The Skeletal System

- Parts of the skeletal system
  - Bones (skeleton)
  - Joints
  - Cartilages
  - Ligaments
- Divided into two divisions
  - Axial skeleton
  - Appendicular skeleton
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

Figure 5.2b
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)
Classification of Bones

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

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

- 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

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

- **Diaphysis**
  - **Shaft**
    - Composed of compact bone
- **Epiphysis**
  - Ends of the bone
  - Composed mostly of spongy bone

Figure 5.2a
Structures of a Long Bone

- Periosteum
  - Outside covering of the diaphysis
  - Fibrous connective tissue membrane
  - Sharpey’s fibers
    - Secure periosteum to underlying bone
- Arteries
  - Supply bone cells with nutrients

Figure 5.2c
Structures of a Long Bone

- Articular cartilage
  - Covers the external surface of the epiphyses
  - Made of hyaline cartilage
  - Decreases friction at joint surfaces

Figure 5.2a
Structures of a Long Bone

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

Figure 5.2a
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
Microscopic Anatomy of Bone

- Osteon (Haversian System)
  - A unit of bone
- Central (Haversian) canal
  - Opening in the center of an osteon
  - Carries blood vessels and nerves
- Perforating (Volkman’s) canal
  - Canal perpendicular to the central canal
  - Carries blood vessels and nerves
Microscopic Anatomy of Bone

- **Lacunae**
  - Cavities containing bone cells (osteocytes)
  - Arranged in concentric rings
- **Lamellae**
  - Rings around the central canal
  - Sites of lacunae
- **Canaliculi**
  - Tiny canals
  - Radiate from the central canal to lacunae
  - Form a transport system
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
Long Bone Formation and Growth

**Growth**
Bone grows in length because:

1. Cartilage grows here
2. Cartilage replaced by bone here
3. Cartilage grows here
4. Cartilage replaced by bone here

**Remodeling**
Growing shaft is remodeled by:

1. Bone resorbed here
2. Bone added by appositional growth here
3. Bone resorbed here
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
- Bone remodeling is a process by both osteoblasts and osteoclasts
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
<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="image" 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="image" alt="Compression Illustration" /></td>
<td>Bone is crushed.</td>
<td>Common in porous bones (i.e., osteoporotic bones).</td>
</tr>
<tr>
<td>Depressed</td>
<td><img src="image" 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="image" 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="image" 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="image" alt="Greenstick Illustration" /></td>
<td>Bone breaks incompletely, much in the way a green twig breaks.</td>
<td>Common in children, whose bones are more flexible than those of adults.</td>
</tr>
</tbody>
</table>
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
PART A

The Skeletal System

ESSENTIALS
OF HUMAN
ANATOMY
& PHYSIOLOGY
EIGHTH EDITION

ELAINE N. MARIEB
The Axial Skeleton

- Forms the longitudinal part of the body
- Divided into three parts
  - Skull
  - Vertebral column
  - Bony thorax
Figure 5.6

The Axial Skeleton
The Skull

- Two sets of bones
  - Cranium
  - Facial bones

- Bones are joined by sutures

- Only the mandible is attached by a freely movable joint
Paranasal Sinuses

- Hollow portions of bones surrounding the nasal cavity

Figure 5.10
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 with another bone
- Serves as a moveable base for the tongue
The Fetal Skull

- The fetal skull is large compared to the infants total body length

Figure 5.13
The Fetal Skull

- Fontanelles – fibrous membranes connecting the cranial bones
  - Allow the brain to grow
  - Convert to bone within 24 months after birth
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
Structure of a Typical Vertebrae

Figure 5.16

- **Posterior**
  - Lamina
  - Transverse process
  - Superior articular process and facet
  - Vertebral arch

- **Anterior**
  - Vertebral foramen
  - Body
  - Pedicle
Regional Characteristics of Vertebrae

Figure 5.17a–b
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 Skeletal System

PowerPoint® Lecture Slide Presentation by Jerry L. Cook, Sam Houston University

ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY
EIGHTH EDITION

ELAINE N. MARIEB
The Appendicular Skeleton

- Limbs (appendages)
- Pectoral girdle
- Pelvic girdle
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 shoulder (pectoral) girdle

(b) Right clavicle
Bones of the Shoulder Girdle

(c) Right scapula, posterior aspect

(d) Right scapula, anterior aspect
The arm is formed by a single bone

- Humerus
Bones of the Upper Limb

- The forearm has two bones
  - Ulna
  - Radius
Bones of the Upper Limb

- The hand
  - Carpals – wrist
  - Metacarpals – palm
  - Phalanges – fingers

Figure 5.22
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

Figure 5.23a

- Iliac crest
- Sacroiliac joint
- Pelvic brim
- Ischial spine
- Acetabulum
- Pubic symphysis
- Sacrum
- Hip bone (Coxal bone)
- Pubic bone
- Ischium
- Coccyx
- Public arch (a)
Gender Differences of the Pelvis

Figure 5.23c

(c) Pubic arch (more than 90°)

Pelvic brim

False pelvis

Inlet of true pelvis

Pubic arch (less than 90°)
Bones of the Lower Limbs

- The thigh has one bone
  - Femur – thigh bone

Figure 5.24a–b
Bones of the Lower Limbs

- The leg has two bones
  - Tibia
  - Fibula
Bones of the Lower Limbs

- The foot
  - Tarsus – ankle
  - Metatarsals – sole
  - Phalanges – toes
Arches of the Foot

- Bones of the foot are arranged to form three strong arches
  - Two longitudinal
  - One transverse
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

Examples

- Sutures
  - Allows more movement than sutures
  - Example: distal end of tibia and fibula

- Syndesmoses

Figure 5.27a–b
Cartilaginous Joints

- Bones connected by cartilage

- Examples
  - Pubic symphysis
  - Intervertebral joints

Figure 5.27d–e
Synovial Joints

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

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

(a) Plane joint
(b) Hinge joint
(c) Pivot joint

(c) Humerus
(b) Ulna
(a) Carpals

(f) Nonaxial
(b) Uniaxial
(c) Biaxial
(d) Multiaxial

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
Clinical Forms of Arthritis

- Gouty Arthritis
  - Inflammation of joints is caused by a deposition of urate crystals from the blood
  - Can usually be controlled with diet
Developmental Aspects of the Skeletal System

- At birth, the skull bones are incomplete.
- Bones are joined by fibrous membranes – fontanelles.
- Fontanelles are completely replaced with bone within two years after birth.