

DEPARTMENT OF ORAL AND
MAXILLOFACIAL PATHOLOGY & ORAL
MICROBIOLOGY

PULP

ANATOMY

General feature

Pulp of maxillary teeth

Pulp of mandibular teeth

Coronal pulp

Radicular pulp

Apical foramen

Accessory canal

STRUCTURAL FEATURE

Intercellular substances

Fibroblast

Fibers

Undifferentiated mesenchymal cells

Odontoblasts

Defense cells

Blood vessels

Lymph vessels

Nerves

Nerve endings

FUNCTION

Inductive

Formative

Nutritive

Protective

Defensive or reparative

PRIMARY AND PERMANENT PULP ORGAN

REGRESSIVE CHANGES

Cell changes

Fibrosis

Pulp stones or denticles

Diffuse calcification

DEVELOPMENT

CLINICAL CONSIDERATION

Introduction

Dental pulp is soft connective tissue located centrally of each tooth.

General feature:

Total of 52 pulp organ in each person.

32 in permanent teeth

20 in deciduous teeth

Shape of organ is conform to that of respective of tooth.

Total volume of permanent teeth pulp organ is 0.38 cc.



Pulp organ of permanent teeth

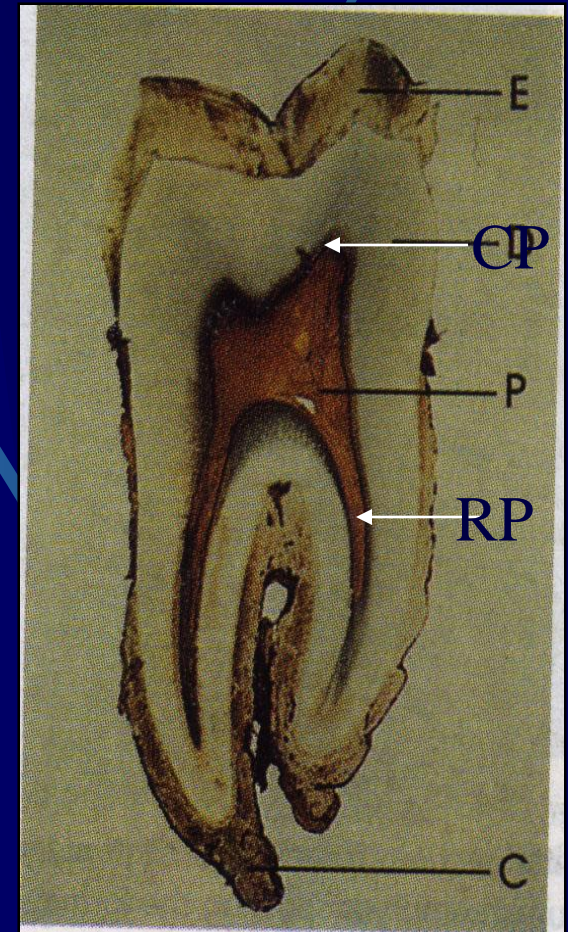
Pulp is divided in two parts.

1. Coronal pulp.

- Located centrally in the crown of tooth.
- Resembles the shape of outer surface of the crown of dentin.
- Six surface: -
 - Occlusal, mesial, floor, distal, buccal, lingual.
- It has a pulp horn, which are protrusion that extended into the cusp of each tooth, their number depends on cuspal number.

2. Radicular pulp

- Extending from cervical region of the crown to the root apex.
- Anterior teeth.- It is single.
- Posterior teeth.- It is multiple.
- Vary in size, shape and number.
- Continuous with periapical connective tissue, through apical foramen.



Apical foramen:-

Location – at the apex of root, but it may be undergo changes

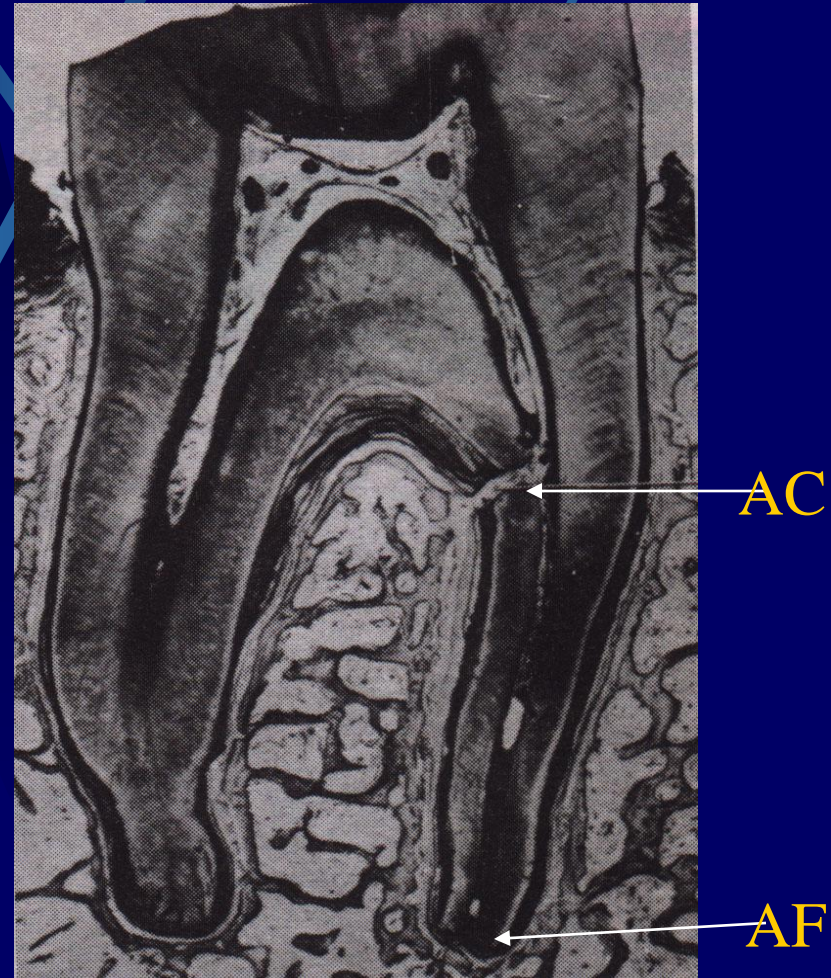
**Size - maxillary teeth in dultaverage
- 0.4 mm**

**Mandibular teeth in adult
average -0.3mm**

Accesory canals:-

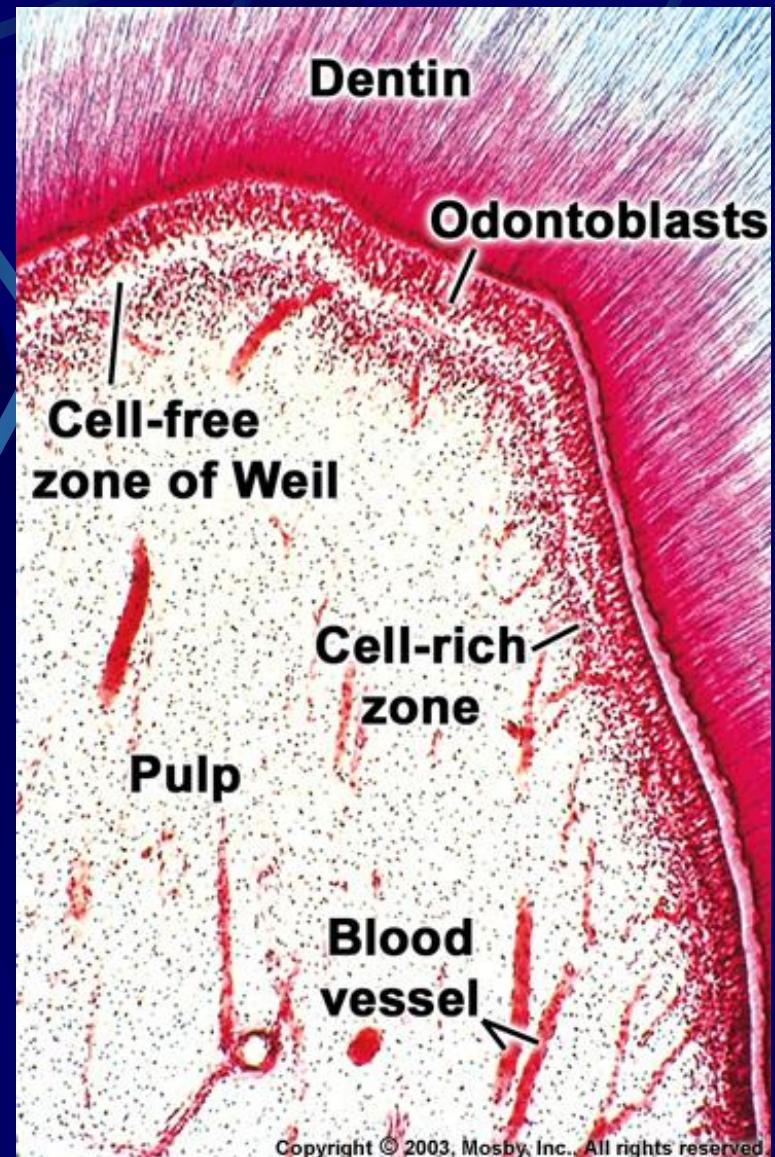
It leading from the radicular pulp laterally through root dentin to the periodontal tissue,

May be seen anywhere along the root but are particularly numerous in the apical third of the root.



STRUCTURAL FEATURE

- Centrally pulp contain large nerve trunks and blood vessels.
- Peripherally it circumscribed by the specialized odontogenic region, composed of
 - 1.The odontoblast – dentin forming cells
 - 2.The free zone (weils zone) in which odontoblast may move pulp ward during the tooth development
 - 3.The cell rich zone :- contain fibroblast and undifferentiated mesenchymal cells.



Intercellular substance

Dence gellike in nature caries in appearance from finelu granular to fibrillar.

Composed of both polysacharides and protein polysacharides (glycosaminoglycans and proteoglycans)

- During early development, chondroitin A, chondroitin B and hyaluronic has been demonstrated.

Function :- support to the cells of pulp

Transport of nutrients and metabolites product.

Fibroblast :-

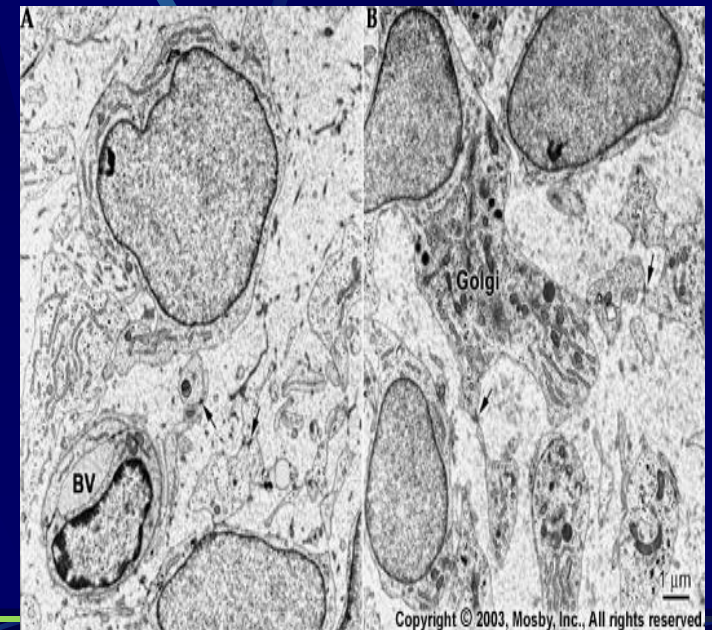
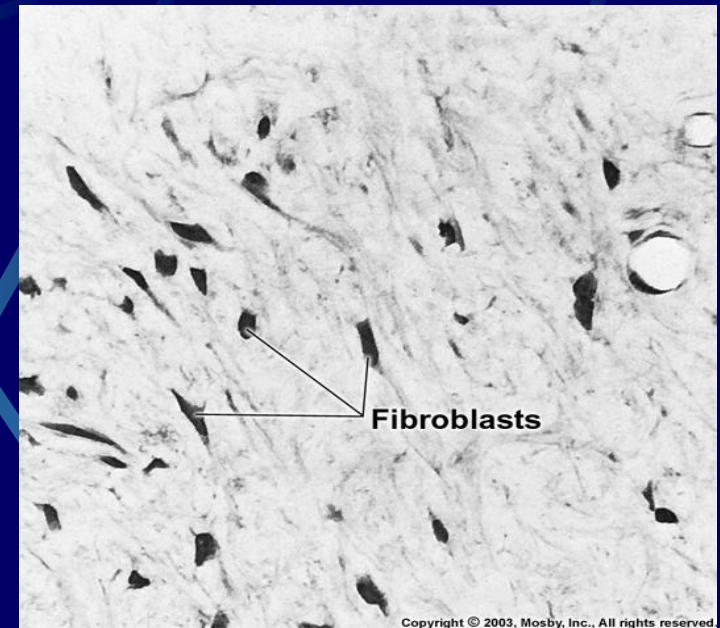
- Most numerous cell type in pulp

Shape – typical stellate with extensive processes, nuclei stain deeply with basic dyes, cytoplasm is lighter stained and homogeneous.

- Their appearances depend on age. In young pulp cells are divide and active in protein synthesis but in older pulp they are rounded or spindle shaped with short processes termed fibrocytes

Function – collagen fiber formation

- synthesis and degradation of same cell.



Fibers :-

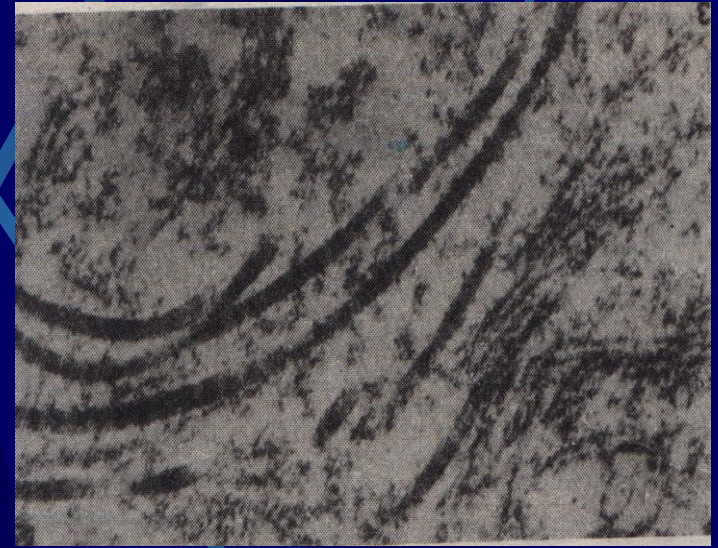
➤ Exhibit typical cross striation at 64nm

Length – 10 to 100 nm or more

Diameters – 10 to 12 nm

➤ May scattered throughout the coronal pulp (diffuse collagen) or may appear in bundles in radicular pulp (bundles collagen)

➤ Their significance is known.



Collagen fibers

Undifferentiated mesenchymal cells

➤ Primary cell in very young pulp.

➤ Decreases after root completion.

Shape :- polyhedral with peripheral processes and large oval staining nuclei

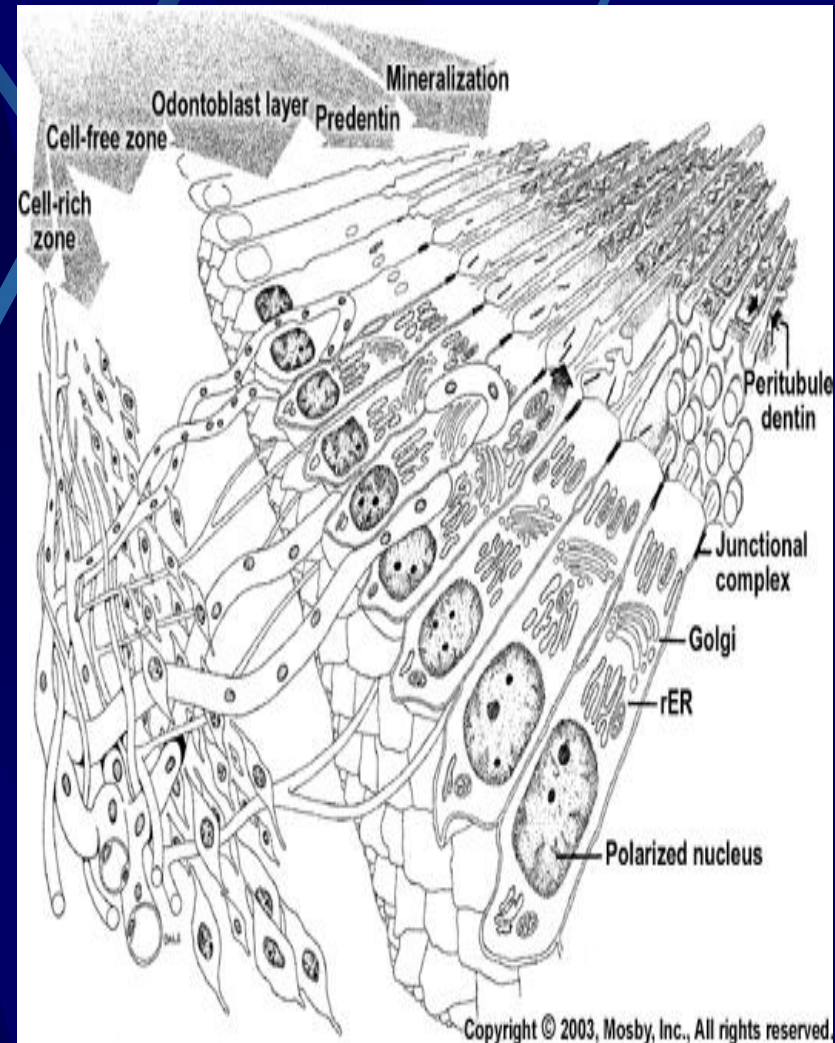
Function :- Totipotent cell

- When need arises they may become odontoblast, fibroblast and macrophage

Odontoblast

Second most predominant cell in pulp

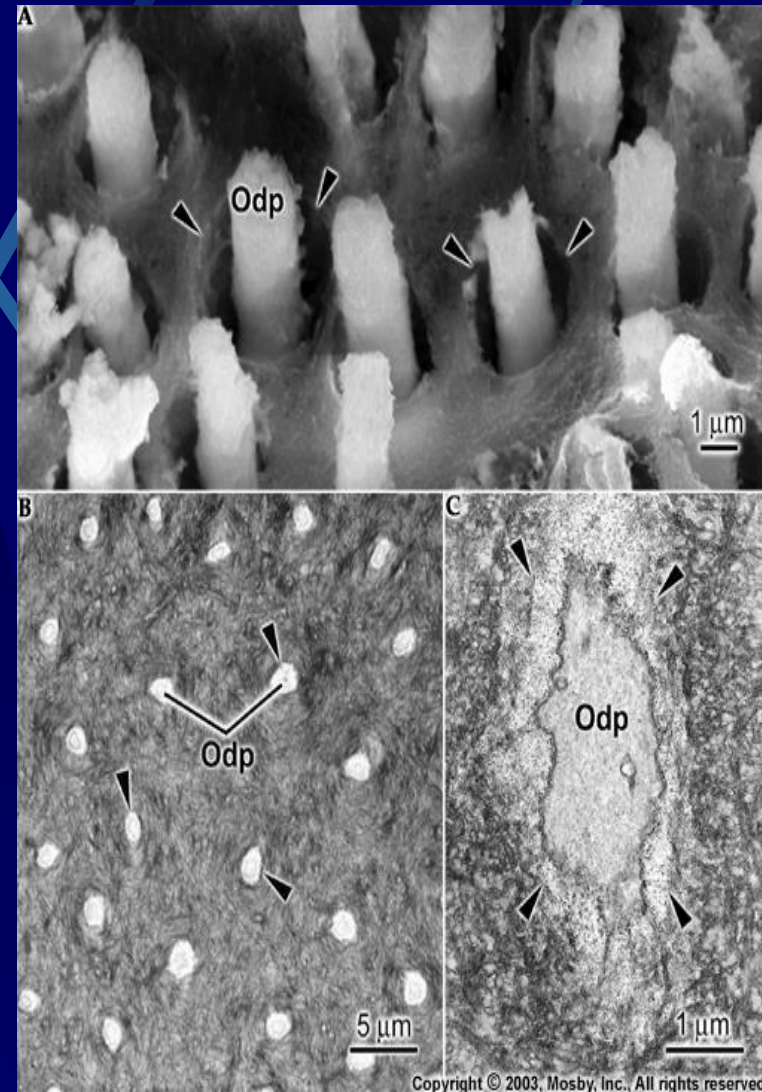
- *Length* :-25 to 40 micrometer
- *location* :- Adjacent to predentin with cell bodies in the pulp (odontogenic zone) and cell processes in the dentinal tubules.
- they very lie close to each other in the row and plasma membrane of adjacent cells exhibit junctional complexes.



Shape :- Cell body tall columnar in the crown and the cuboidal in the middle of the root. Cell bodies has larger oval nuclei which fill the basal part of the cell adjacent to the nucleus basally is rough surface endoplasmic raticulum and golgi apparatus.

➤ Near the pulp pre detention junction the cell cytoplasm is devoid of organelles.

➤ Clear terminal part of the cell body and adjacent intercellular junction is termed as terminal bar apparatus of the odontoblast. At this zone cell constricted about 3 to 6 micrometer diameter where the cell process enter pre dentin.



Copyright © 2003, Mosby, Inc., All rights reserved.

Defense cell

1. histiocytes or macrophages

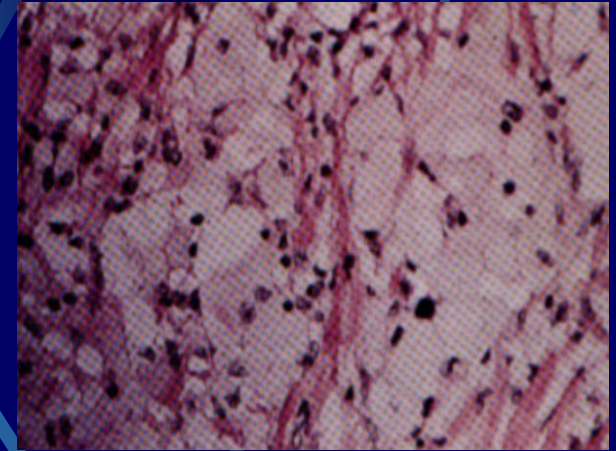
shape :- irregular with short blunt processes

nucleus :- smaller, more rounded, and darker stain than fibroblast.

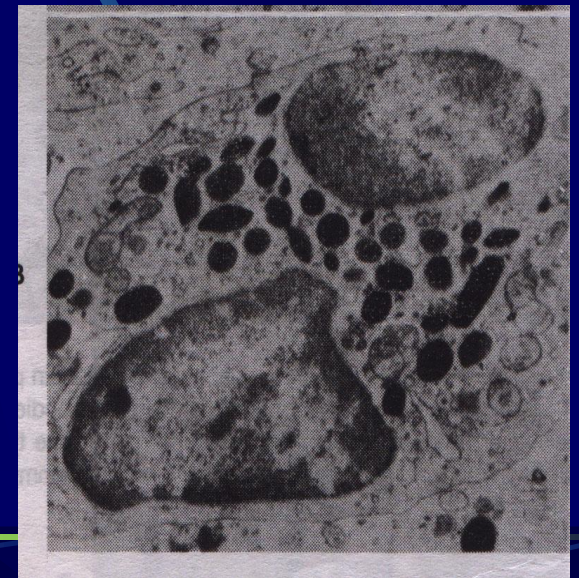
➤ Cytoplasm is granular and during pulpal inflammation cytoplasm exhibit granules and vacuoles, nuclei increase in size and a prominent nucleolus.

2 .Lymphocytes and eosinophils

➤ Found extravascularly in the normal pulp, but during inflammation they increases in number.



Macrophages



Eosinophils

3. Mast cells :-

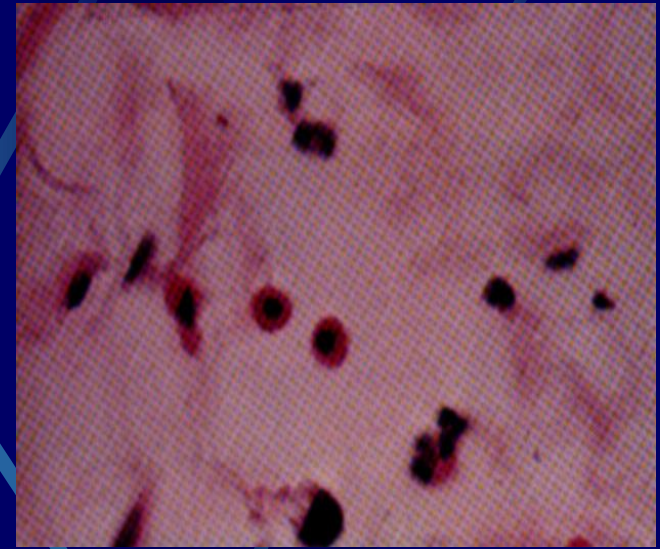
- Seen along vessels in inflamed pulp
- Nucleus round
- Cytoplasm – contain many dark staining granules which is increases during inflammation

4. Plasma cell :-

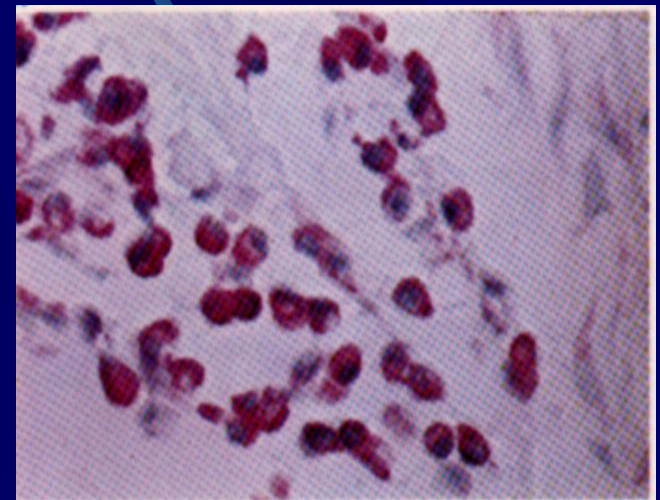
- Seen during inflammation
- Small nucleus
- Cytoplasm is concentric and contain light stained golgi zone, densely packed rough surface endoplasmic reticulum.
- Both mature and immature cells may be found

function :- Production of anti bodies

In addition there are the blood vascular element such as the eosinophils, basophils, lymphocytes and monocytes are also present in pulp.



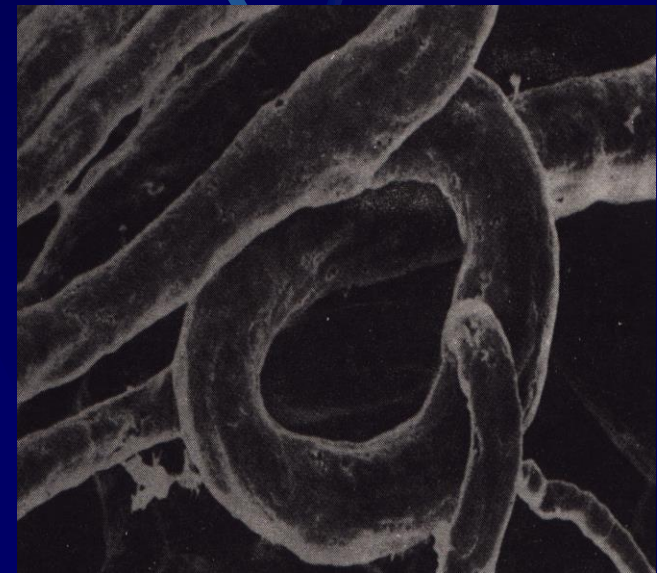
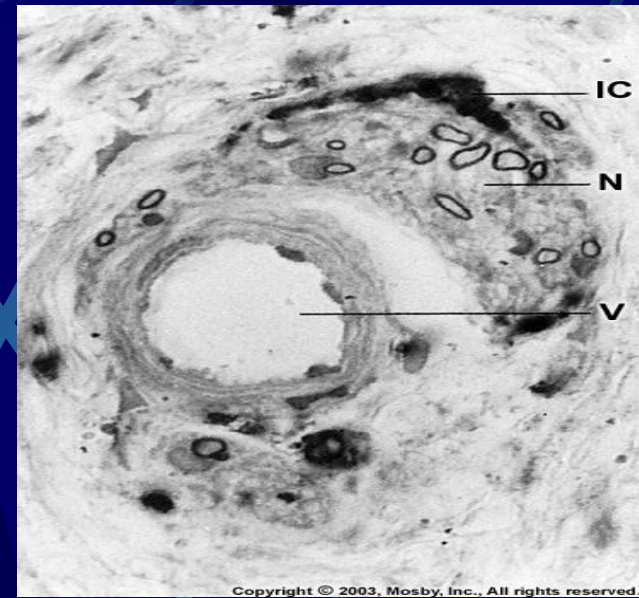
Mast cell



Plasma cell

Blood vessels

- Pulp organ is extensively vascularised.
- B.V. of both pulp and periodontium arise from the inferior or superior alveolar artery.
- B.V. in the pulp are different in structure. As the vessels enter the tooth their walls become considerably thinner than those surrounding the tooth.
- Small arteries and arterioles enter the apical canals and pursue a direct route to the coronal pulp. Along their course they give off numerous branches in the radicular pulp that pass peripherally to form a plexus in the odontogenic region
- Pulp blood flow is more rapid than in most areas of the body.



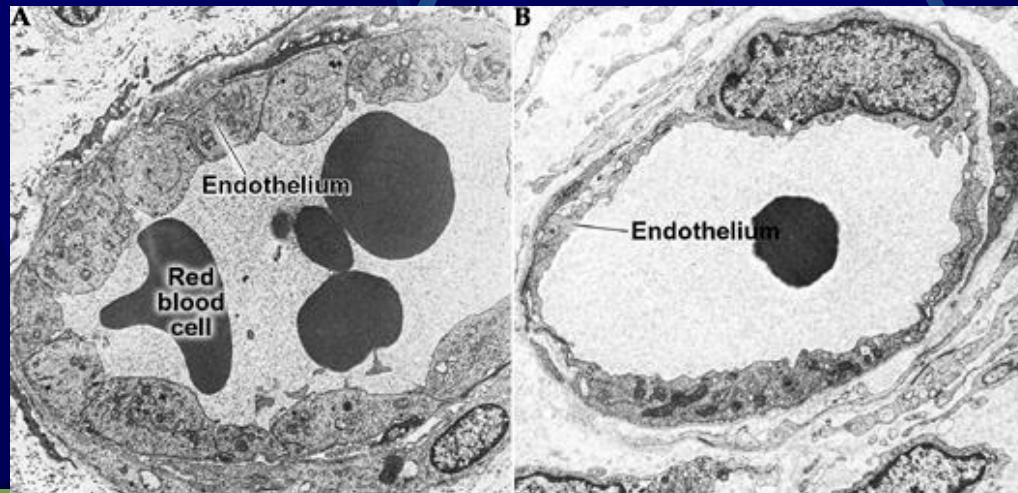
Artery loop in pulp

The largest arteries in the human pulp are 50 to 100 micrometer in diameter. These has three layers.

1. Tunica intima – consists of squamous or cuboidal endothelial cells-surrounded by closely associated basal lamina.

2. Tunica media - one or three layer of smooth muscles cells.

3. Tunica adventitia - made up of few collagen fibers.



Copyright © 2003, Mosby, Inc., All rights reserved.

structure of artery

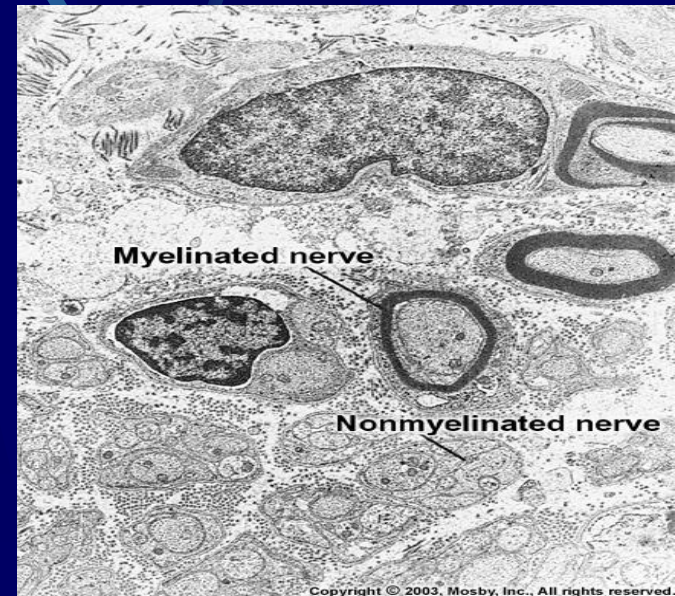
- **Arterioles with diameter of 20 to 30 micrometer with one or two layers of smooth muscle cells are common throughout coronal pulp.**
- **Terminal arterioles with diameter of 10 to 15 micrometer appear peripherally of the pulp.**
- **Veins and venules that are larger than the arteries and appear in central region of root pulp. 100 to 150 micrometer in diameter.**
- **Both venous - venous anastomosis and arteriole -venous anastomosis occur in the pulp.**
- **Blood capillaries, appear as endothelined tubes, 8 to 10 micrometer in diameter**

Lymph vessels

- **The presence of lymph vessels in the dental pulp is questioned by some and - agreed upon by other investigator.**
- **Lymph vessels are described as endothelium lined tubes that join thin walled lymph vessels or veins in the central pulp .**
- **Lymph vessels described pulp and periodontal ligament have common outlet**
- **Ant. Teeth – sub mental lymphnode**
Post. Teeth - submandibular and deep cervical lymph nodes

Nerves

- Thick nerve bundle enter through apical foramen rd coronal pulp where their fibers separate and radiated peripherally to the odontogenic zone.
- Number of fiber in bundles 150 to more than 1200.
- 5 to 13 micrometer in diameter.
- Majority of nerves are non myelinated many of these gain a myelin sheath later in life .Mostly they are sympathetic in nature. They have terminals on the muscles cell of vessels and function in vasoconstriction.



Large myelinate fibers mediate the sensation of pain that may be caused by external stimuli.

➤ The peripheral axon form network of nerve located adjacent to cell rich zone is termed parietal layer of nerve also known as plexus of rashkow. This layer develop gradually, becoming prominent when root formation is complete.



Plexus of rashkow

Nerve endings

- Nerve axon from the parietal zone pass through the cell rich and cell free zone either terminate among or pass between the odontoblast processes.
- Most of the nerve ending are believed to be receptors.
- More nerve fibers and endings are found in the pulp horns than in other peripheral areas of the coronal pulp.
- Recently some neurotransmitters are found in pulp such as substance p, 5 - hydroxytryptamine, vasoactive intestinal peptide, somatostatin and prostaglandins as well as acetylcholine and norepinephrine.
- This transmitters affect vascular tone and subsequently modify the excitability of the nerve endings .



Function

1. Inductive

Induce oral epithelium differentiation in to dental lamina and enamel organ formation.

Also induce the developing enamel organ to become particular type of tooth .

2. Formative

Pulp organ cells produces dentin that surround and protect pulp.

Pulpal odontoblasts develop the organic matrix and function in its calcification

3. Nutritive

Pulp nourishes the dentin through the odontoblast and their processes and by means of the blood vascular system of the pulp.

4. Protective

Sensory nerve in the tooth responds with pain to all stimuli such as heat, cold , pressure, operative cutting procedures and chemical agent.

5. Defensive or reparative

Pulp responds to irritation, whether mechanical and chemical, thermal or bacterial by producing reparative dentin and mineralizing any affected dentinal tubules.

- This reparative dentin are attempts to wall off the pulp from the source of irritation.
- Pulp has defense cells , which aid in the process of repair of the pulp.

PRIMARY AND PERMANENT PULP ORGAN

1. Primary pulp organ

- Function for a shorter period of time than do the permanent pulps. (about – 8.3 yrs .)
- This time is divided in to three periods.
 - I. Pulp organ growth (11.85 months)
 - crown and root are developing
 - II. Pulp maturation (45.3 months)
 - from root completion to root resorption begins.
 - III. Pulp regression (3 yrs.9 months)
 - from root resorption to exfoliation

2. Permanent pulp organ

- Period of development of permanent pulp organ might be longer than those of primary pulp organ
- Time during crown completing formation and calcification is average 5 yrs, 5 months
- Time from crown completion to tooth eruption is 3 yrs, 6 months
- Time from eruption to root completion is 3 yrs, 11 months
- Thus pulp of the permanent teeth undergoes development for about 12 yrs, 4 months .

REGRESSIVE CHANGES

1. Cell changes :-

- Cells are decreases in size and number of cytoplasmic organelles with aging.
- The fibroblast in aging pulp exhibit less perinuclear cytoplasm and possess long, thin cytoplasmic process.
- Intercellular organelles are reduced in size and number.

2. Fibrosis

- Accumulation of both diffuse fibrillar components and bundles of collagen seen in aging pulp.
- Increase fibers in the pulp organ is gradual and is generalized through out the organ.
- Any external trauma such as dental caries or deep restoration usually causes localized fibrosis or scarring effect
- Increase in collagen fibers may be more apparent than actual, being attributable to the decreases in the size of the pulp, which make the fibers present occupy less space, and hence they become more concentrated without increasing in total volume.

PULP STONE OR DENTICLES

- Pulp stone or denticles are nodular calcified masses appearing in either or both the coronal or root portion of the pulp organ.
- Pulp stone may eventually fill substantial parts of pulp chamber.

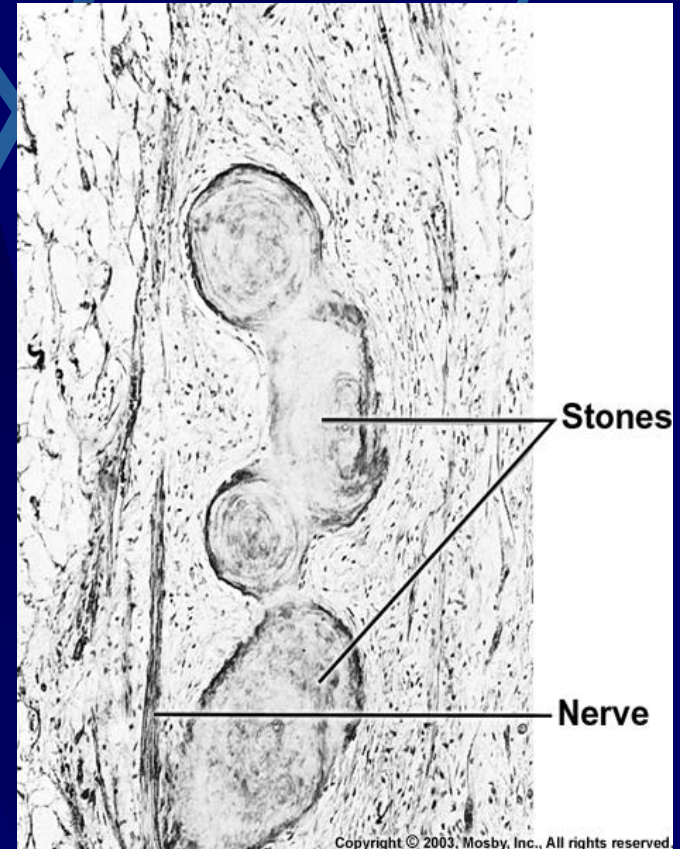
Type :-

According to their structure .

- True denticles
- False denticles
- Diffuse calcification

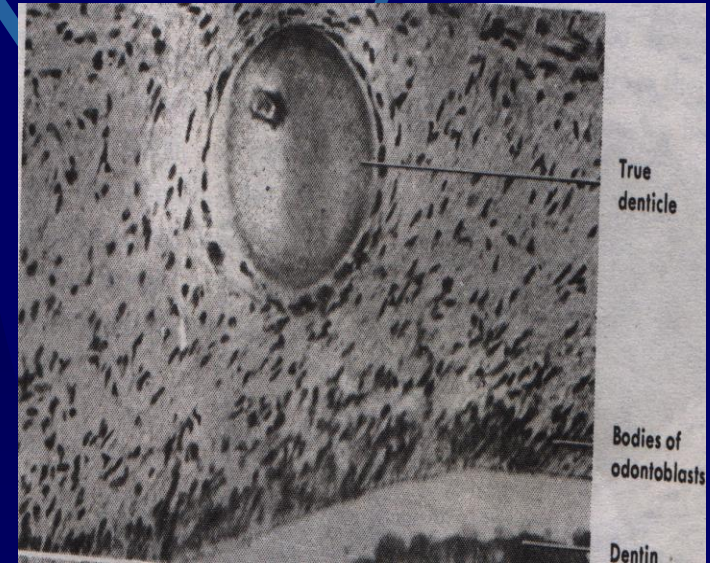
According to their location in pulp.

- Free denticles
- Attached denticles
- Embedded denticles



1. True denticles

- Structure similar to dentin, exhibit dental tubuli containing odontoblastic processes.
- Comparatively rare.
- Usually located close to apical foramen.
 - It is caused by the inclusion of remnants of epithelial root sheath within pulp. These remnants induce the cells of pulp to differentiate in to odontoblasts, which then form dentin masses called true pulp stone.



2. False denticles :-

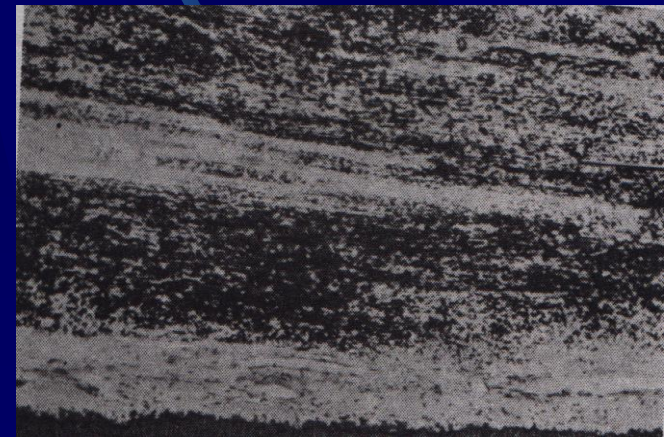
- It do not exhibit dentinal tubules but appear as concentric layers of calcified tissue.
- In the center of this concentric layer of calcified tissue there may be a remnant of necrotic and calcified cells.
- All denticles begins as small nodules but increase in size by incremental growth on their surface.



False denticles

3. Diffuse calcification :-

- It appear as irregular calcified deposits in the pulp tissue, usually following collagen fibers bundles on blood vessels.



Diffuse calcification

Free denticles

- Entirely surrounded by pulp tissue.

Attached denticles

- Partly fused with the dentin.

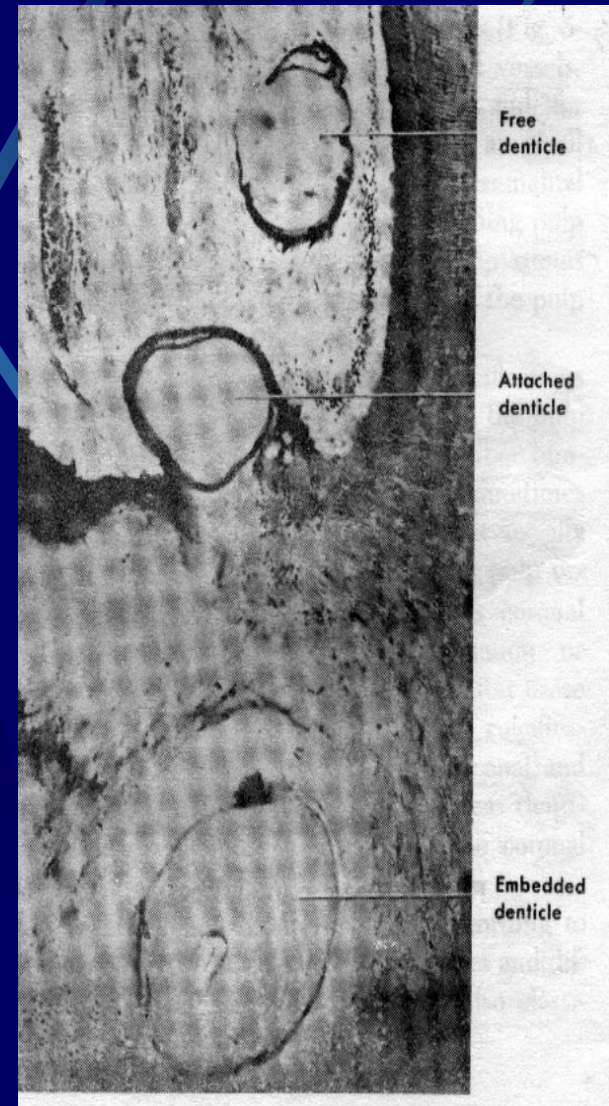
Embedded denticles

- Entirely surrounded by dentin.
- All are believed to be formed free in the pulp and later to become attached or embedded as dentin formation progresses.
- All pulp stone may appear close to B.V. and nerve trunks.
- Incidence as well as size increase with age.

10 to 30 yrs of age – 66 %

30 to 50 yrs of age – 80 %

50 yrs or more of age – 90 %



CLINICAL CONSIDERATION:

For all operative procedures the shape of the pulp chamber and its extension into the cusp, the pulp horns is important to remember.

- In young person pulp horn is high.
- In older person pulp horn is low.

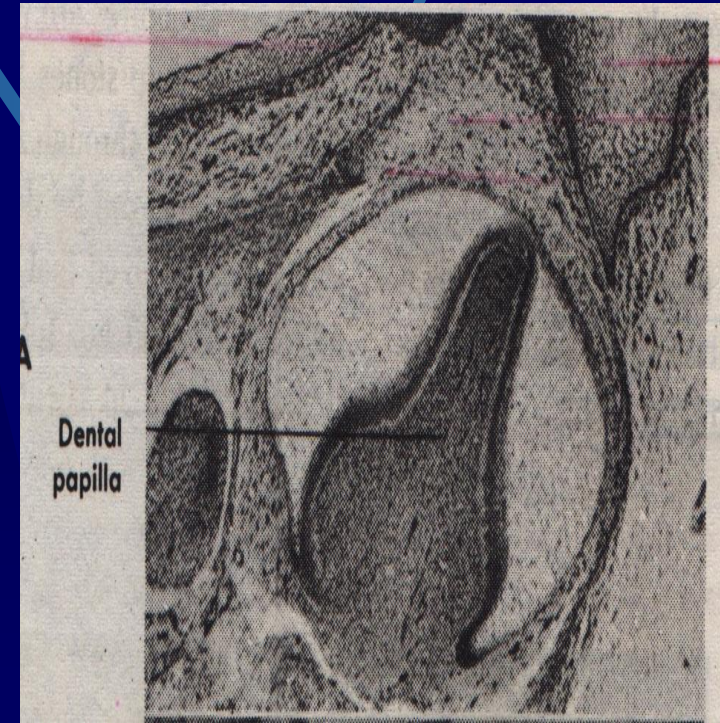
➤ Shape of the apical foramen and its location play an important part in root canal therapy.

➤ Accessory canals are rarely seen in x-ray. In any event it would be mechanically difficult or impossible to reach them.

- All operative procedure cause an initial response on pulp. Pulp is highly responsive to stimuli even a slight stimulus will cause inflammatory cell infiltration.
- when a filling a material containing harmful chemicals, an appropriate cavity liner should be used.
- A vital pulp is essential to good dentition. A non vital tooth become brittle is subject to fracture. there fore, every precaution should be taken to preserve the vitality of the pulp. Instrument called “vitalometer”, are used to check the vitality of the pulp.

DEVELOPMENT

- Tooth pulp is initially called a dental papilla. Dental papilla designated as "pulp" only after dentin forms around it.
- Under the organizing influence of the proliferating epithelium of enamel organ, the ectomesenchyme that is partially enclosed by the invaginated portion of the inner enamel epithelium proliferates. It condense to form the dental papilla, which is the formative organ of dentin and the premordium of the pulp.

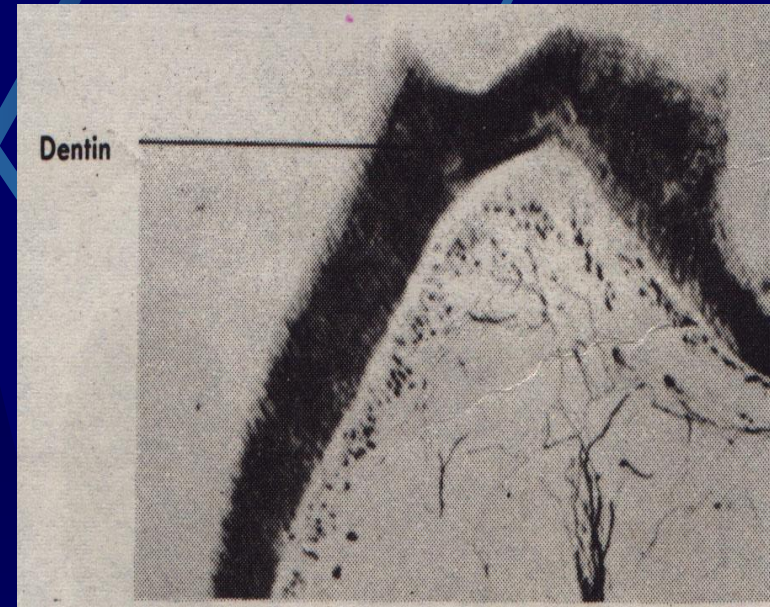


BELL STAGE

■ Change in the dental papilla occur concomitantly with development of the epithelium enamel organ.

■ In bell stage, the peripheral cells of the mesenchymal dental papilla differentiated in to odontoblast under the organizing influence of epithelium before the enamel epithelium begins to produce enamel.

- The dental papilla shows active budding of capillaries mitotic figures.
 - As the dentin production begins, the tissue is no longer called dental papilla, but it is now designated as pulp organ.
 - Few large myelinated nerve are found in the pulp until the dentin of the crown is well advanced. At that time nerve reach the odontogenic zone in the pulp horns.
 - Sympathetic nerve follow the blood vessels in to dental papilla as the pulp begin to organic



Young tooth stained with silver to demonstrate neural elements



THANK YOU