8

The Appendicular Skeleton

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An Introduction to the Appendicular Skeleton

• Learning Outcomes
  • 8-1 Identify the bones that form the pectoral girdle, their functions, and their superficial features.
  • 8-2 Identify the bones of the upper limbs, their functions, and their superficial features.
  • 8-3 Identify the bones that form the pelvic girdle, their functions, and their superficial features.
  • 8-4 Identify the bones of the lower limbs, their functions, and their superficial features.
  • 8-5 Summarize sex differences and age-related changes in the human skeleton.
Studying Tips

With 206 bones populating the human body, the skeletal system can be difficult to remember. Still, there are tricks one can do to make this job simpler, such as using mnemonics to make recall of the names easier, or by using charts.

- **Studying and Flash Cards**
  - People have different ways of learning, and it's best to tackle the skeletal system in a fashion that has proved successful for you in the past. Create a chart of the entire skeleton and work your way down, from the cranium to the phalanges, writing down the name of each bone as you go on a note card and write the function or the names of articulating bones on the back. You can then group them into easier to remember sections, like skull bones and the vertebral column.

- **Mnemonics**
  - Mnemonics can help you remember things through the use of a key word or a key phrase. They can be useful, whether you need to remember the simple facts of which larger bones go where (for the fibula, remember the "fibuLA is LAteral") or for tougher ones (such as the cranial bones, "PEST OF 6", parietal, ethmoid, sphenoid, temporal, occipital and frontal, and there are only 6). When using mnemonics, it's often a good idea to develop your own; it's easier to recall your own triggers rather than using someone else's.
Figure 8-1 The Appendicular Skeleton

- Includes every bone not in the axial skeleton
- 4 groups (2 limbs and 2 girdles):
  - Pectoral girdle
  - Upper limbs
  - Pelvic girdle
  - Lower limbs
Figure 8-1 The Appendicular Skeleton (Part 2 of 2)

- Lower limbs
  - Femur: 2
  - Patella: 2
  - Tibia: 2
  - Fibula: 2
  - Tarsal bones: 14
  - Metatarsal bones: 10
  - Phalanges: 28
An Introduction to the Appendicular Skeleton

- The **Appendicular Skeleton**
  - 126 bones
  - Allows us to move and manipulate objects
  - Includes all bones besides axial skeleton
    - The limbs
    - The supportive *girdles*
The Pectoral Girdle

- Also called *shoulder girdle*
- Connects the arms to the body
- Positions the shoulders
- Provides a base for arm movement
- Consists of:
  - **Two clavicles**
  - **Two scapulae**
- Connects with the axial skeleton only at the manubrium
Figure 8-2a The Right Clavicle

The position of the clavicle within the pectoral girdle, anterior view.

Where is the manubrium?

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8-1 The Pectoral Girdle

• The Clavicles
  • Also called collarbones
  • Long, S-shaped bones
  • Originate at the manubrium (sternal end)
  • Articulate with the scapulae (acromial end)
Define Superior, Medial, and Lateral

Superior view of the right clavicle.

- Close to the Scapulae
- Acromial end
- S-shaped
- Close to the manubrium
- S-shaped
- Sternal end
- Facet for articulation with acromion

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8-1 The Pectoral Girdle

• The **Scapulae**
  - Also called shoulder blades
  - Broad, flat triangles
  - Articulate with arm and collarbone
Figure 8-3a  The Right Scapula

- Triangle shaped
- Articulates with arm and collarbone
- Define Anterior view

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8-1 The Pectoral Girdle

• The Scapulae
  • Structures of the scapula
    • **Body** has three sides
      1. Superior border
      2. Medial border
      3. Lateral border
Figure 8.3a  The Right Scapula

- Superior border
- Lateral border
- Medial border

Near the skull

Near the arm

Near the spine

Anterior view
8-1 The Pectoral Girdle

• The Scapulae
  • **Body** has three corners
    • Superior angle
    • Inferior angle
    • Lateral angle (head)
  • The scapular *head*
    • Holds *glenoid cavity*
    • Which articulates with humerus (arm)
    • To form shoulder joint (glenohumeral joint)
8-1 The Pectoral Girdle

- The Scapulae
  - Processes of the *glenoid cavity*
    - Coracoid process
      - Anterior, smaller
    - Acromion
      - Posterior, larger
      - Articulates with clavicle
      - At the *acromioclavicular joint*
Figure 8-3b  The Right Scapula

- Acromion
- Coracoid process
- Spine
- Glenoid cavity
- Lateral border
- Inferior angle

Lateral view
Figure 8-3c  The Right Scapula

- Inferior angle
- Acromion
- Superior border
- Coracoid process
- Neck
- Spine
- Body
- Medial border
- Lateral border

**Define Posterior**

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The Upper Limbs

- Consist of:
  - The arms, forearms, wrists, and hands

- Note: *arm* (*brachium*) = 1 bone, the **humerus**

```
Upper limbs  60
  Humerus  2
  Radius   2
  Ulna     2
  Carpal bones 16
  Metacarpal bones 10
  Phalanges 28
```
8-2 The Upper Limbs

- The **Humerus**
  - Also called the *arm*
  - The long, upper arm bone
  - Articulates with the pelvic girdle
8-2 The Upper Limbs

• The Humerus

Define Proximal and Distal
8-2 The Upper Limbs

• The Humerus

  • Tubercles of the proximal epiphysis
    • Separated by the *intertubercular groove*
      • **Greater tubercle**
        • Lateral
        • Forms tip of shoulder
      • **Lesser tubercle**
        • Anterior, medial
Figure 8-4a The Right Humerus and Elbow Joint

Greater tubercle
Lesser tubercle
Intertubercular groove

Head
Anatomical neck
Surgical neck
Deltoid tuberosity
Shaft
Radial fossa
Lateral epicondyle
Coronoid fossa
Medial epicondyle
Capitulum
Trochlea
Condyle
Anterior surface
8-2 The Upper Limbs

• The Humerus

  • **Head**
    • Rounded, articulating surface
    • Contained within joint capsule

  • **Anatomical neck**
    • Margin of joint capsule

  • **Surgical neck**
    • The narrow metaphysis
Figure 8-4a The Right Humerus and Elbow Joint

Proximal end

- Greater tubercle
- Lesser tubercle
- Intertubercular groove
- Head
- Anatomical neck
- Surgical neck
- Shaft
- Radial fossa
- Lateral epicondyle
- Coronoid fossa
- Medial epicondyle
- Capitulum
- Trochlea
- Condyte
- Anterior surface

Round

Narrow
8-2 The Upper Limbs

• The Humerus
  • The distal epiphysis
    • Medial and lateral epicondyles
      • For muscle attachment
Figure 8-4a The Right Humerus and Elbow Joint

Greater tubercle
Lesser tubercle
Intertubercular groove
Head
Anatomical neck
Surgical neck
Shaft
Distal End
Lateral epicondyle
Coronoid fossa
Medial epicondyle
Capitulum
Trochlea
Anterior surface
8-2 The Upper Limbs

- The Humerus
  - Distal end
    - Trochlea
      - olecranon fossa
        - Articulates with ulna
    - Capitulum
      - Articulates with radius
Figure 8-4c The Right Humerus and Elbow Joint

Elbow joint, anterior view

- Humerus
- Coronoid fossa
- Medial epicondyle
- Trochlea
- Capitulum
Figure 8-4b The Right Humerus and Elbow Joint

- Head
- Greater tubercle
- Anatomical neck
- Surgical neck
- Olecranon fossa
- Medial epicondyle
- Lateral epicondyle
- Trochlea
- Posterior surface
Figure 8-4d  The Right Humerus and Elbow Joint

- Medial epicondyle
- Olecranon fossa
- Trochlea of humerus

Elbow joint, posterior view
8-2 The Upper Limbs

- The Forearm
  - Also called the *antebrachium*
  - Consists of two long bones
    1. **Ulna** (medial)
    2. **Radius** (lateral)

Always near the pinky. “U” = In anatomical position, the Ulna is closer to “you”

Always near the thumb. Right palm up, left palm down. Radius is always on the right.
8-2 The Upper Limbs

- The **Ulna**
  - The **olecranon**
    - Superior end of ulna
    - Point of elbow
    - Superior lip of *trochlear notch*
    - Articulates with trochlea of humerus
  - The **coronoid process**
    - Inferior lip of trochlear notch
Figure 8-5c  The Right Radius and Ulna

Olecranon

Trochlear notch

Coronoid process

Radial notch

Ulnar tuberosity

ULNA

Point of the elbow

Lateral view of ulna, showing trochlear notch
8-2 The Upper Limbs

• The Ulna
  • Articulations with the humerus
    • Forearm extended
      • Olecranon enters **olecranon fossa**
    • Forearm flexed
      • Coronoid process enters **coronoid fossa**

We will go over this in the next section and in lab.
8-2 The Upper Limbs

• The Ulna
  • Other articulations
    • Radial notch
      • Articulates with head of radius
      • Forms *proximal radio-ulnar joint*
    • Ulnar head
      • Prominent *styloid process*
      • Attaches to *articular disc* between forearm and wrist
Figure 8-5b The Right Radius and Ulna

- Radial head
- Neck of radius
- Radial tuberosity
- Trochlear notch
- Coronoid process
- Radial notch
- Ulnar tuberosity
- Distal radio-ulnar joint
- Ulnar head
- Styloid process of radius

Anterior view
Figure 8-5a The Right Radius and Ulna

- Olecranon
- Proximal radioulnar joint
- Radial head
- Neck of radius
- Ulna
- RADIUS
- Ulnar head
- Ulnar notch of radius
- Styloid process of ulna
- Styloid process of radius

Posterior view
8-2 The Upper Limbs

• The **Radius**
  • Lateral bone of forearm
  • Disk-shaped **radial head** above the neck
  • **Radial tuberosity** below the neck, attaches biceps
  • Articulations of the radius
    • **Ulnar notch**
      • Distal end
      • Articulates with wrist and radius
    • **Styloid process**
      • Stabilizes wrist joint
Figure 8-5a  The Right Radius and Ulna

- **Olecranon**
- **Proximal radioulnar joint**
- **Radial head**
- **Neck of radius**
- **ULNA**
- **RADIUS**
- **Ulnar head**
- **Ulnar notch of radius**
- **Styloid process of ulna**
- **Styloid process of radius**

*Posterior view*
Figure 8-5b The Right Radius and Ulna

- Radial head
- Neck of radius
- Radial tuberosity
- RADIUS
- Radial notch
- Ulnar tuberosity
- ULNA
- Trochlear notch
- Coronoid process
- Distal radio-ulnar joint
- Ulnar head
- Styloid process of radius

Anterior view
8-2 The Upper Limbs

• Eight **Carpal Bones**
  • Four *proximal carpal bones*
  • Four *distal carpal bones*
  • Allow wrist to bend and twist
The Four **Proximal Carpal Bones**

1. **Scaphoid**
   - Near styloid process

2. **Lunate**
   - Medial to scaphoid

3. **Triquetrum**
   - Medial to lunate

4. **Pisiform**
   - Anterior to triquetrum
8-2 The Upper Limbs

• The Four **Distal Carpal Bones**

1. **Trapezium**
   - Lateral

2. **Trapezoid**
   - Medial to trapezium

3. **Capitate**
   - Largest

4. **Hamate**
   - Medial, distal
Figure 8-6 Bones of the Right Wrist and Hand

- **RADIUS**
- **Lunate**
- **Scaphoid**
- **Trapezium**
- **Trapezoid**
- **Capitate**
- **Metacarpal bones**
- **Proximal phalanx**
- **Distal phalanx**

- **ULNA**
- **Triquetrum**
- **Pisiform**
- **Hamate**
- **Metacarpal bones**
- **Proximal phalanx**
- **Middle phalanx**
- **Distal phalanx**

**a** Anterior view

**b** Posterior view
8-2 The Upper Limbs

- **Metacarpal Bones**
  - The five long bones of the hand
  - Numbered I–V from lateral (thumb) to medial
  - Articulate with proximal phalanges

- **Phalanges of the Hands**
  - 14 total finger bones
    - **Pollex** (thumb)
      - Two phalanges (*proximal, distal*)
    - Fingers
      - Three phalanges (*proximal, middle, distal*)
Figure 8-6 Bones of the Right Wrist and Hand

- **RADIUS**
  - Lunate
- **Scaphoid**
- **Trapezium**
- **Trapezoid**
- **Capitate**
- **Metacarpal bones**
- **Proximal phalanx**
- **Distal phalanx**

- **ULNA**
  - Triquetrum
  - Pisiform
- **Hamate**

**Anterior view**
- RADIUS
- Lunate
- Scaphoid
- Trapezium
- Trapezoid
- Capitate
- Metacarpal bones
- Proximal phalanx
- Distal phalanx

**Posterior view**
- RADIUS
- Lunate
- Scaphoid
- Trapezium
- Trapezoid
- Capitate
- Metacarpal bones
- Proximal phalanx
- Middle phalanx
- Distal phalanx

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The Pelvic Girdle

- Made up of two hip bones (coxal bones)
- Strong to bear body weight, stress of movement
- Part of the pelvis
- Coxal bones
  - Made up of three fused bones
    1. Ilium (articulates with sacrum)
    2. Ischium
    3. Pubis
8-3 The Pelvic Girdle

• Coxal Bones
  • The acetabulum
    • Also called the hip socket
    • Is the meeting point of the ilium, ischium, and pubis
    • Is on the lateral surface of the hip bone (coxal bone)
    • Articulates with head of the femur (lunate surface)
  • Acetabular notch
    • A gap in the ridge of the margins of the acetabulum
Figure 8-7a The Right Hip Bone

- Ilium
- Ischium
- Pubis
- Iliac crest
- Greater sciatic notch
- Acetabulum
- Acetabular notch
- Lesser sciatic notch
- Obturator foramen

Right hip bone, lateral view
8-3 The Pelvic Girdle

- Marks of the Ilium
  - Greater sciatic notch
    - For sciatic nerve
  - Iliac crest
    - Upper brim
Figure 8-7a The Right Hip Bone

- Ischium
- Iliac crest
- Ilium
- Pubis
- Greater sciatic notch
- Acetabulum
- Acetabular notch
- Lesser sciatic notch
- Obturator foramen

Right hip bone, lateral view

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8-3 The Pelvic Girdle

- Marks of the Pubis
  - Pubic Symphysis
  - Obturator foramen
    - Formed by ischial and pubic rami
    - Attaches hip muscles
Figure 8-7a The Right Hip Bone

- **Ilium**
- **Ischium**
- **Pubis**
- **Iliac crest**
- **Greater sciatic notch**
- **Lesser sciatic notch**
- **Acetabulum**
- **Acetabular notch**
- **Obturator foramen**

**Right hip bone, lateral view**
Figure 8-7b The Right Hip Bone

- Iliac crest
- Auricular surface for articulation with sacrum
- Greater sciatic notch
- Lesser sciatic notch
- Location of pubic symphysis

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8-3 The Pelvic Girdle

- Coxal Bones
  - Articulations of the pelvic girdle
    - *Sacroiliac joint*
      - Articulation of posterior *auricular surface* of ilium
      - With the sacrum

- The *Pelvis*
  - Consists of two coxal bones, the sacrum, and the coccyx
  - Stabilized by ligaments of pelvic girdle, sacrum, and lumbar vertebrae
Figure 8-8a The Pelvis of an Adult Male

- SACRUM
- COCCYX
- ILIUM
- PUBIS
- ISCHIUM

Hip bone (Figure 8–7)

Iliac crest

Sacrotuber joint

Acetabulum

Obturator foramen

L5

Anterior view

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Figure 8-8b  The Pelvis of an Adult Male

Posterior view

- SACRUM
- COCCYX
- ILIUM
- PUBIS
- ISCHIUM
- Iliac crest

Greater sciatic notch

Hip bone (Figure 8–7)
8-3 The Pelvic Girdle

- Divisions of the Pelvis
  - True pelvis
    - Encloses *pelvic cavity*
  - Pelvic brim
    - Upper edge of true pelvis
    - Encloses *pelvic inlet*
  - Perineum region
    - Inferior edges of true pelvis
    - Forms *pelvic outlet*
    - Perineal muscles support organs of pelvic cavity
8-3 The Pelvic Girdle

- Divisions of the Pelvis
  - False pelvis
    - Blades of ilium above arcuate line
Figure 8-9a Divisions of the Pelvis

Superior view.
The pelvic brim, pelvic inlet, and pelvic outlet.
Lateral view. The boundaries of the true (lesser) pelvis (shown in purple) and the (false) greater pelvis.
Figure 8-9c  Divisions of the Pelvis

Inferior view. The limits of the pelvic outlet.
The Pelvic Girdle

- Comparing the Male Pelvis and Female Pelvis
  - Female pelvis
    - Smoother and lighter
    - Less prominent muscle and ligament attachments
  - Pelvis modifications for childbearing
    - Enlarged pelvic outlet
    - Broad pubic angle (>100°)
    - Less curvature of sacrum and coccyx
    - Wide, circular pelvic inlet
    - Broad, low pelvis
    - Iliac project laterally, not upwards
Figure 8-10  Anatomical Differences between a Male and Female Pelvis

- **Ischial spine**
  - **Male**
    - 90° or less
  - **Female**
    - 100° or more
Figure 8-10a  Anatomical Differences between a Male and Female Pelvis

Ischial spine

90° or less

Male
Figure 8-10b  Anatomical Differences between a Male and Female Pelvis

Ischial spine

100° or more

Female
8-4 The Lower Limbs

• Functions of the Lower Limbs
  • Weight bearing
  • Motion
  • Note: leg = lower leg; thigh = upper leg
8-4 The Lower Limbs

• Bones of the Lower Limbs
  • **Femur** (thigh)
  • **Patella** (kneecap)
  • **Tibia and fibula** (leg)
  • **Tarsals** (ankle)
  • **Metatarsals** (foot)
  • **Phalanges** (toes)
8-4 The Lower Limbs

- The **Femur**
  - The proximal epiphysis
    - Femoral head
      - Articulates with pelvis at acetabulum
    - The neck
      - Narrow area between head and **trochanters**
      - Joins **shaft** at angle
8-4 The Lower Limbs

• The Femur
  • The proximal epiphysis
    • Trochanters
      • Greater trochanter and lesser trochanter
      • Tendon attachments
Figure 8-11  Bone Markings on the Right Femur

- Neck
- Greater trochanter
- Femoral head
- Lesser trochanter
- Shaft
- Patellar surface
- Lateral epicondyle
- Lateral condyle
- Medial epicondyle
- Medial condyle
- Anterior surface
- Posterior surface
- Intercondylar fossa
- Lateral epicondyle
- Lateral condyle
- Neck
- Greater trochanter
8-4 The Lower Limbs

• The Femur

  • The distal epiphysis
    • **Medial epicondyle** and **lateral epicondyle**
      • Above the knee joint
    • **Medial condyle** and **lateral condyle**
      • Separated by **intercondylar fossa** and **patellar surface**
      • Form part of knee joint
Figure 8-11  Bone Markings on the Right Femur

- Neck
- Greater trochanter
- Femoral head
- Lesser trochanter
- Shaft
- Patellar surface
- Lateral epicondyle
- Lateral condyle
- Medial epicondyle
- Medial condyle
- Intercondylar fossa
- Lateral epicondyle
- Lateral condyle

a  Anterior surface
b  Posterior surface
8-4 The Lower Limbs

- The **Patella**
  - Also called the kneecap
  - A sesamoid bone
Figure 8-12c  The Right Patella (a, b) and Patella with Femur (c)

Inferior view of right femur and patella

- Patella surface
- Lateral condyle of femur
- Medial condyle of femur
- Inferior view of right femur and patella
8-4 The Lower Limbs

- The **Tibia**
  - Also called the shinbone
  - Supports body weight
  - Larger than fibula
  - Medial to fibula

So which bone is the tibia? fibula?
8-4 The Lower Limbs

• The Tibia

  • The proximal epiphysis

    • **Medial and lateral tibial condyles**
      • Articulate with medial and lateral condyles of femur

    • **Tibial tuberosity**
      • Attaches patellar ligament
8-4 The Lower Limbs

• The Tibia
  • The shaft
  • The distal epiphysis
    • Medial malleolus
      • Medial projection at the ankle
Figure 8-13a The Right Tibia and Fibula

- Lateral tibial condyle
- Head of fibula
- Superior tibiofibular joint
- Medial tibial condyle
- Tibial tuberosity
- Medial malleolus (tibia)

Anterior view
8-4 The Lower Limbs

• The **Fibula**
  
  • Attaches muscles of feet and toes
  
  • Smaller than tibia
  
  • Lateral to tibia
Figure 8-13b The Right Tibia and Fibula

- Articular surface of medial tibial condyle
- Intercondylar eminence
- Articular surface of lateral tibial condyle
- Medial tibial condyle
- Lateral tibial condyle
- Head of fibula
- Medial malleolus (tibia)
- Inferior tibiofibular joint
- Posterior view
• The Ankle
  • Also called the *tarsus*
    • Consists of seven *tarsal bones*
  • Bones of the ankle
    • *Talus*
      • Carries weight from tibia across *trochlea*
    • *Calcaneus* (heel bone)
      • Transfers weight from talus to ground
      • Attaches *calcaneal (Achilles) tendon*
    • *Cuboid*
      • Articulates with calcaneus
Figure 8-14a  Bones of the Ankle and Foot

- Calcaneus
- Trochlea of talus
- Cuboid
- Talus
- Navicular
- Cuneiform bones
  - Lateral
  - Intermediate
  - Medial
- Metatarsal bones
- Hallux
  - Proximal phalanx
  - Distal phalanx

Phalanges
- Proximal
- Middle
- Distal

Superior view, right foot
8-4 The Lower Limbs

• The Ankle

  • Bones of the ankle

    • Navicular
      - Articulates with talus and three cuneiform bones

    • Medial cuneiform

    • Intermediate cuneiform

    • Lateral cuneiform
Figure 8-14a Bones of the Ankle and Foot

- Calcaneus
- Trochlea of talus
- Cuboid
- Talus
- Navicular

Cuneiform bones
- Lateral
- Intermediate
- Medial

Metatarsal bones

Phalanges
- Proximal
- Middle
- Distal

Hallux
- Proximal phalanx
- Distal phalanx

a Superior view, right foot
8-4 The Lower Limbs

• **Metatarsal Bones** of the Foot
  • Five long bones of foot
  • Numbered I–V, medial to lateral
  • Articulate with toes
8-4 The Lower Limbs

• **Phalanges** of the Foot

  - Phalanges
    - 14 bones of the toes

  - Hallux
    - *Big toe or great toe*, two phalanges (distal, proximal)

  - Other four toes
    - Three phalanges (distal, medial, proximal)
Figure 8-14a  Bones of the Ankle and Foot

- Calcaneus
- Trochlea of talus
- Cuboid
- Talus
- Navicular
- Cuneiform bones
  - Lateral
  - Intermediate
  - Medial
- Metatarsal bones
- Phalanges
  - Proximal
  - Middle
  - Distal
- Hallux
  - Proximal phalanx
  - Distal phalanx

a Superior view, right foot
8-4 The Lower Limbs

- Arches of the Feet
  - Arches transfer weight from one part of the foot to another
  - The **longitudinal arch**
  - The **transverse arch**
    - Formed by a difference in curvature between medial and lateral borders of the foot
Figure 8–14b Bones of the Ankle and Foot

Medial view, right foot

- Medial cuneiform bone
- Navicular
- Talus
- Phalanges
- Metatarsal bones
- Calcaneus
- Transverse arch
- Longitudinal arch

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8-5 Individual Skeleton Variation

• Studying the Skeleton
  • Reveals characteristics
    • Muscle strength and mass (bone ridges, bone mass)
    • Medical history (condition of teeth, healed fractures)
    • Sex and age (bone measurements and fusion)
    • Body size
# 8-5 Sex Differences in the Human Skeleton

<table>
<thead>
<tr>
<th>Region and Feature</th>
<th>Male (compared to female)</th>
<th>Female (compared to male)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SKULL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General appearance</td>
<td>Heavier, rougher</td>
<td>Lighter, smoother</td>
</tr>
<tr>
<td>Forehead</td>
<td>More sloping</td>
<td>More vertical</td>
</tr>
<tr>
<td>Sinuses</td>
<td>Larger</td>
<td>Smaller</td>
</tr>
<tr>
<td>Cranium</td>
<td>About 10% larger</td>
<td>About 10% smaller</td>
</tr>
<tr>
<td>Mandible</td>
<td>Larger, more robust</td>
<td>Smaller, lighter</td>
</tr>
<tr>
<td>Teeth</td>
<td>Larger</td>
<td>Smaller</td>
</tr>
</tbody>
</table>
# 8-5 Sex Differences in the Human Skeleton

<table>
<thead>
<tr>
<th>Region and Feature</th>
<th>Male (compared to female)</th>
<th>Female (compared to male)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PELVIS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General appearance</strong></td>
<td>Narrower, more robust, rougher</td>
<td>Broader, lighter, smoother</td>
</tr>
<tr>
<td>Pelvic inlet</td>
<td>Heart shaped</td>
<td>Oval to round shaped</td>
</tr>
<tr>
<td>Iliac fossa</td>
<td>Deeper</td>
<td>Shallower</td>
</tr>
<tr>
<td>Ilium</td>
<td>More vertical; extends farther superior to sacroiliac joint</td>
<td>Less vertical; less extension superior</td>
</tr>
<tr>
<td>Angle inferior to pubic symphysis</td>
<td>Under 90°</td>
<td>100° or more (Figure 8–10)</td>
</tr>
<tr>
<td>Acetabulum</td>
<td>Directed laterally</td>
<td>Faces slightly anteriorly as well as laterally</td>
</tr>
<tr>
<td>Obturator foramen</td>
<td>Oval</td>
<td>Triangular</td>
</tr>
<tr>
<td>Ischial spine</td>
<td>Points medially</td>
<td>Points posteriorly</td>
</tr>
<tr>
<td>Sacrum</td>
<td>Long, narrow triangle with pronounced sacral curvature</td>
<td>Broad, short triangle with less curvature</td>
</tr>
<tr>
<td>Coccyx</td>
<td>Points anteriorly</td>
<td>Points inferiorly</td>
</tr>
</tbody>
</table>
### 8-5 Sex Differences in the Human Skeleton

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<tr>
<th>Region and Feature</th>
<th>Male (compared to female)</th>
<th>Female (compared to male)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTHER SKELETAL ELEMENTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone weight</td>
<td>Heavier</td>
<td>Lighter</td>
</tr>
<tr>
<td>Bone markings</td>
<td>More prominent</td>
<td>Less prominent</td>
</tr>
</tbody>
</table>
## 8-5 Age-Related Changes in the Skeleton

<table>
<thead>
<tr>
<th>Region and Feature</th>
<th>Events</th>
<th>Age in Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL SKELETON</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bony matrix</strong></td>
<td>Reduction in mineral content; increased risk of osteoporosis</td>
<td>Begins at age 30–45; values differ for males versus females between ages 45 and 65; similar reductions occur in both sexes after age 65</td>
</tr>
<tr>
<td><strong>Bone markings</strong></td>
<td>Reduction in size, roughness</td>
<td>Gradual reduction with increasing age and decreasing muscular strength and mass</td>
</tr>
</tbody>
</table>
## 8-5 Age-Related Changes in the Skeleton

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<tr>
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<tbody>
<tr>
<td>SKULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fontanelles</td>
<td>Closure</td>
<td>Completed by age 2</td>
</tr>
</tbody>
</table>
## 8-5 Age-Related Changes in the Skeleton

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<tr>
<td><strong>VERTEBRAE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curvature</td>
<td>Development of major curves</td>
<td>3 months–10 years</td>
</tr>
<tr>
<td><strong>Intervertebral discs</strong></td>
<td>Reduction in size, percentage contribution to height</td>
<td>Accelerates in later years (60)</td>
</tr>
</tbody>
</table>
## 8-5 Age-Related Changes in the Skeleton

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<tbody>
<tr>
<td><strong>LONG BONES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epiphyseal cartilages</td>
<td>Fusion</td>
<td>Begins about age 3; ranges vary, but general analysis permits determination of approximate age</td>
</tr>
<tr>
<td><strong>PECTORAL AND PELVIC GIRDLES</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Epiphyses</td>
<td>Fusion</td>
<td>Relatively narrow ranges of ages (e.g., 14–16, 16–18, 22–25) increase accuracy of age estimates</td>
</tr>
</tbody>
</table>