

**Hole's Human
Anatomy and Physiology**
Tenth Edition
Shier Butler Lewis

Chapter 7

SKELETAL SYSTEM

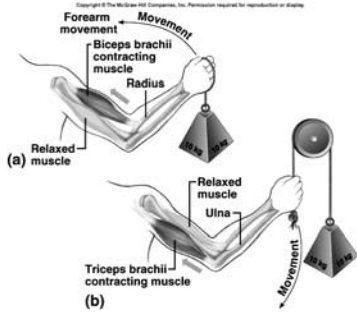
Functions of the Skeletal System

- 1. Support**
 - A.
- 2. Protection**
 - A.
- 3. Movement**
 - A.

Levers

1. Four Basic Components
 - A. rigid bar – bones
 - B. fulcrum – joint
 - C. object
 - D. force – muscles
2. First class lever: Straightening the arm
3. Second class lever: opening the mouth.
4. Third class lever: Bending the upper arm at the elbow

Levers and Movement



Function of Bones, 4-5

4. Mineral storage

A. Reservoir

- 99% of the body's calcium
- 85% of the body's phosphorous
- Adipose tissue

5. Blood cell formation

A. hematopoiesis

Bone Classification

- 206 named bones in the human body.
- 2 large groups:
 - Axial skeleton
 - .
 - .
 - .
 - Appendicular skeleton
 - .
 - .

Bones are classified according to shape

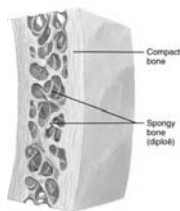
- 1. Long bones
 - A. shaft with two ends.
- 2. Short bones
 - A. cube-like.
- 3. Flat bones
 - A. broad and thin.
- 4. Irregular bones
 - A. vary in shape.
- 5. Sesamoid or round bones
 - A. small bones embedded in tendons.

Classification – Bone Shape

- F. Sutural Bones, or Wormian bones,**
 - A. small, flat, irregularly shaped bones between the flat bones of the skull.
 - B. individual variations

Classification – Bone Structure

- 1. spongy bone
 - A. cancellous bone,
- 2. compact bone
 - A. dense bone,

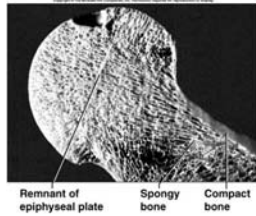


Structure of Typical Long Bone

1. Diaphysis
 - A.
 - B. compact bone surrounding a medullary cavity
2. Epiphysis (pl. -es)
 - A. expanded end of long bones
 - B. Articular cartilage
3. Epiphyseal lines

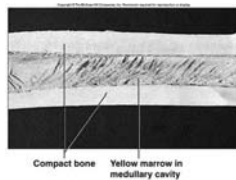
Spongy Bone

1. trabeculae
2. open space
3. Epiphyses consist mainly of spongy bone
 - A. surrounded by a thin layer of compact bone.



Compact Bone

1. solid, dense, and smooth.
2. Forms the shafts
3. Bone cells occur in Haversian systems



Marrow

1. A loose connective tissue
2. Yellow marrow
 - A. stores fat,
 - B.
3. Red marrow
 - A. Hematopoiesis:

Location of Hematopoietic Tissue

1. Red Marrow
 - A. meshwork
 - B. In infants:
 - C. In adults:

Microscopic Structure of Bone

1. Osteocytes
 - A. bone cells
 - B. transport nutrients and wastes
2. Lacunae
 - A. contain osteocytes.

Bone Structure

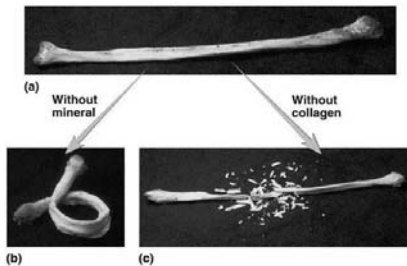
1. intercellular matrix
 - A. 1/3 organic and 2/3 inorganic by weight.
2. Organic component
 - A. Collagen fibers and other organic materials
 - B.

Inorganic component of bone matrix

1. calcium phosphate and calcium hydroxide. (**hydroxyapatite** $[\text{Ca}_3(\text{PO}_4)_2 \cdot (\text{OH})_2]$).
2. smaller amounts of magnesium, fluoride, and sodium.
3. hardness and ability to resist compression.

Bone Matrix

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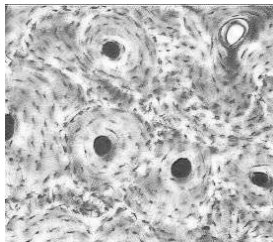


Microscopic Structure of Compact Bone

1. Structural unit
 - A. Haversian system or Osteon.
 - a. Elongated cylinders

Compact Bone Osteons

1. Haversian system:
 - A. osteocytes
 - B. lacunae
 - C. lamellae
 - D. Haversian canal



Bone Development

Osteogenesis or Ossification

1. Formation of the skeleton in embryos
2. Bone growth until early adulthood
3. Bone thickness, remodeling, and repair

BONE DEVELOPMENT AND GROWTH

1. Skeleton of an embryo
 - A. fibrous connective tissue membranes
 - B. This skeleton provides supporting structures for ossification
2. At 6-7 weeks of gestation, ossification begins and continues throughout adulthood

Formation of the Bony Skeleton

1. Before week 8, the embryonic skeleton is made of fibrous membranes and hyaline cartilage.
2. After week 8, bone tissue begins to replace the fibrous membranes and hyaline cartilage.
 - A. intramembranous ossification.
 - B. endochondral ossification.

Ossification follows one of two patterns

1. Intramembranous Ossification
 - A. Intramembranous Bones
 - a. broad, flat bones
 - b.

Ossification follows one of two patterns

2. Endochondral Ossification
 - A. Endochondral bones begin as hyaline cartilage
 - B. most bones of the skeleton

Postnatal Bone Growth

1. Longitudinal growth
 - A. bones lengthen by growth at the epiphyseal plates (or discs)
 - a. band of cartilage
 - b. cartilage is replaced by bone

Longitudinal growth

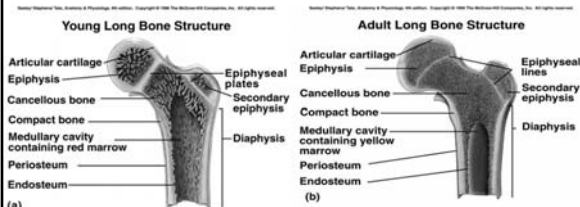
1. The epiphyseal plate allows for bone lengthening until adulthood.
2. As a child grows
 - A. Cartilage cells are produced
 - B. and replaced by bone

Longitudinal growth

2.
 - C. the bone on the diaphyseal side increases in length.

Long Bone Structure

2. When growth stops, the cartilage of the epiphyseal plate is replaced by bone forming the epiphyseal line.



Postnatal Bone Growth

1. Appositional growth
 - A. Remodeling
 - B. The process by which bones grow in thickness

Remodeling

1. By age 25, nearly all bones are ossified.
2. Bone is continuously remodeled throughout life
3. Bone is broken down and reformed
 - A. Balance between actions of osteoclasts and osteoblasts
4. 3-5 % of bone calcium exchanged each year

Remodeling of Bone Tissue

1. Bone Resorption
 - A. Osteoclasts
 - a. secrete an acid
 - b. lysosomal enzymes
 - c. development, growth, maintenance & repair
 - B. and parathyroid hormone
2. Bone Deposition
 - A. osteoblasts and calcitonin

Bone Remodeling

1. Bone is a dynamic tissue.
 - A.
2. Wolff's law

Factors Affecting Bone Development,
Growth, and Repair

1. Vitamins
2. Hormones
3. Physical Stress

Nutrition and Bone Development

1. Deficiency of Vitamin A
 - A.
 - B.

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Nutrition and Bone Development

1. Vitamin C
2. Deficiency of Vitamin C
 - A. Scurvy
 - a.
 - b. symptoms

Nutrition and Bone Development

- 1. Vitamin D
- 2. Vitamin D deficiency or inadequate calcium cause
 - A. rickets in children
 - B. osteomalacia in adults.
- 3. The bones of children with rickets are poorly mineralized

Nutrition and Bone Development

- 1. The gene that codes for vitamin D docking determines the tendency to accumulate bone mass early in life, and the risk for osteoporosis later

Factors Affecting Bone Development, Growth, and Repair

- 1. Insufficient Growth Hormone
 - A.
- 2. Excessive Growth Hormone
 - A.
- 3. Insufficient Thyroid Hormone
 - A.
- 4. Sex Hormones
 - A.
 - B.
- 5. Physical Stress
 - A.

EFFECTS OF EXERCISE ON BONE, 1

1. Bone shape reflects forces
 - A. sites where tendons attach.
2. As muscles become more powerful,
3. Heavily stressed bones become thicker and stronger.
4. Bones not subjected to ordinary stresses become thin and brittle.

EFFECTS OF EXERCISE ON BONE , 2

1. Regular exercise maintains normal bone structure.
2. Moderate amounts of physical activity and weight-bearing activities stimulate normal bone maintenance and bone strength.

EFFECTS OF EXERCISE ON BONE, 3

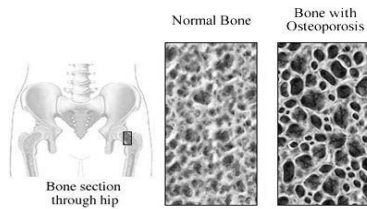
1. Degenerative changes
2. For example, .
3. Unstressed bones will lose mass.
4. Bones rebuild quickly
5. Astronauts and bedridden or paralyzed patients

Life-Span Changes

1. decrease in height at about age 30
2. calcium levels fall
3. bones become brittle
4. osteoclasts outnumber osteoblasts
5. spongy bone weakens before compact bone
6. bone loss rapid in menopausal women
7. hip fractures common
8. vertebral compression fractures common

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Osteoporosis



1. Group of diseases in which bone reabsorption outpaces bone deposit
2. Spongy bone is most vulnerable

Life-Span Changes

1. By age 35, everyone loses bone mass.
2. Women lose bone mass faster between menopause and age seventy.
3. Trabecular bone is lost before compact bone

Why is osteoporosis more common in older women than in older men?

1. Estrogen
2. Menopause
3. Males sex hormones (androgens)

Osteoporosis: Treatment

1. Calcium and vitamin D supplements (maybe not)
2. weight-bearing exercise
3. Hormone (estrogen) replacement therapy (HRT)
4. Progesterone
5. Statins

Bone Fractures (Breaks)

1. Bone fractures
 - A. displaced, nondisplaced
 - B. complete, incomplete
 - C. linear, transverse
 - D. simple, compound

A greenstick fracture is incomplete, and the break occurs on the convex surface of the bend in the bone.



A comminuted fracture is complete and fragments the bone.

A fissured fracture involves an incomplete longitudinal break.

A transverse fracture is complete, and the break occurs at a right angle to the axis of the bone.



A spiral fracture is caused by twisting a bone excessively.

An oblique fracture occurs at an angle other than a right angle to the axis of the bone.

Stages in the Healing of a Bone Fracture, 1

1. Hematoma formation
 - A. hemorrhage
 - B. Hematoma
 - C. Site becomes swollen, painful, and inflamed

Fracture Repair, 2

1. Spongy bone forms in regions near blood vessels and fibrocartilage forms farther away.

Fracture Repair, 3

1. A bony callus replaces the fibrocartilage.
2. Osteoclasts remove excess bony tissue
