

ALVEOLAR BONE

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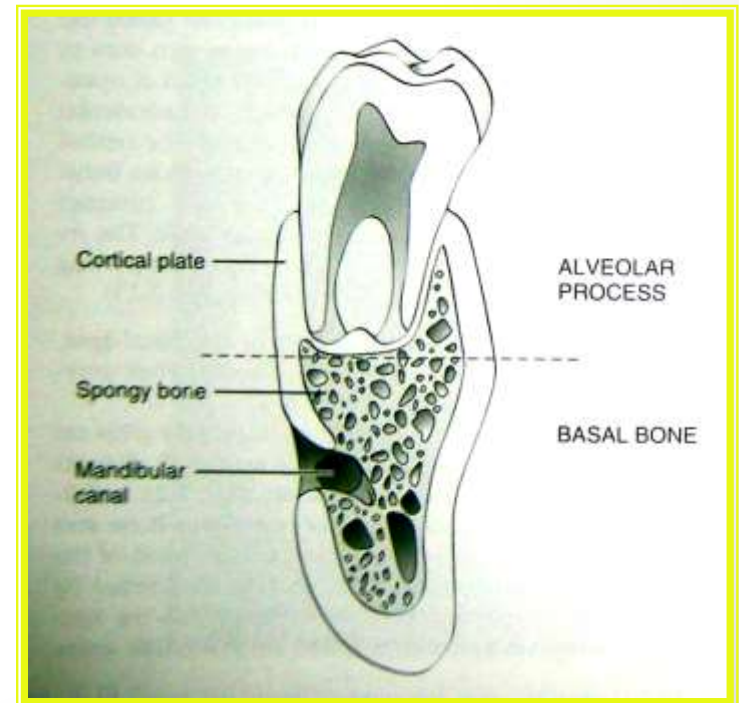
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- **Morphology of alveolar bone**
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- **Bone remodeling**

Alveolar bone

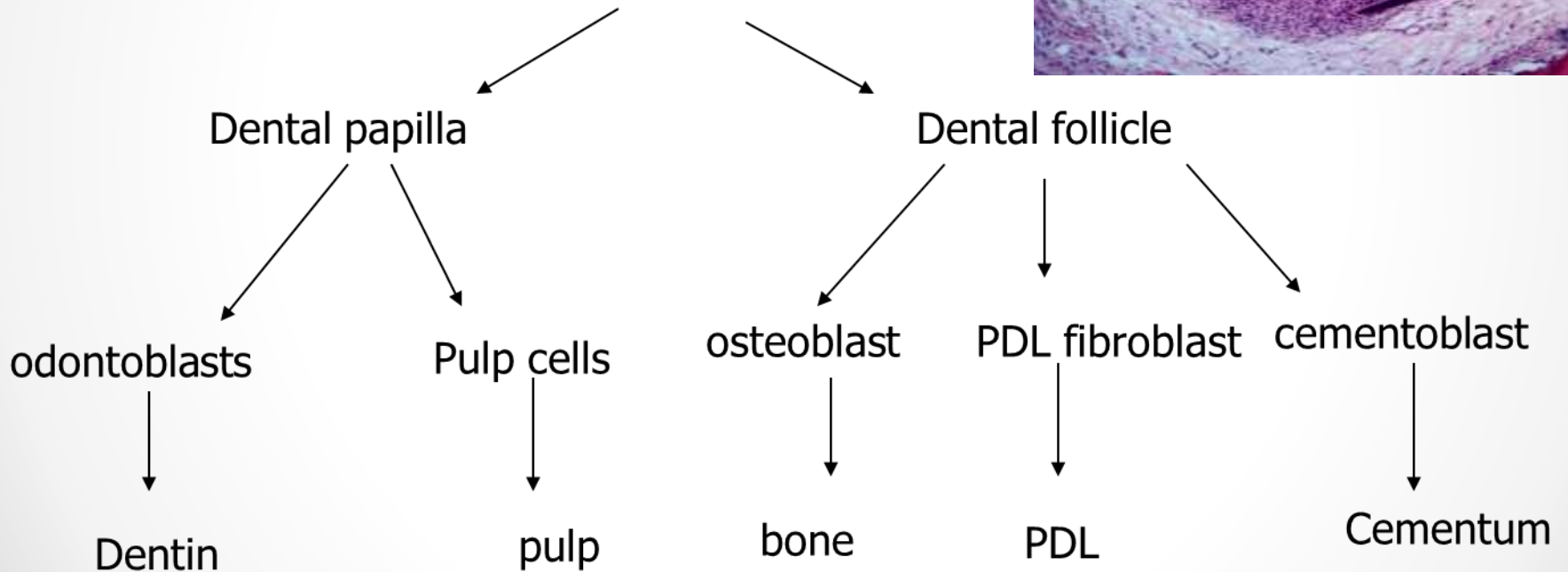
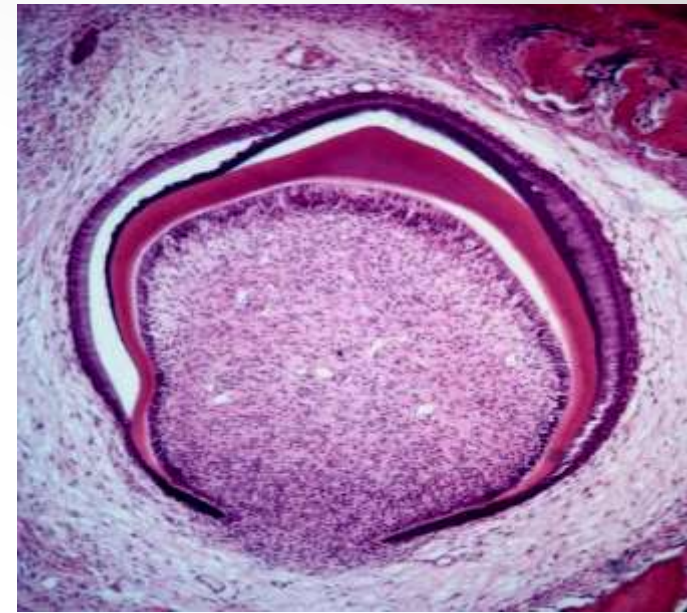
- The jaw bone can be divided into
 - **Alveolar Process**
 - **Basal bone**

The alveolar process is the portion of the maxilla and mandible that forms and supports the tooth sockets (alveoli).



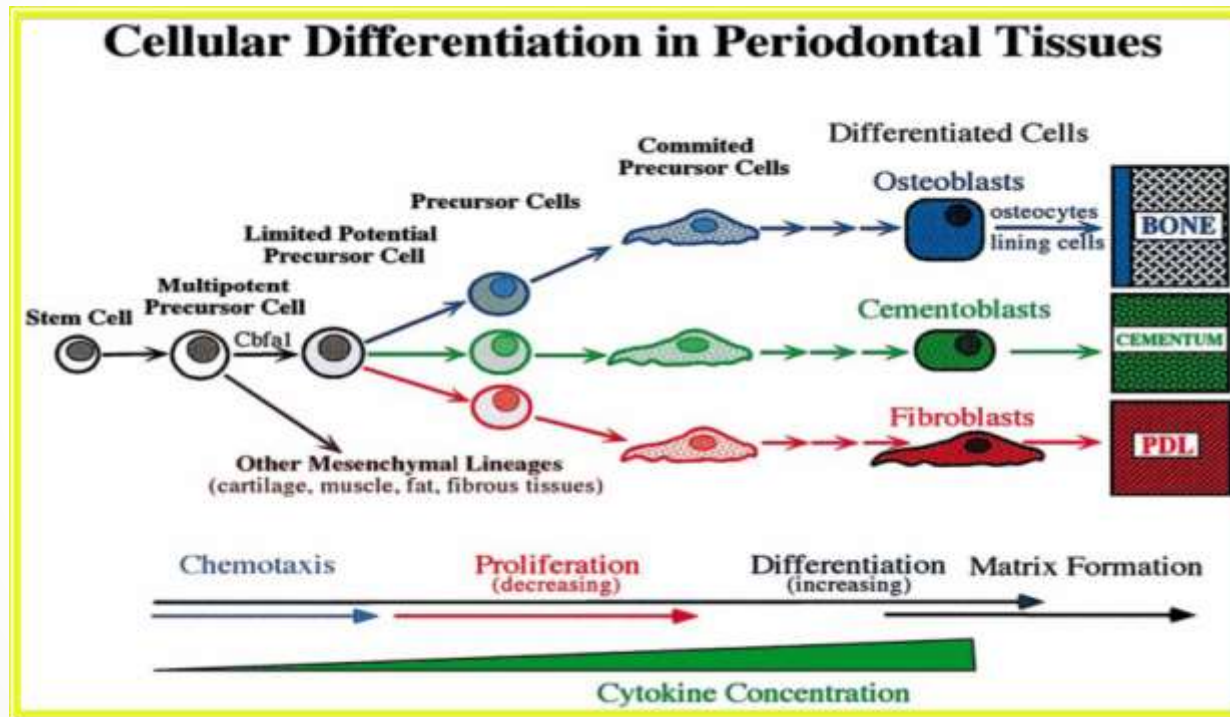
Development

Dental ectomesenchyme



Development

Actual alveolar process develops during tooth eruption.



The formation of alveolar bone proper is closely related to the formation of PDL and cementum during root formation and tooth eruption.

Composition

- Bone is a mineralized connective tissue.

2/3rd of inorganic matter and 1/3rd of organic matrix

o Inorganic : 60%

o Organic : 25%

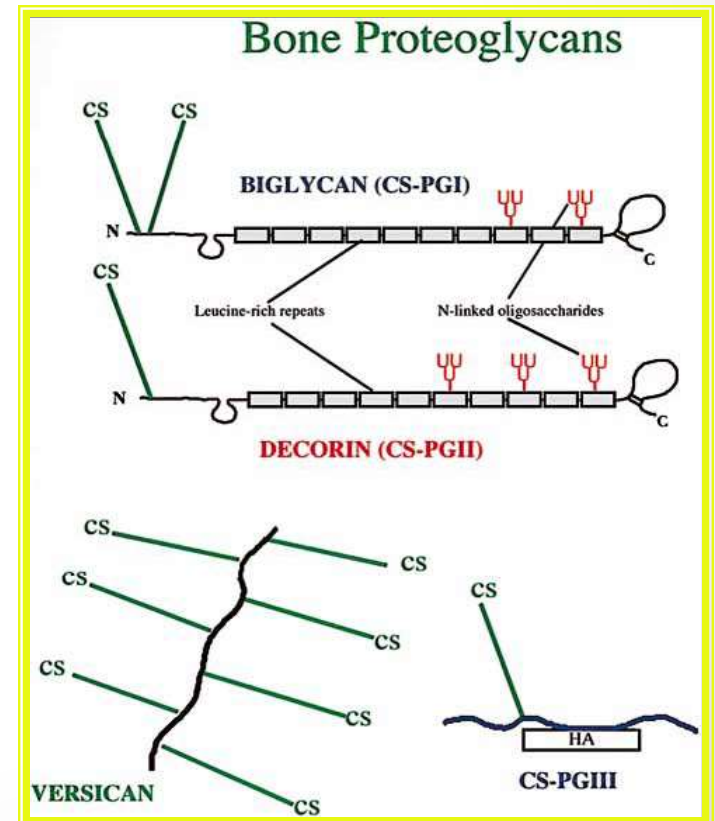
o Water : 15%

The inorganic component consists of:

- Calcium & Phosphate
- Hydroxyl, Carbonate, Citrate
- Trace amount of other ions such as Sodium, Magnesium & Fluorine.

The organic component consists of:

- Collagen : 88%-89%
- Type I collagen: 95%
- Noncollagen : 11%-12%
- Glycoproteins : 6.5%-10%
- Proteoglycans : 0.8%
- Sialoproteins : 0.35%
- Lipids : 0.4%



Classification of bone

➤ *Developmentally*

- Intramembranous bone
- Endochondral bone

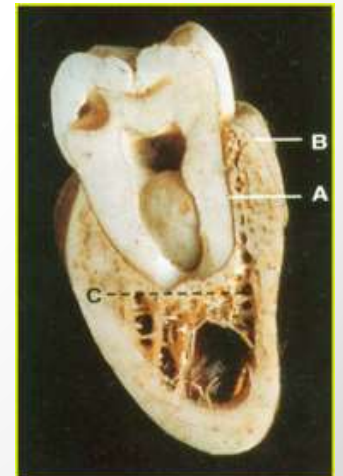
➤ *Histologically*

- Compact (cortical) bone
- Cancellous (spongy) bone



Structure of alveolar bone

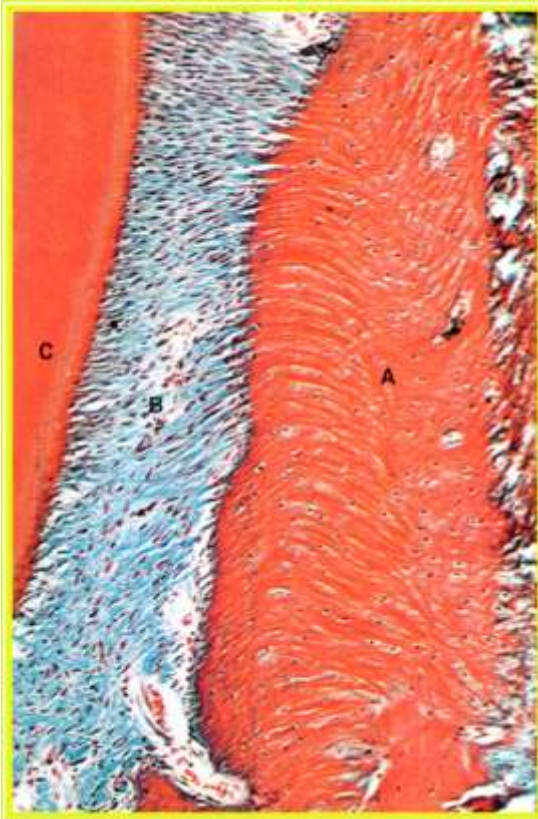
- The alveolar process consists of:
 - An external plate of cortical bone
 - **Alveolar bone proper:** consists of a thin lamella of bone that surrounds the root of the tooth and gives attachment to principal fibers of the periodontal ligament.



- The compact layer of bone lining the tooth socket has been given various names.
- **Cribriform plate**



Bundle bone



Lamina dura

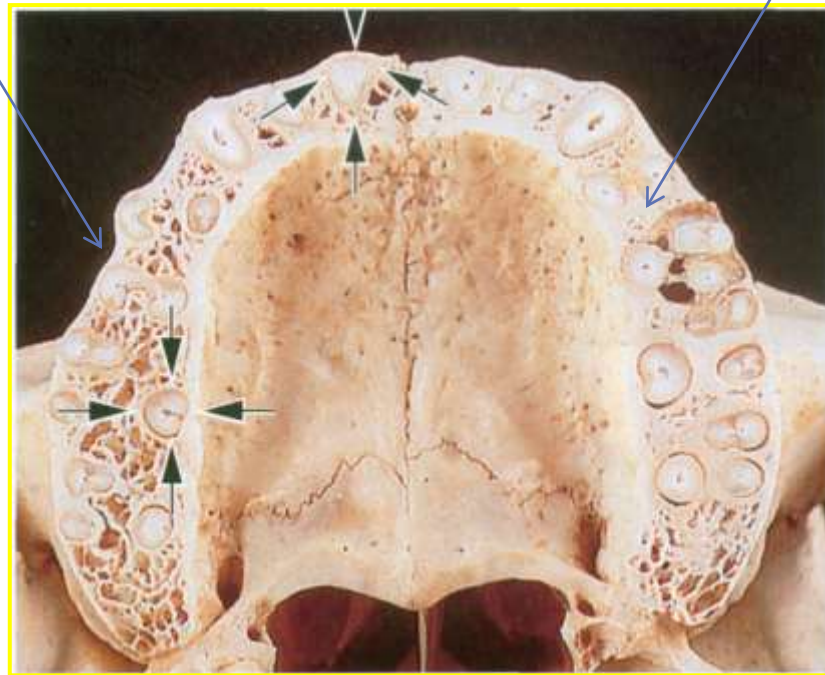


➤ **Supporting alveolar Bone**

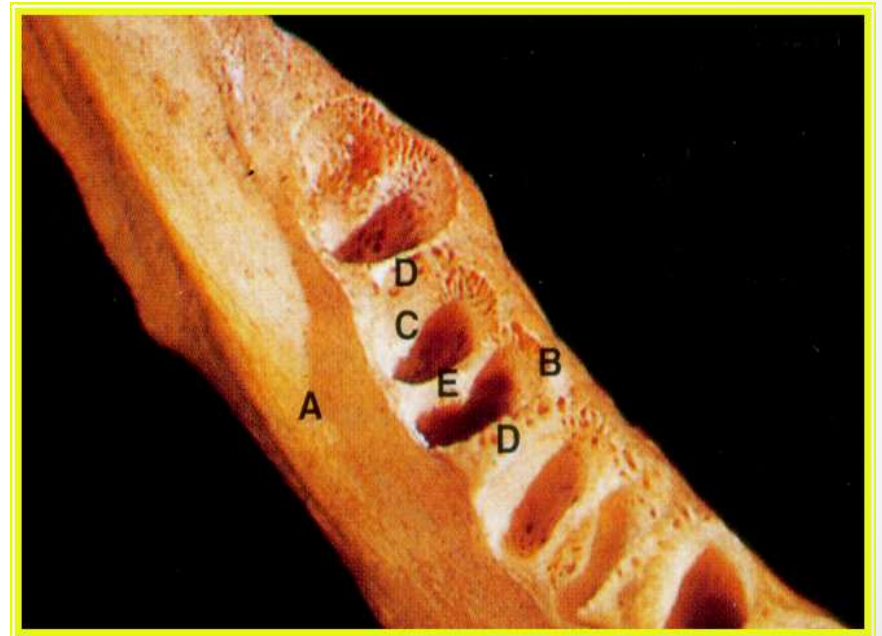
- *The spongy bone, which fills the area between these plates and the alveolar bone proper.*
- *The interdental septum consists of cancellous supporting bone enclosed within a compact border.*

Cortical Bone

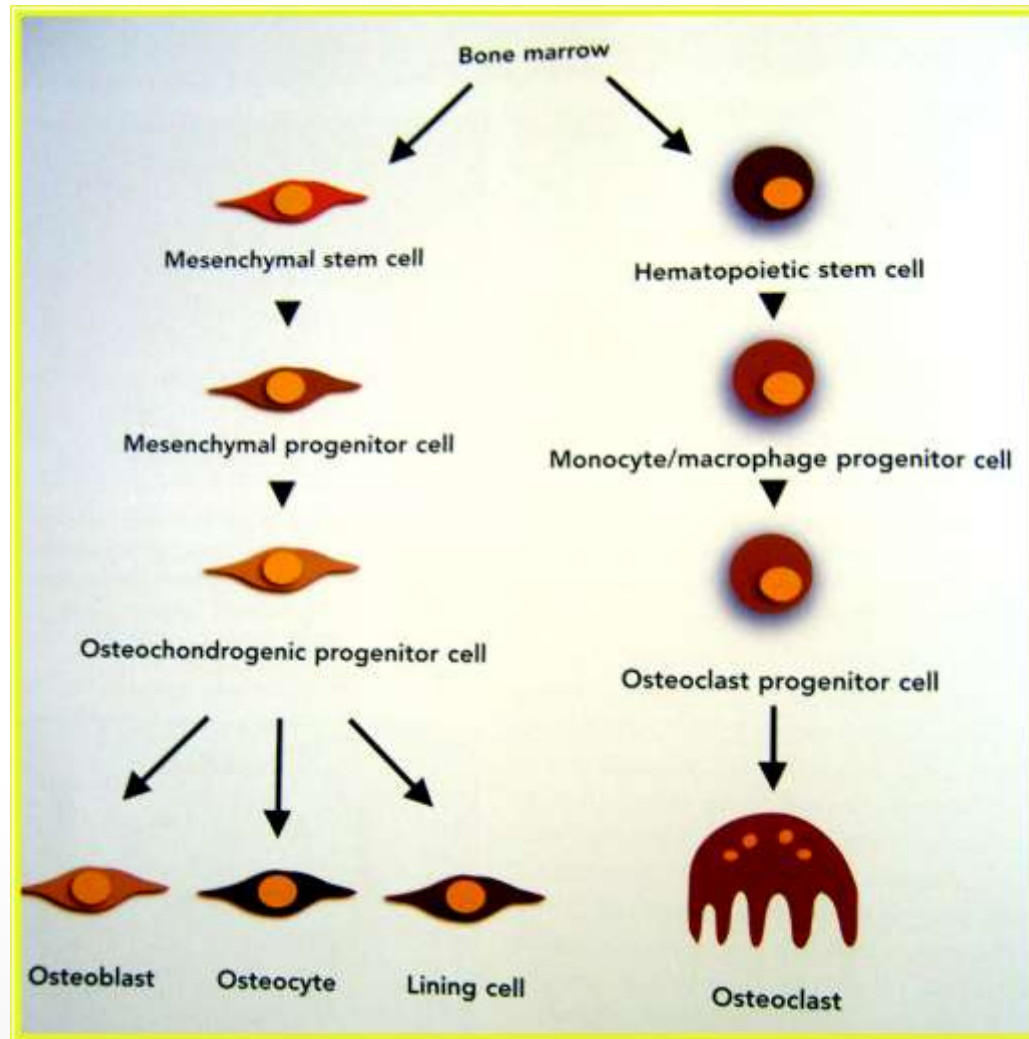
Cancellous Bone



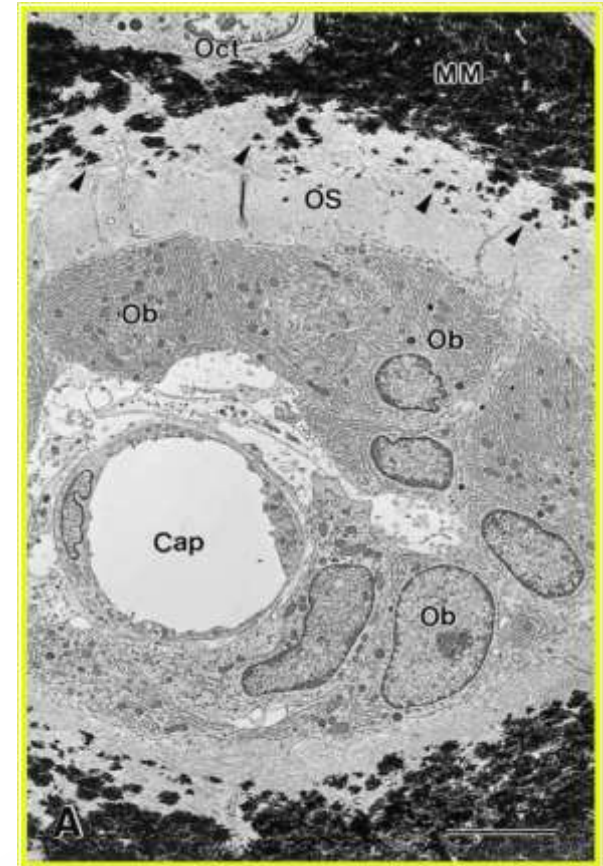
- **MANDIBLE WITH TEETH REMOVED TO DEMONSTRATE PARTS OF ALVEOLAR BONE:**
- **A-OUTER ALVEOLAR PLATE**
- **B-INNER ALVEOLAR PLATE**
- **C-CRIBRIFORM PLATE**
- **D-INTERDENTAL SEPTUM**
- **E-INTERRADICULAR SEPTUM**



Cells of Alveolar Bone



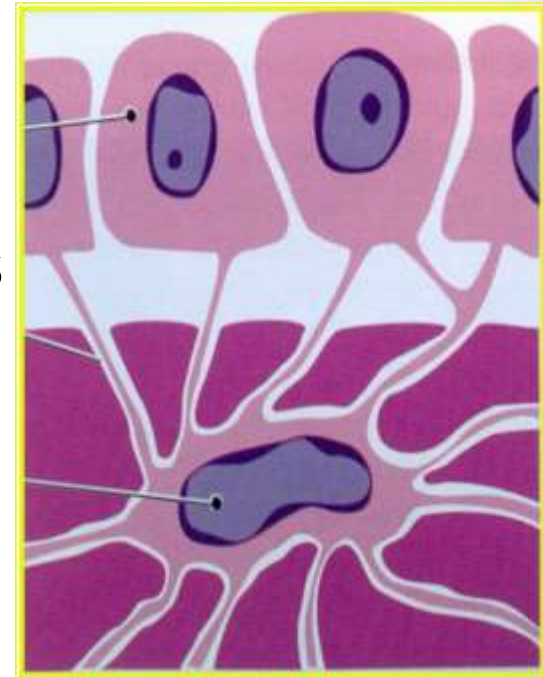
- **Osteoblasts**
 - Osteoblasts are of mesenchymal origin & are differentiated from pluripotent follicle cells.
 - Osteoblasts are cuboidal or slightly elongated cells that produce the organic matrix of bone.
 - Osteoblasts are the most actively secreting cells in the bone.



Functions of osteoblasts

- **Secretion of osteoid and control of mineralization of bone.**

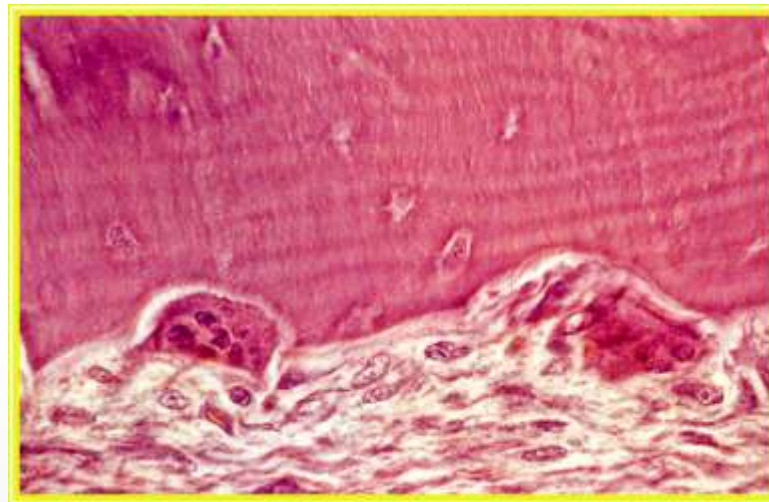
- **Osteocytes- 'entrapped' osteoblasts'.**
- Osteocytes are mature bone cells formed from osteoblasts that have made bone tissue around themselves
- Osteocytes are enclosed within spaces called lacunae surrounded by bone matrix
- Numerous cell processes from the osteocytes run in the canaliculi in all directions.



- **Bone lining cells**
- **These are former osteoblasts which have become flat and pancake-shaped**
- **They line the surface of bone and are responsible for calcium release when blood calcium level is low**

Quiescent surfaces are known to be a primary site of mineral ion exchange between blood and adult bone

- **Osteoclasts**
- They are derived from haemopoietic cells of the monocyte/ macrophage lineage by fusion of mononuclear precursors, giving rise to multinucleated cells.
- *Howship's lacunae : bony concavities*



OSTEOCLAST FORMATION

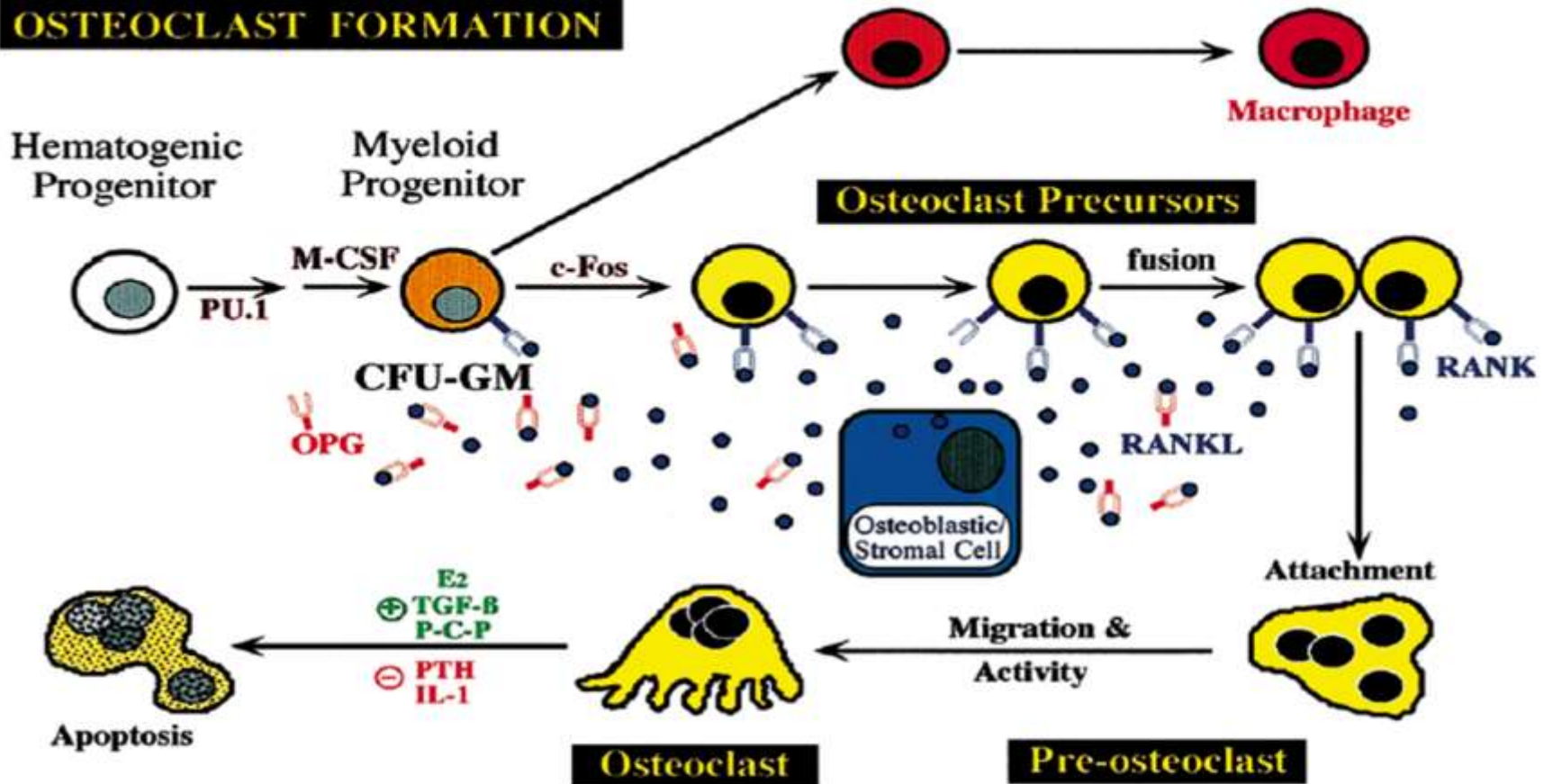


Fig. 8. Osteoclastic differentiation. Osteoclasts are formed from a haematogenic precursor cell which generates a progenitor of the granulocyte/macrophage (CFU-GM) lineage under the influence of the PU.1 gene and M-colony-stimulating factor. The myeloid progenitor requires a functional c-Fos gene to differentiate along the osteoclast pathway which is regulated by the receptor activator of nuclear factor κ B (RANK)/receptor activator of nuclear factor κ B ligand (RANKL) receptor/ligand system. Receptor activator of nuclear factor κ B ligand, also known as osteoprotegerin ligand produced by stromal bone cells binds to receptor activator of nuclear factor κ B receptors on the pre-osteoclasts and promotes osteoclast differen-

tiation while the truncated, soluble form of receptor activator of nuclear factor κ B, osteoprotegerin (OPG), can bind receptor activator of nuclear factor κ B ligand and block signaling, thereby preventing osteoclast differentiation. Pre-osteoclasts form by fusion of precursors and following attachment to the bone surface become active osteoclasts. The survival and activity of the osteoclast is dependent upon factors such as estrogen (E), transforming growth factor- β (TGF- β) and bis-phosphonates (P-C-P) which promote osteoclast apoptosis, while parathyroid hormone (PTH) and interleukin-1 (IL-1) block osteoclast apoptosis.

- ***Osteoid- unmineralized bone matrix***
- **Osteoid thickness 5-10 μ before reaching a level of maturity conducive to mineralization.**
- **There is a lag phase of about 10 days before the deeper layer of osteoid has matured sufficiently to undergo mineralization.**

- **Bone organization**



- **Compact bone**

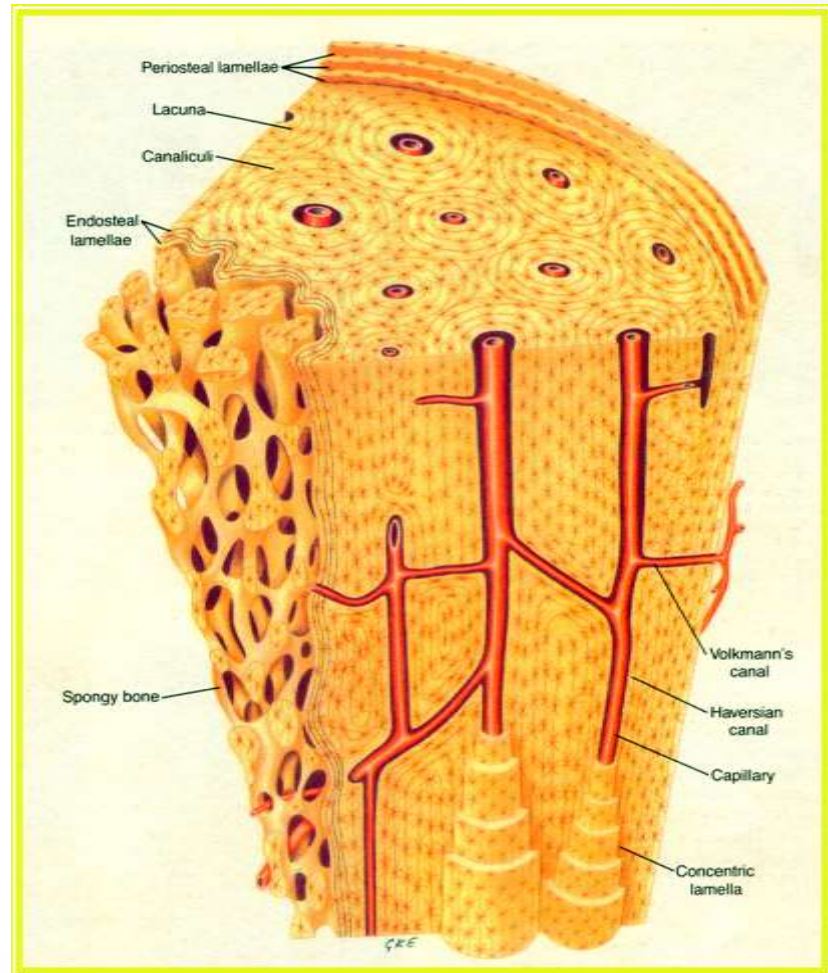


- lamellae

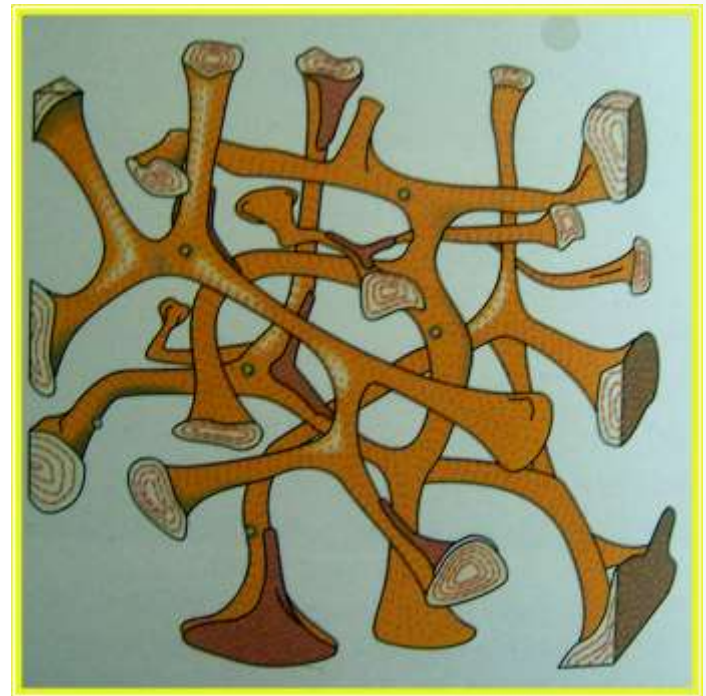


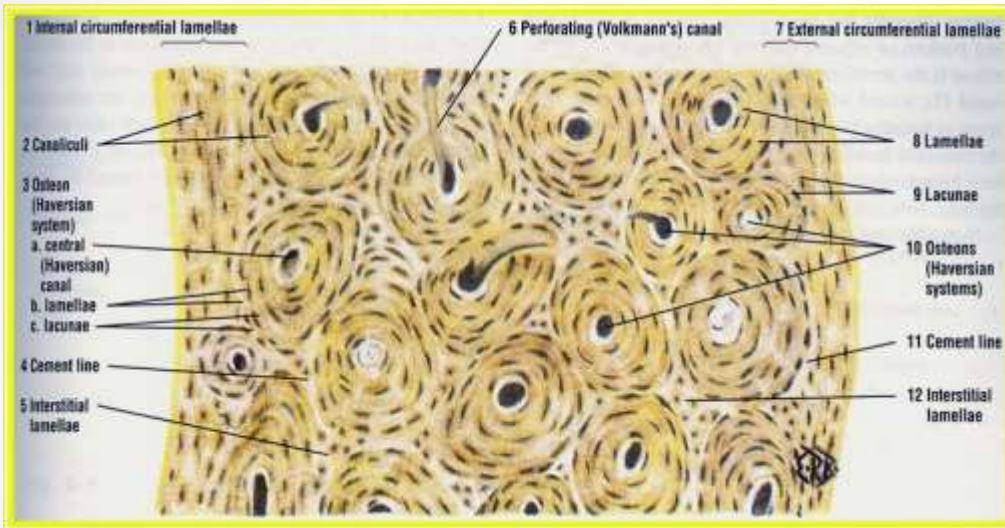
- haversian system
or osteon

- **There may be 4-20 concentric lamellae with in each haversian system**



- **cancellous (Spongy)**
- **Found predominantly present in inter-radicular and interdental spaces.**
- **Bone trabeculae present**

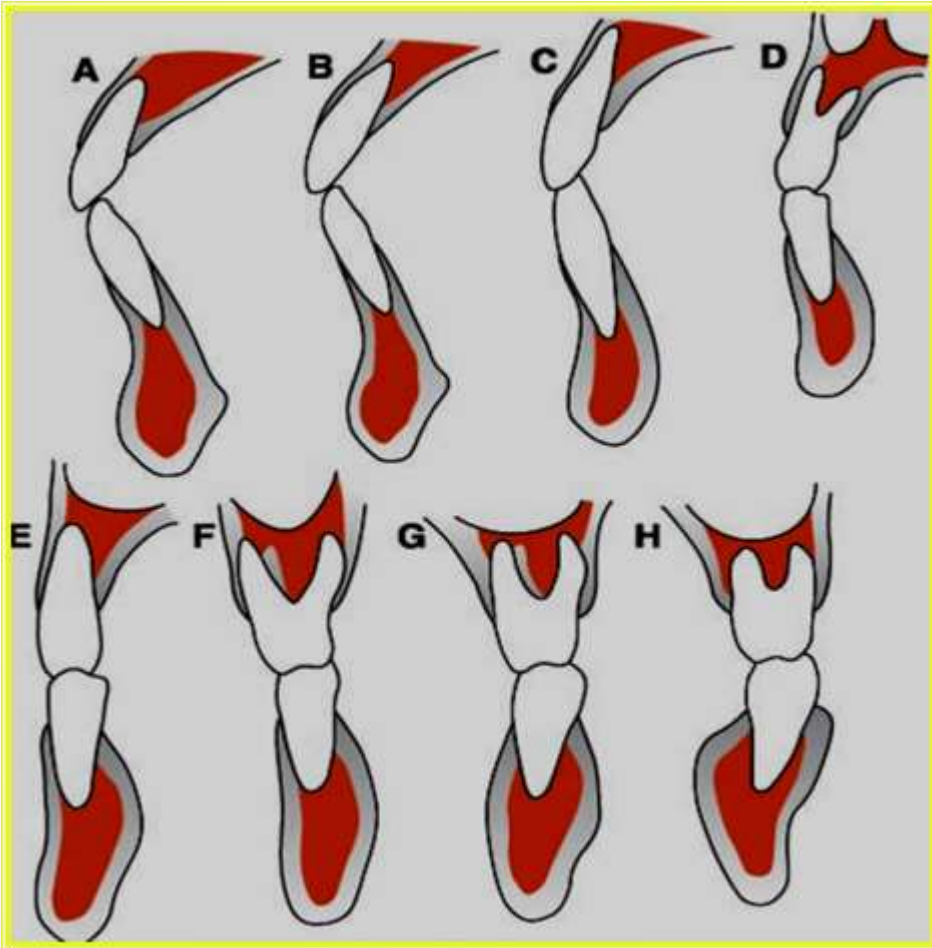




← Transverse section of long bone

Longitudinal section →





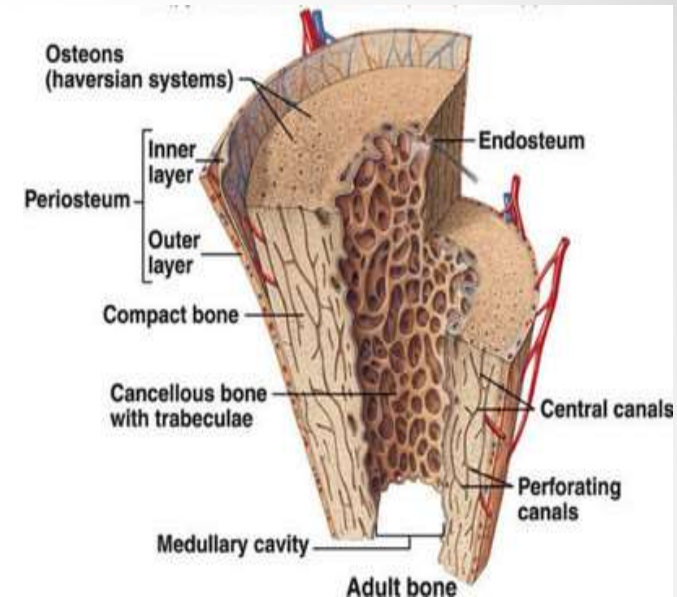
 Cancellous Bone

 Compact Bone

- **Periosteum:**
- *The tissue covering the outer surface of bone is termed periosteum.*

- **The periosteum consists of:**

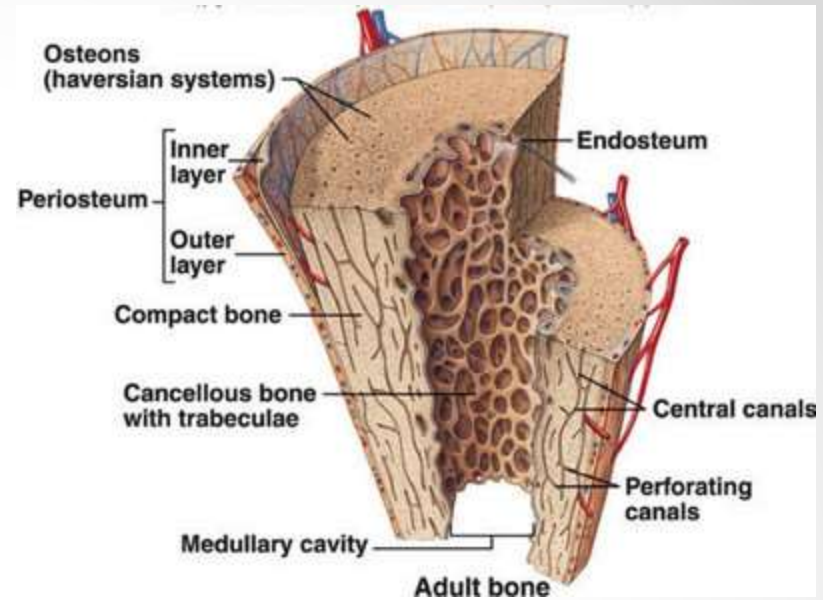
- **An inner layer composed of osteoblasts surrounded by osteoprogenitor cells, which have the potential to differentiate into osteoblasts,**
- **An outer layer rich in blood vessels and nerves and composed of collagen fibers and fibroblasts.**



- **Endosteum:**
- *The tissue lining the internal bone cavities is called endosteum.*

- **The endosteum consists of:**

- **Single layer of osteoblast and sometimes small amount of connective tissue.**

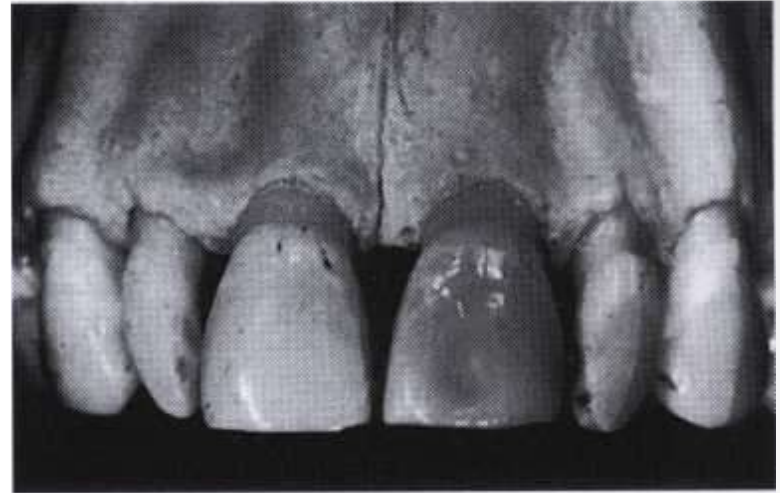


- **Bone Marrow:**
- In the embryo and newborn, the cavities of all bones are occupied by red hematopoietic marrow. The red marrow gradually undergoes a physiologic change to the fatty or **yellow** inactive type of marrow.
- In the adult, the marrow of the jaw is normally of the later type, and red marrow is found only in ***the ribs, sternum, vertebrae, skull, and humerus.***

- **Interdental septum:**

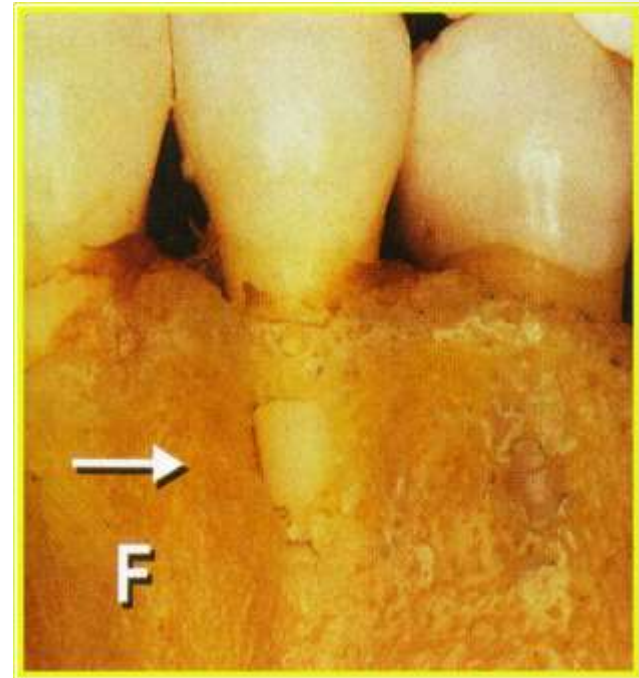
- It consists of cancellous bone bordered by the socket wall cribriform plates (lamina dura or alveolar bone proper) of approximating teeth.
- The mesiodistal angulation of crest of interdental septum usually parallels the line drawn between cemento-enamel junctions of approximating teeth.
- The distance between the crest of the alveolar bone and the cemento-enamel junction in young adults varies between 0.75-1.49mm (average 1.08mm).

- **Osseous Topography**



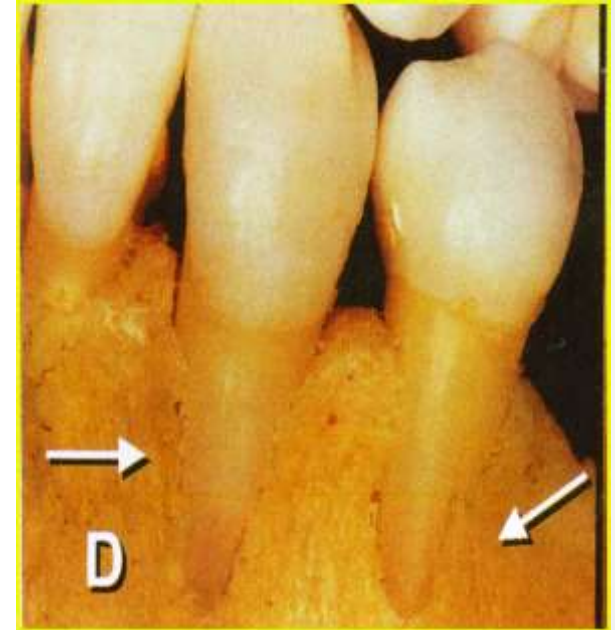
- **The bone contour normally conforms to the prominence of the roots, with intervening vertical depressions that taper towards the margin.**
- **The height and thickness of facial and lingual bony plates are affected by the alignment of the teeth, by the angulation of the root to bone, and by occlusal forces.**

- **Fenestrations**
- Isolated areas in which the root is denuded of bone and the root surface is covered only by periosteum and overlying gingiva are termed ***Fenestrations***.



- **Dehiscences:**

When the denuded areas extend through the marginal bone, the defect is called a Dehiscence.



Prominent root contours, malposition, and labial protrusion of the root combined with a thin bony plate are predisposing factors

Functions of Alveolar Bone

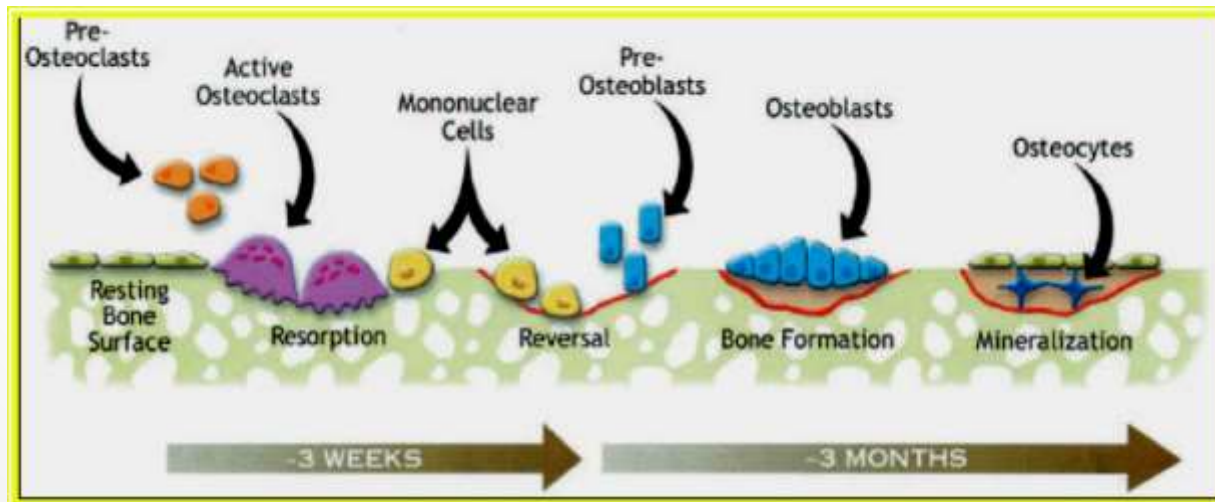
- *The bone holds the tooth firmly in position to masticate*

It also:

- **Helps to move the teeth for better occlusion**
- **Supplies vessels for the PDL**
- **Houses & protects developing permanent teeth while supporting primary teeth**
- **Organizes successive eruptions of primary & secondary teeth**

Remodeling of Alveolar Bone

- Remodeling is the major pathway of bone changes in shape
- Bone formation and bone resorption are processes that are “coupled”.
- Osteoclasts resorb an area of bone, and osteoblasts are signaled to come in and replace bone.



BONE RESORPTION

- ▶ Resorption of mineralized tissues requires the recruitment of a specialized cell, the osteoclast, which is produced by the monocyte/macrophage lineage of hematopoietic cells that are derived from bone marrow.
- ▶ **Tencate**, described the sequence of events in the resorptive process is as follows:
 - Attachment of osteoclast to the mineralized surface of bone.
 - Creation of a sealed acidic environment through the action of the proton pump, which demineralizes bone and exposes the organic matrix.
 - Degradation of exposed organic matrix to its constituent amino acids by the action of released enzymes, such as acid phosphatase and cathepsin B.
 - Sequestering of mineral ions and amino acids within the osteoclast.

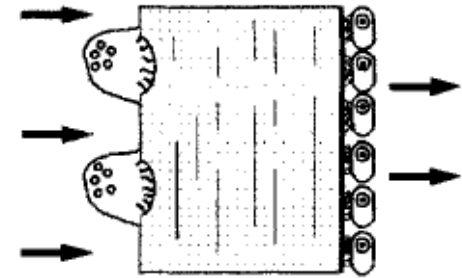
- **Factors that regulate bone remodeling**

- **Local factors:**

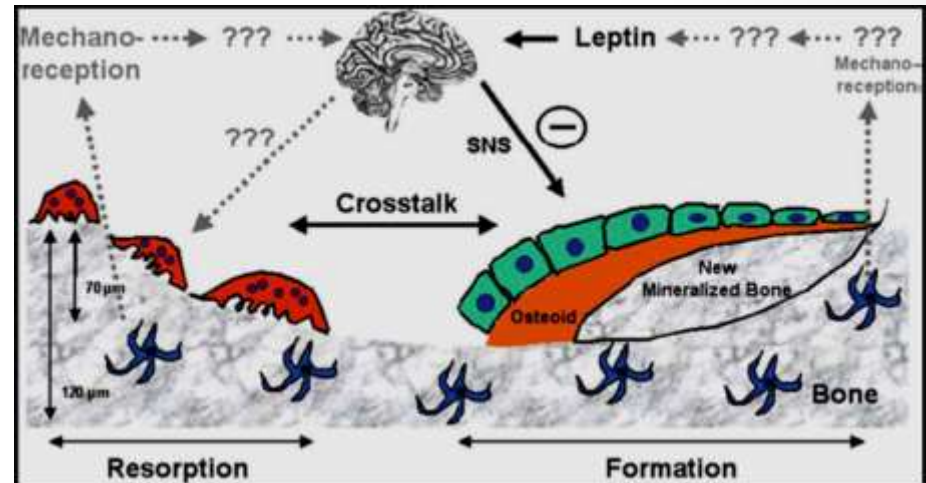
- functional requirements on the tooth
- age related changes in bone cells.

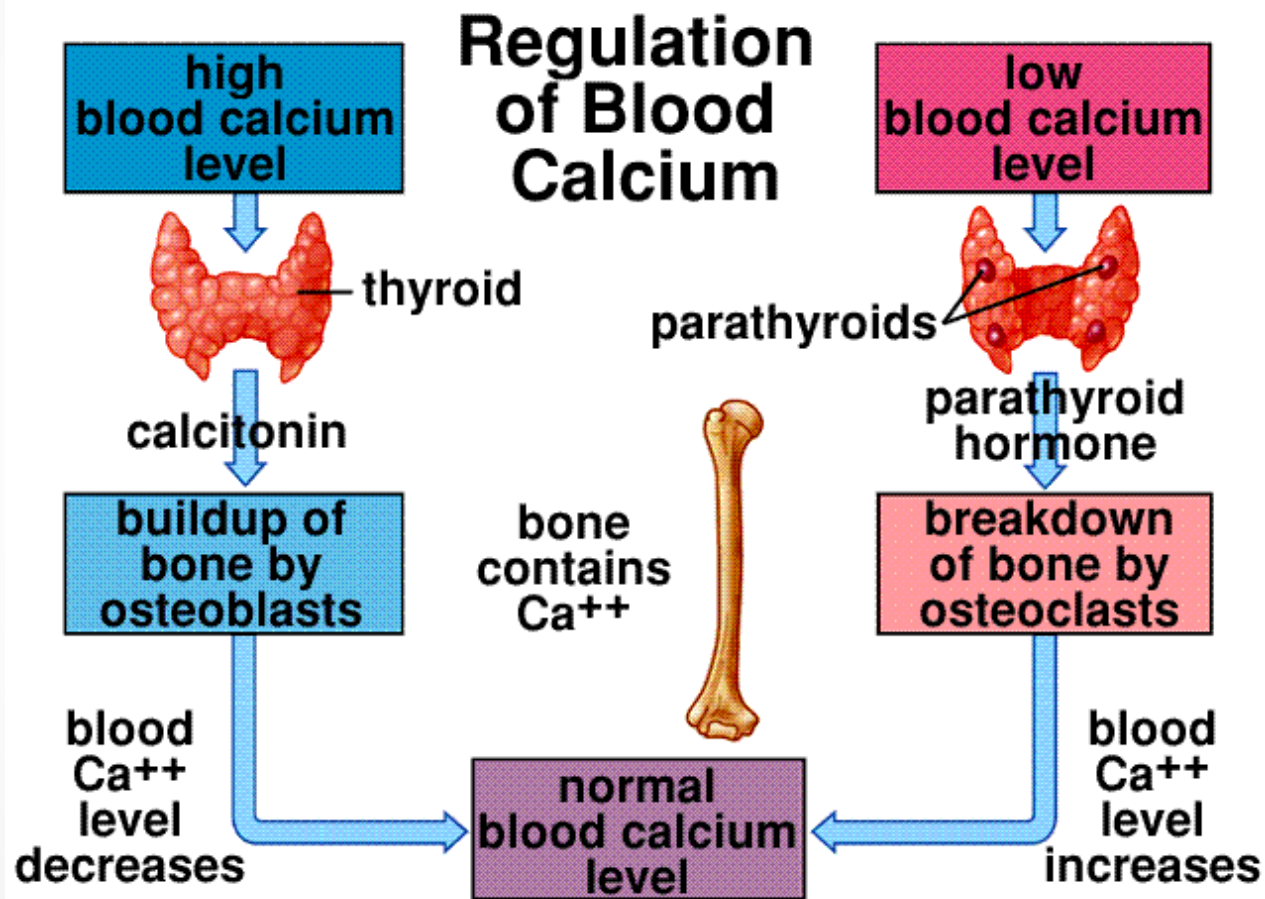
- **Systemic factors:**

- hormonal e.g. parathyroid hormone, calcitonin, vitamin D.



- **Coupling : a systemic hypothalamic relay as well as local fine tuning**





Important questions

LAQ

1. Define alveolar process and write in details.
2. Alveolar bone in health and disease.

SAQ

1. Difference between periosteum and endosteum
2. Fenestration and dehiscence
3. Resorption and remodelling

THANK YOU