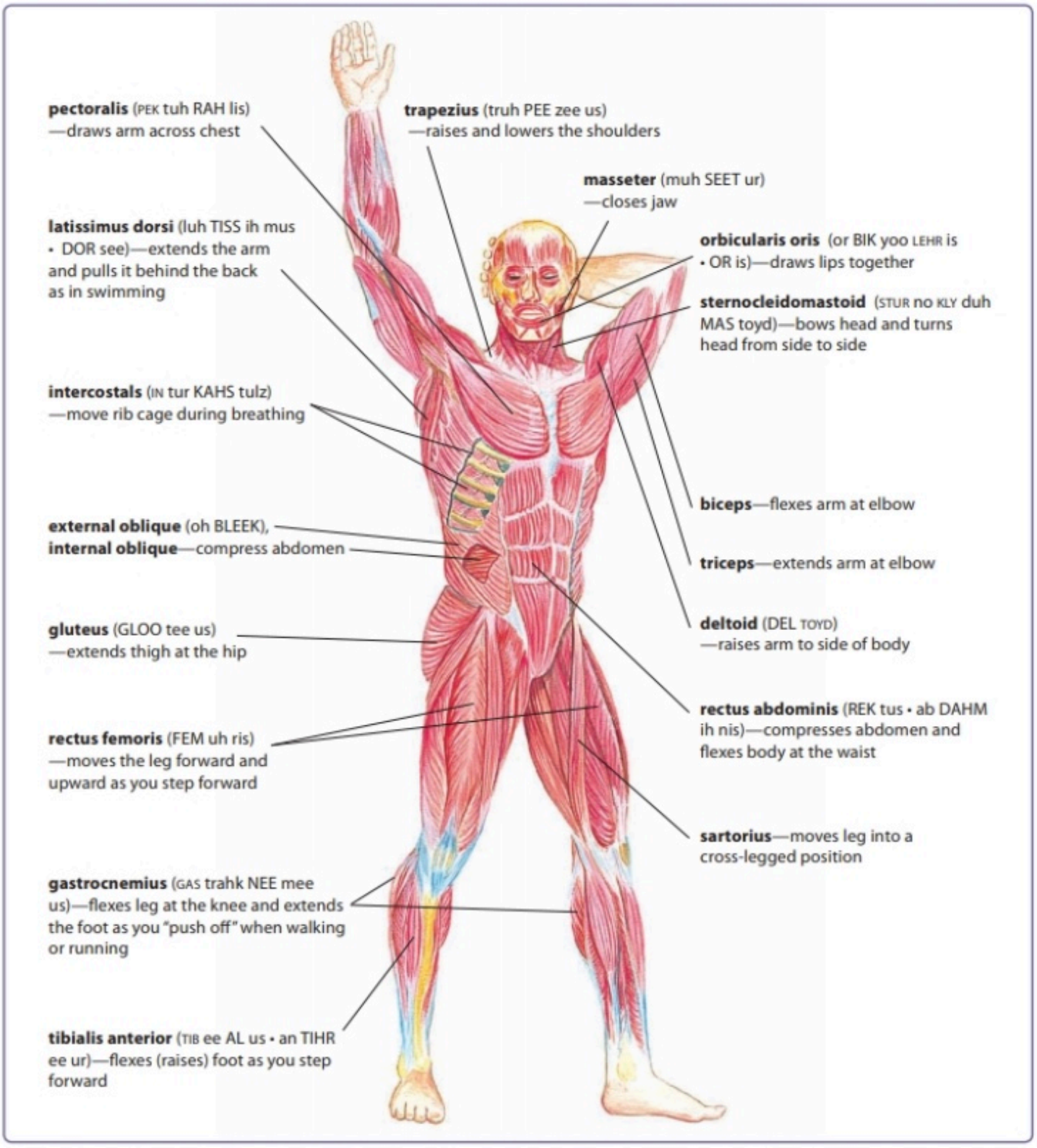
cardiac: (Gk. *kardia*—heart)

19.10 Muscle Physiology

Muscles contract to move your body or to move substances inside your body. This may seem fairly simple, but the steps involved are quite complex.

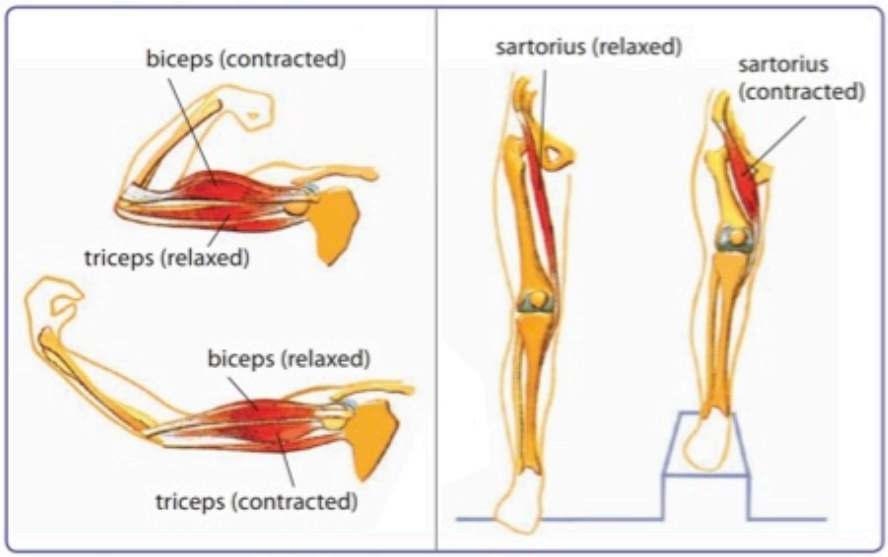
How Muscles Move

Skeletal muscles usually work in pairs. When the biceps (BY seps) muscle of your arm contracts, your arm bends at the elbow. At the same time the triceps (TRY seps) muscle in the back of your arm stretches as it relaxes. When the triceps contracts, the arm straightens and the biceps stretches as it relaxes.



19-13 Human muscular system. Try using each of these muscles in your body and noting the movements they perform.

With your left hand, feel the movements of the muscles in your right arm as you flex your arm (pick up an object by bending only at the elbow) and extend your arm (push down on your desk with the back of your hand).



19-14 A typical muscle pair (left) and a muscle that extends across joints (right)

Many of the skeletal muscles that move your body extend across at least one joint and attach to two different bones. Normally the joint the muscle crosses is the joint that moves when the muscle contracts. For example, the sartorius (sar TOR ee us) muscle, the longest muscle in your body, attaches at the upper part of the pelvic bone, extends across both the hip and the knee joints, and attaches to the inner side of the tibia bone near the knee joint. You use this muscle to cross one of your legs in front of the other, as you would when kicking a soccer ball in a lateral pass.

Some skeletal muscles do not extend across joints. Instead they cause movement of the skin or other muscles to which they attach. For example, the muscles around the eyes and mouth change the size of these openings. Also, the tongue and throat muscles that help you swallow do not extend across joints.

Think About It

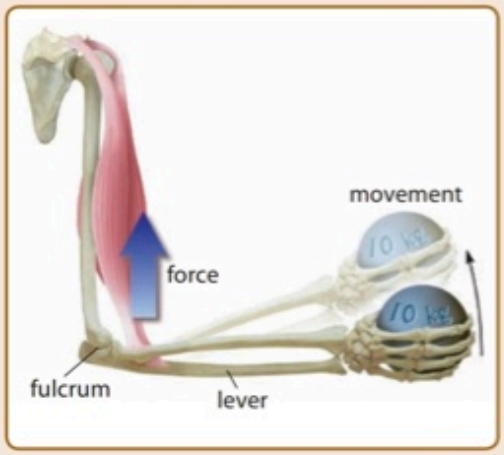
Muscle tissue contracts to produce movement. What type of tissue controls that movement?

19-2 Types of Muscles

Muscle	Location	Function	Striated or nonstriated	Voluntary or involuntary
skeletal	mostly attached to bones and other movable structures of the body	move parts of the body	striated	voluntary
smooth	walls of internal organs and blood vessels	move organ or substance within the organ	nonstriated	involuntary
cardiac	heart	contract heart to pump blood	striated	involuntary

Physics Connection

The bones and muscles in your body function as levers. A lever is a hard rod that moves around a pivot point called the fulcrum. Bones act as levers, and joints are the fulcrums. Muscle tissue then provides the force needed to produce movement.



How Muscles Work

Muscles need a constant supply of energy to function properly. Stored energy comes to muscles in the form of glucose (sugar) carried by the blood. Muscle cells break down glucose during cellular respiration (see pp. 78–80). This process converts the stored energy of glucose into the usable energy of ATP.

Connections in Science: Modern Robotics

What comes to your mind when you hear the word *robot*? Do you think of a stiff machine moving slowly around a room? Or a "tin man" trying to accomplish the normal actions of a human? Today robots are used for hundreds of jobs and have diverse forms—from mechanical arms that weld automobile frames to rovers that have explored the surface of Mars and searched through rubble at disaster sites. For example, search-and-rescue (SAR) robots fitted with cameras and heat sensors were used after the 9/11 terrorist attacks to search for survivors in areas that were too dangerous for human rescuers to search.

Some military robots are used to find and defuse explosives.

The field of robotics has expanded rapidly. Scientists are now trying to create robots that can move just like you. These human-shaped robots are called androids (AN DROYDZ), and they aren't limited to science fiction. One use of android technology is providing fully functional prosthetic limbs to replace missing body parts. Those who were born with deformed arms or legs or lost them due to injury or surgery would benefit from advanced prosthetics.

Many prosthetic limbs are custom-made using computers to analyze the movements of the amputee (the person receiving the new limb). Some prosthetic limbs have microprocessors that pick up nerve impulses and cause small motors to move the limb.

One problem prosthetic researchers face is the muscular system. Researchers are working to make prosthetic limbs that more closely imitate human movement. But to do this, they must understand how the muscles, bones, skin, nerves, and other structures work together to produce movement. Scientists are now designing bionic limbs that operate by electrical signals to move in sync with other parts of the body. The studies so far show that bionic limbs permit greater mobility than any other prosthesis has.

android: andr- (Gk. *andr*—man) + -oid (Gk. *eidos*—shape or form)

Prosthetic limbs can restore mobility to people who have lost limbs.

Prosthetic limbs have improved greatly over the years, and they likely will continue to improve. However, even scientists' best attempts at copying just some of the body's movements cannot reproduce God's original design. God designed, created, and sustains your body in ways that no human engineer ever could.

Aerobic cellular respiration requires oxygen. In your lungs, the oxygen that you breathe in is transferred to your bloodstream. Blood then carries the oxygen to all the parts of your body, including your muscles. Muscles use oxygen to break down glucose during aerobic cellular respiration. The ATP (usable energy) that is released is then available to make the muscle cells contract.

When you work or play hard, you begin to breathe rapidly and deeply. This supplies your muscles with the oxygen they need to continue to operate. Occasionally, when you are very active, your muscles may not be able to get enough oxygen to perform aerobic cellular respiration. When this happens, they may break down glucose without oxygen. This process is called lactic acid fermentation. It is the type of anaerobic cellular respiration (see pp. 81–83) that produces lactic acid. Anaerobic respiration does not produce as much ATP as aerobic respiration does. But it does allow muscle cells to continue to function for a short time even without oxygen.

Health Hint—Muscle Cramps

Have you ever experienced the pain of a muscle cramp? Maybe you had just run a race or gone swimming. *Cramps* are painful, involuntary contractions of skeletal muscles that have been overused.

Another type of muscle problem is *shin splints*. This is soreness on the front of the lower leg (the shin) caused by muscle strain. Shin splints often result from walking up and down hills.

Most minor muscle impairments, such as cramps and shin splints, can be treated by simply resting the muscle. Massaging the muscle and applying heat may also help. In more severe muscle injuries, the muscle tissue may actually tear. These injuries may require medical treatment.

19-15 Skeletal muscles can become fatigued because of overuse.

Functions of the Muscular System

- Movement
- Posture
- Regulation of body temperature (heat production)

Have you ever wondered why your muscles are sore after exercising or playing hard? One theory suggests that the buildup of lactic acid in the muscle tissue causes them to be sore. However, studies show that lactic acid is cleared from the muscle tissue in just a few hours. Therefore, it could not be responsible for the soreness experienced for several days after exercise. More recent research indicates that the soreness may instead be the result of microscopic damage to the fibers and resulting inflammation.

Other Functions of Muscles

Skeletal muscles do more than provide movement. They also maintain your bodily posture. The muscles along your back and neck keep your backbone in an erect position when you are active as well as when you are standing or sitting.

When muscles contract, they produce heat. This heat warms the body and helps maintain the body's constant temperature. Strenuous exercise, especially on hot days, can produce too much body heat, which the body must eliminate. When you are inactive on a cold day, you may begin to shiver. Shivering is actually a result of involuntary muscle contractions that produce heat and raise the body temperature. Another involuntary muscle contraction causes goose bumps (see p. 417).

19D Section Review

1. Skeletal muscle is
   a. striated.
   b. smooth.
   c. voluntary.
   d. cardiac.
   e. A and B.
   f. A and C.
2. What organ has involuntary, striated muscle?
3. Explain the difference between voluntary and involuntary muscles. Give an example of each.
4. (True or False) Muscles work by pulling, never by pushing.
5. The muscle located at the back of the lower leg is the
   a. gastrocnemius.
   b. rectus abdominis.
   c. sartorius.
   d. triceps.
6. The muscle that closes the jaw is the _____.
7. How do muscles get the energy they need to function?
8. Give at least one reason why your muscles might be sore after strenuous exercise.
9. Shin splints could result from strain to which muscle?
   a. biceps
   b. orbicularis oculi
   c. external oblique
   d. tibialis anterior
10. How do muscles help regulate body temperature?

Pulling It All Together

Gathering the Data

- Because the human body is a tool that God has given us to use for His glory, the study of human anatomy and physiology is important for the Christian. God created us, and we are accountable to Him.
- Anatomy is the study of the structure of an organism and its parts. Physiology is the study of the functions of an organism and its parts. *Anterior* means "toward the front"; *posterior* means "toward the back." *Superior* means "toward the head"; *inferior* means "toward the feet."
- A tissue is a group of cells that function together. The four tissue types are connective, epithelial, muscle, and nerve. Groups of tissues functioning together are called organs. Organ systems are groups of organs that work together to accomplish a life function.
- The integumentary system consists of the skin, hair, and nails. The skin functions in sensation, protection, and regulation of body temperature.
- The outer layer of skin is the epidermis, and the inner layer is the dermis. The dermis contains blood vessels, nerve receptors, hair follicles, sweat glands, and oil glands. The subcutaneous layer below the skin consists of fat cells that cushion and insulate the body, and fibers that attach the skin to the muscles beneath.
- The dark pigment melanin and the yellowish pigment carotene produce much of the color of human skin. Getting a little sun is important for your body to produce vitamin D, but too much can lead to skin cancer.
- First-degree burns affect only the outer epidermal layers. Second-degree burns affect all of the epidermis and part of the dermis. Third-degree burns go through all of the dermis and sometimes into the subcutaneous layer.
- The skeletal system provides a supporting framework for the body, protects the body's organs, stores minerals, and produces blood cells.
- Bone and cartilage make up the skeleton. Bones consist of living bone cells and the nonliving material (containing calcium and phosphorus) that they secrete. Blood vessels supply nutrients to the living bone cells. One unit of bone is called an osteon. Cartilage is softer and more flexible than bone and contains little calcium and phosphorus. An embryo's skeleton is mostly cartilage. As the baby develops in the womb and then grows after birth, most of the cartilage is gradually converted to bone.
- Many bones have a central chamber filled with bone marrow. Red bone marrow produces blood cells. Much of it changes to yellow bone marrow as a person ages. The

Learning the Lingo

outer surface of a bone is covered with periosteum, which forms new bone tissue as a person grows.

- Ligaments are bands of connective tissue that attach bones to other bones at joints. Tendons attach muscles to bones.
- A joint is a place where bones meet. The five main types of joints are hinge, gliding, ball-and-socket, pivot, and fused joints. Inflammation of a joint is called arthritis.
- A broken bone is called a fracture. Incomplete fractures crack the bone, and complete fractures break the bone into two pieces. Fractures that splinter the bone are called comminuted fractures. Osteoporosis is a condition in which minerals are removed from bones, making them thinner and easier to break.
- The muscular system moves your body or substances inside your body. Voluntary muscles are under your conscious control, and involuntary muscles are not. Skeletal muscle is voluntary; it is also striated. Smooth muscle lines the blood vessels and internal organs; it is involuntary and nonstriated. Cardiac muscle is found in the heart; it is involuntary and striated.
- Muscles usually work in pairs. They only pull; they never push. Muscles also help maintain posture and regulate body temperature. Muscles rely on a supply of usable energy (ATP) from cellular respiration to function properly.

Sorting the Data

Note: For True/False questions that are false, explain why the statement is false or suggest a way to make it true.

1. A student studying the names, sizes, and locations of the bones in the human body is studying
   a. anatomy. c. physiology.
   b. dactylography. d. dermatology.
2. The heart is _____ to the intestines.
   a. anterior c. posterior
   b. superior d. inferior
3. Which type of tissue lines the internal and external surfaces of the body?
   a. connective c. epithelial
   b. nerve d. muscle
4. Why is skin considered a major defense against disease?
5. What structures are found in the dermis?
6. What is the purpose of the subcutaneous layer?
7. (True or False) Excessive exposure to sunlight can lead to skin cancer because it depletes the body of melanin.
8. What is the best way to treat most first-degree burns?
9. Of the two main tissues that make up the skeleton, which is softer and more flexible? Why is this?

10. What is the relationship between bone marrow and blood?
11. Which of these bones is *not* found in the arm?
    a. ulna
    b. humerus
    c. radius
    d. fibula
12. What kind of joint does *not* allow movement?
13. When you write your answer to this question, what type of muscles are you using?
14. Smooth muscle is
    a. striated and involuntary.
    b. striated and voluntary.
    c. nonstriated and involuntary.
    d. nonstriated and voluntary.
15. Where in the body would you find skeletal muscle? Smooth muscle? Cardiac muscle?
16. What metabolic processes supply the energy for muscles to contract?

Outside the Lab

17. Research a disease or disorder of one of the human body systems discussed in this chapter. Prepare a short report about the disease. Include information about causes, symptoms, statistics, and treatments.

Analyzing the Data

18. Besides physical differences, how else are humans different from animals?
19. Why is the study of the human body important for a Christian?
20. Can one human organ system function independently of the other systems? Why or why not? Give an example to support your explanation.
21. Why does it hurt to cut your skin, but it does not hurt to cut your hair or nails?
22. If your skin produced no pigment, what color would it be? Why?
23. How does the Bible say you should treat someone whose looks or physical features are different from yours?
24. How could you tell if a burn was a first-degree burn or a second-degree burn?
25. After vigorous exercise, your friend looks both red and sweaty. Explain how the processes that cause both of these conditions help your friend cool down.
26. Describe how ligaments and tendons are similar and how they are different.
27. How do the amounts of bone and cartilage in a person's skeleton change as he grows?

Drawing Conclusions

In 3–5 sentences, summarize the main ideas from the chapter in your own words.

Standardized-Test Prep Questions

1. Which is an example of smooth muscle?
   a. triceps
   b. stomach muscles
   c. heart muscle
   d. none of these
2. Which muscle moves the leg into a cross-legged position?
   a. deltoid
   b. gastrocnemius
   c. rectus abdominis
   d. sartorius

Use Diagram A to answer Questions 3–5.

3. Which of these structures contains dead, keratin-filled cells?
   a. A
   b. B
   c. C
   d. D
   e. A and B
   f. C and D
4. Which layer contains much connective tissue?
   a. B, epidermis
   b. D, adipose layer
   c. B, epithelial layer
   d. C, dermis
5. What substance causes structure B to darken when exposed to the sun for long periods of time?
   a. keratin
   b. vitamin D
   c. melanin
   d. perspiration

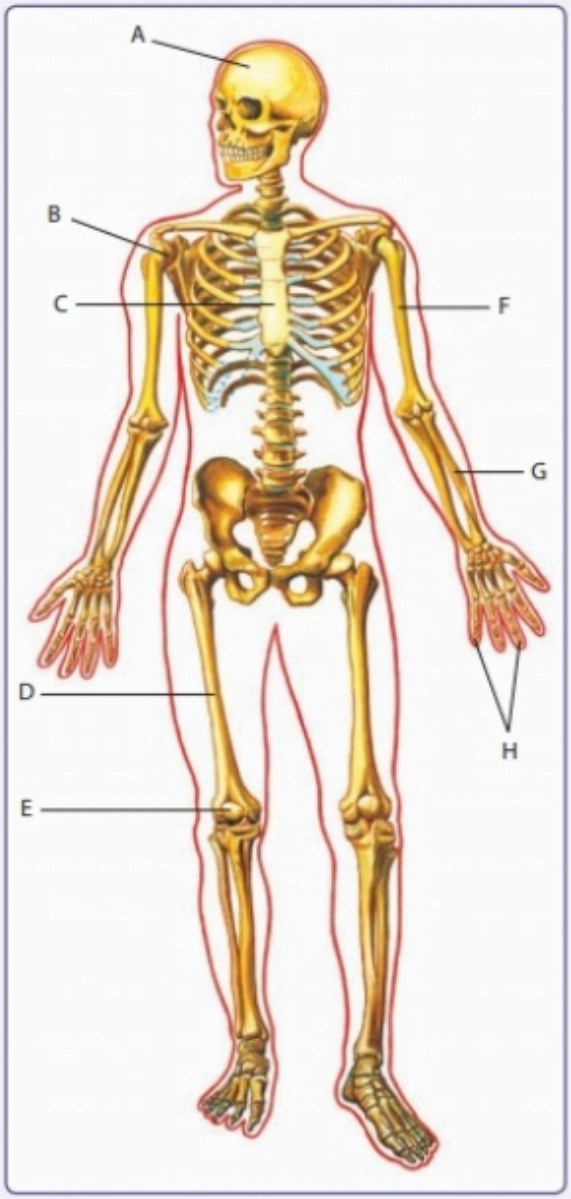


Diagram B

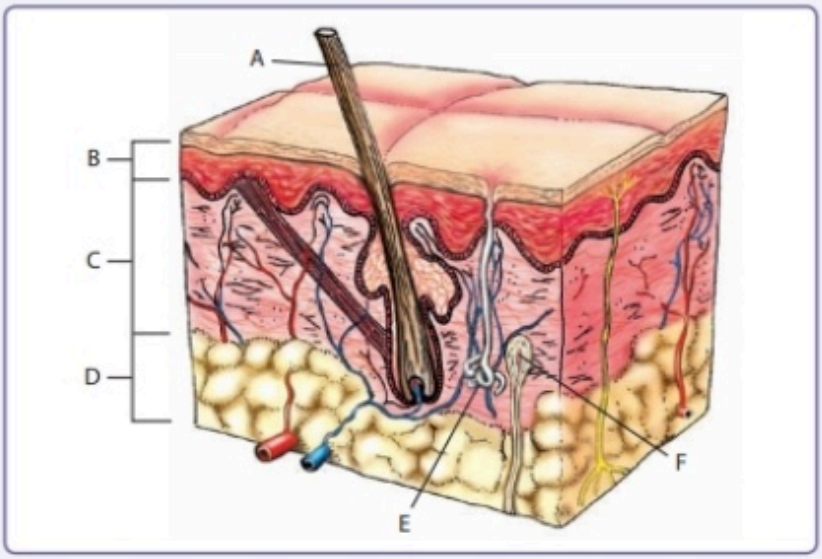


Diagram A

Use Diagram B to answer Questions 6–10.

6. Where would a fused joint be located?
   a. A
   b. B
   c. E
   d. G
7. The bone marrow inside bones such as D and F is involved in producing
   a. cartilage.
   b. epithelium.
   c. blood cells.
   d. melanin.

8. Structure B is a
   a. hinge joint.
   b. fused joint.
   c. pivot joint.
   d. ball-and-socket joint.
9. The connective tissue that attaches bone F to bone G is
   a. a ligament.
   b. periosteum.
   c. a tendon.
   d. voluntary muscle.
10. What is the name of bone E?
    a. femur
    b. ulna
    c. patella
    d. tarsal

Use Diagram C to answer Questions 11–12.

11. In what age range do women have the lowest bone density?
    a. 25–49
    b. 50–64
    c. 65–79
    d. 80+
12. Which conclusion can be drawn based on the data in this graph?
    a. Most women lose bone density as they age.
    b. Low bone density is not a risk factor for osteoporosis.
    c. Women over age 65 should eat less red meat.
    d. Osteoporosis leads to low bone density.

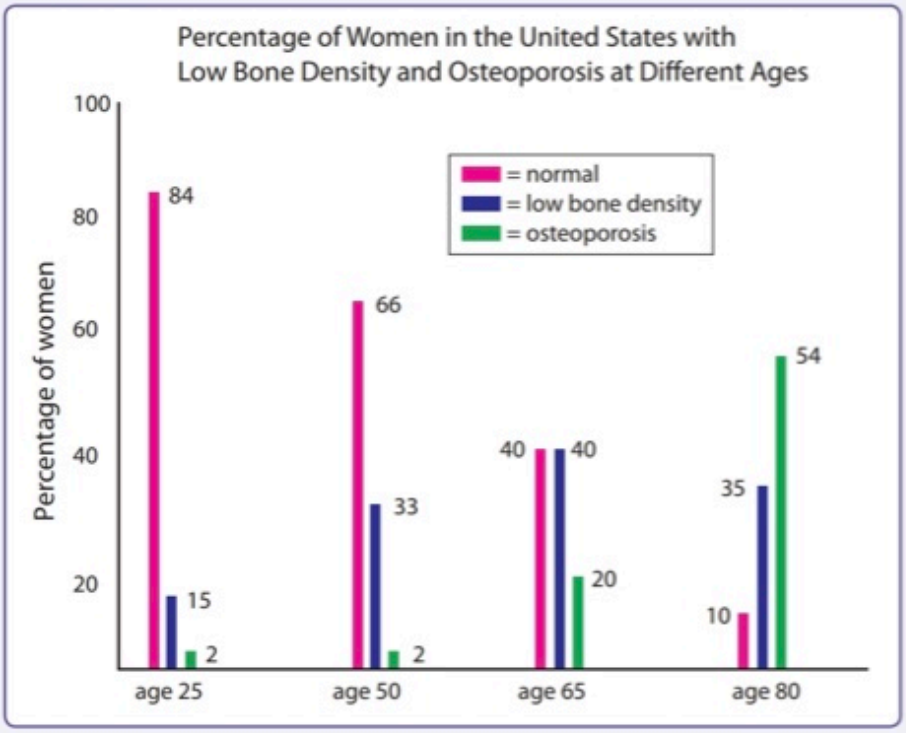


Diagram C