

# Dentin

- Dentin is a hard tissue of the tooth that surrounds the pulp and makes up the bulk and general form of tooth
- Characterized by presence of tubules throughout its thickness
- Dentinal tubules contain process of odontoblasts within them → thus dentin is a living or vital tissue

# Physical properties

- Colour

- Young age → light yellow
- With advancing age → becomes darker

- Consistency

- Elastic and resilient
- Harder than bone but softer than enamel

# Chemical properties

## ● Composition

- Organic matter → 35%
- Inorganic matter → 65%

## ● Organic matrix

- Collagen fibrils
- Ground substance (mucopolysccharides)
  - Proteoglycans
  - Glycos aminoglycans

- Inorganic component

- Calcium and phosphate in the form of Hydroxyapatite crystals

- Each crystal has a basic chemical formula →  
 $3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$

- Plate shaped

- Smaller than the hydroxyapatite crystals of enamel

- Also contains small amounts of phosphates, carbonates and sulfates

# Structure

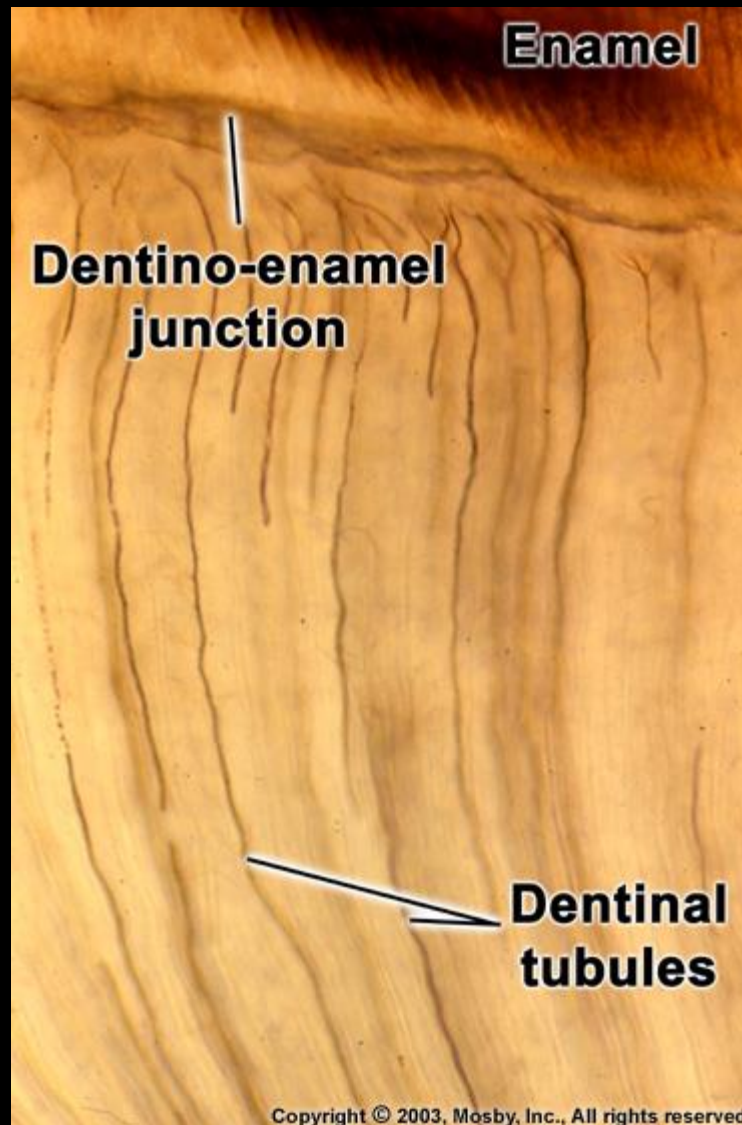


- Odontoblasts are present in the pulp and are arranged in a layer lining the pulpal surface of dentin
- Each cell gives out a long thin process which enters a hollow tube like structure within the dentin called as “dentinal tubule”

# Dentinal tubules

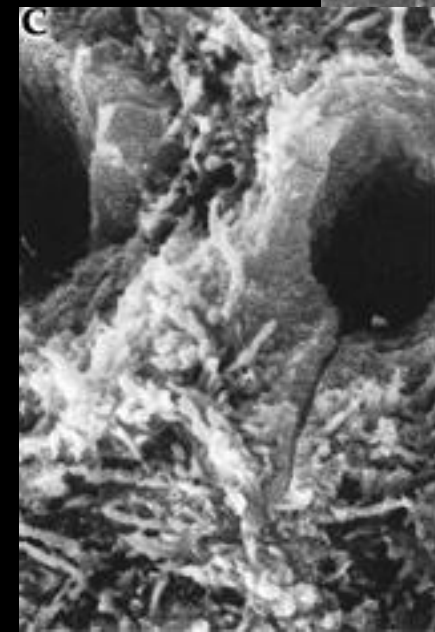
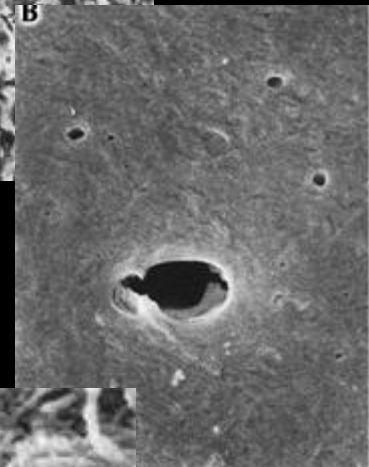
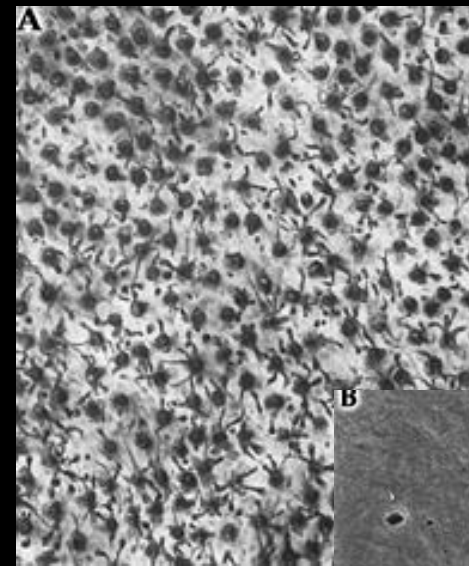
- Traverse throughout the thickness of dentin
- Follows a gentle curvature in the crown which resembles “S-shape”
- Starting from the pulpal surface the first convexity of the curvature is towards the root
- Curvature is less prominent in the root portion





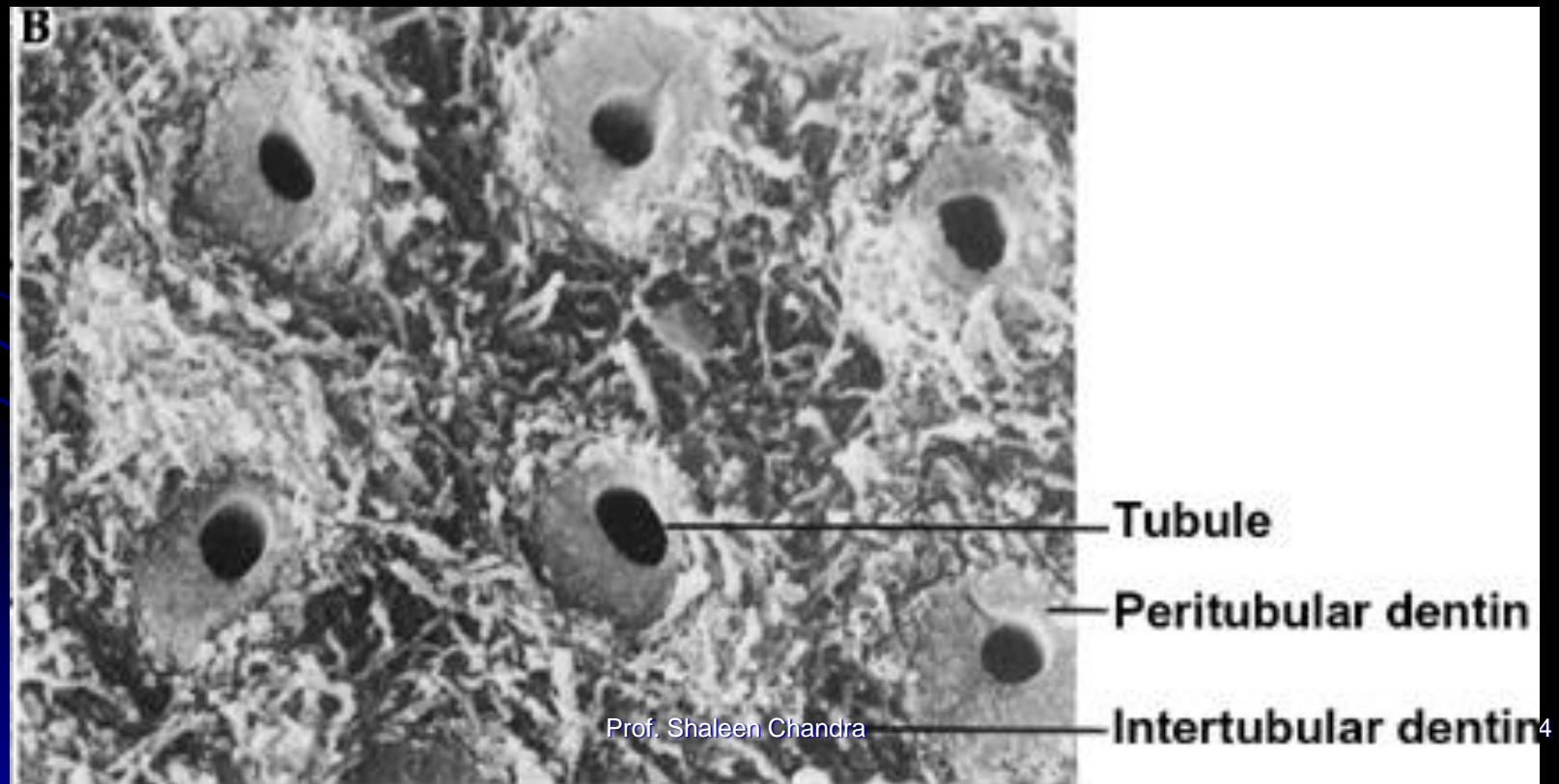
- The tubules are perpendicular to the dentino-enamel junction and the dentino-cemental junction
- Near the root tips and incisal edges the tubules are almost straight
- Surface area of dentin is greater at enamel surface than pulpal surface → dentinal tubules are further apart at enamel surface of dentin
- Tubules are larger in diameter at the pulpal end (3-4 $\mu$ m) as compared to enamel end (1 $\mu$ m)

- No. of tubules per unit area at the pulpal surface is about 4 times that of enamel surface
- More tubules per unit area in the crown portion as compared to root
- Lateral branches of dentinal tubules are called “canaliculi” or “microtubules” (1 $\mu$ m in diameter)
- Few dentinal tubules extend through the DEJ into enamel  $\rightarrow$  enamel spindles



# Peritubular dentin

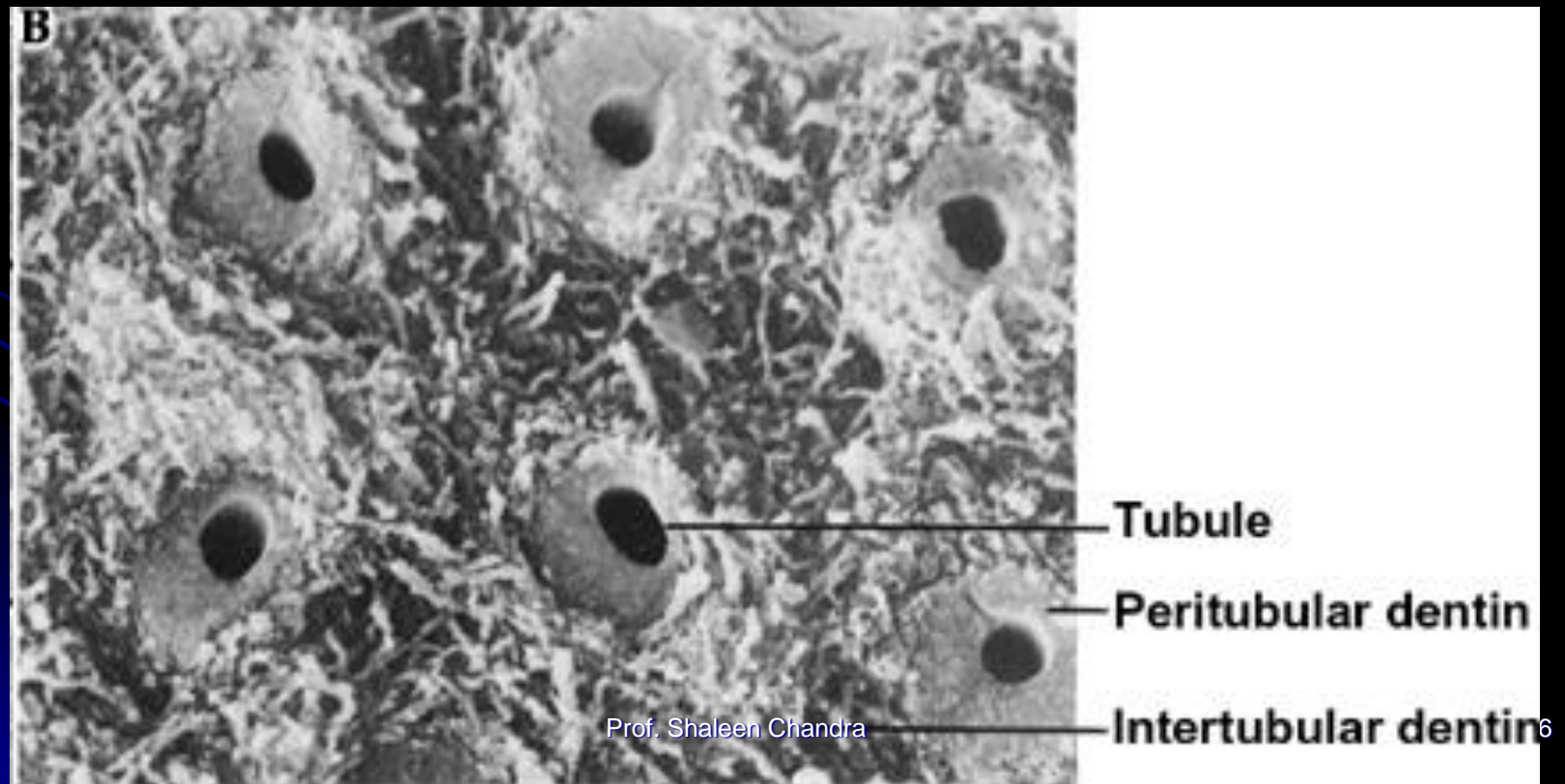
- Dentin that immediately surrounds the dentinal tubules



- Found throughout the thickness of dentin except near the pulp
- More highly mineralized (9% more) than intertubular dentin
- Twice as thick in outer dentin than in inner dentin
- Thin organic membrane rich in glycosaminoglycans on the inner side → lamina limitans

# Intertubular dentin

- Located between the dentinal tubules and forms the main body of dentin

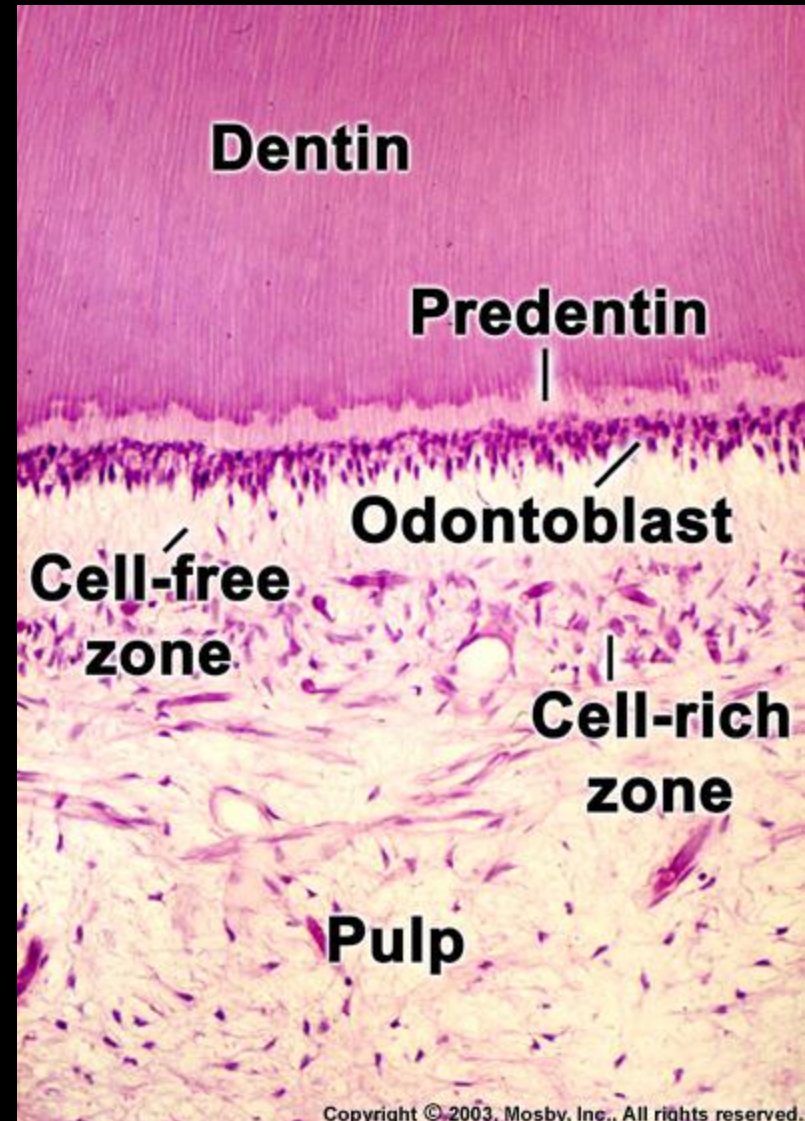




- Less mineralized than peritubular dentin
- About one half of the volume is organic matrix made up of collagen fibers oriented around the dentinal tubules
- Fibers are  $0.2\mu\text{m}$  –  $0.5\mu\text{m}$  in diameter and exhibit  $64\mu\text{m}$  crossbanding
- Hydroxyapatite crystals ( $0.1\mu\text{m}$  in length) are present with long axis parallel to collagen fibers

# Predentin

- 2 $\mu$ m - 6 $\mu$ m wide layer of unmineralized dentin matrix located adjacent to pulp tissue
- First formed dentin
- Thickness depends on the activity of odontoblasts



# Odontoblastic process

- Cytoplasmic extensions of odontoblasts into the dentinal tubules
- Greatest diameter is near the pulp ( $3\mu\text{m}$  -  $4\mu\text{m}$ ) and taper further in dentin ( $1\mu\text{m}$ )



- Extent of odontoblastic process into the dentin → still debatable ???

- Two theories

1. Odontoblastic process extends throughout the thickness of dentin

- Organic matrix within the dentinal tubules is found even at DEJ

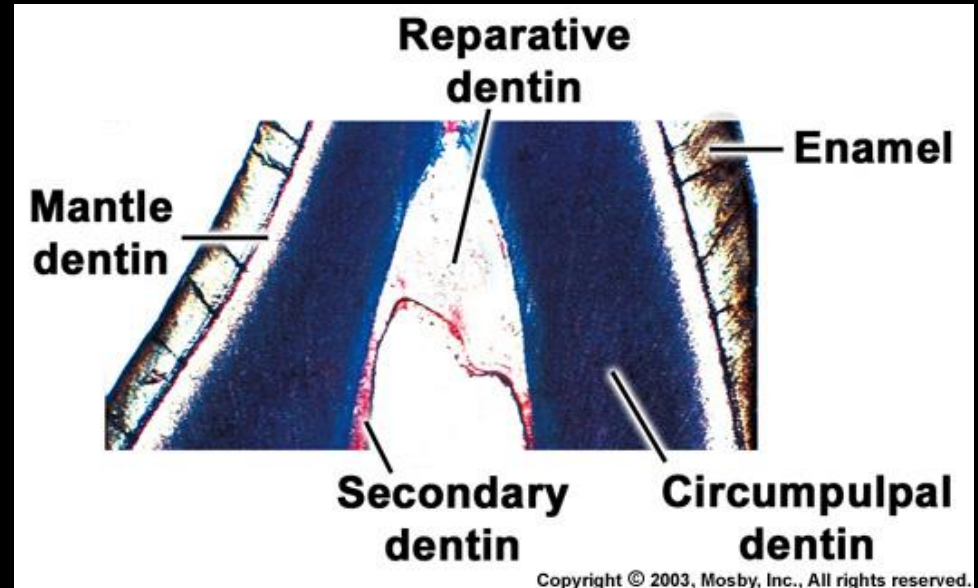
2. Odontoblastic process is present only upto partial extent in dentin

- Structure interpreted as odontoblastic process is actually almina limitans

- Odontoblastic process is composed of
  - Microtubules
  - Mitochondria
  - Lysosomes
  - Microvesicles

# Types of dentin

- ***Primary Dentin***
- ***Secondary Dentin***
- ***Tertiary Dentin***



- **Primary Dentin:**

- ***Dentin formed before root completion***
- ***Major part of dentin***
  - ***Mantle dentin – outer layer***
  - ***Circumpulpal dentin***

# Mantle dentin

- First formed dentin in the crown
- Seen just below the DEJ
- 20 $\mu$ m in thickness
- Organic matrix is formed by collagen fibrils arranged perpendicular to the DEJ
- Linear mechanism of calcification



# Circumpulpal dentin

- Remaining portion of primary dentin which forms the bulk of the tooth
- Collagen fibrils are much smaller in diameter (0.05 $\mu\text{m}$ ) and are more closely packed together
- May be slightly more mineralized than mantle dentin
- Globular mechanism of calcification

- **Secondary Dentin:**

- Develops after root formation
- Slower rate of deposition
- Tubules → less regular

Greater deposition on the roof and floor



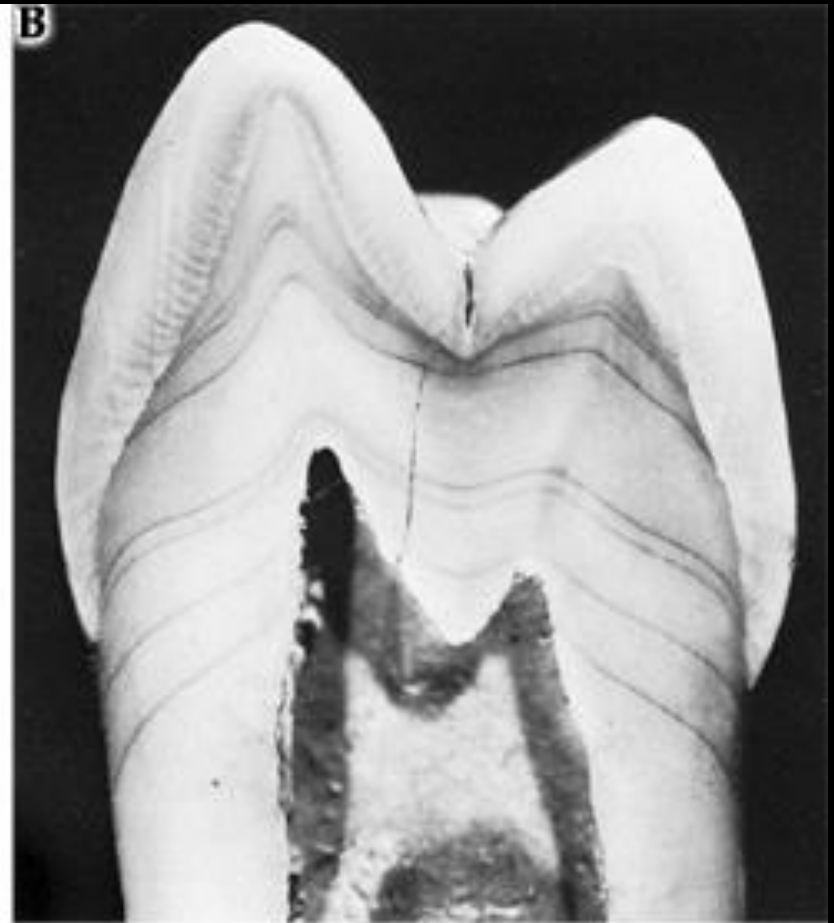
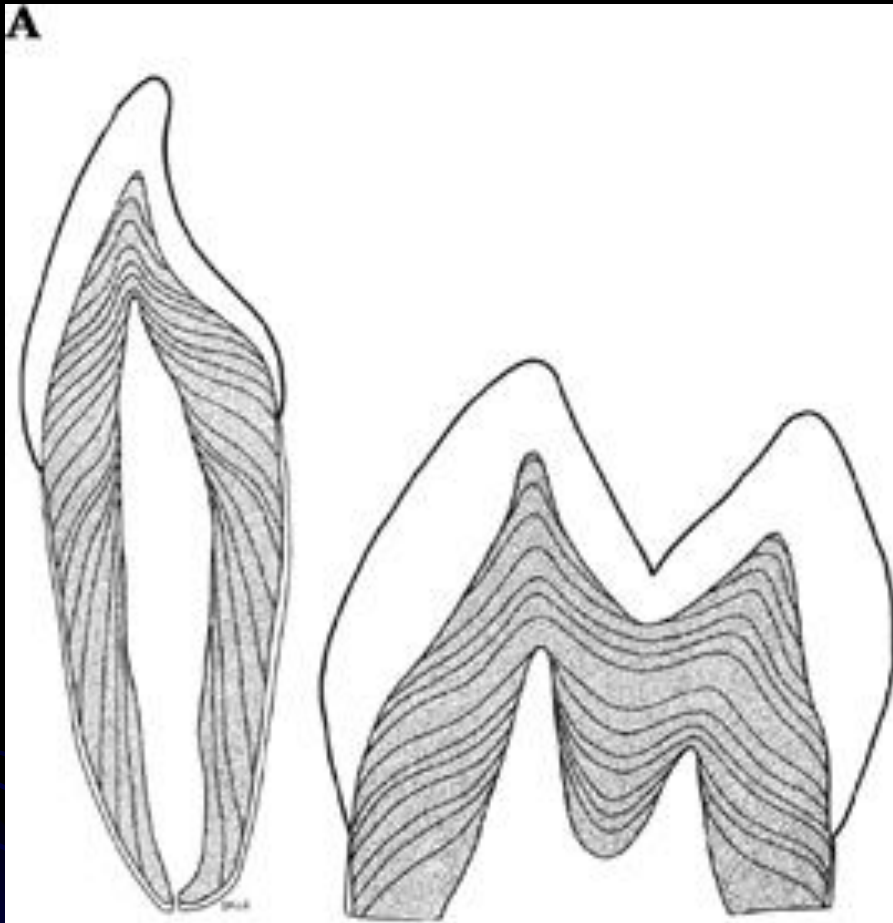
Pulp recession

# Tertiary Dentin

- Produced in reaction to various stimuli
  - Attrition, caries, or a restorative dental procedure
- May have tubules
  - continuous with those of secondary dentin
  - sparse in number and irregularly arranged
- ***Osteodentin*** – cells entrapped in tertiary dentin
- ***Reactionary dentin*** – preexisting Odontoblasts
- ***Reparative dentin*** – newly differentiated odontoblast-like cells

# Incremental lines

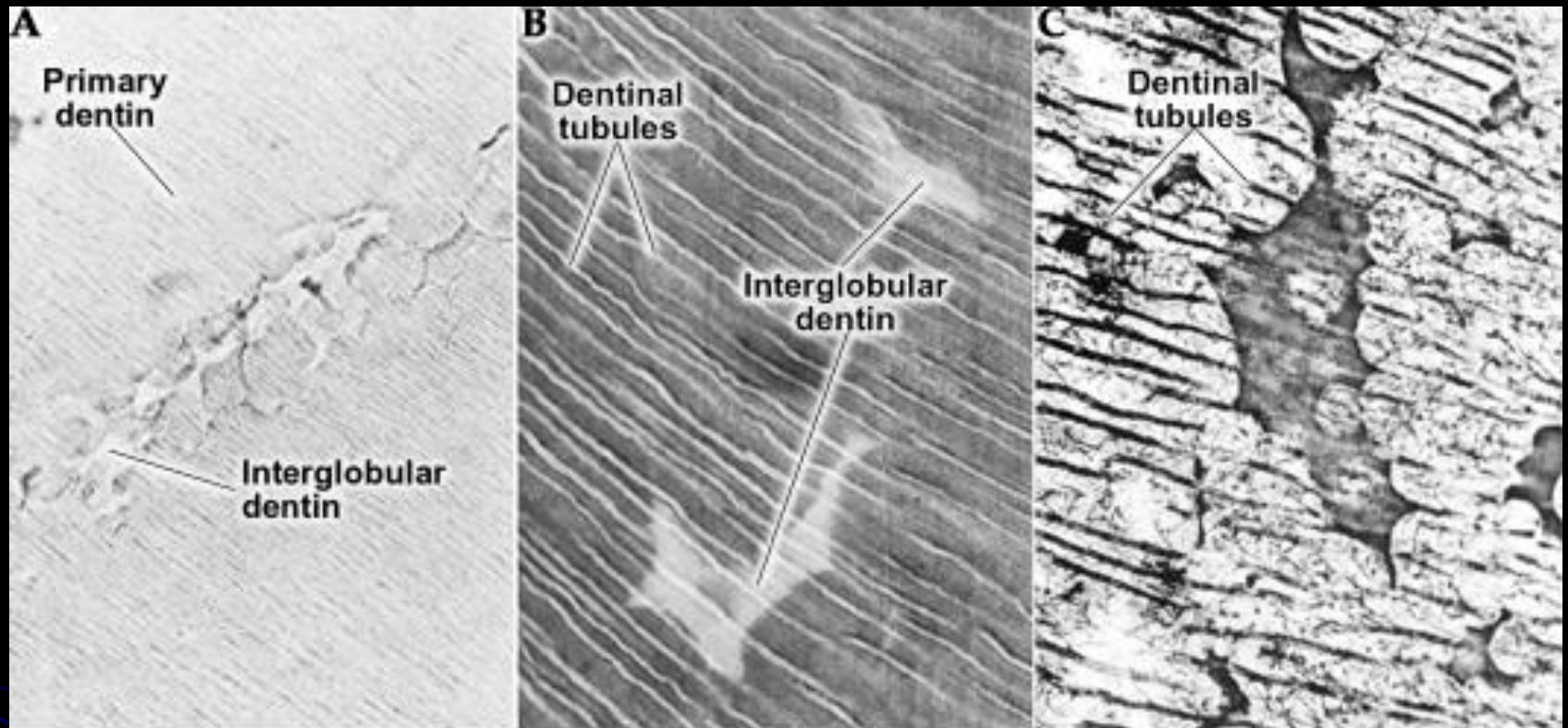
- Represent daily rhythmic deposition of dentin
- Run at right angles to dentinal tubules
- Separated by  $4\mu\text{m}$  → represent daily deposition of dentin  
→ no name
- Accentuated incremental lines separated by  $20\mu\text{m}$  → represent 5 day deposition → ***“incremental lines of von Ebner”***
- Lines caused by accentuated deficiencies in mineralization → ***“contour lines of Owen”***



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# Interglobular dentin

- Unmineralized or hypomineralized dentin where globular zones of mineralization (calcospherites) have failed to fuse into a homogenous mass within mature dentin
- Vitamin D deficiency
- high level fluoride exposure
- Most frequently seen in Circumpulpal dentin just below the mantle dentin
- Normal dentinal tubular architecture is visible → defect of mineralization and not of matrix formation
- No Peritubular dentin exists around the tubules



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# Granular layer of Tomes

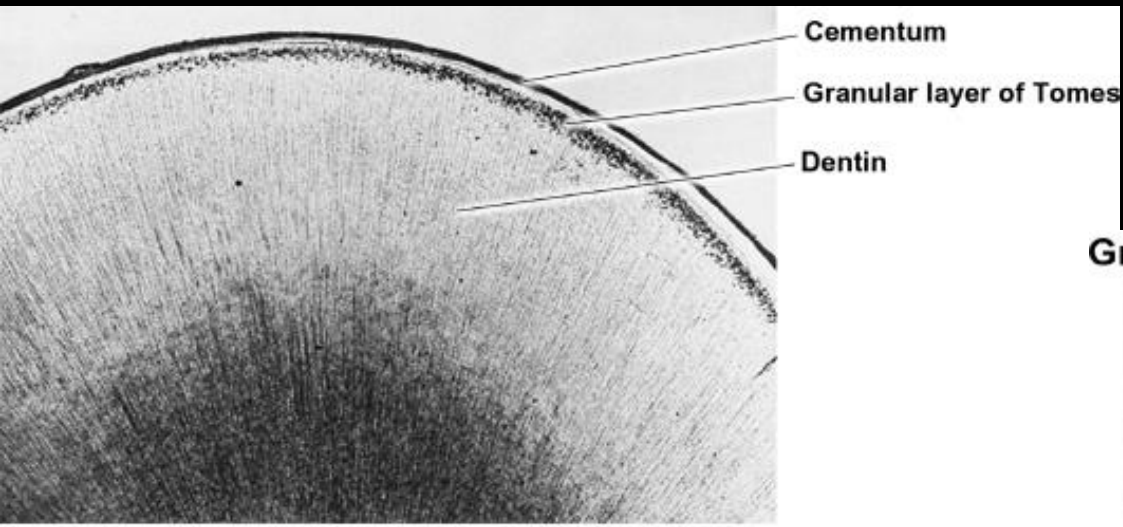
When dry ground sections of root dentin are visualized in transmitted light



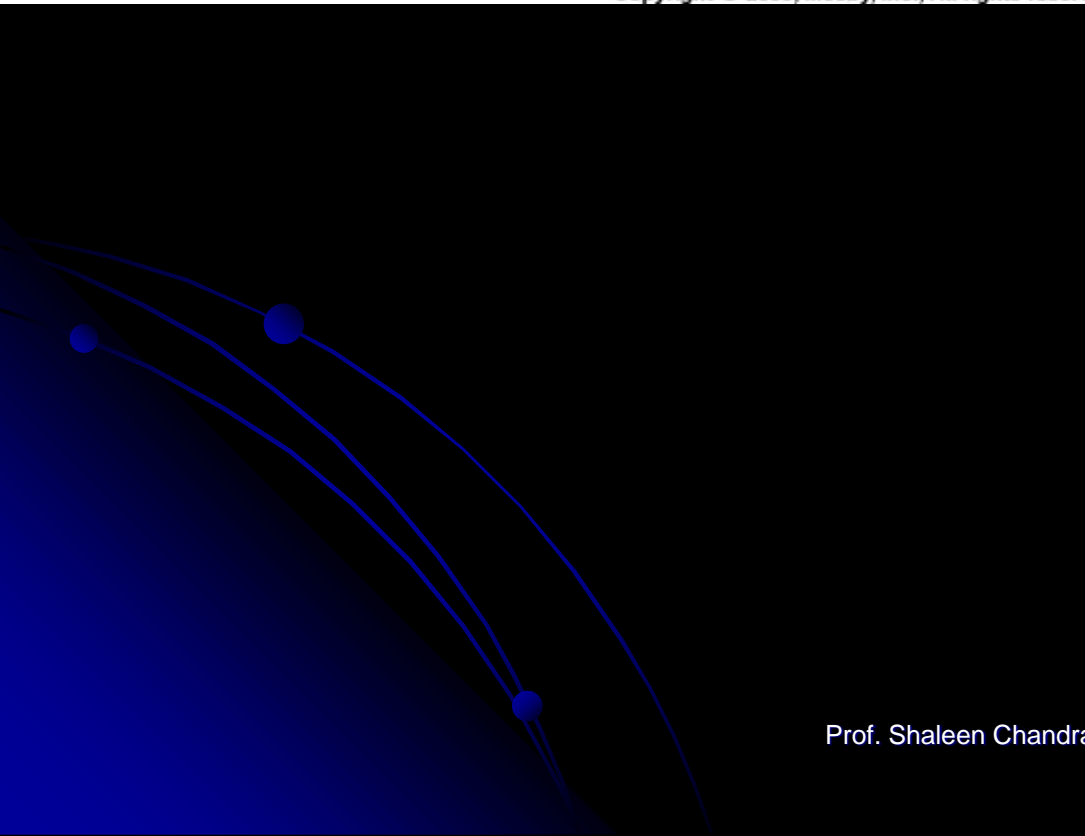
A zone adjacent to cementum appears granular

- More prominent towards the apical portion
- Caused by coalescing and looping of terminal portions of dentinal tubules





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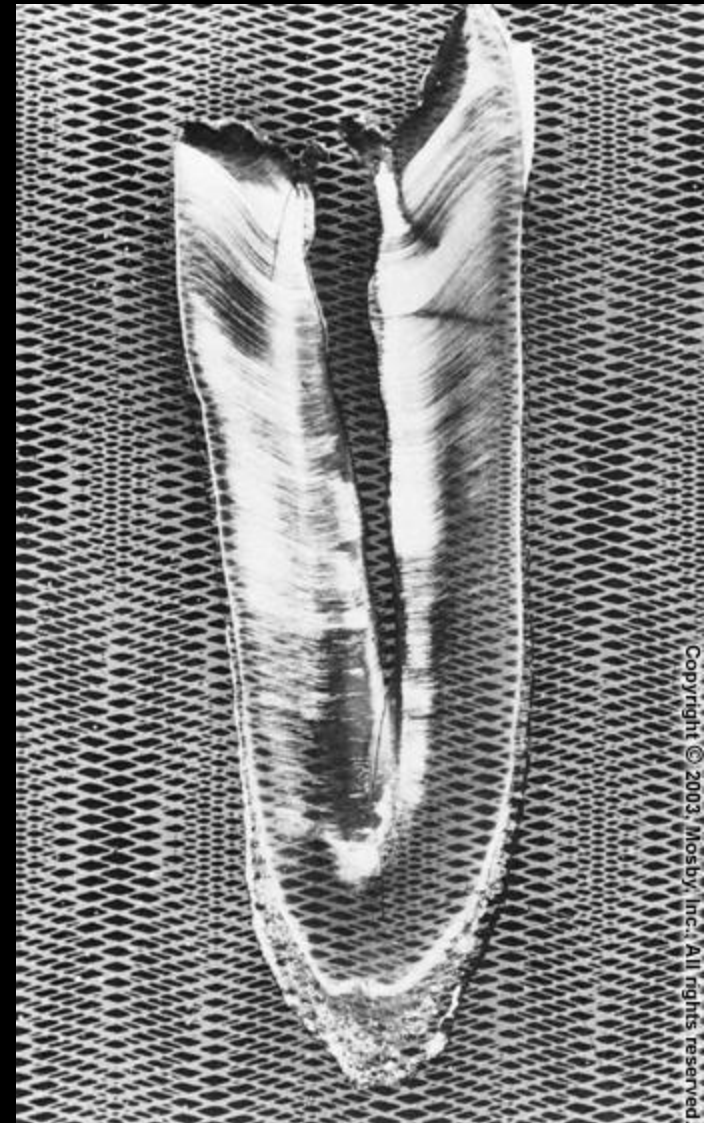
Prof. Shaleen Chandra

# Age changes in dentin

# Sclerotic dentin

- Dentinal tubules that have become occluded with calcified material
- Assume a glassy appearance and become translucent
- Also called as transparent dentin

- More common in the apical third of the root
- Physiologic response to aging
- Thought to be due to
  - Continued deposition of peritubular dentin
  - Deposition of mineral within the dentinal tubule
  - Mineralization of the odontoblastic process



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# Reparative dentin

- It is a form of tertiary dentin

Noxious stimulus on the pulp

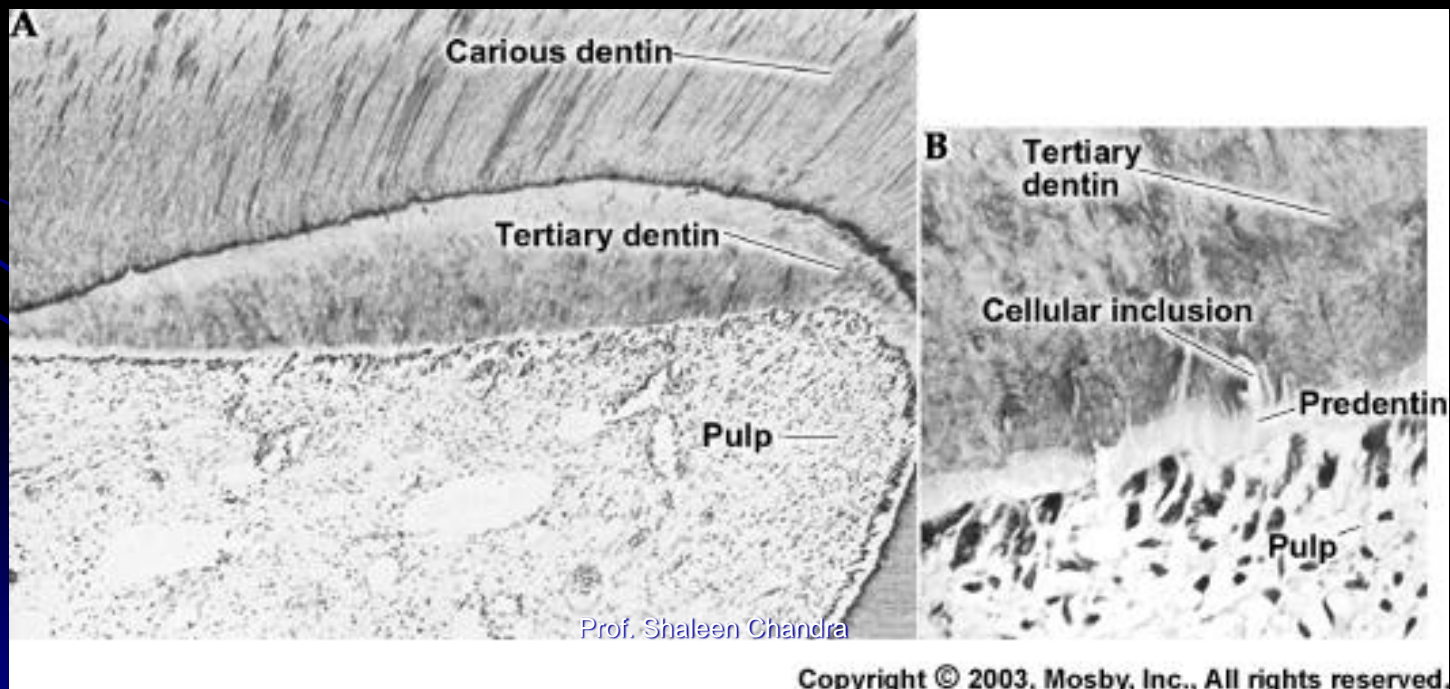


Differentiation of odontoblasts from undifferentiated cells in the pulp



Odontoblasts lay down a layer of dentin in the exposed area to protect the pulp from damage

- Fewer and more twisted tubules than normal dentin
- Dentin forming cells are usually trapped within the reparative dentin → osteodentin



# Dead tracts

Due to death and loss of odontoblastic process



Dentinal tubules become empty



Become filled with air



Appear black in transmitted light as air does not allow the light to pass

**A****B**



- Seen in areas of loss of odontoblastic process due to
  - Caries
  - Attrition
  - Abrasion
  - Erosion
  - Cavity preparation