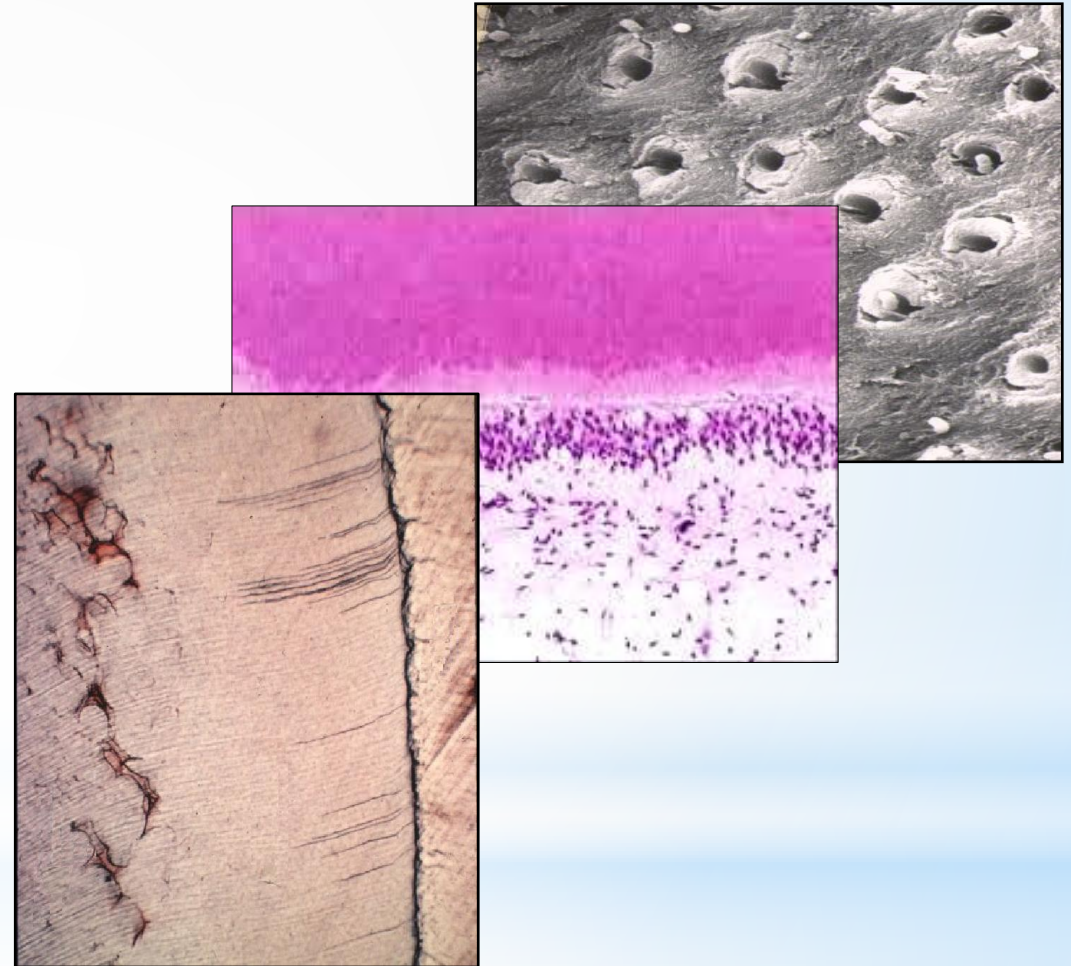


1

Dentin

Structure and Functions

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2026



DENTIN



Definitions:

Dentin is a hard, mineralized tissue that forms the main bulk of the tooth.

Dentin is covered by enamel in the crown and by cementum in the root.

Dentin encloses a central cavity that contains the dental pulp.

Dentin is a vital tissue that lined by a layer of odontoblast cells at the pulp interface.

Dentin contains odontoblastic processes extended from odontoblasts.

As the tooth remains vital, dentin continues to be formed throughout life.

Physical Properties

Color:

Dentin is a pale-yellow in color.

Hardness:

Dentin is harder than cementum and bone but softer than enamel.

Elasticity:

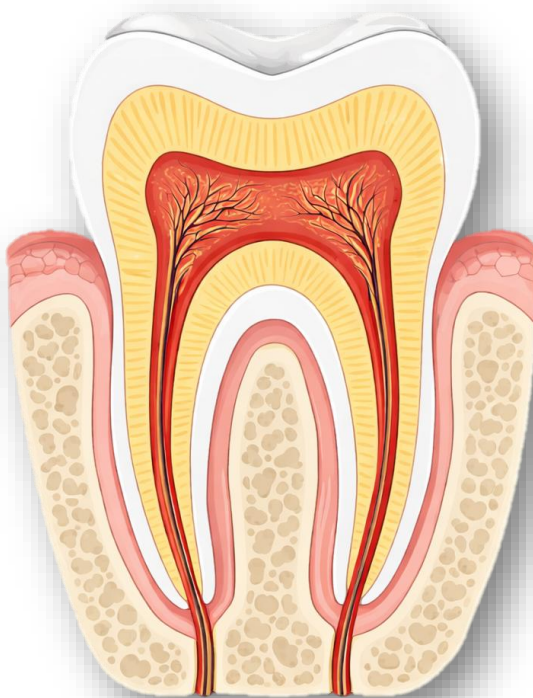
Dentin is a resilient tissue allowing it to withstand minor deformation.

Thickness:

Ranged from 3 to 10 mm.

Permeability:

Dentin is a permeable tissue.



Vitality:

Dentin is a vital tissue.

Sensitivity:

Dentin is a sensitive tissue.

Continuous deposition:

Dentin is continuously formed throughout life.



X-ray appearance:

Dentin appears radiopaque but less than enamel.

Chemical Composition

Inorganic materials

65 – 70 % by weight



- Inorganic materials of dentine is present in the form of crystals termed:

Hydroxy-apatite crystals

- This apatite crystals is composed mainly of Calcium and phosphorous in a chemical form of:



- This in addition to Carbonate, Magnesium, and trace elements of Fluoride.

Organic materials and H₂O

30 – 35 % by weight

- 10 % Water.
- 20 – 25 % Organic materials.

Organic materials

A. Collagen Fibers:

Type I and small amount of type III & type V.

B. Ground Substance:

- Proteoglycans, Glycoprotein, and Lipid.
- Growth factors as:
 - ✓ Transforming growth factor- β (TGF- β).
 - ✓ Bone morphogenetic proteins (BMPs)

Functions of collagen:

- Provides strength and elasticity.
- Forms a scaffold for mineral deposition.

Types of dentin

Types of dentin according to time of formation

1. Primary Dentin:

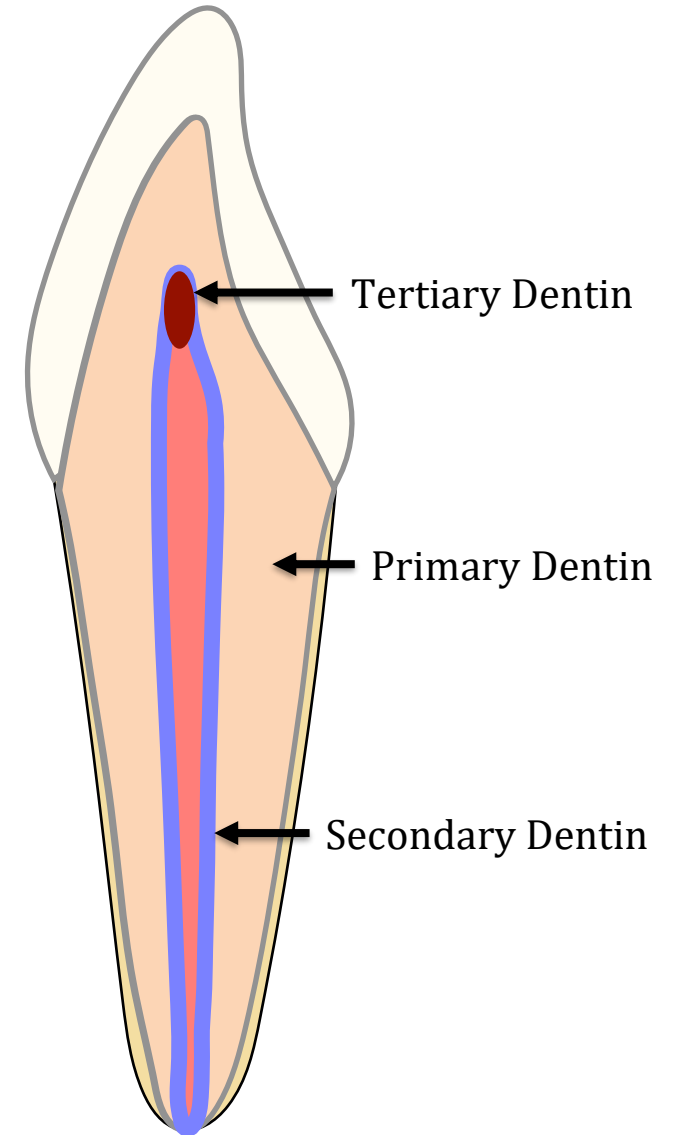
- Formed before root completion.
- Constitutes the bulk of dentin.

2. Secondary Dentin:

- Formed after root completion.
- Deposited slowly throughout life.
- Causes gradual reduction in pulp size.

3. Tertiary Dentin:

- Formed in response to stimuli (e.g., caries, attrition, trauma).
- Localized to the area of irritation.
- Two types:
 - a) Reactionary dentin, formed by the odontoblasts.
 - b) Reparative dentin, formed by odontoblast-like cells.



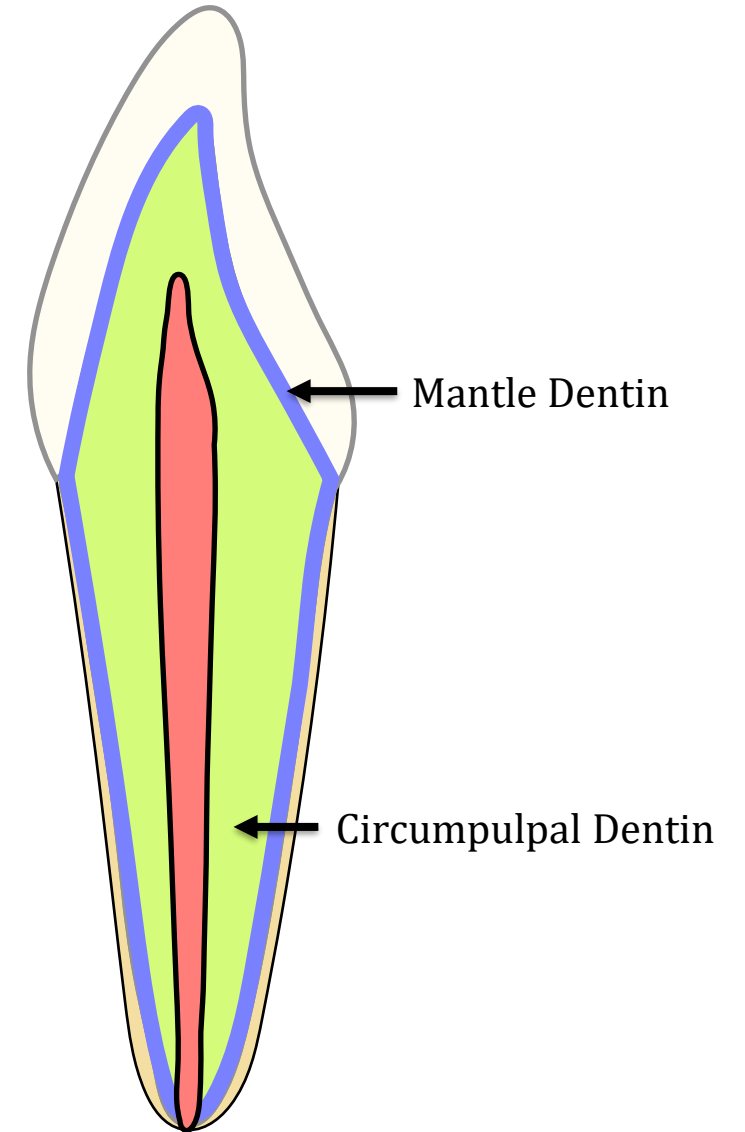
Types of dentin according to location

1. Mantle Dentin:

- It represent the outer first layer of dentin.
- Located just beneath enamel in crown and beneath cementum in root.
- Mantle dentin measure about 20 μm .
- Mantle dentin is less calcified and more resilient layer.
- Contains large collagen fibers arranged at right angle to the dentin surface (termed Von Korff's fibers).

2. Circumpulpal Dentin:

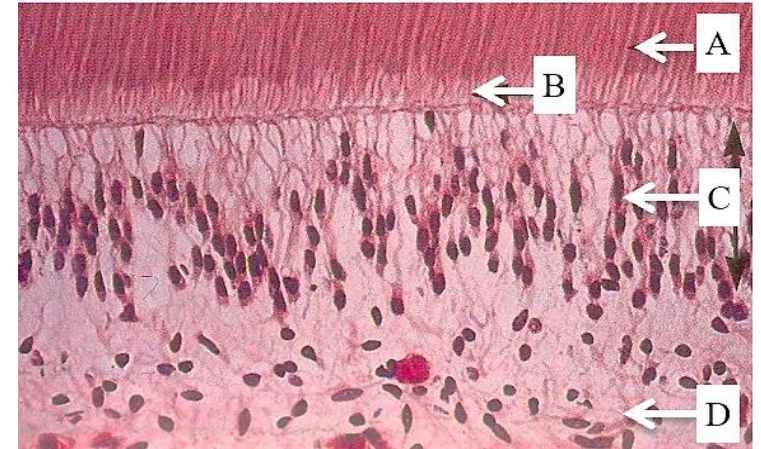
- It represent the bulk of primary dentin.
- Located between mantle dentin and pulp.
- Contains smaller and regularly arranged collagen fibers.



Types of dentin according to calcification

4. Predentin:

- It represent the inner non-calcified layer of dentin facing the pulp.
- It is the most recently formed dentin matrix.
- Composed mainly of type I collagen fibers and ground substance.
- Predentin measure about 20 μm in thickness.
- After mineralization of this layer, new predentin layer must be formed.
- The last layer of dentin must be the predentine layer if the dentin is alive.

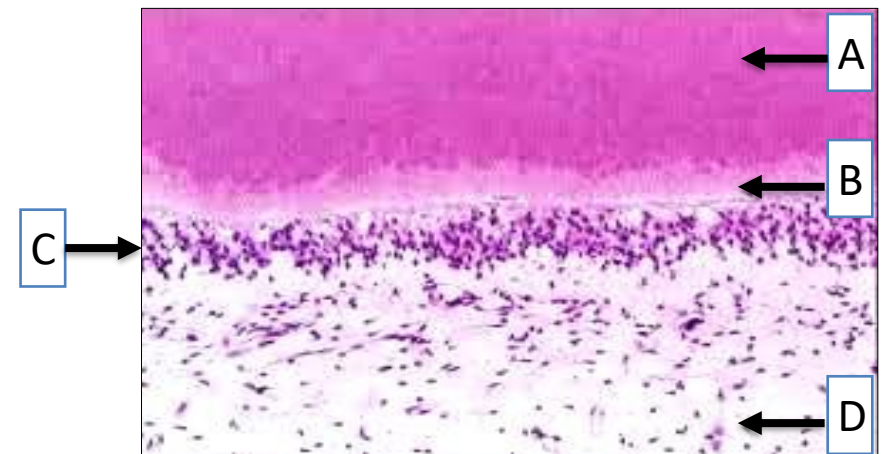


LS. decalcified section of dentin-pulp complex showing:

- A) Dentin.
- B) Predentin.
- C) Odontoblast cells.
- D) Pulp.

5. Calcified Dentin:

It represent the bulk of dentin.



Histology of Dentin

1. Dentinal tubules.
2. Odontoblast cells.
3. Peritubular dentin.
4. Intertubular dentin.
5. Incremental lines.

Histological Structure of Dentin

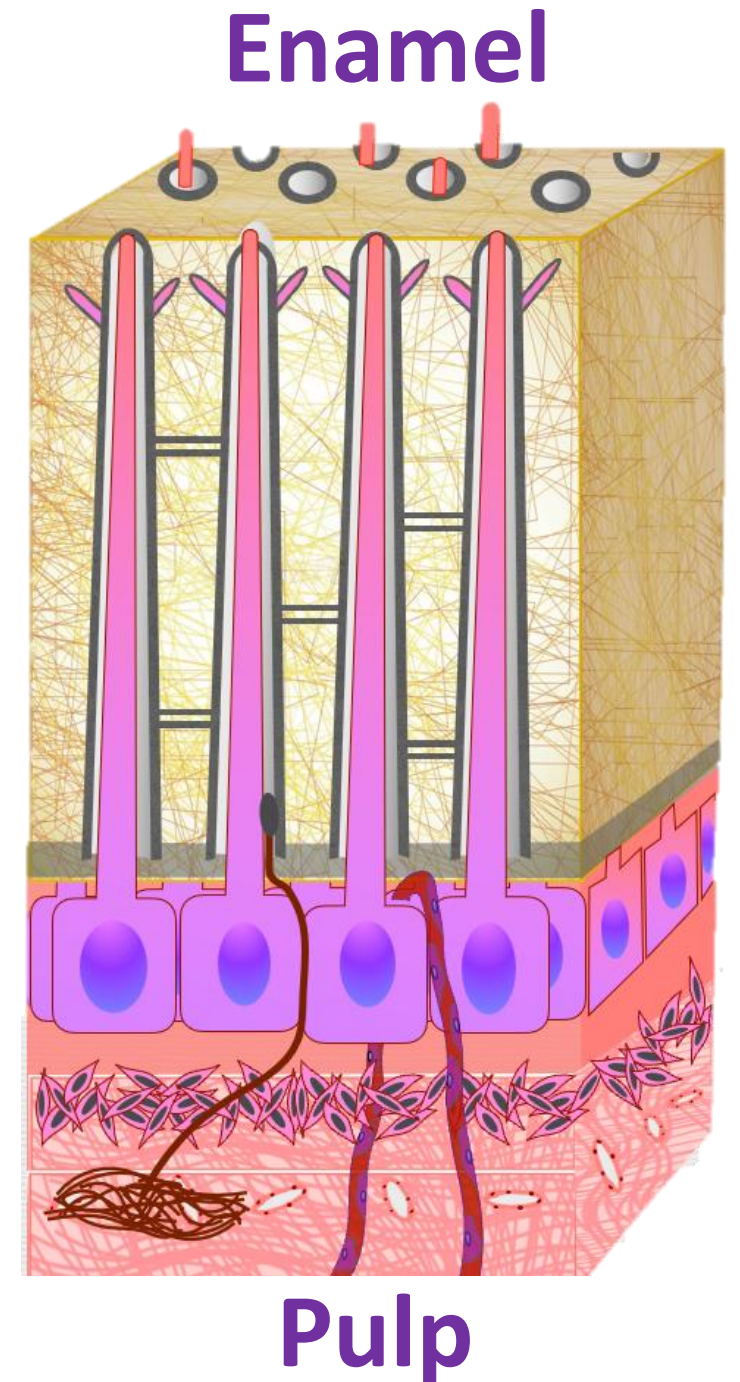
1. Dentinal Tubules

Definition:

- Dentinal tubule is the Unit structure of dentin extend from the pulp to the enamel or cementum.
- Dentinal tubules contain a process of odontoblast termed odontoblastic process.

General properties of dentinal tubule:

- a) Course of dentinal tubule.
- b) Diameter of dentinal tubule.
- c) Branching of dentinal tubule.
- d) Number of dentinal tubule per unit area.
- e) Contents of dentinal tubules.



a) Course of Dentinal Tubules:

❑ Straight course:

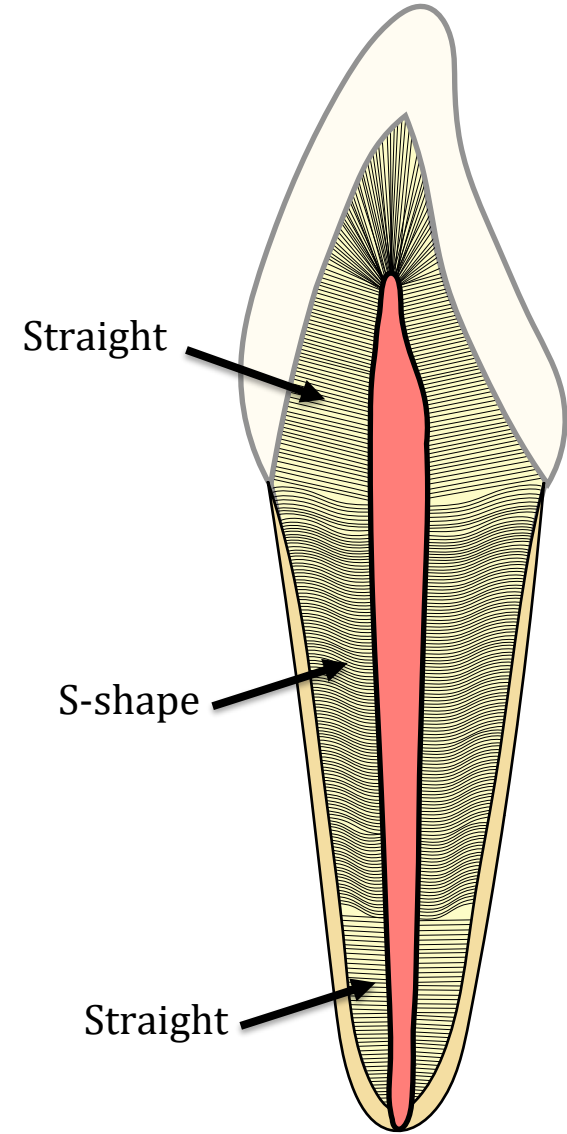
1. Crown.
2. Apical 1/3 of the root.

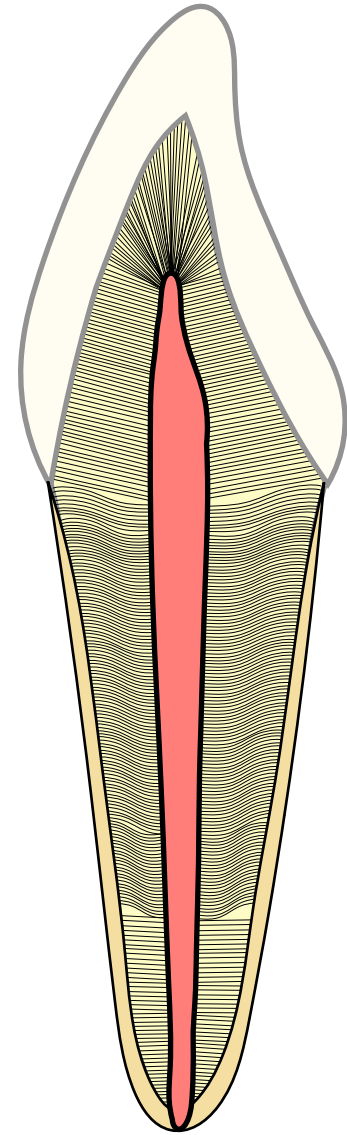
❑ S-shape course:

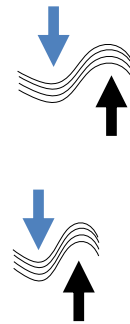
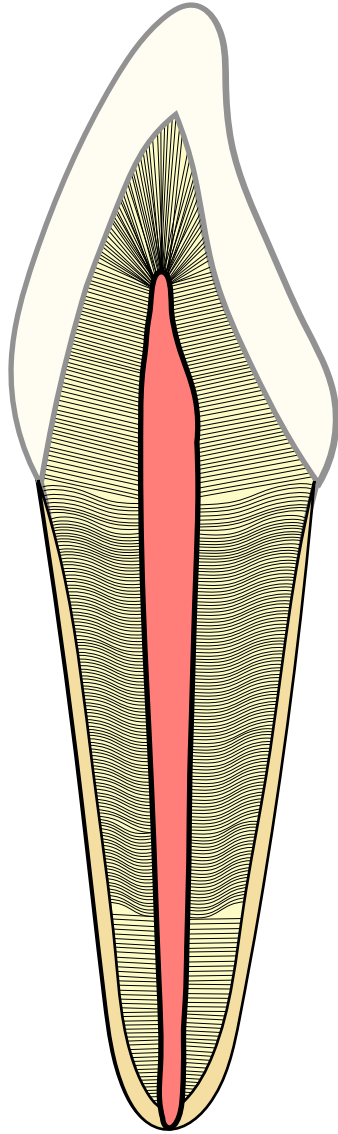
- The first convexity of the S-shape near the pulp facing toward the apex.
- The second convexity near the enamel and cementum facing toward the crown.
- The S-shape course of dentinal tubules are termed **(primary curvature)**.

❑ Secondary curvature:

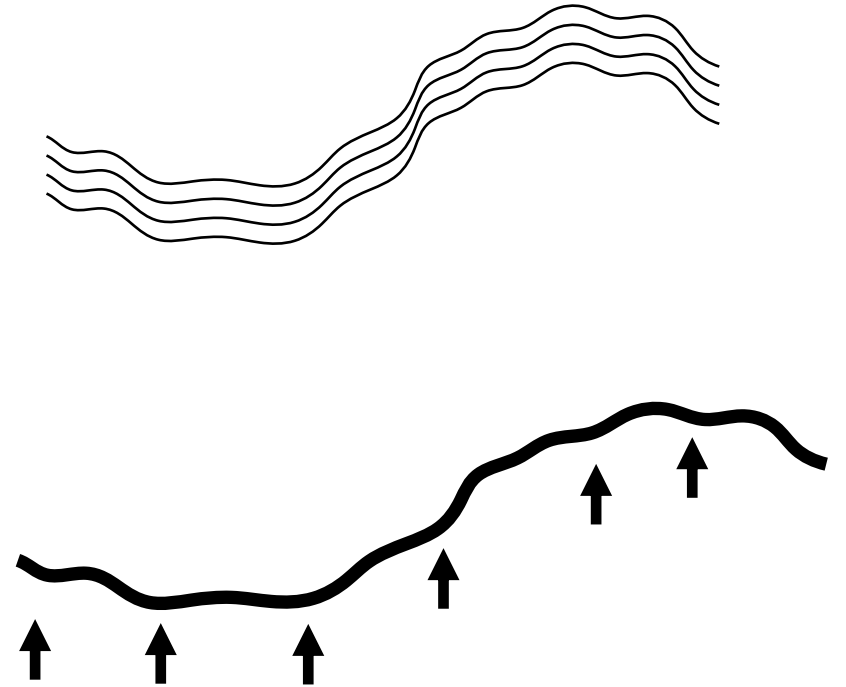
The dentinal tubules exhibit a minute secondary curvature within the S-shape primary curvature.







S-shape curvature



Secondary curvature

b) Diameter of Dentinal Tubules:

- Dentinal tubule is Tapered in shape.
- Dentinal tubules show a gradual increase in diameter from near the enamel toward the pulp.
- Dentinal tubules near the enamel or cementum are narrow and measure about **1 μm** .
- Dentinal tubules near the pulp become wider and measure about **4 μm** .

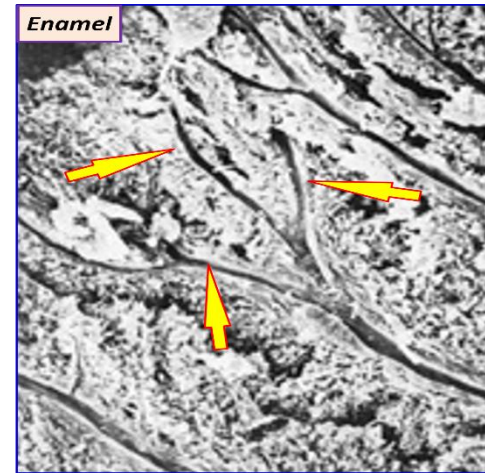
c) Branching of Dentinal Tubules:

❖ Lateral branches (Canaliculi):

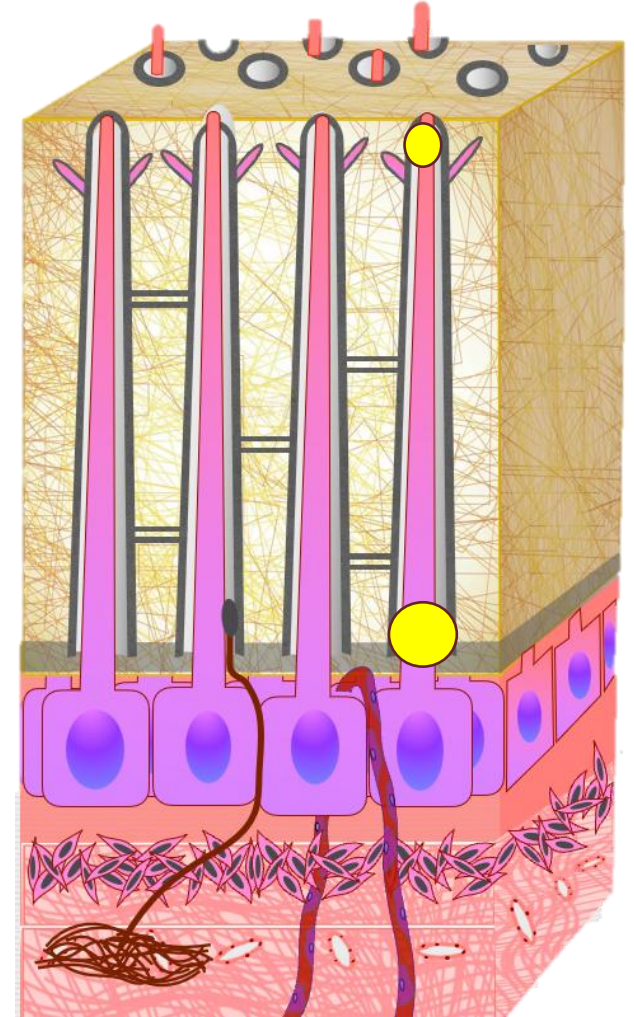
- Branched from dentinal tubule to the adjacent.
- Run at right angle to the tubules.
- Measure about 1 μm in diameter.

❖ Terminal branches:

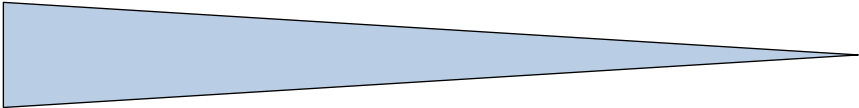
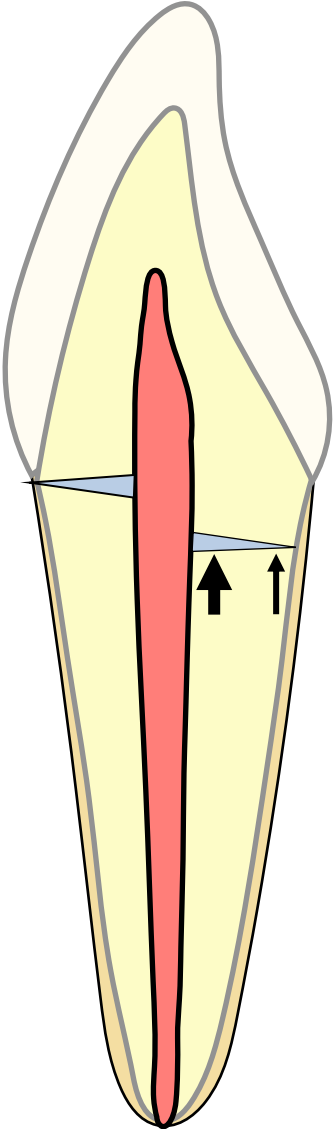
- More in root dentin than in crown dentin.
- These anastomosing system explain the high degree of permeability.



Terminal branches



Diameter of dentinal tubules



4 : 1

d) Number of Dentinal Tubules per mm³ :

- Number of dentinal tubule near the pulp is 75.000 / mm³.
- Number of dentinal tubule near the enamel is 20.000 / mm³.
- Number of dentinal tubule is greater in crown than in the root.
- The ratio between number per mm³ near the pulp to near enamel is **4-1**.
- The dentin surface adjacent to the pulp is narrower compared to the surfaces facing the enamel, resulting in a higher density of dentinal tubules in this region

e) Contents of Dentinal Tubules:

➤ Odontoblastic processes (Tomes' fibers):

- Extensions of odontoblasts cells.
- Responsible for dentin formation and maintenance.

➤ Dentinal fluid (dental lymph):

- Small amounts of fluid containing glycoproteins responsible for nutrition.

➤ Sensory nerve ending from the pulp:

- Contribute to the transmission of pain signals.

2. Odontoblast cells

Definition, origin, and site of odontoblast cells:

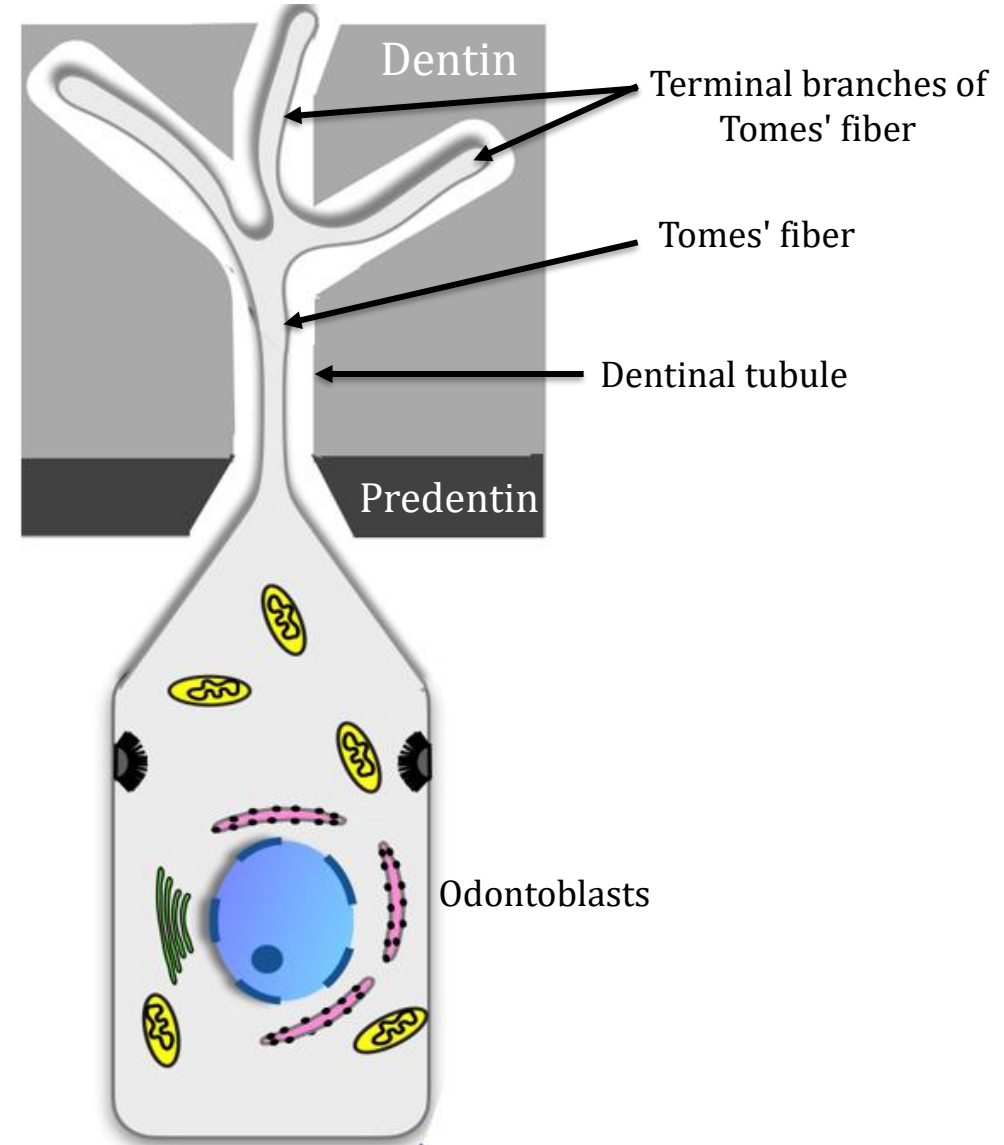
Odontoblast cells are cells of ectomesenchymal origin lined the pulpal surface of dentine and responsible for dentine formation.

Structure:

- Cell body (Perikaryon).
- Odontoblastic process (Tomes' fiber).
- **Active cells:** RER, GC, Mitochondria, and Secretory vesicles.
- **Rest cells:** less cell organelles.

Shape:

- **Coronal pulp:** Columnar with oval nucleus.
- **Mid part of the pulp:** Cuboidal with round nucleus.
- **Apical part of the pulp:** The cells are flat in shape.



2. Odontoblastic Processes (Tomes' fibers)

Definition of odontoblastic processes:

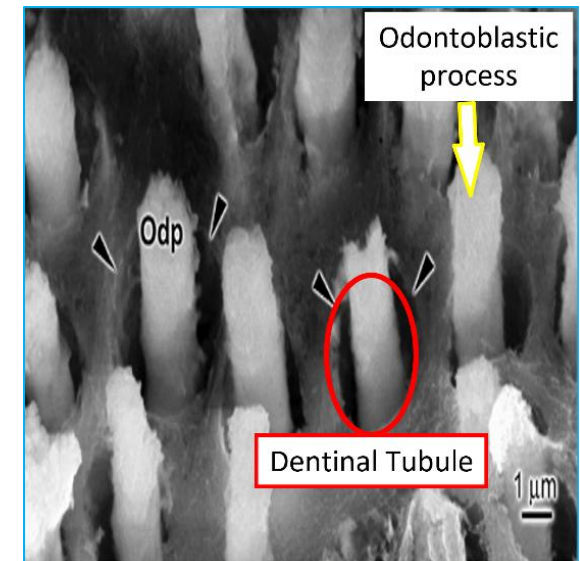
- Odontoblastic Processes are cytoplasmic extension from odontoblasts cells run within the dentinal tubules.
- The odontoblastic process run within the dentinal tubules in space termed pre-odontoblastic space.
- Odontoblastic processes contain microtubule and occasionally mitochondria.

Diameter:

- Odontoblastic Processes are wider near the odontoblast cell body (3-4 μm) and taper to 1 μm near the enamel.

Branches of Odontoblastic Processes:

- Lateral branches run inside the lateral canaliculi of dentinal tubules.
- Terminal branches run inside the terminal canaliculi of dentinal tubules.
- Enamel spindle is an extension of odontoblastic process within the enamel.



3. Peritubular dentin

Definition:

Peritubular dentin is the part of dentine form the wall of dentinal tubules.

Terminology: Peritubular dentine = Intratubular dentine.

Structure:

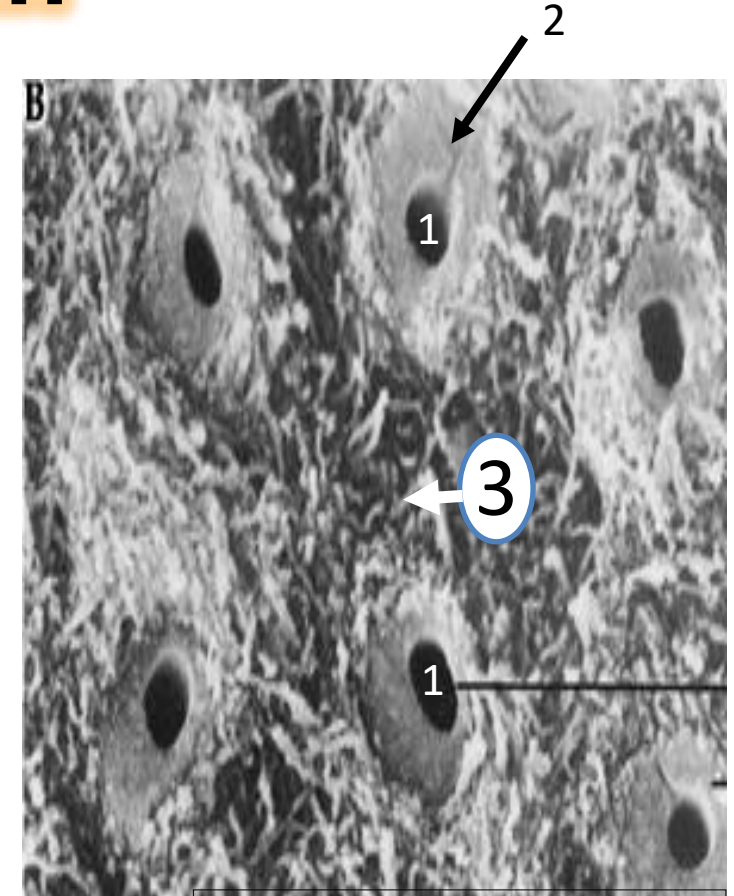
- Highly mineralized layer with less collagen fibers.
- The collagen fibers are arranged at right angle to dentinal tubules.
- The collagen fibers are very small.

Thickness:

0.4 um near the pulp, 0.7 um near the enamel.

Continuous formation of peritubular dentin:

- Peri-tubular dentin is continuously formed by the action of odontoblastic processes.
- This leads to decreases the diameter of dentinal tubule.
- The older part of dentinal tubule is narrower than that near the pulp.



1. Dentinal tubule
2. Peritubular dentine
3. Intertubular dentine

4. Intertubular dentin

Definition:

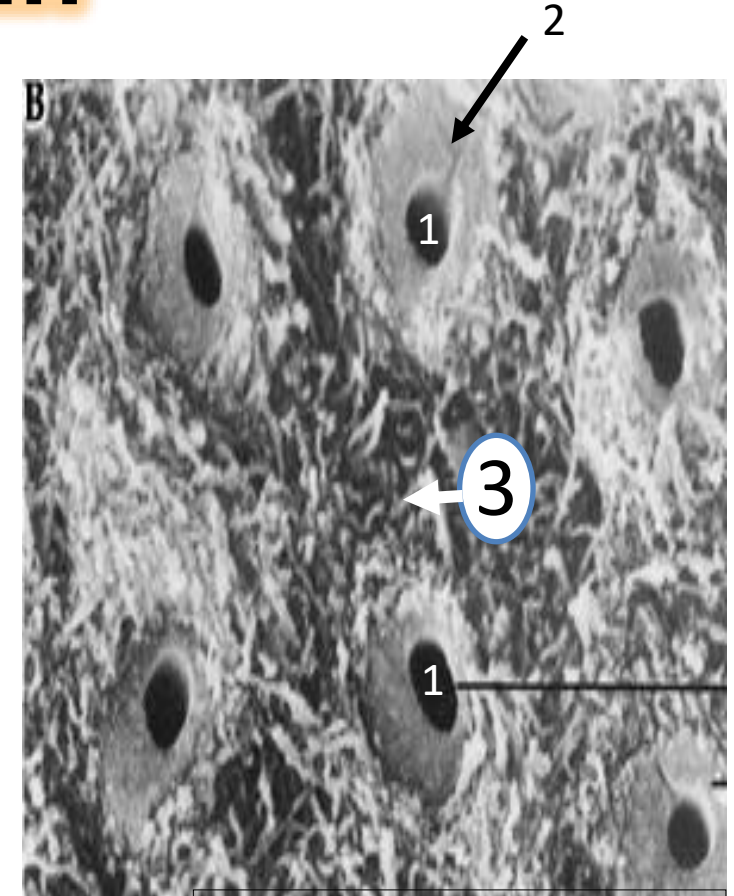
- Inter-tubular Dentin is a hard tissue that forms the bulk of dentine and is located between the dentinal tubules.

Structure:

- It is a calcified dentin but less than the peritubular dentin.
- It is composed mainly of a collagen-rich organic matrix in the form of network (randomly arranged).
- It plays an important role in resisting masticatory forces and maintaining the overall tooth integrity.

Neuman's sheath:

- Neumann's sheath is the interface between peri-tubular and inter-tubular dentin.



1. Dentinal tubule
2. Peritubular dentine
3. Intertubular dentine

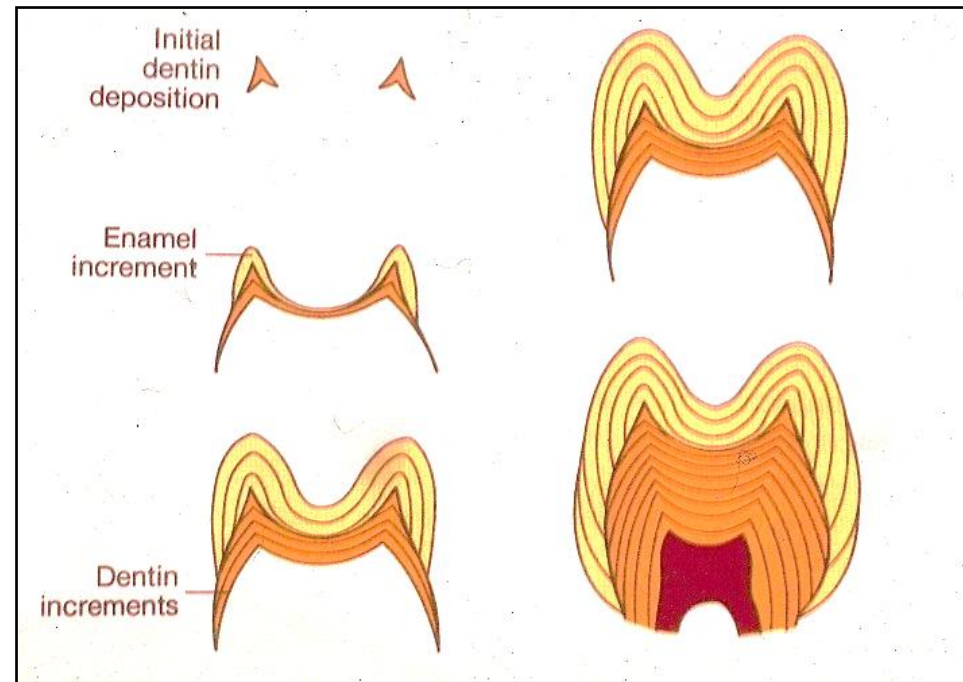
5. Incremental lines of dentin

Definition:

- Incremental lines of dentin are fine hypomineralized brown lines indicating the daily or periodic pattern of dentin formation.

Types:

1. Incremental Lines of von Ebner.
2. Contour Lines of Owen.
3. Neonatal Line.



1. Incremental Line of Von Ebner

Definition:

- Incremental line of Von Ebner is a brownish bands appear in ground result from rhythmic deposition of dentine into layers.
- Each line corresponds to approximately 4 μm of dentin formed per day.
- Found throughout both primary and secondary dentine.

Shape:

1. In longitudinal section:

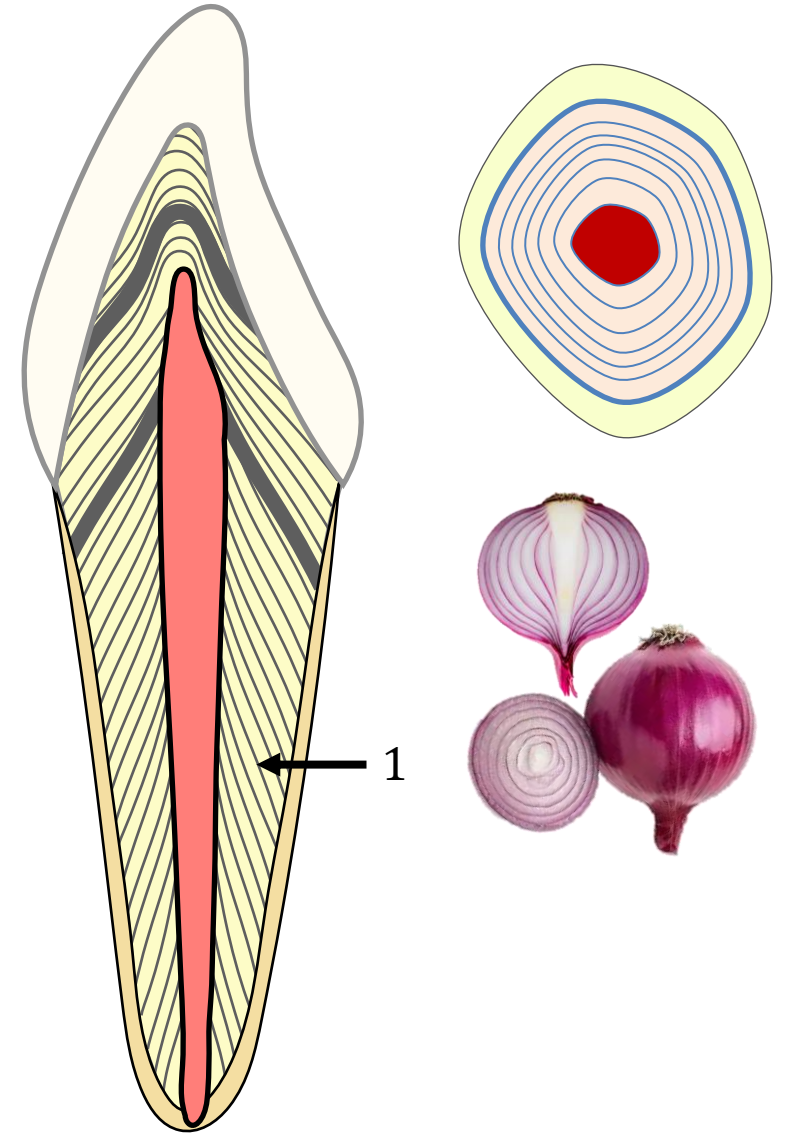
- a) At the crown appear as inverted cones.
- b) At the root is oblique lines.

2. In cross section:

- a) They appear as circles surrounding the pulp.
- b) Run at right angle to dentinal tubules.

Results from:

Rhythmic deposition of dentin in period of activity alternated with period of rest.



2- Contour Line of Owen

Definition:

Contour line of Owen is an accentuated (prominent) incremental line of Von Ebner's due to period of illness leading to long disturbance in mineralization.

3- Neonatal Contour Line

Definition:

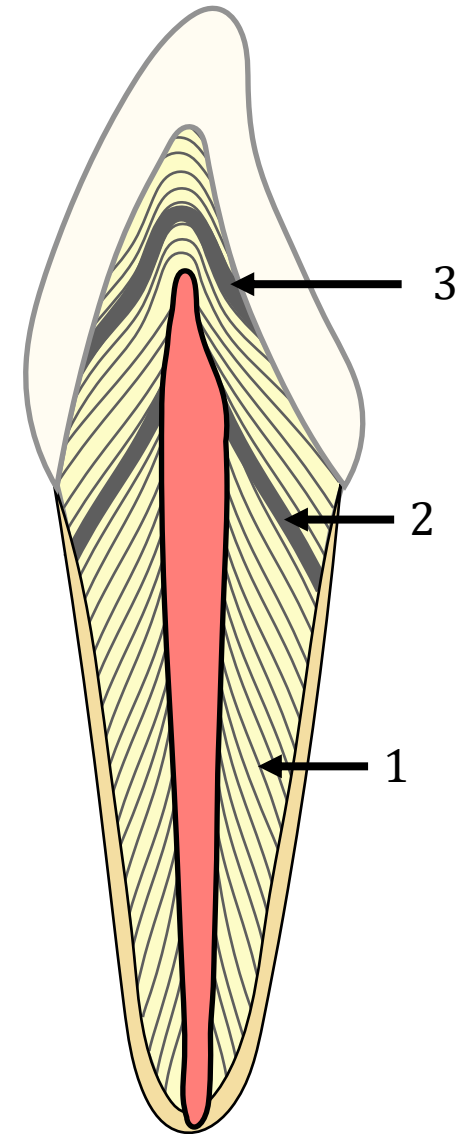
Neonatal line is an enlarged incremental line represent the line of separation between dentin being formed before birth and that formed after birth.

Site: (imp)*

All deciduous teeth and first permanent molars only.

Formed due to:

- Neonatal line is formed due to abrupt change in the nutrition and environment after delivery.
- The quality of prenatal dentin is usually better than the postnatal dentine due to better nutrition.



Pattern of dentin mineralization

1. Linear mineralization:

This pattern of mineralization is occurred by calcification of one layer of dentine at one time.

2. Globular mineralization:

- Dentine mineralization begin as small circles of Ca^{++} termed **globules = Calcospherites**.
- These globules grows toward each other by deposition of minerals on its surface.
- These globules enlarged until fused together to form homogenous mineralized dentine.
- This pattern of mineralization is termed **Globular Mineralization**.

3. Mixed mineralization:

- Mostly, Dentine mineralization performed by a mix of both linear and globular mineralization.

Interglobular dentin

Definition:

Interglobular dentin appears as dark star-shaped hypocalcified or noncalcified areas in the in the first layer of Circumpulpal dentin adjacent to mantle dentin of the crown.

Seen only: in ground section of the tooth.

Criteria:

- Interglobular dentin is a normal structure.
- Dentinal tubules pass normally through them without peritubular dentin.
- Follow the incremental line of dentin.

Important note:

Vitamin D deficiency during dentin formation increases the frequency of formation of inter-globular dentin.

How to form:

The calcospherite globules fail to fuse, resulting in the persistence of uncalcified dark areas between them.



Tome's granular layer

Definition:

Tome's granular layer appeared as minute black spaces in the dentine of the root just adjacent to cementum.

Seen only: in ground section of the tooth.

Criteria:

- Tomes' granular layer is a normal structure.
- Dentinal tubules begin at Tomes' granular layer.
- Does not follow the incremental pattern of dentin.

Theories of Tomes' granular layer:

1. It results from looping of the terminal portion of dentinal tubules.
2. Represent small areas of inter-globular dentin within the root.

