

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

1. 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 |

2. 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 |

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).

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

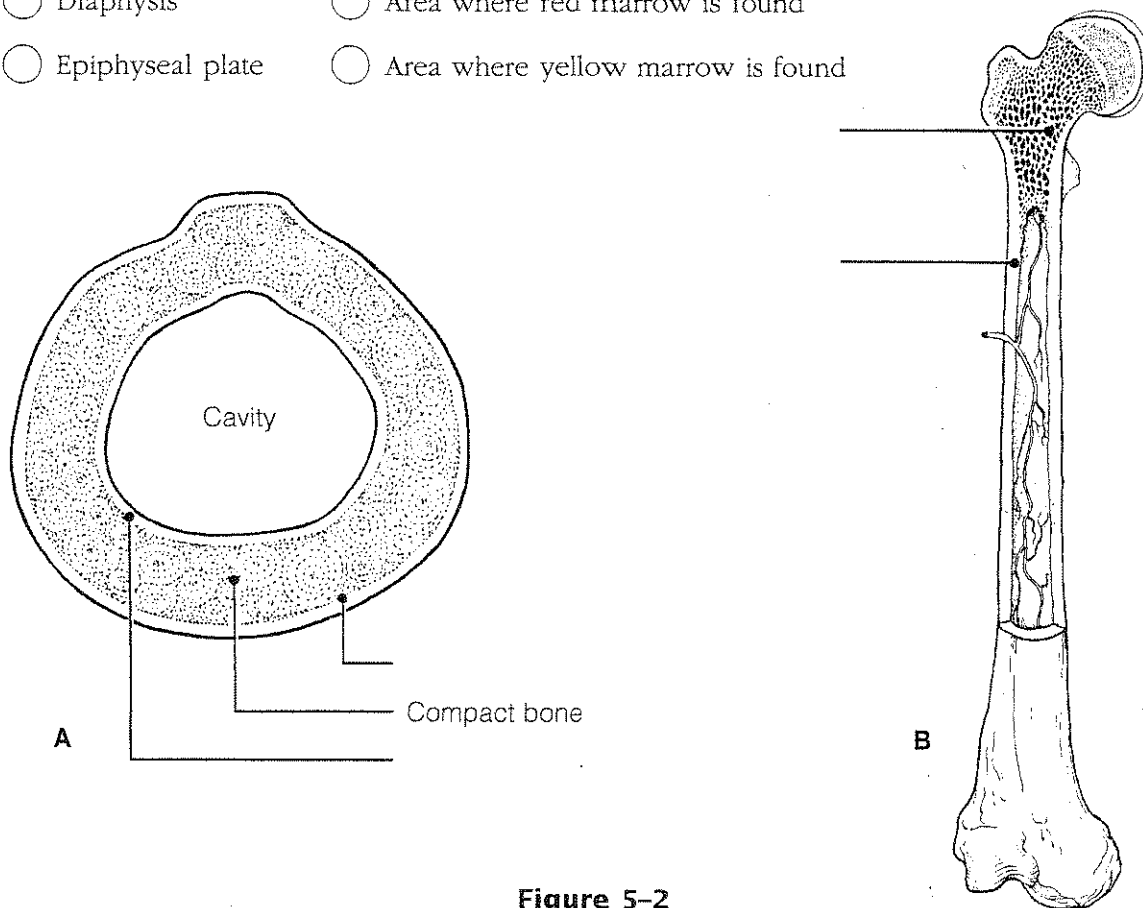


Figure 5-2

8. The following events apply to the endochondral ossification process as it occurs in the primary ossification center. Put these events in their proper order by assigning each a number (1-6).

- _____ 1. Cavity formation occurs within the hyaline cartilage.
 _____ 2. Collar of bone is laid down around the hyaline cartilage model just beneath the periosteum.
 _____ 3. Periosteal bud invades the marrow cavity.
 _____ 4. Perichondrium becomes vascularized to a greater degree and becomes a periosteum.
 _____ 5. Osteoblasts lay down bone around the cartilage spicules in the bone's interior.
 _____ 6. Osteoclasts remove the cancellous bone from the shaft interior, leaving a marrow cavity that then houses fat.

12. 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.

Sphenoid sinus

Ethmoid sinuses

Frontal sinus

Maxillary sinus

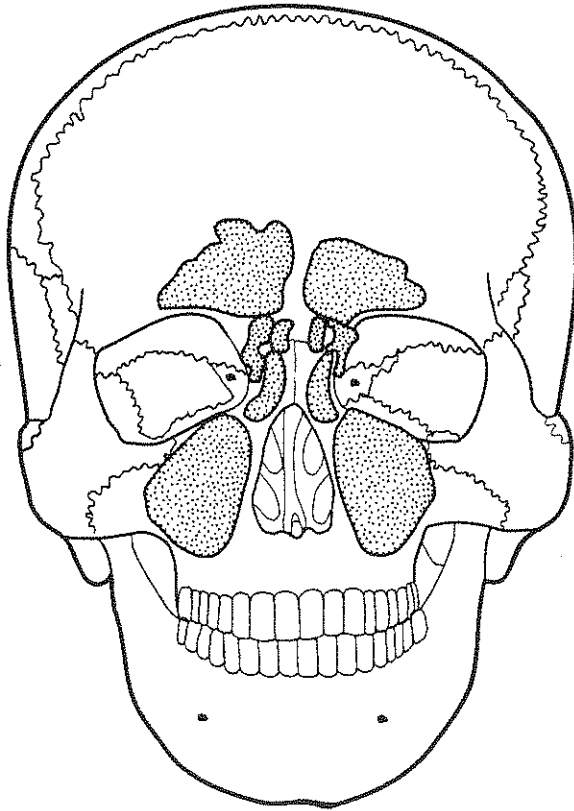


Figure 5-4

1. What *are* sinuses? _____

2. What purpose do they serve in the skull? _____

3. Why are they so susceptible to infection? _____

Vertebral Column

13. 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 part of the vertebra
- _____ 3. Provide(s) levers for the muscles to pull against
- _____ 4. Provide(s) an articulation point for the ribs
- _____ 5. Openings allowing spinal nerves to pass

14. The following statements provide distinguishing characteristics of the vertebrae composing the vertebral column. Using the 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

17. 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.

- 1. _____ ○
- 2. _____ ○
- 3. _____ ○
- 4. _____ ○
- 5. _____ ○
- 6. _____ ○
- 7. _____ ○

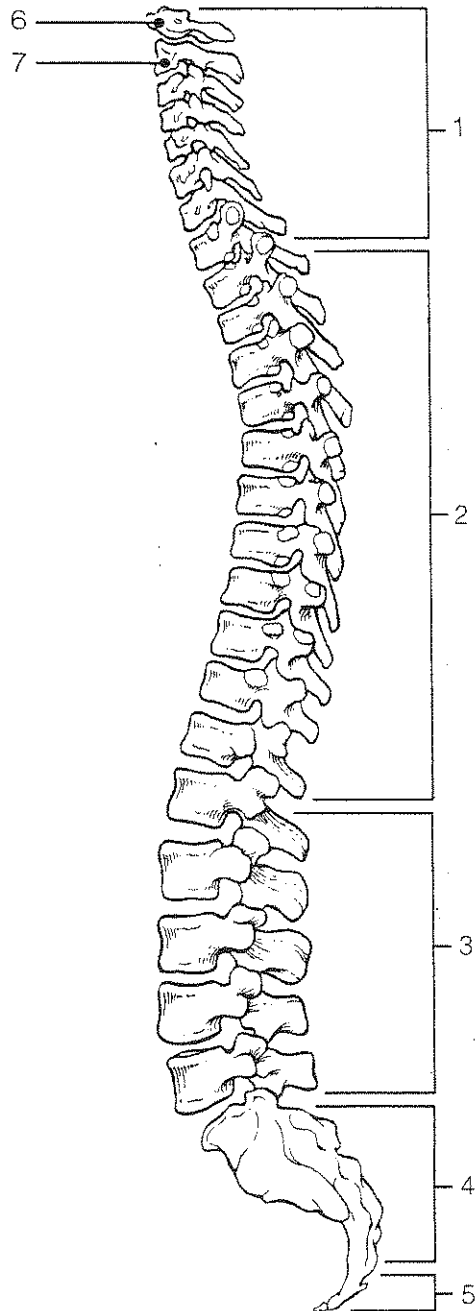


Figure 5-6

Thoracic Cage

18. Complete the following statements referring to the thoracic cage 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 _____ 3. 12 are also called (5) ribs. All ribs articulate posteriorly with the (6), and most connect anteriorly to the (7), _____ 4. either directly or indirectly.
- _____ 5. The general shape of the thoracic cage is (8).
- _____ 6.
- _____ 7.
- _____ 8.

19. Figure 5-7 is an anterior view of the thoracic cage. 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 |

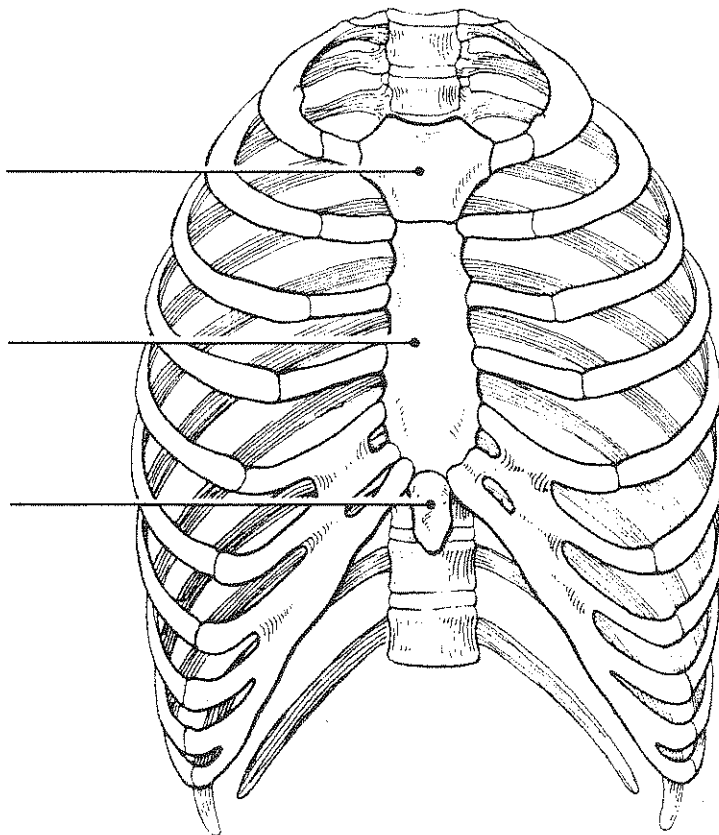


Figure 5-7

BONE FRACTURES

31. 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

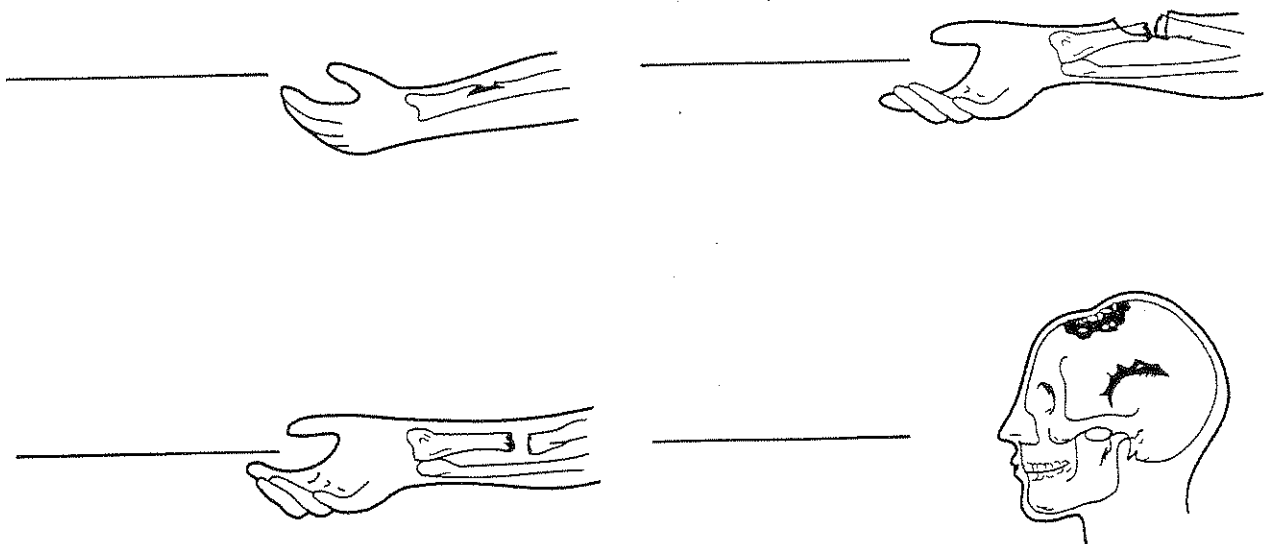


Figure 5-14

32. For each of the following statements that is true about bone breakage and the repair process, 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. Nonbony 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

33. 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

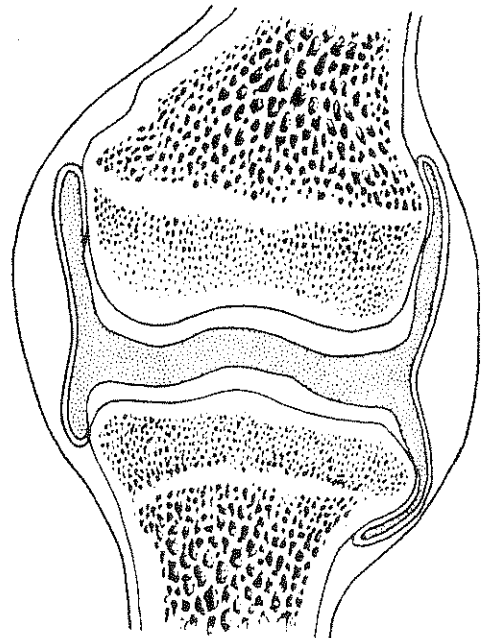


Figure 5-15

- 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.

34. 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 the 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

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

Homeostatic Imbalances of Bones and Joints

36. 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 caused by 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

37. 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

38. 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.
- _____ 2. _____ 3. Eventually these soft spots are replaced by immovable joints called (4).
- _____ 4. _____ 5. 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.
- _____ 6. _____ 7. _____ 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 ...*

39. 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. _____ 4. 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 disklike cells are appearing. You decide that these disklike 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 ropelike 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

- _____ 7. horizontal passageway joins with a vertical passage that runs with the longitudinal axis of the bone. This is obviously a _____
- _____ 8. (7) canal. Because you would like to see how nutrients are brought into (8) bone, you decide to follow this channel.
- _____ 9. Reasoning that there is no way you can possibly scale the slick walls of the channel, you leap and grab onto a white cord hanging down its length. Because it is easier to slide down than to try to climb up the cord, you begin to lower yourself, hand over hand. During your descent, you notice small openings in the wall, which are barely large enough for you to wriggle through. You conclude that these are the _____
- _____ 10. (9) that connect all the (10) to the nutrient supply in the central canal. You decide to investigate one of these tiny
- _____ 11. _____
- _____ 12. _____

openings and begin to swing on your cord, trying to get a foothold on one of the openings. After managing to anchor yourself and squeezing into an opening, you use a flashlight to illuminate the passageway in front of you. You are startled by a giant cell with many dark nuclei. It appears to be plastered around the entire lumen directly ahead of you. As you watch this cell, the bony material beneath it, the (11), begins to liquefy. The cell apparently is a bone-digesting cell, or (12), and because you are unsure whether or not its enzymes can also liquefy you, you slither backwards hurriedly and begin your trek back to your retrieval site.



AT THE CLINIC

40. Antonio is hit in the face with a football during practice. An X ray reveals multiple fractures of the bones around an orbit. Name the bones that form margins of the orbit.
41. Mrs. Brusco, a woman in her 80s, is brought to the clinic with a fractured hip. X rays reveal compression fractures in her lower vertebral column and extremely low bone density in her vertebrae, hip bones, and femurs. What are the condition, cause, and treatment?
42. Jack, a young man, is treated at the clinic for an accident in which he hit his forehead. When he returns for a checkup, he complains that he can't smell anything. A hurried X ray of his head reveals a fracture. What part of which bone was fractured to cause his loss of smell?

43. A middle-aged woman comes to the clinic complaining of stiff, painful joints and increasing immobility of her finger joints. A glance at her hands reveals knobby, deformed knuckles. For what condition will she be tested?
44. At his 94th birthday party, James was complimented on how good he looked and was asked about his health. He replied, "I feel good most of the time, but some of my joints ache and are stiff, especially my knees, hips, and lower back, and especially in the morning when I wake up." A series of X rays and an MRI scan taken a few weeks earlier had revealed that the articular cartilages of these joints were rough and flaking off, and bone spurs (overgrowths) were present at the ends of some of James's bones. What is James's probable condition?
45. Janet, a 10-year-old girl, is brought to the clinic after falling out of a tree. An X ray shows she has small fractures of the transverse processes of T₃ to T₅ on the right side. Janet will be watched for what abnormal spinal curvature over the next several years?
46. The serving arm of many tennis players is often significantly larger (thicker) than the other arm. Explain this phenomenon.
47. Jerry is giving cardiopulmonary resuscitation to Ms. Jackson, an elderly woman who has just been rescued from the waters of Cape Cod Bay. What bone is he compressing?



THE FINALE: MULTIPLE CHOICE

48. Select the best answer or answers from the choices given.

1. Important bone functions include:
 - A. support of the pelvic organs
 - B. protection of the brain
 - C. providing levers for movement of the limbs
 - D. protection of the skin and limb musculature
 - E. storage of water
2. A passageway connecting neighboring osteocytes in an osteon is a:
 - A. central canal
 - B. lamella
 - C. lacuna
 - D. canaliculus
 - E. perforating canal
3. What is the earliest event (of those listed) in endochondral ossification?
 - A. Ossification of proximal epiphysis
 - B. Appearance of the epiphyseal plate
 - C. Invasion of the shaft by the periosteal bud
 - D. Cavitation of the cartilage shaft
 - E. Formation of secondary ossification centers
4. The growth spurt of puberty is triggered by:
 - A. high levels of sex hormones
 - B. the initial, low levels of sex hormones
 - C. growth hormone
 - D. parathyroid hormone
 - E. calcitonin
5. Deficiency of which of the following hormones will cause dwarfism?
 - A. Growth hormone
 - B. Sex hormones
 - C. Thyroid hormones
 - D. Calcitonin
 - E. Parathyroid hormone
6. Women suffering from osteoporosis are frequent victims of _____ fractures of the vertebrae.
 - A. compound
 - B. spiral
 - C. comminuted
 - D. compression
 - E. depression
7. Which of the following bones are part of the axial skeleton?
 - A. Vomer
 - B. Clavicle
 - C. Sternum
 - D. Parietal
 - E. Coxal bone
8. A blow to the cheek is most likely to break what superficial bone or bone part?
 - A. Superciliary arches
 - B. Zygomatic process
 - C. Mandibular ramus
 - D. Styloid process
9. Which of the following are part of the sphenoid?
 - A. Crista galli
 - B. Sella turcica
 - C. Petrous portion
 - D. Pterygoid process
 - E. Lesser wings
10. Structural characteristics of *all* cervical vertebrae are:
 - A. small body
 - B. bifid spinous process
 - C. transverse foramina
 - D. small vertebral foramen
 - E. costal facets
11. Which of the following bones exhibit a styloid process?
 - A. Hyoid
 - B. Temporal
 - C. Humerus
 - D. Radius
 - E. Ulna

12. Hip bone markings include:

- A. ala
- B. sacral hiatus
- C. gluteal surface
- D. pubic ramus
- E. fovea capitis

13. Cartilaginous joints include:

- A. syndesmoses
- B. symphyses
- C. synostoses
- D. synchondroses

14. Considered to be part of a synovial joint are:

- A. bursae
- B. articular cartilage
- C. tendon sheath
- D. capsular ligaments

15. Abduction is:

- A. moving the right arm out to the right
- B. spreading out the fingers
- C. wiggling the toes
- D. moving the sole of the foot laterally

16. In comparing two joints of the same type, what characteristic(s) would you use to determine strength and flexibility?

- A. Depth of the depression of the concave bone of the joint
- B. Snugness of fit of the bones
- C. Size of bone projections for muscle attachments
- D. Presence of menisci

17. Which of the following joints has the greatest freedom of movement?

- A. Interphalangeal
- B. Saddle joint of thumb
- C. Distal tibiofibular
- D. Coxal

18. Which specific joint does the following description identify? "Articular surfaces are deep and secure, multiaxial; capsule heavily reinforced by ligaments; labrum helps prevent dislocation; the first joint to be built artificially; very stable."

- A. Elbow
- B. Hip
- C. Knee
- D. Shoulder

19. An autoimmune disease resulting in inflammation and eventual fusion of diarthrotic joints is:

- A. gout
- B. rheumatoid arthritis
- C. degenerative joint disease
- D. pannus

20. Plane joints allow:

- A. pronation
- B. flexion
- C. rotation
- D. gliding