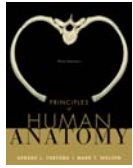


Chapter 6 Bone Tissue



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Bones are organs made of different tissues.

- Ossious tissue
- Connective tissue
 - Cartilage
 - Dense connective
 - Adipose
- Epithelial tissue
- Nervous tissue

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Main points in this chapter

- How bones form
- How bones age
- How bones are affected by exercise & activity

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What is the function of bones and the skeletal system they form?

- Support: serving as a structural framework
- Protection: physically shield soft internal organs
- Movement: skeletal muscles attach to bones; contraction causes movement

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What is the function of bones and the skeletal system they form?

- Mineral storage: minerals (especially calcium) are stored and released as needed
- Hemopoiesis: production of blood cells occurs in red bone marrow
- Fat storage: adipose cells provide energy reserves for the body

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Figure 6.1 – Types of bones

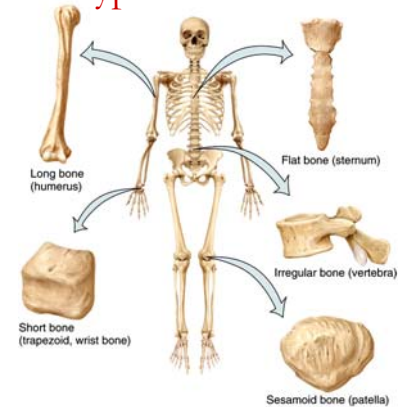


Figure 06.01 Tortora - P11A 11a
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Types of bones

- Long bones – longer than wide; contain more compact than spongy bone
- Short bones – length and width similar; contain more spongy than compact bone
- Flat bones – thin, contain a layer of spongy bone sandwiched between 2 parallel layers of compact bone

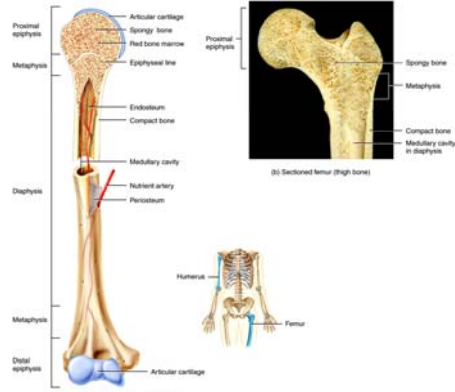
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Types of bones

- Irregular bones – exhibit a complex shape that doesn't fit other groups; contain both compact and spongy bone in varying amounts
- Sesamoid bones – generally small smooth bones that develop within tendons
 - Prevent excessive wear in high friction areas (e.g., base of big toe)

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Figure 6.2 – Anatomy of a long bone



(a) Partially sectioned humerus (arm bone)
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Figure 6.3 – Bone tissue cell types

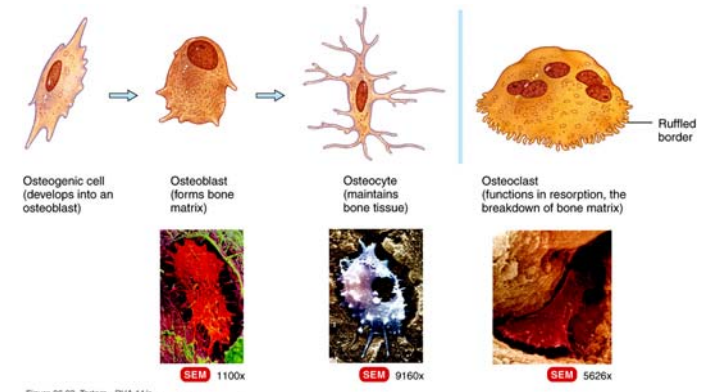


Figure 06.03 Tortora - PHA 11/e
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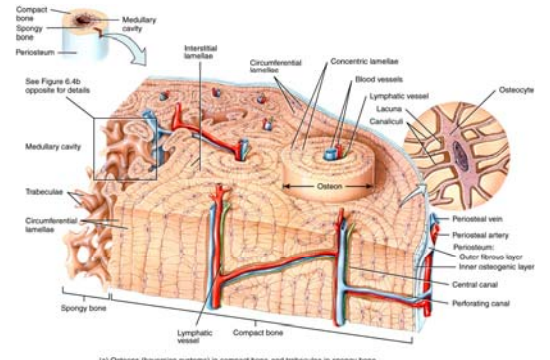
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Bone tissue cell types

- Osteogenic cells – unspecialized stem cells
- Osteoblasts – bone builders
- Osteocytes – mature bone cells derived from osteoblasts
- Osteoclasts – bone ‘breakers’ are multinucleate

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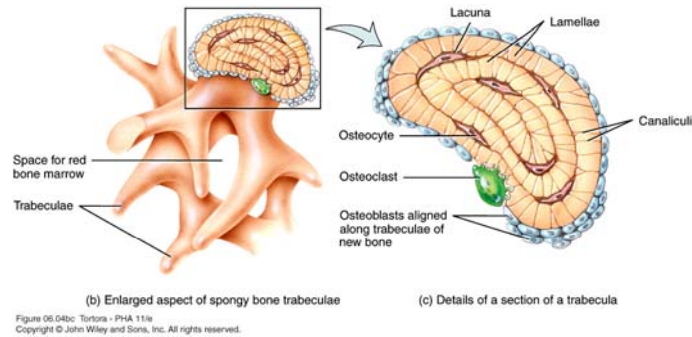
Figure 6.4a – Histology of compact bone



(a) Osteons (Haversian systems) in compact bone and trabeculae in spongy bone
 Figure 06.04a Tortora - PHA 11/e
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Figure 6.4b,c – Histology of spongy bone



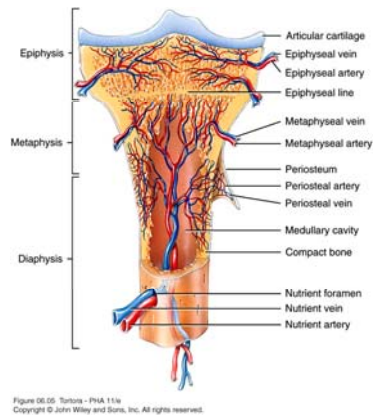
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Histology of compact and spongy bone

- One is distinguished from the other by differences location, density, & anatomy
- Compact bone
 - Location: bone surface
 - Density: high density; contains small spaces
 - Surface Anatomy: concentric layers near surface
 - Deep Anatomy: concentric circles or rings (osteons)
- Spongy bone
 - Location: bone interior
 - Density: low density; large spaces visible to the naked eye
 - Anatomy: lamellae arranged into thin columns (trabeculae)

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Figure 6.5 – Blood supply of a long bone



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Perfusing bone with blood

- Periosteal arteries – enter the diaphysis and carry blood to the periosteum & outer layers of compact bone
- Nutrient arteries – enter the diaphysis and carry blood into proximal and distal regions of the medullary cavity
- Metaphyseal and epiphyseal arteries – enter the metaphysis/epiphysis & carry blood to the ends of long bones and the red bone marrow

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Draining blood from bone

- Nutrient veins – drain blood from the periosteum & outer layers of compact bone
- Metaphyseal/epiphyseal veins – drain blood from the proximal and distal regions of the medullary cavity
- Periosteal veins – drain blood from the ends of long bones and the red bone marrow

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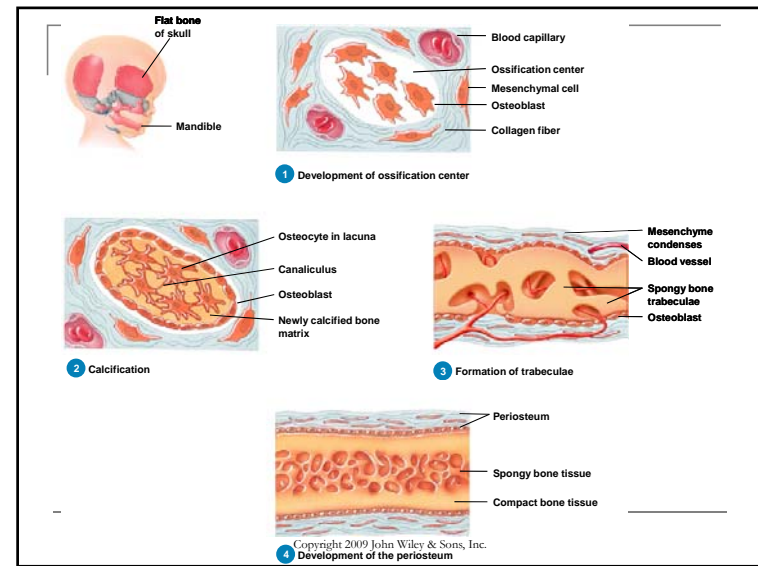
Bone formation

- Intramembranous ossification
- Endochondral ossification

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Intramembranous Ossification Process Diagram Step-by-Step Figure 6.6

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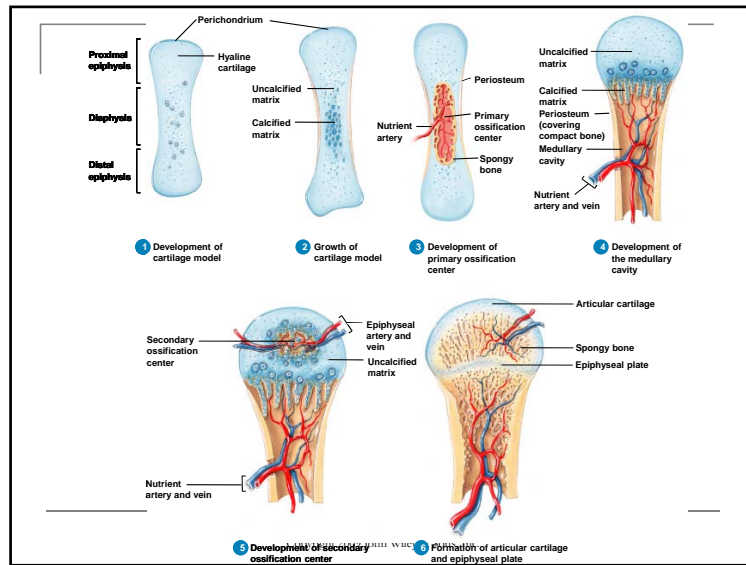
Intramembranous ossification

- Simpler process than endochondral ossification
- Examples: flat bones of the skull
- Involves a 4-step process:
 1. An ossification center develops
 2. Calcification occurs due to mineral deposition
 3. Trabeculae are formed in the interior
 4. Mesenchyme is replaced with periosteum and a thin layer of compact bone

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Endochondral Ossification Process Diagram Step-by-Step Figure 6.7

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Endochondral ossification

- Cartilage is replaced by bone
- Examples: most bones of the body
- Involves a 6-step process:
 1. A cartilage model forms
 2. Growth occurs by interstitial & appositional mechanisms
 3. Primary ossification centers develop
 4. A medullary cavity develops
 5. Secondary ossification centers develop at the epiphyses
 6. Hyaline cartilage is replaced by articular cartilage at the ends, and between the diaphysis and the epiphyses by the epiphyseal (bony) plate

Endochondral Growth – length

- The cartilage model grows in length by mitosis and by the deposition of extracellular matrix. This process is called **interstitial growth** (i.e., growth from within).

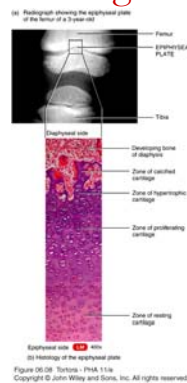
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Endochondral Growth – thickness

- In contrast, growth of cartilage in thickness is due mainly to the addition of more extracellular matrix to the periphery. This growth pattern, in which extracellular matrix is deposited on the cartilage surface, is called **appositional growth**.

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Figure 6.8 – Events at the epiphyseal plate permits growth of long bones



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The role of the epiphyseal plate in bone growth.

- The growth in length of a long bone involves (1) interstitial growth of cartilage on the epiphyseal side of the epiphyseal plate and (2) replacement of cartilage with bone by endochondral ossification on the diaphyseal side of the epiphyseal plate.

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Figure 6.9 – Increased bone thickness occurs via appositional growth

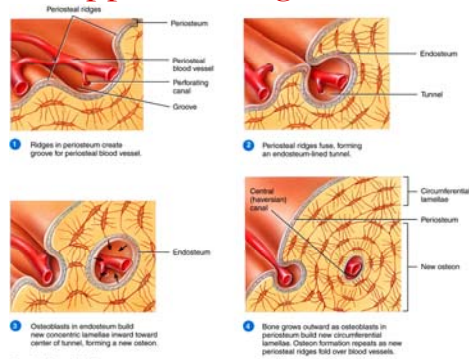


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Remodeling of bone

- **Bone remodeling** is the ongoing replacement of old bone tissue by new bone tissue. It involves **bone resorption**, the removal of minerals and collagen fibers from bone by osteoclasts, and **bone deposition**, the addition of minerals and collagen fibers to bone by osteoblasts.

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Clinical connection – osteoporosis

- **Osteoporosis** literally means “porous bones”
- The problem is that bone resorption (destruction) outpaces bone deposition (formation).

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Clinical connection – osteoporosis

- Older women suffer from osteoporosis more often than men for two reasons
 - (1) Women’s bones are less massive than men’s bones, and
 - (2) Production of estrogens in women declines dramatically at menopause
- Production of the main androgen in older men (testosterone) wanes gradually and only slightly.

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Common types of bone fractures

- Open (compound) fracture
- Comminuted fracture
- Greenstick fracture
- Impacted fracture
- Pott's fracture
- Colles' fracture
- Stress fracture

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Open (compound) fracture

- broken ends of the bone protrude through the skin

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Comminuted fracture

- The bone is splintered, crushed, or broken into pieces at the site of impact, and smaller bone fragments lie between the two main fragments.

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Greenstick fracture

- A partial fracture in which one side of the bone is broken and the other side bends; occurs only in children.

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Impacted fracture

- One end of the fractured bone has been forcefully driven into the interior of the other

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Pott's fracture

- A fracture of the distal end of the lateral leg bone (fibula), with serious injury of the distal tibial articulation.

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Colles' fracture

- A fracture of the distal end of the lateral forearm bone (radius) in which the distal fragment is displaced posteriorly.

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Stress fracture

- Microscopic fissures or fractures in bone that usually form from repeated, strenuous activities.
- About 25% of stress fractures involve the tibia..

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Figure 6.10 – Types of bone fractures

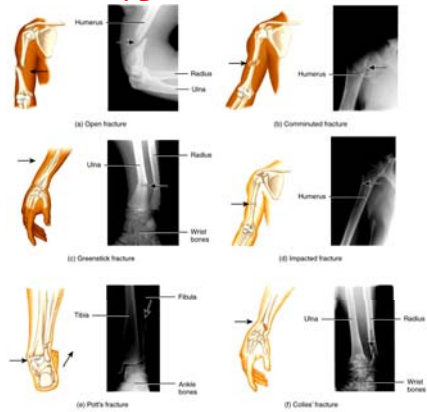


Figure 6.10 Types of bone fractures
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