



# The Skeletal System

The skeleton is constructed of two of the most supportive tissues found in the human body—cartilage and bone. Besides supporting and protecting the body as an internal framework, the skeleton provides a system of levers that the skeletal muscles use to move the body. In addition, the bones provide a storage depot for substances such as lipids and calcium, and blood cell formation goes on within their red marrow cavities.

The skeleton consists of bones connected at joints, or articulations, and is subdivided into two divisions. The axial skeleton includes those bones that lie around the body's center of gravity. The appendicular skeleton includes the bones of the limbs.

Topics for student review include structure and function of long bones, location and naming of specific bones in the skeleton, fracture types, and a classification of joint types in the body.

## BONES—AN OVERVIEW

- Classify each of the following terms as a projection (*P*) or a depression or opening (*D*). Enter the appropriate letter in the answer blanks.

- |                |                |                   |
|----------------|----------------|-------------------|
| ___ 1. Condyle | ___ 4. Foramen | ___ 7. Ramus      |
| ___ 2. Crest   | ___ 5. Head    | ___ 8. Spine      |
| ___ 3. Fissure | ___ 6. Meatus  | ___ 9. Tuberosity |

- Group each of the following bones into one of the four major bone categories. Use *L* for long bone, *S* for short bone, *F* for flat bone, and *I* for irregular bone. Enter the appropriate letter in the space provided.

- |                  |                   |                 |
|------------------|-------------------|-----------------|
| ___ 1. Calcaneus | ___ 4. Humerus    | ___ 7. Radius   |
| ___ 2. Frontal   | ___ 5. Mandible   | ___ 8. Sternum  |
| ___ 3. Femur     | ___ 6. Metacarpal | ___ 9. Vertebra |

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3. Using the key choices, characterize the following statements relating to long bones. Enter the appropriate term(s) or letter(s) in the answer blanks.

**Key Choices**

- |                     |               |                         |
|---------------------|---------------|-------------------------|
| A. Diaphysis        | C. Epiphysis  | E. Yellow marrow cavity |
| B. Epiphyseal plate | D. Red marrow |                         |

- \_\_\_\_\_ 1. Site of spongy bone in the adult
- \_\_\_\_\_ 2. Site of compact bone in the adult
- \_\_\_\_\_ 3. Site of hematopoiesis in the adult
- \_\_\_\_\_ 4. Scientific name for bone shaft
- \_\_\_\_\_ 5. Site of fat storage in the adult
- \_\_\_\_\_ 6. Site of longitudinal growth in a child

4. Complete the following statements concerning bone formation and destruction, using the terms provided in the key. Insert the key letter or corresponding term in the answer blanks.

**Key Choices**

- |               |                |                |                          |
|---------------|----------------|----------------|--------------------------|
| A. Atrophy    | C. Gravity     | E. Osteoclasts | G. Parathyroid hormone   |
| B. Calcitonin | D. Osteoblasts | F. Osteocytes  | H. Stress and/or tension |

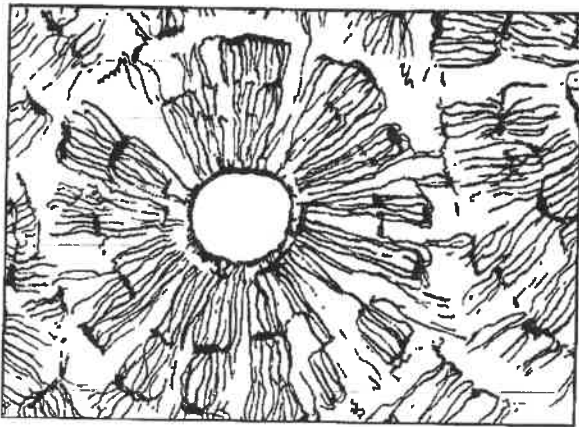
- \_\_\_\_\_ 1. When blood calcium levels begin to drop below homeostatic levels, (1) is released, causing calcium to be released from bones.
- \_\_\_\_\_ 2. Mature bone cells, called (2), maintain bone in a viable state.
- \_\_\_\_\_ 3. Disuse such as that caused by paralysis or severe lack of exercise results in muscle and bone (3).
- \_\_\_\_\_ 4. Large tubercles and/or increased deposit of bony matrix occur at sites of (4).
- \_\_\_\_\_ 5. Immature, or matrix-depositing, bone cells are referred to as (5).
- \_\_\_\_\_ 6. (6) causes blood calcium to be deposited in bones as calcium salts.
- \_\_\_\_\_ 7. Bone cells that liquefy bone matrix and release calcium to the blood are called (7).
- \_\_\_\_\_ 8. Our astronauts must do isometric exercises when in space because bones atrophy under conditions of weightlessness or lack of (8).

5. Five descriptions of bone structure are provided in Column A. First identify the structure by choosing the appropriate term from Column B and placing the corresponding answer in the answer blank. Then consider Figure 5-1A, a diagrammatic view of a cross section of bone, and 5-1B, a higher magnified view of compact bone tissue. Select different colors for the structures and bone areas in Column B, and use them to color the coding circles and corresponding structures on the figure diagrams. Since the concentric lamellae would be difficult to color without confusing other elements, identify one lamella by using a bracket and label.

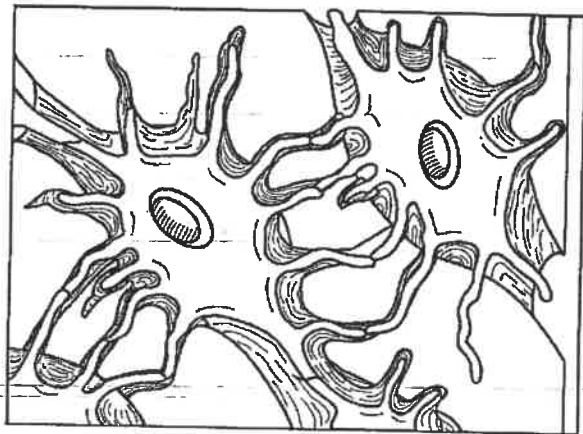
## Column A

## Column B

- |  |  |
|--|--|
| _____ 1. Layers of calcified matrix                            | A. Central (Haversian) canal <input type="radio"/> |
| _____ 2. "Residences" of osteocytes                            | B. Concentric lamellae                             |
| _____ 3. Longitudinal canal, carrying blood vessels and nerves | C. Lacunae <input type="radio"/>                   |
| _____ 4. Nonliving, structural part of bone                    | D. Canaliculi <input type="radio"/>                |
| _____ 5. Tiny canals, connecting lacunae                       | E. Bone matrix <input type="radio"/>               |
|  | F. Osteocyte <input type="radio"/>                 |



A



B

Figure 5-1

6. Circle the term that does not belong in each of the following groupings.

- |                      |                     |               |                   |
|----------------------|---------------------|---------------|-------------------|
| 1. Hematopoiesis     | Red marrow          | Yellow marrow | Spongy bone       |
| 2. Lamellae          | Canaliculi          | Circulation   | Osteoblasts       |
| 3. Osteon            | Marrow cavity       | Central canal | Canaliculi        |
| 4. Epiphysis surface | Articular cartilage | Periosteum    | Hyaline cartilage |

7. Figure 5-2A is a midlevel, cross-sectional view of the diaphysis of the femur. Label the membrane that lines the cavity and the membrane that covers the outside surface.

Figure 5-2B is a drawing of a longitudinal section of the femur. Color the bone tissue gold. Do *not* color the articular cartilage; leave it white. Select different colors for the bone regions listed at the coding circles below. Color the coding circles and the corresponding regions on the drawing. Complete Figure 5-2B by labeling compact bone and spongy bone.

- ☐ Diaphysis ☐ Area where red marrow is found  
☐ Epiphyseal plate ☐ Area where yellow marrow is found

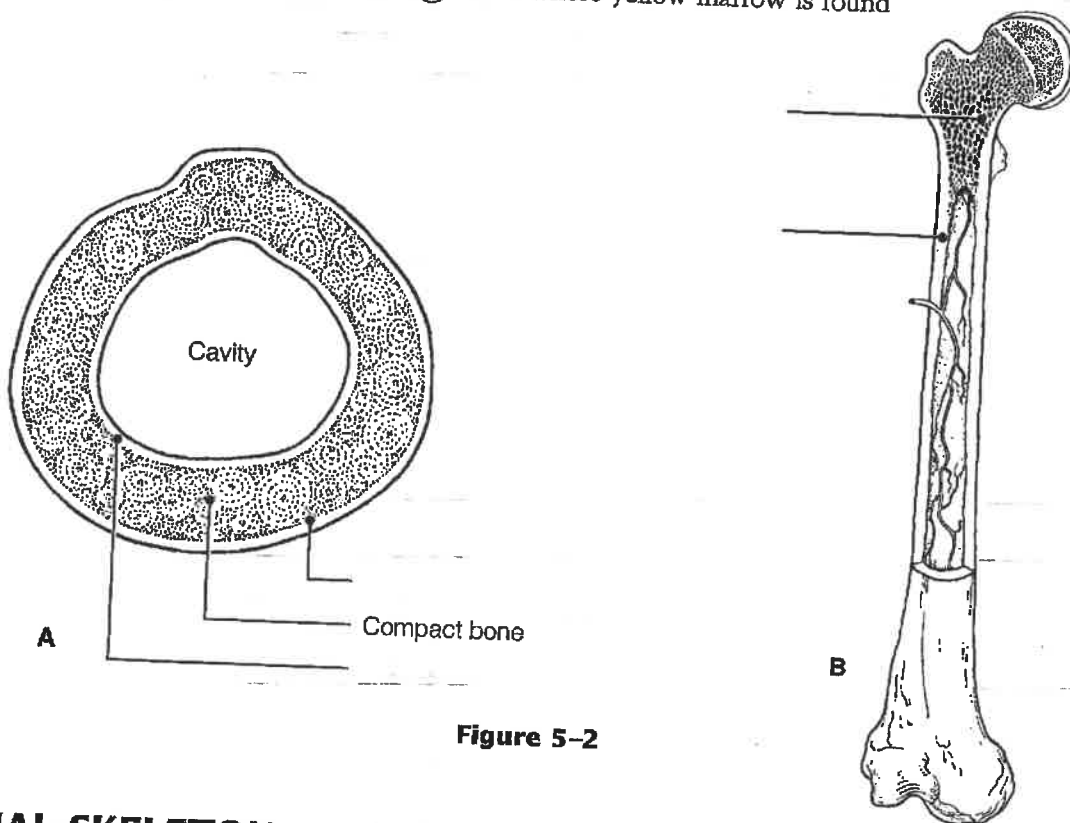


Figure 5-2

## AXIAL SKELETON

### Skull

8. Using key choices, identify the bones indicated by the following descriptions. Enter the appropriate term or letter in the answer blanks.

#### Key Choices

- |              |              |              |              |
|--------------|--------------|--------------|--------------|
| A. Ethmoid   | E. Mandible  | I. Palatines | L. Temporals |
| B. Frontal   | F. Maxillae  | J. Parietals | M. Vomer     |
| C. Hyoid     | G. Nasals    | K. Sphenoid  | N. Zygomatic |
| D. Lacrimals | H. Occipital |              |              |

1. Forehead bone
2. Cheekbone
3. Lower jaw
4. Bridge of nose
5. Posterior part of hard palate
6. Much of the lateral and superior cranium
7. Most posterior part of cranium
8. Single, irregular, bat-shaped bone, forming part of the cranial floor
9. Tiny bones, bearing tear ducts
10. Anterior part of hard palate
11. Superior and middle nasal conchae formed from its projections
12. Site of mastoid process
13. Site of sella turcica
14. Site of cribriform plate
15. Site of mental foramen
16. Site of styloid process
17. \_\_\_\_\_
18. Four bones, containing paranasal sinuses
19. \_\_\_\_\_
20. \_\_\_\_\_
21. Its condyles articulate with the atlas
22. Foramen magnum contained here
23. Middle ear found here
24. Nasal septum
25. Bears an upward protrusion, the "cock's comb," or crista galli
26. Site of external acoustic meatus

9. Figure 5-3, A-C shows lateral, anterior, and inferior views of the skull. Select different colors for the bones listed below and color the coding circles and corresponding bones in the figure. Complete the figure by labeling the bone markings indicated by leader lines.

- |                                |                                |                                 |                                |
|--------------------------------|--------------------------------|---------------------------------|--------------------------------|
| <input type="radio"/> Frontal  | <input type="radio"/> Sphenoid | <input type="radio"/> Zygomatic | <input type="radio"/> Nasal    |
| <input type="radio"/> Parietal | <input type="radio"/> Ethmoid  | <input type="radio"/> Palatine  | <input type="radio"/> Lacrimal |
| <input type="radio"/> Mandible | <input type="radio"/> Temporal | <input type="radio"/> Occipital | <input type="radio"/> Vomer    |
| <input type="radio"/> Maxilla  |                                |                                 |                                |

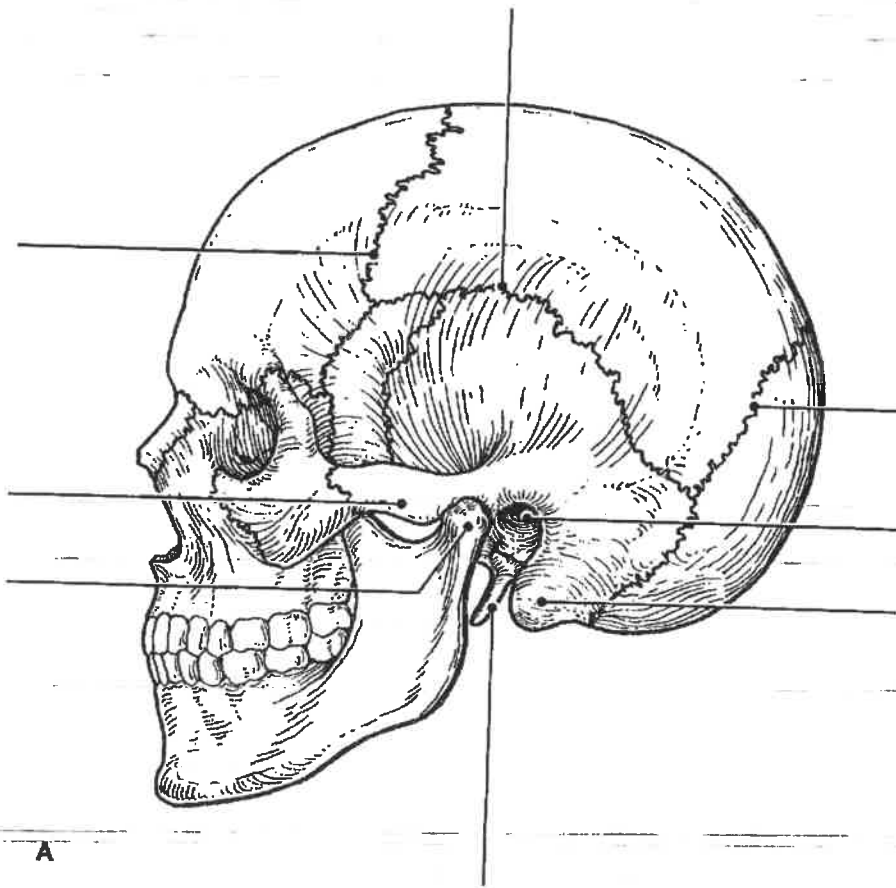
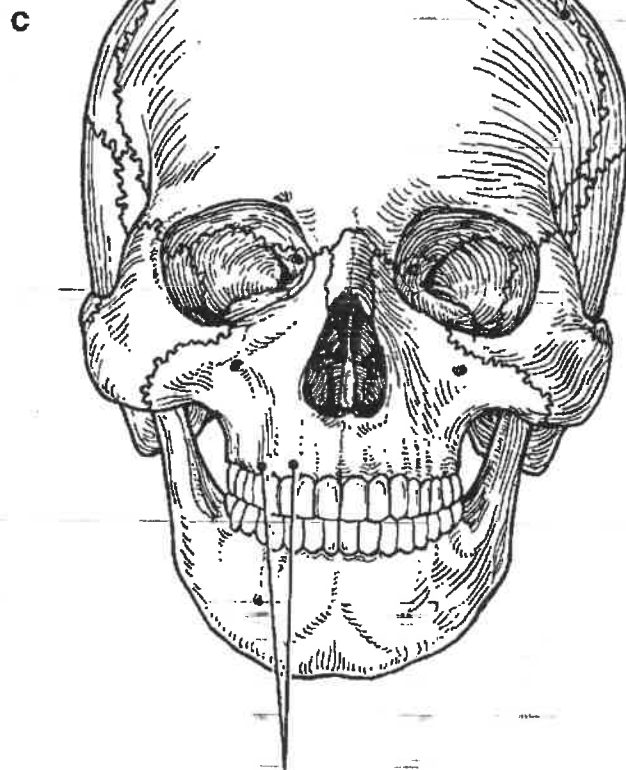
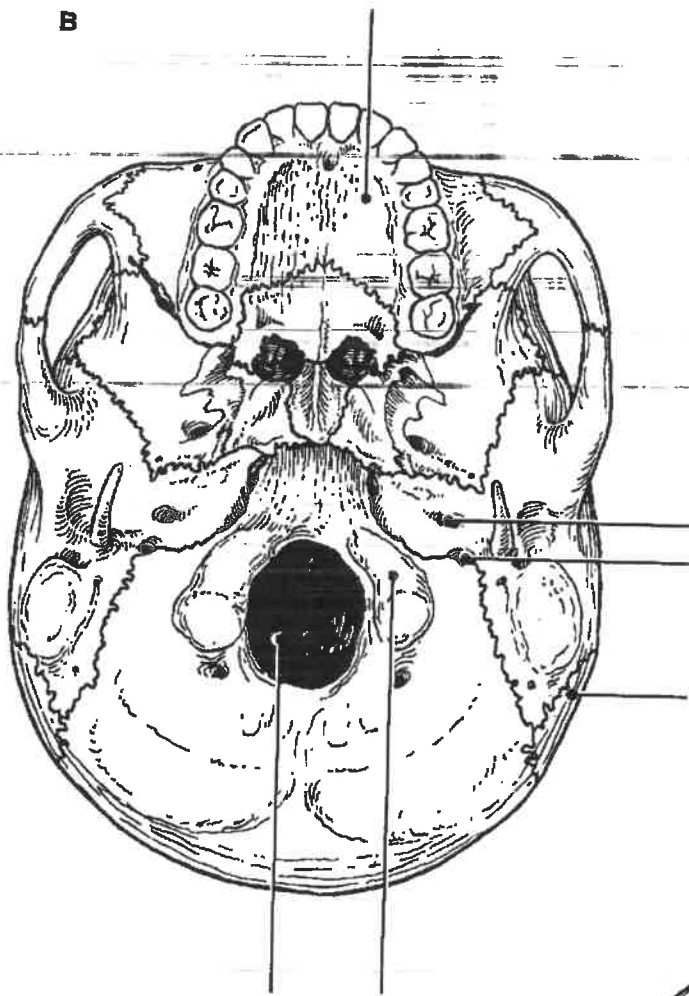


Figure 5-3, A-C



10. An anterior view of the skull, showing the positions of the sinuses, is provided in Figure 5-4. First select different colors for each of the sinuses and use them to color the coding circles and the corresponding structures on the figure. Then briefly answer the following questions concerning the sinuses.

1. What are sinuses?

2. What purpose do they serve in the skull?

3. Why are they so susceptible to infection?

☐ Sphenoid sinus

☐ Ethmoid sinuses

☐ Frontal sinus

☐ Maxillary sinus

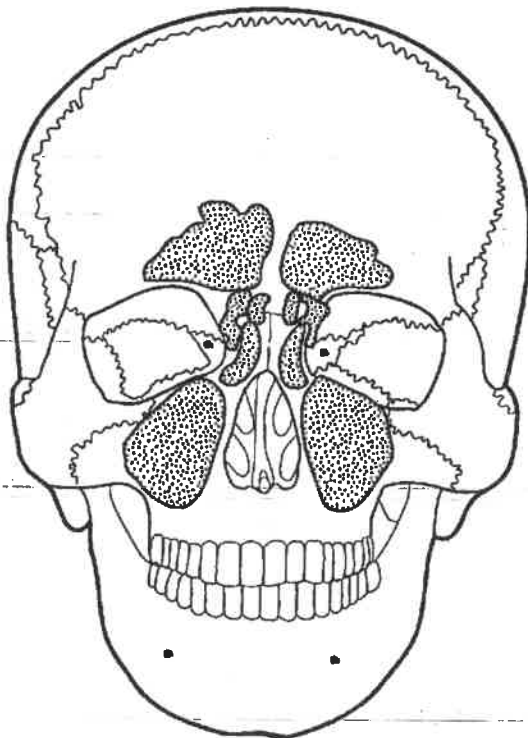


Figure 5-4

## Vertebral Column

11. Using the key choices, correctly identify the vertebral parts/areas described as follows. Enter the appropriate term(s) or letter(s) in the spaces provided.

### Key Choices

- |                            |                               |                       |
|----------------------------|-------------------------------|-----------------------|
| A. Body                    | C. Spinous process            | E. Transverse process |
| B. Intervertebral foramina | D. Superior articular process | F. Vertebral arch     |

- \_\_\_\_\_ 1. Structure that encloses the nerve cord
- \_\_\_\_\_ 2. Weight-bearing portion of the vertebra
- \_\_\_\_\_ 3. Provide(s) levers for the muscles to pull against
- \_\_\_\_\_ 4. Provide(s) an articulation point for the ribs
- \_\_\_\_\_ 5. Openings providing for exit of spinal nerves

12. The following statements provide distinguishing characteristics of the vertebrae composing the vertebral column. Using key choices, identify each described structure or region by inserting the appropriate term(s) or letter(s) in the spaces provided.

### Key Choices

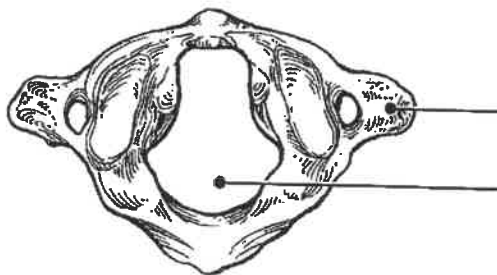
- |                              |                    |                      |
|------------------------------|--------------------|----------------------|
| A. Atlas                     | D. Coccyx          | F. Sacrum            |
| B. Axis                      | E. Lumbar vertebra | G. Thoracic vertebra |
| C. Cervical vertebra—typical |                    |                      |

- \_\_\_\_\_ 1. Type of vertebra(e) containing foramina in the transverse processes, through which the vertebral arteries ascend to reach the brain
- \_\_\_\_\_ 2. Its dens provides a pivot for rotation of the first cervical vertebra
- \_\_\_\_\_ 3. Transverse processes have facets for articulation with ribs; spinous process points sharply downward
- \_\_\_\_\_ 4. Composite bone; articulates with the hip bone laterally
- \_\_\_\_\_ 5. Massive vertebrae; weight-sustaining
- \_\_\_\_\_ 6. Tailbone; vestigial fused vertebrae
- \_\_\_\_\_ 7. Supports the head; allows the rocking motion of the occipital condyles
- \_\_\_\_\_ 8. Seven components; unfused
- \_\_\_\_\_ 9. Twelve components; unfused

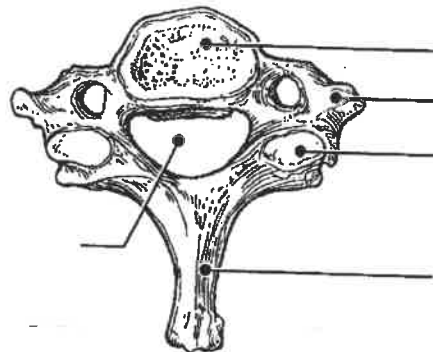
13. Complete the following statements by inserting your answers in the answer blanks.

1. In describing abnormal curvatures, it could be said that (1) is an exaggerated thoracic curvature, and in (2) the vertebral column is displaced laterally.
- 2.
3. Intervertebral discs are made of (3) tissue. The discs provide (4) to the spinal column.
- 4.

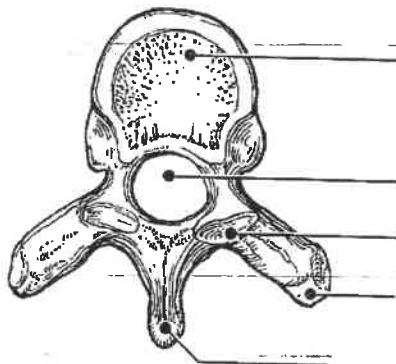
14. Figure 5-5, A-D shows superior views of four types of vertebrae. In the spaces provided below each vertebra, indicate in which region of the spinal column it would be found. In addition, specifically identify Figure 5-5A. Where indicated by leader lines, identify the vertebral body, spinous and transverse processes, superior articular processes, and vertebral foramen.



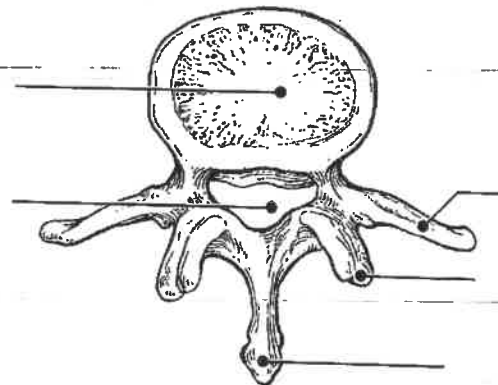
A \_\_\_\_\_



B \_\_\_\_\_



C \_\_\_\_\_



D \_\_\_\_\_

Figure 5-5

15. Figure 5-6 is a lateral view of the vertebral column. Identify each numbered region of the column by listing in the numbered answer blanks the region name first and then the specific vertebrae involved (for example, sacral region, S# to S#). Also identify the modified vertebrae indicated by numbers 6 and 7 in Figure 5-6. Select different colors for each vertebral region and use them to color the coding circles and the corresponding regions.

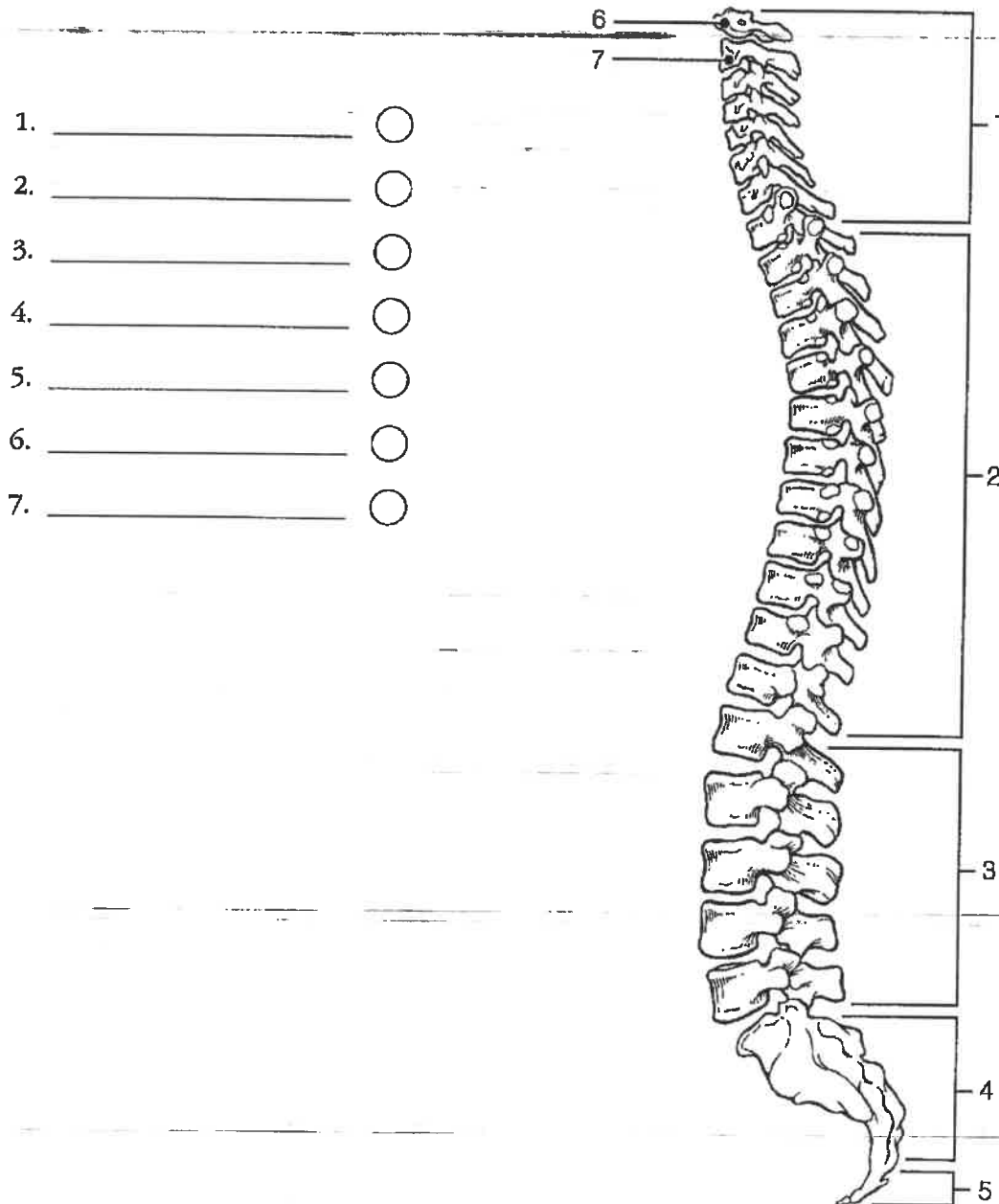


Figure 5-6

## Bony Thorax

16. Complete the following statements referring to the bony thorax by inserting your responses in the answer blanks.

1. The organs protected by the thoracic cage include the (1) \_\_\_\_\_ and the (2) \_\_\_\_\_. Ribs 1 through 7 are called (3) \_\_\_\_\_ ribs,
2. whereas ribs 8 through 12 are called (4) \_\_\_\_\_ ribs. Ribs 11 and 12 are also called (5) \_\_\_\_\_ ribs. All ribs articulate posteriorly
3. with the (6) \_\_\_\_\_, and most connect anteriorly to the (7) \_\_\_\_\_, either directly or indirectly.

4. \_\_\_\_\_

5. The general shape of the thoracic cage is (8) \_\_\_\_\_.

6. \_\_\_\_\_

7. \_\_\_\_\_

8. \_\_\_\_\_

17. Figure 5-7 is an anterior view of the bony thorax. Select different colors to identify the structures below and color the coding circles and corresponding structures. Then label the subdivisions of the sternum indicated by leader lines.

- |   |                                      |
|---|--------------------------------------|
| <input type="radio"/> All true ribs     | <input type="radio"/> All false ribs |
| <input type="radio"/> Costal cartilages | <input type="radio"/> Sternum        |

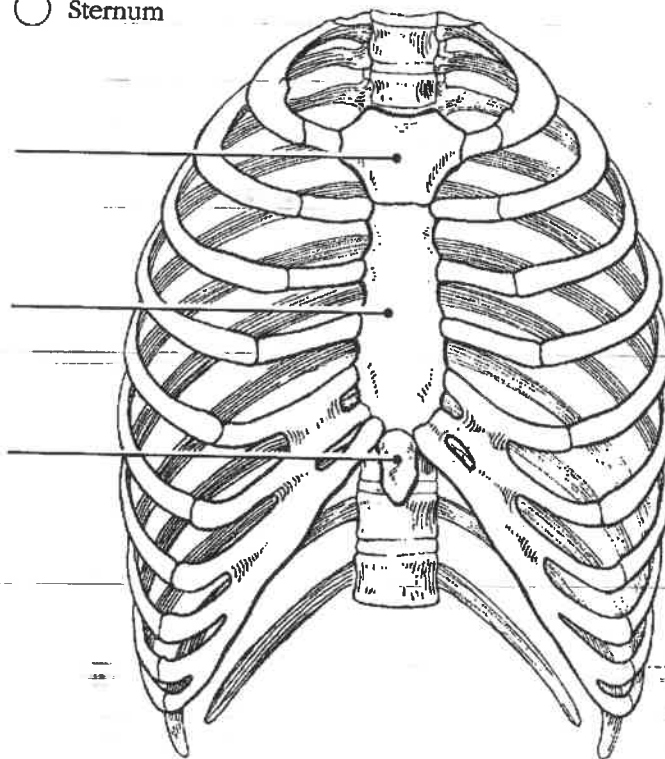


Figure 5-7

## APPENDICULAR SKELETON

Several bones forming part of the upper limb and/or shoulder girdle are shown in Figures 5-8 to 5-11. Follow the specific directions for each figure.

18. Identify the bone in Figure 5-8. Insert your answer in the blank below the illustration. Select different colors for each structure listed below and use them to color the coding circles and the corresponding structures in the diagram. Then, label the angles indicated by leader lines.

○ Spine    ○ Glenoid cavity    ○ Coracoid process    ○ Acromion

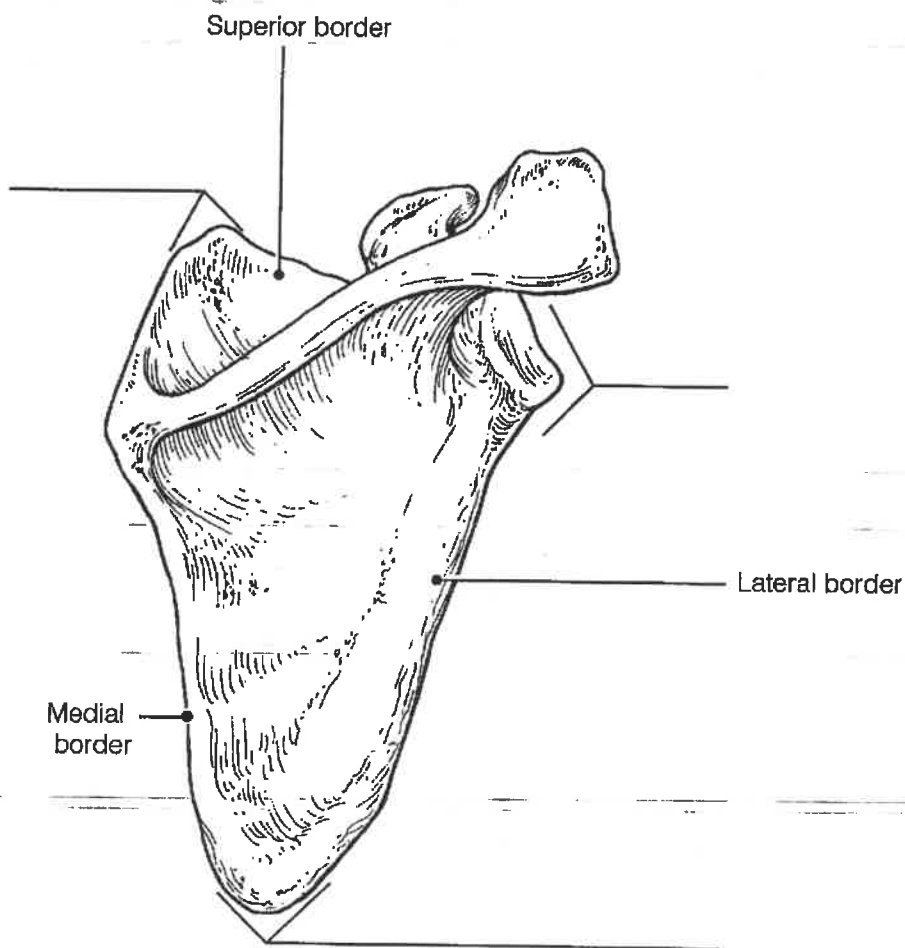


Figure 5-8

**19.** Identify the bones in Figure 5-9 by labeling the leader lines identified as A, B, and C. Color the bones different colors. Using the following terms, complete the illustration by labeling all bone markings provided with leader lines.

Trochlear notch

Capitulum

Coronoid process

Trochlea

Deltoid tuberosity

Olecranon process

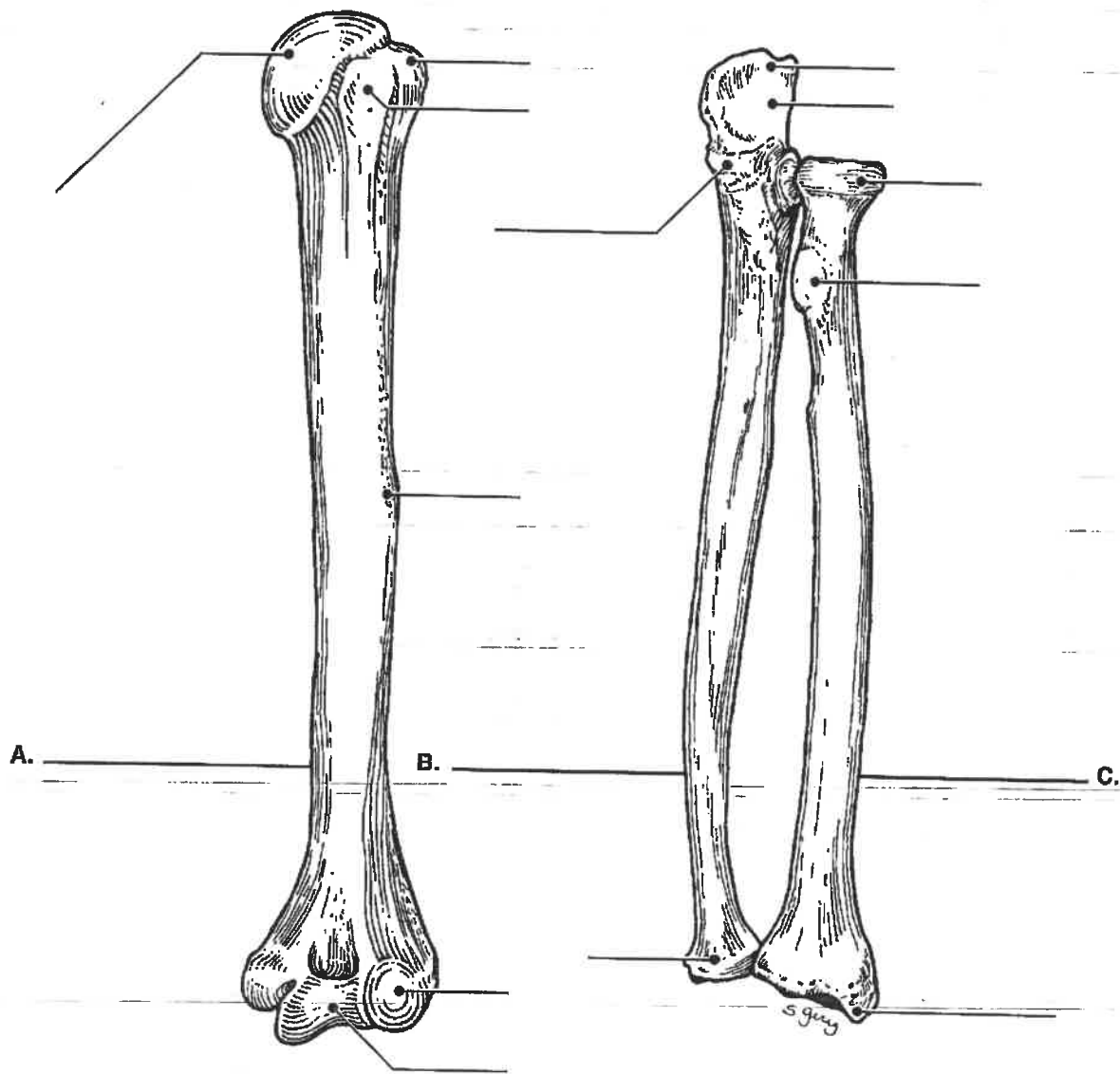
Radial tuberosity

Head (three)

Greater tubercle

Styloid process

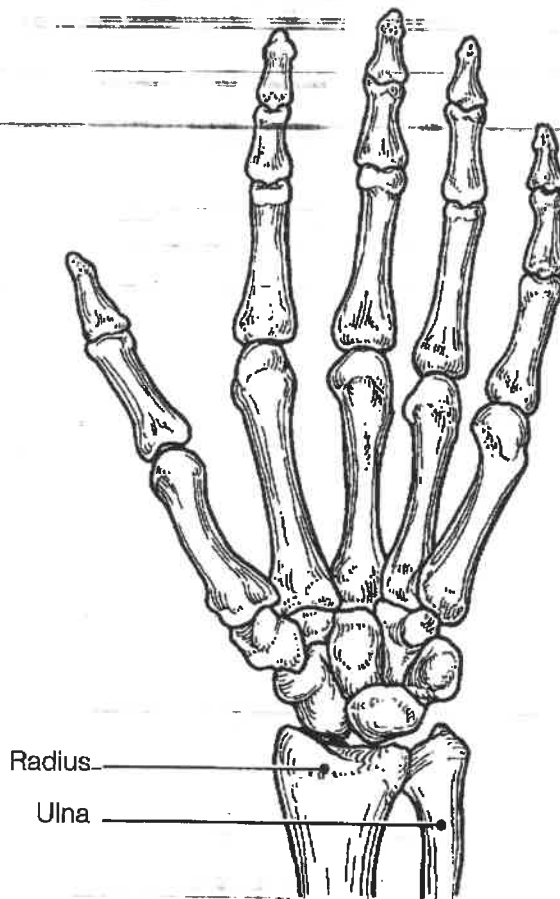
Lesser tubercle



**Figure 5-9**

20. Figure 5-10 is a diagram of the hand. Select different colors for the following structures, and use them to color the coding circles and the corresponding structures in the diagram.

○ Carpals      ○ Metacarpals      ○ Phalanges



**Figure 5-10**

21. Compare the pectoral and pelvic girdles by choosing descriptive terms from the key choices. Insert the appropriate key letters in the answer blanks.

**Key Choices**

- |                |  |
|----------------|--|
| A. Flexibility | D. Shallow socket for limb attachment      |
| B. Massive     | E. Deep, secure socket for limb attachment |
| C. Lightweight | F. Weight-bearing                          |

Pectoral: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ Pelvic: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

22. Using key choices, identify the bone names or markings according to the descriptions that follow. Insert the appropriate term or letter in the answer blanks.

**Key Choices**

A. Acromion	F. Coronoid fossa	K. Olecranon fossa	P. Scapula
B. Capitulum	G. Deltoid tuberosity	L. Olecranon process	Q. Sternum
C. Carpals	H. Glenoid cavity	M. Phalanges	R. Styloid process
D. Clavicle	I. Humerus	N. Radial tuberosity	S. Trochlea
E. Coracoid process	J. Metacarpals	O. Radius	T. Ulna

- \_\_\_\_\_ 1. Raised area on lateral surface of humerus to which deltoid muscle attaches
- \_\_\_\_\_ 2. Arm bone
- \_\_\_\_\_ 3. \_\_\_\_\_ 4. Bones composing the shoulder girdle
- \_\_\_\_\_ 5. \_\_\_\_\_ 6. Forearm bones
- \_\_\_\_\_ 7. Point where scapula and clavicle connect
- \_\_\_\_\_ 8. Shoulder girdle bone that has no attachment to the axial skeleton
- \_\_\_\_\_ 9. Shoulder girdle bone that articulates anteriorly with the sternum
- \_\_\_\_\_ 10. Socket in the scapula for the arm bone
- \_\_\_\_\_ 11. Process above the glenoid cavity that permits muscle attachment
- \_\_\_\_\_ 12. Commonly called the collarbone
- \_\_\_\_\_ 13. Distal medial process of the humerus; joins the ulna
- \_\_\_\_\_ 14. Medial bone of the forearm in anatomical position
- \_\_\_\_\_ 15. Rounded knob on the humerus that articulates with the radius
- \_\_\_\_\_ 16. Anterior depression; superior to the trochlea; receives part of the ulna when the forearm is flexed
- \_\_\_\_\_ 17. Forearm bone involved in formation of elbow joint
- \_\_\_\_\_ 18. \_\_\_\_\_ 19. Bones that articulate with the clavicle
- \_\_\_\_\_ 20. Bones of the wrist
- \_\_\_\_\_ 21. Bones of the fingers
- \_\_\_\_\_ 22. Heads of these bones form the knuckles

23. Figure 5-11 is a diagram of the articulated pelvis. Identify the bones and bone markings indicated by leader lines on the figure. Select different colors for the structures listed below and use them to color the coding circles and the corresponding structures in the figure. Also, label the dashed line showing the dimensions of the true pelvis and that showing the diameter of the false pelvis. Complete the illustration by labeling the following bone markings: obturator foramen, iliac crest, anterior superior iliac spine, ischial spine, pubic ramus, and pelvic brim. Last, list three ways in which the female pelvis differs from the male pelvis and insert your answers in the answer blanks.

- ☐ Coxal bone      ☐ Pubic symphysis  
☐ Sacrum      ☐ Acetabulum

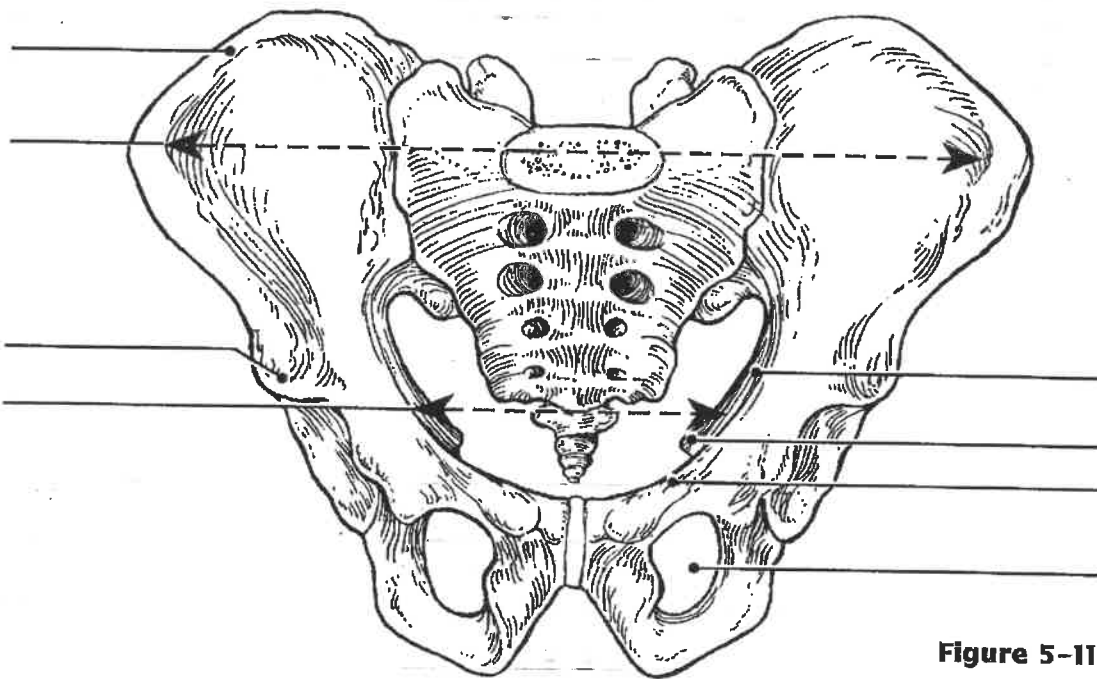


Figure 5-11

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

24. Circle the term that does not belong in each of the following groupings.

- |              |              |                  |                |
|--------------|--------------|------------------|----------------|
| 1. Tibia     | Ulna         | Fibula           | Femur          |
| 2. Skull     | Rib cage     | Vertebral column | Pelvis         |
| 3. Ischium   | Scapula      | Ilium            | Pubis          |
| 4. Mandible  | Frontal bone | Temporal bone    | Occipital bone |
| 5. Calcaneus | Tarsals      | Carpals          | Talus          |

25. Using key choices, identify the bone names and markings, according to the descriptions that follow. Insert the appropriate key term(s) or letter(s) in the answer blanks.

**Key Choices**

A. Acetabulum	I. Ilium	O. Patella
B. Calcaneus	J. Ischial tuberosity	R. Pubic symphysis
C. Femur	K. Ischium	S. Pubis
D. Fibula	L. Lateral malleolus	T. Sacroiliac joint
E. Gluteal tuberosity	M. Lesser sciatic notch	U. Talus
F. Greater sciatic notch	N. Medial malleolus	V. Tarsals
G. Greater and lesser trochanters	O. Metatarsals	W. Tibia
H. Iliac crest	P. Obturator foramen	X. Tibial tuberosity

- \_\_\_\_\_ 1. Fuse to form the coxal bone (hip bone)
- \_\_\_\_\_ 2. Receives the weight of the body when sitting
- \_\_\_\_\_ 3. Point where the coxal bones join anteriorly
- \_\_\_\_\_ 4. Upper margin of iliac bones
- \_\_\_\_\_ 5. Deep socket in the hip bone that receives the head of the thigh bone
- \_\_\_\_\_ 6. Point where axial skeleton attaches to the pelvic girdle
- \_\_\_\_\_ 7. Longest bone in body, articulates with the coxal bone
- \_\_\_\_\_ 8. Lateral bone of the leg
- \_\_\_\_\_ 9. Medial bone of the leg
- \_\_\_\_\_ 10. Bones forming the knee joint
- \_\_\_\_\_ 11. Point where the patellar ligament attaches
- \_\_\_\_\_ 12. Kneecap
- \_\_\_\_\_ 13. Shinbone
- \_\_\_\_\_ 14. Distal process on medial tibial surface
- \_\_\_\_\_ 15. Process forming the outer ankle
- \_\_\_\_\_ 16. Heel bone

- \_\_\_\_\_ 17. Bones of the ankle
- \_\_\_\_\_ 18. Bones forming the instep of the foot
- \_\_\_\_\_ 19. Opening in a coxal bone formed by the pubic and ischial rami
- \_\_\_\_\_ 20. Sites of muscle attachment on the proximal end of the femur
- \_\_\_\_\_ 21. Tarsal bone that articulates with the tibia
26. For each of the following statements that is true, insert T in the answer blank. If any of the statements are false, correct the underlined term by inserting the correct term in the answer blank.

- \_\_\_\_\_ 1. The pectoral girdle is formed by the articulation of the hip bones and the sacrum.
- \_\_\_\_\_ 2. Bones present in both the hand and the foot are carpals.
- \_\_\_\_\_ 3. The tough, fibrous connective tissue covering of a bone is the periosteum.
- \_\_\_\_\_ 4. The point of fusion of the three bones forming a coxal bone is the glenoid cavity.
- \_\_\_\_\_ 5. The large nerve that must be avoided when giving injections into the buttock muscles is the femoral nerve.
- \_\_\_\_\_ 6. The long bones of a fetus are constructed of hyaline cartilage.
- \_\_\_\_\_ 7. Bones that provide the most protection to the abdominal viscera are the ribs.
- \_\_\_\_\_ 8. The largest foramen in the skull is the foramen magnum.
- \_\_\_\_\_ 9. The intercondylar fossa, greater trochanter, and tibial tuberosity are all bone markings of the humerus.
- \_\_\_\_\_ 10. The first major event of fracture healing is hematoma formation.

27. The bones of the thigh and the leg are shown in Figure 5-12. Identify each and put your answers in the blanks labelled A, B, and C. Select different colors for the lower limb bones listed below and use them to color in the coding circles and corresponding bones on the diagram. Complete the illustration by inserting the terms indicating bone markings at the ends of the appropriate leader lines in the figure.

☐ Femur

☐ Tibia

☐ Fibula

Head of femur

Anterior border of tibia

Head of fibula

Intercondylar eminence

Lesser trochanter

Medial malleolus

Tibial tuberosity

Greater trochanter

Lateral malleolus

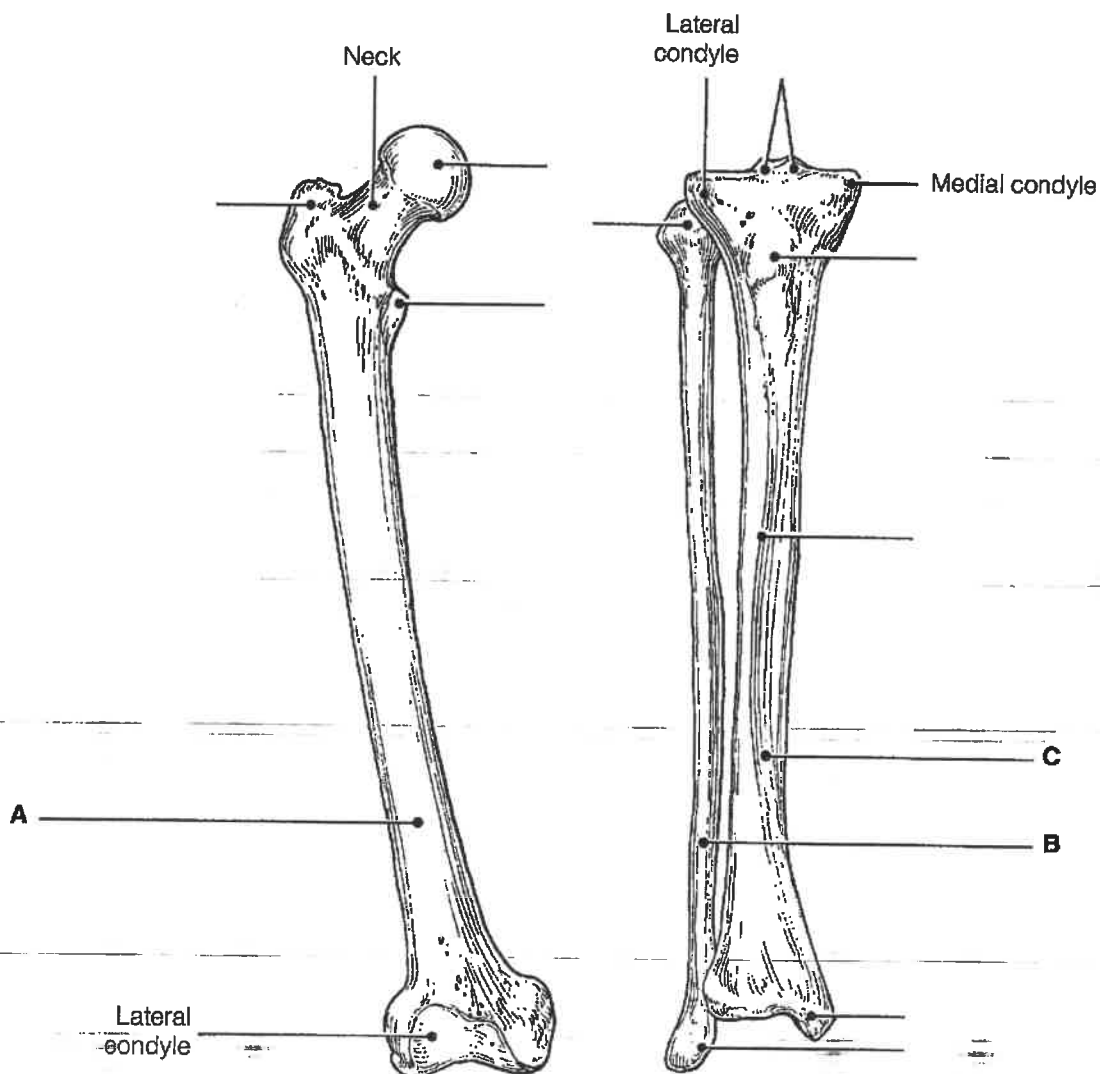


Figure 5-12

28. Figure 5-13 is a diagram of the articulated skeleton. Identify all bones or groups of bones by writing the correct labels at the end of the leader lines. Then, select two different colors for the bones of the axial and appendicular skeletons and use them to color in the coding circles and corresponding structures in the diagram.

☐ Axial skeleton

☐ Appendicular skeleton

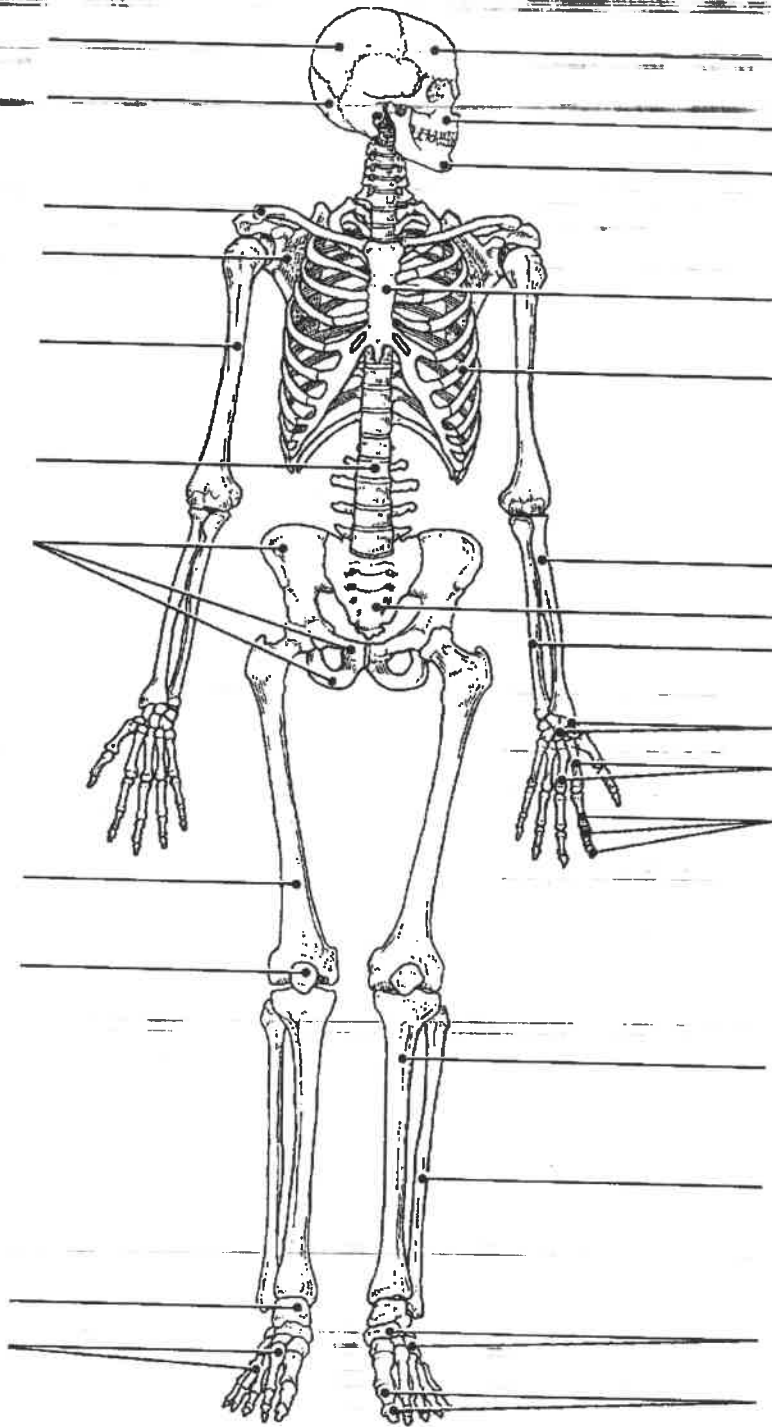


Figure 5-13

## BONE FRACTURES

29. Using the key choices, identify the fracture (fx) types shown in Figure 5-14 and the fracture types and treatments described below. Enter the appropriate key letter or term in each answer blank.

### Key Choices

- |                         |                        |                    |
|-------------------------|------------------------|--------------------|
| A. Closed reduction     | D. Depressed fracture  | G. Simple fracture |
| B. Compression fracture | E. Greenstick fracture | H. Spiral fracture |
| C. Compound fracture    | F. Open reduction      |                    |

- \_\_\_\_\_ 1. Bone is broken cleanly; the ends do not penetrate the skin
- \_\_\_\_\_ 2. Nonsurgical realignment of broken bone ends and splinting of bone
- \_\_\_\_\_ 3. A break common in children; bone splinters, but break is incomplete
- \_\_\_\_\_ 4. A fracture in which the bone is crushed; common in the vertebral column
- \_\_\_\_\_ 5. A fracture in which the bone ends penetrate through the skin surface
- \_\_\_\_\_ 6. Surgical realignment of broken bone ends
- \_\_\_\_\_ 7. A result of twisting forces

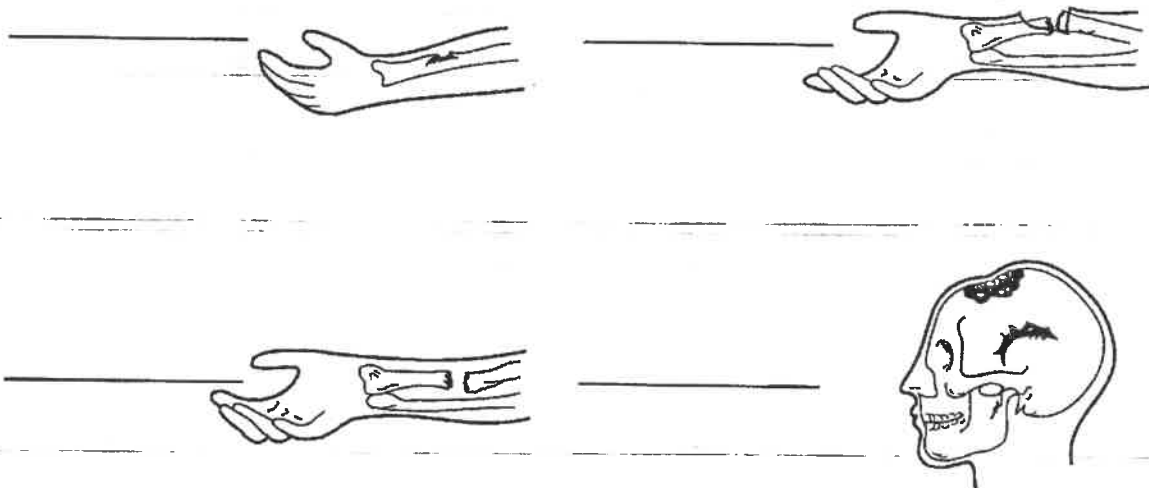


Figure 5-14

30. For each of the following statements about bone breakage and the repair process that is true, insert T in the answer blank. For false statements, correct the underlined terms by inserting the correct term in the answer blank.

- \_\_\_\_\_ 1. A hematoma usually forms at a fracture site.
- \_\_\_\_\_ 2. Deprived of nutrition, osteocytes at the fracture site die.
- \_\_\_\_\_ 3. Non-bony debris at the fracture site is removed by osteoclasts.
- \_\_\_\_\_ 4. Growth of a new capillary supply into the region produces granulation tissue.
- \_\_\_\_\_ 5. Osteoblasts from the medullary cavity migrate to the fracture site.
- \_\_\_\_\_ 6. The fibrocartilage callus is the first repair mass to splint the broken bone.
- \_\_\_\_\_ 7. The bony callus is initially composed of compact bone.

## JOINTS

31. Figure 5-15 shows the structure of a typical diarthrotic joint. Select different colors to identify each of the following areas and use them to color the coding circles and the corresponding structures on the figure. Then, complete the statements below the figure.

- ☐ Articular cartilage of bone ends
- ☐ Fibrous capsule
- ☐ Synovial membrane
- ☐ Joint cavity

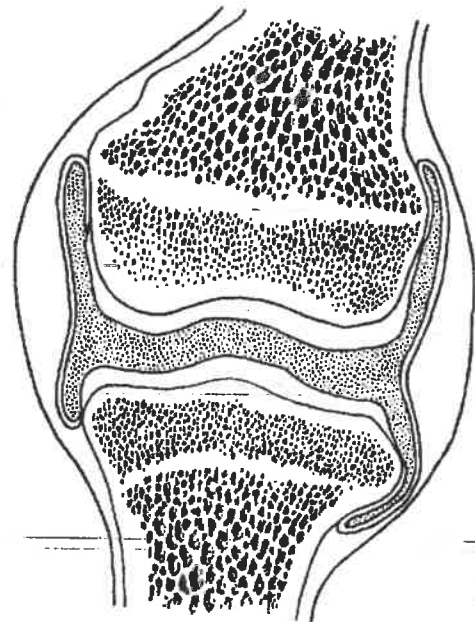


Figure 5-15

1. \_\_\_\_\_ The lubricant that minimizes friction and abrasion of joint surfaces is (1).
2. \_\_\_\_\_ The resilient substance that keeps bone ends from crushing when compressed is (2).
3. \_\_\_\_\_ (3) which reinforce the fibrous capsule help to prevent dislocation of the joint.

32. For each joint described below, select an answer from Key A. Then, if the Key A selection is *other than C* (a synovial joint), see if you can classify the joint further by making a choice from Key B.

**Key Choices**

Key A: A. Cartilaginous

B. Fibrous

C. Synovial

Key B: 1. Epiphyseal disk

2. Suture

3. Symphysis

1. Has amphiarthrotic and synarthrotic examples
2. All have a fibrous capsule lined with synovial membrane surrounding a joint cavity
3. Bone regions united by fibrous connective tissue
4. Joints between skull bones
5. Joint between atlas and axis
6. Hip, elbow, and knee
7. All examples are diarthroses
8. Pubic symphysis
9. All are reinforced by ligaments
10. Joint providing the most protection to underlying structures
11. Often contains a fluid-filled cushion
12. Child's long-bone growth plate made of hyaline cartilage
13. Most joints of the limbs
14. Often associated with bursae
15. Have the greatest mobility

33. Which structural joint type is *not* commonly found in the axial skeleton and why not?

## Homeostatic Imbalances of Bones and Joints

34. For each of the following statements that is true, enter *T* in the answer blank. For each false statement, correct the underlined words by writing the correct words in the answer blank.

1. In a sprain, the ligaments reinforcing a joint are excessively stretched or torn.
2. Age-related erosion of articular cartilages and formation of painful bony spurs are characteristic of gouty arthritis.
3. Chronic arthritis usually results from bacterial invasion.
4. Healing of a partially torn ligament is slow because its hundreds of fibrous strands are poorly aligned.
5. Rheumatoid arthritis is an autoimmune disease.
6. High levels of uric acid in the blood may lead to rheumatoid arthritis.
7. A "soft" bone condition in children, usually due to a lack of calcium or vitamin D in the diet, is called osteomyelitis.
8. Atrophy and thinning of bone owing to hormonal changes or inactivity (generally in the elderly) is called osteoporosis.

## DEVELOPMENTAL ASPECTS OF THE SKELETON

35. Using the key choices, identify the body systems that relate to bone tissue viability. Enter the appropriate key terms or letters in the answer blanks.

### Key Choices

- |                  |             |                 |
|------------------|-------------|-----------------|
| A. Endocrine     | C. Muscular | E. Reproductive |
| B. Integumentary | D. Nervous  | F. Urinary      |

1. Conveys the sense of pain in bone and joints
2. Activates vitamin D for proper calcium usage
3. Regulates uptake and release of calcium by bones
4. Increases bone strength and viability by pulling action
5. Influences skeleton proportions and adolescent growth of long bones
6. Provides vitamin D for proper calcium absorption

36. Complete the following statements concerning fetal and infant skeletal development. Insert the missing words in the answer blanks.

1. "Soft spots," or membranous joints called (1) in the fetal skull, allow the skull to be (2) slightly during birth passage. They also allow for continued brain (3) during the later months of fetal development and early infancy.
3. Eventually these soft spots are replaced by immovable joints called (4).

4. The two spinal curvatures well developed at birth are the (5) and (6) curvatures. Because they are present at birth, they are called (7) curvatures. The secondary curvatures develop as the baby matures. The (8) curvature develops as the baby begins to lift his or her head. The (9) curvature matures when the baby begins to walk or assume the upright posture.

8.

9.



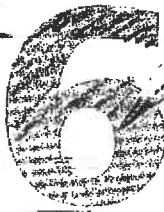
## INCREDIBLE JOURNEY

### A Visualization Exercise for the Skeletal System

... stalagmite- and stalactite-like structures that surround you. ...  
Since the texture is so full of holes. ...

37. Where necessary, complete statements by inserting the missing words in the answer blanks.

1. For this journey you are miniaturized and injected into the interior of the largest bone of your host's body, the (1).
2. Once inside this bone, you look around and find yourself examining the stalagmite- and stalactite-like structures that surround you. Although you feel as if you are in an underground cavern, you know that it has to be bone. Since the texture is so full of holes, it obviously is (2) bone.
3. Although the arrangement of these bony spars seems to be haphazard, as if someone randomly dropped straws, they are precisely arranged to resist points of (3). All about you is frantic, hurried activity. Cells are dividing rapidly, nuclei are being ejected, and disk-like cells are appearing. You decide that these disk-like cells are (4), and that this is the (5) cavity. As you explore further, strolling along the edge of the cavity, you spot many tunnels leading into the solid bony area on which you are walking. Walking into one of these drainpipe-like openings, you notice that it contains a glistening white rope-like structure (a (6), no doubt), and blood vessels running the length of the tube. You eventually come to a point in the channel where



# The Muscular System

Muscles, the specialized tissues that facilitate body movement, make up about 40% of body weight. Most body muscle is the voluntary type, called skeletal muscle because it is attached to the bony skeleton. Skeletal muscle contributes to body contours and shape, and composes the organ system called the muscular system. These muscles allow you to grin, frown, run, swim, shake hands, swing a hammer, and to otherwise manipulate your environment. The balance of body muscle is smooth and cardiac muscles, which form the bulk of the walls of hollow organs and the heart. Smooth and cardiac muscles are involved in the transport of materials within the body.

Study activities in this chapter deal with microscopic and gross structure of muscle, identification of voluntary muscles, body movements, and important understandings of muscle physiology.

## OVERVIEW OF MUSCLE TISSUES

1. Nine characteristics of muscle tissue are listed below and on page 90. Identify the muscle tissue type described by choosing the correct response(s) from the key choices. Enter the appropriate term(s) or letter(s) of the key choice in the answer blank.

### Key Choices

A. Cardiac

B. Smooth

C. Skeletal

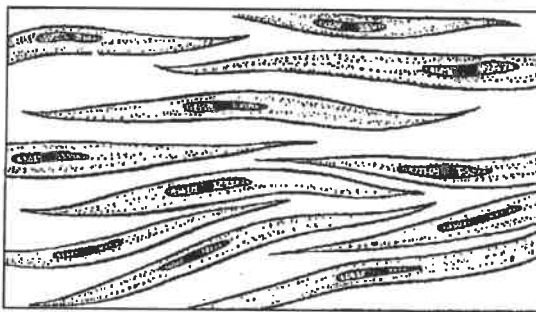
- \_\_\_\_\_ 1. Involuntary
- \_\_\_\_\_ 2. Banded appearance
- \_\_\_\_\_ 3. Longitudinally and circularly arranged layers
- \_\_\_\_\_ 4. Dense connective tissue packaging
- \_\_\_\_\_ 5. Figure-8 packaging of the cells
- \_\_\_\_\_ 6. Coordinated activity to act as a pump

**Key Choices**

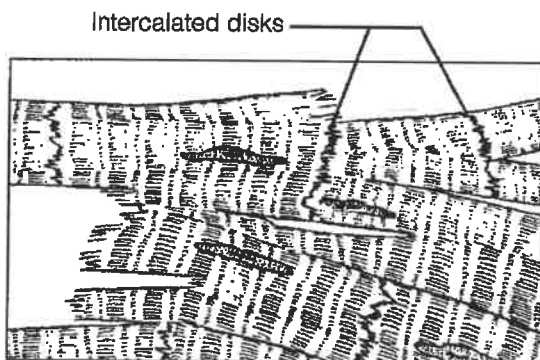
A. Cardiac      B. Smooth      C. Skeletal

- \_\_\_\_\_ 7. Moves bones and the facial skin  
 \_\_\_\_\_ 8. Referred to as the muscular system  
 \_\_\_\_\_ 9. Voluntary

2. Identify the type of muscle in each of the illustrations in Figure 6-1. Color the diagrams as you wish.



A \_\_\_\_\_



B \_\_\_\_\_

**Figure 6-1**

3. Regarding the functions of muscle tissues, circle the term in each of the groupings that does not belong with the other terms.

- |                       |                        |                 |                             |
|-----------------------|------------------------|-----------------|-----------------------------|
| 1. Urine              | Foodstuffs             | Bones           | Smooth muscle               |
| 2. Heart              | Cardiac muscle         | Blood pump      | Promotes labor during birth |
| 3. Excitability       | Response to a stimulus | Contractility   | Action potential            |
| 4. Ability to shorten | Contractility          | Pulls on bones  | Stretchability              |
| 5. Maintains posture  | Movement               | Promotes growth | Generates heat              |

## MICROSCOPIC ANATOMY OF SKELETAL MUSCLE

4. First, identify the structures in Column B by matching them with the descriptions in Column A. Enter the correct letters (or terms if desired) in the answer blanks. Then, select a different color for each of the terms in Column B that has a color-coding circle and color the structures in on Figure 6-2.

### Column A

- \_\_\_\_\_ 1. Connective tissue surrounding a fascicle
- \_\_\_\_\_ 2. Connective tissue ensheathing the entire muscle
- \_\_\_\_\_ 3. Contractile unit of muscle
- \_\_\_\_\_ 4. A muscle cell
- \_\_\_\_\_ 5. Thin connective tissue investing each muscle cell
- \_\_\_\_\_ 6. Plasma membrane of the muscle cell
- \_\_\_\_\_ 7. A long, filamentous organelle found within muscle cells that has a banded appearance
- \_\_\_\_\_ 8. Actin- or myosin-containing structure
- \_\_\_\_\_ 9. Cordlike extension of connective tissue beyond the muscle, serving to attach it to the bone
- \_\_\_\_\_ 10. A discrete bundle of muscle cells

### Column B

- A. Endomysium ☐
- B. Epimysium ☐
- C. Fascicle
- D. Fiber ☐
- E. Myofibril
- F. Myofibril ☐
- G. Perimysium ☐
- H. Sarcolemma
- I. Sarcomere
- J. Sarcoplasm
- K. Tendon ☐

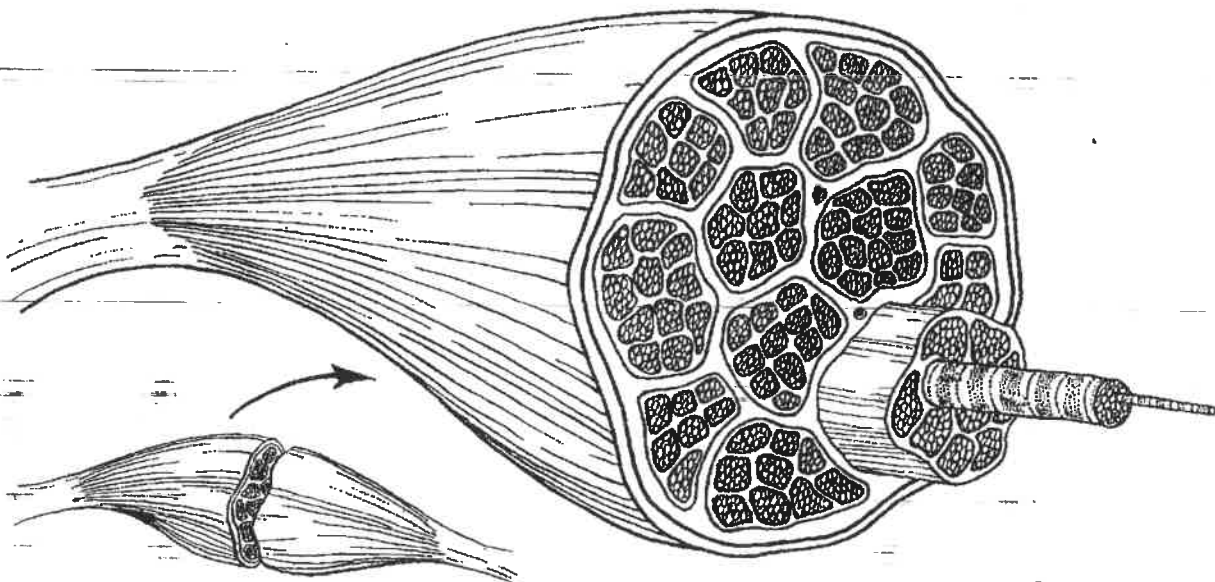


Figure 6-2

5. Figure 6-3 is a diagrammatic representation of a small portion of a relaxed muscle cell (bracket indicates the portion enlarged). First, select different colors for the structures listed below. Use them to color the coding circles and corresponding structures on Figure 6-3. Then bracket and label an A band, an I band, and a sarcomere. When you have finished, draw a contracted sarcomere in the space beneath the figure and label the same structures, as well as the light and dark bands.

☐ Myosin      ☐ Actin filaments      ☐ Z disc

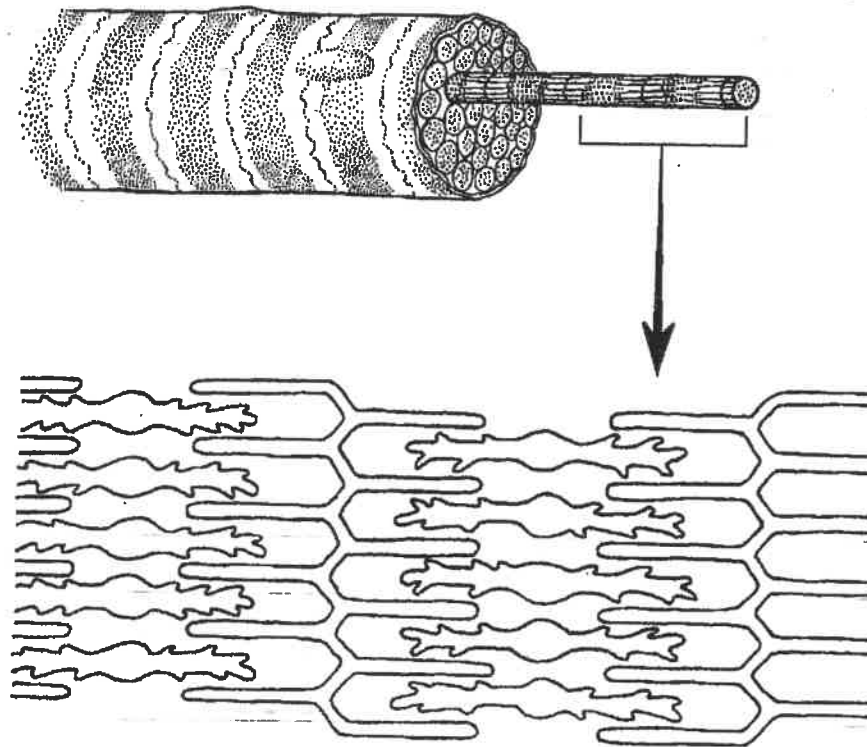


Figure 6-3

1. Looking at your diagram of a contracted sarcomere from a slightly different angle—which region of the sarcomere shortens during contraction—the dark band, the light band, or both?

## SKELETAL MUSCLE ACTIVITY

6. Complete the following statements relating to the neuromuscular junction.  
Insert the correct answers in the numbered answer blanks.

- \_\_\_\_\_ 1. A motor neuron and all of the skeletal muscle cells it stimulates is called a (1). The axon of each motor neuron
- \_\_\_\_\_ 2. has numerous endings called (2). The actual gap between an axonal ending and the muscle cell is called a (3).
- \_\_\_\_\_ 3. Within the axonal endings are many small vesicles containing a neurotransmitter substance called (4).
- \_\_\_\_\_ 4.
- \_\_\_\_\_ 5. When the (5) reaches the ends of the axon, the neurotransmitter is released, and it diffuses to the muscle cell membrane to combine with receptors there. Binding of the neurotransmitters with muscle membrane receptors causes the membrane to become permeable to sodium, resulting in the influx of sodium ions and (6) of the membrane. Then contraction of the muscle cell occurs.
- \_\_\_\_\_ 6.

7. Figure 6-4 shows the components of a neuromuscular junction. Identify the parts by coloring the coding circles and the corresponding structures in the diagram. Add small arrows to indicate the location of the ACh receptors and label appropriately.

- |   |                                      |                                 |
|---|--------------------------------------|---------------------------------|
| <input type="radio"/> Mitochondrion     | <input type="radio"/> T tubule       | <input type="radio"/> Sarcomere |
| <input type="radio"/> Synaptic vesicles | <input type="radio"/> Synaptic cleft |                                 |

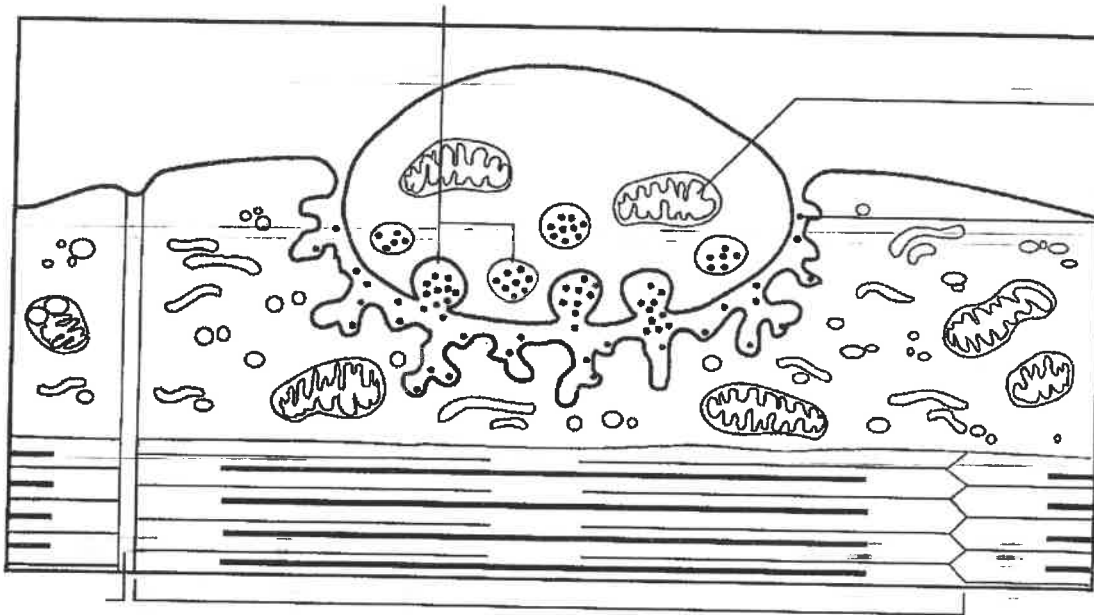


Figure 6-4

**94** Anatomy & Physiology Coloring Workbook

8. Number the following statements in their proper sequence to describe the contraction mechanism in a skeletal muscle cell. The first step has already been identified as number 1.

- 1 1. Acetylcholine is released into the neuromuscular junction by the axonal terminal.
- \_\_\_\_\_ 2. The action potential, carried deep into the cell, causes the sarcoplasmic reticulum to release calcium ions.
- \_\_\_\_\_ 3. The muscle cell relaxes and lengthens.
- \_\_\_\_\_ 4. Acetylcholine diffuses across the neuromuscular junction and binds to receptors on the sarcolemma.
- \_\_\_\_\_ 5. The calcium ion concentration at the myofilaments increases; the myofilaments slide past one another, and the cell shortens.
- \_\_\_\_\_ 6. Depolarization occurs, and the action potential is generated.
- \_\_\_\_\_ 7. As calcium is actively reabsorbed into the sarcoplasmic reticulum, its concentration at the myofilaments decreases.

9. The following incomplete statements refer to a muscle cell in the resting, or polarized, state just before stimulation. Complete each statement by choosing the correct response from the key choices and entering the appropriate letter in the answer blanks.

**Key Choices**

- |   |  |
|---|--|
| A. $\text{Na}^+$ diffuses out of the cell | G. Relative ionic concentrations on the two sides of the membrane during rest  |
| B. $\text{K}^+$ diffuses out of the cell  | H. Electrical conditions   |
| C. $\text{Na}^+$ diffuses into the cell   | I. Activation of the sodium-potassium pump, which moves $\text{K}^+$ into the cell and $\text{Na}^+$ out of the cell |
| D. $\text{K}^+$ diffuses into the cell    | J. Activation of the sodium-potassium pump, which moves $\text{Na}^+$ into the cell and $\text{K}^+$ out of the cell |
| E. Inside the cell                        |  |
| F. Outside the cell                       |  |

- \_\_\_\_\_ 1. There is a greater concentration of  $\text{Na}^+$  (1), and there is a greater concentration of  $\text{K}^+$  (2). When the stimulus is delivered, the permeability of the membrane is changed, and (3), initiating the depolarization of the membrane. Almost as soon as the depolarization wave begins, a repolarization wave follows it across the membrane. This occurs as (4).
- \_\_\_\_\_ 2. Repolarization restores the (5) of the resting cell membrane. The (6) is (are) reestablished by (7).
- \_\_\_\_\_ 3.
- \_\_\_\_\_ 4.
- \_\_\_\_\_ 5.
- \_\_\_\_\_ 6. \_\_\_\_\_ 7.

10. Complete the following statements by choosing the correct response from the key choices and entering the appropriate letter or term in the answer blanks.

**Key Choices**

- |                         |                          |                     |
|-------------------------|--------------------------|---------------------|
| A. Fatigue              | E. Isometric contraction | I. Many motor units |
| B. Isotonic contraction | F. Whole muscle          | J. Repolarization   |
| C. Muscle cell          | G. Tetanus               | K. Depolarization   |
| D. Muscle tone          | H. Few motor units       |                     |

- \_\_\_\_\_ 1. \_\_\_\_\_ is a continuous contraction that shows no evidence of relaxation.
- \_\_\_\_\_ 2. A(n) \_\_\_\_\_ is a contraction in which the muscle shortens and work is done.
- \_\_\_\_\_ 3. To accomplish a strong contraction, \_\_\_\_\_ are stimulated at a rapid rate.
- \_\_\_\_\_ 4. When a weak but smooth muscle contraction is desired, \_\_\_\_\_ are stimulated at a rapid rate.
- \_\_\_\_\_ 5. When a muscle is being stimulated but is not able to respond due to "oxygen debt," the condition is called \_\_\_\_\_.
- \_\_\_\_\_ 6. A(n) \_\_\_\_\_ is a contraction in which the muscle does not shorten but tension in the muscle keeps increasing.

11. The terms in the key refer to the three ways that muscle cells replenish their ATP supplies. Select the term(s) that best apply to the conditions described and insert the correct key letter(s) in the answer blanks.

**Key Choices**

- |                                   |                        |
|-----------------------------------|------------------------|
| A. Coupled reaction of CP and ADP | C. Aerobic respiration |
| B. Anaerobic glycolysis           |                        |

- \_\_\_\_\_ 1. Accompanied by lactic acid formation
- \_\_\_\_\_ 2. Supplies the highest ATP yield per glucose molecule
- \_\_\_\_\_ 3. Involves the simple transfer of a phosphate group
- \_\_\_\_\_ 4. Requires no oxygen
- \_\_\_\_\_ 5. The slowest ATP regeneration process
- \_\_\_\_\_ 6. Produces carbon dioxide and water
- \_\_\_\_\_ 7. The energy mechanism used in the second hour of running in a marathon
- \_\_\_\_\_ 8. Used when the oxygen supply is inadequate over time
- \_\_\_\_\_ 9. Good for a sprint

12. Briefly describe how you can tell when you are repaying the oxygen debt.

13. Which of the following occur within a muscle cell during oxygen debt? Place a check (✓) by the correct choices.

- |   |  |
|---|--|
| <input type="checkbox"/> 1. Decreased ATP         | <input type="checkbox"/> 5. Increased oxygen         |
| <input type="checkbox"/> 2. Increased ATP         | <input type="checkbox"/> 6. Decreased carbon dioxide |
| <input type="checkbox"/> 3. Increased lactic acid | <input type="checkbox"/> 7. Increased carbon dioxide |
| <input type="checkbox"/> 4. Decreased oxygen      | <input type="checkbox"/> 8. Increased glucose        |

## MUSCLE MOVEMENTS, TYPES, AND NAMES

14. Relative to general terminology concerning muscle activity, first label the following structures on Figure 6-5: insertion, origin, tendon, resting muscle, and contracting muscle. Next, identify the two structures named below by choosing different colors for the coding circles and the corresponding structures in the figure.

- ☐ Movable bone
- ☐ Immovable bone

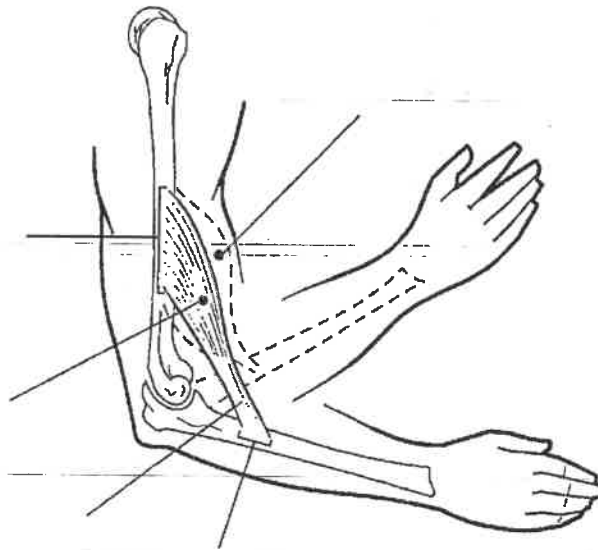


Figure 6-5

15. Complete the following statements. Insert your answers in the answer blanks.

1. Standing on your toes as in ballet is (1) of the foot. Walking on your heels is (2).
2. \_\_\_\_\_
3. Winding up for a pitch (as in baseball) can properly be called (3). To keep your seat when riding a horse, the tendency is to (4) your thighs.
4. \_\_\_\_\_
5. In running, the action at the hip joint is (5) in reference to the leg moving forward and (6) in reference to the leg in the posterior position. When kicking a football, the action at the knee is (7). In climbing stairs, the hip and knee of the forward leg are both (8). You have just touched your chin to your chest; this is (9) of the neck.
6. \_\_\_\_\_
7. \_\_\_\_\_
8. Using a screwdriver with a straight arm requires (10) of the arm. Consider all the movements of which the arm is capable. One often used for strengthening all the upper arm and shoulder muscles is (11).
9. \_\_\_\_\_
10. \_\_\_\_\_
11. Moving the head to signify "no" is (12). Action that moves the distal end of the radius across the ulna is (13). Raising the arms laterally away from the body is called (14) of the arms.
12. \_\_\_\_\_
13. \_\_\_\_\_
14. \_\_\_\_\_

16. The terms provided in the key are often used to describe the manner in which muscles interact with other muscles. Select the key terms that apply to the following definitions and insert the correct letter or term in the answer blanks.

**Key Choices**

A. Antagonist      B. Fixator      C. Prime mover      D. Synergist

1. Agonist \_\_\_\_\_
2. Postural muscles for the most part \_\_\_\_\_
3. Stabilizes a joint so that the prime mover can act at more distal joints \_\_\_\_\_
4. Performs the same movement as the prime mover \_\_\_\_\_
5. Reverses and/or opposes the action of a prime mover \_\_\_\_\_
6. Immobilizes the origin of a prime mover \_\_\_\_\_

17. Several criteria are applied to the naming of muscles. These are provided in Column B. Identify which criteria pertain to the muscles listed in Column A and enter the correct letter(s) in the answer blank.

Column A	Column B
<input type="checkbox"/> 1. <del>Gluteus maximus</del>	A. Action of the muscle
<input type="checkbox"/> 2. Adductor magnus	B. Shape of the muscle
<input type="checkbox"/> 3. Biceps femoris	C. Location of the muscle's origin and/or insertion
<input type="checkbox"/> 4. Abdominis transversus	D. Number of origins
<input type="checkbox"/> 5. Extensor carpi ulnaris	E. Location of muscle relative to a bone or body region
<input type="checkbox"/> 6. Trapezius	F. Direction in which the muscle fibers run relative to some imaginary line
<input type="checkbox"/> 7. Rectus femoris	G. Relative size of the muscle
<input type="checkbox"/> 8. External oblique	

## GROSS ANATOMY OF THE SKELETAL MUSCLES

### Muscles of the Head

18. Identify the major muscles described in Column A by choosing a response from Column B. Enter the correct letter in the answer blank. Select a different color for each muscle described and color in the coding circle and corresponding muscle on Figure 6-6.

Column A	Column B
<input type="radio"/> 1. Used in smiling	A. Buccinator
<input type="radio"/> 2. Used to suck in your cheeks	B. Frontalis
<input type="radio"/> 3. Used in winking	C. Masseter
<input type="radio"/> 4. Used to form the horizontal frown crease on the forehead	D. Orbicularis oculi
<input type="radio"/> 5. The "kissing" muscle	E. Orbicularis oris
<input type="radio"/> 6. Prime mover of jaw closure	F. Sternocleidomastoid
<input type="radio"/> 7. Synergist muscle for jaw closure	G. Temporalis
<input type="radio"/> 8. Prime mover of head flexion; a two-headed muscle	H. Trapezius
	I. Zygomaticus