

The Bone

(Special Connective Tissue)

Lec.6

Histology

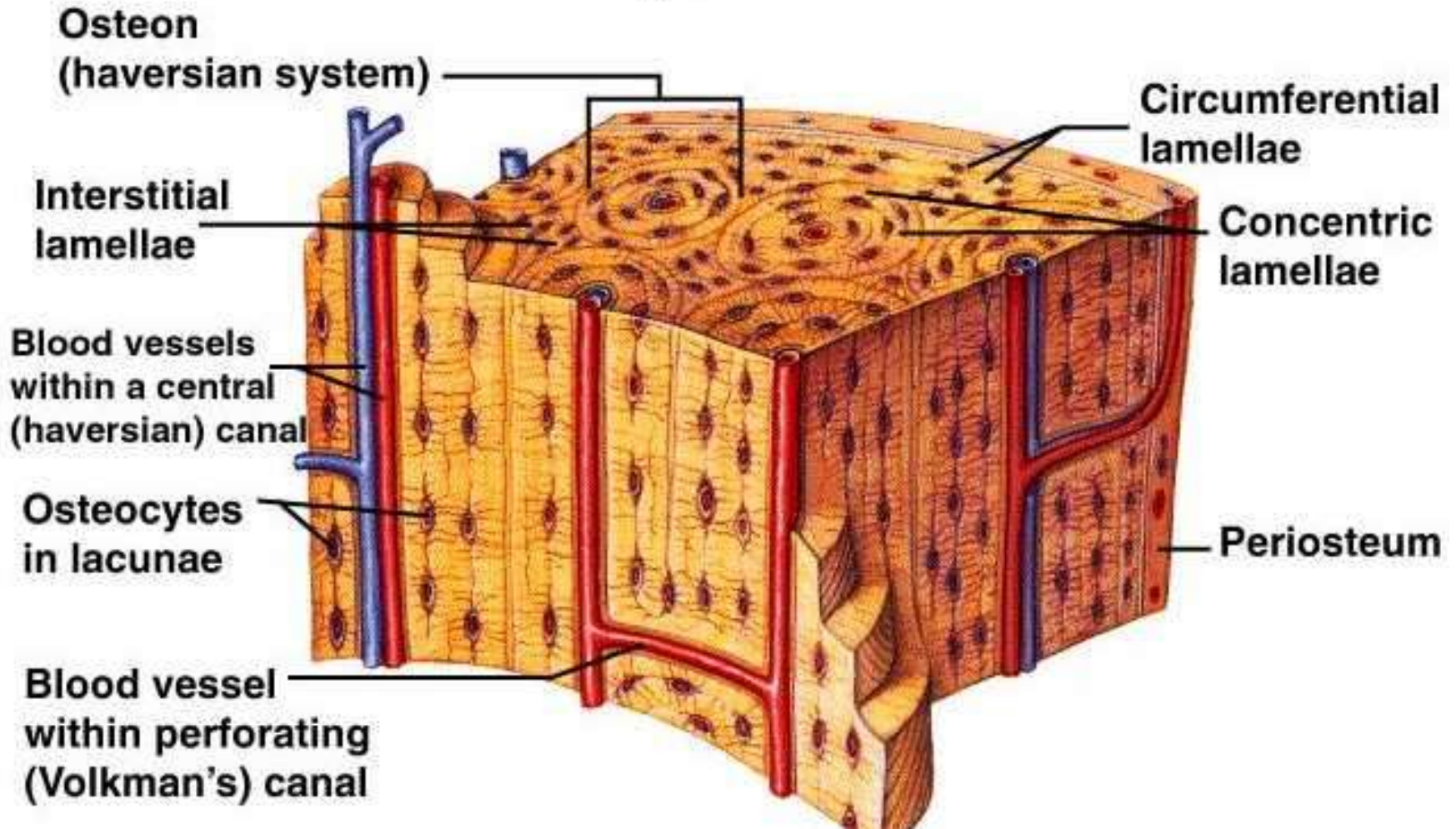
Functions: Bone

- 1. Maintain body shape.**
- 2. Protect internal organs, brain, spinal cord.**
- 3. System of levers for the muscle system to act upon.**
- 4. Mineral storage – Ca^{2+} and Phosphorus.**
- 5. Blood formation: hematopoiesis.**
- 6. Surface features for muscle insertions and origins.**

Bone Matrix

- **35% collagen – organic**
 - **Some chondroitin sulfate, hyaluronic acid and polysaccharides**
- **65% calcium phosphate minerals – hydroxyapatite**
- **Combination provides strength and rigidity**
 - **Laid down by osteoblasts**

Compact Bone



Periosteum – where you find pain receptors and more vessels

Bone Cells

1. Osteoprogenitor cells (or stem cells of bone)

are located in the periosteum and endosteum. They are very difficult to distinguish from the surrounding connective tissue cells. They differentiate into Osteoblasts.

2. Osteoblasts (or bone forming cells)

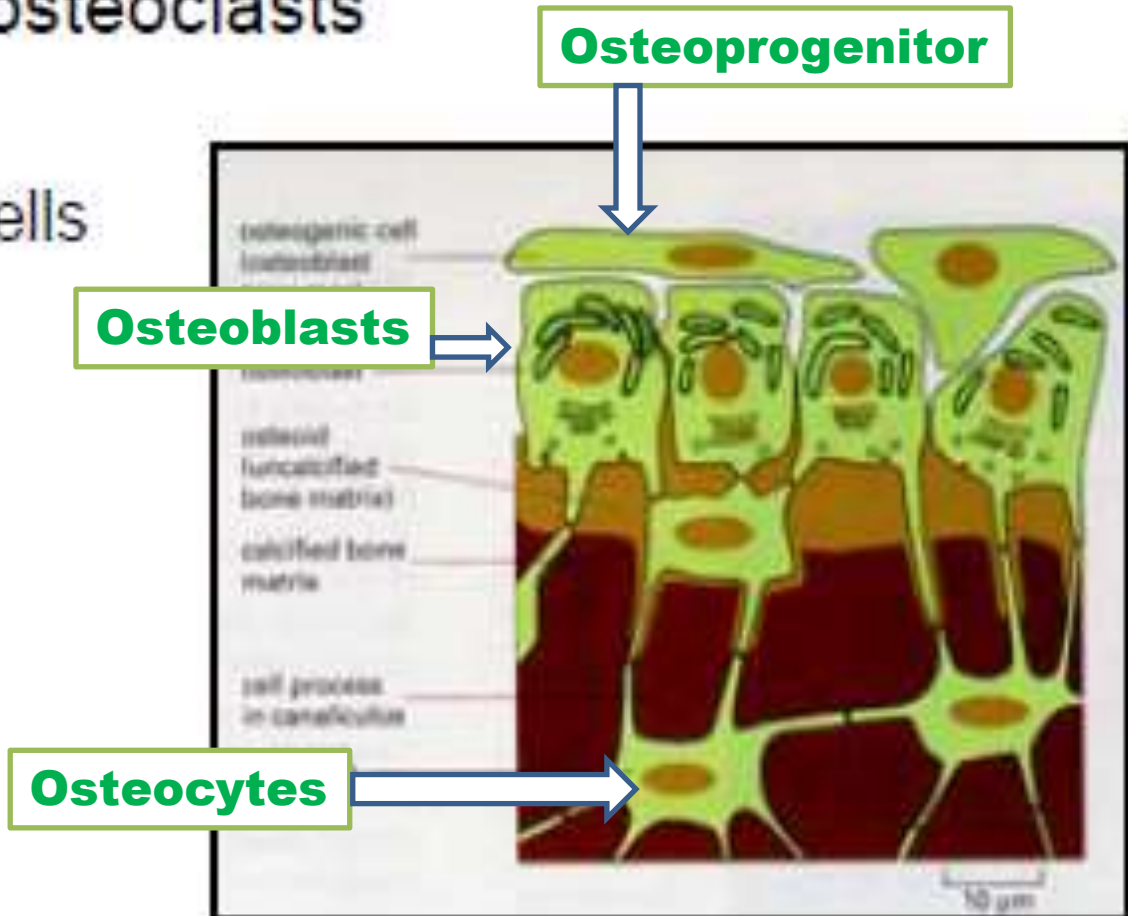
may form a low columnar "epitheloid layer" at sites of bone deposition. They contain plenty of rough endoplasmatic reticulum (collagen synthesis) and a large Golgi apparatus. As they become trapped in the forming bone they differentiate into.

3. Osteocytes

Osteocytes contain less endoplasmatic reticulum and are somewhat smaller than osteoblasts.

Bone Cells

- Osteocytes
- Osteoblasts and osteoclasts
 - Derived from osteoprogenitor cells



Bone Cells

4- Osteoclasts

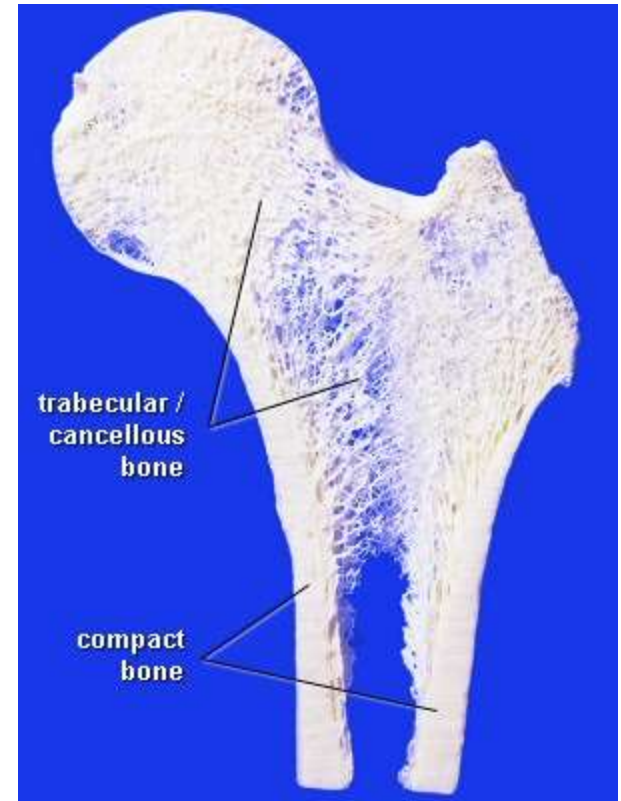
- are Very Large, Multi-nucleated, bone-resorbing cells. They arise by the fusion of monocytes or macrophages.
- Osteoclasts attach themselves to the bone matrix. The cell membrane opposite the matrix has deep invaginations forming a ruffled border. Osteoclasts empty the contents of lysosomes into the extracellular space between the ruffled border and the bone matrix. The released enzymes break down the collagen fibers of the matrix.
- Osteoclasts are stimulated by parathyroid hormone (produced by the parathyroid gland) and inhibited by calcitonin (produced by specialized cells of the thyroid gland).
- Osteoclasts are often seen within the indentations of the bone matrix that are formed by their activity (resorption bays or Howship's lacunae).

4- Osteoclasts

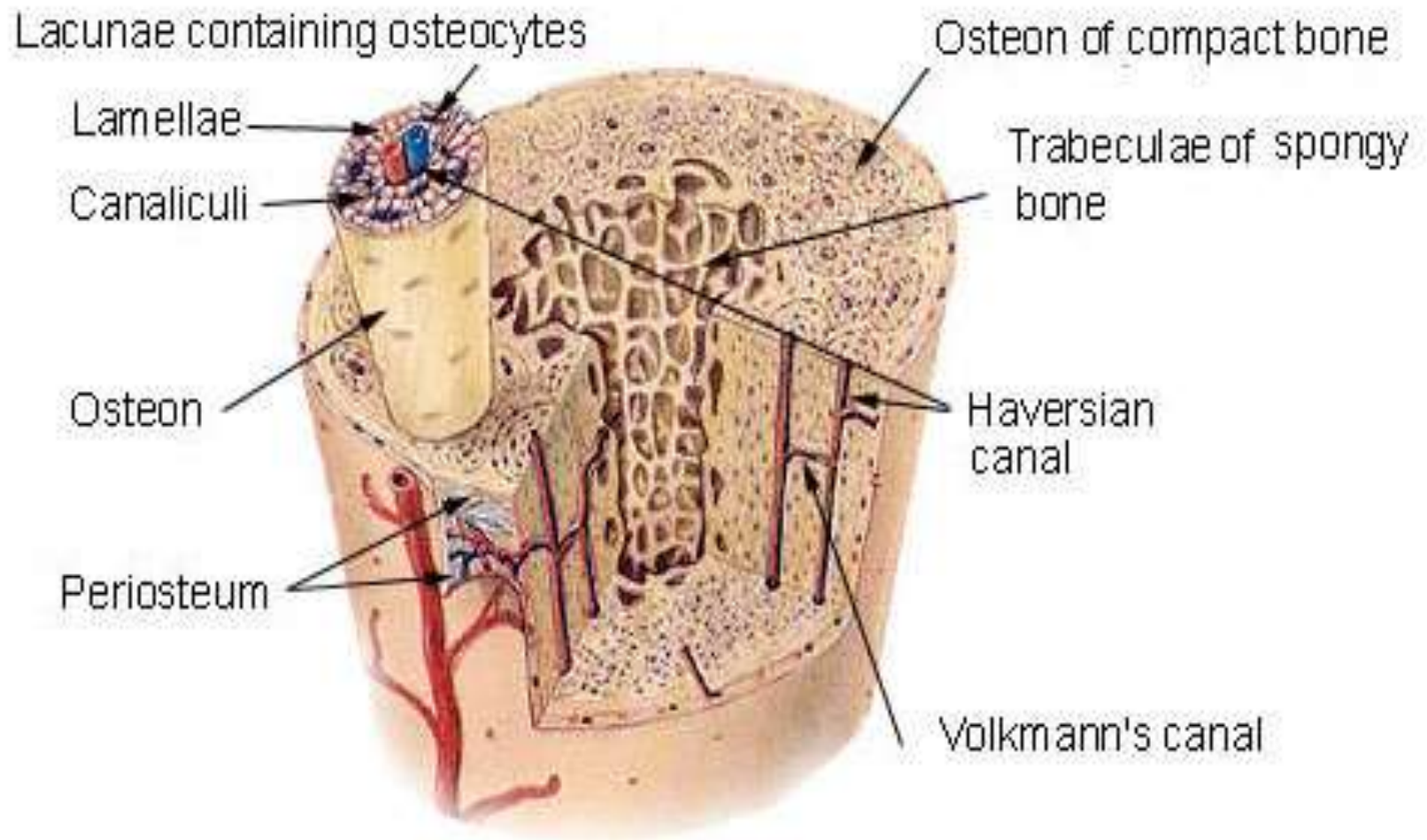


Two types of bone can be distinguished macroscopically:

1. **Trabecular bone (also called cancellous or spongy bone)** consists of delicate bars and sheets of bone, trabeculae, which branch and intersect to form a sponge like network. The ends of long bones (or epiphyses) consist mainly of trabecular bone.
2. **Compact bone** does not have any spaces or hollows in the bone matrix that are visible to the eye. Compact bone forms the thick-walled tube of the shaft (or diaphysis) of long bones, which surrounds the marrow cavity (or medullary cavity). A thin layer of compact bone also covers the epiphyses of long bones.

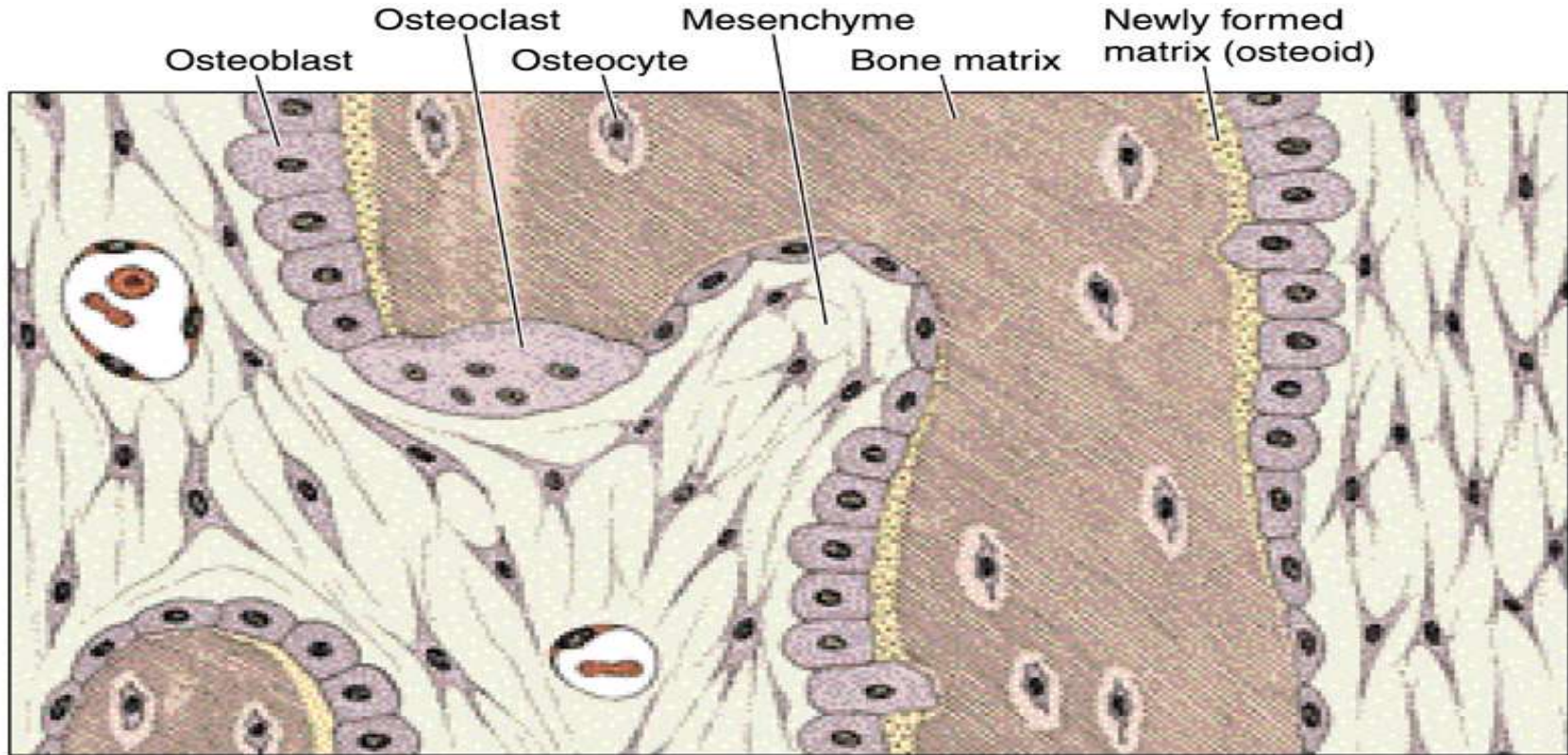


Compact Bone & Spongy (Cancellous Bone)



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 cells become osteocytes.**
- ❑ **Cancellous bone eventually becomes compact bone.**



Events that occur during intramembranous ossification.

- **Osteoblasts are synthesizing collagen, which forms a strand of matrix that traps cells.**
- **As this occurs, the osteoblasts gradually differentiate to become osteocytes.**
- **an osteoblast being trapped in newly formed bone matrix.**

Compact Bone

- Compact bone consists almost entirely of extracellular substance, the matrix. Osteoblasts deposit the matrix in the form of thin sheets which are called lamellae. Collagen fibers within each lamella run parallel to each other. Collagen fibers which belong to adjacent lamellae run at oblique angles to each other. Fiber density seems lower at the border between adjacent lamellae, which gives rise to the lamellar appearance of the tissue. Bone which is composed by lamellae when viewed under the microscope is also called lamellar bone.
- In the process of the deposition of the matrix, osteoblasts become encased in small hollows within the matrix, the lacunae. Unlike chondrocytes, osteocytes have several thin processes, which extend from the lacunae into small channels within the bone matrix, the canaliculi. Canaliculi arising from one lacuna may anastomose with those of other lacunae and, eventually, with larger, vessel-containing canals within the bone. Canaliculi provide the means for the osteocytes to communicate with each other and to exchange substances by diffusion.

- In mature compact bone most of the individual lamellae form concentric rings around larger longitudinal canals within the bone tissue. These canals are called Haversian canals. Haversian canals typically run parallel to the surface and along the long axis of the bone. The canals and the surrounding lamellae (8-15) are called a **Haversian system** or an osteon. A Haversian canal generally contains one or two capillaries and nerve fibers.
- A second system of canals, called **Volkman's canals**, penetrates the bone more or less perpendicular to its surface. These canals establish connections of the Haversian canals with the inner and outer surfaces of the bone. Vessels in Volkman's canals communicate with vessels in the Haversian canals on the one hand and vessels in the endosteum on the other. A few communications also exist with vessels in the periosteum.

Trabecular Bone

The matrix of trabecular bone is also deposited in the form of lamellae. In mature bones, trabecular bone will also be lamellar bone. However, lamellae in trabecular bone do not form Haversian systems. Lamellae of trabecular bone are deposited on preexisting trabeculae depending on the local demands on bone rigidity.

Osteocytes, lacunae and canaliculi in trabecular bone resemble those in compact bone.