Chapter 5
The Skeletal System

Day 1 Notes:
The Skeletal System

- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments (bone to bone) (tendon = bone to muscle)
- Divided into two divisions
  - Axial skeleton: bones of the skull, vertebral column, and rib cage
  - Appendicular skeleton: bones of the upper and lower limbs, shoulder and hip
Functions of Bones

- Support of the body
- Protection of soft organs
- Movement due to attached skeletal muscles
- Storage of minerals and fats
- Blood cell formation
Bones of the Human Body

• The adult skeleton has 206 bones
• Two basic types of bone tissue
  • Compact bone
    • Homogeneous
  • Spongy bone
    • Small needle-like pieces of bone
    • Many open spaces
Classification of Bones on the Basis of Shape

(a) Long bone (e.g., humerus of arm)
(b) Short bones (e.g., carpals of wrist)
(c) Flat bone (e.g., parietal bone of skull)
(d) Irregular bone (e.g., vertebra)

Figure 5.1
Classification of Bones

1. Long bones
   - Typically longer than wide
   - Have a shaft with heads at both ends
   - Contain mostly compact bone
   - Examples: Femur, humerus
Classification of Bones

2. Short bones
   - Generally cube-shape
   - Contain mostly spongy bone
     - Examples: Carpals, tarsals
Classification of Bones

- 3. Flat bones
  - Thin and flattened
  - Usually curved
  - Thin layers of compact bone around a layer of spongy bone
  - Examples: Skull, ribs, sternum
Classification of Bones

4. Irregular bones
   - Irregular shape
   - Do not fit into other bone classification categories
     - Example: Vertebrae and hip
Gross Anatomy of a Long Bone

- **Diaphysis**
  - Shaft (middle)
  - Composed of compact bone

- **Epiphysis**
  - Ends of the bone
  - Composed mostly of spongy bone
Structures of a Long Bone

1. Periosteum
   - Outside covering of the diaphysis
   - Fibrous connective tissue membrane

2. Sharpey’s fibers
   - Secure periostemeum to underlying bone

3. Arteries
   - Supply bone cells with nutrients

Figure 5.2c
Structures of a Long Bone

• 4. Articular cartilage
  • Covers the external surface of the epiphyses
  • Made of hyaline cartilage
  • Decreases friction at joint surfaces
Structures of a Long Bone

- **5. Medullary cavity**
  - Cavity of the shaft
  - Contains *yellow* marrow (mostly fat) in adults
  - Contains *red* marrow (for blood cell formation) in infants
Bone Markings

- Surface features of bones
- Sites of attachments for muscles, tendons, and ligaments
- Passages for nerves and blood vessels
- Categories of bone markings
  - Projections and processes – grow out from the bone surface
  - Depressions or cavities – indentations
Changes in the Human Skeleton

- In embryos, the skeleton is primarily hyaline cartilage
- During development, much of this cartilage is replaced by bone
- Cartilage remains in isolated areas
  - Bridge of the nose
  - Parts of ribs
  - Joints
Bone Growth

• Epiphyseal plates allow for growth of long bone during childhood
  • New cartilage is continuously formed
  • Older cartilage becomes ossified
  • Cartilage is broken down
  • Bone replaces cartilage
Bone Growth

- Bones are remodeled and lengthened until growth stops
  - Bones change shape somewhat
  - Bones grow in width
Long Bone Formation and Growth

Figure 5.4a
Types of Bone Cells

- Osteocytes
  - Mature bone cells
- Osteoblasts
  - Bone-forming cells
- Osteoclasts
  - Bone-destroying cells
  - Break down bone matrix for remodeling and release of calcium
STOP: What’s Next?
- Bone Fractures
- How Bones Heal
- Axial Skeleton
- The Skull
Bone Fractures

• A break in a bone

• Types of bone fractures
  • Closed (simple) fracture – break that does not penetrate the skin
  • Open (compound) fracture – broken bone penetrates through the skin

• Bone fractures are treated by reduction and immobilization
  • Realignment of the bone
### Common Types of Fractures

<table>
<thead>
<tr>
<th>Fracture type</th>
<th>Illustration</th>
<th>Description</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comminuted</td>
<td><img src="image1.png" alt="Comminuted Illustration" /></td>
<td>Bone breaks into many fragments.</td>
<td>Particularly common in the aged, whose bones are more brittle.</td>
</tr>
<tr>
<td>Compression</td>
<td><img src="image2.png" alt="Compression Illustration" /></td>
<td>Bone is crushed. (i.e., osteoporotic bones).</td>
<td>Common in porous bones</td>
</tr>
<tr>
<td>Depressed</td>
<td><img src="image3.png" alt="Depressed Illustration" /></td>
<td>Broken bone portion is pressed inward.</td>
<td>Typical of skull fracture.</td>
</tr>
<tr>
<td>Impacted</td>
<td><img src="image4.png" alt="Impacted Illustration" /></td>
<td>Broken bone ends are forced into each other.</td>
<td>Commonly occurs when one attempts to break a fall with outstretched arms</td>
</tr>
<tr>
<td>Spiral</td>
<td><img src="image5.png" alt="Spiral Illustration" /></td>
<td>Ragged break occurs when excessive twisting forces are applied to a bone.</td>
<td>Common sports fracture.</td>
</tr>
<tr>
<td>Greenstick</td>
<td><img src="image6.png" alt="Greenstick Illustration" /></td>
<td>Bone breaks incompletely, much in the way a green adults.</td>
<td>Common in children, whose bones are more flexible than those of</td>
</tr>
</tbody>
</table>

**Table 5.2**
Repair of Bone Fractures

• Hematoma (blood-filled swelling) is formed

• Break is splinted by fibrocartilage to form a callus

• Fibrocartilage callus is replaced by a bony callus

• Bony callus is remodeled to form a permanent patch
Stages in the Healing of a Bone Fracture

1. Hematoma formation
2. Fibrocartilage callus formation
3. Bony callus formation
4. Bone remodeling

Figure 5.5
The Axial Skeleton

- Divided into three parts
  - Skull
  - Vertebral column
  - Bony thorax
The Skull

- Two sets of bones
  - Cranium
  - Facial bones
- Bones are joined by sutures
- Only the mandible is attached by a freely movable joint
The Skull

Figure 5.7

Coronal suture
Parietal bone
Temporal bone
Lambdoid suture
Squamous suture
Occipital bone
Zygomatic process
External auditory meatus
Mastoid process
Styloid process
Mandibular ramus
Frontal bone
Sphenoid bone
Ethmoid bone
Lacrimal bone
Nasal bone
Zygomatic bone
Maxilla
Alveolar margins
Mandible (body)
Mental foramen
Bones of the Skull

Figure 5.11
Human Skull, Inferior View

- Maxilla
- Palatine bone
- Hard palate
- Zygomatic bone
- Temporal bone
- Vomer
- Mandibular fossa
- Styloid process
- Mastoid process
- Temporal bone
- Parietal bone
- Maxilla
- Sphenoid bone
- Foramen ovale
- Carotid canal
- Foramen magnum
- Occipital condyle
- Jugular foramen
- Temporal bone (greater wing)
Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity
Paranasal Sinuses

- Functions of paranasal sinuses
  - Lighten the skull
  - Give resonance and amplification to voice

Figure 5.10
The Hyoid Bone

- The only bone that does not articulate (move) with another bone
- Serves as a moveable base for the tongue

Figure 5.12
The Fetal Skull

- The fetal skull is large compared to the infant’s total body length.
The Fetal Skull

- Fontanelles – fibrous membranes connecting the cranial bones

  - Allow the brain to grow
  - Convert to bone within 24 months after birth

Figure 5.13
Stop:
What’s Next?
The Upper half of the body
The Vertebral Column

- Vertebrae separated by intervertebral discs
- The spine has a normal curvature
- Each vertebrae is given a name according to its location

Figure 5.14
The Bony Thorax

- Forms a cage to protect major organs

Figure 5.19a
The Bony Thorax

• Made-up of three parts
  • Sternum
  • Ribs
  • Thoracic vertebrae
The Appendicular Skeleton

- Limbs (appendages)
- Pectoral girdle
- Pelvic girdle
The Appendicular Skeleton

Figure 5.6c
The Pectoral (Shoulder) Girdle

- Composed of two bones
  - Clavicle – collarbone
  - Scapula – shoulder blade
- These bones allow the upper limb to have exceptionally free movement
Bones of the Shoulder Girdle

(a) Articulated pectoral girdle

Figure 5.20a, b
Bones of the Upper Limb

• The arm is formed by a single bone
  • Humerus

Figure 5.21a, b
Bones of the Upper Limb

The forearm has two bones:

- Ulna
- Radius

Figure 5.21c
Bones of the Upper Limb

- The hand
  - Carpals – wrist
  - Metacarpals – palm
  - Phalanges – fingers
Bones of the Pelvic Girdle

- Hip bones
- Composed of three pair of fused bones
  - Ilium
  - Ischium
  - Pubic bone
- The total weight of the upper body rests on the pelvis
- Protects several organs
  - Reproductive organs
  - Urinary bladder
  - Part of the large intestine
The Pelvis

Iliac crest
Sacroiliac joint
Pelvic brim
Ischial spine
Acetabulum
Pubic symphysis

(a)

Coxal bone (or hip bone)
Ilium
Sacrum
Pubic bone
Coccyx
Ischium

Pubic arch

Figure 5.23a
Gender Differences of the Pelvis

Figure 5.23c
STOP
What’s Next?
Lower half of the body
Bones of the Lower Limbs

- The thigh has one bone
  - Femur – thigh bone
Bones of the Lower Limbs

- The leg has two bones
  - Tibia
  - Fibula

Figure 5.35c
Bones of the Lower Limbs

- The foot
  - Talus – ankle
  - Metatarsals –
  - Phalanges – toes

Figure 5.25
Stop 😊 What’s Next?
-Joints
-Pathologies
Joints

- Articulations of bones
- Functions of joints
  - Hold bones together
  - Allow for mobility
- Ways joints are classified
  - Functionally
  - Structurally
Functional Classification of Joints

- **Synarthroses** – immovable joints
- **Amphiarthroses** – slightly moveable joints
- **Diarthroses** – freely moveable joints
Structural Classification of Joints

- Fibrous joints
  - Generally immovable
- Cartilaginous joints
  - Immovable or slightly moveable
- Synovial joints
  - Freely moveable
Fibrous Joints

- Bones united by fibrous tissue – synarthrosis or largely immovable.

Figure 5.27d, e
Cartilaginous Joints – mostly amphiarthrosis

• Bones connected by cartilage

• Examples
  • Pubic symphysis
  • Intervertebral joints

Figure 5.27b, c
Synovial Joints

- Articulating bones are separated by a joint cavity
- Synovial fluid is found in the joint cavity

Figure 5.27f–h
Features of Synovial Joints - Diarthroses

- Articular cartilage (hyaline cartilage) covers the ends of bones
- Joint surfaces are enclosed by a fibrous articular capsule
- Have a joint cavity filled with synovial fluid
- Ligaments reinforce the joint
Structures Associated with the Synovial Joint

• Bursae – flattened fibrous sacs
  • Lined with synovial membranes
  • Filled with synovial fluid
  • Not actually part of the joint

• Tendon sheath
  • Elongated bursa that wraps around a tendon
The Synovial Joint

Figure 5.28

- Acromion of scapula
- Ligament
- Bursa
- Ligament
- Joint cavity containing synovial fluid
- Articular (hyaline) cartilage
- Synovial membrane
- Fibrous articular capsule
- Humerus
- Tendon sheath
- Tendon of biceps muscle
Types of Synovial Joints Based on Shape

Figure 5.29a–c
Types of Synovial Joints Based on Shape

Figure 5.29d–f
Inflammatory Conditions Associated with Joints

• Bursitis – inflammation of a bursa usually caused by a blow or friction

• Tendonitis – inflammation of tendon sheaths

• Arthritis – inflammatory or degenerative diseases of joints
  • Over 100 different types
  • The most widespread crippling disease in the United States
Clinical Forms of Arthritis

• Osteoarthritis
  • Most common chronic arthritis
  • Probably related to normal aging processes

• Rheumatoid arthritis
  • An autoimmune disease – the immune system attacks the joints
  • Symptoms begin with bilateral inflammation of certain joints
  • Often leads to deformities
**A Healthy Joint**

In a healthy joint, the ends of bones are encased in smooth cartilage. Together, they are protected by a joint capsule lined with a synovial membrane that produces synovial fluid. The capsule and fluid protect the cartilage, muscles, and connective tissues.

**A Joint With Osteoarthritis**

With osteoarthritis, the cartilage becomes worn away. Spurs grow out from the edge of the bone, and synovial fluid increases. Altogether, the joint feels stiff and sore.