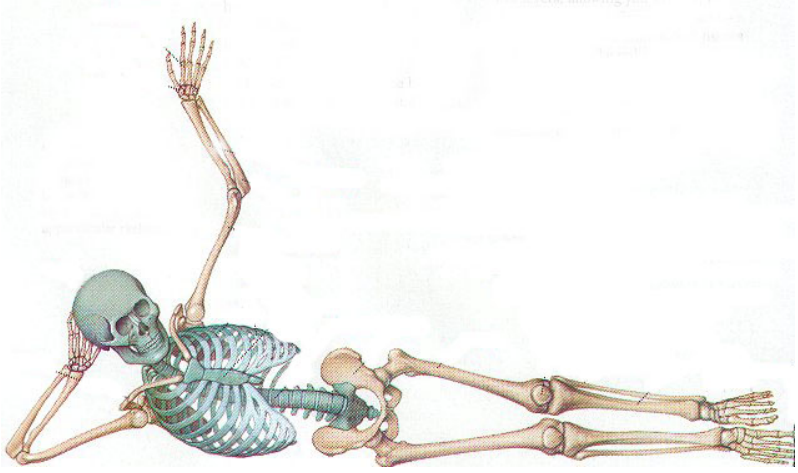
Skeletal System

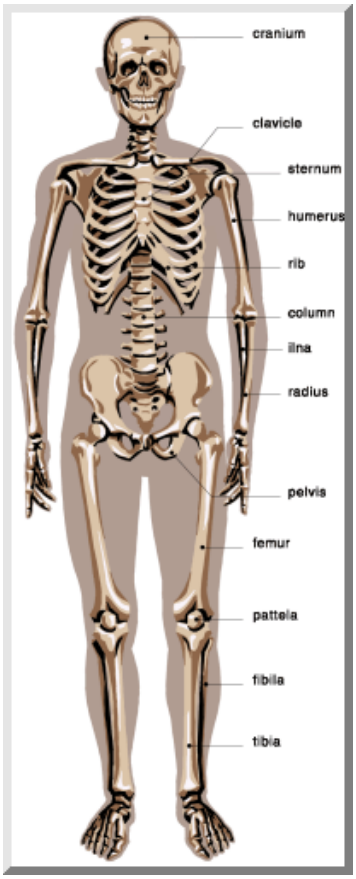


Objective

- Describe general structure of a bone, and list the functions of its parts.
- Locate and identify the bones and the major features of the bones.
- Discuss the major functions of bones.
- Distinguish between the axial and appendicular skeletons and name the major parts of each.
- Explain how skeletal system produce movement at joints and identify several types of such movements.

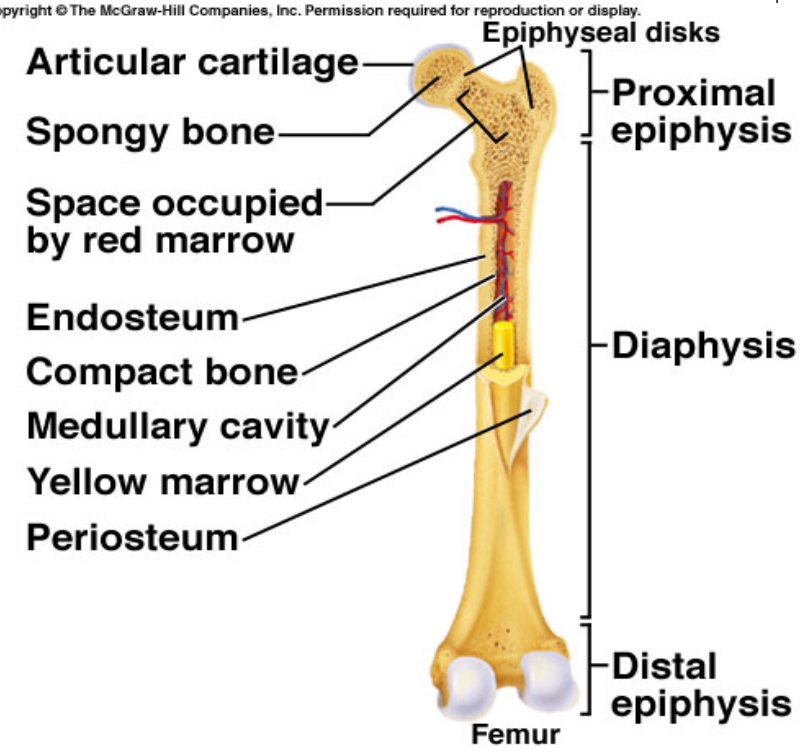
Introduction

- Individual bone composed of a variety of:
  - tissues
  - cartilage
  - epithelial tissue
  - fibrous connective tissue
  - blood
  - nervous tissue
- Classification of bones
  - Flat bone
  - Irregular bone
  - Long bone
  - Short bone



Bone Structure

Long Bone



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Microscopic Structure

- Bone cells (osteocytes) are located within lacuna that lie in concentric circles around osteonic canals.
- Osteocytes pass nutrients and gasses in the matrix through canaliculi.
- Intercellular material consists of collagen and inorganic salts.
- In compact bone, osteocytes and intercellular material are organized into osteons that are cemented together.
- Osteonic canals contain blood vessels and nerve fibers, and extend longitudinally through bone.
- Osteonic canals are interconnected by transverse perforating canals.
- Unlike compact bone, the osteocytes and intercellular material in spongy bone are not arranged around osteonic canals.

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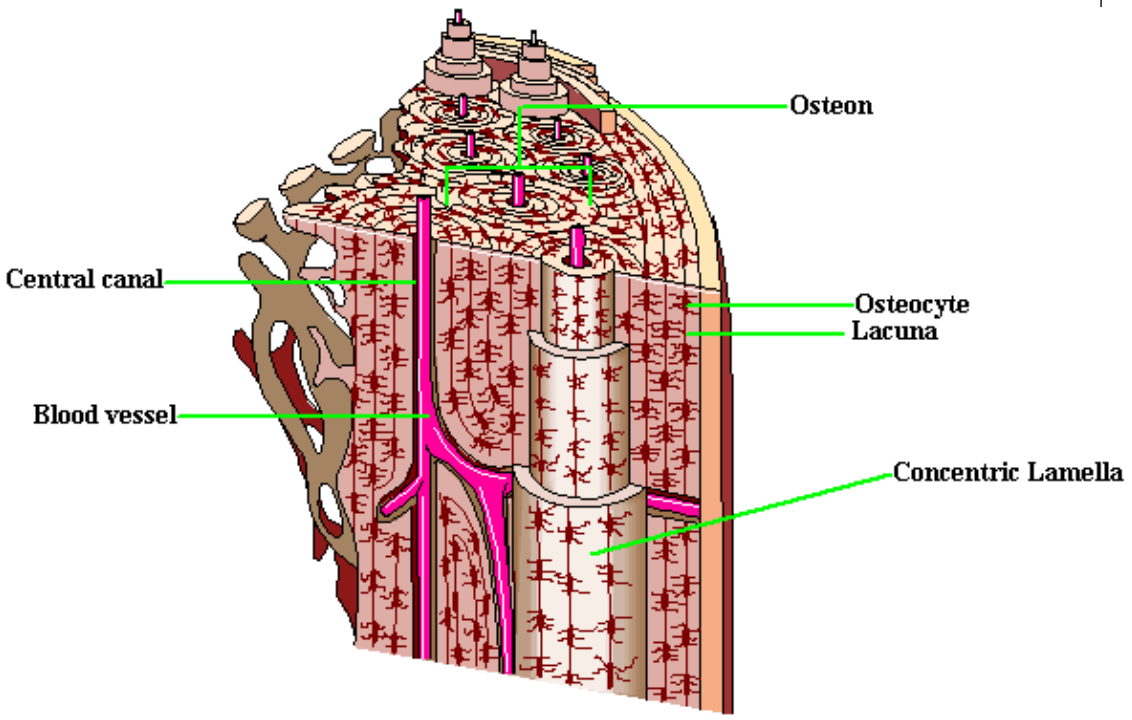
Osteon
Central canal
Osteocyte
Lacuna
Blood vessel
Concentric Lamella
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Bone Development & Growth

- Begins to form during the first weeks of prenatal development
- **Two methods**

  - intramembranous bones
    - originate within sheets of connective tissue

  - endochrondral bones
    - begin as models of hyaline cartilage that are replaced by bone

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Intramembranous Bone

- Bones form by replacing connective tissue in the fetus.
- Some form within sheet like layers of connective tissue (intramembranous bones), while others replace masses of cartilage (endochondral bones).
- The flat bones of the skull form as intramembranous bones that develop from layers of connective tissue.
- Osteoblasts deposit bony tissue around themselves.
- Once osteoblast's deposit bone are located in lacunae, they are called osteocytes.
- Cells of the membranous connective tissue that lie outside the developing bone give rise to the periosteum.

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Endochondral Bone

- They first develop as hyaline cartilage models and are then replaced with bone.
- Cartilage is broken down in the diaphysis and progressively replaced with bone while the periosteum develops on the outside.
- Cartilage tissue is invaded by blood vessels and osteoblasts that first form spongy bone at the primary ossification center in the diaphysis.
- Osteoblasts beneath the periosteum lay down compact bone outside the spongy bone.
- Secondary ossification centers appear later in the epiphyses.
- A band of hyaline cartilage, the epiphyseal plate, forms between the two ossification centers.

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Endochondral Bone (cont.)

- Layers of cartilage cells undergoing mitosis make up the epiphyseal plate.
- Osteoclasts break down the calcified matrix and are replaced with bone-building osteoblasts that deposit bone in place of calcified cartilage.
- Epiphyseal plates are responsible for lengthening bones while increases in thickness are due to intramembranous ossification underneath the periosteum.
- A medullary cavity forms in the region of the diaphysis due to the activity of osteoclasts.
- Homeostasis of Bone Tissue
- Osteoclasts tear down and osteoblasts build bone throughout the lifespan with the processes of resorption and deposition, with an average of 3% to 5% of bone calcium exchanged annually.

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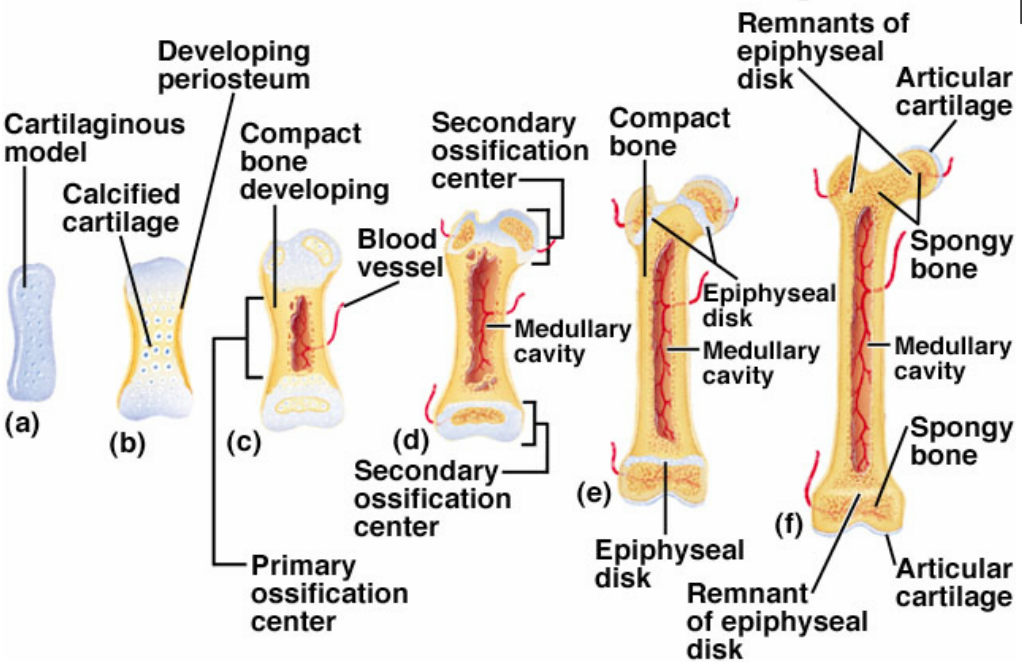
Endochondral Bone Development



Effects of Hormones & Vitamins

Molecule	Effect on Bone
HORMONES	
Calcitonin	Promotes calcium deposition in bone and inhibits osteoclast activity.
Growth hormone	Stimulates liver to produce the hormone somatomedin, which causes cartilage proliferation at epiphyseal plate and resulting bone elongation.
Parathyroid hormone	Increased blood calcium levels by encouraging bone resorption.
Sex hormone (estrogen & testosterone)	Stimulate osteoblast; promote epiphyseal plate growth and closure.
Thyroid	Stimulate bone growth by stimulating metaboloic rate of osteoblast.
VITAMINS	
Vitamin A	Activates osteoblasts.
Vitamin C (ascorbic acid)	Promotes collagen production.
Vitamin D	Promotes absorption of calcium and phosphate into blood.[12]

Effects of Exercise

- Stress in form of exercise is required for normal bone remodelling.
- Stress increases: production of calcitonin hormone.
- Weight bearing activities help thicken, build and retain bone mass.
- Research shown that regular weight bearing exercise can increase total bone mass in adolescents, young adults and at even 70 -80 years old people.

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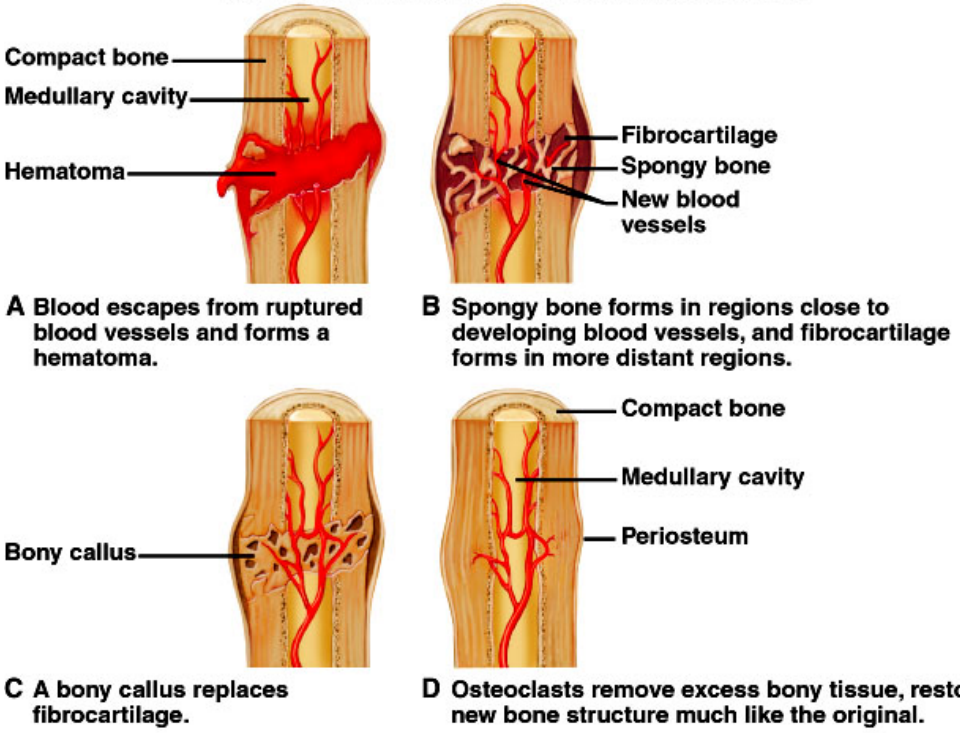
Repair of Bone Fracture



A Blood escapes from ruptured blood vessels and forms a hematoma.

B Spongy bone forms in regions close to developing blood vessels, and fibrocartilage forms in more distant regions.

C A bony callus replaces fibrocartilage.

D Osteoclasts remove excess bony tissue, restoring new bone structure much like the original.

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Functions of Bones

- Support and protection
  - Bones give shape to the head, thorax, and limbs.
  - Bones such as the pelvis and lower limbs provide support for the body.
  - Bones of the skull protect the brain, ears, and eyes.

- Body movement
  - Bones can act as levers.
    - A lever has four components: a rigid bar, a pivot or fulcrum, an object that is moved against resistance, and a force that supplies energy.

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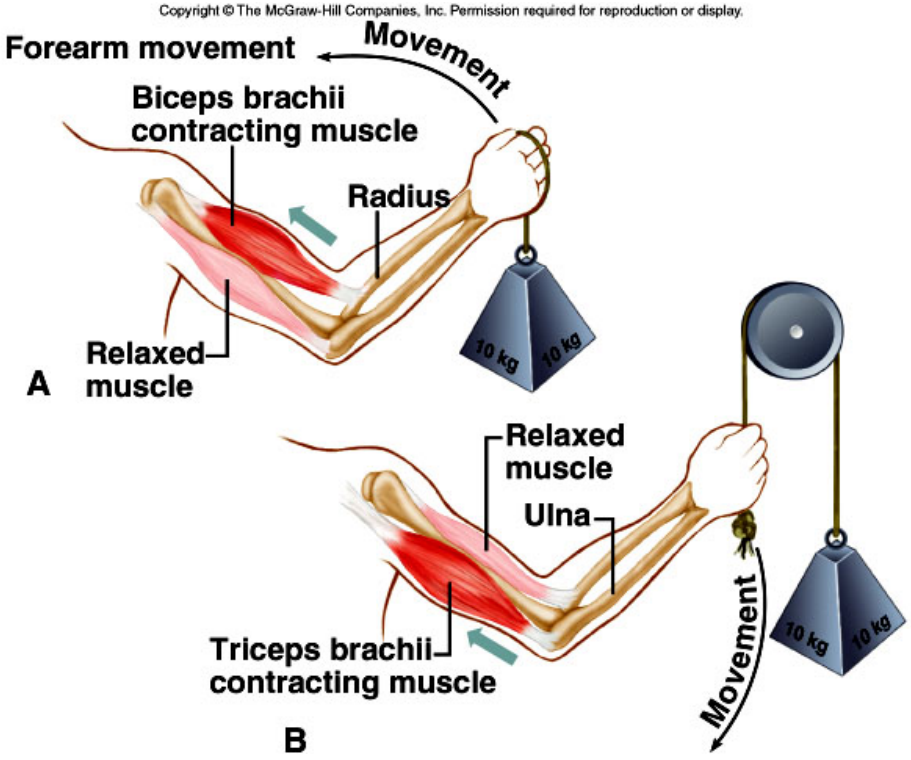

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Functions of Bones

- Blood Cell Formation
  - Two kinds of marrow occupy the medullary cavities of bone.
    - Red marrow functions in the formation of red blood cells, white blood cells, and platelets, and is found in the spongy bone of the skull, ribs, sternum, clavicles, vertebrae, and pelvis.
    - Yellow marrow, occupying the cavities of most bones, stores fat.

Functions of Bones

- Storage of inorganic salts
  - **The inorganic matrix of bone stores inorganic mineral salts in the form of calcium phosphate that is important in many metabolic processes.**
  - **Calcium in bone is a reservoir for body calcium; when blood levels are low, osteoclasts release calcium from bone.**
  - **Calcium is stored in bone under the influence of calcitonin when blood levels of calcium are high.**
  - **Bone also stores magnesium, sodium, potassium, and carbonate ions.**
  - **Bones can also accumulate harmful elements, such as lead, radium, and strontium.**

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