Functions of the Skeletal System

1. Support
   - Rigid strong bone – bearing weight & support the tissue of the body.
   - Cartilage – firm, yet flexible – nose, external ear and trachea.
2. Protection
   - Bone is hard and protects underlying organs.
3. Movement
   - Muscle attach to bone. When muscles contract they move the bones producing body movements.

1

Functions of the Skeletal System

4. Storage
   - Stores minerals
     - Calcium
     - Phosphorus
     - Should these mineral levels fall in the blood then they are released from the bone.
5. Blood Cell Production
   - Contain cavities filled with bone marrow which gives rise to blood cells & platelets.

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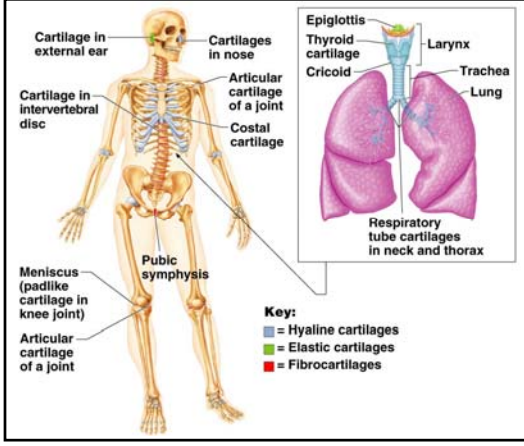

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Cartilage

- 3 Types
  1. Hyaline cartilage
  2. Elastic cartilage
  3. Fibrocartilage
- Most of the bones in the body develop from hyaline cartilage.
- Repair of bones involve hyaline cartilage.

4

Hyaline cartilage

- 3 main types of cells.
  1. Chondroblasts – produce new cartilage.
  2. Chrondrocyte – chondroblast surrounded by matrix.
  3. Lacuna – space around a chrondrocyte.

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Elastic Cartilage

- Similar to hyaline cartilage, but contains many elastic fibers.
- Can tolerate repeated bending.
- Epiglottis, outer ear.

6

Fibrocartilage

- Resists both strong tension & compression.
- Intermediate between hyaline cartilage and dense regular tissue.
- Intervertebral discs & menisci of the knee.

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Cartilage

- Perichondrium – a double-layered connective tissue sheath that surrounds cartilage.
  - Outer layer – Dense irregular connective tissue.
  - Inner layer – Delicate, fewer fibers and contains chondroblasts.

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Cartilage

- Blood vessels & nerves penetrate the outer layer, but do not enter the cartilage matrix, so nutrients must diffuse through the matrix to reach the chondrocytes.
- Articular cartilage – covering the ends of bones – has no perichondrium, blood vessels or nerves.

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Cartilage Growth

- Appositional growth – Chondroblasts in the perichondrium lay down new matrix and add new chondrocytes to the outside of the tissue.
- Interstitial growth – Chondrocytes within the tissue divide and add more matrix.

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Gross Anatomy of Bones

- Compact Bone
  - External layer
  - Dense
- Spongy Bone
  - AKA: **Trabecular bone**.
  - A honeycomb of small needle-like or flat pieces known as **trabeculae**.
  - Spaces in trabeculae are filled with yellow marrow.

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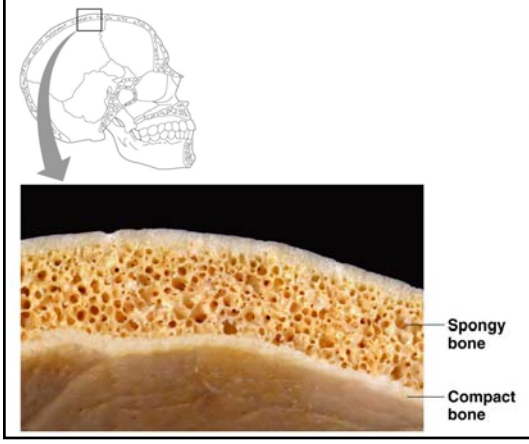

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Bones

- Periosteum – Double layer connective tissue that covers bones.
  - Outer layer – Dense connective tissue that contains blood vessels and nerves.
  - Inner layer – Single layer of bones cells that include osteoblasts, osteoclasts & osteoprogenerator cells.

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Bones

- Where tendons & ligaments attach to bone, the collagen fibers of the tendon or ligament become continuous with those of the periosteum.
- Some fibers penetrate the periosteum into the bone for added strength – **Sharpy's fibers**.
- Endosteum – lines the medullary cavity.

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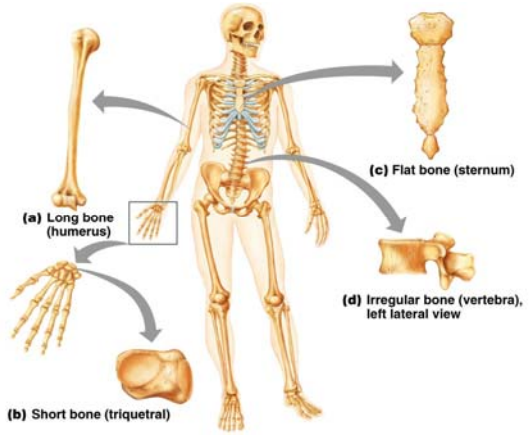

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Long Bones

- Long Bones are longer than they are wide.
- 3 Major Components
  1. Diaphysis – Shaft – Compact bone.
  2. Epiphysis – End – Cancelous (spongy) bone
     - Outer surface – compact bone
  3. Epiphyseal plate (growth plate) – Hyaline cartilage – between diaphysis & epiphysis – growth in length – growth stops, ossifies & is called epiphyseal line.

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Long Bones

- Medullary Cavity – large cavity in the center of a long bone.
  - Red marrow – site of blood cell formation – found mostly in flat bones and at the ends of long bones.
  - Yellow marrow – mostly adipose tissue – found mostly in the long bones of the limbs.
- Children have more red bone marrow than adults. Red in limbs is replaced by yellow as children age.

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Flat Bone

- No diaphysis or epiphyses.
- Inner framework of cancellous bone sandwiched between compact bone.

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Short & Irregular Bone

- Similar to the epiphyses of long bone.
- compact bone surface with a cancellous bone center with spaces filled with marrow.
- No Diaphysis, some have small epiphyses.
- Some have air-filled cavities - sinuses - Skull

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Microscopic Structure of Compact Bone

- Bone looks solid to the naked eye
  - Actually bone has many passageways
  - Blood vessels, Lymphatic vessels, Nerves
- Bone consists of:
  - Cells
  - Extracellular matrix
    - Collagen fibers
    - Ground substance
    - Tissue fluid (less than other connective tissue)
    - **Mineral crystals**

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Osteon / Haversian System

- Act like pillars in the bone.
- Cylindrical & parallel to long axis of bone.
- Made up of **lamella** – smaller rings (like the structure of a tree).
  - Layer of bone matrix where collagen fibers & mineral crystals align & run in same direction.
  - Adjacent lamella fibers run opposite direction increasing the ability to withstand stresses.
  - Helps to inhibit crack propagation.

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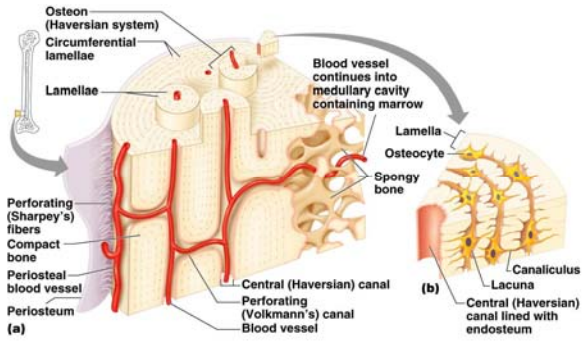

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Osteon / Haversian System

- Central or Haversian canal
  - Lined with endostem.
  - Blood vessels that supply nutrients to the bone cells of the osteon and its own nerve fibers.
- Perforating or Volkmann's Canals
  - Right angles to central canals.
  - Connects blood & nerve supply of the periosteum to the central canals & marrow cavity.

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Osteon / Haversian System

- Osteocytes
  - Mature bone cells – spider shaped.
  - "Spider bodies" occupy small cavities called Lacunae "little lakes" and their "spider legs" occupy tubes called canaliculi.
    - Canaliculi "little canals" connect nearby lacunae to the nearest capillaries.
    - "Spider legs" form gap junctions to transfer nutrients from osteocyte to osteocyte.

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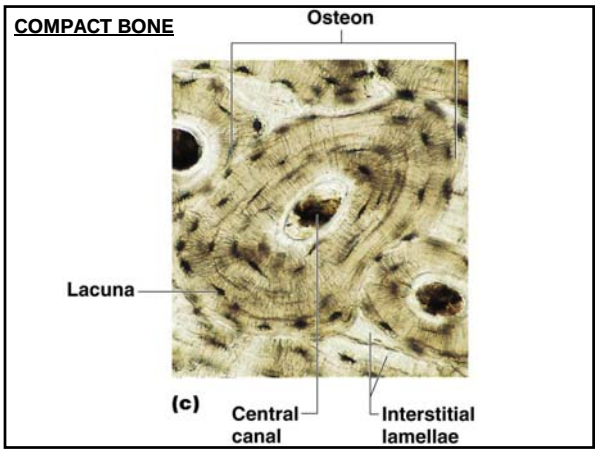

Microscopic Structure of Spongy Bone

- Less complex than compact bone.
- Each trabecula contain several layers of lamellae and osteocytes, but too small to contain osteons or vessels.
- Osteocytes receive nutrients from capillaries in the endosteum surrounding the trabecula.

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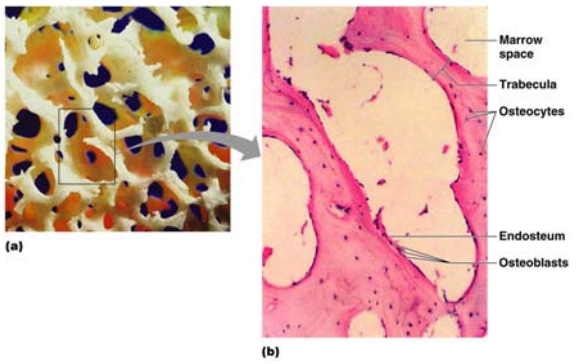

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Chemical Composition of Bone Tissue

- Organic components
  - Cells
  - Fibers
  - Ground substance
- 35% of tissue mass
- Collagen allows for bone flexibility and tensile strength – stretching & twisting.

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Chemical Composition of Bone Tissue

- Inorganic components
  - Hydroxyapatites (mineral salts)
    - Calcium phosphate
    - Tiny crystals that lie in & around collagen fibrils.
    - Pack tightly giving bone its exceptional hardness.
  - 65% of tissue mass

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Chemical Composition of Bone Tissue

- Ideal bone has the proper balance of organic and inorganic material.
- Too much organic material = soft bone
  No support
- Too much inorganic`material = brittle bone
  Break easily under little stress

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Bone Development

- Mesenchymal cells & connective tissue form **osteoblasts** – secret organic part of matrix called **osteoid**.
- Osteoid then becomes mineralized.
- Once surrounded by matrix osteoblasts are called **osteocytes**.
- Forms woven bone which lacks the lamellae of mature spongy bone.
- Outer edges thicken and form compact bone.

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Bone Development

- Bones widen as they lengthen.
  - Osteoblasts in periosteum add bone tissue to external face as osteoclasts in the endosteum remove bone from the internal surface of the diaphysis wall.
  - This process is called **appositional growth**.

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Bone Development

- Bone growth is regulated by hormones
  - Growth hormone – pituitary – stimulates epiphyseal plates to grow.
  - Thyroid hormone – keeps proper proportions.
  - Sex hormones – androgens & estrogens – first promote bone growth then induce the closure of the epiphyseal plates.

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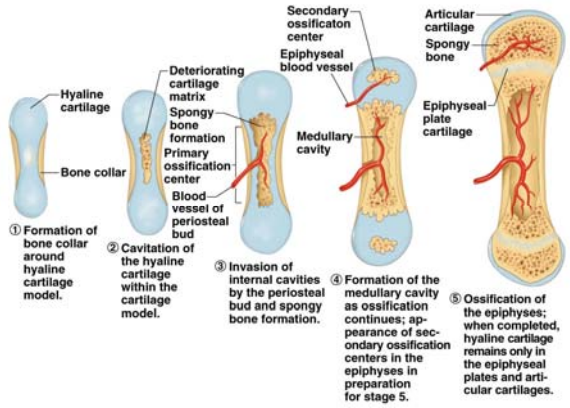

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Bone Remodeling

- Bone resorption is constantly taken place by cells called **osteoclasts**.
- Bone deposition is constantly taken place by cells called **osteoblasts**.
- Spongy bone replaced every 4 years.
- Compact bone replaced every 10 years.

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Bone Disorders

- DISORDERS DISCUSSED IN BOOK
  - Osteoporosis
  - Osteomalacia
  - Rickets
  - Paget's Disease
  - Osteosarcoma

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