

*Histology of dental pulp* [1]

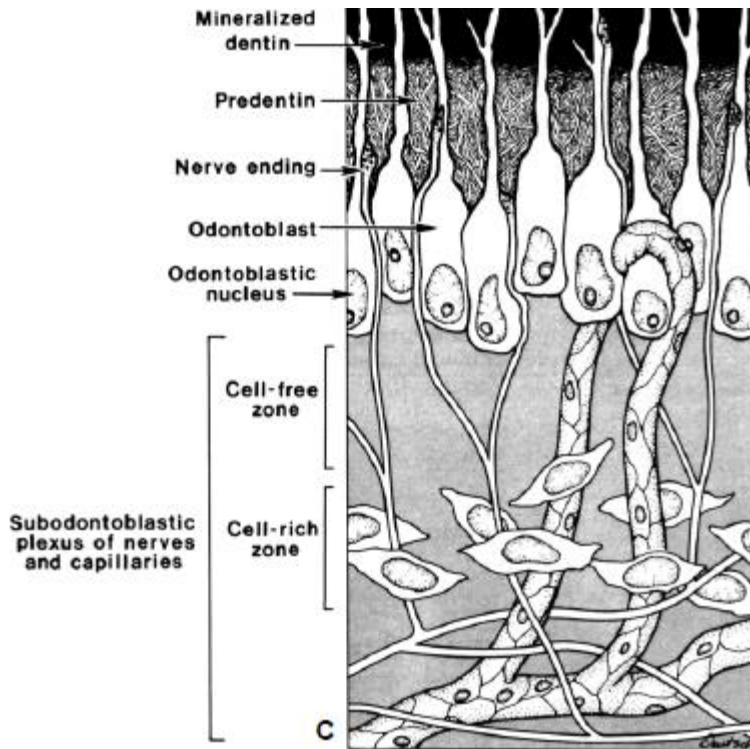
Dental pulp occupies the pulp cavity and it is a viscous connective tissue of collagen fibers and ground substance supporting the vital cellular, vascular and nerve structure of the tooth.

The pulp organ is divided into:

- 1- **Coronal pulp:** it is located in the pulp chamber in the crown portion of the tooth, including the pulp horns.
- 2- **Radicular pulp:** It is located in the pulp canals in the root portion of the tooth; the radicular pulp is continuous with the periapical tissue by connecting through the apical foramen.

**Pulp histology:**

- 1- **Odontoblastic zone:** odontoblastic cells lie at the periphery of the pulp.
- 2- **Cell-free zone:** It is a space which was previously occupied by odontoblasts which have moved during tooth development.
- 3- **Cell-rich zone:** They are mainly fibroblast cells and undifferentiated mesenchymal cells.
- 4- **Pulp core:** It is the central region of the pulp, contains the large nerves and blood vessels.



## Structure of the pulp

### I- Cells

**1- Undifferentiated mesenchymal cells:** They have the capability of differentiation upon demand into most of the mature cell types.

**2- Fibroblasts:** Most of the cells of the pulp are fibroblast, derived from mesenchymal cells and responsible for the production of collagen fibers and pulp matrix.

**3- Defense cells:** that include

a- **Histiocytes and Macrophages:** Undifferentiated mesenchymal cells around blood vessels can differentiate into fixed or wandering histiocytes (macrophages), these cells are highly phagocytic and can remove bacteria, foreign bodies, dead cells or their debris.

b- **Polymorphonuclear leukocytes:** They are major cell type in microabscess formation and are very effective at destroying and phagocytizing bacteria or dead cells.

c- **Lymphocytes and plasma cells:** These inflammatory cell types. These cells are not normally present in the healthy pulp. Their presence would indicate the presence of a persistent irritant.

d- **Mast cells:** They are seldom found in normal pulp, these cells are near blood vessels releases histamine which increases vessel permeability, allowing fluid and leukocytes to escape.

**4-Odontoblasts:** The principal cell of the dentin-forming layer, arise from mesenchymal cells. It lines the predentin border. The layer is about 6-8 cells in depth. Each odontoblastic process occupies canaliculi in the dentinal matrix. The odontoblastic processes are called Toms fiber. When dentin is injured, the arrangement and continuity of the odontoblast cells are altered and initiate a reaction within the pulp.

In the mature tooth, the odontoblasts form dentin in response to injury, particularly when the original dentin thickness has been reduced by caries, attrition, trauma, or restorative procedures. Dentin can also be formed at sites where its continuity has been lost, such as at a site of pulp exposure. Dentin formation occurs in this situation through the induction, differentiation, and migration of new odontoblasts or odontoblast-like cells to the exposure site

### II- Intercellular matrix (fibrous matrix)

a- **Fibers:** mainly collagen fibers and there are no elastic fibers except in the walls of blood vessels.

The greatest concentration of collagen generally occurs in the most apical portion of the pulp. —Significance: — During pulpectomy; engaging the pulp with a barbed broach in the region of apex affords a better opportunity to remove the tissue intact.

b- Ground substance: It is dense and gel like which acts as a medium to transport nutrients to cells and metabolites of cells to the blood vessels and composed of acid mucopolysaccharides, protein polysaccharides, and water.

**III- Blood vessels:** The communication between the pulp and the periodontium is through the apical foramen and the accessory canals. Blood flow is more rapid in the pulp than in the most area of the body and the blood pressure is quite high. The walls of pulpal vessels become very thin as they enter the pulp.

**IV- Lymph vessels:** The anterior teeth drainage passes to the submental lymph nodes. The posterior teeth drainage passes to the submandibular and deep cervical lymph nodes.

**Nerves:** They follow the distribution of blood vessels and most of the nerves are myelinated, but there are also unmyelinated. The Unmyelinated C fibers are True nociceptive fibers that Pain-conducting fibers that respond to stimuli capable of injuring tissue Remain excitable even in necrotic tissue (last tissue to die). The peripheral axons form a network of nerves located adjacent to the cell rich zone and this is termed parietal layer of nerves and also known as plexus of raschkow.

A small number of axons pass between the odontoblast cell bodies to enter the dentinal tubules in proximity to the odontoblast process

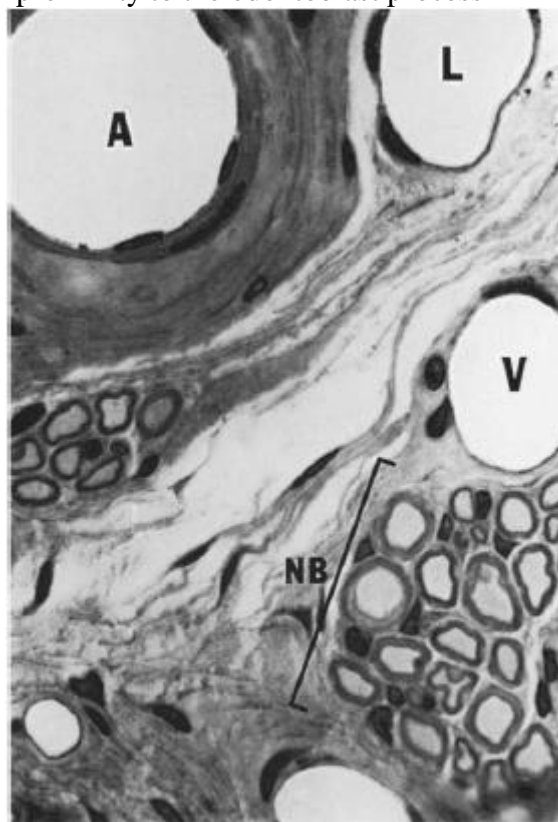


Figure 2-11 Cross-section from the central pulp showing major support systems, including arterioles (A) with a muscular wall, thin-walled lymphatics (L), venules (V), and nerve bundles (NB) containing myelinated and unmyelinated nerves. Reproduced with permission from [unclear].

The sensory response in the pulp cannot differentiate between heat, touch, pressure or chemicals; this is because the pulp organ lacks those types of receptors that distinguish these other stimuli.

### **Age changes of pulp[2]:**

- 1- Continuous formation of secondary dentin through life, thus gradually reducing the size of the pulp chamber and root canals that make the location of root canal orifice difficult to obtain.
- 2- There is a gradual decrease in the cellularity and increase in number and thickness of collagen fibers, particularly in the radicular pulp.
- 3- There is a progressive reduction in the number of nerves and blood vessels.
- 4- The odontoblasts decrease in number and size and may disappear in a certain area of the pulp particularly on the pulp floor over the bifurcation areas of multirooted teeth.
- 5- The appearance of calcium deposit known as pulp stone.

### **The function of pulp[2]:**

- 1-The induction of dental lamina and enamel organ formation.
- 2- The formation of dentin through odontoblast cells.  
The primary function of the pulp is formative; it gives rise to odontoblasts that not only form dentin but also interact with dental epithelium early in tooth development to initiate the formation of enamel
- 3-Nutrition of dentin due to the presence of blood vessels.
- 4-Protection of dentin due to the presence of sensory nerves fibers that respond to pain with all stimuli.
- 5-Defensive or reparative by the production of reparative dentin.

**\*Pulp stones (denticles):** They are calcified structures which are found frequently within the pulp of healthy, diseased, unerupted or impacted teeth, although their incidence increase with age.

**Pulp irritation:** Pulp irritation is classified according to the type of irritant into:

**1- Bacterial irritants:** Bacteria can reach the pulp and cause irritation through dental caries, through periodontal disease by lateral canals or by an infection which could occur by systemic disease as tuberculosis, leprosy, actinomycosis.....

**2- Physical irritants:** Which may include

**A- Thermal insult:** Heat generated by grinding procedures of tooth structure as the greatest single cause of pulp damage during cavity preparation or polishing. The inevitable inflammation following cavity preparation ranges

from reversible to irreversible pulpitis. The rise in temperature of pulp depends on several factors:

i- The depth of preparation: The deeper the cavity, the more damage to the pulp will occur. Occasionally during cavity preparation (full crown), the dentin is seen to suddenly blush due to increase in pulpal pressure that caused rupture of pulp vessels and the erythrocytes reach to dentinal tubules, but this condition may disappear with time.

ii- The speed of the bur: The more the speed of rotation, the more damage especially if there is no water coolant.

iii- The size, shape and the composition of bur: Thermal damage with steel bur is greater than carbide bur; also the larger burs give more damage than smaller burs.

iv- The amount of pressure applied: It is inversely proportional to pulp damage.

v- Type of tissue being cut whether it is enamel or dentin.

**B- Dehydration:** Constant drying with warm air during cavity preparation under rubber dam may contribute to pulp inflammation and possible necrosis.

**C- Orthodontic tooth movement:** Pulp can be devitalized during orthodontic tooth movement. Also, hemorrhage can occur and the blood vessels in periodontal ligaments may rupture and lead to loss of nutritional supply to a pulp.

**D- Tooth fracture:** This may occur by direct trauma to the tooth causing fracture of cusps or incisal edge, or indirectly by abrasion, attrition, abrasion...

**E- Pin insertion:** The insertion of pins introducing the hazards of tooth fracture, pulp exposure or perforation through the periodontal ligament.

**F-Laser Burn:** Laser beams are sometimes used to weld dental materials intraorally, particularly gold and nickel-chromium alloys. Ruby laser radiation has been shown to be most damaging to the pulp.

**3- Irradiation effect:** It occurs in patients who are exposed to radiation of oral cavity and neck for treatment of malignant disease. In time the odontoblasts and the cells undergo death and pulp become necrotic. The salivary glands are affected leading to decrease in salivary flow. The teeth with necrotic pulp should be treated endodontically, because extracting teeth may lead to necrosis of the involved bone.

**4- Chemical irritation:** The pulp is subjected to chemical irritation from:

i- Various filling materials that produce some chemical toxicity, acidity and absorption of water during setting. For example, in deep cavities, no irritating material should be placed like zinc oxide eugenol.

\* **Zinc oxide eugenol ZOE:** In order to determine the toxic effect of eugenol, scientists have found that eugenol could pass the dentin barrier and the thicker the remaining dentin, the less is the toxic effect of eugenol.

\***Cavit** (Premier Dental; Norristown, Pa.), the resin-reinforced, ZOE temporary cement used extensively in pulpless teeth, enjoys less favor in temporizing vital teeth because of the pulpal discomfort that ensues. When Cavit is placed against dentin covering a vital pulp, it causes desiccation. Although Cavit, like ZOE, is hygroscopic, it has a six-fold greater water absorption value than ZOE. The pain on insertion undoubtedly arises from fluid displacement in the dentin tubule. Therefore, Cavit should always be placed in a moist cavity.

ii-Local anesthesia contains vasoconstrictor that may cause a reduction in blood flow and could lead to concentration of irritants accumulating within the pulp.

iii-Various medicaments used for desensitization or dehydration of dentin-like Alcohol, Ether.

iv- Low pH drinks.

v- Fumes of acids which are deleterious to the teeth.

#### REFERENCES

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2. Torabinejad, M., R.E. Walton, and A. Fouad, *Endodontics-e-book: Principles and practice*. 2015: Elsevier Health Sciences.