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32 Skeletal, Muscular, and Integumentary Systems

Big Idea Structure and Function

Q: What systems form the structure of the human body?

	WHAT I KNOW	WHAT I LEARNED
32.1 How does the structure of the skeletal system allow it to function properly?		
32.2 How do muscles help you move?		
32.3 Why is the integumentary system a necessary organ system?		

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32.1 The Skeletal System

Lesson Objectives

- List the structures and functions of the skeletal system.
- Describe the structure of a typical bone.
- List the different kinds of joints and describe the range of motion of each.

Lesson Summary

The Skeleton The human skeleton, like that of other vertebrates, is an endoskeleton.

- The adult human skeleton consists of 206 bones. Some bones are considered part of the axial skeleton and others of the appendicular skeleton.
  - The skull, vertebral column, and rib cage form the **axial skeleton**, which supports the central axis of the body.
  - The bones of the arms, legs, shoulders, and hips make up the **appendicular skeleton**.
- The skeleton supports the body, protects internal organs, produces movement by acting as levers, stores minerals, and produces blood cells.

Bones A solid network of living cells and protein fibers surrounded by calcium salts forms the bones of the human body.

- Bones have a complex structure. A layer of tough connective tissue called the periosteum covers a bone. Bones are made up of two types of bone tissue.
  - Compact bone is a dense outer layer that is arranged around **Haversian canals**—channels through which blood vessels and nerves run.
  - Spongy bone is a less dense layer found at the ends of long bones and in the center of flat bones, which adds strength without adding excess mass.
  - Soft tissue called **bone marrow** fills cavities in some bones. Yellow marrow stores fat. Red marrow contains stem cells, which make most types of blood cells.
- In infants, the skeleton is almost all **cartilage**, which is a dense tissue built around protein fibers. Bone replaces cartilage by a process called **ossification**, during which cells called **osteoblasts** secrete minerals. Osteoblasts mature into cells called **osteocytes**, which maintain the minerals in bone and strengthen the bone.
- Mature bone contains some osteoblasts, which build new bone, and cells called **osteoclasts**, which break down bone minerals. These cells enable the repair of broken or damaged bones and keep bone from becoming brittle and weak.

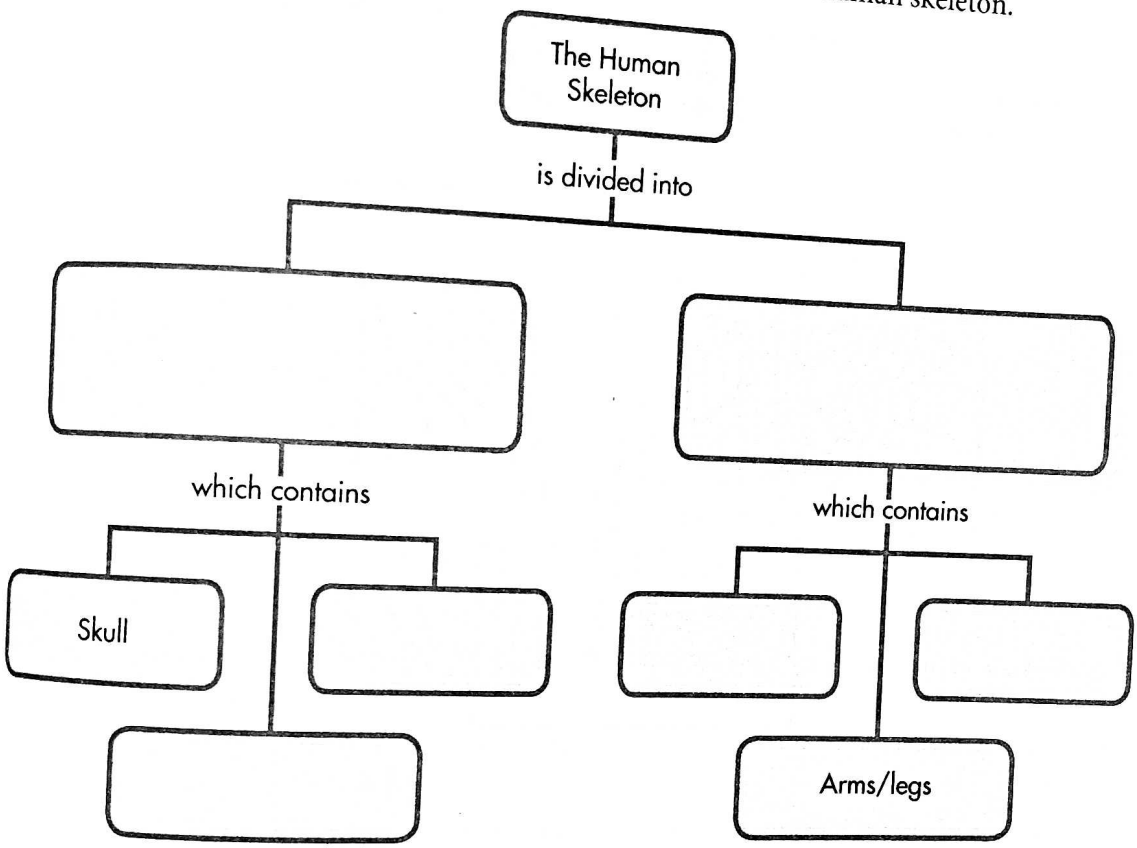
Joints Bones meet at **joints**, which contain connective tissues that hold the ends together. Joints permit bones to move without damaging each other.

- Joints are classified into three types:
  - Immovable, or fixed, joints allow no movement. These joints are found between bones in the skull.
  - Slightly movable joints, such as those found between vertebrae, permit some movement.
  - Freely movable joints, such as those found in the elbows and knees, permit movement in two or more directions.

- Cartilage covers the ends of the bones in a joint. **Ligaments**, tough strips of connective tissue, hold bones together. Synovial fluid reduces friction between moving bones. Bursae are sacs of synovial fluid that also act as shock absorbers.
- Joint injuries include ligament damage, inflammation, or loss of cartilage. Bursitis is inflammation of the bursae. Osteoarthritis is a painful stiffening of joints caused by the breakdown of cartilage.

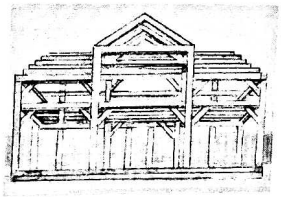
The Skeleton

1. Complete the concept map that summarizes the parts of the human skeleton.



For Questions 2–3, refer to the Visual Analogy comparing the skeleton to the wooden frame of a house.

2. VISUAL ANALOGY What would happen to a house if its upright beams were not strong and sturdy? Compare that to what would happen in the human body if upright bones were not strong and sturdy.



3. Suggest another possible analogy for the structure and function of the skeleton.

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4. List five functions of the skeletal system.

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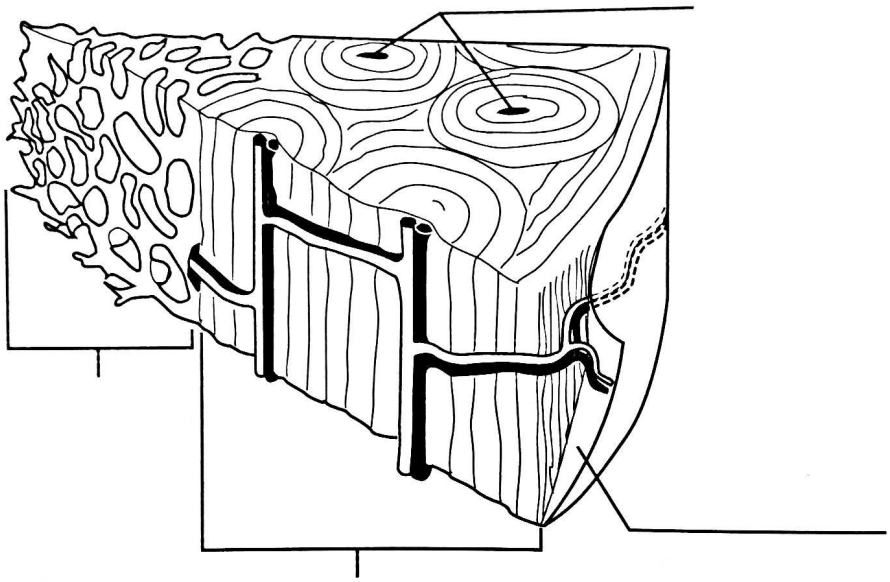
Bones

5. THINK VISUALLY The diagram shows a cross-section of bone. Label the Haversian canals, periosteum, compact bone, and spongy bone. On the lines below, describe the difference between spongy bone and compact bone.



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For Questions 6–12, complete each statement by writing the correct word or words.

6. A tough layer of connective tissue called the _____ surrounds a bone.
7. Nerves and blood vessels run through the _____ in bones.
8. Bone _____ is soft tissue in bone cavities that _____ (yellow) or produces blood cells (red).
9. Bone with a latticework structure is called _____ bone.

10. During the process of _____, cartilage is replaced by bone.

11. Cells that secrete mineral deposits that form bone are called _____.

12. A disorder called _____ results when _____ break down bone minerals more quickly than they can be deposited.

Joints

13. What is a joint?

_____

_____

14. List the three classifications of joints, based on their type of movement.

_____

_____

For Questions 15–19, match each joint with the category of joints that it represents.

Joint	Category
____ **15.** Ankle	**A.** Ball-and-socket joint
____ **16.** Between two vertebrae	**B.** Hinge joint
____ **17.** Shoulder	**C.** Immovable joint
____ **18.** Elbow	**D.** Pivot joint
____ **19.** Between skull bones	**E.** Slightly movable joint

For Questions 20–22, write True or False on the line provided.

_____ **20.** Ligaments protect the ends of bones as they move against each other at joints.

_____ **21.** Synovial fluid prevents the ends of bones from slipping past each other at joints.

_____ **22.** Osteoarthritis is joint pain and stiffness caused by loss of cartilage.

Apply the Big Idea

23. Plumbers use the word *joint* to refer to the place where two pipes are joined together. How are the structure and function of pipe joints similar to and different from the skeletal system's joints?

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32.2 The Muscular System

Lesson Objectives

- Describe the structure and function of each of the three types of muscle tissue.
- Describe the mechanism of muscle contraction.
- Describe the interaction of muscles, bones, and tendons to produce movement.

Lesson Summary

Muscle Tissue About one third of the mass of the body is muscle. There are three different types of muscle tissue.

- Skeletal muscle, which has alternating light and dark bands called striations, makes up muscles that are usually attached to bones. Movements of most skeletal, or striated, muscle are consciously controlled by the central nervous system. The cells in skeletal muscle are often called **muscle fibers**.
- Smooth muscle, which lacks striations and is made up of spindle-shaped cells, lines the walls of hollow structures such as the stomach and blood vessels. Movements of smooth muscle are usually involuntary.
- Cardiac muscle, which is also striated but has smaller cells than skeletal muscle, is found only in the heart. The control of cardiac muscle is involuntary.

Muscle Contraction Skeletal muscles produce movements by contracting from end to end. The contractions result from the interaction of two kinds of muscle protein filaments—actin and myosin.

- Skeletal muscle fibers are tightly packed with **myofibrils**, which are bundles of protein filaments. Thick filaments of the protein **myosin** and thin filaments of the protein **actin** are arranged in an overlapping pattern, which creates the striations of skeletal muscle. Actin filaments are bound together in areas called Z lines. Two Z lines and the filaments between them make up a unit called a **sarcomere**.
- During a muscle contraction, myosin filaments (powered by ATP) form connections called cross-bridges with actin filaments. The cross-bridges change shape and pull the actin filaments toward the center of the sarcomere. This action decreases the distance between Z lines, and the sarcomere shortens.
- Motor neurons control muscle fiber contractions. A motor neuron meets a muscle fiber at a synapse called a **neuromuscular junction**. The neurotransmitter **acetylcholine** carries nerve impulses across the synapse to the muscle cell.

Muscles and Movement Muscles produce force by contracting in only one direction.

- Strips of connective tissue called **tendons** attach skeletal muscles to bones, which act like levers. Controlled movements are possible because muscles work in opposing pairs.
- Red muscles, or slow-twitch muscles, contain many mitochondria and can work for long periods of time. White muscles, or fast-twitch muscles, contain fewer mitochondria, but can generate more force than slow-twitch. They are used for quick bursts of strength or speed.
- Regular exercise helps maintain muscle strength and flexibility, which makes muscle injuries less likely to occur.

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Muscle Tissue

For Questions 1–6, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ 1. Large skeletal muscles have long, slender cells with multiple <u>nuclei</u>.

_____ 2. The light and dark bands in skeletal muscles are called <u>Z lines</u>.

_____ 3. The cells of smooth muscle are shaped like <u>boxes</u>.

_____ 4. Smooth-muscle tissue lines the <u>inside</u> of the blood vessels and the digestive tract.

_____ 5. Cardiac muscle is under <u>voluntary</u> control.

_____ 6. The cells in cardiac muscle are connected to each other by <u>gap</u> junctions that allow electrical impulses to pass from cell to cell.

7. Complete the table that compares and contrasts the three types of muscle tissue.

Types of Muscle Tissue

Type of Muscle	Striated/Not Striated	Type of Control
	Striated	
		Involuntary
Cardiac		

Muscle Contraction

For Questions 8–13, complete each statement by writing the correct word or words.

8. Muscle fibers are filled with _____, which are bundles of tightly packed protein filaments.

9. The thick protein filaments in muscle fibers are called _____, and the thin protein filaments are called _____.

10. The thick filaments in muscle fibers form _____, which cause the filaments to slide past each other.

11. The energy used in muscle contraction is supplied by _____.

12. Impulses passed from motor neurons release _____ ions within the muscle fibers.

13. The difference between a strong muscle contraction and a weak muscle contraction is the _____ muscle fibers that contract.

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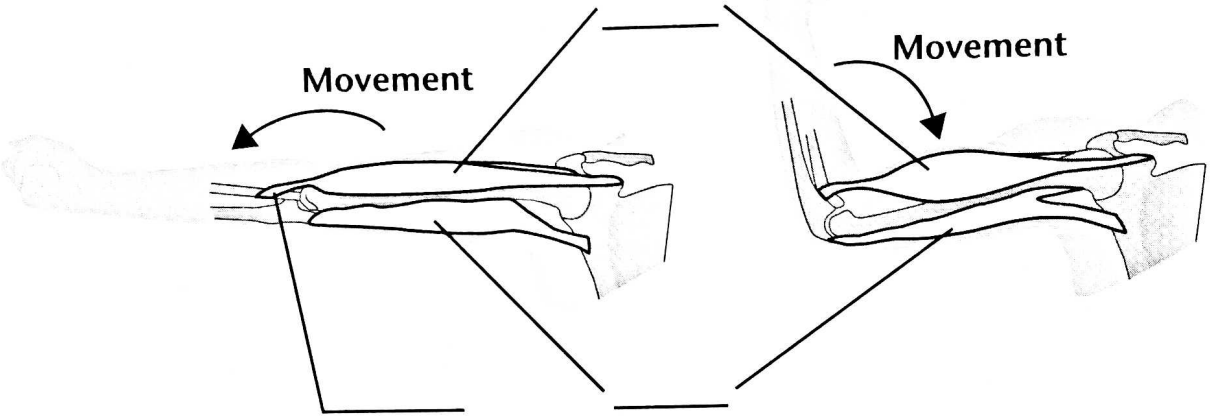
Muscles and Movement

14. THINK VISUALLY Complete the illustration showing how the muscles of the upper arm produce movements of the forearm by adding labels for the structures indicated. Then, on the lines below the illustration, explain how the muscles cause the elbow to bend and straighten.



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_____

For Questions 15–19, complete each statement by writing the correct word or words.

15. While producing movements, muscles supply the force, bones act as _____, and a joint acts as a(n) _____.

16. Skeletal muscles work in _____ pairs.

17. Red muscle fibers contain _____, which stores oxygen.

18. White muscle is also called _____ muscle.

19. Many mitochondria are found in the cells of _____ muscle, which uses oxygen for aerobic respiration.

Apply the Big Idea

20. When viewed under a microscope, a sample of tissue reveals striations and long, thin fibers that contain many nuclei and mitochondria. What type of tissue is most likely being viewed? Explain your answer.

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32.3 Skin—The Integumentary System

Lesson Objectives

- State the functions of the integumentary system.
- Identify the structures of the integumentary system.
- Describe some of the problems that affect the skin.

Lesson Summary

Integumentary System Functions The skin, hair, and nails make up the integumentary system, which functions to protect internal organs, regulate body temperature, excrete wastes, gather information about the environment, and produce vitamin D.

Integumentary System Structures The system consists of skin and its related structures—hair, nails, and several types of glands. Skin consists of two main layers.

- The outer layer of the skin is the **epidermis**, which has an upper layer of dead cells and an inner layer of rapidly dividing living cells. Living epidermal cells make **keratin**, the tough fibrous protein that fills dead skin cells. The epidermis also contains cells called **melanocytes**, which make melanin. **Melanin** is the brown pigment that gives skin its color and protects the skin from ultraviolet radiation.
- The **dermis** is the thick inner layer of skin that contains structures that interact with other body systems to maintain homeostasis by regulating body temperature. **Sebaceous glands** in the dermis secrete sebum, an oily acidic substance that keeps the epidermis flexible and waterproof and kills bacteria.
- Hairs are large columns of cells that have filled with keratin and died. They are produced in **hair follicles**, pockets in the epidermis that extend into the dermis.
- Nails grow from rapidly dividing cells at the tips of fingers and toes. The cells fill with keratin and produce the tough, platelike nails.

Skin Problems Many external and internal factors affect the health of the skin.

- Acne is a condition that develops when sebum and dead skin cells plug hair follicles.
- Hives are red welts that result from allergies to food or medicines.
- Skin cancer, the abnormal growth of skin cells, results from excessive exposure to ultraviolet radiation in sunlight and in the lights of tanning beds.

Integumentary System Functions

For Questions 1–5, write True or False on the line provided.

_____ 1. Protection from pathogens, water loss, and ultraviolet radiation are functions of the dermis.

_____ 2. The skin releases excess heat but holds in some body heat.

_____ 3. Sweat contains salts and urea excreted by the skin.

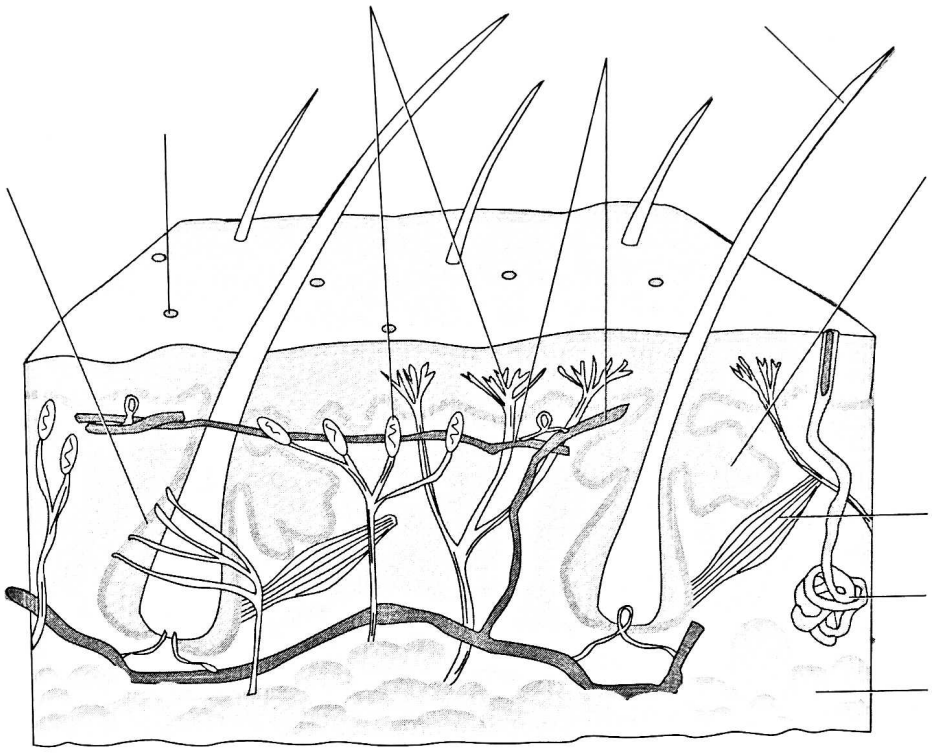
_____ 4. The skin has sensory receptors for both pressure and pain.

_____ 5. The skin needs sunlight to produce vitamin B.

Name _____

Integumentary System Structures

6. THINK VISUALLY Label the structures of the skin.



For Questions 7–14, complete each statement by writing the correct word or words.

7. The outer layer of the skin is called the _____.
8. The inner layer of the epidermis includes _____ cells that divide rapidly, producing new skin cells that push old ones to the surface.
9. Epidermal cells, called _____, produce the brown pigment _____.
10. The brown pigment in skin protects it by absorbing _____.
11. The lower layer of skin that contains many specialized structures is the _____.
12. Structures that help maintain homeostasis by excreting salts and urea from the skin are called _____.
13. The _____ produce a fluid that kills bacteria.
14. Both hair and _____ contain _____, the same tough, fibrous protein made by skin cells.
15. How does the dermis help regulate body temperature?

_____

_____

_____

16. How does sweat help keep you cool?

_____

17. What is the function of sebum?

18. How does the hair in the nose and ears and around the eyes help protect the body?

19. What causes hair to grow?

20. What is a nail root?

Skin Problems

21. Complete the table that summarizes types of skin problems and their causes.

Types of Skin Problems		
Skin Problem	**Description**	**Cause**
	Bumps that become red, may contain pus, and may leave scars	
Hives		
Skin cancer		

Apply the Big Idea

22. Why is a third-degree burn, which damages both the epidermis and the dermis of the skin, a very serious injury?

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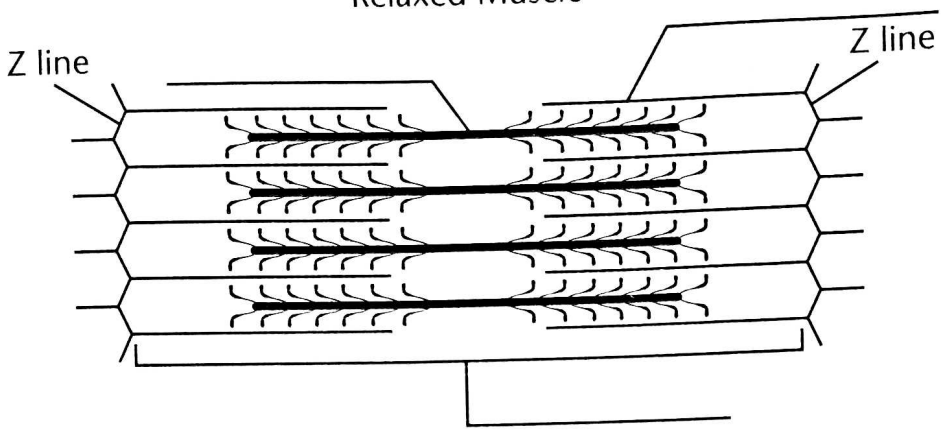
Chapter Vocabulary Review

1. The diagram below shows muscle filaments in a relaxed muscle. Label the myosin, actin, and sarcomere. Then on the lines below, describe how the position of the actin filaments changes during muscle contraction.

Relaxed Muscle



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For Questions 2–9, match the cell or tissue named with its description.

Cell/Tissue	Description
_____ **2.** Dermis	**A.** Attaches two bones at a joint
_____ **3.** Epidermis	**B.** Attaches muscles to bones
_____ **4.** Ligament	**C.** Bone cell that breaks down minerals in bone
_____ **5.** Melanocyte	**D.** Inner layer of the skin
_____ **6.** Osteoblast	**E.** Mature bone cell that maintains bone
_____ **7.** Osteoclast	**F.** Outer layer of the skin
_____ **8.** Osteocyte	**G.** Skin cell that produces a brown pigment
_____ **9.** Tendon	**H.** Bone cell that builds bone

For Questions 10–15, complete each statement by writing the correct word or words.

10. A(n) _____ is a section of a myofibril that includes two Z lines and the filaments between them.

11. A substance that waterproofs the skin and kills bacteria on it is produced by the _____.

12. A(n) _____ is a bundle of actin and _____ filaments.

13. Hair and nails are both made of the protein _____.

14. The neurotransmitter _____ is released at neuromuscular junctions of motor neurons and muscle fibers.

15. Nerves and blood vessels in compact bone run through structures called _____.

