Chapter 6: Bones and Skeletal Tissue

I. Skeletal Cartilages

A. Basic Structure, Types, and Locations
   1. Skeletal cartilages are made from cartilage
   2. Hyaline cartilage is the most abundant skeletal cartilage,
   3. Elastic cartilages are more flexible than hyaline, and are located only in the external ear and the epiglottis of the larynx.
   4. Fibrocartilage is located in areas that must withstand a great deal of pressure or stretch, such as the cartilages of the knee and the intervertebral discs.

II. Classification of Bones

A. There are two main divisions of the bones of the skeleton: the axial skeleton, consisting of the skull, vertebral column, and rib cage; and the appendicular skeleton, consisting of the bones of the upper and lower limbs, and the girdles that attach them to the axial skeleton

B. Shape

Long bones are longer than they are wide, have a definite shaft and two ends, and consist of all limb bones except patellas, carpals, and tarsals.

   2. Short bones are somewhat cube-shaped and include the carpals and tarsals.
   3. Flat bones are thin, flattened, often curved bones that include most skull bones, the sternum, scapulae, and ribs.
   4. Irregular bones have complicated shapes that do not fit in any other class, such as the vertebrae and coxae.

IV. Bone Structure

A. Gross Anatomy
   1. Bone markings are projections, depressions, and openings found on the surface of bones that function as sites of muscle, ligament, and tendon attachment, as joint surfaces, and as openings for the passage of blood vessels and nerves.
   2. Bone Textures: Compact and Spongy Bone
      a. All bone has a dense outer layer consisting of compact bone that appears smooth and solid.
      b. Internal to compact bone is spongy bone, which consists of honeycomb, needle-like, or flat pieces, called trabeculae.
   3. Structure of a Typical Long Bone
      a. Long bones have a tubular bone shaft, consisting of a bone collar surrounding a hollow medullary cavity, which is filled with yellow bone marrow in adults.
      b. Epiphyses are at the ends of the bone, and consist of internal spongy bone covered by an outer layer of compact bone.
      c. The epiphyseal line is located between the epiphyses and diaphysis, and is a remnant of the epiphyseal plate.
      d. The external surface of the bone is covered by the periosteum.

   5. Location of Hematopoietic Tissue in Bones
      a. Hematopoietic tissue of bones, red bone marrow, is located within the trabecular cavities of the spongy bone in flat bones, and in the epiphyses of long bones.
      b. Red bone marrow is found in flat bones and the proximal epiphyses of the humerus and femur.

B. Microscopic Anatomy of Bone
    1. The structural unit of compact bone is the osteon, or Haversian system, which consists of concentric tubes of bone matrix (the lamellae) surrounding a central Haversian canal that serves as a passageway for blood vessels and nerves.
        a. Volkmann's, canals lie at right angles to the long axis of the bone, and connect the blood and nerve supply of the periosteum to that of the central canals and medullary cavity.
        b. Osteocytes occupy lacunae at the junctions of the lamellae, and are connected to each other and the central canal via a series of hair-like channels, canaliculi.

V. Bone Development

B. Postnatal Bone Growth
    1. Growth in length of long bones occurs at the ossification zone.
    2. Growth in width, or thickness, occurs through appositional growth due to deposition of bone matrix by osteoblasts beneath the periosteum.
    3. Hormonal Regulation of Bone Growth.
        b. At puberty, testosterone and estrogen promote a growth spurt, but ultimately induct the closure of the epiphyseal plate.

VI. Bone Homeostasis: Remodeling and Repair

A. Bone Remodeling
    1. In adult skeletons, bone remodeling is balanced bone deposit and removal, bone deposit occurs at a greater rate when bone is injured, and bone resorption allows minerals of degraded bone matrix to move into the blood.
    2. Control of Remodeling
        a. The hormonal mechanism is mostly used to maintain blood calcium homeostasis,
        b. In response to mechanical stress and gravity, bone grows or remodels in ways that allow it to withstand the stresses it experiences.
        c. Osteoclasts remove bone tissue; osteoblasts build bone tissue, and osteocytes are the cells in bone tissue
B. Bone Repair
    1. Fractures are breaks in bones, and are classified by: the position of the bone ends after fracture, completeness of break, orientation of the break relative to the long axis of the bone,
    2. and whether the bone ends penetrate the skin.

    2. Repair of fractures involves four major stages:.

VII. Homeostatic Imbalances of Bone

    2. Rickets is inadequate mineralization of bones in children caused by insufficient calcium or vitamin D deficiency.
B. Osteoporosis refers to a group of disorders in which the rate of bone resorption exceeds the rate of formation
    1. Bones have normal bone matrix, but bone mass is reduced and the bones become more porous and lighter increasing the likelihood of fractures.
    2. Older women are especially vulnerable to osteoporosis, due to the decline in estrogen after menopause.
    3. Other factors that contribute to osteoporosis include a petite body form, insufficient exercise or immobility, a diet poor in calcium and vitamin D, abnormal vitamin D receptors, smoking, and certain hormone-related conditions.

C. Paget’s disease is characterized by excessive bone deposition and resorption, with the resulting bone abnormally high in spongy bone. It is a localized condition that results in deformation of the affected bone.
D. VIII. Developmental Aspects of Bones: Timing of Events
E. The skeleton derives from embryonic mesenchymal cells, with ossification occurring at precise times. Most long bones have obvious primary ossification centers by 12 weeks gestation.
B. At birth, most bones are well ossified, except for the epiphyses, which form secondary ossification centers.
C. Throughout childhood, bone growth exceeds bone resorption; in young adults, these processes are in balance; in old age, resorption exceeds formation.