



**Faculty of Biological Science and Technology**  
**Zoology and Botanical Department**  
**Practical Histology**

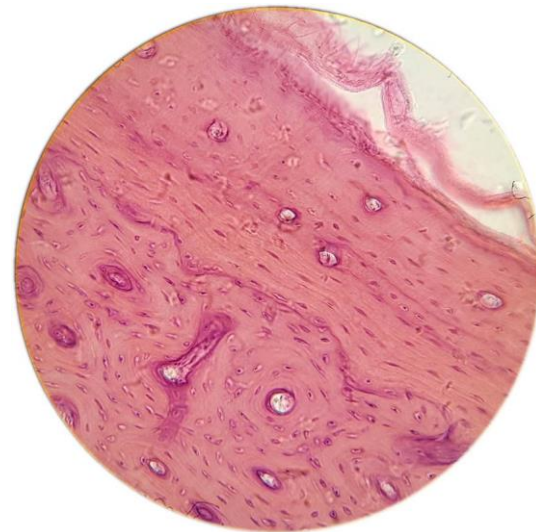
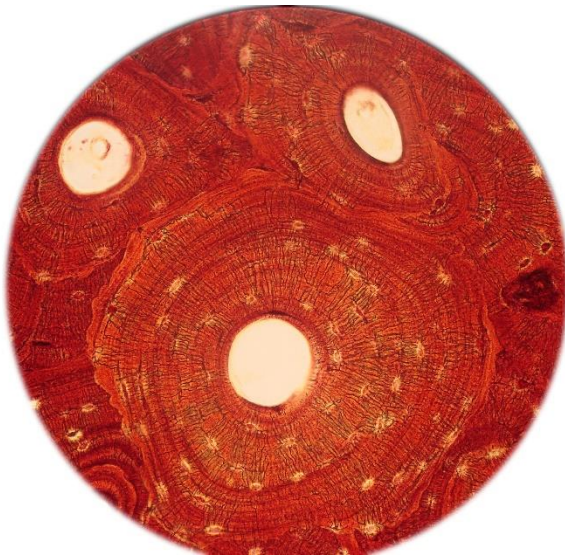
**Connective tissue**  
**Bone**

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## Introduction

- ▶ Bone is a specialized connective tissue which composed of cells, fibers and ECM, but its ECM is calcified
- ▶ Osteoblasts, osteocyte and osteoclasts are special bone cells
- ▶ In some methods of bone tissue preparation, bone cells are removed and only empty lacunae remain. Chemical or enzymatic methods are used to remove cells from the bone tissue

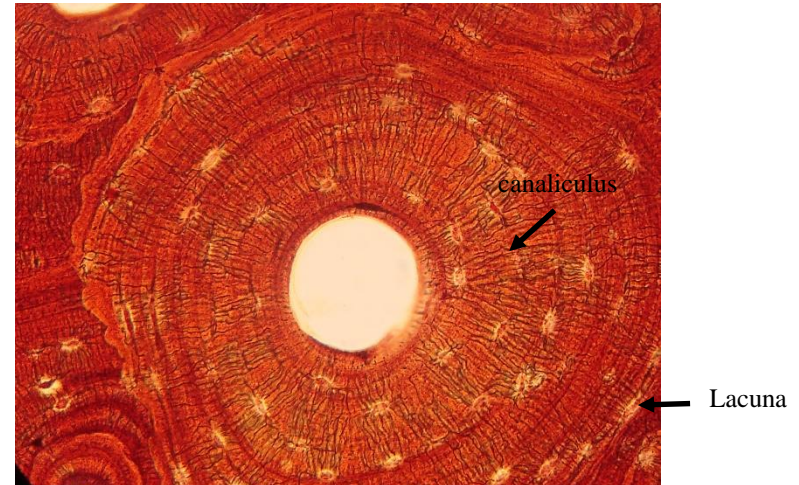
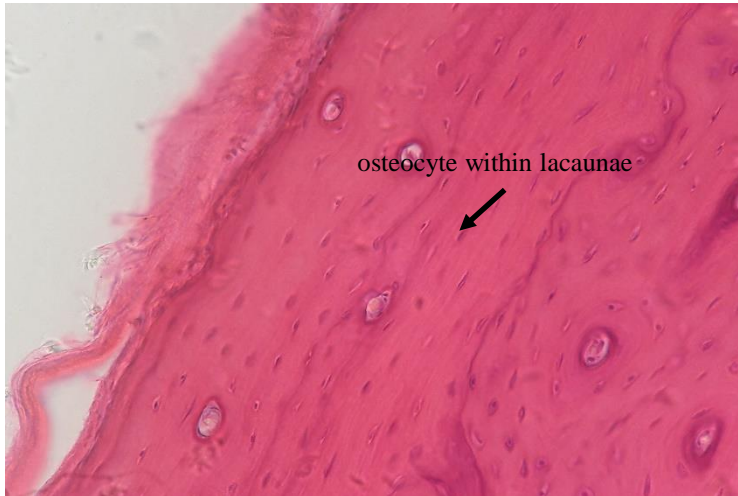


Cross sections of compact bone. Left: decellularized bone. 4X. Right: bone cells are preserved. 4X. These pictures are taken from histological slide in histology laboratory of Isfahan University



## Osteocytes

- ▶ Osteocytes are oval or almond-shaped; However, They are wrinkled during bone tissue preparation, so their shape can be guessed from the shape of lacunae
- ▶ Each osteocyte has many thin processes which are located in canaliculi
- ▶ Canaliculi are small canals run through bone matrix

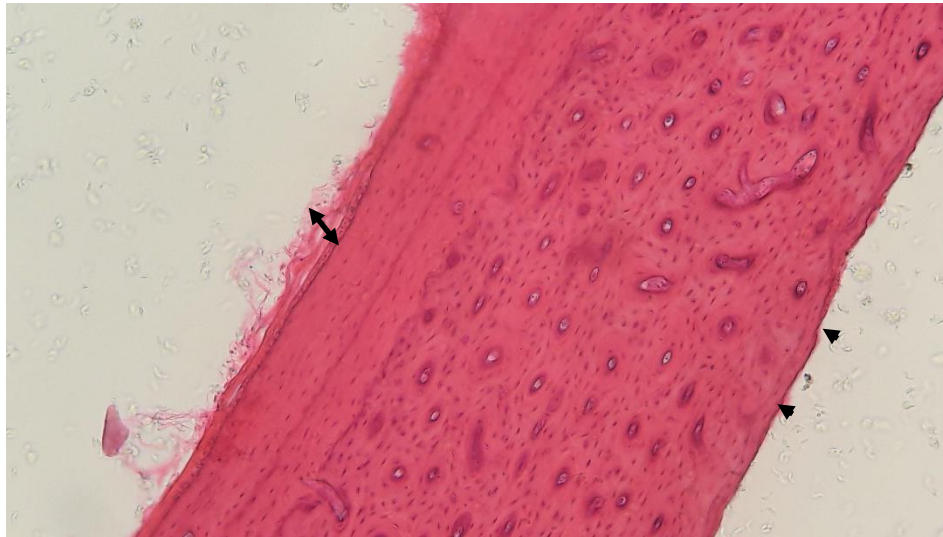


Cross sections of bone. Left: Osteocyte nucleus is seen in lacunae. H&E, 40X. Right: ground preparation method for studying bone tissue. Canaliculi is better observed in this method. 40X. These pictures are taken from histological slide in histology laboratory of Isfahan University



## Periosteum & Endosteum

- ▶ Periosteum is made up of connective tissue that covers all external surfaces of a bone except at joints. It is composed of two layers:
  - ▶ The outer layer or fibrous layer which is made up of dense connective tissue
  - ▶ The inner layer or osteogenic layer which contains more cells (especially osteoprogenitor cells)
- ▶ endosteum is a thin layer of connective tissue which line all internal surfaces of a bone (such as internal surfaces of canaliculi, Haversian canal and bone marrow cavity). It is much thinner of periosteum

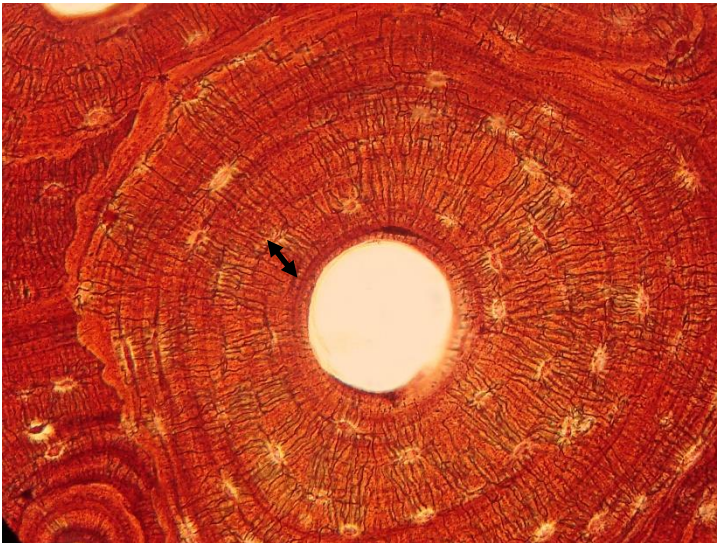


Cross section of compact bone. Double headed arrow depicts periosteum. Endosteum is shown by arrow head. This picture is taken from histological slide in histology laboratory of Isfahan University



## Types of bone tissue

- ▶ There are two types of bone tissue based on macroscopic view:
  - ▶ Compact or cortical bone tissue
  - ▶ Cancellous (spongy) or trabecular bone tissue
- ▶ There are two types of bone tissue based on microscopic view
  - ▶ Woven or irregular bone tissue
  - ▶ Lamellar or regular bone tissue
- ▶ Organized arrangement of collagen fibers into layers are called lamellae. Both compact and cancellous bone tissue have similar microscopic structure and are arranged in the form of lamellar bone

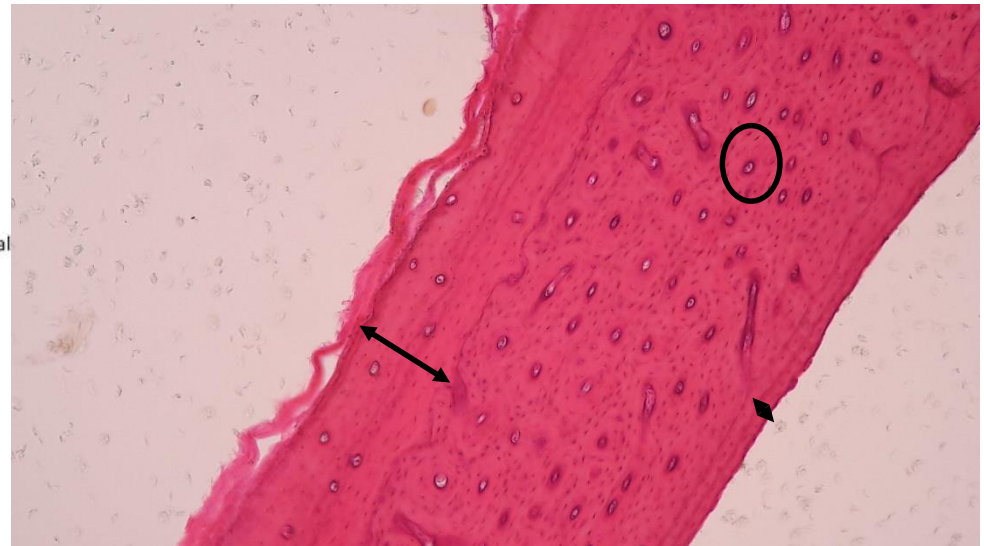
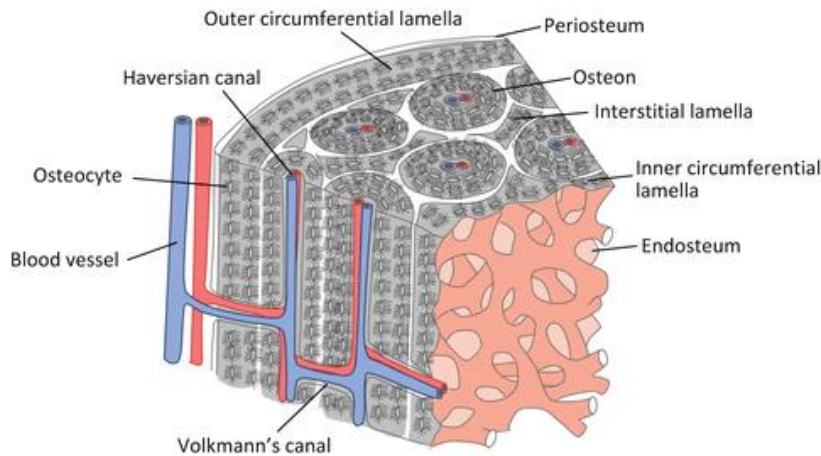


Bone lamellae in compact bone (left) and cancellous bone (right). These pictures are taken from histological slide in histology laboratory of Isfahan University



## The arrangement of bone lamellae in compact bone

- ▶ There are four types of lamellar arrangement in compact bone including:
- ▶ outer circumferential lamellae
- ▶ Inner circumferential lamellae
- ▶ Haversian system or osteon
- ▶ Interstitial lamellae



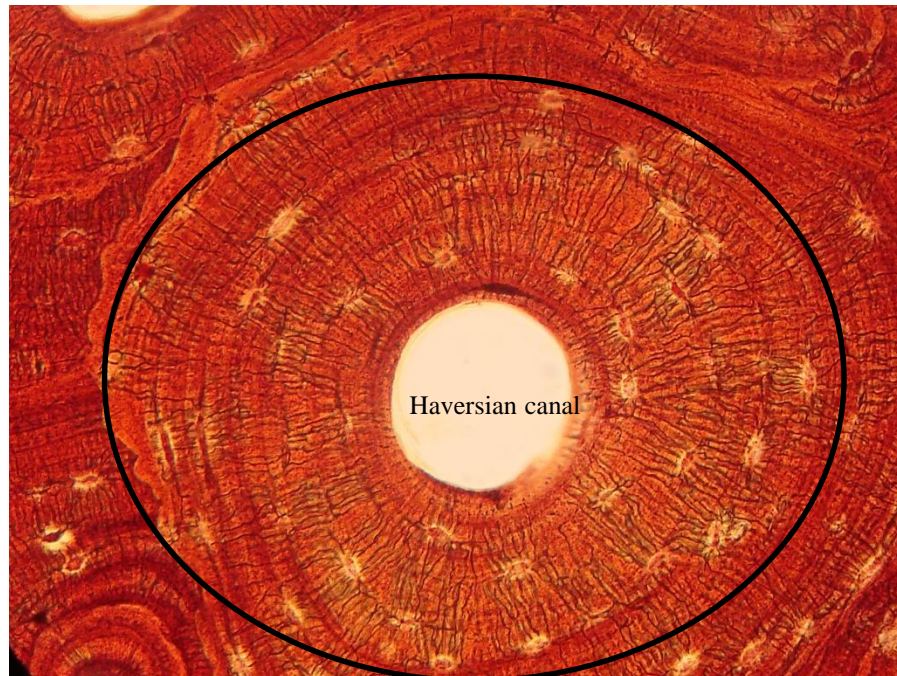
From: <https://basicmedicalkey.com/bone-tissue-and-biomaterial-design-based-on-the-anisotropic-microstructure/>

Cross section of compact bone. Outer circumferential lamellae (long double headed arrow), inner circumferential lamellae (short double headed arrow), Haversian system (circle). H&E, 4X. This picture is taken from histological slide in histology laboratory of Isfahan University



## Haversian system

- ▶ Haversian system is a cylindrical structure formed by concentric collagenic lamellae which are organized around a central tube Known as Haversian canal
- ▶ Haversian canal surrounds blood vessels and nerves
- ▶ Lacunae have located between lamella and contain osteocytes

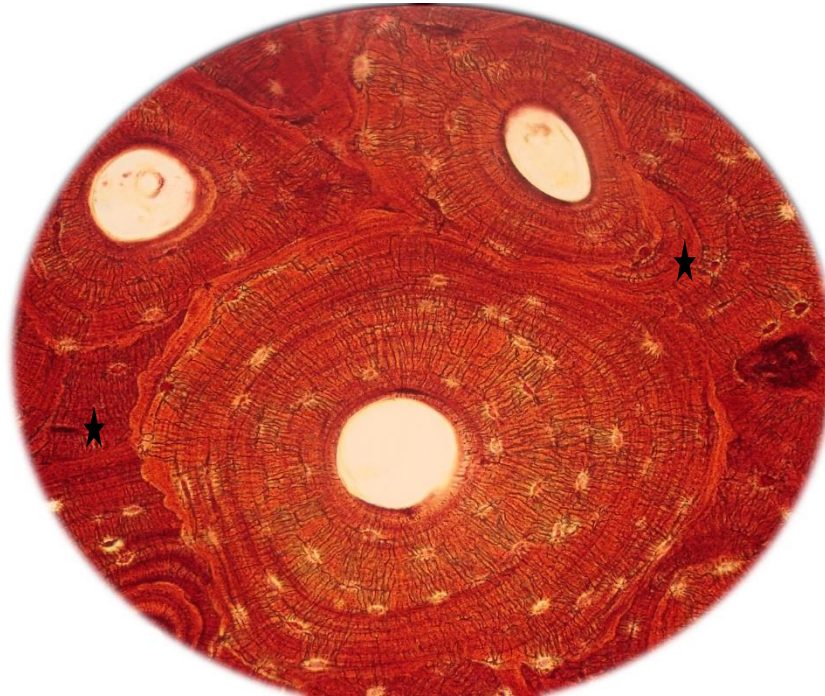


Haversian system. H&E, 40X. This picture is taken from histological slide in histology laboratory of Isfahan University



## Interstitial lamellae

- ▶ The interstitial lamellae are remnants of older osteons



Interstitial lamellae (asterisks) in compact bone. H&E, 40X. This picture is taken from histological slide in histology laboratory of Isfahan University





## Wolkmann's canal

- ▶ Wolkmann's canals are small canals that connect Haversian canal together. They are contain blood vessels
- ▶ Wolkmann's canal located perpendicular to the Haversian canals

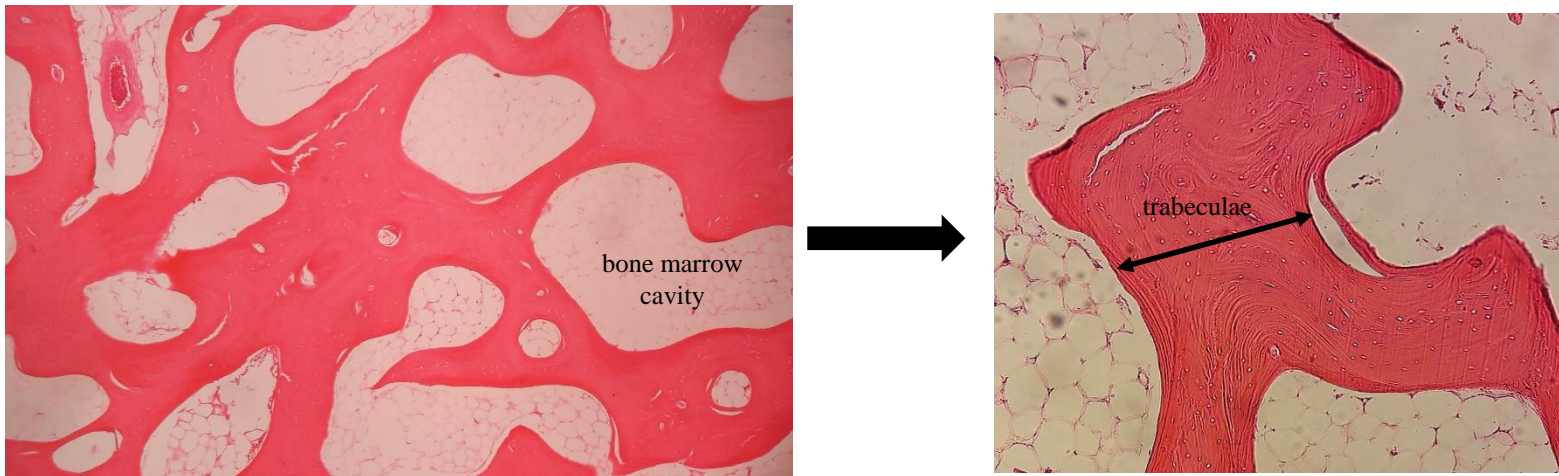


Cross section of compact bone. Wolkmann's canal is shown by black asterisk. H&E, 40X. This picture is taken from histological slide in histology laboratory of Isfahan University



## Spongy bone

- ▶ Spongy or cancellous bone has a highly porous structure which composed of interconnecting plates called trabecula
- ▶ There are no Haversian system or peripheral lamella in spongy bones

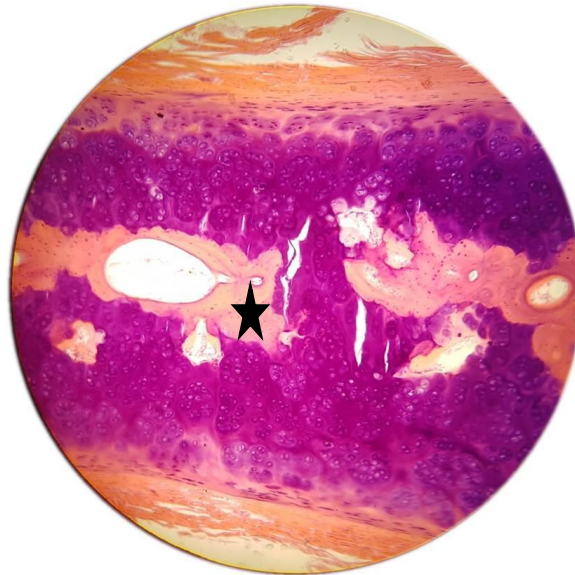


Left: Spongy bone. Bone marrow cavities contain white adipose tissue are present between trabecula. H&E, 10X. Right: Trabecula made up of dense irregular bone lamellae. H&E, 40X. These pictures are taken from histological slide in histology laboratory of Isfahan University



## Ossification

- ▶ There are two types of osteogenesis:
- ▶ Intramembranous ossification which bones develop from mesenchymal sheets directly
- ▶ Endochondral ossification which bones develop by replacing hyaline cartilage



Endochondral ossification. Asterisk depicts ossified area in the middle of hyaline cartilage. H&E, 4X. This picture is taken from histological slide in histology laboratory of Isfahan University



## Bone growth

- ▶ Longitudinal bone growth takes place in epiphyseal growth plates
- ▶ Histologically, there are five area or zone in epiphyseal growth plate including:
- ▶ Resting zone
- ▶ Proliferative zone
- ▶ Hypertrophy zone
- ▶ calcified cartilage zone
- ▶ Ossification zone

Different zones in epiphyseal growth plate. Ossification zone is not shown. H&E, 10X. This picture is taken from histological slide in histology laboratory of Isfahan University

