**Skeletal System – Axial & Appendicular**

**AXIAL Skeleton – The Skull**
Formed by two sets of bones
1. Cranial bones (cranium) - enclose the brain in the cranial cavity; provides site of attachment for head and neck muscles
   - 8 Cranial Bones – frontal, parietal (2), occipital, temporal (2), sphenoid, ethmoid
   - 4 sutures mark articulations of parietal bones with frontal, occipital, and temporal bones..... coronal suture (between parietal/frontal); sagittal (between parietal bones); lambdoid suture (between parietal/occipital); squamous suture (between parietal/temporal)
2. Facial bones – contains cavities for senses, openings for air and food passage and site of attachment for teeth and muscles
   - 14 Facial Bones – mandible, maxillae (2), zygomatic (2), nasal (2), lacrimal (2), palatine (2), vomer, inferior nasal conchae (2)

Paranasal Sinuses - mucosa-lined, air-filled spaces; Sinuses lighten skull, enhance resonance of voice, warm and humidify air. Found in the frontal, sphenoid, ethmoid and maxillary bones.

Hyoid Bone – not a bone of the skull and does not articulate directly with another bone; site of attachment for muscles of swallowing and speech.
(a) Inferior view of the skull (mandible removed)

(b) Superior view of the skull, calvaria removed
AXIAL Skeleton – The Vertebrae
- Transmits weight of trunk to lower limbs; surrounds and protects spinal cord.
- Flexible curved structure containing 26 irregular bones (vertebrae) in five major regions
  1. Cervical vertebrae (7)
  2. Thoracic vertebrae (12)
  3. Lumbar vertebrae (5)
  4. Sacrum
  5. Coccyx

Vertebral Curvatures – Increase resilience and flexibility of spine
- Cervical and lumbar curvatures - concave posteriorly
- Thoracic and sacral curvatures - convex posteriorly

Abnormal spine curvatures
1. Scoliosis - abnormal lateral curve
2. Kyphosis (hunchback) – exaggerated thoracic curvature
3. Lordosis (swayback) – accentuated lumbar curvature

Intervertebral Disc - cushionlike pad composed of two parts
- Nucleus pulposus - inner gelatinous nucleus; gives disc its elasticity and compressibility
- Anulus fibrosus - outer collar composed of collagen and fibrocartilage
Vertebrae Structure –
- Body or centrum - anterior weight-bearing region
- Vertebral arch - composed of pedicles and laminae that, along with centrum, enclose vertebral foramen
- Vertebral foramina - together make up vertebral canal for spinal cord
- Intervertebral foramina - lateral openings between adjacent vertebrae for spinal nerves
- Seven processes per vertebra: Spinous process (projects posteriorly), Transverse processes (project laterally), Superior articular processes (protrude superiorly), Inferior articular processes (protrude inferiorly)

CERVICAL vertebrae -
- C₁ to C₇: smallest, lightest vertebrae
- C₃ to C₇ share following features: oval body; spinous processes are bifid (except C₇); large, triangular vertebral foramen; transverse foramen in each transverse process; C₇ is vertebra prominens
Atlas & Axis – C₁ (atlas) & C₂ (axis)

- **Atlas** (C₁) - no body or spinous process; consists of anterior and posterior arches, and two lateral masses; superior surfaces of lateral masses articulate with occipital condyles; movement for "Yes"

- **Axis** (C₂) - dens projects superiorly into anterior arch of atlas; is "missing" body of atlas; dens is a pivot for rotation of atlas; movement for "No"

**THORACIC vertebrae** – T₁ to T₁₂

- All articulate with ribs at facets and demifacets
- Long, spinous process that points inferiorly
- Circular vertebral foramen
- Location of articular facets allows rotation of this area of spine
**LUMBAR vertebrae - L₁ to L₅**
- Receives most stress
- Short, thick pedicles and laminae
- Flat hatchet-shaped spinous processes point posteriorly
- Vertebral foramen triangular
- Orientation of articular facets locks lumbar vertebrae together to prevent rotation

**SACRUM & COCCYX**
- Sacrum – 5 fused vertebrae (S₁–S₅); forms posterior wall of pelvis; articulates with L₅ superiorly, and with auricular surfaces of hip bones, forming sacroiliac joints
- Coccyx – tailbone; 3–5 fused vertebrae; articulates superiorly with sacrum
**AXIAL Skeleton – The Thoracic Cage**

- Composed of: thoracic vertebrae, sternum and costal cartilages, ribs
- Functions: protects vital organs of thoracic cavity; supports shoulder girdles and upper limbs; provides attachment sites for muscles of neck, back, chest, and shoulders

**Sternum** – contains 3 fused bones
- Manubrium
- Body
- Xiphoid process – not ossified until ~age 40

**Ribs** – 12 pairs
- All attach posteriorly to bodies and transverse processes of thoracic vertebrae
- Pairs 1-7: True ribs - attach directly to sternum by costal cartilages
- Pairs 8-12: False ribs -- pairs 8–10: attach indirectly to sternum by joining costal cartilage of rib above; pairs 11–12: floating ribs

**Main parts of ribs** -
- Head - articulates with facets (demifacets) on bodies of two adjacent vertebrae
- Neck - constricted portion beyond head
- Tubercle (lateral to neck) - articulates posteriorly with transverse costal facet of same-numbered thoracic vertebra
- Shaft - most of rib
APPENDICULAR Skeleton – Pectoral Girdle

**Clavicle**
- Attach upper limbs to axial skeleton; provide attachment sites for muscles that move upper limbs

**Acromial (lateral) end**
- Anterior
- Posterior

- **Acromial end**
- **Sternal (medial) end**

**Scapula**
- Between ribs 2 and 7; flat and triangular, with three borders and three angles; several large fossae named according to location

- **Acromion**
- **Supraspinous fossa**
- **Infraspinous fossa**
- **Spine**
- **Supraglenoid tubercle**
- **Coracoid process**
- **Glenoid cavity**
- **Infraglenoid tubercle**
- **Subscapular fossa**
- **Coracoid process**
- **Suprascapular notch**
- **Acromion**
- **Glenoid cavity at lateral angle**
- **Lateral border**
- **Medial border**
- **Superior border**
- **Subscapular fossa**
- **Inferior angle**
- **Superior angle**
**APPENDICULAR Skeleton - The Upper Limb** (30 bones)

Humerus – articulates with glenoid cavity of scapula & radius/ulna

- **Ulna & Radius**
  - Ulna - forms major portion of elbow joint with humerus
  - Radius - head articulates with capitulum of humerus and radial notch of ulna
  - Interosseous membrane connects radius and ulna along their entire length
Carpals – 8 bones
- Proximal row (lateral to medial) - Scaphoid, lunate, triquetrum, and pisiform
- Distal row (lateral to medial) - Trapezium, trapezoid, capitate, and hamate
- Only scaphoid, lunate, and triquetrum form wrist joint

Metacarpals (palm) – 5 metacarpal bones form the palm (I to V from thumb to little finger)

Phalanges (fingers) – fingers numbered I to V starting at thumb (pollex); digit 1 has 2 bones (no middle phalanx) & digits II to V have 3 bones (distal, middle and proximal phalanx)
APPENDICULAR Skeleton – Pelvic Girdle

- Two coxal bones – attach lower limbs to axial skeleton with ligaments; transmit weight of upper body to lower limbs and supports pelvic organs
- Less mobility but more stable than shoulder joint
- Three fused bones form coxal bone -- ilium, ischium, and pubis
- Bony pelvis formed by coxal bones, sacrum, and coccyx
Comparison of female & male pelvis

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>FEMALE</th>
<th>MALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>General structure and functional</td>
<td>Tilted forward; adapted for childbearing; true pelvis defines the</td>
<td>Tilted less far forward; adapted for support of a male’s heavier</td>
</tr>
<tr>
<td>modifications</td>
<td>birth canal; cavity of the true pelvis is broad, shallow, and has a</td>
<td>build and stronger muscles; cavity of the true pelvis is narrow and</td>
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<tr>
<td></td>
<td>greater capacity</td>
<td>deep</td>
</tr>
<tr>
<td>Bone thickness</td>
<td>Less; bones lighter, thinner, and smoother</td>
<td>Greater; bones heavier and thicker, and markings are more</td>
</tr>
<tr>
<td>Acetabula</td>
<td>Smaller; farther apart</td>
<td>prominent</td>
</tr>
<tr>
<td>Pubic angle/arch</td>
<td>Broader (80° to 90°), more rounded</td>
<td>Angle is more acute (50° to 60°)</td>
</tr>
<tr>
<td>Anterior view</td>
<td></td>
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**APPENDICULAR Skeleton – The Lower Limb**

*Femur* – largest and strongest bone in the body; length ~ ¼ of person’s height

*Patella* – sesamoid bone in quadriceps tendon

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<tr>
<th>CHARACTERISTIC</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Sacrum</td>
<td>Wider; shorter; sacral curvature is accentuated</td>
<td>Narrow; longer; sacral promontory more ventral</td>
</tr>
<tr>
<td>Coccyx</td>
<td>More movable; projects inferiorly</td>
<td>Less movable; projects anteriorly</td>
</tr>
<tr>
<td>Greater sciatic notch</td>
<td>Wide and shallow</td>
<td>Narrow and deep</td>
</tr>
<tr>
<td>Left lateral view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pelvic inlet (brim)</td>
<td>Wider; oval from side to side</td>
<td>Narrow; basically heart shaped</td>
</tr>
<tr>
<td>Pelvic outlet</td>
<td>Wider; ischial tuberosities shorter, farther apart and everted</td>
<td>Narrower; ischial tuberosities longer, sharper, and point more medially</td>
</tr>
<tr>
<td>Posteroinferior view</td>
<td></td>
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</tr>
</tbody>
</table>

![Femur Diagram](image)

![Patella Diagram](image)
Tibia & Fibula

- Tibia – receives weight of body from femur
- Fibula – no articulation with femur
Tarsals – 7 bones
- Body weight carried primarily by talus and calcaneus
- Other tarsal bones – cuboid, navicular, medial cuneiform, intermediate cuneiform, lateral cuneiform

Metatarsals – 5 bones (I to V from hallux to little toe); enlarged head of metatarsal I forms “ball of the foot”

Phalanges – 14 bones; digit I has 2 bones (no middle phalanx); digits II to V have 3 bones (distal, middle, and proximal phalanx)
Developmental Aspects of Fetal Skull
• Infant skull has more bones than adult skull
• Skull bones such as mandible and frontal bones are unfused
• Skull bones connected by fontanelles - unossified remnants of fibrous membranes; ease birth and allow brain growth; 4 fontanelles (anterior, posterior, mastoid, and sphenoidal)

Developmental Aspects of Spinal Curvature
• Primary thoracic and sacral curvatures obvious at birth - give spine a C shape; convex posteriorly
• Secondary curvatures - cervical and lumbar; convex anteriorly; appear as child develops (e.g., lifts head, learns to walk)

Developmental Aspects – Old Age
• Intervertebral discs thin, less hydrated, and less elastic - risk of disc herniation increases
• Several centimeter height loss common by 55
• Costal cartilages ossify - rigid thorax causes shallow breathing and less efficient gas exchange
• All bones lose mass, so fracture risk increases