BONE TISSUE

- **structural component of bones**
- specialized connective tissue for support and protection
- composition:  
  - **cells**
  - mineralized intercellular matrix – bone matrix

Histological composition of the bone tissue:

1. Bone matrix – *intercellular substance*

   a. **Inorganic components** → Ca, P, Mg, K, Na → hydroxyapatite crystals (65%)
      crystals lie alongside collagen fibrils and are surrounded by amorphous ground substance

   b. **Organic components**:

      *Fibers*: collagen fibers (collagen type I)!

      *Amorphous ground substance*: noncollagenous proteins
      GAG, PG, structural GP
      small regulatory proteins

2. Cells

   a. **Osteoprogenitor cells** (preosteoblasts)
   b. **Osteoblasts** (bone forming cells)
   c. **Osteocytes** (inactive osteoblast)
   d. **Osteoclasts** (bone resorbing cells)

Osteoblasts

- line endosteal and periosteal surfaces (1 layer)

- cuboidal cells with basophilic cytoplasm (proteosynthesis)

- deposit of unmineralized organic matrix –**osteoid** – produced at the surface of the bone tissue when new bone tissue is required
FUNCTION:

1) synthesis of organic components of bone matrix (growth, response to fracture, remodelling)
2) regulate mineralization of bone matrix
3) regulate activity of bone resorption (osteoclasts)

Produce:

- collagen type I (95 %)
- non-collagenous bone matrix proteins:
  - GAG, proteoglycans (hyaluronan, chondroitin and keratan sulfate)
  - calcium binding proteins- osteocalcin
  - multiadhesive glycoproteins- sialoproteins, osteonectin
- membrane limited matrix vesicles rich in phosphatases (alkaline phosphatase, pyrophosphatase)

Osteocytes

- are differentiated osteoblasts surrounded by mineralized bone matrix- terminally differentiated cells for years
- involved in maintenance of bone matrix

oval shape cells with long processes
- occupy small cavities – lacunae
- nucleus with higher content of heterochromatin
- reduced GER, GA
- osteocytes lie in the lacunae between or inside the lamellae of mineralized matrix

thin cytoplasmic processes inside thin tunnels make contact of adjacent cells - communication - maintain physiological links between the living osteocytes and distribute nutrients to and from Harversian canals
Osteoclasts

- derived from the fusion of mononuclear hemopoiteic cells (mononuclear phagocyte system)
- involved in resorption of bone matrix
- found in depressions on the bone surface of bone tissue - Howship’s launae
- 5-50 nuclei, very large cells - 40\(\mu\)m, motile cells
- abundant mitochondria - acidophilic cytoplasm
- great number of lysosomes

1) erosion of bone starts with its demineralization – acidification
2) range of lysosomal proteolytic enzymes digest organic components extracellularly
Types of bone tissue:

1. primary woven bone tissue - immature
2. secondary lamellar bone tissue – mature
   a. trabecular bone tissue (cancellous or spongy bone tissue)
   b. compact bone tissue (dense bone tissue)

1. PRIMARY- woven-immature bone tissue
   ► formed at the beginning
   - primary bone tissue is replaced by lamellar!!

   - In growing skeleton, particularly in fetus
   - In adults- during rapid bone remodelling (post fracture repair), tooth sockets, tendon insertion
   a) bundles of collagen fibres are irregular
   b) more bone cells per unit area, randomly arranged
   c) irregular lacunae ossium
   d) less mineralized, no lamellae are present!!
2) SECONDARY BONE tissue - lamellar - mature
a) collagen fibers in lamellae are **parallely arranged**
b) embedded in mineralized bone matrix
c) concentric layers - **lamellae** thick 3-7 µm
d) osteocytes occupy the cavities - **lacunae** at the outer margin of the lamellae, or inside of lamellae
e) basic units – **osteons (Harversian) systems**

**TYPES OF LAMELLAR BONE TISSUE:**
1. cancellous (spongy) in epiphysis
2. compact (in diaphysis)

**Cancellous bone (spongy) tissue:**
- Network of irregular plates (**trabeculae**)
- Bone marrow between trabeculae, **covered by endost**
- Parallel lamellae, osteocytes between lamellae, Haversian systems only in thick trabecules

**Compact bone tissue** - 4 systems of lamellae:
1. **Outer circumferential** lamellae
2. **Haversian systems** (osteons)
3. **Interstitial** lamellae
4. **Inner circumferential** lamellae
Structural unit of compact bone tissue is **OSTEON**

**OSTEONS** are long, cylindrical units
arranged in parallel manner with long axis of the diaphysis of long bone
- consists of a central canal surrounded by 4-20 concentric lamellae-**lamellae ossium**
  - between and within the lamellae lie the **osteocytes** which are located in empty spaces called – **lacunae ossium**.
- Osteocytes have long cytoplasmic **processes** which lie in empty tunnels – **canaliculi**.

The Haversian canals communicate with the marrow cavity, the periostium, and each other through transverse or oblique **Volkmann’s canals**. Volkmann's canals run at right angle to the Haversian canals. **Haversian canal** contains - blood vessels, nerves and loose connective tissue.
Periosteum – covers the **external surface** of the bone
- **outer layer**: dense connective tissue; Sharpey’s fibers (collagen type I)
- **inner layer**: osteoprogenitor cells – spindle shaped – can change to active osteoblasts - growth and repair of the bone

Endosteum
- covers the **internal surface** of bone marrow cavity, surface of cancellous bone, Haversian canal
- thin layer of connective tissue and osteoprogenitor cells

**Anatomical types of bones**

according to shape - location of spongy and compact bone tissue varies with bone shape

Long bones – epiphysis, diaphysis  
Short bones  
Flat bones of the skull (diploë)  
Irregular bones

**Bones** are organs of skeletal system.  
BONE as an organ is composed of:  
**bone tissue**
- cartilage - articular surface
- connective tissue proper - periosteum
- adipose tissue-in bone marrow
- hemopoietic tissue-in bone marrow
- vessels
- nerves