PERIODONTAL LIGAMENT(PDL)-:Anatomy and Histological contents

DR SHREYA SHETTY

BDS, MDS(PERIODONTICS), FICOI

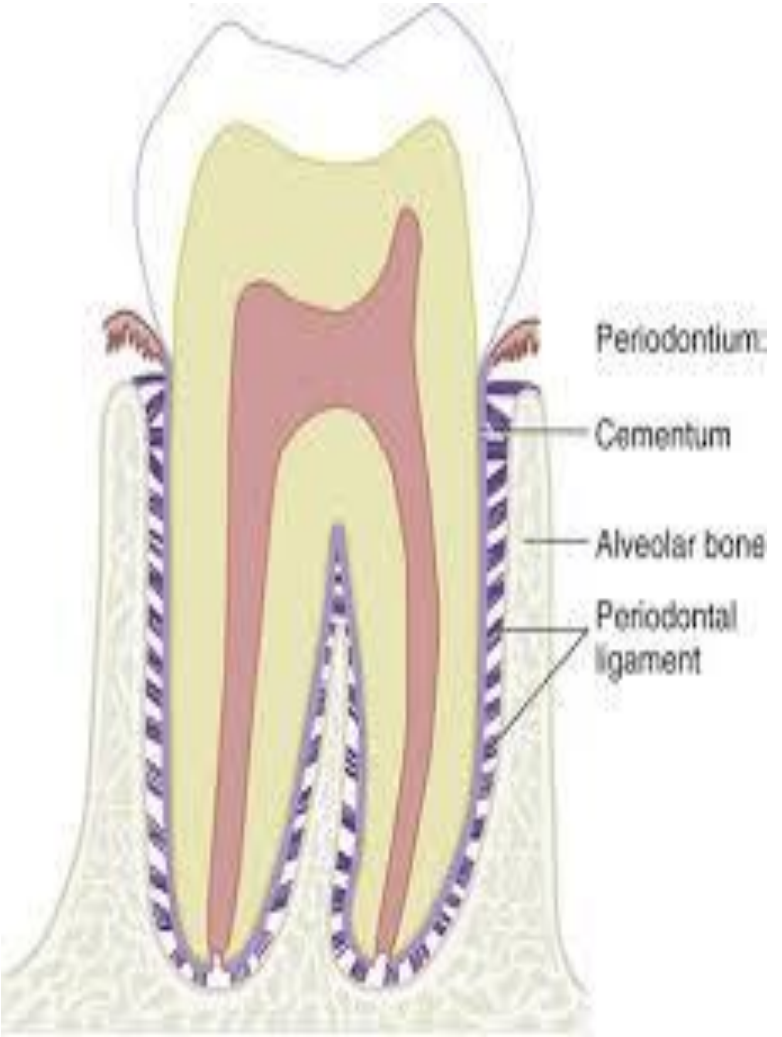
LECTURE LEARNING OUTCOMES

Describe the structure of PDL including its various cells ,fibers and biochemical composition of periodontal ligament

Outline the radiographic and histological appearance of PDL

WHAT IS THE PERIODONTAL LIGAMENT???

- a number of terms.
- Desmodont, gomphosis, pericementum, dental periosteum, alveolodental ligament, and periodontal membrane.
- “Periodontal membrane” and “periodontal ligament” are the terms that are most commonly used.
- Neither term describes the structure and its functions adequately.
- Neither a typical membrane nor a typical ligament.
- However, because it is a complex soft connective tissue providing continuity between two mineralized connective tissues, the term “periodontal ligament” appears to be the more appropriate term.



Orban’s oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 173

- **The periodontal ligament is composed of a complex vascular and highly cellular connective tissue that surrounds the tooth root and connects it to the inner wall of the alveolar bone**.
- Measurements - range from 0.15 to 0.38 mm.
- Thinnest in the middle region of the root.
- The average width - about 0.2 mm.
-  With reduced function/unerupted teeth
-  with hyperfunction of teeth

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 32-33

Radiographic appearance

THIN RADIOLUCENT LINE

WIDENING/ THICKENING OF PDL

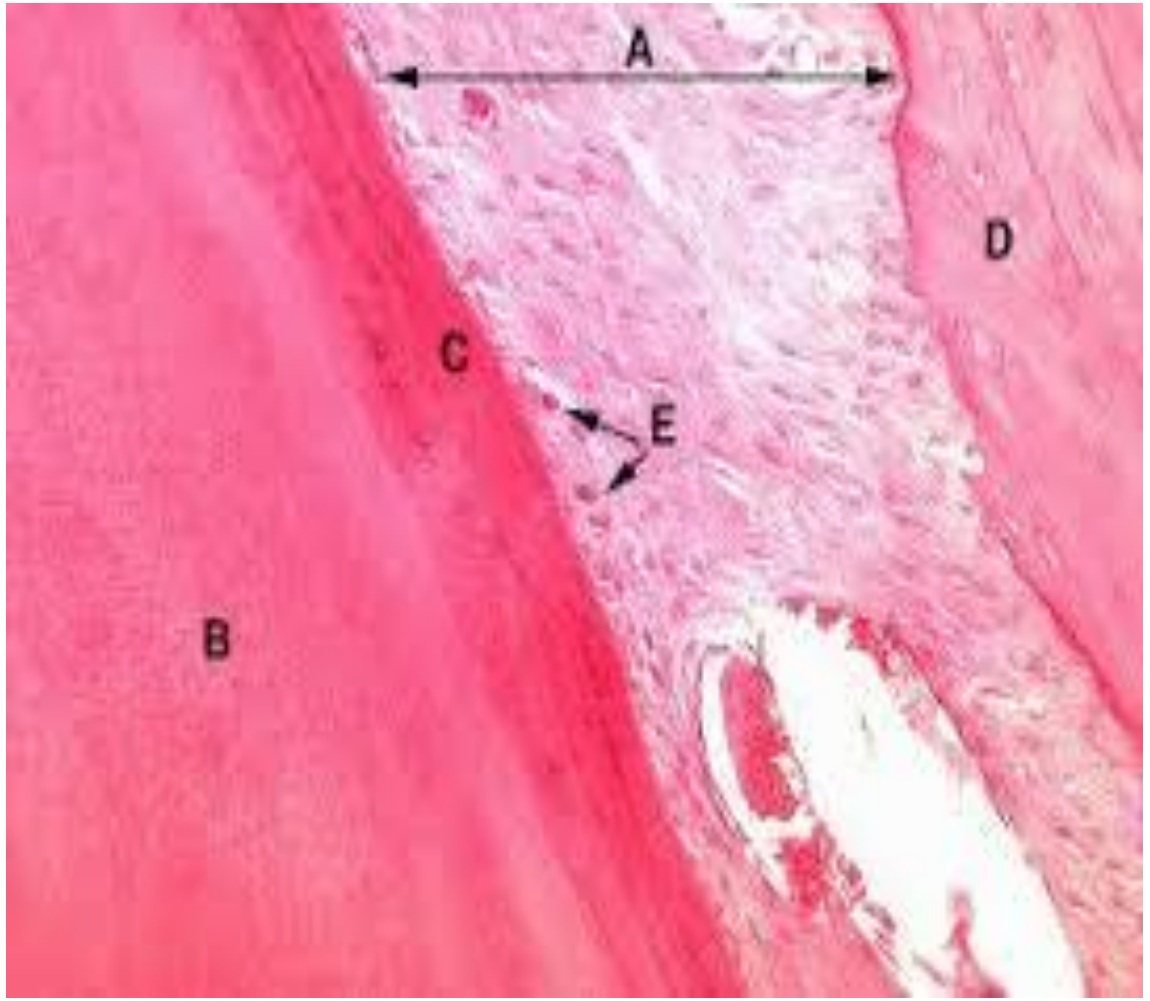
STRUCTURE OF PDL

- FIBERS
- CELLS
- GROUND SUBSTANCE

PERIODONTAL FIBERS

- The most important elements of the periodontal ligament are the ***principal fibers,*** which are collagenous and arranged in bundles and which follow a wavy course when viewed in longitudinal section.

- The terminal portions of the principal fibers that are inserted into cementum and bone are termed ***Sharpey fibers.***



Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 32-33

- The principal fibers – mainly composed of **collagen**
- Collagen is a protein that is composed of different **amino acids**, the most important of which are glycine, proline, hydroxylysine,

  and hydroxyproline.
- Collagen is responsible for the maintenance of the framework and the tone of tissue, and it exhibits a wide range of diversity.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 32-33

- Collagen biosynthesis occurs inside the fibroblasts to form **tropocollagen molecules**. These aggregate into **microfibrils** that are packed together to form **fibrils**.
- **Fibrils** associate to form **fibers**;
- The **fibers** associate to form **bundles**
- The molecular configuration of collagen fibers provides them with a tensile strength that is greater than that of steel.
- Consequently, collagen imparts a unique combination of flexibility and strength to the tissues.

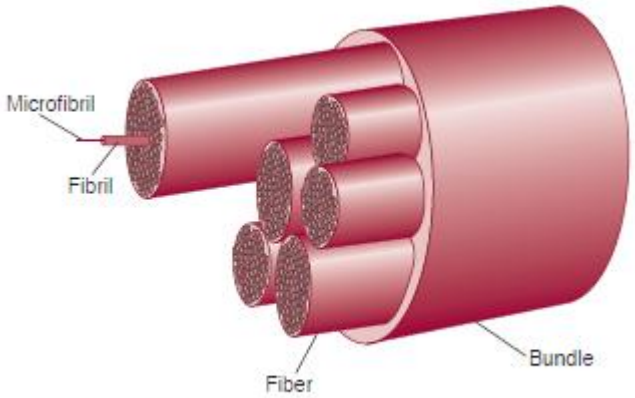


Fig. 3.33 Collagen microfibrils, fibrils, fibers, and bundles.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 32-33

- The principal fibers are composed mainly of collagen type I
- are arranged in six groups that develop sequentially in the developing root:
- the transseptal,
- alveolar crest,
- horizontal,
- oblique,
- apical, and
- interradicular fibers .

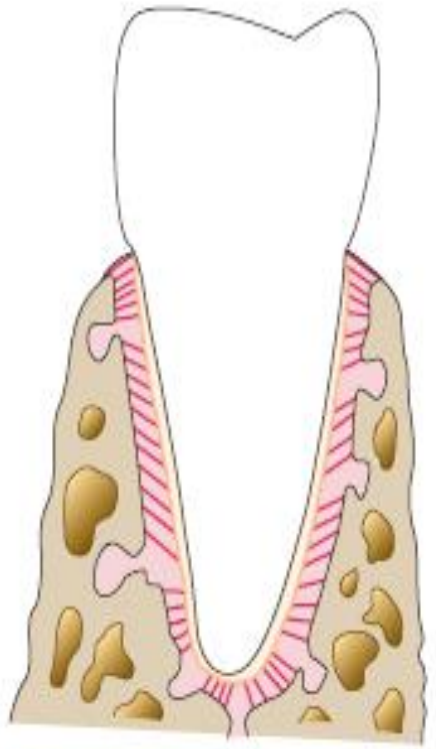
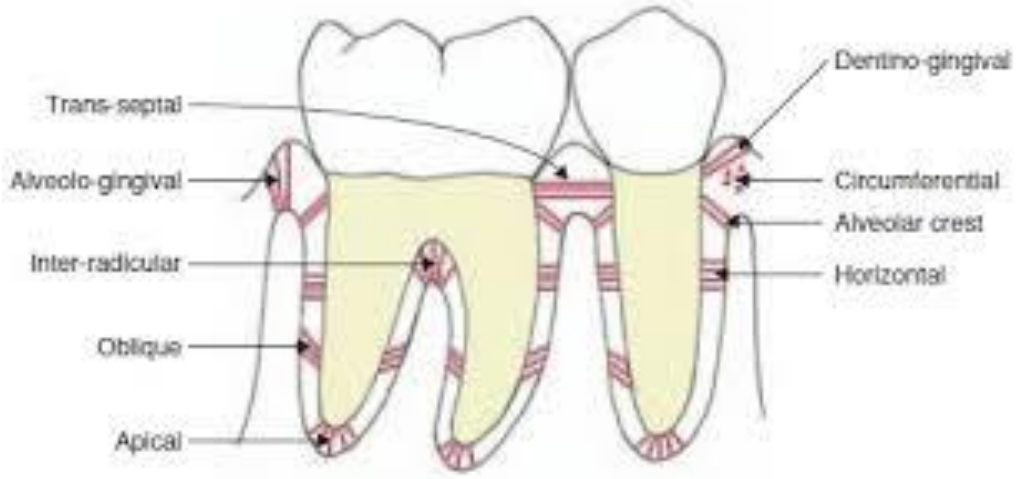


Fig. 3.34 Diagram of the principal fiber groups.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 34-35

- *Transseptal fibers* extend interproximally over the alveolar bone crest and are embedded in the cementum of adjacent teeth.

- They are reconstructed even after destruction of the alveolar bone that results from periodontal disease.



Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 34-35

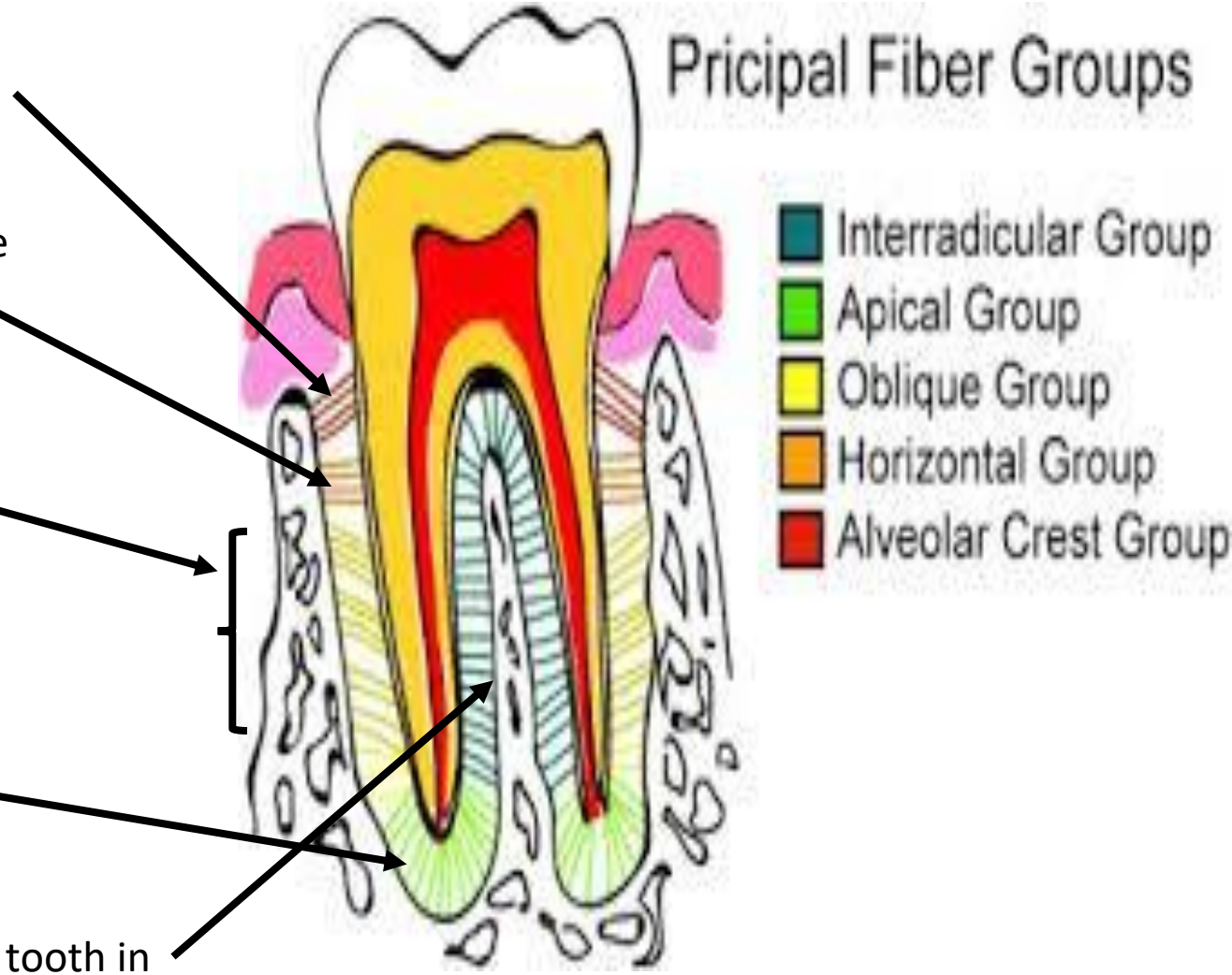
Alveolar crest fibers extend obliquely from the cementum just beneath the junctional epithelium to the alveolar crest.
Function - prevent the extrusion of the tooth and resist lateral tooth movements.

Horizontal fibers extend at right angles to the long axis of the tooth from the cementum to the alveolar bone.

Oblique fibers, which constitute the largest group in the periodontal ligament, extend from the cementum in a coronal direction obliquely to the bone.
Function - They bear the brunt of vertical masticatory stresses and transform such stresses into tension on the alveolar bone.

The ***apical fibers*** radiate in a rather irregular manner from the cementum to the bone at the apical region of the socket. They do not occur on incompletely formed roots.

The ***interradicular fibers*** fan out from the cementum to the tooth in the furcation areas of multirooted teeth.



Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 34-35

Other fibers

- Although the periodontal ligament does not contain mature elastin, two immature forms are found: **oxytalan and elaunin**.
- The principal fibers are remodeled by the periodontal ligament cells to adapt to physiologic needs and in response to different stimuli.
- In addition to these fiber types, small collagen fibers associated with the larger principal collagen fibers - run in all directions and form a plexus called the *indifferent fiber plexus.*

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 34-35

CELLULAR ELEMENTS

- Various types of cells have been identified in the periodontal ligament:
- **connective tissue cells - Synthetic cells**
  - Fibroblasts
  - Osteoblasts
  - Cementoblasts
- **immune system cells - Defense cells**
  - Mast cells
  - Macrophages
  - Eosinophils

- **Resorptive cells**
  - Osteoclasts
  - Fibroblasts
  - Cementoclasts

- **epithelial rest cells**
- **Undifferentiated mesenchymal cells - Progenitor cells**
- **Cells associated with neurovascular elements**.

Newman and Carranza's clinical periodontology – 14th edition; chapter 3 – Anatomy, structure and function of the periodontium; page 35

Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 178

- Fibroblasts are the most common cells in the periodontal ligament; they appear as ovoid or elongated cells oriented along the principal fibers, and they exhibit pseudopodia-like processes.
- These cells synthesize collagen and possess the capacity to phagocytose “old” collagen fibers and degrade them via enzyme hydrolysis

Newman and Carranza’s clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 35

- **Osteoblasts, cementoblasts, osteoclasts, and odontoclasts** are also seen in the cemental and osseous surfaces of the periodontal ligament.
- The ***epithelial rests of Malassez*** appear as either isolated clusters of cells or interlacing strands.
- The epithelial rests are considered **remnants of the Hertwig root sheath**, which disintegrates during root development.
- They diminish in number with age.
- Although their functional properties are still considered to be unclear, epithelial rests **proliferate when stimulated**,and they participate in the formation of **periapical cysts and lateral root cysts**.
- The ***defense cells*** in the periodontal ligament include neutrophils, lymphocytes, macrophages, mast cells, and eosinophils.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 35

GROUND SUBSTANCE

- A large proportion of ground substance that fills the spaces between fibers and cells.
- consists of two main components:

➢ *glycosaminoglycans,* such as hyaluronic acid and proteoglycans, and

➢ *glycoproteins,* such as fibronectin and laminin.

➢ high water content (i.e., 70%).

- Calcified masses called *cementicles,* which are adherent to or detached from the root surfaces.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 35 -36

- the ground substance is a gel-like matrix present in every nook and cranny, including the interstices between fibers and between fibrils.
- Its integrity is essential, if the cells of the ligament have to function properly
- All components of the ground substance are presumed to be secreted by fibroblasts.

Newman and Carranza's clinical periodontology – 14th edition;
chapter 3 – Anatomy, structure and function of the periodontium; page 35-36

BLOOD SUPPLY

- Abundant and rich vasculature.
- *Arterial supply.*

the **inferior and the superior alveolar arteries to the mandible and maxilla** respectively reach the PDL from three sources:

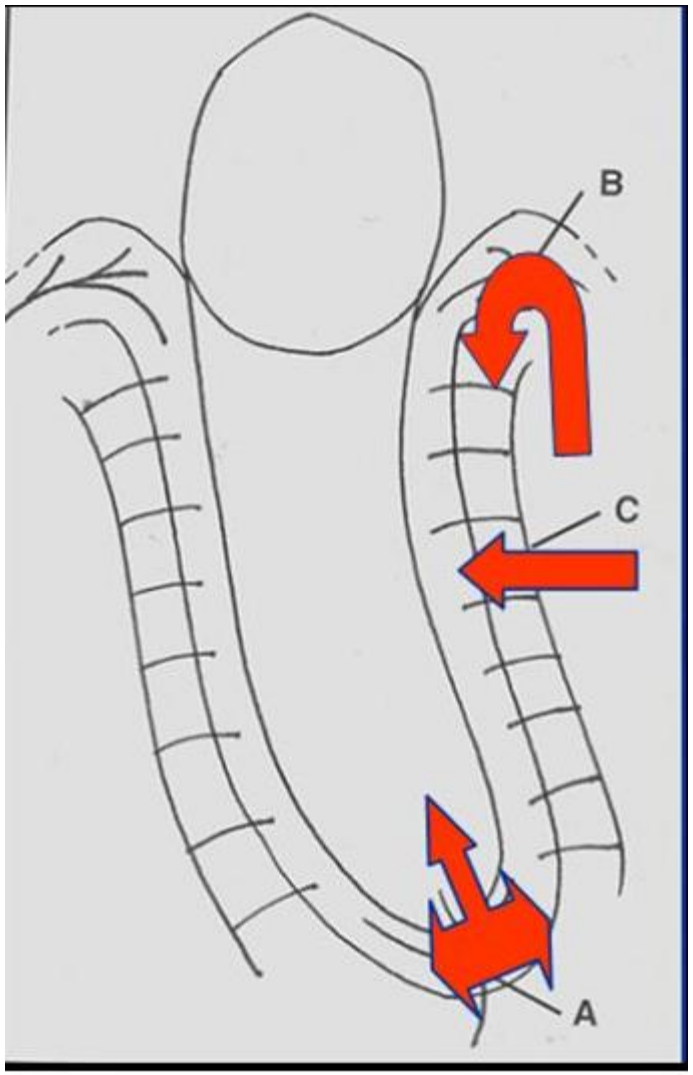
1. Branches in the periodontal ligament from **apical vessels** that supply the dental pulp.

2. Branches from **intra-alveolar vessels**. These branches run horizontally, penetrating the alveolar bone to enter the periodontal ligament.

3. Branches from **gingival vessels**. These enter the periodontal ligament from the coronal direction.

- *Venous drainage.*

The venous channels accompanying their arterial counterparts.



Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 194

Lymphatic drainage

- The lymph from the periodontal tissues drains into the lymph nodes of head and neck.
- The submental nodes
- The submandibular lymph
- The jugulodigastric lymph nodes.
- The deep cervical lymph nodes.

Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 195

- **Nerves**
- The PDL has functionally two types of nerve fibers:

sensory and autonomic.

The sensory fibers are associated with touch, pressure, pain and proprioceptive sensations.

The autonomic fibers are associated with PDL vessels.

Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 195-196

UNIQUE FEATURES OF PERIODONTAL LIGAMENT

- it has cells that form and resorb cementum and bone
- the collagen fibers in a specific orientation connecting the two mineralized tissues makes it unique.

Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 199-200

CLINICAL CONSIDERATIONS

- practice of restorative dentistry
- Occlusal trauma
- Orthodontic tooth movement
- Periapical granuloma, may contain epithelial cells that undergo proliferation and produce a cyst
- chronic inflammatory periodontal disease.
- surgical techniques like guided tissue regeneration are being used for correction of PDL destruction

Orban's oral histology and embryology; 13th edition; chapter 8 – periodontal ligament, page 200-201

END OF PART 1

THANK YOU