Ch. 12 Skeletal System

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Points to ponder

• What are the five functions of the skeletal system?
• What are the parts of a long bone?
• How do bones grow, remodel, and repair?
• How are hormones involved in bone growth?
• What is osteoporosis?
• How are age, gender, and ethnicity determined through skeletal remains?
• What are the components of the axial and appendicular skeletons?
• What are synovial joints and what kind of angular movements do they allow?
Skeletal System: Made of Connective Tissue

- Three types of connective tissue
  - Bone
  - Ligaments
  - Cartilage
Bone – Functions

- Five important functions
  1. Support
Bone – Functions

• Five important functions
  1. Support
  2. Protection
Bone – Functions

• Five important functions
  1. Support
  2. Protection
  3. Movement
Bone – Functions

• Five important functions
  1. Support
  2. Protection
  3. Movement
  4. Blood cell formation
Bone – Functions

• Five important functions
  1. Support
  2. Protection
  3. Movement
  4. Blood cell formation
  5. Mineral storage
     • Calcium
     • Phosphate
     • Some fat storage (yellow marrow)
Bone – Structure

- **Bone**: hard inorganic matrix of calcium salts
  - **Compact**: forms shaft and ends, contains marrow space
  - **Spongy**: trabeculae
  - **Types**: long, flat, irregular

- **Periosteum**: connective tissue covering

- **Parts of the long bone**:
  - **Diaphysis**: shaft made of compact filled w/ yellow marrow
  - **Epiphysis**: ends, made of spongy bone
  - **Articular cartilage**: hyaline cart @ ends on bones

Figure 5.1a

- Spongy bone (spaces contain red bone marrow)
- Compact bone
- Yellow bone marrow
- Blood vessel
- Periosteum
- Central cavity (contains yellow bone marrow)

a) A partial cut through a long bone.
Bone – Structure (Review)

- Osteons/Haversian system: cellular arrangement
- Osteoblasts → build bone
- Osteoclasts → breakdown bone
- Osteocytes → mature bone cells

b) A closer view of a section of bone. Compact bone is a nearly solid structure with central canals for the blood vessels and nerves.
Cartilage and Ligaments

• Cartilage
  ➢ Function: support
  ➢ Types
    • Fibrocartilage
    • Hyaline
    • Elastic cartilage

• Ligaments
  ➢ Function: attach bone to bone
  ➢ Dense fibrous CT
Bone Development

- **Fetus: First 2 months**
  - Developing periosteum
  - Blood vessel

- **Fetus: At 2–3 months**
  - Cartilage growth plate

- **Childhood**
  - Cartilage growth Plate (epiphyseal)
  - Compact bone containing osteocytes

- **Adolescence**

**a)** *Chondroblasts* form hyaline cartilage, creating a rudimentary model of future bone.

**b)** The periosteum begins to develop and cartilage starts to dissolve. Newly developing blood vessels transport osteoblasts into the area from the periosteum.

**c)** Osteoblasts secrete osteoid and enzymes, facilitating the deposition of hard hydroxyapatite crystals.

**d)** The growth plates in long bones move farther apart and osteoblast activity continues just below the periosteum. The bone lengthens and widens.
How do bones lengthen?

12.5 Bone Growth and Homeostasis

Chondroblasts deposit new cartilage at the outer surface
Osteoblasts convert cartilage to bone at the inner surface

Figure 12.12 Increasing bone length.
Hormonal Control of Bone Growth

• Preadolescence
  ➢ **Growth hormone** stimulates bone lengthening

From Lord of the Flies
Hormonal Control of Bone Growth

• Early Adolescence
  ➢ Estrogen & testosterone stimulate bone lengthening
Hormonal Control of Bone Growth

• Late Adolescence
  ➢ Estrogen/testosterone cause replacement of cartilage growth plates with bone

• Changes in shape, size, strength
  ➢ Dependent on diet, exercise, age
Mature Bone Remodeling and Repair

- Bone cells regulated by hormones
  - Parathyroid hormone (PTH): removes calcium from bone
  - Calcitonin: adds calcium to bone
- Repair: hematoma and callus formation
Bone remodeling

- Diameter increases
- Bone absorption inside the shaft
- Matched by bone formation outside the shaft

Figure 12.13 Bone remodeling.
Figure 12.14  Bone repair following a fracture.
Abigail’s left arm
Abigail’s left arm
Human Skeleton

- 270 bones → 206 bones
- **Axial skeleton**
  - Skull, vertebral column, sternum
- **Appendicular skeleton**
  - Pectoral girdle, pelvic girdle, limbs
12.2 Bones of the Axial Skeleton

The 206 bones of the skeleton

Figure 12.2 The axial and appendicular skeletons.
Bones of the face and the hyoid bone

Figure 12.4  The bones of the face and the location of the hyoid bone.
Axial Skeleton: The vertebral column

- **Vertebral column**
  - Regions: cervical (7), thoracic (12), lumbar (5), sacral (5 fused), coccygeal (3-4 fused)
  - Intervertebral disks: cushion vertebrae; assist in movement and flexibility

- **Ribs**
  - Twelve pairs

- **Sternum: breastbone**
  - Manubrium, sternum & xiphoid process

- **Intervertebral disks**
  - Fibrocartilage btn vertebrae
Vertebrate Column conditions

- Kyphosis
- Lordosis
- Scoliosis
Axial Skeleton: Vertebral Column

a) Healthy disks.
b) A herniated disk.
Axial Skeleton: Vertebral Column (cont.)

Manubrium

Sternum (breastbone)

Ribs

Cartilage

Vertebral column

Floating ribs

Xiphoid process
Appendicular Skeleton

• Pectoral girdle: shoulder
  ➢ Clavicle and scapulas

• Pelvic girdles: hip
  ➢ Ilium, ischium & pubis

• Limbs
  ➢ Arms: humerus, radius, ulna, carpals (wrist), metacarpals (hand bones) & phalanges (fingers)
  ➢ Legs: femur, tibia, fibula, tarsals (ankle), metatarsals (foot bones) & phalanges (toes)
Appendicular Skeleton

Pectoral girdle

- Clavicle (collar bone)
- Scapula (shoulder blade)

Humerus (upper arm)

- Ulna
- Radius

Forearm

- 8 Carpals (wrist)
- 5 Metacarpals (hand)
- 14 Phalanges (finger bones)

Figure 5.10

Carpal bones
- Metacarpals
- Phalanges
Appendicular Skeleton

Coxal bones and sacrum (pelvis)
- Femur (upper leg)
- Patella (knee cap)
- Lower leg
  - Tibia
  - Fibula
- 7 Tarsals (ankle)
- 5 Metatarsals (foot)
- 14 Phalanges (toe bones)

Figure 5.11

Illium

Ischium

Pubis

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Appendicular Skeleton
Male vs Female Pelvis

- Male pelvis: Opening is smaller, more obstructed.
  - Pubic arch is V shaped.

- Female pelvis: Opening is larger & less obstructed.
  - Pubic arch is U shaped.
Joints (Articulations): where bones meet bones

- Classified by degree of movement
  - **Fibrous joint**: immovable (e.g., fontanels)
  - **Cartilaginous joint**: slightly movable, cartilage connection (e.g., backbone)
  - **Synovial joint**: freely movable
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12.4 Articulations

Anatomy of a synovial joint

Figure 12.9 The structure of a synovial joint.

a. A gymnast depends on flexible joints.

b. Generalized synovial joint

c. Ball-and-socket joint

d. Hinge joint

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Synovial Joints

- Joint capsule: synovial membrane + hyaline cartilage
- Synovial membrane secretes synovial fluid as a lubricant
- Hyaline cartilage acts as a cushion
- Types of synovial joints
  - Hinge joint
  - Ball and socket joint
- Tendons – join bone to muscle
Figure 5.12

b) A view of the knee with muscles, tendons, and ligaments in their normal position surrounding the intact joint capsule. The combination of ligaments, tendons, and muscles holds the knee tightly together.

a) A cutaway anterior view of the right knee with muscles, tendons, and the joint capsule removed and the bones pulled slightly apart so that the two menisci are visible.
Abduction: Movement of a limb away from a body’s midline
Adduction: Movement of a limb toward the body’s midline

a) Abduction and adduction.
b) Rotation and circumduction.
c) Flexion, extension, and hyperextension.
d) Supination and pronation.
12.4 Articulations

Visualizing synovial joints movements

Figure 12.10  Synovial joints allow for a variety of movement.

Flexion: Joint angle decreases.  
Extension: Joint angle increases.  
Adduction: Body part moves toward midline.  
Abduction: Body part moves away from midline.  
Rotation: Body part moves around its own axis.  
Supination: Hand faces anterior or downward.  
Pronation: Hand faces posterior or downward.  
Circumduction: Body part moves so that a cone shape is outlined.  
Eversion: Sole of foot turns outward.

Figure 12.10  Synovial joints allow for a variety of movement.
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Diseases and Disorders of the Skeletal System

• **Sprains**: stretched or torn ligaments
Diseases and Disorders of the Skeletal System

- **Bursitis** and **tendinitis**: inflammations

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Diseases and Disorders of the Skeletal System

- **Arthritis**: inflammation of joints
  - Osteoarthritis
  - Rheumatoid arthritis
Osteoporosis

• Osteoporosis bones are weakened
  – decreased bone mass

• Age 40: Bone reabsorption exceeds absorption

• Risk factors include: women, white or Asian, thin, family history, early menopause, smoking, diet low in calcium, excessive caffeine or alcohol consumption, and a sedentary lifestyle
Diseases and Disorders of the Skeletal System

- Osteoporosis
Fig. 12C

a. Normal bone

b. Osteoporosis

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a) A scanning electron micrograph (SEM) of normal bone.

b) SEM of a bone showing osteoporosis.
Disorders of the Skeletal System

- Avascular Necrosis
- Bone spur (osteophyte)
- Osteogenesis Imperfecta
- Osteomyelitis (bone infection)