Today's Medical Assistant

2th edition

Chapter 07

Skeletal System

Lesson 7.1

Overview of the Skeletal System

1. List and describe five functions of the skeletal system.
2. Explain the difference between compact and spongy bone.
3. Classify bones according to size and shape.

Lesson 7.1

Overview of the Skeletal System (cont'd)

4. Identify the general features of a long bone.
5. Explain the process by which long bones grow in length.
6. Explain the difference between the axial and appendicular skeletons.

Introduction to the Skeletal System

- Consists of:
  - Bones and cartilage
  - Ligaments
  - Tendons associated with bones

Functions of the Skeletal System

- **Support**
  - Provides a rigid framework
  - Supports the soft organs of the body
- **Protection**
  - Protects the soft body parts
    - Cranium protects the brain
    - Vertebrae protect the spinal cord
    - Rib cage protects heart and lungs

Functions of the Skeletal System

- **Movement**
  - Bones and muscles work together to produce body movement
- **Storage**
  - Calcium: needed for vital metabolic processes
    - When blood calcium levels decrease: calcium is released from the bones
    - When blood calcium levels increase: excess calcium is stored in the bones
  - Fat is stored in the yellow bone marrow

Functions of the Skeletal System

- **Blood cell formation**
  - **Hematopoiesis:** blood cell formation (red blood cells, white blood cells, platelets)
  - Takes place mostly in the red bone marrow
    - Found in most bones in an infant
    - With age: largely replaced by yellow marrow (fat) storage

Structure of Bone Tissue

- **Compact bone**
  - **Osteon (haversian system):** the microscopic unit of compact bone
    - Packed tightly together to form a solid mass
  - **Osteonic (haversian) canal:** a central canal in the osteon
    - Contains a blood vessel

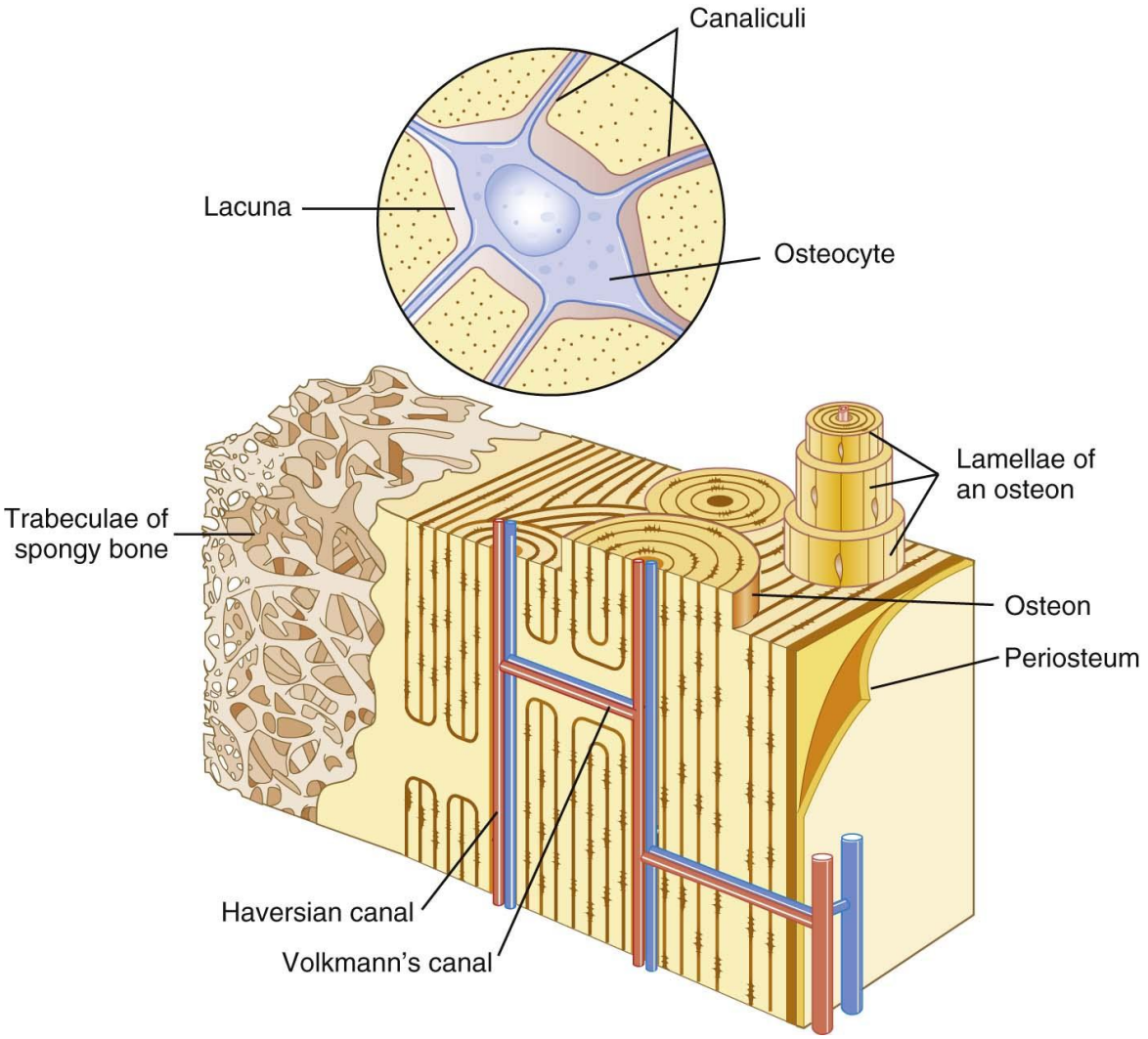
Structure of Bone Tissue

- **Compact bone**
  - **Lamellae:** concentric rings of hard calcified matrix that surrounds osteonic canals
  - **Osteocytes:** bone cells
  - **Lacunae:** spaces between the rings of matrix, which contain bone cells **(osteocytes)**
  - **Canaliculi:** small channels that radiate from the lacunae to the osteonic canal
    - Provide passageways through the hard matrix

Structure of Bone Tissue

- **Spongy (cancellous) bone**
  - Lighter and less dense than compact bone
  - Consists of plates of bone **(trabeculae)**

Structure of Bone Tissue



Classification of Bones

- **Long bones:** longer than they are wide
  - Consist of a long shaft with two bulky ends
  - Primarily compact bone
  - May have a large amount of spongy bone at the ends
  - Examples: thigh, leg, arm, and forearm
- **Short bones:** cube shaped
  - Consist primarily of spongy bone
  - Covered by a thin layer of compact bone
  - Examples: bones of wrist and ankle

Classification of Bones

- **Flat bones:** thin, flattened, and often curved
  - Arranged similar to a sandwich
  - Middle layer of spongy bone covered on each side by a layer of compact bone
  - Example: most of the bones of the cranium
- **Irregular bones**
  - Primarily spongy, covered with a thin layer of compact bone
  - Examples: vertebrae and some skull bones

General Features of a Long Bone

- **Diaphysis:** shaft of a long bone
  - Consists of compact bone
- **Medullary cavity:** space inside the shaft of a long bone
  - In adults: contains yellow bone marrow

General Features of a Long Bone

- **Epiphysis:** the expanded portion at the end of a long bone
  - Spongy bone covered by a thin layer of compact bone
- **Articular cartilage:** thin layer of hyaline cartilage that covers the ends of long bones
  - Provides smooth surfaces for movement in the joints

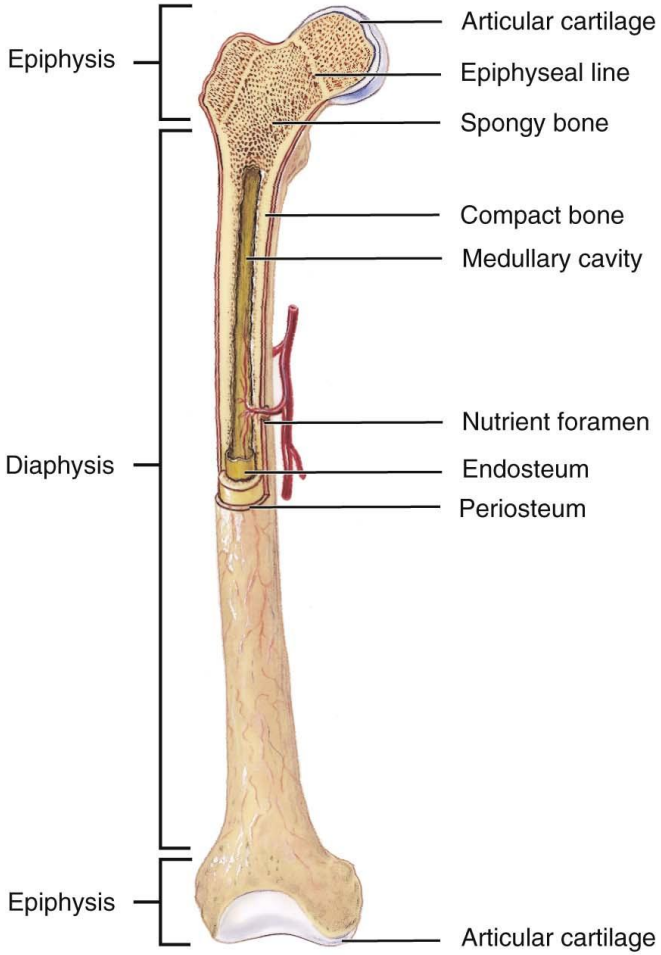
General Features of a Long Bone

- **Epiphyseal plate:** plate of hyaline cartilage between the diaphysis and epiphysis
  - Bones grow in length at the epiphyseal plate
  - Growth ceases when the cartilaginous epiphyseal plate is replaced by a bony **epiphyseal line**
- **Periosteum:** tough, fibrous connective tissue that covers a long bone except in the region of the articular cartilage
  - Richly supplied with nerve fibers, lymphatic vessels, blood vessels, and osteoblasts

General Features of a Long Bone

- **Nutrient foramina:** small openings in the diaphysis of the bone for the passage of blood vessels
- **Endosteum:** thin connective tissue membrane that lines the medullary cavity

General Features of a Long Bone



Bone Development and Growth

- **Osteogenesis** (also known as **ossification**): process of bone formation
- **Cells involved:**
  - **Osteoblasts:** bone-forming cells
  - **Osteocytes:** mature bone cells
  - **Osteoclasts:** break down and reabsorb bone

Bone Development and Growth

- **Bone growth in length**
  - Hyaline cartilage in epiphyseal plate: grows by mitosis
    - Chondrocytes next to diaphysis age and degenerate
    - Osteoblasts ossify the matrix to form bone
  - Continues throughout childhood and adolescence
  - Cartilage growth ceases: usually in early 20s
  - Epiphyseal plate completely ossifies
  - **Epiphyseal line** remains
  - Bones can no longer grow in length

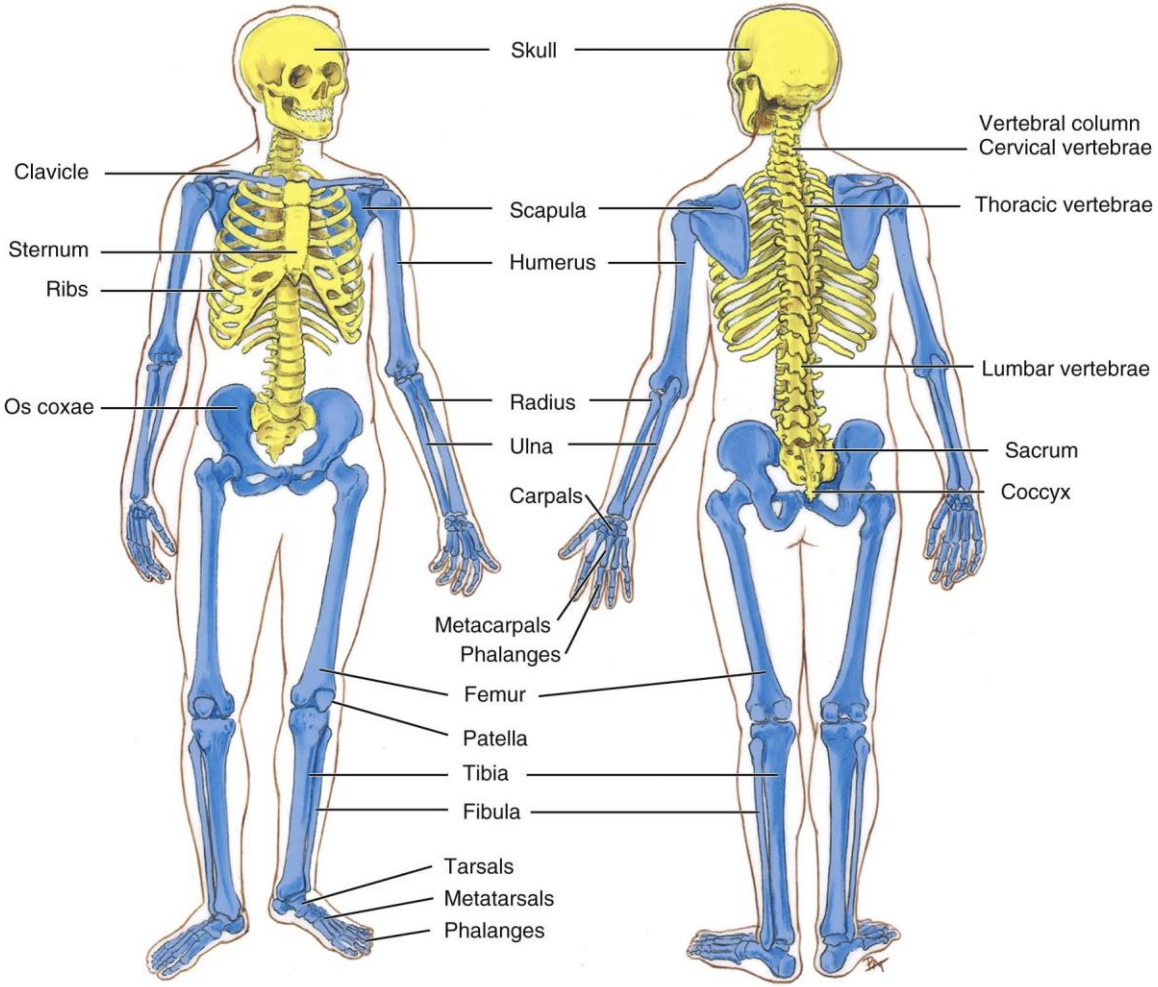
Bone Development and Growth

- **Bone growth in length**
  - Bone growth under influence of:
    - Growth hormone (secreted by anterior pituitary)
    - Sex hormones (secreted by ovaries and testes

Division of the Skeleton

- Adult skeleton: consists of 206 bones
- **Axial skeleton:** 80 bones, which include bones of head, vertebral column, ribs, sternum
- **Appendicular skeleton:** 126 bones, which include the free appendages and their attachments to the axial skeleton

Divisions of the Skeleton



Lesson 7.2

Bones and Articulations

7. Identify the bones of the skull.
8. Identify the structural features of vertebrae.
9. List and describe the divisions of the vertebral column.
10. Describe the structural features of the sternum and ribs.

Lesson 7.2

Bones and Articulations (cont'd)

11. Identify the parts of the pectoral girdle.
12. Identify the bones of the upper extremities.
13. Identify the parts of the pelvic girdle.
14. Identify the bones of the lower extremities.

Lesson 7.2

Bones and Articulations (cont'd)

15. List and describe the different types of joints.
16. Describe ways in which the aging of an individual affects the skeletal system.
17. Identify pathology related to the skeletal system.

Skull

- **Skull**
  - Made up of 28 bones
- **Cranium**
  - Houses the brain

Cranium

- **Frontal bone**
  - Paranasal **frontal sinuses:** air-filled cavities in the frontal bone
    - Reduce the weight of the skull
- **Parietal bones**
  - Joined to each other in the midline by the **sagittal suture**
  - Joined to the frontal bone by the **coronal suture**

Cranium

- **Occipital bone**
  - Joined to the parietal bones by the **lambdoid suture**
  - **Foramen magnum:** large opening on the lower surface of the occipital bone
    - Spinal cord passes through this opening
  - **Occipital condyles:** rounded processes on each side of the foramen magnum
    - Articulate with the first cervical vertebra

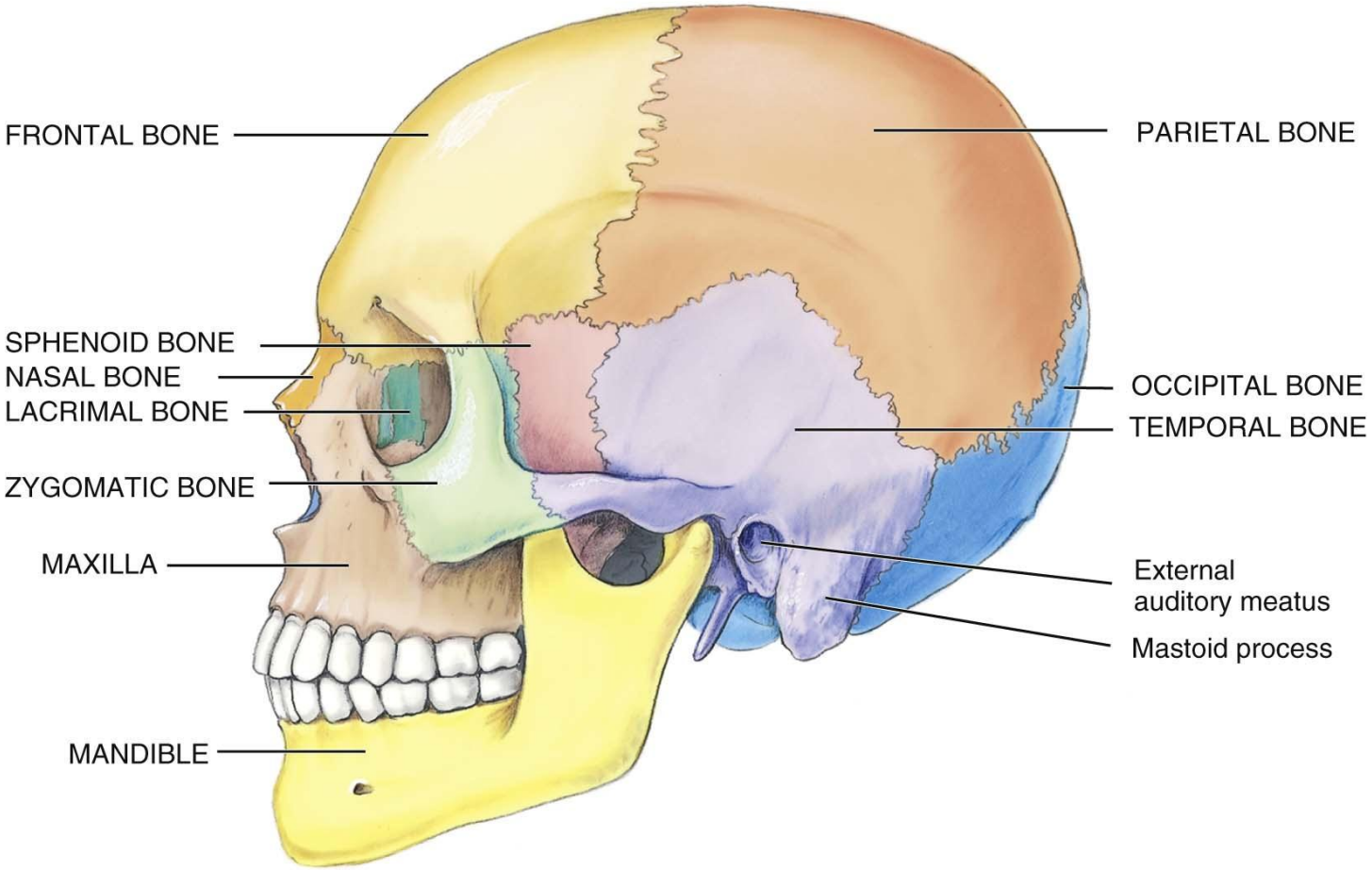
Cranium

- **Temporal bones**
  - Meet the parietal bone at the **squamous suture**
  - **External auditory meatus:** canal that leads to the middle ear
  - **Mandibular fossa:** articulates with the mandible
  - **Mastoid process:** contains air cells that drain into middle ear cavity
  - **Zygomatic process:** helps form the prominence of the cheek

Cranium

- **Sphenoid bone**
  - Spans the entire width of the cranial floor
  - Optic foramina: two openings for the passage of the optic nerve
  - Contains paranasal **sphenoid sinuses**
- **Ethmoid bone**
  - Forms most of the bony area between the nasal cavity and the orbits
  - Contains paranasal **ethmoidal sinuses**

Cranium



Facial Bones

- Form the basic framework and shape of the face
- **Maxillary bones**
  - Forms upper jaw
  - Alveolar process: tooth socket
- **Palatine bones**
  - Form posterior portion of hard palate and lateral walls of nasal cavity
- **Nasal bones**
  - Form the bridge of the nose

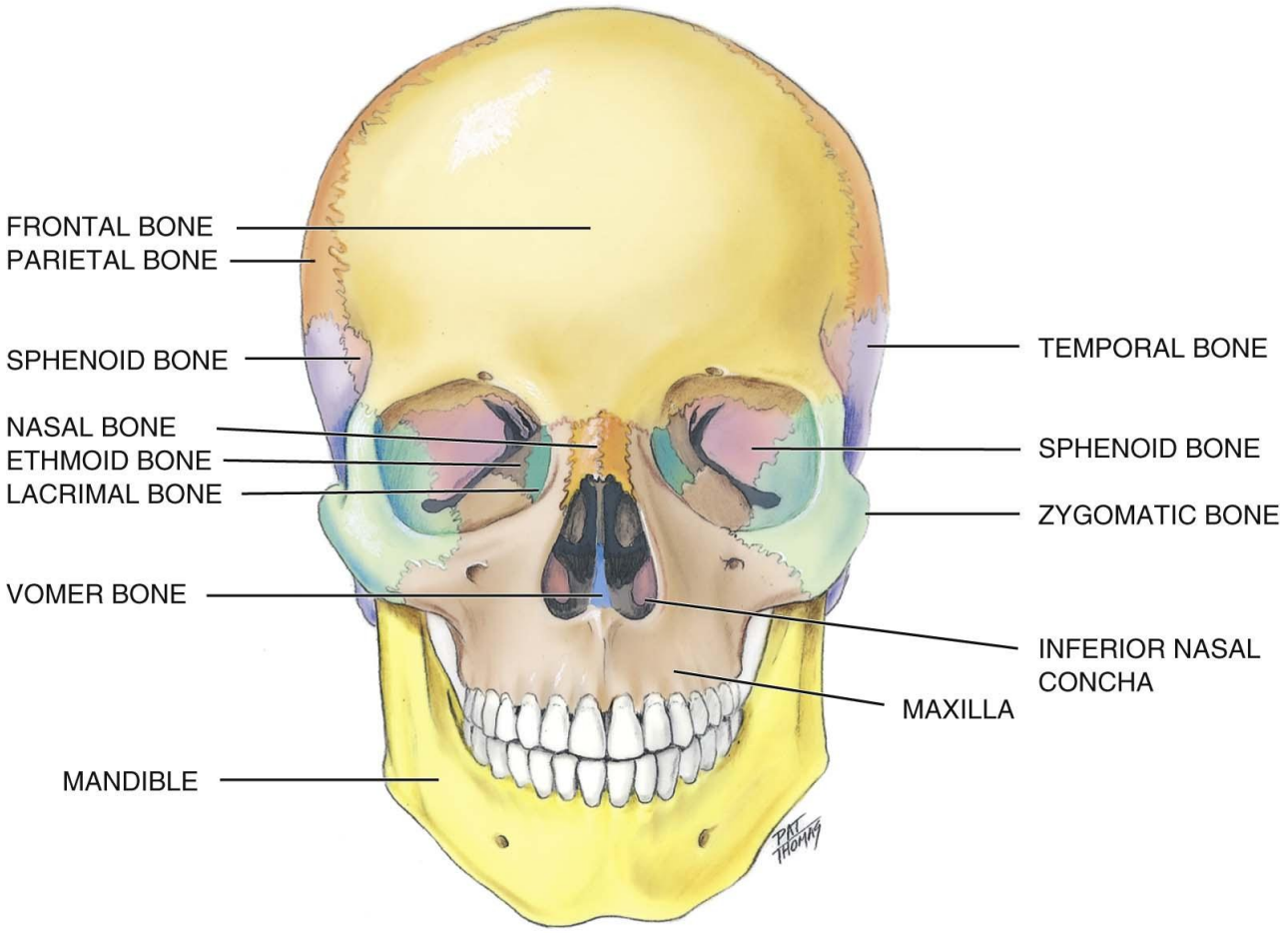
Facial Bones

- **Lacrimal bones**
  - **Lacrimal groove:** pathway for a tube that carries tears from eyes to nasal cavity
- **Zygomatic bones**
  - Form the prominences of the cheeks
  - **Temporal process** that forms the **zygomatic arch**
- **Inferior nasal conchae**
  - Thin, curved bones attached to the lateral walls of the nasal cavity

Facial Bones

- **Vomer**
  - Helps to form the **nasal septum**
- **Mandible**
  - Forms the lower jaw
  - **Mandibular condyle** fits into mandibular fossa of the temporal bone to form the **temporomandibular** joint
  - **Alveolar process:** tooth socket

Facial Bones



Auditory Ossicles

- **Malleus, incus, stapes**
  - Transmit sound waves from the tympanic membrane to inner ear

Hyoid Bone

- U-shaped bone in the neck
- Located between the mandible and the larynx

Hyoid Bone

- Only bone in the body that does not articulate directly with another bone
- Functions:
  - Serves as a base for the tongue
  - Attachment for several muscles associated with swallowing

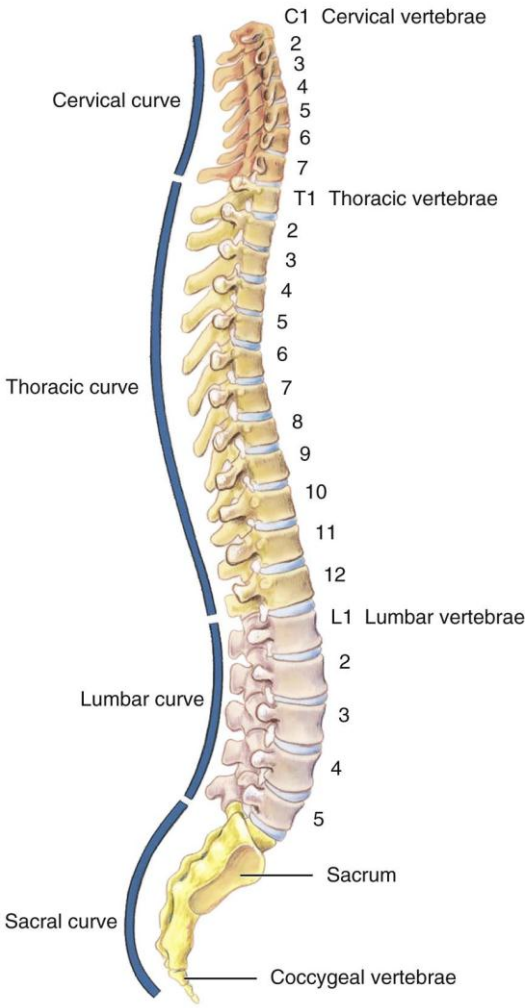
Vertebral Column

- Extends from skull to pelvis
- Contains 26 **vertebrae**
- **Intervertebral discs:** pads of fibrocartilage that separate vertebrae
  - Function
    - Shock absorbers
    - Allow the vertebral column to bend

Vertebral Column

- Four curvatures: increase strength and resilience of the column
  - **Cervical**
  - **Thoracic**
  - **Lumbar**
  - **Sacral**

Vertebral Column



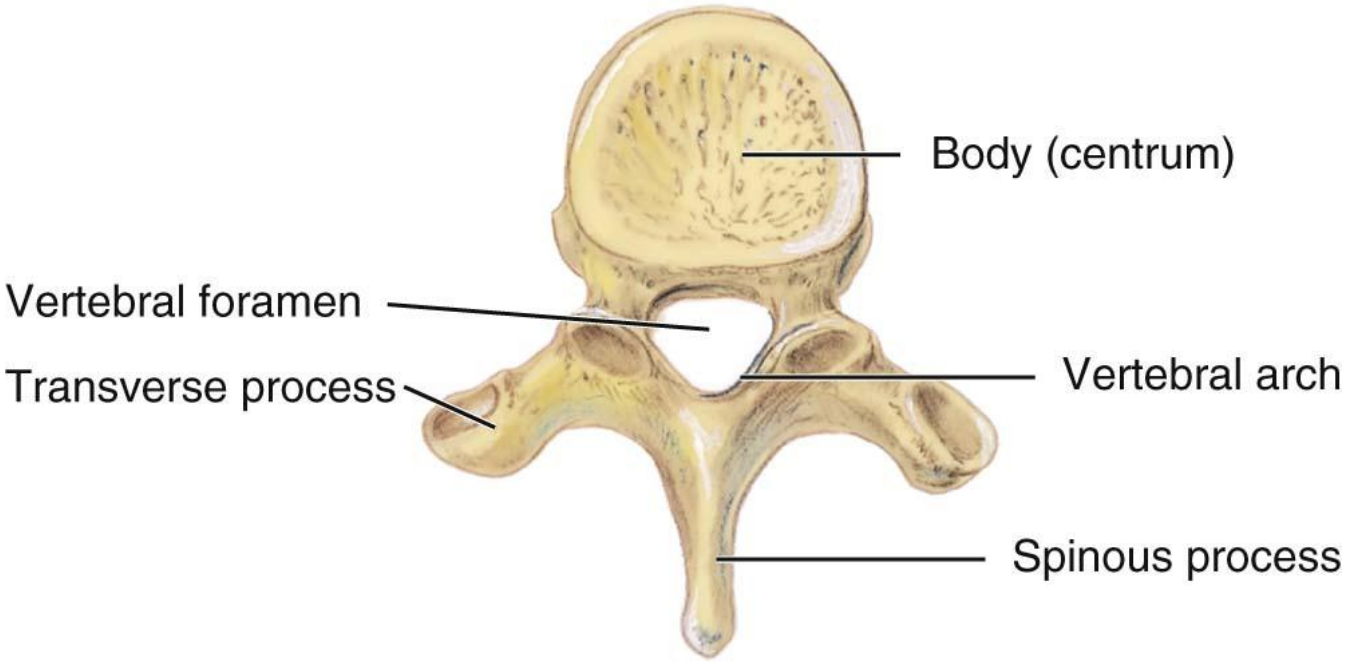
General Structure of Vertebrae

- **Body (centrum):** weight-bearing portion
- **Vertebral arch:** posterior curved portion is the vertebral arch
- **Vertebral foramen:** central large opening
  - When all the vertebrae are stacked together in a column
    - Vertebral foramina make a canal that contains the spinal cord

General Structure of Vertebrae

- **Transverse processes:** project laterally from the vertebral arch
  - Place for muscle attachment
- **Spinous process:** projects from the posterior midline
  - Place for muscle attachment
  - Can be felt as bony projections along the midline of the back

General Structure of Vertebrae



Composition of the Vertebral Column

- **Cervical vertebrae:** C1-C7
- **Thoracic vertebrae:** T1-T12
- **Lumbar vertebrae:** L1-L5
  - Make up the small of the back
  - Consist of large, heavy bodies
    - Support most of body weight
    - Have many back muscles attached to them

Composition of the Vertebral Column

- **Sacrum:** triangular bone just below the lumbar vertebrae
  - Forms posterior wall of pelvic cavity
- **Coccyx** (tailbone): last part of vertebral column

Thoracic Cage

- Protects heart, lungs, and great vessels
- Supports bones of the shoulder girdle
- Plays a role in breathing
- Components:
  - Thoracic vertebrae dorsally
  - Ribs laterally
  - Sternum and costal cartilage anteriorly

Sternum

- Consists of three parts:
  - **Manubrium**: superior
    - **Jugular (suprasternal) notch:** indentation in the superior margin of the manubrium
    - Articulates with clavicles and first two pairs of ribs
  - **Body:** middle
    - **Sternal angle:** where manubrium and body meet (felt as a horizontal ridge)
  - **Xiphoid process:** inferior

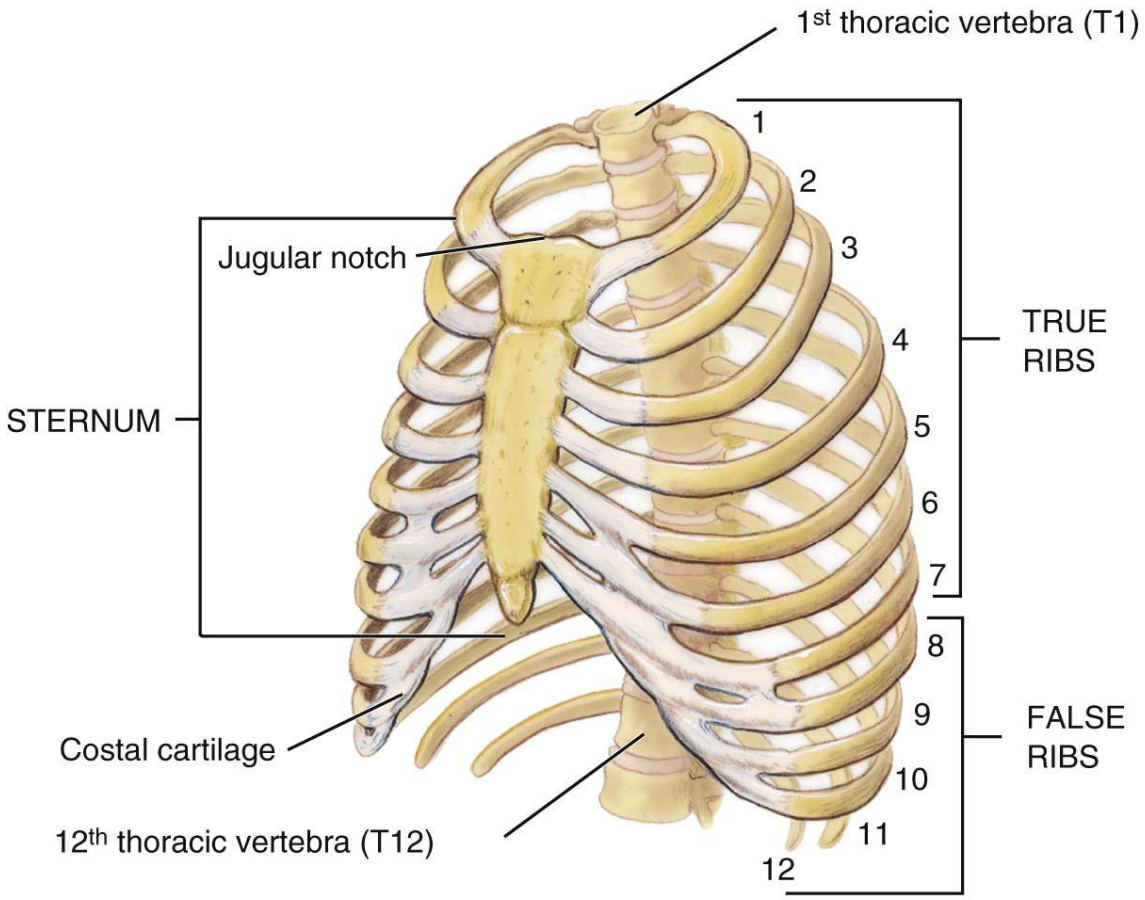
Ribs

- Twelve pairs of **ribs**
- One pair attached to each of 12 thoracic vertebrae
- **True ribs:** upper seven pairs
  - Attach to sternum directly by **costal cartilage**

Ribs

- **False ribs:** lower five pairs
  - Their costal cartilage does not reach sternum directly
  - **Vertebrochondral ribs:** first three pairs of false ribs
    - Reach sternum indirectly by joining with cartilage of ribs above
  - **Vertebral ribs (floating ribs):** bottom two rib pairs
    - Have no anterior attachment

Ribs



Bones of the Appendicular Skeleton

- 126 bones
- Suspended from two yokes or girdles that are anchored to axial skeleton
- Appendages to the axis of the body
- Designed for movement

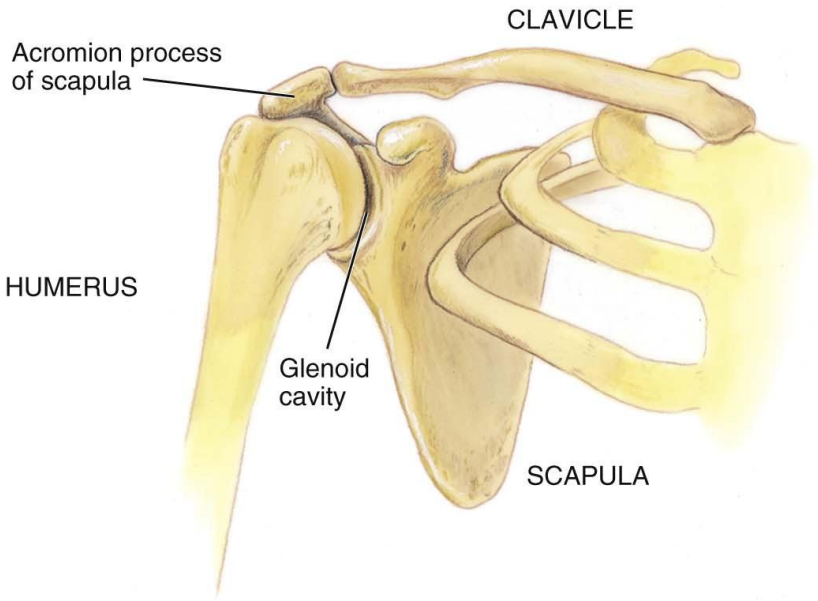
Pectoral Girdle

- **Clavicle** (commonly called the **collarbone**)
  - S-shaped bone that articulates with manubrium of sternum and scapula
- **Scapula** (commonly called the **shoulder blade**)
  - Thin, flat triangular bone that articulates with the clavicle and humerus

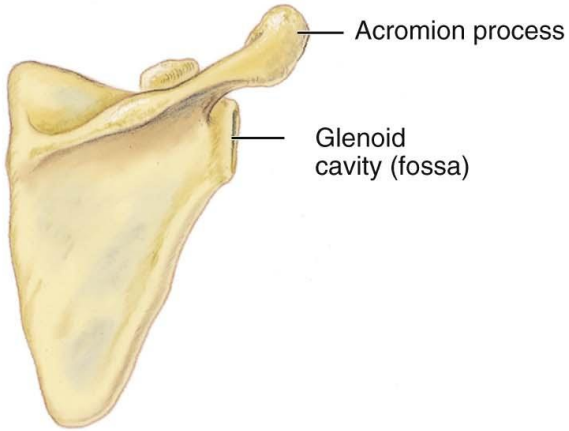
Pectoral Girdle

- **Scapula**
  - **Acromion process:** forms the point of the shoulder
  - **Glenoid cavity** (fossa): shallow depression where head of humerus connects to scapula

Pectoral Girdle



CLAVICLE (right, superior view)

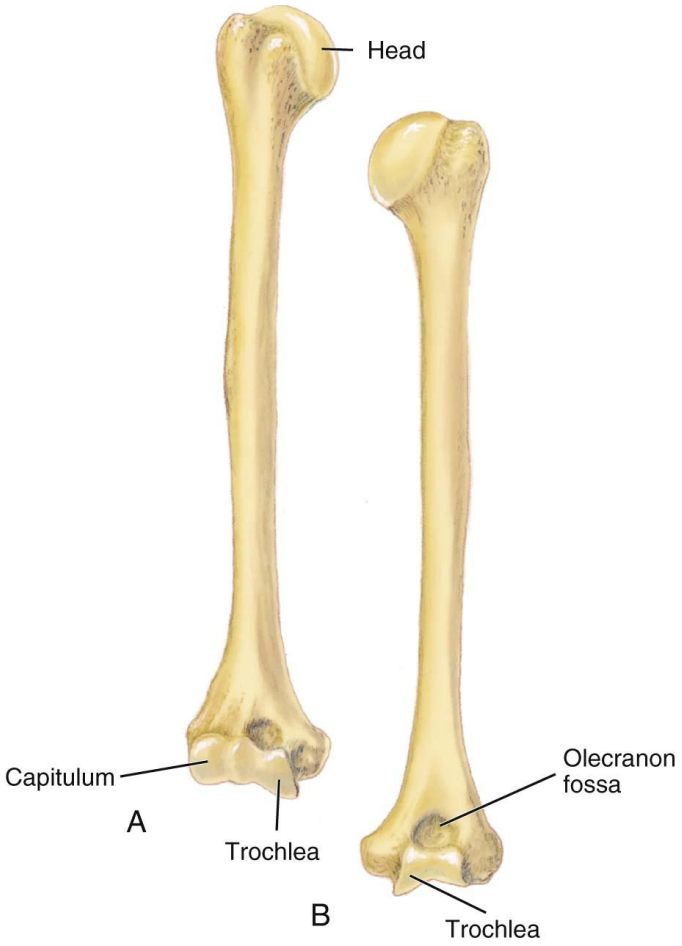


SCAPULA (right, posterior view)

Upper Extremity

- **Arm**
  - **Humerus**
    - **Head:** large, smooth, rounded end that fits into scapula
    - **Greater and lesser tubercle:** blunt projections for muscle attachment
    - **Deltoid tuberosity:** attachment for deltoid muscle
    - **Lateral** and **medial epicondyles:** for attachment of forearm muscles
    - **Olecranon fossa:** where ulna fits with humerus to form elbow joint
    - **Coronoid fossa:** also for ulna to fit with humerus
    - **Capitulum:** articulates with radius
    - **Trochlea:** articulates with the ulna

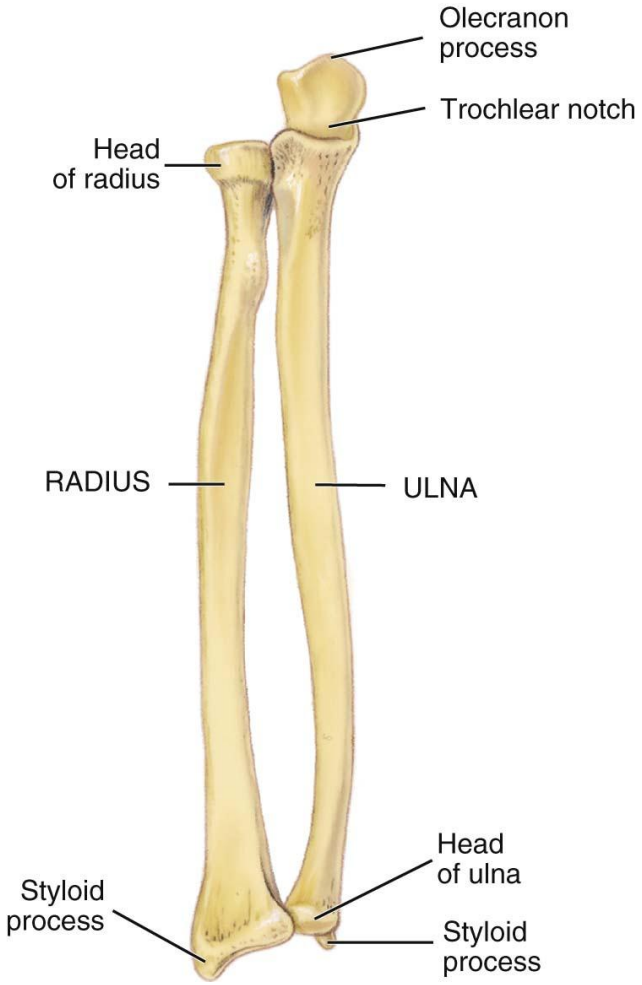
Upper Extremity



Upper Extremity

- **Forearm**
  - **Radius:** lateral side
  - **Ulna:** medial side

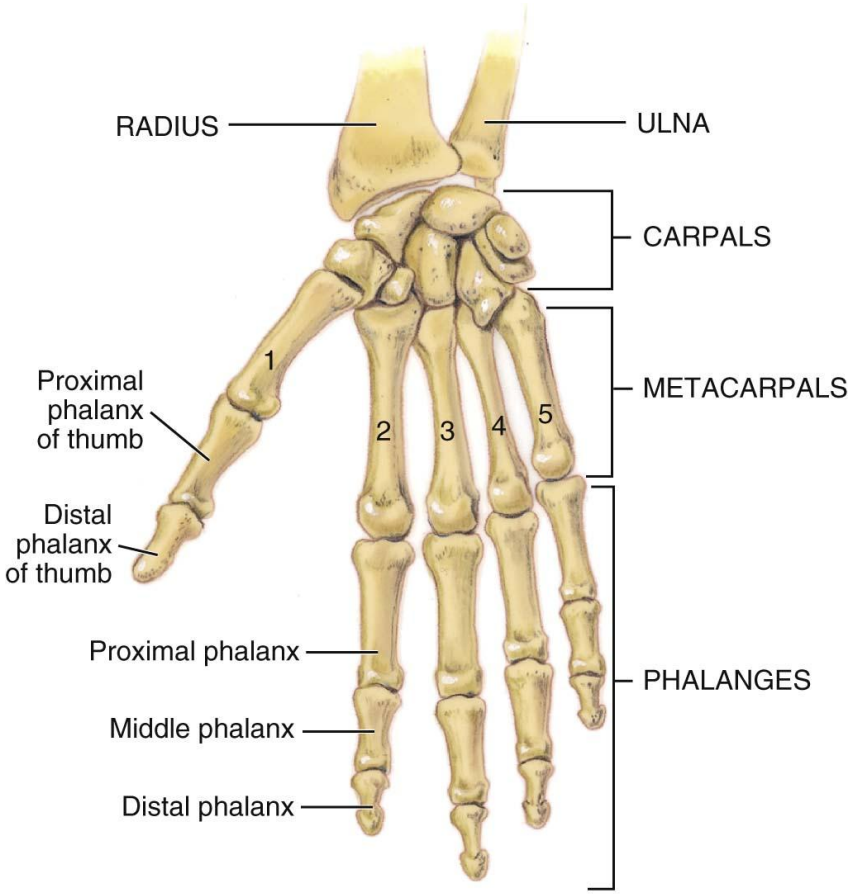
Upper Extremity



Hand

- **Wrist** (or **carpus**): contains eight small **carpal bones**
- **Palm** (or **metacarpus**): contains five **metacarpal bones**
- **Phalanges:** bones of the fingers
  - Three phalanges in each finger (a proximal, middle, and distal phalanx)
    - Except the thumb, which has two (lacks a middle phalanx)

Hand



Hand (right, palmar aspect)

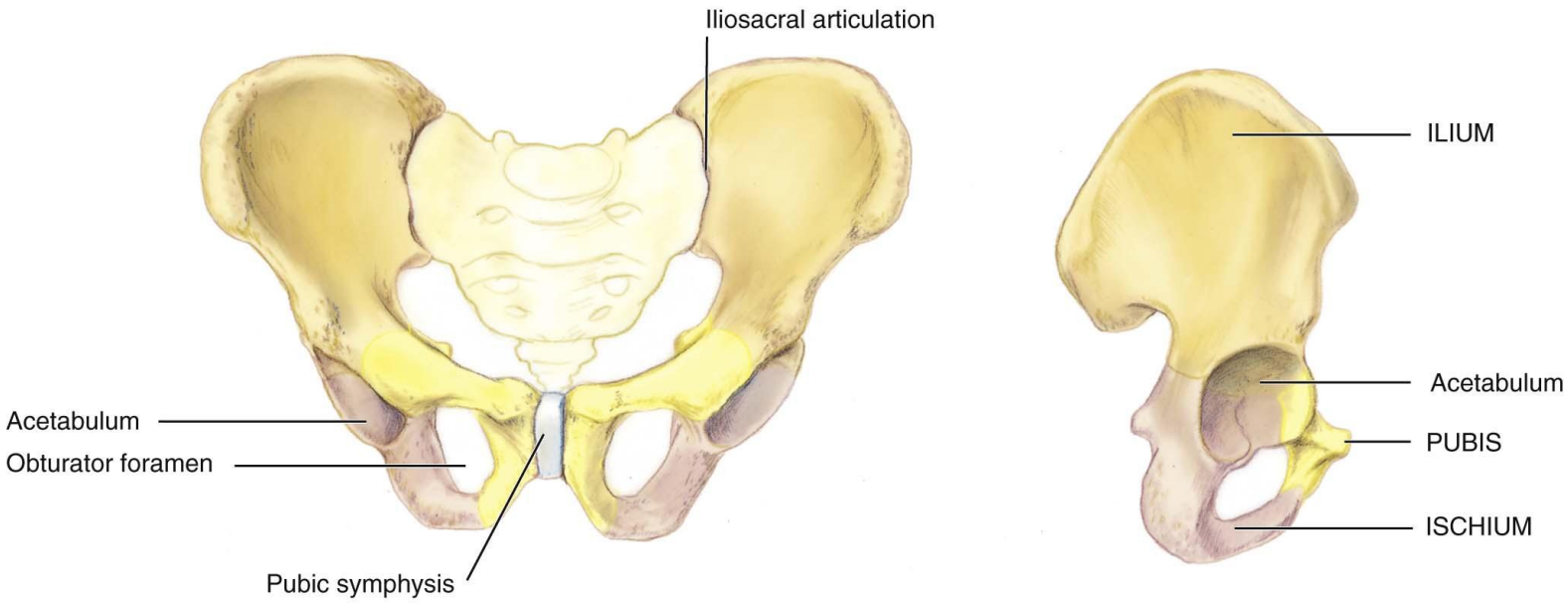
Pelvic Girdle

- Attaches lower extremities to axial skeleton
- Provides a strong support for weight of body
- Provides support and protection for:
  - Urinary bladder
  - A portion of large intestine
  - Reproductive organs located in pelvic cavity

Pelvic Girdle

- Consists of two **coxal** (hip) **bones**
  - Articulate with each other at the **symphysis pubis (anteriorly)**
  - Articulate with the sacrum at the **iliosacral joints (posteriorly)**
  - Made up of three fused bones:
    - **Ilium, ischium, and pubis**
    - **Acetabulum:** large depression where three bones meet
    - **Obturator foramen:** large opening between pubis and ischium
    - **Iliac crest:** superior margin of ileum
    - **Pubis:** anterior portion of coxal bone is the pubis

Pelvic Girdle



PELVIC GIRDLE (anterior view)

OS COXAE (right, lateral view)

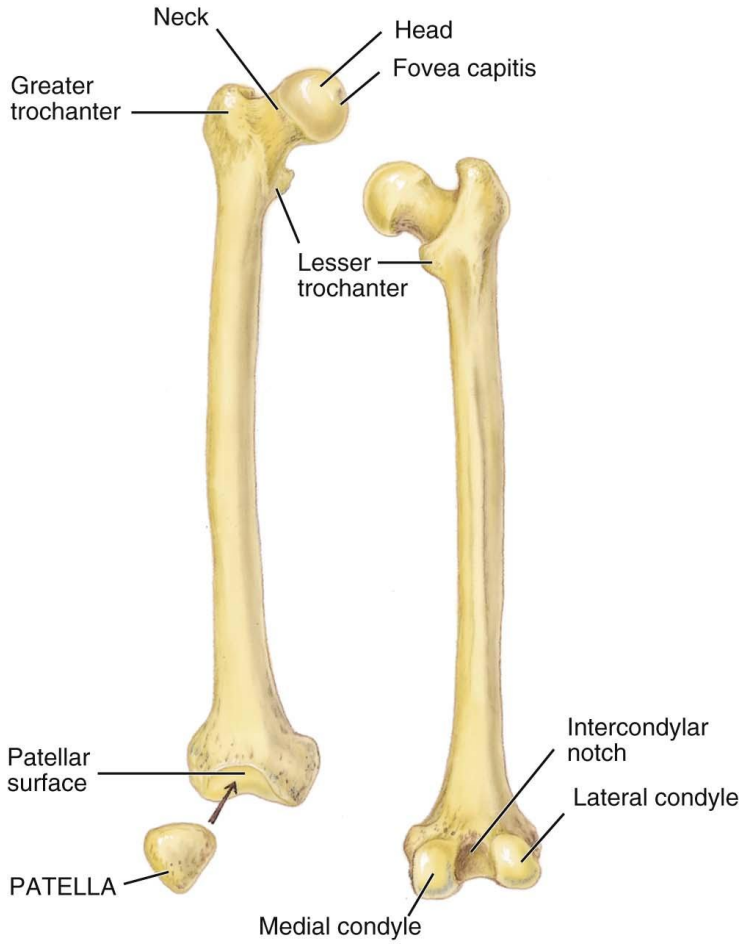
Lower Extremity

- Support the entire weight of the body when it is erect
- Exposed to tremendous forces: during walking, running, jumping
- Bones are larger and stronger than those in upper extremity

Lower Extremity

- **Thigh**
  - Region from the hip to the knee
  - Consists of the **femur:** longest and strongest bone in the body
    - **Head** of femur: has a small depression called the **fovea capitis**
    - **Greater** and **lesser trochanters:** sites for muscle attachment
    - **Lateral** and **medial condyles:** form joints with bones of the leg

Lower Extremity



FEMUR and PATELLA (right)

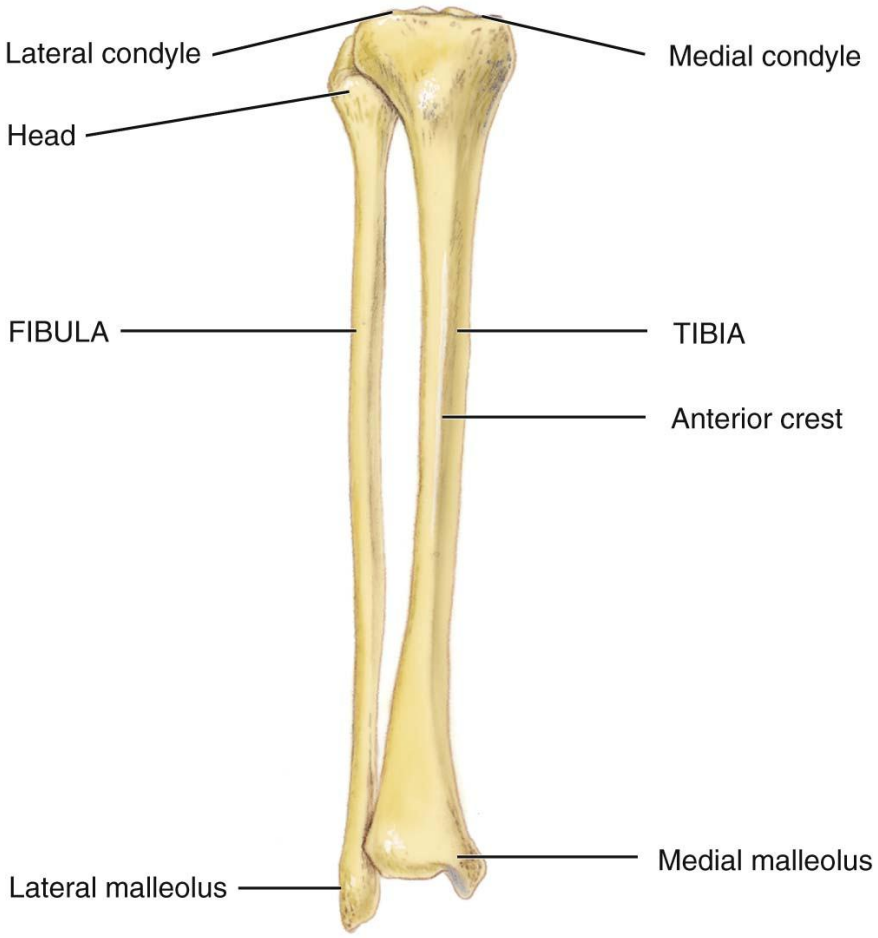
Leg

- Region between knee and ankle
- Consists of:
  - **Fibula:** lateral side
  - **Tibia:** medial side
    - Articulates with femur to form knee joint

Leg

- **Lateral malleolus:** projection at distal end of fibula
  - Forms lateral bulge of ankle
- **Tibial tuberosity:** attachment of ligaments associated with knee
- **Anterior crest:** sharp ridge on anterior surface of tibia
  - Forms the shin
- **Medial malleolus:** projection at distal end of tibia
  - Forms medial bulge of ankle

Leg

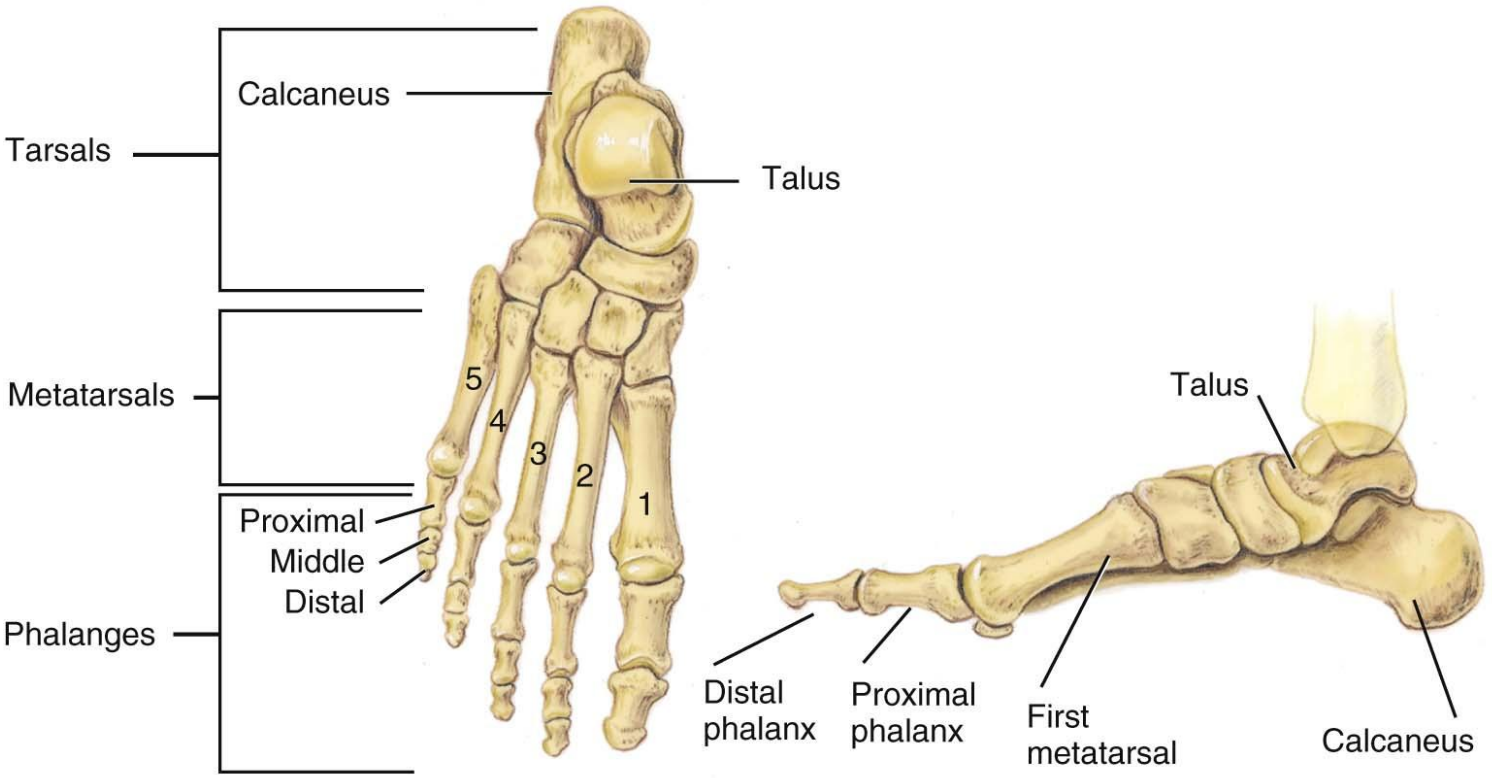


Anterior view (right)

Foot

- Composed of ankle, instep, and toes
- **Tarsus:** ankle
  - Contains seven **tarsal bones**
    - **Calcaneus** (heel bone): largest tarsal bone
    - **Talus:** articulates with tibia
- **Metatarsus:** instep
  - Contains five **metatarsal bones:** one in line with each toe
    - Distal ends of these bones form ball of foot
- **Phalanges**: bones of the toes
  - Three phalanges in each toe (a proximal, middle, and distal phalanx)
    - Except in great (or big) toe, which has two (lacks a middle phalanx)

Foot



Lower Extremity

- **Patella (kneecap)**
  - Flat, triangular bone
  - Enclosed within tendon that anchors anterior thigh muscle to tibia
  - Protects the knee joint

Articulations

- **Articulation** (joint): where two bones come together
- **Synarthroses**
  - Immovable joints
  - Singular form: synarthrosis
  - Bones come in very close contact
  - Are separated only by a thin layer of fibrous connective tissue
  - Example: **sutures** in the skull

Articulations

- **Amphiarthroses**
  - Slightly movable joints
  - Singular form: amphiarthrosis
  - Bones are connected by hyaline cartilage or fibrocartilage
  - Examples:
    - Ribs connected to sternum by costal cartilage (hyaline cartilage)
    - Symphysis pubis: fibrocartilage pad between two bones
    - Joints between the vertebrae (intervertebral discs)

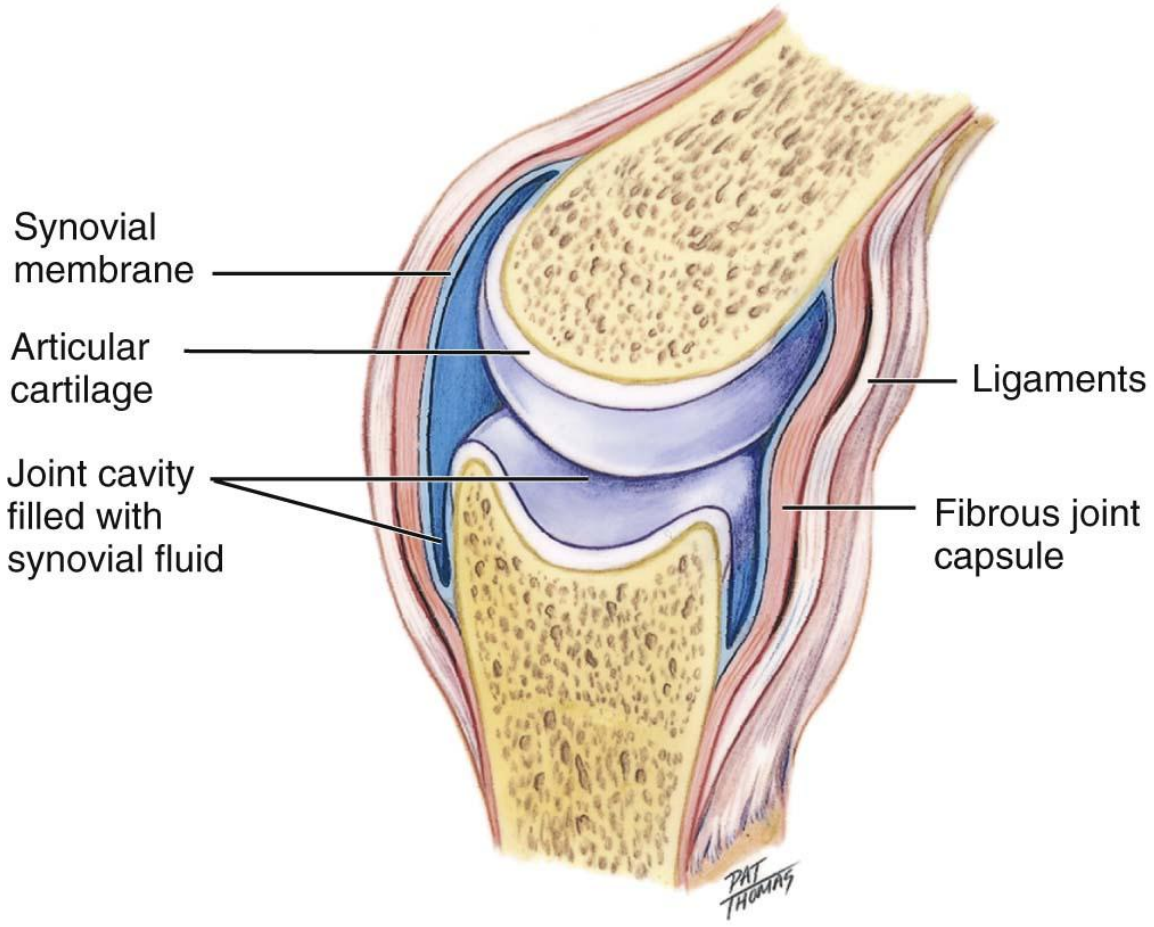
Diarthroses

- Makes up most joints in adult body
- Freely movable joints
- Singular form: diarthrosis
- **Articular cartilage:** covers the ends of the opposing bones
  - Consists of hyaline cartilage

Diarthroses

- **Joint cavity:** space that separates the opposing bones
- **Joint capsule:** encloses the components of the joint
  - Outer layer: consists of the ligaments that hold the bones together
  - Inner layer: **synovial membrane**
    - Secretes **synovial fluid** into the joint cavity for lubrication
- Because these joints have a synovial membrane: called **synovial joints**

Diarthroses



Diarthroses

- Some diarthroses have pads/cushions associated with them
  - Fibrocartilaginous pads in knee: **lateral meniscus** and **medial meniscus**
    - Help stabilize joint
    - Act as shock absorbers
  - **Bursae:** fluid-filled sacs
    - Act as a cushion: help reduce friction
    - **Bursitis:** inflammation of a bursa

Diarthroses

- **Types of diarthroses**
  - **Ball-and-socket:** widest range of movement
    - Examples: shoulder and hip
  - **Condyloid**
    - Examples: metacarpals and metatarsals with phalanges

Diarthroses

- **Types of diarthroses**
  - **Saddle**
    - Thumb joint
  - **Pivot:** permits rotation
    - Example: between atlas and axis
  - **Hinge:** flexion and extension only
    - Examples: elbow and knee
  - **Gliding**
    - Examples: carpals in wrist and tarsals in ankle

Highlight on Conditions Affecting the Skeletal System

Highlight on Conditions Affecting the Skeletal System

Ankylosing spondylitis (ANG-kih-loh-sing spahn-dih-LYE-tis) Inflammation of the spine that is characterized by stiffening of the spinal joints and ligaments so that movement becomes increasingly painful and difficult; also called *rheumatoid spondylitis*

Arthritis (ahr-THRYE-tis) Inflammation of a joint

Bunion (BUN-yun) Abnormal swelling of the joint between the big toe and the first metatarsal bone, resulting from a buildup of soft tissues and bone caused by chronic irritation from ill-fitting shoes

Carpal tunnel syndrome (KAHR-pull TUH-nul SIN-drohm) Condition characterized by pain and burning sensations in the fingers and hand, caused by compression of the median nerve as it passes between a wrist ligament and the bones and tendons of the wrist

Dislocation (dis-loh-KAY-shun) Displacement of a bone from its joint with tearing of ligaments, tendons, and articular capsule; also called *luxation*

Gout (GOWT) A form of acute arthritis in which uric acid crystals develop within a joint and irritate the cartilage, causing acute inflammation, swelling, and pain; most commonly occurs in middle-aged and older men

Lyme disease (LYME dih-ZEEZ) A bacterial disease transmitted to humans by deer ticks; characterized by joint stiffness, headache, fever and chills, nausea, and back pain; complications include severe arthritis and cardiac problems; early stages of the disease respond well to antibiotics

Osteoarthritis (ahs-tee-oh-ahr-THRYE-tis) A noninflammatory disease of the joints that is characterized by degeneration of the articular cartilage and changes in the synovial membrane; also called *degenerative joint disease* (DJD)

Osteomalacia (ahs-tee-oh-mah-LAY-shee-ah) Softening of bone because of inadequate amounts of calcium and phosphorus; bones bend easily and become deformed; in childhood this is called *rickets*

Osteomyelitis (ahs-tee-oh-my-eh-LYE-tis) Inflammation of the bone marrow caused by bacteria

Osteoporosis (ahs-tee-oh-por-OH-sis) Decrease in bone density and mass; commonly occurs in postmenopausal women as a result of increased osteoclast activity caused by diminished estrogen levels; bones fracture easily

Osteosarcoma (ahs-tee-oh-sahr-KOH-mah) Malignant tumor derived from bone; also called *osteogenic sarcoma;* osteoblasts multiply without control and form large tumors in bone

Rheumatoid arthritis (ROO-mah-toyd ahr-THRYE-tis) A chronic systemic disease with changes occurring in the connective tissues of the body, especially the joints; in contrast to osteoarthritis, the symptoms are usually more generalized and severe; evidence indicates it may be an autoimmune disease

Spina bifida (SPY-nah BIFF-ih-dah) A developmental anomaly in which the vertebral laminae do not close around the spinal cord, leaving an opening through which the cord and meninges may or may not protrude

Sprain (SPRAYN) Twisting of a joint with pain, swelling, and injury to ligaments, tendons, muscles, blood vessels, and nerves; most often occurs in the ankle; more serious than a strain, which is the overstretching of the muscles associated with a joint

Talipes (TAL-ih-peez) Congenital deformity of the foot in which the patient cannot stand with the sole of the foot flat on the ground; also called *clubfoot* ■