BONE HISTOLOGY

LEARNING OBJECTIVES

• At the end of the lecture the student should be able to:
• Recognize bone and its functions and composition.
• Differentiate between woven bone and lamellar bone.
• Differentiate between compact bone and spongy bone.
• Learn the applied aspect of bone

BONE

• Bone is a specialized type of connective tissue characterized by intercellular calcified material - The bone matrix

FUNCTIONS OF BONE

• Supports soft tissue
• Protects vital organs (cranium, thoracic cavity)
• Contains bone marrow
• Reservoir of Ca, PO4 to maintain constant concentrations in body fluids
• Locomotion
COMPOSITION

- **Cells**
  - Osteoblasts
  - Osteocytes
  - Osteoclasts

- **Bone matrix**
  - **Organic:** Fiber + ground substance (Proteoglycan and glycoprotein)
  - **Inorganic:** Calcium + phosphorus (hydroxyapatite crystal & noncrystalline amorphous form), bicarbonates and citrate etc

TYPES OF BONE

- **Microscopically**
  - Primary (woven)
  - Secondary (Lamellar)

- **Macroscopically**
  - Compact
  - Cancellous (Both have lamellar arrangement)
WOVEN BONE

- Characterized by random deposition of fine collagen and increased cellularity.
- Relatively radiolucent (low mineral contents).
- Seen in embryonic development, fracture and repair.

LAMELLAR BONE

- Characterized by
- Arrangement of collagen fibers in lamellae organized concentrically around a vascular canal containing blood vessels and nerves.
- The lamellae and the vascular canal constitute the Haversian system or osteon.
- Lacunae containing osteocytes are present between the lamellae.
- Mineralized matrix with few fibers present around each osteon, called the cementing substance.
DIFFERENCE BETWEEN WOVEN AND LAMELLAR BONES

- Woven (primary) bone tissue is temporary and is replaced in adults by Lamellar (secondary) bone tissue except in few places i.e. near sutures of flat bones of skull
- There is irregular array of collagen fibers in Woven (primary) bone tissue
- Woven (primary) bone tissue has lower mineral content
- Woven (primary) bone tissue has higher proportion of osteocytes

COMPACT BONE

- 4 Types of lamellae seen:
  - a. Haversian system
  - b. Outer circumferential
  - c. Inner circumferential
  - d. Interstitial
- Volkman’s canal communicate the osteons and periosteal and endosteal surfaces.
SPONGY BONE

- Bony tissue is in the form of trabeculae having lamellar arrangement.
- Vascular canals are absent as the vessels in marrow cavities provide nutrition by means of diffusion.

OSTEOBLASTS

- Synthesize organic components of matrix (collagen type I, proteoglycans, glycoproteins.)
- Epitheloid appearance, cuboidal or columnar shape
- Shows alkaline phosphatase activity
- Influence deposit of Ca++, PO4.
- Estrogen, PTH stimulate its activity
OSTEOCYTES

- Mature bone cells that sit in lacunae
- Almond shaped cell with condensed nuclear chromatin
- Gap junctions between osteocytes provide nutrition (15 cells in a row)
- Maintain bony matrix; death causes resorption of matrix
- Stimulated by calcitonin; inhibited by PTH

OSTEOCLASTS

- Derived from monocytes; engulf bony material
- Large, multinucleated and branched found in Howship’s lacunae
- Surface foldings forming ruffled border increasing the active resorptive area.
- Secrete enzymes (colleganase etc) that digest matrix

BONE MATRIX

- Organic – 35% collagen
  - Chondroitin sulfate 4&6, hyaluronic acid and osteocalcin
- Inorganic – 65% calcium phosphate minerals – hydroxyapatite crystals, which binds water around it. This hydration shell facilitate exchange of ions between it and body fluids.
- Combination provides strength and rigidity. Laid down by osteoblasts.
**PERIOSTEUM**
- Consists of outer layer of collagen fibers and fibroblast. The fibers penetrate the bone matrix, the Sharpey’s fiber
- Inner layer of reserve cells which can differentiate in osteoblast cells

**ENDOSTEUM**
- Very little connective tissue and single layer of reserve cells
- Lines medullary and marrow cavities of bone

** ENDOCHONDRIAL BONE FORMATION**
- Within the model of hyaline cartilage.
- Hypertrophy and destruction of chondrocytes.
- Calcification of cartilage matrix.
- Arrival of osteogenic bud.
- Osteoblast differentiate from progenetor cells and form bone matrix
INTRAMEMBRANOUS BONE FORMATION

- Connective tissue develops embryonically and gives rise to bone.
- Cells in connective tissue differentiate into osteoblasts.
- Osteoblasts lay down collagen eventually starts to calcify and become osteocytes.
- Cancellous bone eventually becomes compact bone.
Fractures

- Open and
- Closed

- Healing of these takes place in three stages;
  - repair by granulation tissue
  - union by callus
  - consolidation by mature bone
OSTEOPOROSIS

• Most common bone disease
• Bones lose mass & becomes brittle due to loss of both organic matrix & minerals
  – Risk of fracture of hip, wrist & vertebral column.
  – Leads to fatal complications such as pneumonia or pulmonary embolism.
  – Widow’s (dowager’s) hump is deformed spine
  – Postmenopausal white women at greatest risk
    - By age 70, average loss is 30% of bone mass
    - ERT slows its progress, but best treatment is prevention -- exercise & calcium intake (1000 mg/day) between ages 25 and 40.

BONE MAROW BIOPSY

• Passing a metal pin into the medullary cavity, during bone marrow biopsy hardly interferes with the blood supply of the bone, as it is richly supplied.

RICKETS

• Calcification of cartilage fails and ossification of the growth zone is disturbed.
• Osteoid tissue is formed normally and the cartilage cells proliferate freely, but mineralization does not take place.
• This results in craniotabs, rachitic rosary, enlarged epiphyses in limb bones, and spinal & pelvic deformities.
  -Fractures, tumors, and infections of the bone are very painful.
REFERENCES

- MEDICAL HISTOLOGY BY LAIQ HUSSAIN SIDDIQUI
- BASIC HISTOLOGY BY JUNQUEIRA

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