Functions of Bone and Skeletal System

- Support
  - Structural framework of the body
    - Supports soft tissues
    - Provides attachment points for tendons of skeletal muscle
- Protection
  - Protects important internal organs
    - Cranium protects brain
    - Vertebrae protects spinal cord
    - Ribs protect lungs and heart
Functions of Bone and Skeletal System

- **Assistance in Movement**
  - Skeletal muscle attaches to bone
    - Skeletal muscle contraction pulls on bone producing movement

- **Mineral Homeostasis**
  - Bone tissue stores several minerals
    - Acts to serve as a reservoir of critical minerals
      - Calcium (99% of body’s content)
      - Phosphorus
Functions of Bone and Skeletal System

- **Blood Cell Production**
  - Red bone marrow produces (Hemopoiesis)
    - Red blood cells
    - White blood cells
    - Platelets

- **Triglyceride Storage**
  - Yellow bone marrow
    - Stores of Adipose cells
      - Serves as a potential chemical energy reserve
Structure of Bone

- Long Bone Anatomy
  - Diaphysis
  - Epiphysis
  - Metaphysis
    - Epiphyseal growth plate
  - Articular cartilage
    - Perforating fibers
  - Periosteum
  - Medullary cavity
  - Endosteum

![Diagram of bone structure](image)
Histology of Bone Tissue

- The most abundant mineral in bones is **calcium phosphate**
- **Calcification** is initiated by bone-building cells called osteoblasts.
- During this process calcium phosphate is deposited and crystalizes, providing stability.
- Deposited collagen fibers provide flexibility
Bone Tissue Cell Types

- **Osteogenic cells**
  - develops into osteoblasts, osteocytes, and osteoclasts.

- **Osteoblasts**
  - Bone-building cells
  - Regulate blood calcium level

- **Osteocytes**
  - Exchange nutrients and wastes with the blood

- **Osteoclasts**
  - Break down bone tissue (resorption)
  - Regulate blood calcium level
Osteogenic cell (develops into an osteoblast)

Osteoblast (forms bone matrix)

Osteocyte (maintains bone tissue)

Osteoclast (functions in resorption, the breakdown of bone matrix)
Histology of Bone Tissue

■ Compact Bone

■ Resists the stresses produced by weight and movement

■ Osteons or Haversian systems –
  ■ Structural unit of bones.
  ■ Osteons consist of a central (Haversian) canal
Histology of Bone Tissue

- **Osteon**
  - **Central canals** run longitudinally through bone
  - **Concentric lamellae** – branching canals.
  - **Lacunae** – spaces between lamellae with osteocytes.
  - **Canaliculi** – spaces filled with extracellular fluid
Osteon

- Canaliculi and lacunae form a system of interconnected canals
- Providing routes for nutrients and oxygen to reach the osteocytes
- The organization of osteons changes in response to the physical demands placed on the skeleton
Spongy Bone
- Lacks osteons
- **Trabeculae** – thin columns of lamellae.
- Trabeculae are more spaced out to make bones lighter
- Interior bone tissue is made up primarily of spongy bone.
- **Hemopoiesis** (blood cell production) occurs in spongy bone
Blood and Nerve Supply of Bone

- Bone is richly supplied with blood
  - **Periosteal arteries** accompanied by nerves supply the periosteum and compact bone
  - **Epiphyseal veins** carry blood away from long bones
- Nerves accompany the blood vessels that supply bones
Formation of Bone in an Embryo

- The process by which bone forms is called **ossification**
- Cartilage formation and ossification occurs during the **sixth** week of embryonic development
1. Development of ossification center

2. Calcification

3. Formation of trabeculae

4. Development of the periosteum
Bone Formation

- Bone formation follows one of two patterns
  - **Intramembranous ossification**
    - Flat bones of the skull and mandible are formed in this way
    - “Soft spots” that help the fetal skull pass through the birth canal later become ossified forming the skull
  - **Endochondral ossification**
    - The replacement of cartilage by bone
    - Most bones of the body are formed in this way including long bones
Development of cartilage model

Growth of cartilage model

Development of primary ossification center

Development of the medullary cavity

Development of secondary ossification center

Formation of articular cartilage and epiphyseal plate
Bone Growth

- **Epiphyseal plate** – location of bone growth.
- Occurs two ways:
  - 1) Growth of cartilage on the epiphyseal plate
  - 2) Replacement of cartilage by bone tissue in the epiphyseal plate
Bone Growth

At adulthood, the epiphyseal plates close and bone replaces all the cartilage leaving a bony structure called the epiphyseal line.
Factors Affecting Bone Growth

- **Hormones**
  - *Estrogen and testosterone* cause a dramatic effect on bone growth
    - Cause of the sudden “growth spurt” that occurs during the teenage year
    - Promote changes in females, such as widening of the pelvis
    - Shut down growth at epiphyseal plates
  - Parathyroid hormone, calcitriol, and calcitonin are other hormones that can affect bone remodeling
Bone’s Role in Calcium Homeostasis

Actions that help elevate blood Ca\(^{2+}\) level

- **Parathyroid hormone** (PTH) regulates Ca\(^{2+}\) exchange between blood and bone tissue
  - PTH increases the number and activity of osteoclasts
  - PTH acts on the kidneys to decrease loss of Ca\(^{2+}\) in the urine
  - PTH stimulates formation of **calcitriol** a hormone that promotes absorption of calcium from foods in the gastrointestinal tract
Bone’s Role in Calcium Homeostasis

Some stimulus disrupts homeostasis by decreasing blood calcium ($\text{Ca}^{2+}$) level.

- **Receptors**: Parathyroid gland cells detect lowered $\text{Ca}^{2+}$ concentration.
- **Input**: Increased production of cyclic AMP.
- **Control center**: PTH gene “turned on.”
- **Output**: Increased release of PTH.
- **Effectors**: Return to homeostasis when response brings blood $\text{Ca}^{2+}$ level back to normal.
Bone’s Role in Calcium Homeostasis

Input

Increased production of cyclic AMP

Control center

PTH gene “turned on”

Output

Increased release of PTH

Effectors

Osteoclasts increase bone resorption

Kidneys retain Ca^{2+} in blood, excrete phosphate in urine, and produce calcitriol

Increase in blood Ca^{2+} level

Return to homeostasis when response brings blood Ca^{2+} level back to normal

Figure 06.10 Tortora - PAP 12/e
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Bone’s Role in Calcium Homeostasis

Actions that work to decrease blood $Ca^{2+}$ level

- The thyroid gland secretes **calcitonin (CT)** which inhibits activity of osteoclasts

- The result is that CT promotes bone formation and decreases blood $Ca^{2+}$ level
Fracture and Repair of Bone

- Fracture Types
  - Open (compound) fracture
  - Closed (simple) fracture
  - Comminuted fracture
  - Greenstick fracture
  - Impacted fracture
  - Pott’s fracture
  - Colles’ fracture
  - Stress fracture
Fracture and Repair of Bone

- Calcium and phosphorus needed to strengthen and harden new bone after a fracture are deposited only gradually and may take several months.
- The repair of a bone fracture involves the following steps:
  1) **Formation of fracture hematoma**
     - Blood leaks from the torn ends of blood vessels, a clotted mass of blood forms around the site of the fracture.
  2) **Fibrocartilaginous callus formation**
     - Fibroblasts invade the fracture site and produce collagen fibers bridging the broken ends of the bone.
  3) **Bony callus formation**
     - Osteoblasts begin to produce spongy bone trabeculae joining portions of the original bone fragments.
  4) **Bone remodeling**
     - Compact bone replaces spongy bone.
1. Formation of fracture hematoma
2. Fibrocartilaginous callus formation
3. Bony callus formation
4. Bone remodeling
Videos

- Bone surgery
  - http://www.youtube.com/watch?v=s6tIDy6odw4&list=PLyH-hUyYA4htXvMzGCI7tMCTVVMdHS458t
Online Quiz

- Website: [http://highered.mcgraw-hill.com/sites/0072351136/student_view0/chapter6/chapter_quiz.html](http://highered.mcgraw-hill.com/sites/0072351136/student_view0/chapter6/chapter_quiz.html)

- Or Google “anatomy and physiology quiz” and look for the above website. Be sure to go to the Chapter 6 quiz.

- Copy the following questions: 1,4,5,8,9,10,11,14,23,24,31,32,34,37, 38,39 (16 total)

- Each group of student will get a group of questions and will explain the answer to the class.
Chapter 6 Terms

1. Diaphysis
2. Epiphysis
3. Metaphysis
4. Epiphyseal plate
5. Articular cartilage
6. Periosteum
7. Medullary cavity
8. Osteocytes
9. Osteoblasts
10. Osteoclasts
11. Osteons
12. Lacunae
13. Compact bone
14. Spongy bone
15. Calcium
16. Parathyroid hormone
17. Calcitriol
18. Calcitonin

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