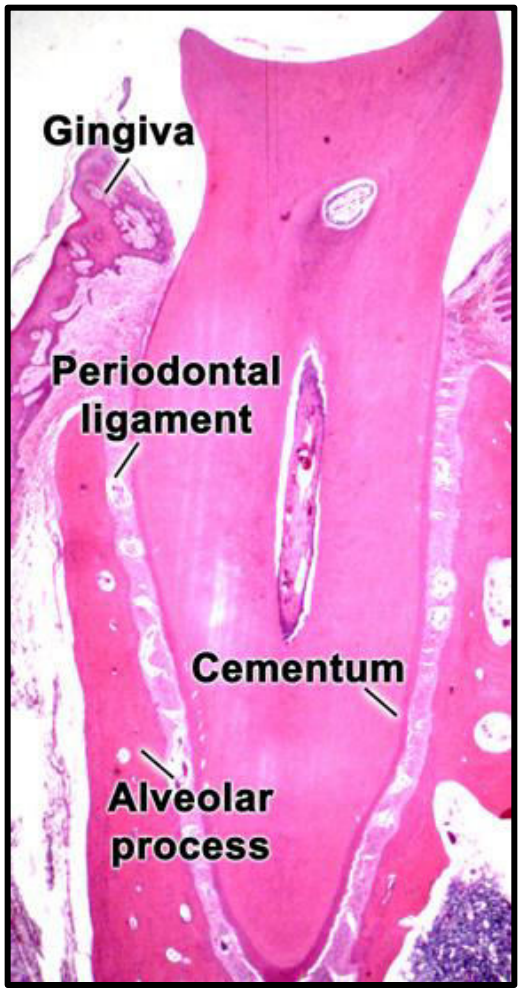
PERIODONTAL LIGAMENT

- The periodontal ligament is the connective tissue that surrounds the root and connects it with the bone.

- It is continuous with the connective tissue of the gingiva and communicates with the marrow spaces through vascular channels in the bone.

- At the root apex, the PDL merges with the dental pulp.


Gingiva
Periodontal ligament
Cementum
Alveolar process

- Together with cementum, alveolar bone and lamina propria of the gingiva, the PDL forms the tissue which supports the teeth in jaw.

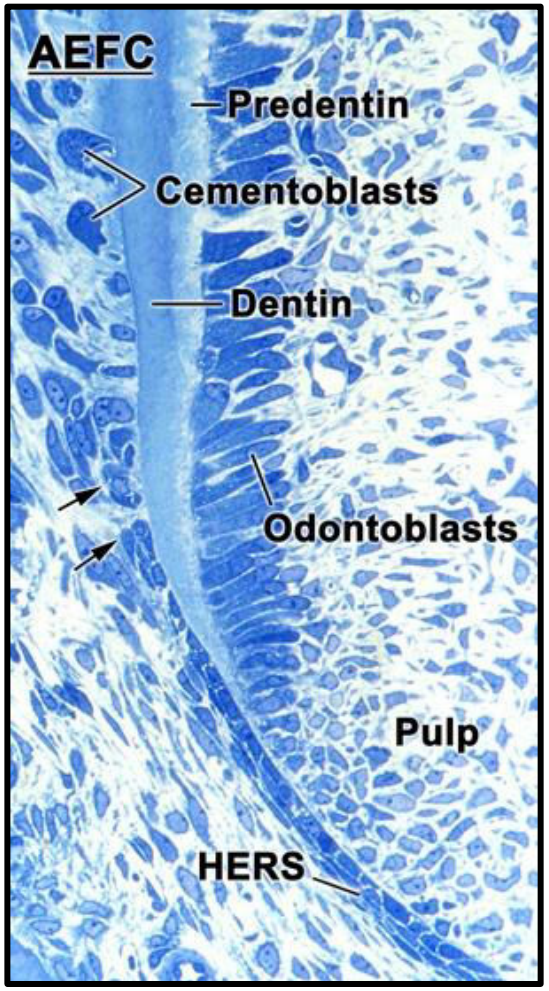
- These supporting tissues are often referred collectively as the ***periodontium.***

Synonyms of PDL-

- Alveolar periosteum
- Dental periosteum
- Cemental ligament
- Alveolodental ligament
- Periodontal membrane

Evolution

- There is a fundamental difference between the attachment of reptilian and mammalian teeth.
- In the reptile the mandiular and maxillary teeth "move" with the bones to which they are fused.
- In the mammal the teeth have to "move" as units independent of the bones, and this movement is made possible by the remodeling of the periodontium.

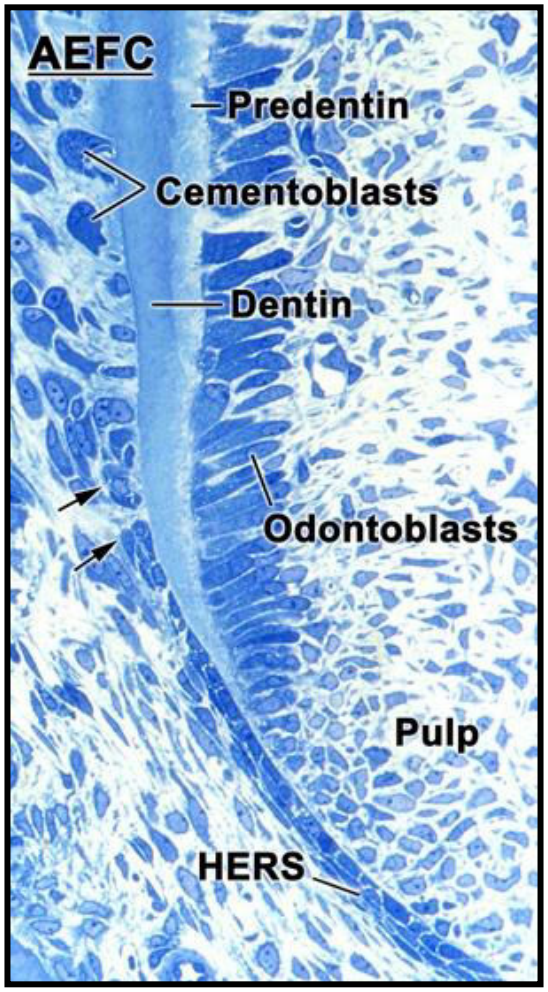

AEFC
Predentin
Cementoblasts
Dentin
Odontoblasts
Pulp
HERS

Development

- Hertwig's epithelial root sheath are surrounded by a condensation of cells of dental sac.
- A thin layer of cells adjacent to dental organ is called as dental follicle.
- Cells surrounds the dental follicle and are called as perifollicular mesenchyme.

Development

- HERS sends inductive signal to ectomesenchymal pulp cells to secrete predentin by differentiating into odontoblasts.
- HERS becomes interrupted and forms strands called as ***Epithelial rests of Malassez***



- This separation permits the cells of the dental follicle /dental sac to migrate to the external surface of the newly formed root dentin and differentiate into

- **Cementoblasts – Cementum**
- **Fibroblasts - Fibers of PDL & ground substance**
- **Osteoblasts – Alveolar Bone**

Principle Cells In PDL

Synthetic Cells

- Osteoblasts
- Fibroblasts
- Cementoblasts

Resorptive Cells

- Osteoclasts
- Fibroblasts
- Cementoclasts

Epithelial cells in ligament

- Epithelial rests of Malassez

Other connective tissue cells

- Mast cells
- Macrophages

Synthesizing Cell/ Active Cell

- Euchromatin present with open or uncoil chromatin
- Nuclear outline is indistinct
- More no. of organelles is present

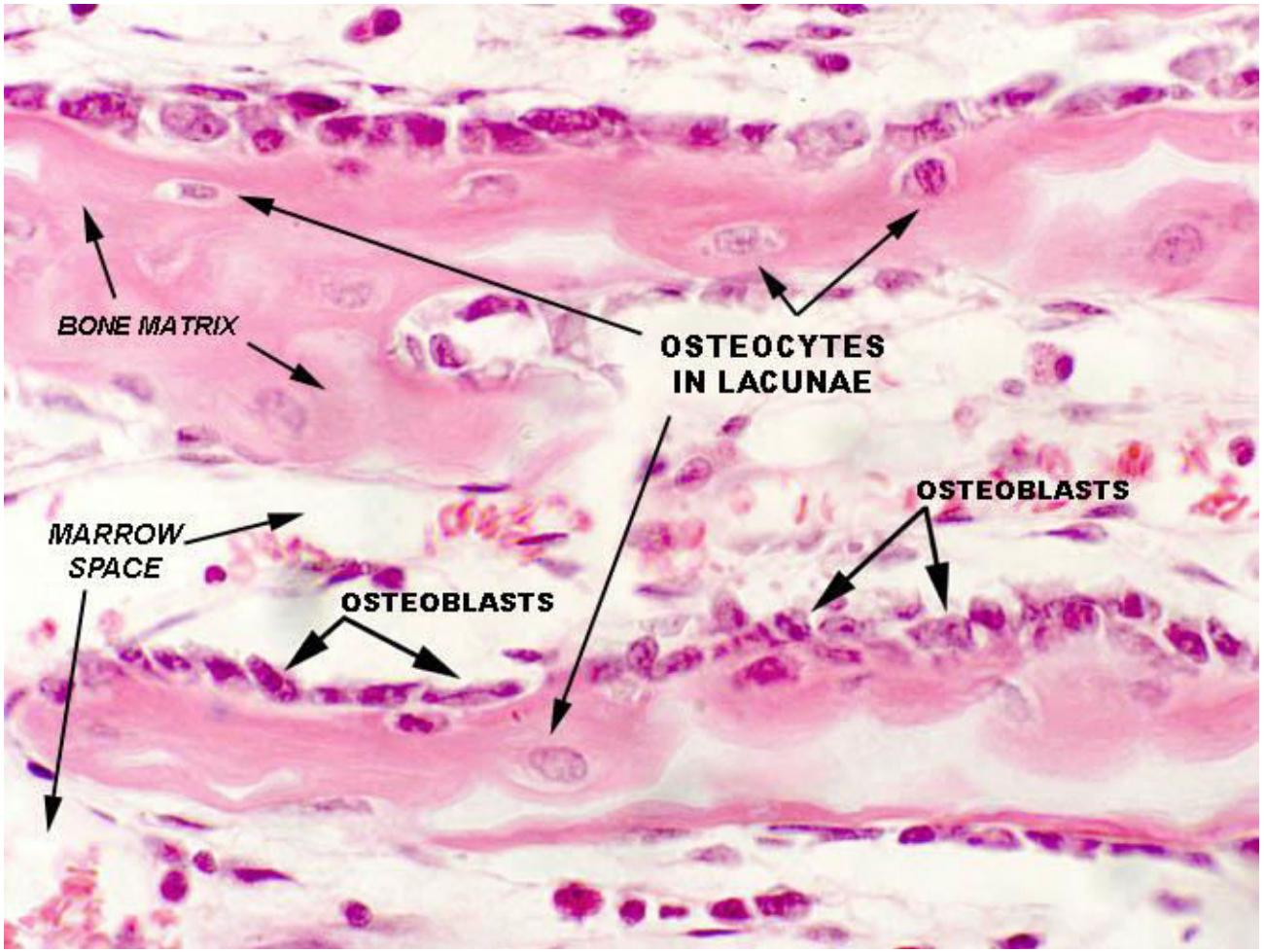
- *Resting / Inactive Cell*
- Heterochromatin or coiled chromatin which is condensed
- Nuclear outline is distinct
- No. of organelles is less

- Increased cytoplasmic content
- Nuclear and overall size of cell is increased
- Metabolically active

- Cytoplasmic content is less
- Nuclear and cell size comparatively less
- Metabolically inactive

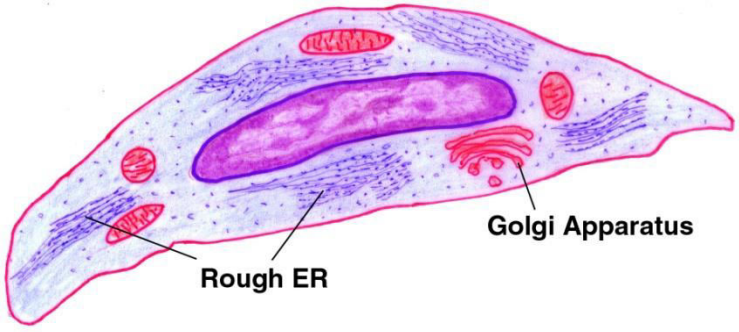
Synthetic Cells - Osteoblasts

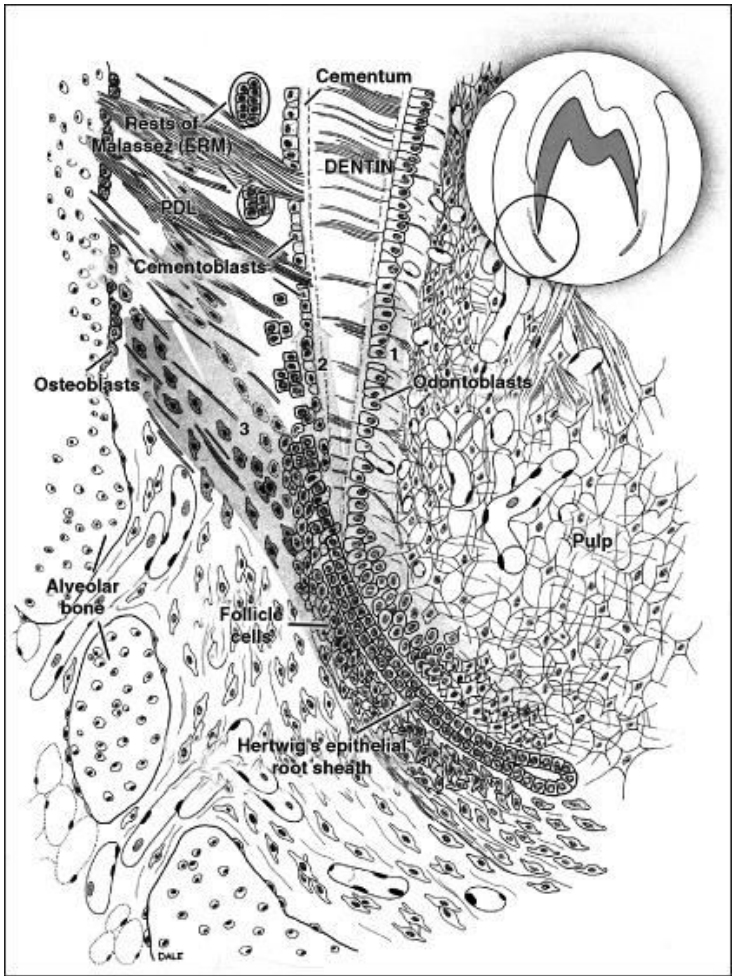
- The osteoblasts covering the periodontal surface of the alveolar bone constitute a modified endosteum and not a periosteum.
- The surface of the bone is covered largely by osteoblasts in various stages of differentiation by progenitor cells as well as ocassional osteoclasts.


BONE MATRIX
OSTEOCYTES
IN LACUNAE
OSTEOBLASTS
MARROW
SPACE
OSTEOBLASTS

Synthetic Cells - Fibroblasts

- In longitudinal sections fibroblasts appear to be ***oriented parallel*** to the bundles of ***collagen fibers.***



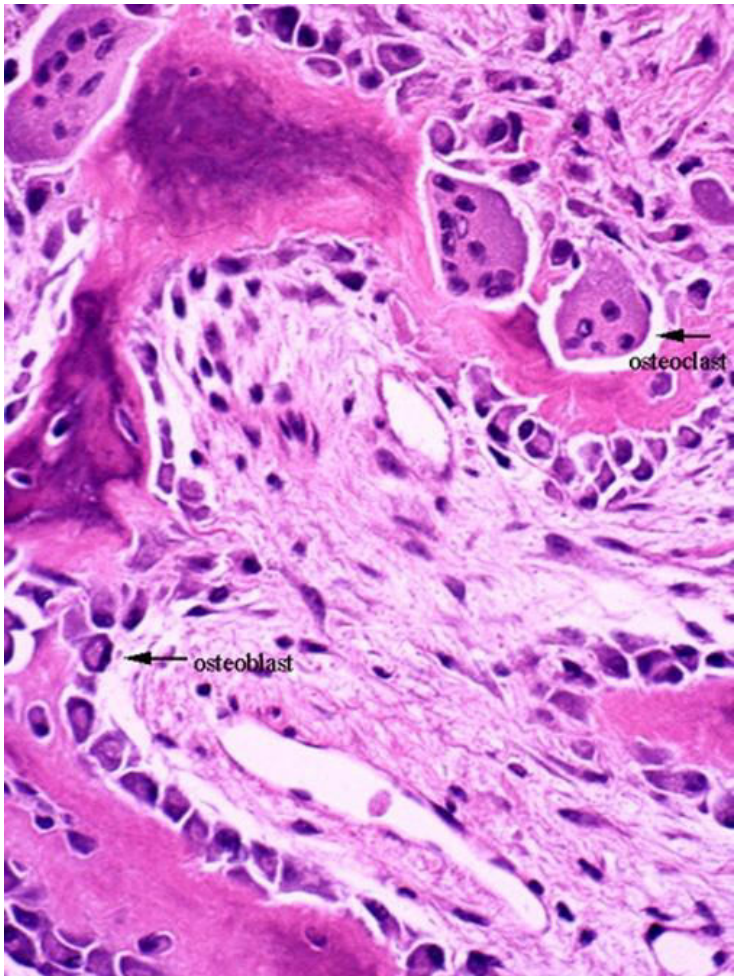

Cementum
Rests of Malassez (ERM)
DENTIN
PDL
Cementoblasts
1
2
3
Osteoblasts
Odontoblasts
Pulp
Alveolar bone
Follicle cells
Hertwig's epithelial root sheath
DALE

Synthetic Cells - Cementoblasts

- The distribution on the tooth surface of variously differentiated cementoblats and their progenitors is similar to the distribution of osteoblasts on the bone surface.

Resorptive Cells - Osteoclasts

- Osteoclasts are cells that ***resorb bone*** and tend to be large and multinucleated but can also be small and mononuclear.
- Multinucleated osteoclasts are formed by fusion of precursor cells similar to circulating monocytes
- In the light microscope cells appear to ***occupy resorption bay in the bone (Howship's Lacunae)***

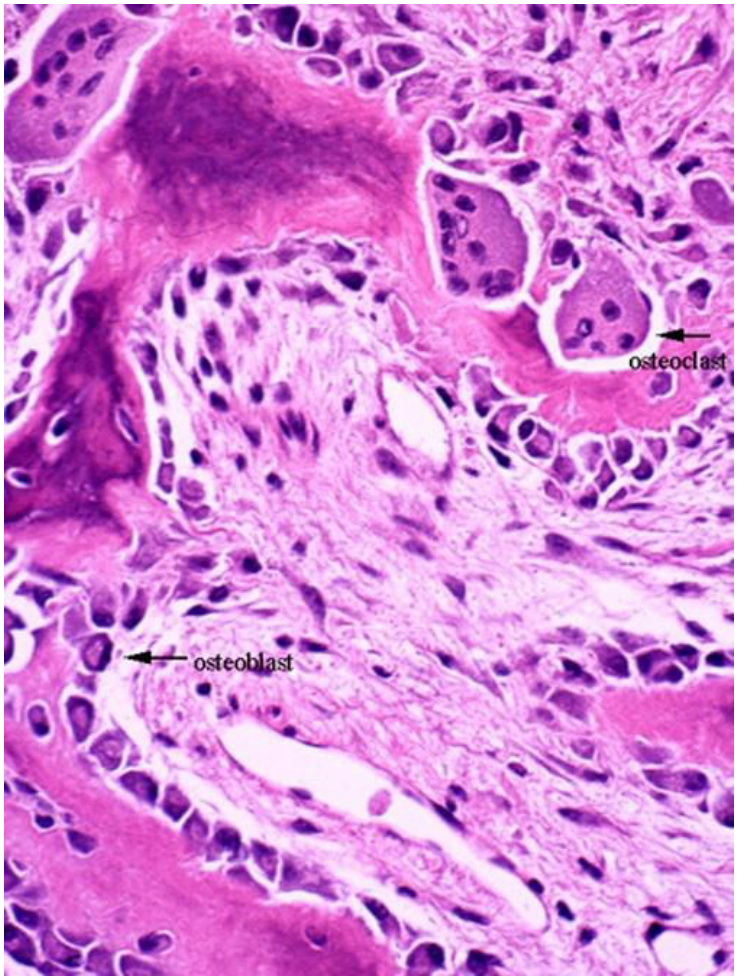

osteoclast
osteoblast

Resorptive Cells - Osteoclasts

- In electron microscope, the part of plasma membrane lying adjacent to bone that is being resorbed is raised in characteristic folds ***called as Ruffled or Striated Border***
- The bone related to the ruffled border can be seen undergoing resorption.

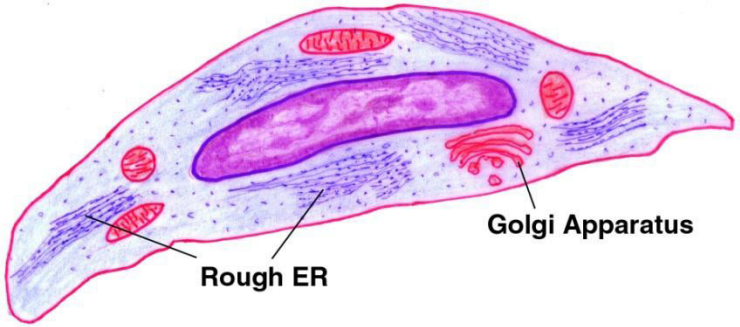
Resorptive Cells - Osteoclasts

- Osteoclasts are rich in *acid*, which is contained in lysosomes.
- Osteoclasts causes removal and deposition of bone that are responsible for its remodeling



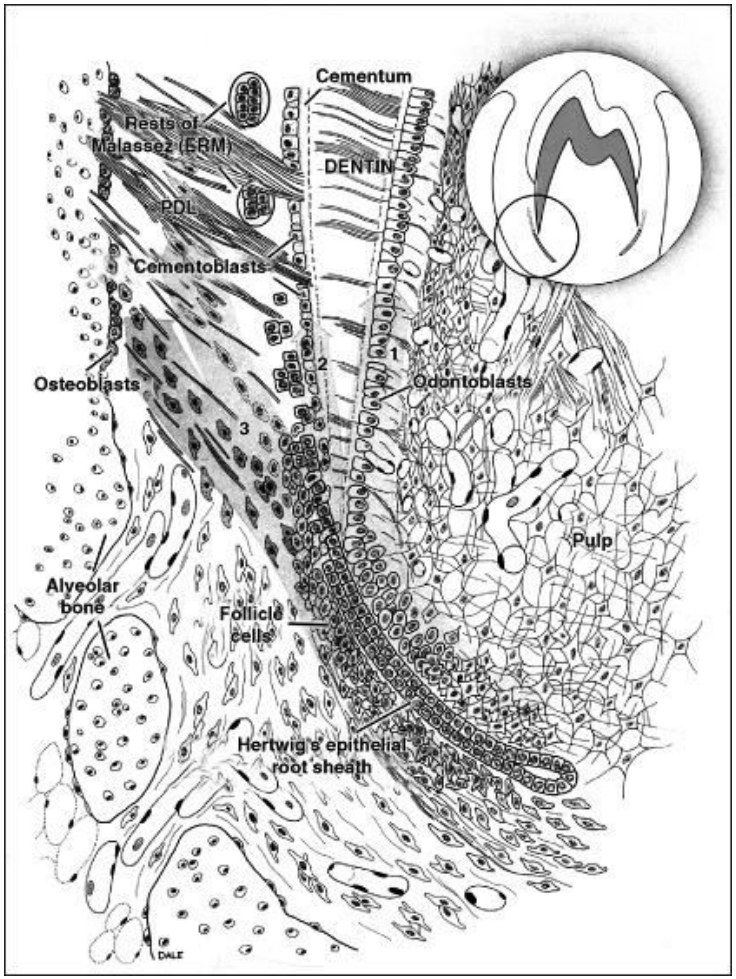
Resorptive Cells - Fibroblasts

- Collagen fibrils in PDL can be resorbed under physiologic condition by mononuclear fibroblasts.
- It produces collagen fiber and extracellular matrix during the life as well as having ingesting and degrading this same matrix.



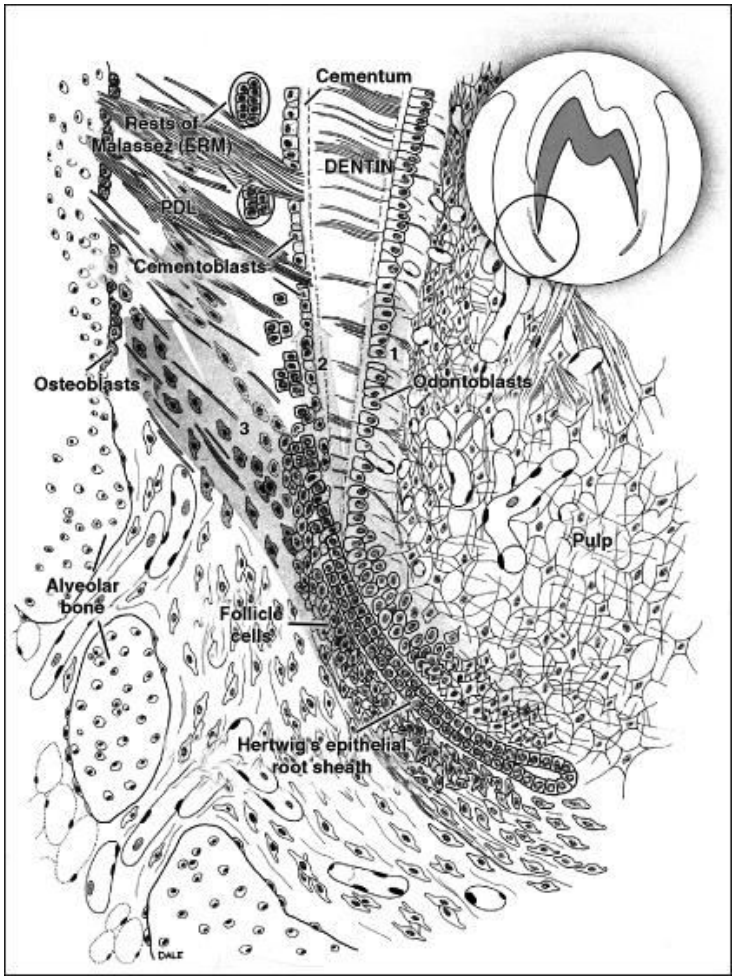
Resorptive Cells - Cementoclasts

- Cementoclasts resembles osteoclasts
- Resorption of cementum occurs under certain circumstances, and carried out by mononucleated cementoclasts or multinucleated giant cells, often located in Howship's lacunae found on the surface of the cementum.



Resorptive Cells - Cementoclasts

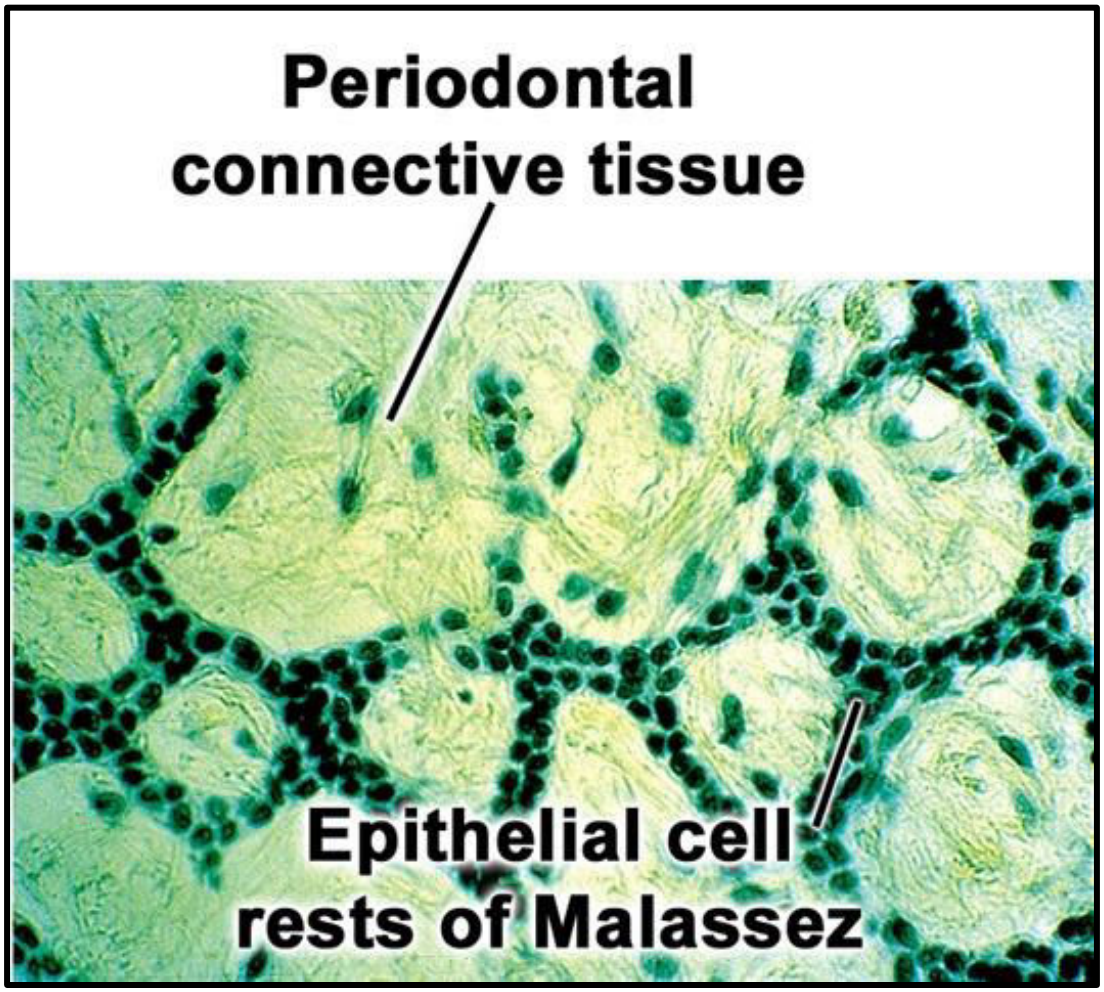
- The origin of cementoclasts is unknown but it is conceivable that they arise in the same manner as osteoclasts.



Progenitor cells

- PDL contain progenitor for synthetic cells that have the capacity to undergo mitotic division.

- After cell division, one of the daughter cells differentiates into a functional type of connective tissue cell, while the other remains as an undifferentiated progenitor cell retaining the capacity to divide when stimulated appropriately.


Periodontal
connective tissue
Epithelial cell
rests of Malassez

Epithelial Rests of Malassez

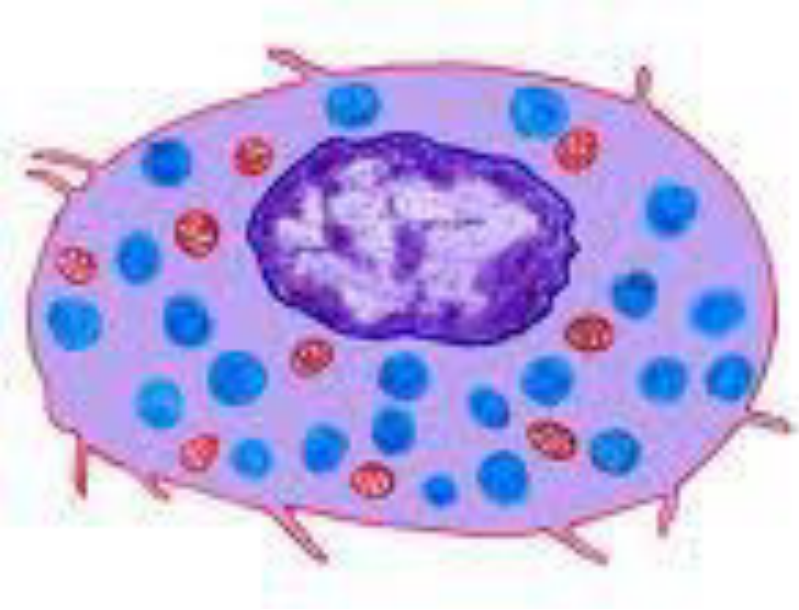
- The PDL contains epithelial cells that are found close to the cementum called as epithelial rests of malassez.
- They are the remnants of epithelium of Hertwig's epithelial root sheath.

Epithelial Rests of Malassez

- In certain pathologic conditions, cells of epithelial rests undergo rapid proliferation and produce a variety of cysts and tumors in the jaw

Mast Cell

- Small, round or oval cell of size 12 to 15 μm contains numerous cytoplamic granules and stains metachromatically.
- It contain enzymes – heparin & histamine
- The physiologic role of heparin – inflammatory reaction



- The connective tissue fibres are mainly collagenous, comprising over 90% of PDL.

- But small amounts of-
  - Oxytalan
  - Reticulin fibres &,
  - Elastin fibers, in some species.

- The main types of collagen in the periodontal ligament are types I and III, and these are categorised as fibrous collagens.
- **70 % is type I collagen**. This is the major protein component of most connective tissues including bone and skin.
- Ligament is relatively rich in **type III Collagen--about 20%** of total.

- Much of the collagen is gathered together to form bundles approximately 5 μm in diameter. These bundles are termed as the **Principal fibres**.

- They appear to be more numerous (but smaller) at their attachments to cementum than at the alveolar bone as these principal collagen fibres passes across the periodontal space from the root to the alveolar bone.

- The fibroblasts are responsible for the synthesis & degradation of collagen.

- Cellular processes surround or envelop the fibre bundles; indeed, processes from adjacent cells are joined by intercellular contacts to form a cellular network.

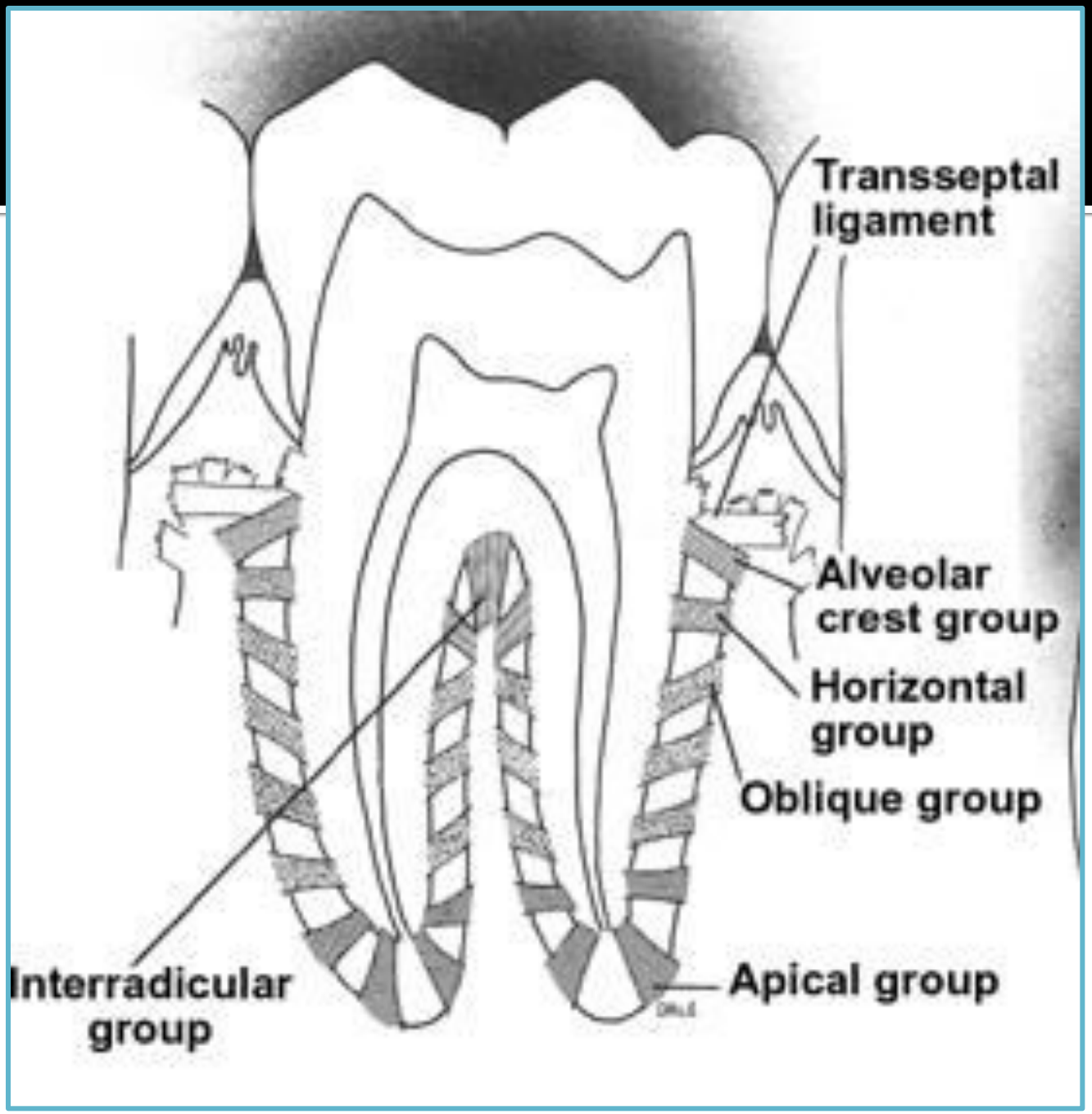
- Many of the isolated islands of cytoplasm present in sections are cell processes from fibroblasts whose cell bodies are beyond the plane of section.

- Controversy exists concerning the extent of individual fibres across the width of the periodontal ligament.

- One view holds that there are distinct tooth-related and bone-related fibres, and that these intercalate near the middle of the ligament at an **intermediate plexus.**

- The principal fibres of the periodontal ligament that are embedded into cementum and the bone lining the tooth socket are termed **'Sharpey's fibers'.**

- The principal fibres are more numerous but smaller at the attachments into cementum than at the alveolar bone.


Transseptal ligament
Alveolar crest group
Horizontal group
Oblique group
Apical group
Interradicular group

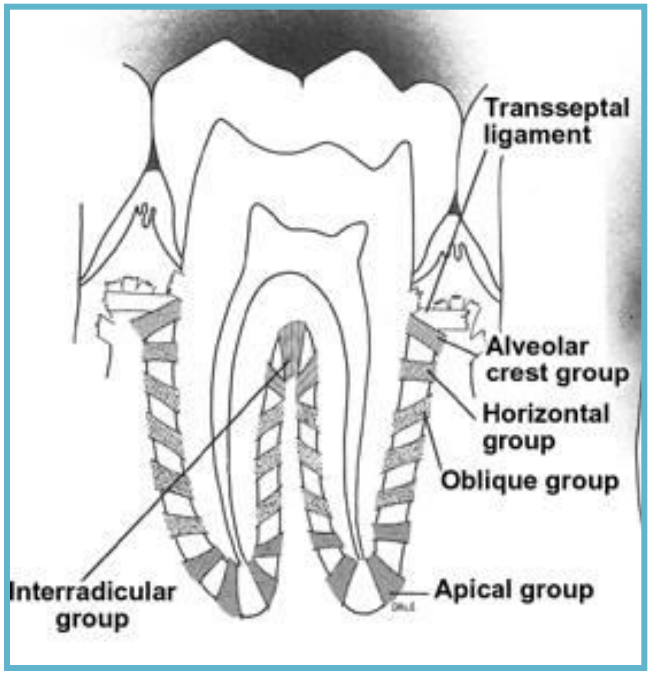
Principle fibers of PDL

5 groups of fibers run from tooth to alveolar bone-

- ***The Alveolar crestal Group-***
  - Attached just apical to CEJ & runs downward & inwards to insert into the rim of the alveolus.

- ***The Horizontal Group-***
  - Just apical to the alveolar crest group & running at right angles to the long axis of the tooth from cementum to bone just below the alveolar crest.

- ***The Oblique Group-***
  - Most numerous & run from cementum in oblique direction to insert in bone coronally.



- **The Apical Group-**
  - Radiates from cementum around the apex of the root to the bone forming base of the socket.

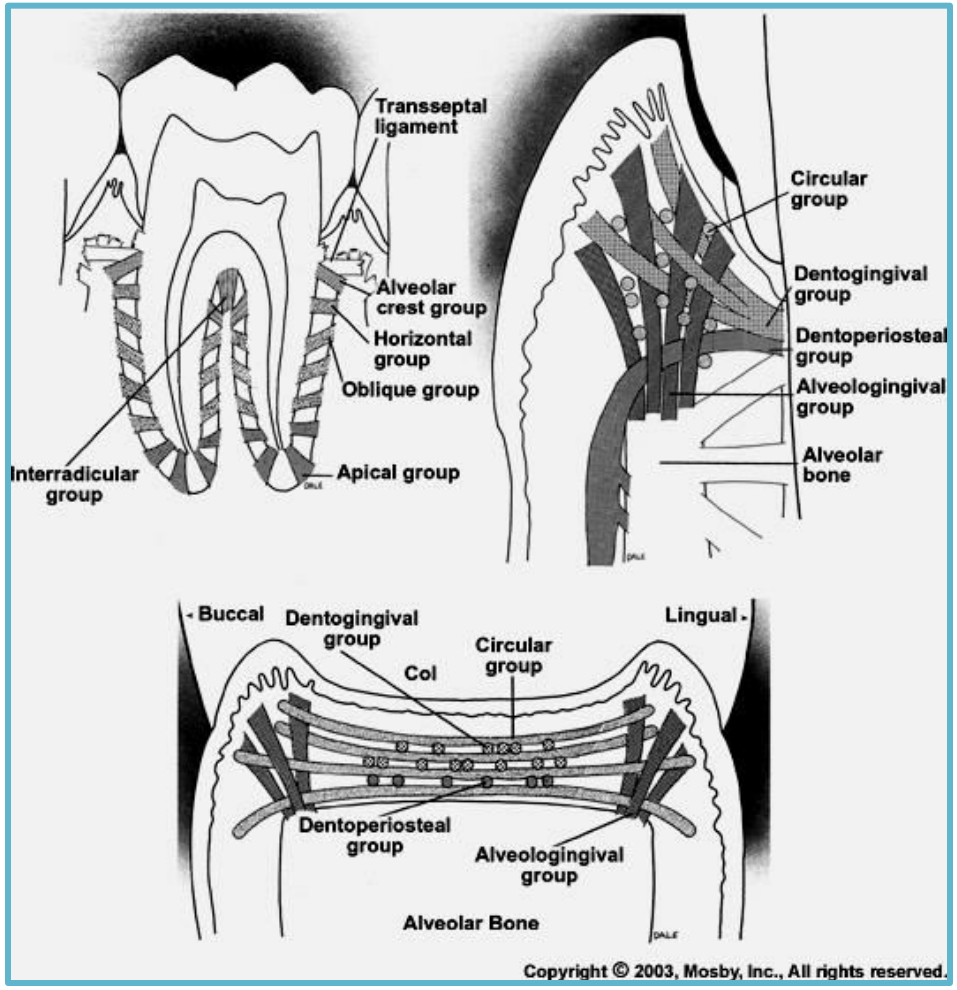
- **The Interradicular Group-**
  - It is found only between roots of multirooted teeth & running from the cementum into the bone, forming the crest of interradicular septum.

GINGIVAL LIGAMENT

- Although not strictly part of PDL, other group of fibers are associated with principal fibers in maintaining integrity of periodontium.

- They are present in lamina propria of gingiva & collectively termed as ***gingival ligament.***

- It is composed of five group of bundles of fibers-
  - Dentoalveolar group
  - Alveologingival group
  - Circular group
  - Dentoperiosteal group
  - Transseptal group


Transseptal ligament
Alveolar crest group
Horizontal group
Oblique group
Interradicular group
Apical group
Circular group
Dentogingival group
Dentoperiosteal group
Alveologingival group
Alveolar bone
Buccal
Dentogingival group
Col
Circular group
Lingual
Dentoperiosteal group
Alveologingival group
Alveolar Bone
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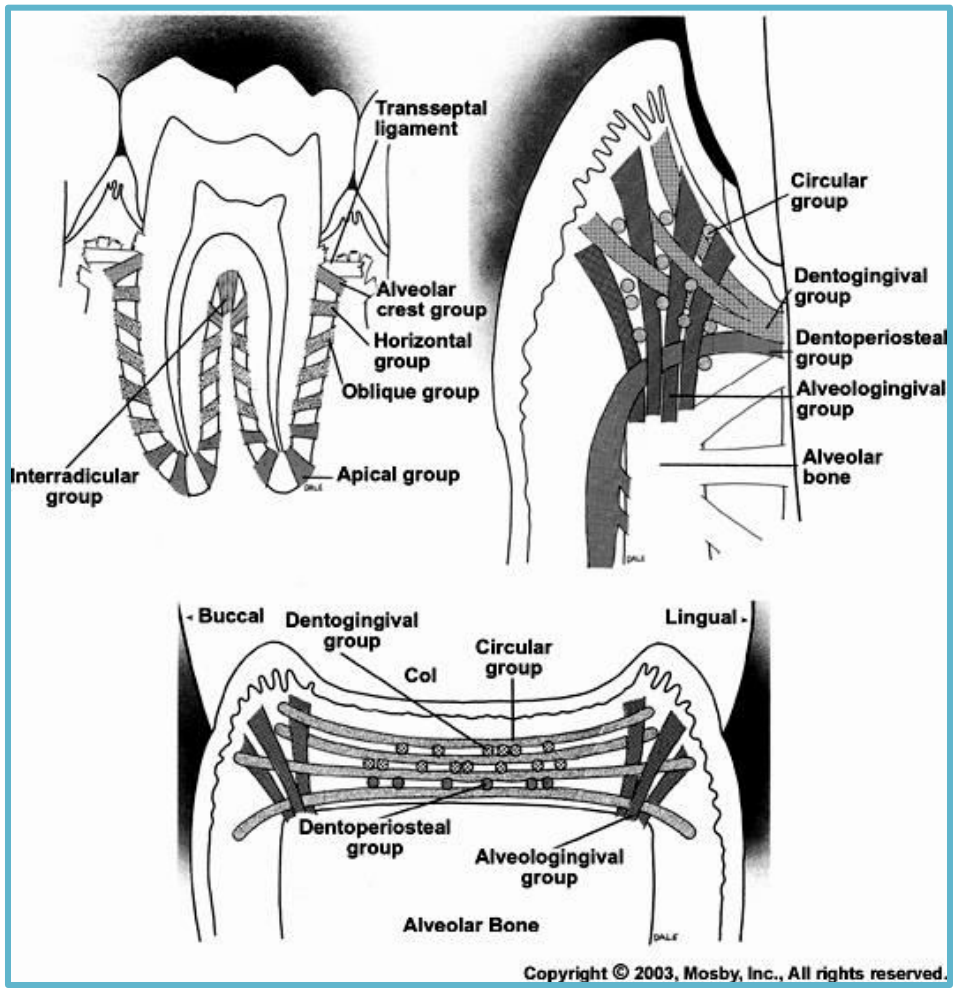
- **Dentogingival group**
  - Most numerous & extend from cervical cementum to lamina propria of the free & attached gingiva.

- **Alveologingival group**
  - These fibers radiate from bone of the alveolar crest & attach in the lamina propria of free & attached gingiva.

- **Circular group**
  - This small group of fibers forms a band around neck of tooth, interlacing with other groups of fibers.


Transseptal ligament
Alveolar crest group
Horizontal group
Oblique group
Interradicular group
Apical group
Circular group
Dentogingival group
Dentoperiosteal group
Alveologingival group
Alveolar bone
Buccal
Dentogingival group
Col
Circular group
Lingual
Dentoperiosteal group
Alveologingival group
Alveolar Bone
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- **Dentoperiosteal group**
  - Run apically from the cementum over the periosteum of the outer cortical plate of the alveolar process, & insert into alveolar process or the vestibular muscle & floor of mouth.

- **Transseptal group**
  - These fibers run interdentally from cementum just apical to CEJ.
  - Together these fibers constitute ***Interdental ligament*** connecting all teeth of the arch**.**

- ELASTIC FIBRES: 2 types

  Mature elastic fibers (elastin fibres)

  Immature elastic fibers (elaunin, oxytalan)

- Elaunin found within fibers of gingival ligament.

- Orientation of oxytalan fiber is different from collagen fiber.
- They support blood vessels of the peridontal ligament.

- Are Immature collagen fibre.
- Related to basement membrane of blood vessels and epithelial cells of PDL.

SECONDARY FIBRES:

- Are located between and among principal fibre.

GROUND SUBSTANCE OF PDL

- Because of its relative inaccessibility and complex biochemical nature little information is there.
- In reality it is a tissue **rich in ground substance**.
- Indeed even the collagen fibre bundles are composed of about 60% ground substance by volume.

- The ground substance of the periodontal ligament consists mainly of
  - Hyaluronic acid
  - Glycosaminoglycans,
  - Proteoglycans and glycoproteins.

- The ground substance is thought to have many important **functions.**
  - ion and water binding & exchange.
  - control of collagen fiber orientation.
- Tissue fluid pressure is high in the pdl, about 10 mm Hg above atmospheric pressure.
- The tissue fluid has been implicated in the tooth support & eruptive mechanisms

Blood supply:

- Branches from apical vessels that supply dental pulp.
- Branches of Intra-alveolar vessels.
- Branches from gingival vessels.

Nerve Supply:-

Two types of nerve fibres:

- Sensory
- Autonomic

Functions

- Supportive
- Sensory
- Nutritive
- Homeostatic
- Eruptive

Supportive

- PDL behaves as a suspensory ligament.
- During mastication/ occlusion periodontal ligament fibers are compressed because of water molecules bound to collagen and act as cushion for the tooth.
- Pressure of blood in PDL acts as hydraulic cushion.

- PDL dissipates occlusal load to alveolar bone through oblique fibres.

Sensory

- PDL through its nerve supply provides most efficient proprioceptive mechanism allowing the individual to detect the application of most delicate forces to teeth and very slight displacement of teeth.

Nutritive

- PDL blood vessels provide anabolites and other substance by the cell and also helps in removal of catabolites.
- Too heavy forces causes necrosis of PDL.

Homeostatic

- PDL cells have capacity to resorb and synthesize extra cellular substance of connective tissue of PDL ligament, bone and cementum.
- Mechanism behind this is unknown.
- Preservation of PDL width through out mammalian life time is important measure of PDL homeostasis.

Eruptive

- Periodontal ligament traction theory