Ch 7 Part 1 - Structure, Growth and Development

1) List the active tissues in a bone.
2) Describe the general structure of a bone, and list the functions of its parts.
3) Distinguish between intramembranous and endochondral bones, and explain how such bones develop and grow.
4) Discuss the major functions of bones.

Introduction:
- Bones are very active tissues
- Each bone is made up of several types of tissues and so is an organ.
- Bone functions:
  - Supports body and provides shape.
  - Protects internal organs.
  - Movement and anchorage of muscles.
  - Mineral storage. (calcium and phosphorus)
  - Hemopoiesis (blood formation)

Bone Structure
- Bones differ in size and shape, yet are similar in several ways.

Classification of Bones
- Long – Forearm and thigh bones
- Short – bones of the wrists and ankles
- Flat – ribs, scapulae and some skull bones
- Irregular – Vertebrae and some facial bones
- Sesamoid (small and nodular)- kneecap

Structure and Formation of Bone
- Osteocytes – mature bone cells; makes up bone
- Bone = 35% organic material and 65% inorganic mineral salts and water.
  - Organic
    - Collagen (fibrous material) - flexibility
    - Jellylike material between collagen fibers
  - Inorganic
    - Mineral salts (magnesium phosphate, calcium carbonate, calcium fluoride, etc)
    - Gives bones hardness and durability, brittle

Parts of a Long Bone
- Expanded ends of bones that form joints with adjacent bones are called epiphyses.
- Articular cartilages (hyaline cartilage) cover the epiphyses.
- The shaft of the bone is the diaphysis.
- A tough layer of vascular connective tissue, called the peristeme, covers the bone and is continuous with ligaments and tendons.
• A bone’s shape makes possible its function; bony processes or grooves indicate places of attachment for muscles.

• Compact bone makes up the wall of the diaphysis; the epiphyses are filled with spongy bone to reduce the weight of the skeleton.

• The diaphysis contains a hollow medullary cavity that is lined with endostem and filled with marrow.

Terminology
• Osteoblasts: Bone cells that deposit new bone tissue
• Osteoclasts: Bone cells that secrete enzymes that dissolve bone from the medullary canal
• Medullary Canal – marrow cavity of the bone
• Central Canals (Haversian) – branch into compact bone and carry blood vessels for nourishment (go up and down)
• Perforating Canals (Volkman’s) – transverse bone tissue (side to side)

Microscopic Structure
• Bone cells (osteocytes) are located within lacunae that lie in concentric circles around central 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.
• Central canals contain blood vessels and nerve fibers, and extend longitudinally through bone.

• Central canals are interconnected by transverse perforating canals.
• Unlike compact bone, the osteocytes and intercellular material in spongy bone are not arranged around central canals.

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.
• Bones can also accumulate harmful elements, such as lead, radium, and strontium.
Blood Cell Formation

- Blood cells begin to form through hematopoiesis in the yolk sac; they are later manufactured in bone marrow.
- 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.

Bone Formation

- Embryonic skeleton – initially collagenous protein fibers secreted by osteoblasts
  - Osteoblasts – primitive embryonic cells
  - Later, hyaline cartilage is deposited between fibers
  - Ossification – mineral matter begins to replace previously formed cartilage created bone (at 8 weeks)
- Fontanel – soft spot on baby’s head (bones not complete)
- Ossification continues through childhood

Bone Development and Growth

- Bones form by replacing connective tissues in the fetus.
- Intramembranous bones – form within sheetlike layers
- Endochondral bones – replace masses of cartilage

Intramembranous 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 osteoblasts deposit bone that is located in lacunae, they are called osteocytes.
- Cells of the membranous connective tissue that lie outside the developing bone give rise to the periosteum.
Endochondral Bones

- Most of the bones of the skeleton fall into this category.
- 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.
- 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.

Bone growth in length

- Bones ossify from center of diaphysis towards epiphyseal extremities.
- Growth zone – where ossification occurs; doesn’t interfere with articulation between 2 bones
- Length of diaphysis continues until all epiphyseal cartilage (growth plate) is ossified.
- New bone growth can occur in a broken bone at any time
- Bone cells near site of fracture become active

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.