Objectives

• Understand the generalized functions of the skeletal system
• Identify long bone structures
• Understand how bones are formed
• Major subdivisions of skeleton and bones in each
• Major disorders of bones and joints
Functions of Skeletal System

- SUPPORT
- PROTECTION
- MOVEMENT
- STORAGE of calcium, a vital resource
- BLOOD CELL FORMATION—process is called hematopoiesis
Types of Bones

• Four major types, according to overall shape of the bone
  – Long—example: humerus (upper arm)
  – Short—example: carpals (wrist)
  – Flat—example: frontal (skull)
  – Irregular—example: vertebrae (spinal bones)
Types of Bones

• Structure of long bones
  – **Diaphysis**, or shaft—hollow tube of hard compact bone
  – **Medullary cavity**—hollow space inside the diaphysis that contains yellow marrow
  – **Epiphyses**, or ends, of the bone—made of spongy bone that contains red bone marrow
  – **Articular cartilage**—thin layer that covers each epiphysis; provides a cushion
  – **Periosteum**—strong, fibrous membrane covering bone everywhere except at joint surfaces
  – **Endosteum**—thin membrane that lines medullary cavity
Microscopic Structure of Bone and Cartilage

• Two major types of connective tissue: bone and cartilage
• Bone types
  – Spongy
    • Texture from needlelike threads of bone called *trabeculae* surrounded by network of open spaces
    • Found in epiphyses of bones
    • Spaces contain red bone marrow
Microscopic Structure of Bone and Cartilage

• Bone types
  – Compact
    • Structural unit is an osteon-calcified matrix arranged in multiple layers or rings called concentric lamella
    • Bone cells, called osteocytes,
Microscopic Structure of Bone and Cartilage

• Structural unit called osteon or Haversian system
Microscopic Structure of Bone and Cartilage

• Cartilage
  – Cell type called chondrocytes
  – Matrix is flexible gel-like substance and lacks blood vessels
Bone Formation and Growth

• New bone-forming cells are called **osteoblasts** and bone resorbing cells are called **osteoclasts**

• The ability of bone to ossify, grow, change shape, heal after injury, and respond to stress occurs because of continuous “sculpting” by osteoblasts and osteoclasts
Bone Formation and Growth

• Bone is formed by two processes
  – Most bones develop from a process called endochondral ossification
Bone Formation and Growth

• Endochondral bone formation
  – Bones develop from cartilage models
  – Center of ossification first appears in diaphysis
  – Centers of ossification then develop in epiphyses
Bone Formation and Growth

• Endochondral bone formation
  – Epiphyseal plate of cartilage between epiphyses and diaphysis remains until skeletal maturity
  – Epiphyseal line (bone) replaces epiphyseal plate (cartilage) when growth ceases
Bone Formation and Growth

• Early bone development (before birth) consists of cartilage and fibrous structures
• Cartilage models gradually replaced by calcified bone matrix—process called endochondral ossification
• Osteoblasts form new bone, and osteoclasts resorb bone
Divisions of Skeleton

• **Axial skeleton** (80 bones)
  – Skull
  – Spine, or vertebral column
  – Thorax

• **Appendicular skeleton** (126 bones)
  – Upper extremities, including shoulder (pectoral) girdle
  – Lower extremities, including hip (pelvic) girdle
Divisions of Skeleton

• **Axial Skeleton** composed of the following divisions and their subdivisions

• Spine or vertebral column
  • Cervical (7 bones)
  • Thoracic (12 bones)
  • Lumbar (5 bones)
  • Sacrum (1 bone)
  • Coccyx (1 bone)
Divisions of Skeleton

• Appendicular Skeleton composed of the following divisions and their subdivisions
  – Thorax
    • Composed of:
      – 12 pairs of ribs
      – Sternum or breastbone
      – Thoracic vertebrae
    • Ribs
      – True ribs—rib pairs 1 through 7
      – False ribs—rib pairs 8 through 10
      – Floating ribs—rib pairs 11 and 12
Divisions of Skeleton

– Appendicular skeleton (126 bones)
  • Bones in shoulder or pectoral girdle connect bones of upper extremity (arm, forearm, wrist, and hands) to axial skeleton
  • Bones in hip or pelvic girdle connect bones of lower extremity (thigh, leg, ankle, and foot) to axial skeleton
Divisions of Skeleton

• Skeleton composed of the following divisions and their subdivisions
  – Upper extremity
    • Shoulder or pectoral girdle formed by:
      – Scapula
      – Clavicle (frequently fractured)
    • Arm—humerus
    • Forearm—radius and ulna
    • Wrist—8 carpal bones
    • Hand—5 metacarpal bones
    • Fingers—14 phalanges or finger bones
Divisions of Skeleton

• Skeleton composed of the following divisions and their subdivisions
  – Lower extremity
    • Hip or pelvic girdle formed by the two coxal or pelvic bones (one on each side) with sacrum and coccyx behind
Divisions of Skeleton

• Skeleton composed of the following divisions and their subdivisions
  – Thigh bone—femur
    • Patella or kneecap articulates with femur and tibia
    • Lower leg—tibia ("shinbone") and fibula
Divisions of Skeleton

• Skeleton composed of the following divisions and their subdivisions
  – Foot
    • 5 metatarsal bones
    • 7 tarsal bones (calcaneus or heel bone is largest tarsal)
    • 14 phalanges or toe bones
    • 3 arches of foot—two longitudinal (medial and lateral) and a transverse or metatarsal arch—if weakened, result is “flat feet”
Differences Between a Man’s and a Woman’s Skeleton

- Size—male skeleton generally larger
- Shape of pelvis—male pelvis deep and narrow; female pelvis broad and shallow
- Size of pelvic inlet—female pelvic inlet generally wider; normally large enough for baby’s head to pass through it
- Pubic angle—angle between pubic bones of female generally wider
Joint (Articulations)

• Joint types classified by degree of movement
  – Synarthrosis (no movement)—fibrous connective tissue grows between articulating bones (e.g., sutures of skull)
  – Amphiarthrosis (slight movement)—cartilage connects articulating bones (e.g., symphysis pubis)
Joint (Articulations)

• Joint types
  – Diarthrosis (free movement)—most joints belong to this class
    • Structures of freely movable joints—joint capsule and ligaments hold adjoining bones together but permit movement at joint
    • Articular cartilage—covers joint ends of bones and absorbs jolts
    • Synovial membrane—lines joint capsule and secretes lubricating fluid
    • Joint cavity—space between joint ends of bones
Joint (Articulations)

- Freely movable joints
  - Ball-and-socket
  - Hinge
Skeletal Disorders

• Tumors of bone and cartilage
  – Osteosarcoma
    • Most common and serious malignant bone neoplasm
    • Frequent sites include distal femur and proximal tibia and humerus
  – Chondrosarcoma
    • Cancer of skeletal hyaline cartilage
    • Second most common cancer of skeletal tissues
Skeletal Disorders

• Metabolic bone diseases
  – Osteoporosis
    • Characterized by loss of calcified bone matrix and reduction in number of trabeculae in spongy bone
    • Bones fracture easily, especially in wrists, hips, and vertebrae
    • Treatment includes drug therapy, exercise, and dietary supplements of calcium and vitamin D
Skeletal Disorders

• Metabolic bone diseases
  – Rickets and osteomalacia—both diseases characterized by loss of bone minerals related to vitamins

• Rickets
  – Loss of bone minerals occurs in infants and young children before skeletal maturity
  – Lack of bone rigidity causes gross skeletal changes (bowing of legs)
  – Treated with vitamin D
Skeletal Disorders

• Metabolic bone diseases
  – *Osteogenesis* imperfecta (also called *brittle bone disease*)
    • Bones are brittle because of lack of organic matrix
    • Treatment may include splinting to reduce fracture and drugs that decrease cell activity
Skeletal Disorders

• Bone infection
  – Osteomyelitis
    • General term for bacterial (usually staphylococcal) infection of bone
    • Treatment may involve surgery, drainage of pus, and IV antibiotic treatment—often over prolonged periods
Skeletal Disorders

• Bone fractures
  – Open (compound) fractures pierce the skin and closed (simple) fractures do not
  – Fracture types include complete and incomplete, linear, transverse and oblique
• Joint disorders
  – Noninflammatory joint disorders—do not usually involve inflammation of the synovial membrane; symptoms tend to be local and not systemic
    • Osteoarthritis, or degenerative joint disease (DJD)
      – Most common noninflammatory disorder of movable joints—often called “wear and tear” arthritis
      – Symptoms: joint pain, morning stiffness
      – Most common cause for partial and total hip and knee replacements
Skeletal Disorders

• Joint disorders
  – Noninflammatory joint disorders
    • Traumatic injury
      – Dislocation or subluxation—articular surfaces of bones in joint are no longer in proper contact
      – Sprain—acute injury to ligaments around joints (e.g., whiplash type injuries)
      – Strain—acute injury to any part of the muscle, tendon, junction between the two, and attachments to bone)
Skeletal Disorders

• Joint disorders
  – Inflammatory joint disorders
    • *Arthritis*: general name for several inflammatory joint diseases that may be caused by infection, injury, genetic factors, and autoimmunity
    • Inflammation of the synovial membrane occurs, often with systemic signs and symptoms
Skeletal Disorders

• Joint disorders
  – Inflammatory joint disorders
    • Rheumatoid arthritis
      – Systemic autoimmune disease—chronic inflammation of synovial membrane with involvement of other tissues such as blood vessels, eyes, heart, and lungs
      – Gouty arthritis—synovial inflammation caused by gout, a condition in which sodium urate crystals form in joints and other tissues
      – Infectious arthritis—arthritis resulting from infection by a pathogen, as in Lyme arthritis and ehrlichioses, caused by two different bacteria that are transmitted to humans by tick bites
Osteoarthritis
Rheumatoid Arthritis and Gouty Arthritis