Chapter 13 Forensic Anthropology: What We Learn from Bones

By the end of this chapter you will be able to:

- Describe how bone is formed
- Distinguish between male and female skeletal remains
- Explain how bones contain a record of injuries and disease
- Describe how a person’s approximate age could be determined
- Explain the differences in facial structures among races
- Discuss the role of mitochondrial DNA in bone identification
Anthropology

- **Anthropology**—the scientific study of all aspects of human development and interaction
- **Physical anthropology**—studies human differences
- **Forensic anthropology**—studies these identifying characteristics on the remains of an individual
Historical Development

- **1800s**—scientists begin studying skulls
- **1897**—sausage maker’s wife murdered; bone fragments found in his factory
- **1932**—the FBI opens the first crime lab
  - Smithsonian Institution partners with FBI
- **1939**—William Krogman publishes *Guide to the Identification of Human Skeletal Material*
- Soldiers killed in World War II are identified using anthropologic techniques
- DNA—new tool to analyze skeletons
Characteristics of Bone

- Bones are alive and full of blood
- Marrow—creates blood cells
- Made with deposits of minerals (hydroxyapatite) and collagen fibers. Hormones affect the amount of calcium in the blood and bones
Development of Bone

Life cycle—bone is deposited, breaks down, and replaced all the time by three types of cells:

- **Osteoblasts**—form bone
- **Osteocytes**—mature bone cells
- **Osteoclasts**—dissolve bone
  - Allows bones to reshape as they grow
  - Balances calcium levels in blood
  - **Osteoporosis**—a deficiency of calcium in the bones due to over action of osteoclasts.
  - Removes cellular wastes and debris from bones

**Ossification**—is the process of making bone when osteoblast cells migrate to cartilage or membranes and deposit minerals (hydroxyapatite)
Accessories of bones

cartilage—wraps the ends of bones for protection and prevents scraping
How Bones Connect

**ligaments**—bands that connect two or more bones together

**tendons**—end of a muscle that connect it to the bone

- Patella (knee cap)
- Anterior cruciate ligament (ACL)
- Lateral collateral ligament (LCL)
- Femur (thigh bone)
- Posterior cruciate ligament (PCL)
- Medial collateral ligament (MCL)
- Gastrocnemius muscle
- Achilles tendon
- Soleus muscle
- Tibia
What Bones Can Tell Us

- **Osteobiography**—bones contain a record of the physical life
- Analyzing bones reveals clues to age, gender, race, height, and health
- **Examples:**
  - In a right-handed person, right arm bones might be slightly larger than the bones of the left arm
  - X-rays may identify prior fractures, pins, artificial joints
Aging of Bone

- Under 30 years of age—bones increase in size and density
- Over 30 years old – bone decreases density
- Exercise slows deterioration
- Osteoporosis and other bone diseases increase deterioration.

With age the skeleton grows in size and change proportions.

The increase in body size from birth to adult.
Determining Age

- Cranial sutures
  - The cranial bones remain separate for about 12-18 months.
  - The spaces between the bones where the sutures are (sometimes known as "soft spots") are called fontanelles.
Determining Age by Skull fontanelles (sutures)

- By about age 30, the lamboid suture at the back of the skull closes.
- By about age 32, the midsagittal suture running across the top of the skull, back to front, closes.
- By about age 50, the coronal suture running side to side over the top of the skull, near the front, closes.
## Skull Gender differences

<table>
<thead>
<tr>
<th>Male Characteristics</th>
<th>Trait</th>
<th>Female Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>More square</td>
<td>Shape of eye</td>
<td>More rounded</td>
</tr>
<tr>
<td>More square</td>
<td>Mandible shape from underside</td>
<td>More V-shaped</td>
</tr>
<tr>
<td>Thick and larger</td>
<td>Upper brow ridge</td>
<td>Thin and smaller</td>
</tr>
<tr>
<td>Male Characteristics</td>
<td>Trait</td>
<td>Female Characteristics</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Present</td>
<td>Occipital protuberance</td>
<td>Absent</td>
</tr>
<tr>
<td>Low and sloping</td>
<td>Frontal bone</td>
<td>Higher and more rounded</td>
</tr>
<tr>
<td>Rough and bumpy</td>
<td>Surface of skull</td>
<td>Smooth</td>
</tr>
<tr>
<td>Straight</td>
<td>Ramus of mandible</td>
<td>Slanting</td>
</tr>
<tr>
<td>Rough and bumpy</td>
<td>Nuchal crest</td>
<td>Smooth</td>
</tr>
</tbody>
</table>
Pelvis bone Gender differences

- An easy method to determine gender
- The subpubic angle of the female pelvis is greater than $90^\circ$; the male’s, less than $90^\circ$
### PELVIS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male Pelvis</th>
<th>Female Pelvis</th>
</tr>
</thead>
<tbody>
<tr>
<td>General appearance</td>
<td>Narrower, rougher, more robust</td>
<td>Broader, smoother, less robust</td>
</tr>
<tr>
<td>Ilium</td>
<td>More vertical; extends farther</td>
<td>Less vertical; less extension</td>
</tr>
<tr>
<td></td>
<td>superior to sacroiliac joint</td>
<td>superior to sacral articulation</td>
</tr>
<tr>
<td>Sacrum</td>
<td>Long, narrow triangle with</td>
<td>Broad, short triangle with less</td>
</tr>
<tr>
<td></td>
<td>pronounced sacral curvature</td>
<td>sacral curvature</td>
</tr>
<tr>
<td>Iliac fossa</td>
<td>Deeper</td>
<td>Shallower</td>
</tr>
<tr>
<td>Pelvic inlet</td>
<td>Narrow, heart shaped</td>
<td>Open, circular shaped</td>
</tr>
<tr>
<td>Pelvic outlet</td>
<td>Points anteriorly</td>
<td>Enlarged</td>
</tr>
<tr>
<td>Coccyx</td>
<td>Directed laterally</td>
<td></td>
</tr>
<tr>
<td>Acetabulum</td>
<td>Oval</td>
<td></td>
</tr>
<tr>
<td>Obturator foramen</td>
<td>Under 90°</td>
<td></td>
</tr>
<tr>
<td>Public angle</td>
<td>100° or more</td>
<td></td>
</tr>
</tbody>
</table>

### OTHER

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Male Pelvis</th>
<th>Female Pelvis</th>
</tr>
</thead>
<tbody>
<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>
Gender—Thigh bones

The male femur is thicker and joins the pelvis at a straighter angle than the female femur.
Age

- At birth— skeleton has 450+ bones
- Adults have 206 bones
- **Epiphysis plate** - appears where cartilage is replaced by bone
- **Epiphysis line** - When the cartilage is fully replaced.

- This information can be used to approximate a skeleton’s age
Age—Epiphysis

- Clavicle, sternal epiph. (closure 18th-24th yr)
- Rarely unite (except in old age)
- Closure between (puberty and 25th yr)
- Closure soon after puberty
- Scapula, vert. margin and int. angle (closure 20th-21st yr)
- Subcoracoid (closure 18th-21st yr)
- Glenoid cavity (closure 19th yr)
- Medial epicondyle (closure male 18th yr, female 15th yr)
- Olecranon (closure male 15th-17th yr, female 14th-15th yr)
- Ulna, distal epiph. (closure male 19th yr, female 17th yr)
- Styloid of ulnar (closure 18th-20th yr)
- Lunate (appears 4th yr)
- Pisiform (appears 12th yr)
- Triquetrum (appears 1st-2nd yr)
- Hamate (appears 6th mo)
- Capitate (appears 6th mo)
- Trapezoid (appears 6th yr)

- Acromion (closure 18th-19th yr)
- Coracoid (closure 18th-21st yr)
- Humerus head center and lesser tuberosities fuse together (4th-8th yr) fuse to shaft (male 19th-21st yr, female 18th-20th yr)
- Humerus capitulum lateral epicondyle and trochea fuse together (at puberty) fuse to shaft (male 17th yr, female 14th yr)
- Radius head (closure male 13th-17th yr, female 14th-15th yr)
- Radial tuberosity (closure 14th-18th yr)
- Radius, distal epiph. (closure male 19th yr, female 17th yr)
- Styloid process, radius (closure variable)
- Navicular (appears 6th yr)
- Trapezium (closure 5th yr)
- Metacarpal I, epiph. (closure 14th-21st yr)
- Proximal phalanx I, epiph. (closure 14th-21st yr)
- Distal phalanx I, epiph. (closure 14th-21st yr)
- Metacarpals II-IV, epiph. (closure 14th-21st yr)
Age—Epiphysis

- Femur, head (closure male 17th-18th yr, female 16th-17th yr)
- Grege trochanter (closure 16th-17th yr)
- Lesser trochanter (closure 16th-17th yr)
- Illiac crest (closure 20th yr)
- Pelvic bones fuse (at puberty)
- Femur, distal epiph. (closure male 18th-19th yr, female 17th yr)
- Proximal epiph. (closure male 18th-19th yr, female 16th-17th yr)
- Tibial tuberosity (closure 19th yr)
- Distal epiph. (closure 17th-18th yr)
- Fibula, proximal epiph. (closure male 18th-20th yr, female 16th-18th yr)
- Fibular malleolus (closure 17th-18th yr)
- Completion variable
- Middle phalanges II-IV, epiph. (closure 18th yr)
- Distal phalanges (closure 18th yr, begins proximally)
- Colcaneus, epiph. (closure 12th-22nd yr)
- Metatarsals I-V, epiph. (closure male 18th yr, female 16th yr)
- Metatarsals, heads (closure 14th-21st yr)
- Proximal phalanges I-V, epiph. (closure 18th yr)
Height

- An estimate of height can be made by measuring one of the long bones (femur or humerus)
- Age, Gender, Race, and Health are taken into consideration
Facial Racial Differences

- Shape of the eye sockets
- Absence or presence of a nasal spine
- Measurements of the nasal index
- Prognathism
- Width of the face
- Angulation of the jaw and face
Facial Reconstruction

- A face can be rebuilt from just skeletal remains
  - Facial markers are positioned at critical locations
  - Clay is contoured to follow the height of the markers
- Facial muscles follow the contour of the skull

Computer programs perform a similar function. Computer programs also can “age” missing persons and criminals.
DNA Evidence

- Bone contains small amounts of nuclear DNA but it does contain mitochondrial DNA.
- Nuclear DNA degenerates before mitochondrial DNA.
- Mitochondrial DNA is inherited only from the mother.
- It is used to compare results with living relatives on the mother’s side of the family.
Skeletal Trauma Analysis

- Forensic anthropologists determine if damage to bones occurred before or after death
- Distinct patterns exist for damage by
  - Environment
  - Sharp-force trauma
  - Blunt-force trauma
  - Gunshot wounds
  - Knife wounds
Summary

- Bones are live and carry on all life functions.
- Bone condition can tell investigators about a person’s health and nutrition during life.
- Male and female skeletons differ.
- The age of a person at death can be estimated by analyzing bones.
Summary

- A person’s height can be estimated by the length of long bones.
- Facial reconstruction is possible to some extent.
- Mitochondrial DNA can be extracted to help identify skeletal remains.
- Skeletal trauma analysis examines bones for evidence of damage.
C13 Forensic Anthropology: Pre-Lab Questions

1. What is forensics **anthropology** and what is its use?
2. Describe three important functions of bones.
3. Describe three types of bone cells and their function.
4. How is the bone developed?
5. How many bones are in the human adult body?
6. Why adults have fewer bones than babies?
7. Describe three structures than join the bones.
8. How does age affect bones?
9. What is **osteobiography**?
10. What six types of information can anthropologists obtain using bones?
11. What are three ways that bones can be used to determine age?
12. Which bones are most used to estimate the age of a person?

14. What are fontanelles? What are sutures?

15. How are epiphyseal plates of long bones used to determine age?

16. Based on the overall appearance, how is a male skeleton different from a female skeleton?

17. Describe three skull differences in males and females.

18. Describe three pelvic differences in males and females.

19. Describe a difference of femur in males and females.

20. How do anthropologists use bones to estimate height?

21. Why are the age and height given in a range number and not in an exact number?

22. What are three ways that bones are used to distinguish race?

23. What is facial reconstruction? How is it used in forensics?

24. What type of DNA is found in bones? Why is this DNA important in forensics?

25. What is "skeletal trauma analysis"?

26. What bones can tell about a weapon that caused death?

27. How do anthropologists determine if a bone was damaged before or after death?
ACTIVITY 13-1     AGE OF A SKULL?

Directions: Answer the following on a separate sheet of paper.

Part A:
Using Figure 13-17 in your textbook showing the relationship between age and skull sutures, determine the approximate age of a skull with the following features:

1. Lambdoidal and sagittal sutures fused. Coronal sutures not fused.
   Age _______________

2. Lambdoidal sutures almost fused. Sagittal and coronal sutures not fused.
   Age_______________

3. All sutures fused.
   Age_______________

   Age_______________

Part B: Refer to the photographs in your textbook and ppt.to answer the following questions.

1. Compare the infant to the adult skull:
   a. similarities
   
   b. differences in numbers of bones, composition

   c. percentage of body length
ACTIVITY 13-2  BONES: MALE OR FEMALE?

Directions: Read the following descriptions to determine if they are a male or female. Refer to Figure 13-11: Summary of male and female skull differences, Figure 13-13, male and female subpubic angles, and Figure 13-15: Male and Female Pelvis Differences

Case #1 ____________________
Round eye orbits, subpubic angle of 103 degrees, rectangular-shaped pubis, smooth skull. Explain your answer.

Case #2 ____________________
Pelvis narrow, protuberance on occipital bone, sloping forehead. Explain your answer. Explain your answer

Case #3 ____________________
The skull was found to be smooth with small brow ridges; would you expect to find a subpubic angle larger or smaller than 90 degrees? Explain your answer. Explain your answer

Case #4 ____________________
A long, narrow sacrum with triangular pubis; would you expect to find the subpubic angle larger or smaller than 90 degrees? Explain your answer. Explain your answer
ACTIVITY 13-5 WHAT THE BONES TELL US

Directions: Using all of the information in your textbook, describe as much as you can about a person from their bones and teeth, as described in the following case studies.

1. A skull has been found: What can you tell about the skull described below?
   a. Lambdoidal suture nearly closed
   b. Large brow ridge
   c. Large supraorbital ridge

2. Only the jaw has been found: What can you tell about the jaw from this information only?
   a. Angle = 100 degrees
   b. Wisdom teeth have emerged
   c. No filings or bridgework

3. Femur only: What can you tell about the femur from this description?
   a. Thin
   b. Osteoporosis present
   c. Length of femur = 47 cm

4. A mass grave is found: What can you tell about the remains?
   b. Sub pubic angle = 80 degrees
   c. Left femur = 49 cm
   d. Right femur = 49.1 cm
   e. Left femur = 45.5 cm
   f. Right femur = 45.3 cm
   g. Left femur = 48 cm
   h. Skull: one partial skull found with rectangular orbits (eye sockets)
   i. How many individuals (minimum) are buried at this one site?
   j. How did you determine this number?
   k. Two of the femurs, one right and one left, had thick bones.
      What can you infer from this information about this person?
   l. Two femurs showed very large attachment sites for tendons.
      What clue might this provide about the owner?

5. A female was reported missing in the area. The family of the missing woman was wealthy, and their slightly built missing daughter never did any strenuous work but did bear three children. How could you verify if the woman is buried in the grave site?
   a. had three children
   b. did not engage in much manual labor
   c. was over the age of 21
   d. was slightly built
   e. was from a wealthy family