Bones and Bone Tissue

Skeletal system

= __________, __________, __________

Bones are main organs:
- osseous tissue
- dense regular and irregular CT, plus bone marrow

Functions of the Skeletal System

• Functions:
  1. Protection

  Protection: Skeleton protects vital organs such as the brain.

  Brain

  2. Mineral storage and ______________

  Mineral storage and acid-base homeostasis:
  Bone stores minerals such as Ca\(^{2+}\) and PO\(_4^3-\), which are necessary for electrolyte and acid-base balance.
Functions of the Skeletal System

3. **Blood cell formation**: _______________ involved in formation of blood cells (hematopoiesis or hemopoiesis)

4. **Fat storage**: in **yellow bone marrow** of _______________

5. **Movement**: bones are sites for *skeletal muscle attachment*

6. **Support**: *supports weight* and provides _______________

Figure 6.1 Functions of the skeletal system.
Functions of the Skeletal System

1. Protection
2. Mineral Storage
3. Blood cell formation
4. Fat Storage
5. Movement
6. Support

Bone Structure Classification
(based on shape)

1. Long bones
   - longer than they are wide;
   - include most bones in arms and legs

2. Short bones
   - roughly cube-shaped
   - include carpals and ________

Figure 6.1 Functions of the skeletal system.

Figure 6.2a Classification of bones by shape.
Bone Structure

3. Flat bones
   – thin and broad bones
   - ribs, pelvis, sternum and __________________

4. Irregular bones
   – include ________ and certain skull bones

5. Sesamoid bones
   – located within ___________
   - patella (kneecap)

Figure 6.2c Classification of bones by shape.
Bone Structure

Structure of long bone:

- **Periosteum**
  - membrane surrounds outer surface
- **Perforating fibers (Sharpey’s fibers)**
  - *anchors periosteum* firmly to bone surface
- **Diaphysis**
- **Epiphysis** - _______ of long bone (proximal & distal)
- **Articular cartilage** – hyaline cartilage
- **Marrow cavity** – contains bone marrow (red or yellow)
- **Endosteum** – thin membrane lining marrow cavity

---

Bone Structure

- **Compact bone**
  - hard, dense outer region
  - allows bone to resist stresses (compression & twisting)

- **Spongy bone (__________ bone)**
  - found inside cortical bone
  - *honeycomb-like framework* of bony struts;
  - resist forces from many directions

*Figure 6.9* Structure of compact bone.
Bone Structure

• **Epiphyseal lines**
  – separates epiphyses from diaphysis
  - remnants of epiphyseal plates

• **Epiphyseal plates (__________ plates)**
  - hyaline cartilage found in developing bones of children

Bone Structure

• **Structure of short, flat, irregular, and sesamoid bones**
  - covered by *periosteum*
  - *diploë* = two outer layers of thin compact bone with middle layer of *spongy bone*
  - *sinuses* = air-filled spaces
Bone Marrow Transplantation (p. 187)

- Diseases of blood
- Needle is inserted into pelvic bone
- Recipient’s marrow is *destroyed*
- **Complications** –
- Many recipients can return to a healthy life if transplant “takes”

**Microscopic Structure**

**Extracellular matrix of bone:**
- **Inorganic matrix** (65%)
  - consisting of \[\text{hydroxyapatite salts of Ca & P}\]
- **Organic matrix** (35%)
  - osteoid
  - consists of collagen fibers and *usual ECM*
Bone Cells

Bone cells:
- Osteogenic – differentiate into osteoblasts
- Osteoblasts – ____________
- Osteocytes – mature bone cells in lacunae
- Osteoclasts
  - bone __________
  - secrete acid and enzymes

Figure 6.6 Types of bone cells.

Figure 6.7 Functions of osteoblasts and osteocytes.
**Histology of Bone**

**Structure of compact bone:**

- Osteon (Haversian system)
  - Lamellae = concentric rings of thin layers of bone
  - Central canal = contains blood vessels & nerves
  - Lacunae = ________ for osteocytes
  - Canaliculi = ________
  - Perforating canals (Volkmann's canals)
    - perpendicular to central canals

*Figure 6.9 Structure of compact bone.*
Histology of Bone

- **Structure of spongy bone**
  - usually not wt. bearing
  - not organized into osteons

  - *trabeculae* =

![Figure 6.10 Structure of spongy bone.](image)

Ossification

- **Ossification (osteogenesis)**
  - Process of bone formation
  - Begins in embryonic period and continues throughout adulthood

  ![fetal “skeleton”](image) [14 weeks]

  - cartilage template
  - endochondral
  - fibrous CT
  - intramembranous

  BONE
Intramembranous Ossification

- **Intramembranous ossification**
  - forms many ________ (bones of skull and clavicles)
  - formed within a *mesenchymal* ____________
  - spongy bone ossifies **before** outer compact bone layers
  - forms **primary ossification center**

- ____________ = areas of incomplete intramembranous ossification

---

**Figure 6.11** The process of intramembranous ossification.
Intramembranous Ossification

Figure 6.11 The process of intramembranous ossification.

Endochondral Ossification

• **Endochondral ossification (Figure 6.12):**
  – Bone development for all bones below head except ___________
  – Many bones *complete ossification* by age 7
Endochondral Ossification

- Endochondral ossification
  - bones begin within hyaline ____________
  - Hyaline cartilage model made of chondrocytes, collagen, and ECM surrounded by CT perichondrium
  - Cartilage breaks down
  - Collar formation (periosteum)
  - __________ ossification center mid-diaphysis
  - secondary ossification centers at __________

Most bones of skeleton formed this way.

---

Endochondral Ossification

Cartilage is replaced by bone.

Figure 6.12 The process of endochondral ossification.
Endochondral Ossification

Cartilage remains at epiphyseal plate and articular ends.

Figure 6.12 The process of endochondral ossification.

Osteoporosis and Healthy Bones (p. 192)

• Most common bone disease in U.S

• Diagnosed by bone density measurement

• Causes – dietary (calcium and/or vitamin D deficiency)

• Prevention

• Treatment
Growth in Length

• Long bones lengthen via **longitudinal growth**; involves division of __________ (not osteocytes or osteoblasts) in epiphysial plate
• Bone growth takes place at epiphysis on side *closest to diaphysis*

Figure 6.13 Structure of the epiphyseal plate.

Figure 6.14 Growth at the epiphyseal plate.
Growth in Length

• **Epiphyseal plate**
  1. **Zone of reserve cartilage** – (found closest to epiphysis) contains cells that are not directly involved in bone growth but can be recruited for cell division if need arises
  2. **Zone of proliferation** - consists of actively dividing chondrocytes by endochondral ossification
  3. **Zone of hypertrophy and maturation** (next region closer to diaphysis) contains mature chondrocytes
  4. **Zone of calcification** (second to last region) contains dead chondrocytes, some of which have been calcified. *Calcified cartilage is replaced with bone.*
  5. **Zone of ossification** (last region) consists of calcified chondrocytes and osteoblasts

Growth in Length

• Longitudinal growth continues at epiphyseal plate as long as mitosis continues in zone of proliferation:
  – Mitotic rate slows around ages of 12-15 years old
    Between ages of 18-21 epiphyseal plate is closed
  – _____________ is a calcified remnant of epiphyseal plate
Growth in Length

Figure 6.14 Growth at the epiphyseal plate.

Growth in Width

**Appositional growth** = _________________

- Osteoblasts, *lay down new bone*
  - Appositional growth does **not** result in immediate formation of osteons; instead, *new circumferential lamellae* are formed
  - Bones may *continue to increase in width* even after epiphyseal plates have *closed* and bone is no longer *lengthening*
Achondroplasia (p. 199)

• Most common cause of **dwarfism**; gene defect

• Defective gene produces an *abnormal growth factor receptor*

• Bones form and grow abnormally;

• Long-term problems

---

Role of Hormones in Bone Growth

• _________ (GH) – secreted by *anterior pituitary gland*; enhances protein synthesis and cell division in most all tissues, including bone

• ________________ - pronounced effect on bone growth:
  – Increases appositional growth in males
  – Increases *rate of mitosis in epiphyseal plate*; leads to “growth spurts” in teenage years

• **Estrogen** also plays a role in bone growth:
  – Increases *rate of longitudinal growth* and inhibits osteoclasts
  – Accelerates closure of epiphyseal plate at much faster rate than testosterone → *average height differences* between gender
Gigantism and Acromegaly (p. 200)

- Excess GH can produce two conditions, depending on when in life it develops; both generally caused by a ________ that secretes hormone

- Childhood – condition is ___________

- Adulthood – condition is ___________

Bone Remodeling

- Bone remodeling = new bone is formed by bone _________ and old bone is removed by bone ___________
  – Maintenance of calcium ion homeostasis
  – Replacement of old brittle bone with newer bone
  – Adaptation to tension and stress
Bone Remodeling

- **PTH** (parathyroid hormone from parathyroid gland)
  - Stimulates effects that **increase** blood Ca\(^{+2}\) levels
    - Increases osteoclast activity
    - Increases *absorption* of calcium from gut
    - Inhibits calcium *loss* in urine

- **Calcitonin** (from thyroid gland)
  - Causes **decrease** blood Ca\(^{+2}\) levels
    - Inhibits osteoclasts
    - Increases calcium *loss* in urine

---

**Thyroid Gland**
- Secretes CALCITONIN

**Parathyroid Glands**
- Secretes PTH
Bone Remodeling

Factors influencing bone remodeling are summarized:

- Compressive load or exercise
- Tension placed on bone
- Testosterone
- Adequate dietary intake of calcium and vitamins C, D, and K
- Estrogen
- Calcitriol
- Increase in blood calcium ion concentration
- Inadequate exercise
- Inadequate dietary intake of calcium or vitamins C, D, or K

Increased osteoblast activity
- Decreased osteoclast activity
- Increased osteoblast activity
- Increased osteoclast activity
- Continuous pressure placed on bone
- Parathyroid hormone
- Decrease in blood calcium ion concentration

Increased bone deposition
- Decreased bone deposition
- Increased bone resorption

Figure 6.15 Structure of the epiphyseal plate.

Figure 6.16 Factors that influence bone remodeling.
Bone Repair

Fractures:

– Simple fractures vs __________ fractures
– Spiral
– Compression
– Comminuted
– Avulsion
– Greenstick
– Epiphyseal plate
Skeletal System = _______ bones plus cartilages
- Axial (80 bones)
- Appendicular (126 bones)

Structure of the Skeletal System and Skeletal Cartilages

Figure 7.1 Divisions of the skeletal system.
Structure of the Skeletal System and Skeletal Cartilages

- **Axial skeleton**
  - Skull, vertebral column, thoracic cage (ribs, sternum),

- **Appendicular skeleton**
  - Bones of pectoral girdle, upper limb, pelvic girdle, and lower limb

  **Pectoral girdle** – _______________; *anchors* upper limb to trunk

  **Pelvic girdle** – ________________ bones; *anchors* lower limb to trunk

Bone Markings

<table>
<thead>
<tr>
<th>Bone Marking</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
</table>
| Fossa (plural, fossae) | Indentation in a bone into which another structure fits | |}
| Fovea | Shallow pit | |}

*Table 7.1 Bone Markings.*
### Bone Markings

#### Table 7.1 Bone Markings

<table>
<thead>
<tr>
<th>Bone Marking</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foramen</td>
<td>Foramen</td>
<td>Foramen (skull)</td>
</tr>
<tr>
<td>Head</td>
<td>Head</td>
<td>Head (skull)</td>
</tr>
<tr>
<td>Canal (meatus)</td>
<td>Canal (meatus)</td>
<td>Canal (meatus)</td>
</tr>
<tr>
<td>Condyle</td>
<td>Condyle</td>
<td>Condyle (femur)</td>
</tr>
</tbody>
</table>

#### Table 7.1 Bone Markings (continued)

<table>
<thead>
<tr>
<th>Bone Marking</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protuberance</td>
<td>Outgrowth from a bone</td>
<td>Occipital bone: External occipital protuberance</td>
</tr>
<tr>
<td>Trochanter</td>
<td>Large projection only on the femur</td>
<td>Femur: Greater trochanter</td>
</tr>
<tr>
<td>Line</td>
<td>Long, narrow ridge</td>
<td>Femur: Línea aspera</td>
</tr>
</tbody>
</table>
Overview of Skull Structure

- Skull = 22 bones organized in *two groups*:
  - **Cranial bones** – collectively known as **cranium**, composed of ____ bones
    (STEP OFF my skull)
    - Frontal -1
    - Occipital -1
    - Ethmoid -1
    - Sphenoid – 1
    - Parietal – 2
    - Temporal - 2

*Figure 7.2* Basic structure of the skull: anterolateral view of the cranial and facial bones.
Overview of Skull Structure

– **Facial bones** = ________ bones
  • Maxillary – 2
  • Zygomatic -2
  • Nasal -2
  • Lacrimal -2
  • Palatine -2
  • Inferior nasal concha -2
  • Mandible -1
  • Vomer -1

Overview of Skull Structure

• Sinuses = ____________, membrane-lined *spaces*;
  **paranasal sinuses** = frontal, ethmoid, sphenoid, maxillary
Understanding How Skull Bones Relate to Each Other

Figure 7.10 Disarticulated skull.

Cavities of the Skull

- **Orbit** – FLEZMS *fused bones*; form walls that encase eyeball, lacrimal gland, and their associated blood vessels, muscles, and nerves (Figure 7.11)
  - Frontal bone
  - Lacrimal
  - Ethmoid
  - Zygomatic
  - Maxilla
  - Sphenoid bone
  - and _________ bones
The Fetal Skull

Fontanel (soft spot) = area of incomplete

---

The Fetal Skull

Figure 7.14a Fetal skull.

Figure 7.14c Fetal skull.
Hyoid Bone

- **Hyoid**
  - doesn’t *articulate* with any *other* bones
  - C-shaped bone
  - Provides numerous muscle attachment points involved in ________________

Forensic Skull Anatomy *(p. 229)*

- Forensic investigators often must identify human remains with little to go on except bones; can provide many clues (particularly skull); one of most basic traits that can be identified from a skull is *gender*
- Four obvious differences:
Overview of the Vertebral Column

**Vertebral column** (spine) – composed of *about ______ bones (vertebrae)*

- 7 **cervical** – located in ______
- 12 **thoracic** – articulate with ______
- 5 **lumbar** – in __________

- 5 fused **sacral** (collectively called **sacrum**)
- 3–5 fused **coccygeal** (collectively called **coccyx**)

---

**Forensic Skull Anatomy**

Male skull  Female skull
Overview of the Vertebral Column

• **Spinal curvatures** – C-shaped vertebral column of newborn → S-shaped secondary curvatures as infant grows
  – Primary curvatures (________ and sacral) present **during** fetal dev.
  – Secondary curvatures (________ and lumbar) dev. **after** fetal period

Overview of the Vertebral Column

• **Abnormal spinal curvatures:**
  o **Scoliosis** – abnormal ________ curvatures
  o **Lordosis** (swayback) – exaggerated cervical and ________ curvatures
  o **Kyphosis** (hunchback)
    – exaggeration of ________ curvature
Structure of the Vertebrae

Figure 7.18 Basic structure of vertebrae.

- **Cervical (7)** – smallest vertebrae
  - ________ foramina allows passage of vertebral arteries and veins
  - $C_1$ (_____)
    - Lacks vertebral body
    - Articulates with occipital condyles and $C_2$
  - $C_2$ (_____)
    - Dens (odontoid process) protrudes from body
    - Allows for rotational movement of head at neck;
      (shaking your head “no”)
Structure of the Vertebrae

- **Thoracic vertebrae** (12)
  - long spinous processes
  - **Superior** and **inferior costal facets**
    (articulate with **head of rib**)
  - **Transverse costal facets** on transverse processes
    (articulate with __________ on rib)

Posterior view: Shaped like giraffe head

- **Lumbar vertebrae** (5) – *largest* and *heaviest* of all vertebrae (______________)

Posterior view- shaped like moose head
Table 7.3 Comparison of Cervical, Thoracic, and Lumbar Vertebrae.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cervical Vertebrae</th>
<th>Thoracic Vertebrae</th>
<th>Lumbar Vertebrae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body shape and size</td>
<td>Small and oval(C1 has the dens on the superior surface of its body)</td>
<td>Larger and heart-shaped; contain costal facets</td>
<td>Largest and kidney-shaped</td>
</tr>
<tr>
<td>Vertebral foramen shape</td>
<td>Triangular</td>
<td>Circular</td>
<td>Flat or triangular</td>
</tr>
<tr>
<td>Transverse processes</td>
<td>Contains transverse foramina</td>
<td>Long, contain articular facets for ribs</td>
<td>Short with no facets or foramina</td>
</tr>
<tr>
<td>Spinous processes</td>
<td>Most are fork-shaped, C1 lacks a spinous process</td>
<td>Long, point inferiorly</td>
<td>Thick, point posteriorly</td>
</tr>
</tbody>
</table>

Table 7.3 Comparison of Cervical, Thoracic, and Lumbar Vertebrae.

Structure of the Vertebrae

- **Sacrum** – 5 fused sacral vertebrae
  - **Sacral promontory** – bony projection at anterior margin of base (superior aspect)
  - **Sacral foramina** – 4 pairs of holes allows for

- **Coccyx** = 4 fused (3-5) vertebrae
Study Boost: Remembering Skull Bones and Vertebrae

- **PEST OF 6** (*six cranial bones*): Parietal, Ethmoid, Sphenoid, Temporal, Occipital, Frontal


- **For Easier Sinus Memorization** (*paranasal sinuses*): Frontal, Ethmoidal, Sphenoidal, Maxillary

- **Breakfast at 7, lunch at 12, dinner at 5** (*number of vertebrae*): 7 cervical, 12 thoracic, and 5 lumbar
Intervertebral Discs

• **Intervertebral disc**
  = *fibrocartilage pad* found between bodies vertebrae
  • **Nucleus pulposus** – *jelly-like* substance; shock absorber
  • **Anulus fibrosus** – outer ring of __________

Herniated disc or “slipped disc”

Herniated Disc *(p. 238)*

• A tear in anulus fibrosus can allow nucleus pulposus to *protrude*, a condition known as a **herniated disc** (commonly called a **slipped disc**)
• Bulging nucleus pulposus *compresses* nerve
• Treatments
The Thoracic Cage

• Thoracic cage
  =
  
  —sternum

  • Manubrium — superiormost
  • Body - middle
  • Xiphoid process - inferior

The Thoracic Cage

Rib cage = 12 pairs of ribs and their costal cartilages

• Ribs 1–7 (_____ ribs or vertebrosternal ribs) attach to sternum via their costal cartilages
• Ribs 8–12 (_____ ribs) not directly attached to sternum
  —Vertebrochondral ribs 8–10 — attached to cartilage of 7th rib
  —_____ or vertebral
  
  ribs 11 & 12
  - are not attached to sternum
The Thoracic Cage

Figure 7.25 Structure of a typical rib.

The Sternum and CPR (p. 239)

• Cardiopulmonary resuscitation (CPR)

• Correct placement of hands on sternum is critical
The Pectoral Girdle

- **Pectoral girdle** – clavicle and scapula
- **Clavicle**
  - Sternal end
  - Acromial end

**Figure 7.26** Overview of the bones of the pectoral girdle and upper limb.

The Pectoral Girdle

- **Scapula**
  - Acromion
  - Coracoid process
  - Subscapular fossa (anterior aspect)
  - Glenoid cavity (articulates with head of humerus)
  - Spine (_________ ridge)
  - Supraspinous fossa
  - Infraspinous fossa
The Humerus

- **Humerus**
  - head articulates with *glenoid cavity* at shoulder joint
  - ________ neck is a groove surrounding head
  - ________ neck proximal diaphysis
  - **greater & lesser tubercle** lateral and anterior to head
  - olecranon fossa
  - coronoid fossa
  - capitulum
  - trochlea

Bones of the Forearm

**Bones of forearm (antebrachium)**

- **Radius** (_______ bone)
  - head, neck, radial tuberosity, styloid process

- **Ulna** (_______)
  - trochlear notch, olecranon, coronoid process, radial notch, styloid process
Bones of the Wrist: Carpals

Wrist (carpus) – ________________ (carpals)
(lateral to medial)
- Scaphoid, Lunate, Triquetrum, Pisiform (proximal)
- Trapezium, Trapezoid

Bones of the Hand and Fingers:
Metacarpals and Phalanges

Metacarpals – 5 each hand
Phalanges – 14 each hand
- proximal, middle, and distal __________
- Thumb
  proximal &
  distal phalanx
Wrist Fractures \((p. 247)\)

- Wrist is the most *frequently injured* region of upper limb;

- Fractures

  *Colles fracture*

Bones of the Pelvic Girdle and Lower Limb

**Pelvic girdle =**
- *coxal bones* (also known as *os coxae*)
- Articulates with *sacrum* (axial skeleton)

**Pelvis** – bowl-shaped sacrum and two coxal bones; creates *boundary* for pelvic cavity
- **Pelvic inlet** – oval *opening* formed by sacrum and pelvic girdle
- **Pelvic brim** – bony *ridge* surrounding inlet that defines boundaries between *greater* and *lesser pelvis*
Bones of the Pelvic Girdle and Lower Limb

• Each _________ is composed of 3 fused bones: **ilium, ischium, and pubis**
Bones of the Pelvic Girdle and Lower Limb

Female and male pelvis differ between genders:
  - female pelvis (adapted for childbirth) is wider and shallower than male

- **Shape of greater pelvis:**
  - pelvis is wider in females with flared iliac crests
  - increases distance between ASIS

- **Coccyx and sacrum:**
  - female sacrum is wider and shorter than male sacrum
  - while female coccyx is more moveable and more posterior than male

Bones of the Pelvic Girdle and Lower Limb

- **Pelvic inlet and outlet:** female inlet is usually wider and oval-shaped whereas male inlet is narrow and heart-shaped; female outlet is generally wider than male

- **Acetabula:** generally farther apart in females and pointed more anteriorly than in males

- **Pubic arch:**
  - angle measured in females =
  - male arch measures between
Bones of the Pelvic Girdle

<table>
<thead>
<tr>
<th>FEMALE PELVIS</th>
<th>CHARACTERISTICS</th>
<th>MALE PELVIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide</td>
<td>Greater pelvis</td>
<td>Narrow</td>
</tr>
<tr>
<td>Wider, shorter</td>
<td>Sacrum</td>
<td>Narrower, longer</td>
</tr>
<tr>
<td>Farther apart</td>
<td>Acetabula</td>
<td>Closer together</td>
</tr>
<tr>
<td>Oval shape</td>
<td>Pelvic inlet</td>
<td>Heart shape</td>
</tr>
<tr>
<td>90°–100° angle</td>
<td>Pubic arch</td>
<td>60°–70° angle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anterior view</td>
</tr>
</tbody>
</table>

Figure 7.36 Differences between the female and male pelves.

The Femur and Patella

- **Femur** – *largest* and *strongest* bone
  - head articulates with __________ at hip joint
  - Neck
  - Greater and Lesser trochanter
  - Linea aspera
  - Medial and a lateral condyles
  - Patellar surface

- **Patella**
Bones of the Leg: Tibia and Fibula

- **Tibia** (_______ bone) larger bone, wt. bearing
  - Tibial tuberosity
  - Medial malleolus

- **Fibula** (_______ bone)
  - Lateral malleolus

Bones of Ankle and Foot: Tarsals, Metatarsals, and Phalanges

- **Tarsals** – 7 short bones
  - Proximal tarsals: ________, calcaneus, and navicular
  - Distal tarsals medial to lateral: 3 cuneiforms (medial, intermediate, lateral) and cuboid

- **Metatarsals** – 5 in each foot
- **Phalanges**
  - 14 in each foot
Bones of Ankle and Foot: Tarsals, Metatarsals, and Phalanges

Figure 7.39a, b  The ankle and foot.

The Study Boost: Remembering Bones of the Arm and Leg

Carpals: Stop Letting The People Touch The Cadaver’s Hand = Scaphoid, Lunate, Triquetrum, Pisiform, Trapezium, Trapezoid, Capitate, Hamate
(Mentions “hand”, so remember that it describes carpals, not tarsals; trapeziUM is by thUMb)

Tarsals: College Needs Me In Lab Classes = Talus, Calcaneus, Navicular; Medial, Intermediate, & Lateral cuneiform, Cuboid
Articulations (joints) = where bones meet
- allow __________
- provide __________
- allow long bones to _________ (epiphyseal plate)

Functional Classification
Based on __________:
• Synarthrosis – no movement between articulating bones
• Amphiarthrosis – small amount of movement between articulating bones
• Diarthrosis – freely moveable, allowing a wide variety of specific movements
Structural Classification

Based on their __________ features:

- **Fibrous joints** – dense regular collagenous CT; (synarthroses or amphiarthroses)

- **Cartilaginous joints** – cartilage; (synarthroses or amphiarthroses)

- **Synovial joints** – fluid-filled joint capsule with hyaline cartilage at articular ends; (diarthrosis)

---

Fibrous Joints

3 types:
- **Suture**
- **Gomphosis**
- **Syndesmosis**

**Suture** - fibrous CT
___________ of cranium; *immoveable* joint

*Figure 8.1a* The three types of fibrous joints.
Fibrous Joints

- **Gomphosis** – tooth in bony socket (periodontal ligament); ___________ joint

- **Syndesmosis** – joint between tibia & fibula, ulna & radius (interosseous membrane); ______________

Figure 8.1b The three types of fibrous joints.

Cartilaginous Joints

2 types:
- Synchondrosis
- Symphysis

**Synchondrosis** - *hyaline cartilage*;
Synarthroses (epiphyseal plate, 1st sternocostal and costochondral joints); ______________
Epiphyseal Plate Fractures (p. 260)

• **Epiphyseal plate** in a child’s long bone is one of the *weakest parts* of a developing skeleton;

• Treatment

Fibrous Joints

• **Symphysis** – *fibrocartilaginous pad; amphiarthrosis*

  – __________

  – Pubic symphysis
Synovial Joints

Synovial Joints:

– **Joint cavity** *(synovial cavity)* – space found between articulating bones

– **Articular capsule** – double-layered structure
  * Outer fibrous layer
  * Inner synovial membrane → synovial fluid (lubricates, metabolic fcn., shock absorber)

- ________ **cartilage** – hyaline cartilage; *covers all* exposed articulating bones within a joint

– **Diarthrosis**

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**Structural Elements**

*Figure 8.3 Structure of a typical synovial joint.*
Stabilizing and Supporting Factors

• Synovial joints allow **more mobility**
  – **less stable** than other joint types
- structures that provide additional stabilization:
  **Ligament** – dense regular CT connects ___________
  **Tendon** - dense regular CT connects ___________

**Bursae and tendon sheaths**
  provide stabilization forces

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**Bursitis** *(p. 264)*

• **Bursitis**

• Most *common sites* of bursitis

• Clinical features
Arthritis

• **Arthritis** – defined as *inflammation* of one or more joints which results in pain and limitations of joint movement:
  – **Osteoarthritis (OA)** – most common; associated with ____________, *injuries*, and advanced *age*;
    characterized by pain, joint stiffness, and lost mobility
  – **Rheumatoid arthritis (RA)** – associated with joint destruction; ____________
  – **Gouty arthritis** – joint damage due to inflammatory reaction to ________________deposits

Movements at Synovial Joints

• **Gliding movements** – *sliding motion* between articulating surfaces
• **Flexion, Extension, Hyperextension**
• **Abduction, Adduction**
• **Circumduction, Rotation**
• **Inversion, Eversion**
• **Supination, Pronation**
• **Dorsiflexion, Plantar flexion**
Movements at Synovial Joints

**Gliding movement**

- Abduction of shoulders and hips
- Adduction of shoulders and hips
- Circumduction of shoulder

**Flexion, Extension, Hyperextension**

- Dorsiflexion, Plantarflexion
- Rotation at C1-C2
- Inversion, Eversion

**Dorsiflexion, Plantarflexion**
Types of Synovial Joints

• **Plane joint** (gliding joint) – most simple and least mobile articulation between *flat surfaces* of two bones

• **Hinge joint** – *convex* articular surface of one bone interacts with *concave* depression of second bone

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Figure 8.11a The six types of synovial joints and motion allowed at each.

Types of Synovial Joints

• **Pivot joint** – one bone pivots or rotates around other

• **Condylar (ellipsoid) joint** – *convex* surface of one bone fits into *concave* articular surface of a second bone

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Figure 8.11c The six types of synovial joints
Types of Synovial Joints

- **Saddle joint** – each bone’s articulating surface has both a *concave* and *convex* region

  ![Saddle joint, biaxial: carpometacarpal joint of thumb](image)

  Figure 8.11e The six types of synovial joints.

- **Ball-and-socket joint** – spherical surface of one bone fits into *cup-shaped depression* in second bone

  ![Ball-and-socket joint, multiaxial: shoulder joint](image)

  Figure 8.12 The Big Picture of Joint Classifications and Stability versus Mobility.
Specific Hinge Joints

**Elbow** – very stable hinge joint (Figure 8.13):

- **Humeroulnar joint** – articulation between *trochlea* of humerus and *trochlear notch* of ulna

- **Humeroradial joint** – articulation between *capitulum* of humerus and *head* of radius
Specific Hinge Joints

- **Knee:**
  - ____________ joint – articulation between femoral and tibial condyles
  - **Patellofemoral joint** – articulation between posterior surface of patella and anterior patellar surface of femur

- **Medial and lateral meniscus** – fibrocartilage pads between femoral and tibial condyles

- **Tibial collateral ligament** (medial collateral) – connects femur, medial meniscus, and tibia to one another to provide *medial joint stabilization*
Specific Hinge Joints

Figure 8.14a, b Anatomical structure of the knee joint.

A&P Flix: Movement at the Knee Joint
Knee Injuries and the Unhappy Triad (p. 276)

Specific Hinge Joints

- **Shoulder** (____________) – ball-shaped head of **humerus** and **glenoid cavity**:
  - **Glenoid labrum** – fibrocartilaginous ring; increases depth of glenoid cavity to provide more **stability**
  - **Biceps brachii tendon** - helps keep head of humerus **within** glenoid cavity
  - **Rotator cuff**, providing **most** of joint’s structural stabilization: ______________, **infraspinatus**, **subscapularis**, and ____________
Figure 8.15c, d Anatomical structure of the shoulder joint.

A&P Flix: Movement at the Glenohumeral Joint
Specific Hinge Joints

• **Hip** (acetabulum) – *acetabulum* and ball-shaped head of femur:
  – **Acetabular labrum** – fibrocartilaginous ring that helps to stabilize head of femur within acetabulum

Figure 8.16c, d  Anatomical structure of the hip joint.
A&P Flix: Movement at the Hip Joint

Hip Joint Replacement Surgery (p. 279)

- **Hip replacement** – surgical procedure that replaces a painful damaged joint with an *artificial prosthetic device*
- Severe *arthritis, trauma, fractures*, and *bone tumors* can all progress to point where hip joint replacement is an option
Hip Joint Replacement Surgery (p. 279)

- Total replacement

- Partial replacement