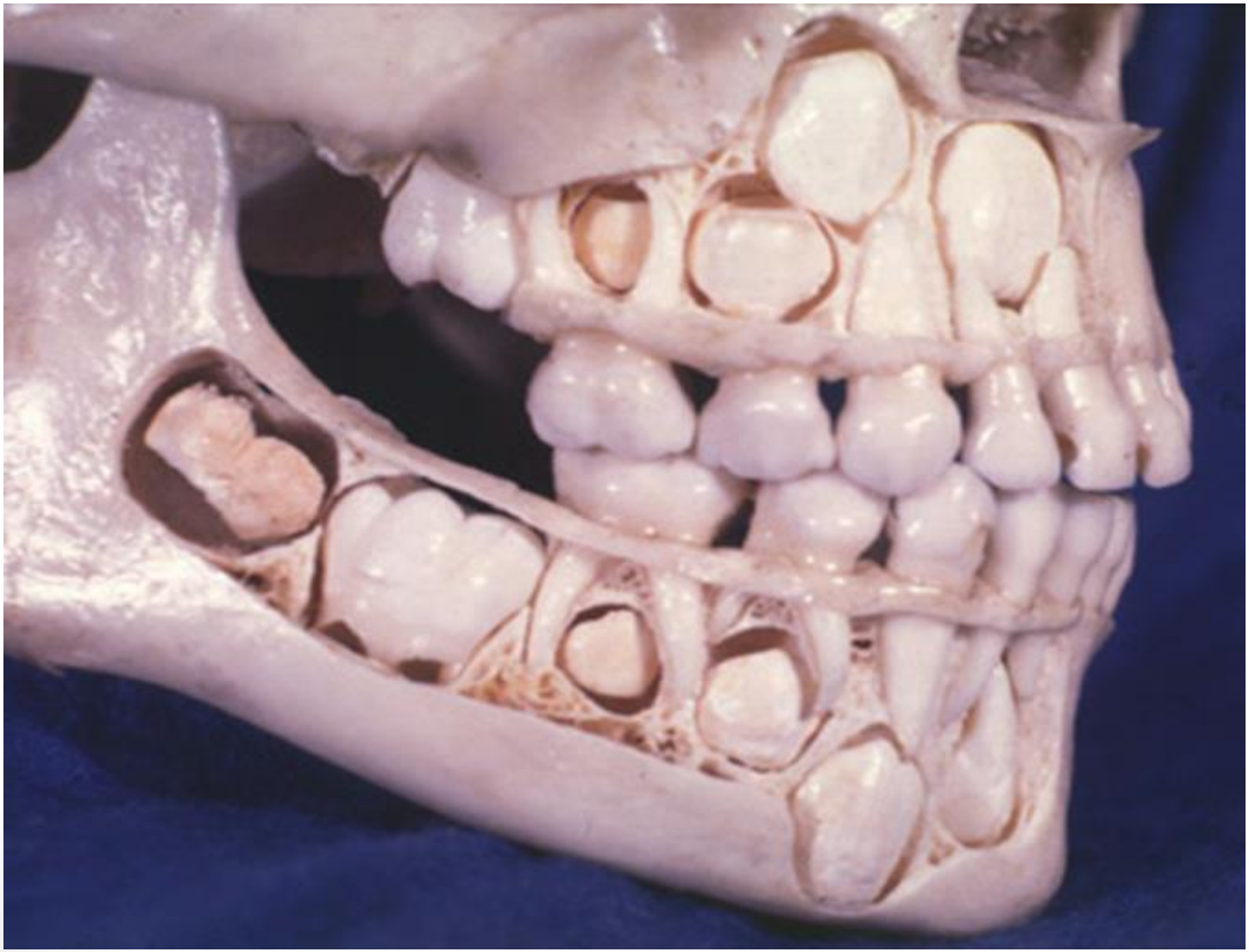
Tooth Eruption



- Eruption: Latin-***ERUMPERE, to break out***

Tooth Eruption is defined as the axial or occlusal movement of the tooth from its developmental position within the jaws to its functional position in the occlusal plane

(Massler and Schour 1941)

Phases of Tooth Eruption

- **Pre-eruptive phase**
- **Eruptive Phase**
- **Post-eruptive phase**

Phases of Tooth Eruption

- **Pre-eruptive phase**

➢ The means by which teeth are placed in the jaws for eruptive movement

➢ **Combination of 2 factors:**

- Total bodily movement of tooth germ
- Growth of one part of tooth germ while other part remains fixed

➢ Occurs in an intra-osseous location, reflected in the bony remodeling taking place within the jaws

- **Eruptive Phase**

➢ Starts with **initiation** of root formation

➢ Made by teeth to move from its position within bone of the jaw to its functional position in occlusion.

➢ Has intraosseous and extraosseous compartments

➢ **4 stages:**

- root formation
- movement
- penetration and
- occlusal contact

- **Post-eruptive phase**

➢ Takes place after the teeth are functioning

➢ Maintain the position of the erupted tooth in occlusion while the jaws are continuing to grow and

➢ Compensate for occlusal and proximal tooth wear.

Axial migration

Mesial migration

Pre-eruptive tooth movement

When deciduous tooth germ first differentiate they are extremely small and there is a good deal of space for them in the developing jaw.

Because the tooth germs grow rapidly, however they become crowded together particularly in the anterior of jaw.

- This crowding is gradually ellivated by the lengthening of the jaws , which permits the 2nd deciduous molar tooth germ to move backwards and anterior tooth germ move forward

- Successional tooth germs develop on the lingual aspect of their deciduous predecessor in the same bony crypt. From this position the tooth germ shift considerably as the jaw develop.

INCISOR and **CANINE**

- Eventually come to occupy a position in their own bony crypt on lingual surface of their deciduous.

PREMOLARS

- Also in their own bony crypt finally position between the divergent roots of the deciduous molars.

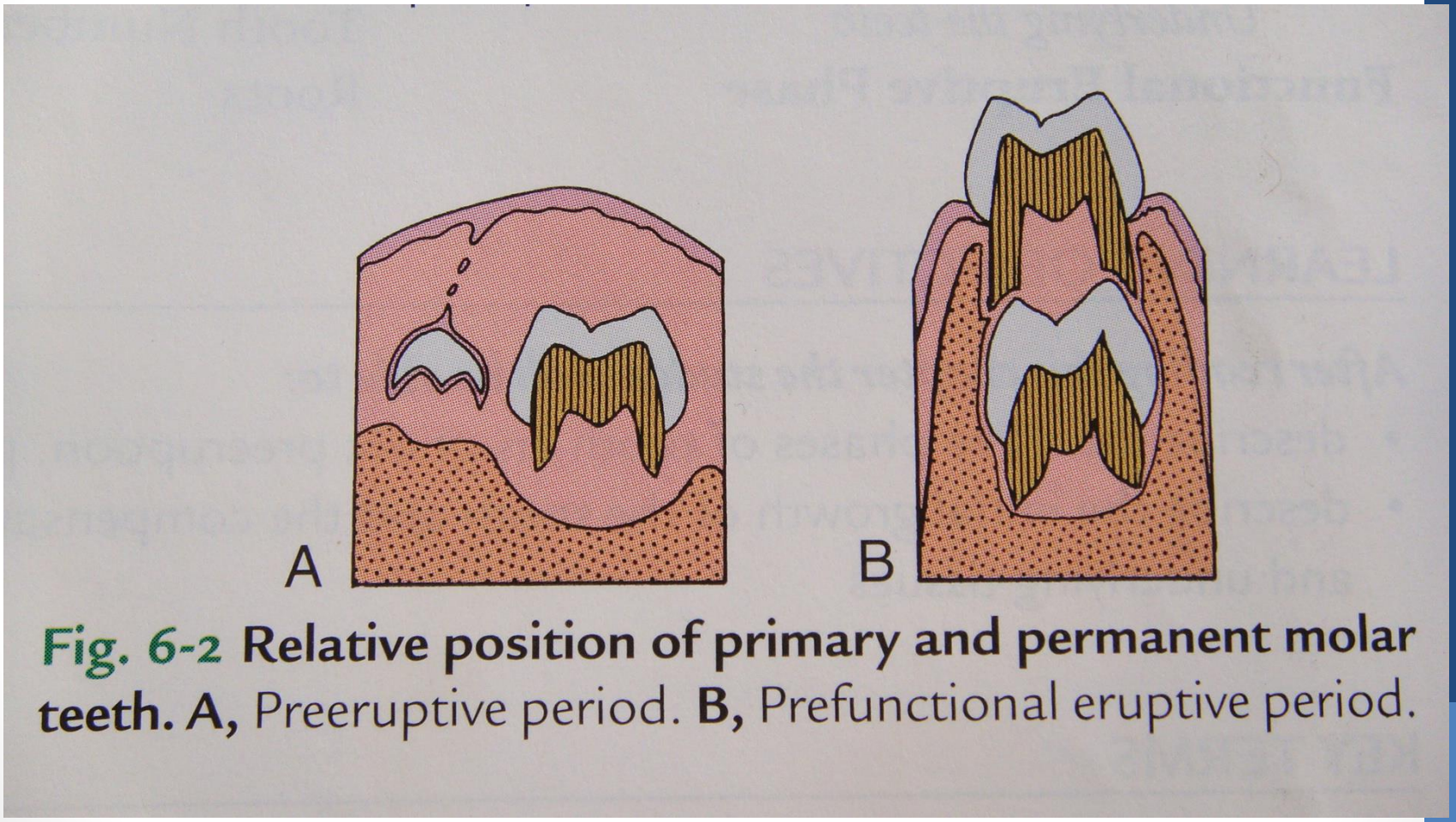


Fig. 6-2 Relative position of primary and permanent molar teeth. A, Preeruptive period. **B,** Prefunctional eruptive period.

PERMANENT MOLAR tooth germ

- No predecessors , develop from backward extension of the dental lamina as there is little space to accommodate these tooth germ.

  - In MAXILLA : MOLAR tooth germ first develop with their occlusal surface facing DISTALLY placed,and can swing into position when maxilla has grown sufficiently.

  - In MANDIBLE : permanent MOLAR develop with their axis showing MESIAL inclination , vertical later.

Pre- eruptive tooth movement:

- Movement positioning the tooth and its crypt within the growing jaws preparatory to tooth eruption.

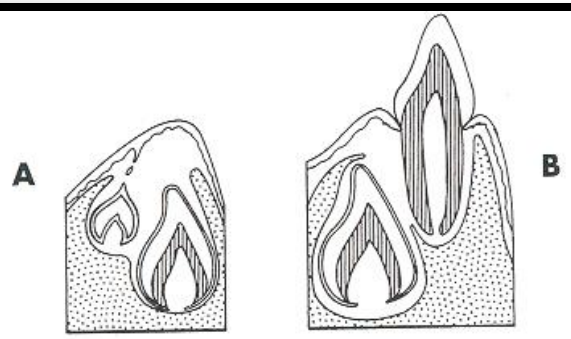


FIG. 6-1 Relative position of primary and permanent incisor teeth in, **A,** preeruptive and, **B,** prefunctional eruptive periods.

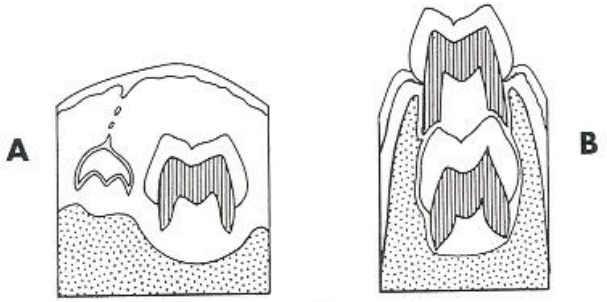
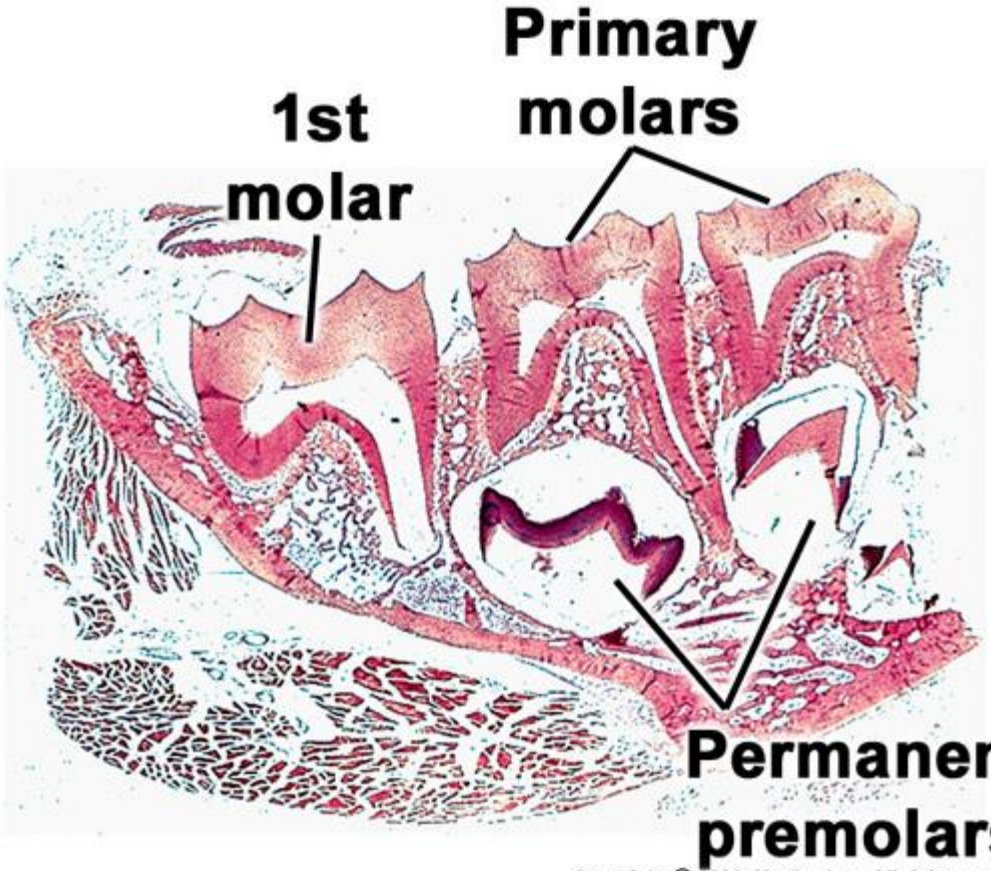
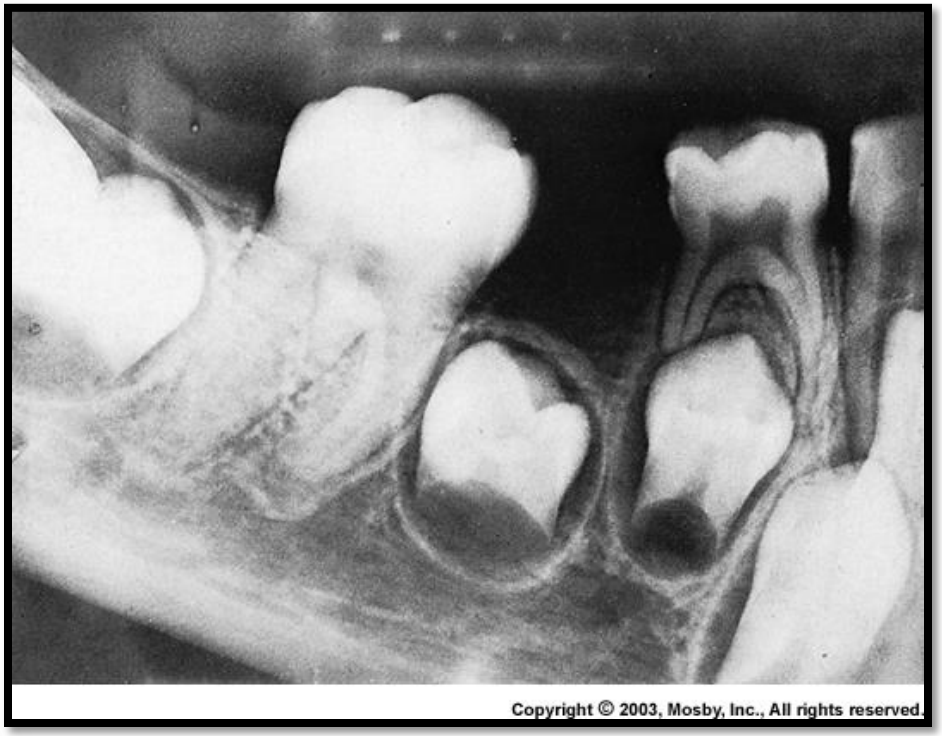
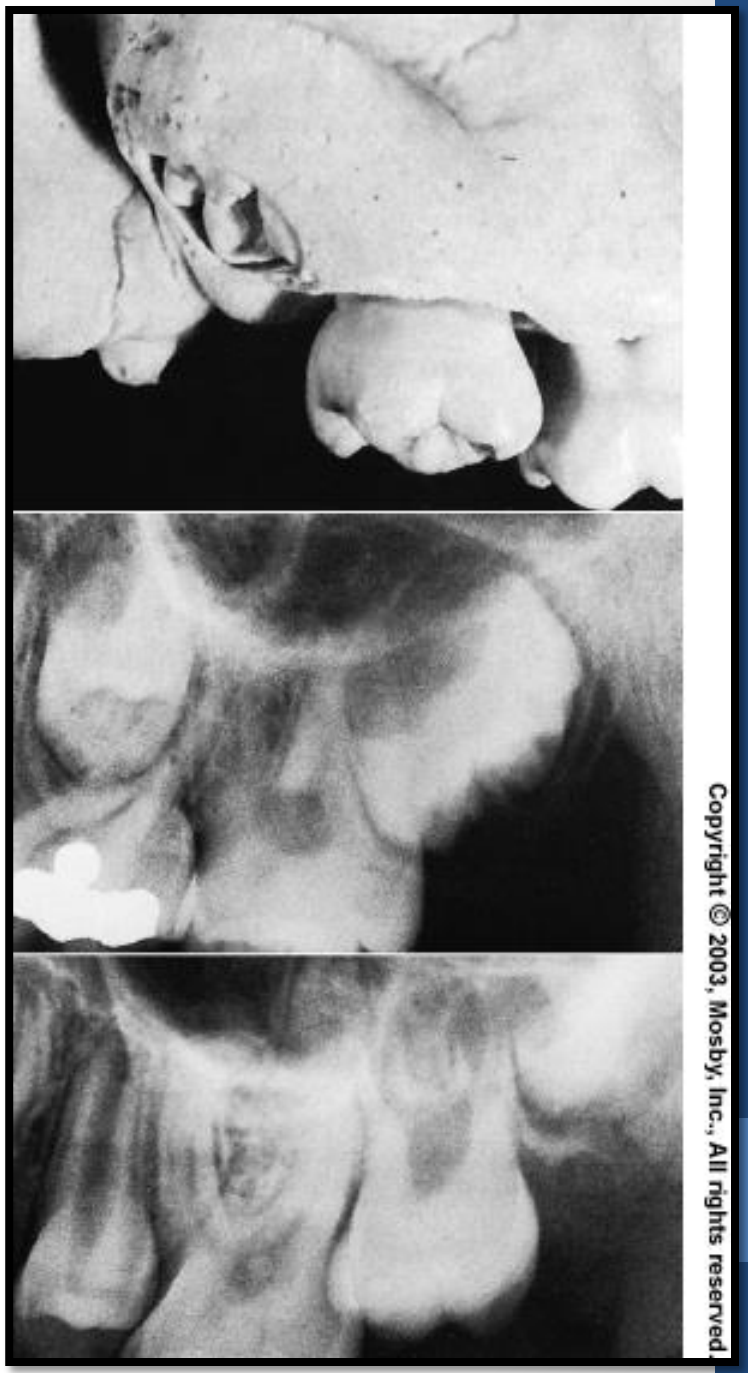


FIG. 6-2 Relative position of primary molar and perm nent teeth in, **A,** preeruptive and, **B,** prefunctional erupti periods.







Eruptive Tooth Movement

- **4 major events occur:**

➢ **Root formation**

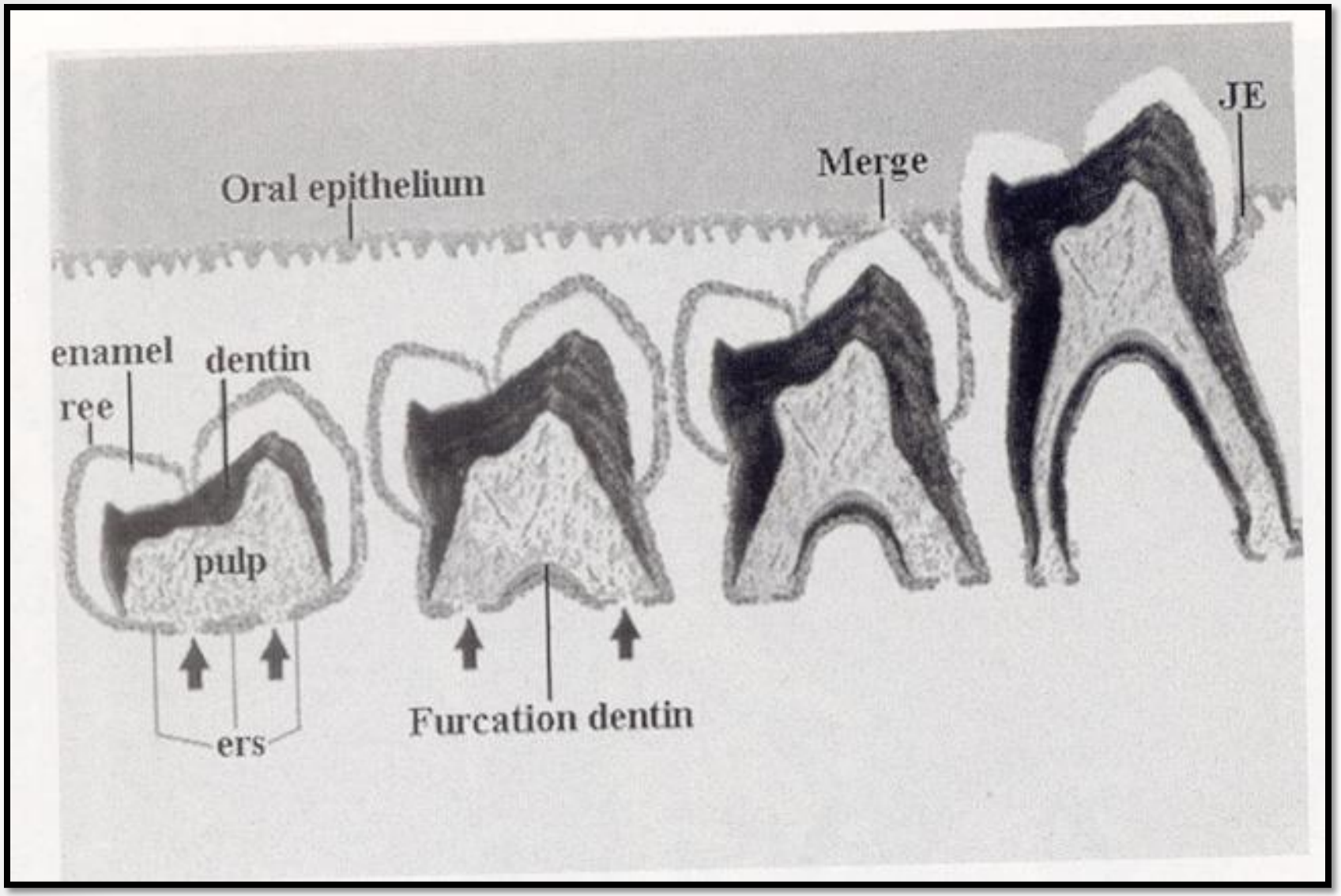
- Space is required for root formation
- Proliferation of epithelial root sheath
- Initiation of root dentin and pulp
- Increase in fibrous tissue of the follicle

➢ **Movement**

- Occurs incisally or occlusally
- The main reason for movement is so that the roots can form normally
- Reduced enamel epithelium fuses and contacts the oral epithelium

- **Penetration** of the tooth's crown tip through the fused epithelial layers allowing entrance of the crown into the oral cavity

- **Intraoral incisal or occlusal movement** of the erupting tooth continues until clinical contact with the opposing crown occurs


Oral epithelium
Merge
JE
enamel
dentin
ree
pulp
ers
Furcation dentin

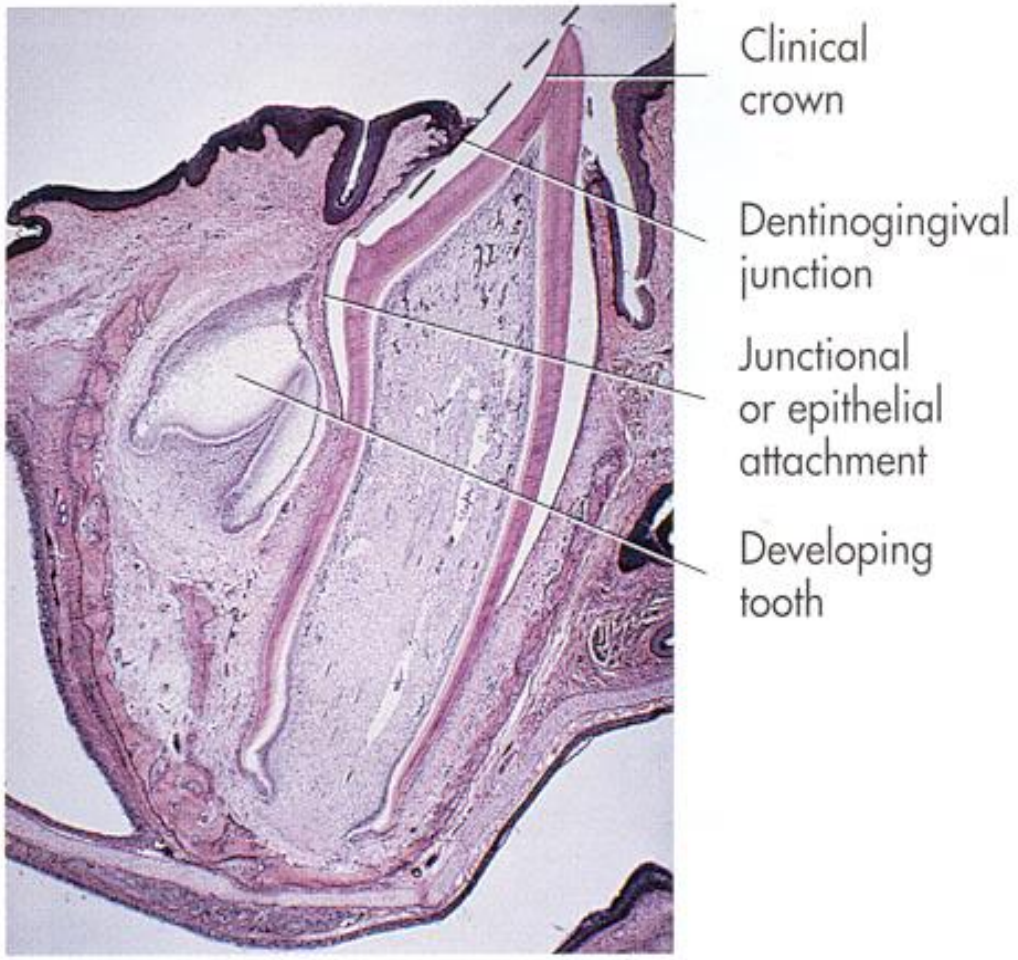
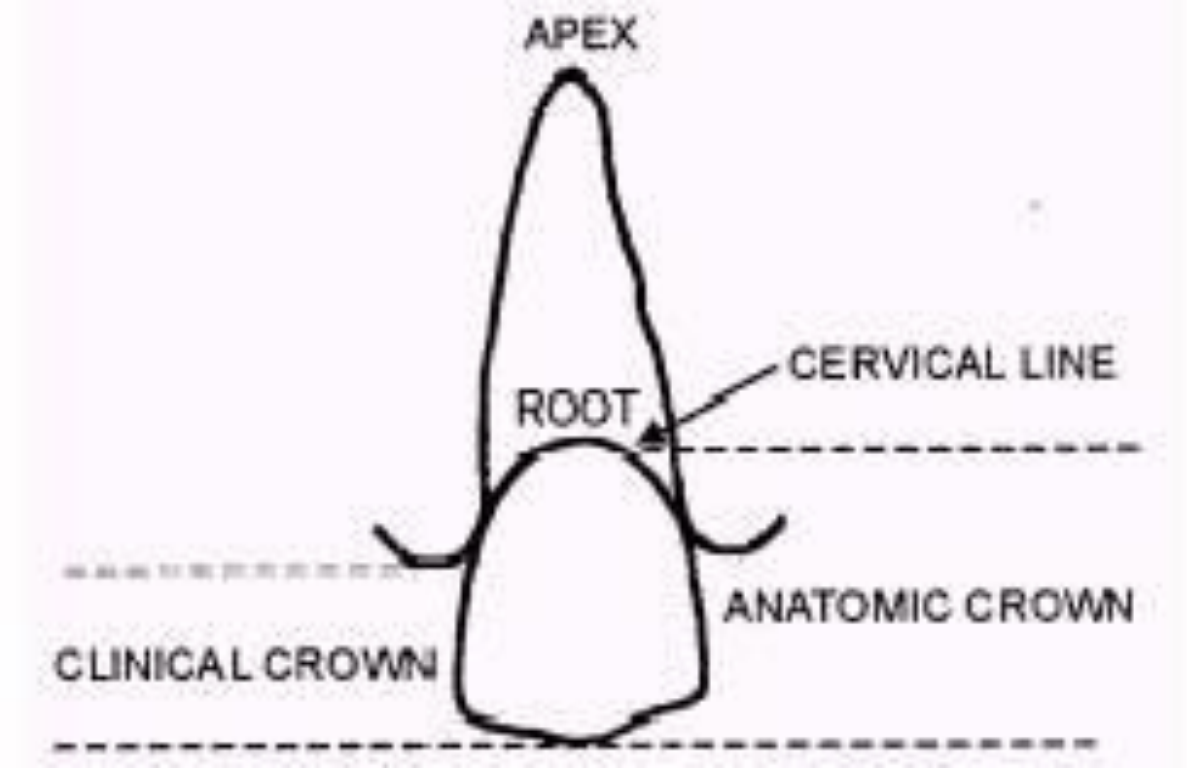


FIG. 6-7 Histology of erupting primary tooth and appearance of clinical crown in mouth. Permanent tooth's position is shown on left. Dotted line indicates cuticle overlying enamel surface of erupting tooth.

Clinical crown: During eruption, the exposed crown extending from the cusp tip to the area of the gingival attachment

Anatomic crown: Entire crown, extending from cusp tip to the Cemento-enamel (CE) junction



Changes occurring in tissues overlying erupting teeth

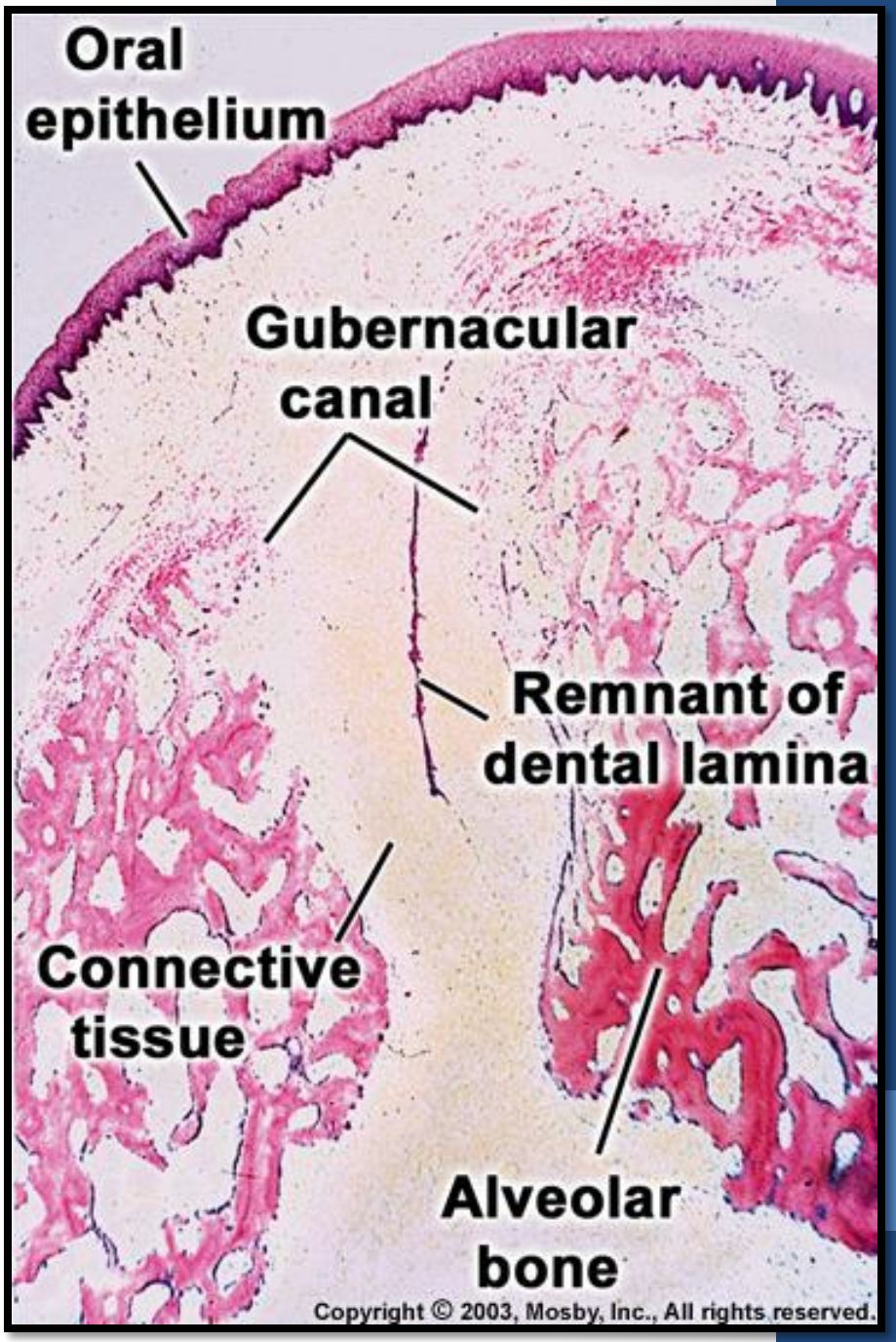
- Degeneration of connective tissue (decrease in blood vessels and degeneration of nerves) immediately overlying the erupting teeth
- Eruption pathway – altered tissue area overlying the teeth
- Macrophages destroy cells and fibers by secreting hydrolytic enzymes

- **Gubernacular cord:** The connective tissue overlying a successional tooth that connects with the lamina propria of the oral mucosa by means of a strand of fibrous connective tissue that contains remnants of dental lamina

- **Gubernacular canal:** Holes noted in a dry skull noted lingual to primary teeth in jaws that represent openings of gubernacular cord

- As the successional teeth erupt, gubernacular canal widens enabling tooth to erupt


Eruption pathway
Enamel space


Oral epithelium
Gubernacular canal
Remnant of dental lamina
Connective tissue
Alveolar bone
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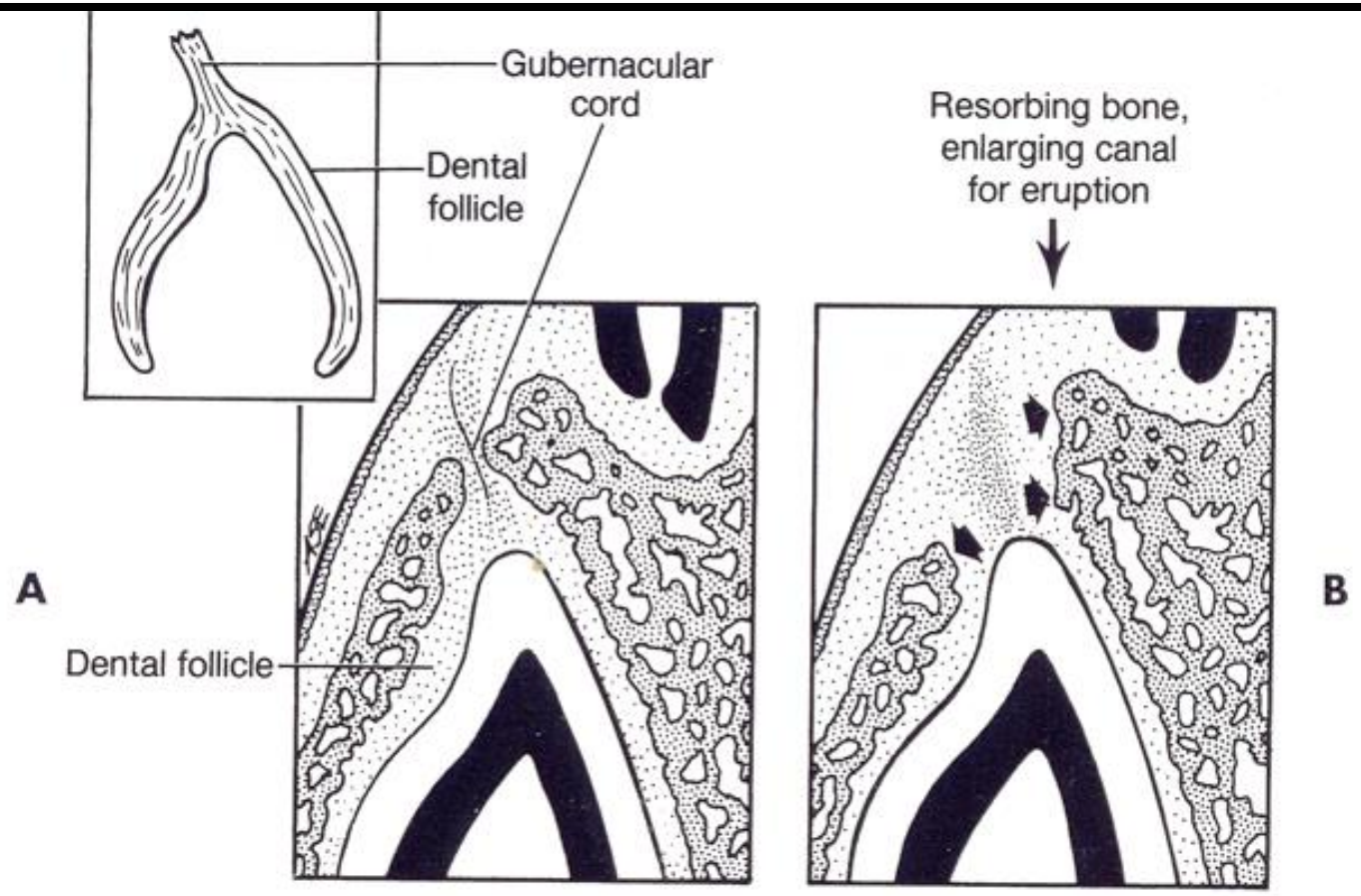
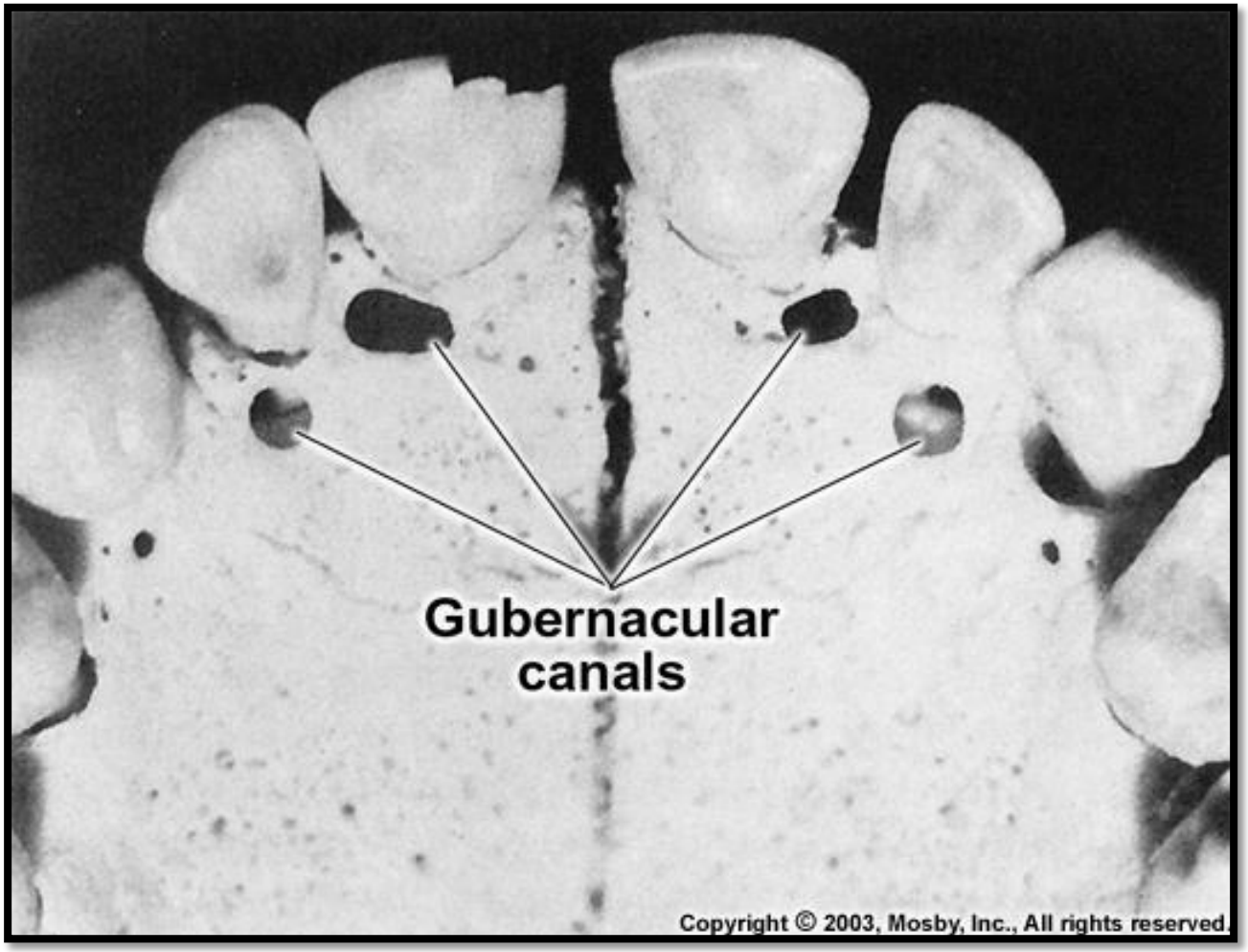


FIG. 6-10 Developing eruption pathway. **A,** Gubernaculum dentis. **B,** Bone resorption in eruption pathway.


Gubernacular
canals
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Histology of Surrounding tissues

- The surrounding fibers change from being parallel to the tooth surface to bundles that are attached to the tooth surface and extending towards the periodontium (bone)

- The periodontal ligament have contractile properties and changes drastically during eruption

- During eruption, collagen fiber formation and turnover are rapid enabling fibers to attach and release and attach in rapid succession. Some fibers may attach and reattach later while the tooth moves occlusally as new bone forms around it and the fibers will organize and increase in number and density as the tooth erupts

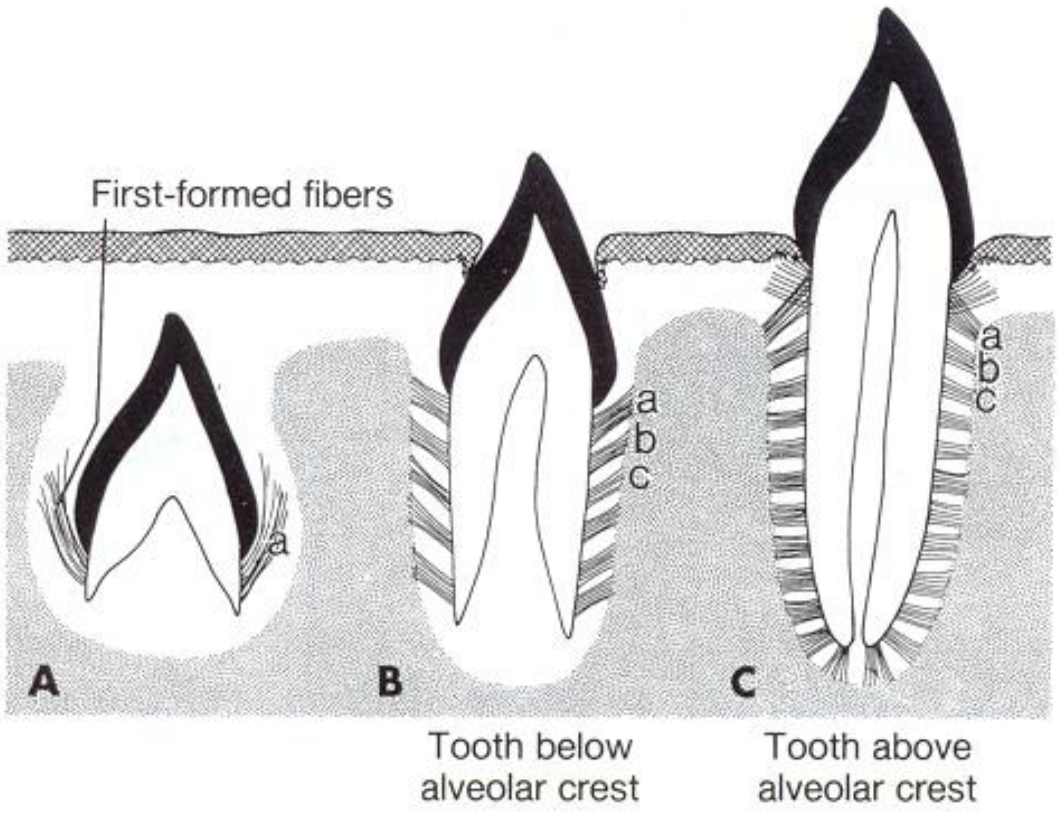


FIG. 6-20 Principal fiber development during tooth eruption. **A,** Origin of fibers at the cervical area. **B,** Fiber development with root growth. **C,** Change in orientation of the fibers with occlusal function. *a,* Initial fiber formation. *b,* Development of secondary fibers. *c,* Further fiber development. Initial fiber groups change direction. Observe the changes in direction of these initial fiber groups.

Histology of the underlying tissues

- As the tooth moves occlusally it creates space underneath the tooth to accommodate root formation
- Fibroblasts around the root apex form collagen that attach to the newly formed cementum
- Bone trabeculae fill in the space left behind as the tooth erupts in the pattern of a ladder which gets denser as the tooth erupts
- After tooth reaches functional occlusion periodontal fibers attach to the apical cementum and extend into the adjacent alveolar bone

The rate of tooth eruption depends on the phase of movement

Intraosseous phase: 1 to 10 µm/day

Extraosseous phase: 75 µm/day

Environmental factors affecting the final position of the tooth:
Muscular forces
Thumb-sucking
Tongue thrusting
Mouth breathing

Mechanism of eruptive tooth movement

- Multi factorial process
- Theories of Tooth Eruption

1. Root formation theory

- Should be an obvious cause of tooth eruption
- But studies have not provided evidence for this. If a tooth that is continuously erupting is prevented from eruption, the root still forms by causing bone resorption.
- Rootless tooth still erupt, some teeth erupt more than the total length of the roots and the teeth still erupt after completion of root formation.
- The tissue beneath the growing root resists the apical movement of the developing root. This resistance results in the occlusal movement of the tooth crown as the root lengthens.

- If root formation is a result to eruptive force, the apical growth of root needs to be translated into occlusal movement and requires a presence of fixed base.
- No fixed base exists.
- Pressure– bone resorption

- **Cushion hammock ligament:**
- At the Base of the socket
- No bony insertion– cant act as fixed base

ROOT DEVELOPMENT IS A CONSEQUENCE AND NOT A CAUSE OF TOOTH ERUPTION. ROOT FORMATION IS ACCOMODATED IN TOOTH ERUPTION.

2. Bone Remodeling Theory

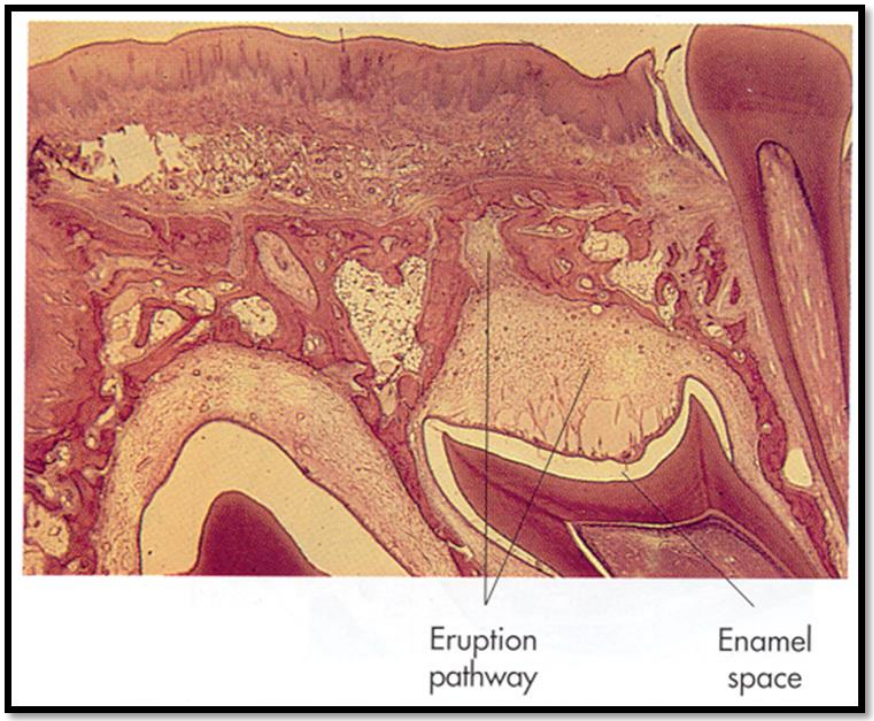
- **Bone Remodeling:**
- Major proof is when a tooth crown is removed without disturbing its follicle or the tooth germ is wired down, an eruptive pathway still forms within bone as osteoclasts widen the gubernacular canal
- If the dental follicle is also removed no eruption path develops
- It is assumed that the follicle provides the source of osteoclastic and osteoblastic activity
- Bone formation also occurs apical to the developing tooth

3. PDL Traction theory

- **Periodontal ligament:**
- Formation and renewal of PDL can be a factor in tooth eruption
- Traction power of the fibroblasts- fibronexus
- Presence of PDL does not always correlate with tooth eruption
- Other factors involved are vascular pressures within the PDL
- Examples of PDL being present but tooth not erupting and rootless teeth erupting have been reported.

4. Dental follicle

- Dental Follicle is defined as the soft tissue located between the bony crypt and the un-erupted tooth crown.
- It is connected to the overlying gingiva by a stalk like extension called the gubernaculum dentis.



- The follicle consists primarily of loose watery tissue in which is located a few connective tissue fibers that travel from the presumptive area of root development into gubernaculum dentis.

- Has been shown to function chemically in collagen breakdown that takes place during the bony remodeling processes.

Role of Dental Follicle

Dental Follicle: Studies have shown that the reduced dental epithelium initiates a cascade of intercellular signals that recruit osteoclasts to the follicle.

By providing a signal and chemo-attractant for osteoclasts, it is possible that the dental follicle can initiate bone remodeling which goes with tooth eruption.

Teeth eruption is delayed or absent in animal models and human diseases that cause a defect in osteoclast differentiation.

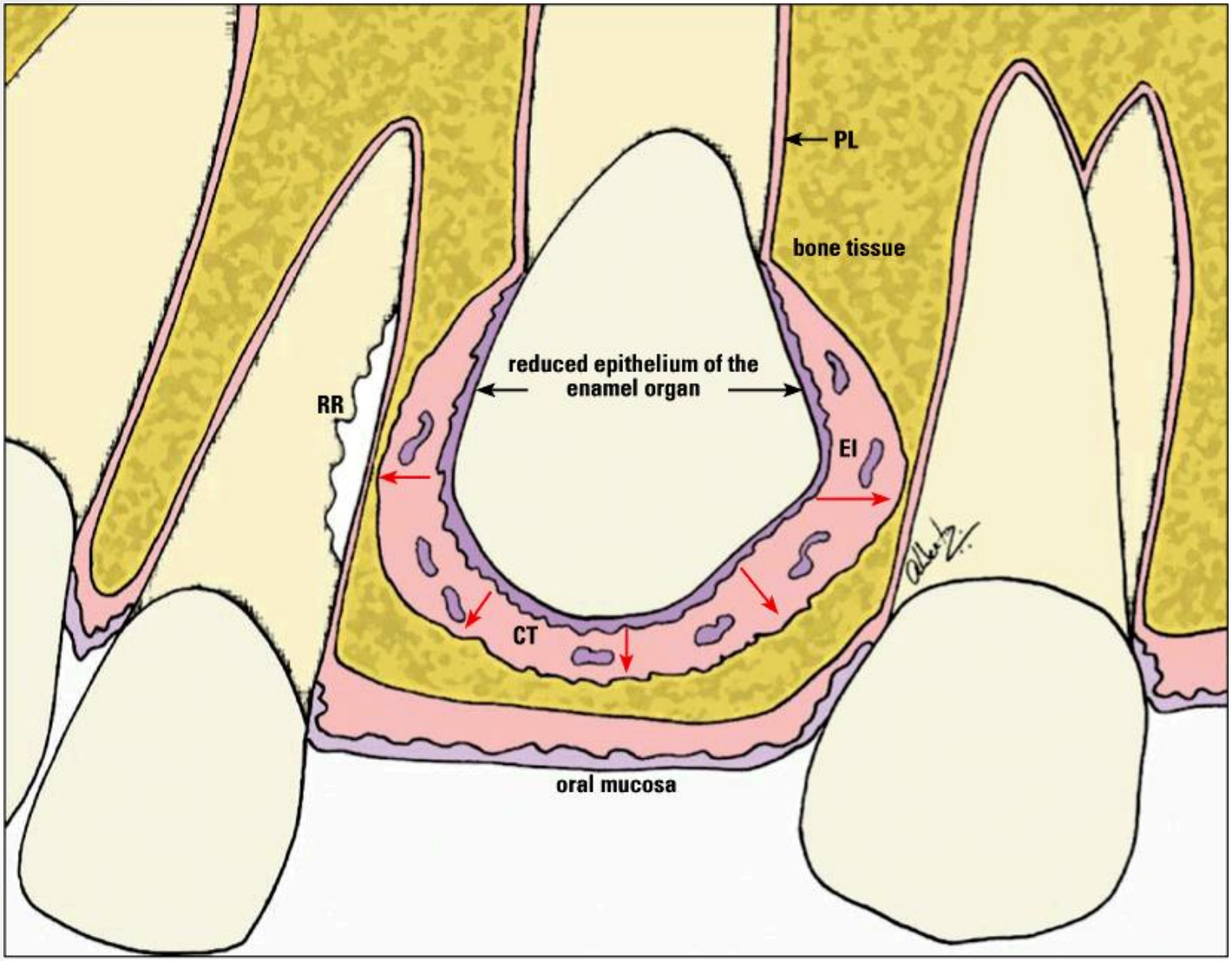


FIGURE 2 - Epithelial structures of the dental follicle—such as the reduced epithelium of the enamel organ and the epithelial islands/cords remnants of the dental lamina (EI)—constantly release epidermal growth factor (EGF, red arrows) in the connective tissue (CT). This mediator, along with other EGF-activated mediators, induces pericoronal bone resorption, an essential phenomenon in the occurrence of tooth eruption. When the path of an unerupted tooth compresses the vessels of the periodontal ligament (PL) of adjacent teeth—with or without orthodontic traction—cementoblasts die on the spot and the root is resorbed (RR) to give rise to the follicle and its moving crown.

- Follicle produces Colony Stimulating Factor-1
- CSF 1: Growth factor– causes differentiation of monocytes to osteoclasts
- Interleukin alpha: promotes bone resorption
- Proteases: by REE cells– breakdown of CT– path of least resistance.

Post-eruptive tooth movement

- Movements to accommodate the growing jaws. Mostly occurs between 14 and 18 years by formation of new bone at the alveolar crest and base of socket to keep pace wit increasing height of jaws.

- Movements to compensate for continued occlusal wear. Compensation primarily occurs by continuous deposition of cementum around the apex of the tooth. However, this deposition occurs only after tooth moves. Similar to eruptive tooth movement.

- Movements to accommodate interproximal wear. Compensated by mesial or approximal drift. Mesial drift is the lateral bodily movement of teeth on both sides of the mouth. Very important in orthodontics.

Several factors control mesial drift

- Several factors control mesial drift:

(a) Contraction of the trans-septal fibers

(b) Adaptability of bone tissue

(c) Anterior compartment of occlusal force

The rules of “Fours” for permanent tooth development (3rd molars not included)

At birth, four 1st molars have initiated calcification
At 4 years of age, all crowns have initiated calcification
At 8 years, all crowns are completed
At 12 years, all crowns emerge
At 16 years, all roots are complete

Rules of “sixes” in dental development

6 weeks old in utero: beginning of dental development
6 months old: emergence of the first primary tooth
6 years old: emergence of first permanent tooth

APPLIED ASPECTS

Problems of Primary Tooth Eruption

Natal and Neonatal Teeth

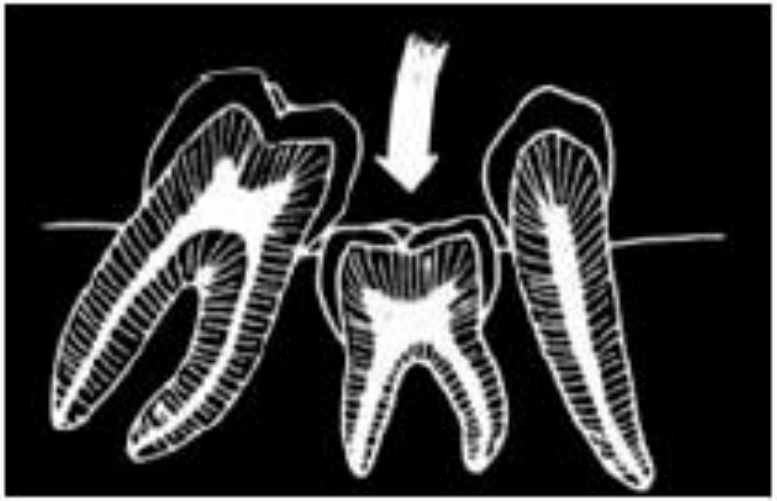
Retained Primary teeth

Submerged primary teeth

Ankylosed Teeth

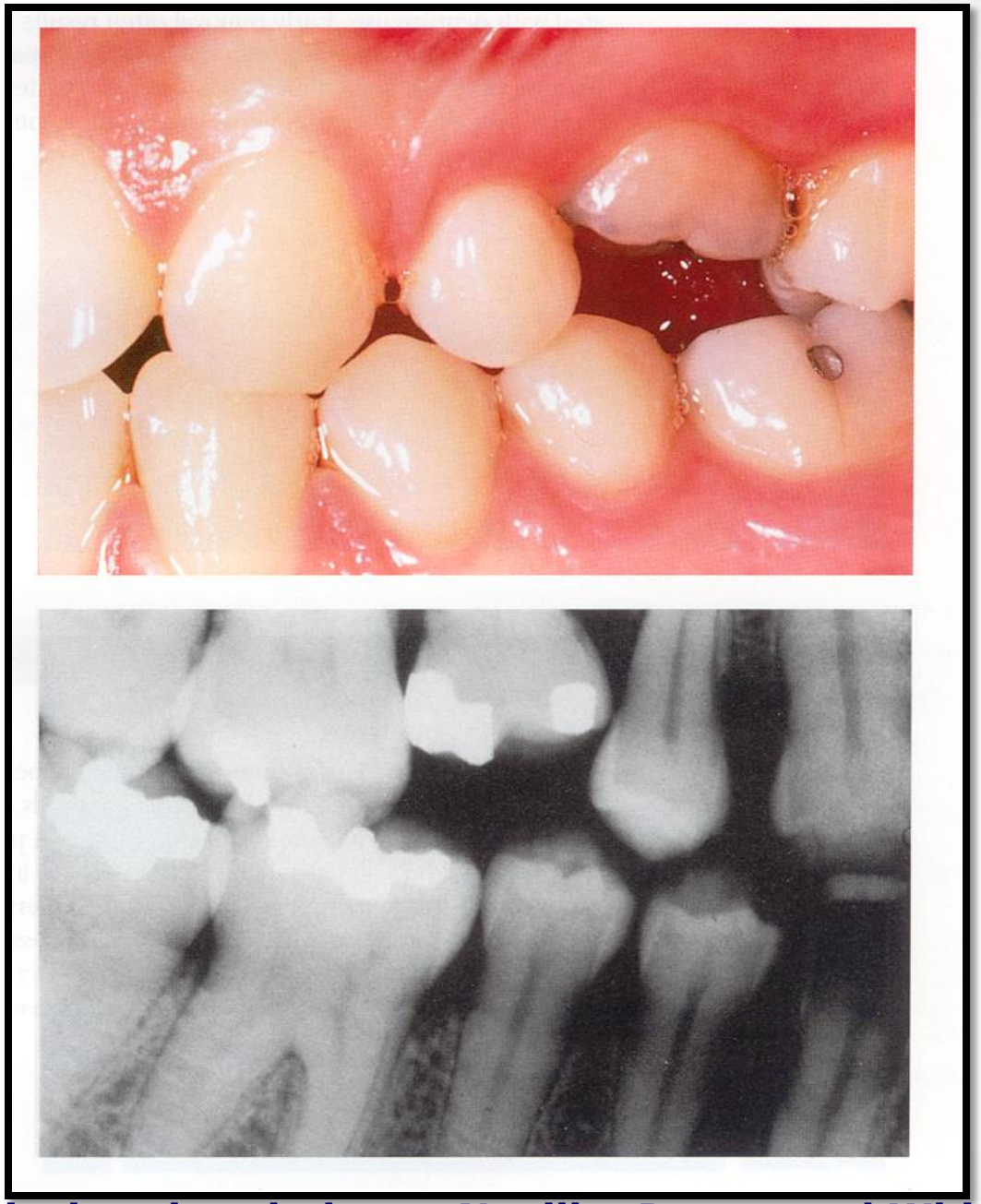
Submerged Teeth

Hyper or supra eruption



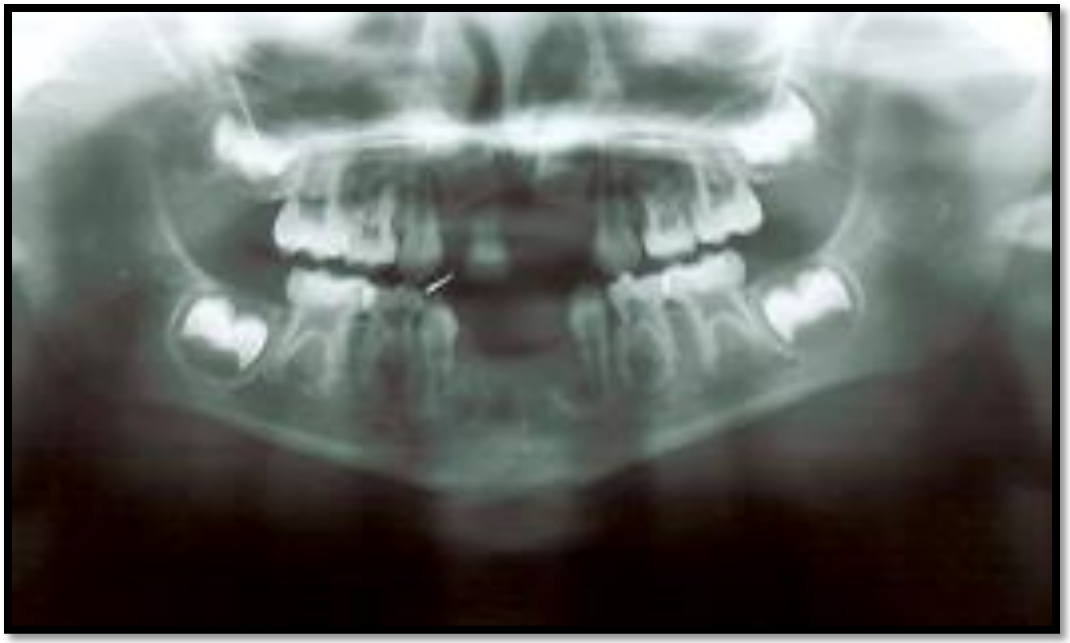
Submerged 2nd primary molar (potentially ankylosed)
Congenital missing of the 2nd permanent premolar

Ankylosis



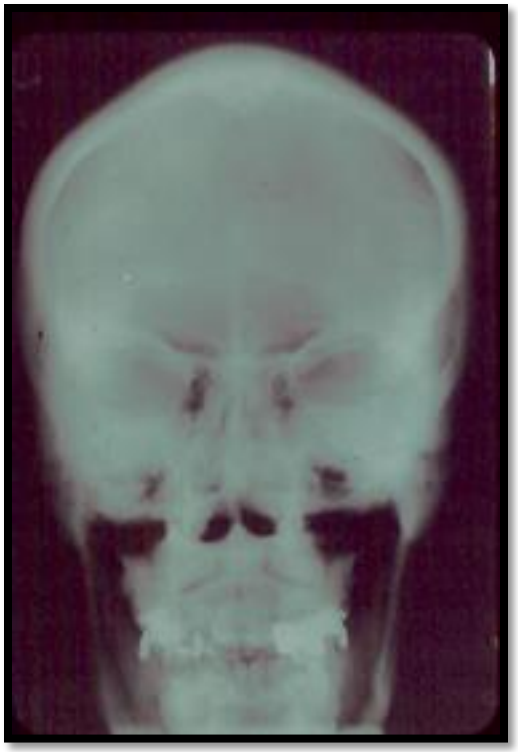
Source: Color atlas of clinical oral pathology. Neville, Damm and White. 2nd edition

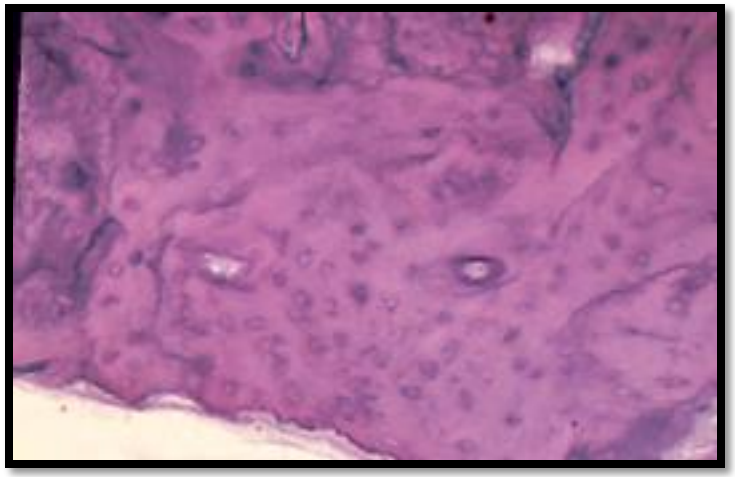
Congenitally Missing Teeth-Anodontia



Cleido-cranial Dysplasia

Osteo-petrosis – Defect in Osteoclasts





- **Multiple Calcifying hyperplastic Dental follicle-**defect of carbohydrate metabolism, multiple calcifications and mucopolysaccharidosis, excessive accumulation of dermatan sulfate associated with delayed eruption of permanent teeth
- **Delayed eruption**
- **Multiple unerupted teeth**
- **Impacted teeth**
- **Eruption sequestrum**

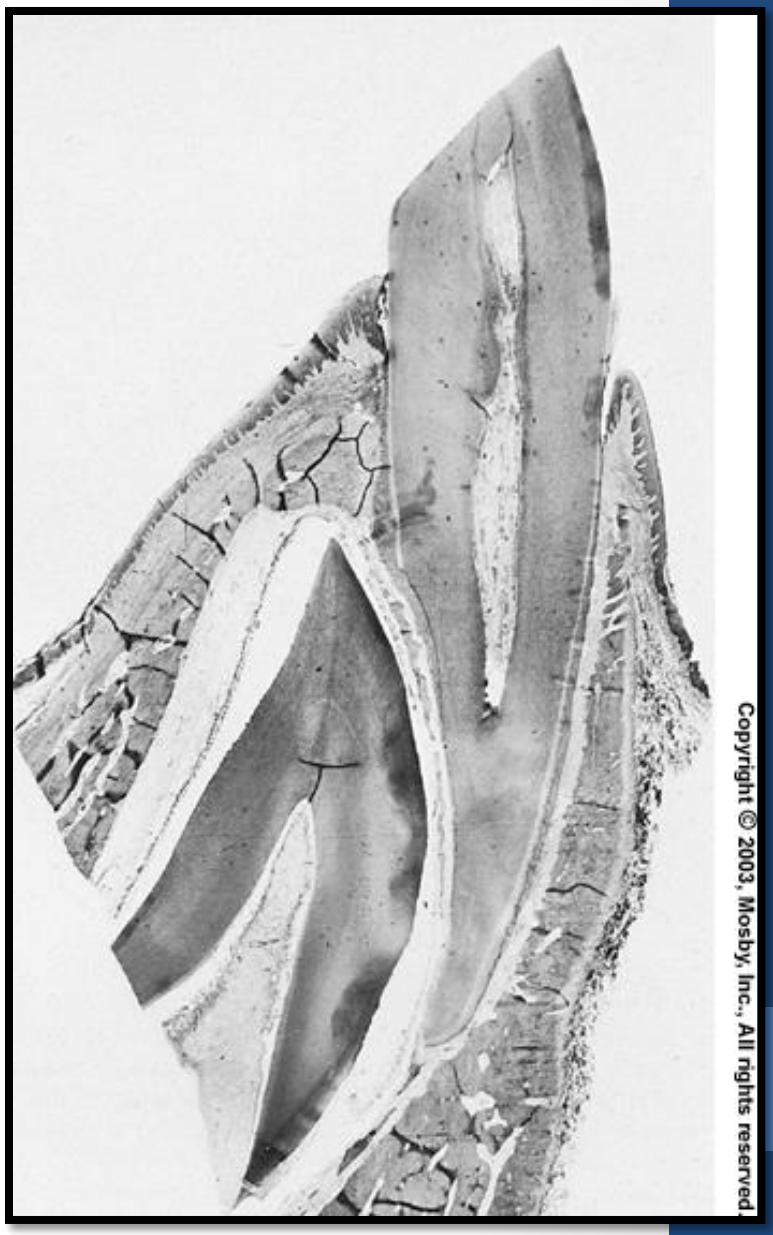
Shedding

- As the permanent incisors, canines and premolars develop, increase in size and begin to erupt, they influence the pattern of resorption and shedding of deciduous teeth.
- Def: The physiologic process resulting in the elimination of the deciduous dentition is called *Shedding or exfoliation*.

- Permanent incisors and canines develop lingually to the deciduous teeth

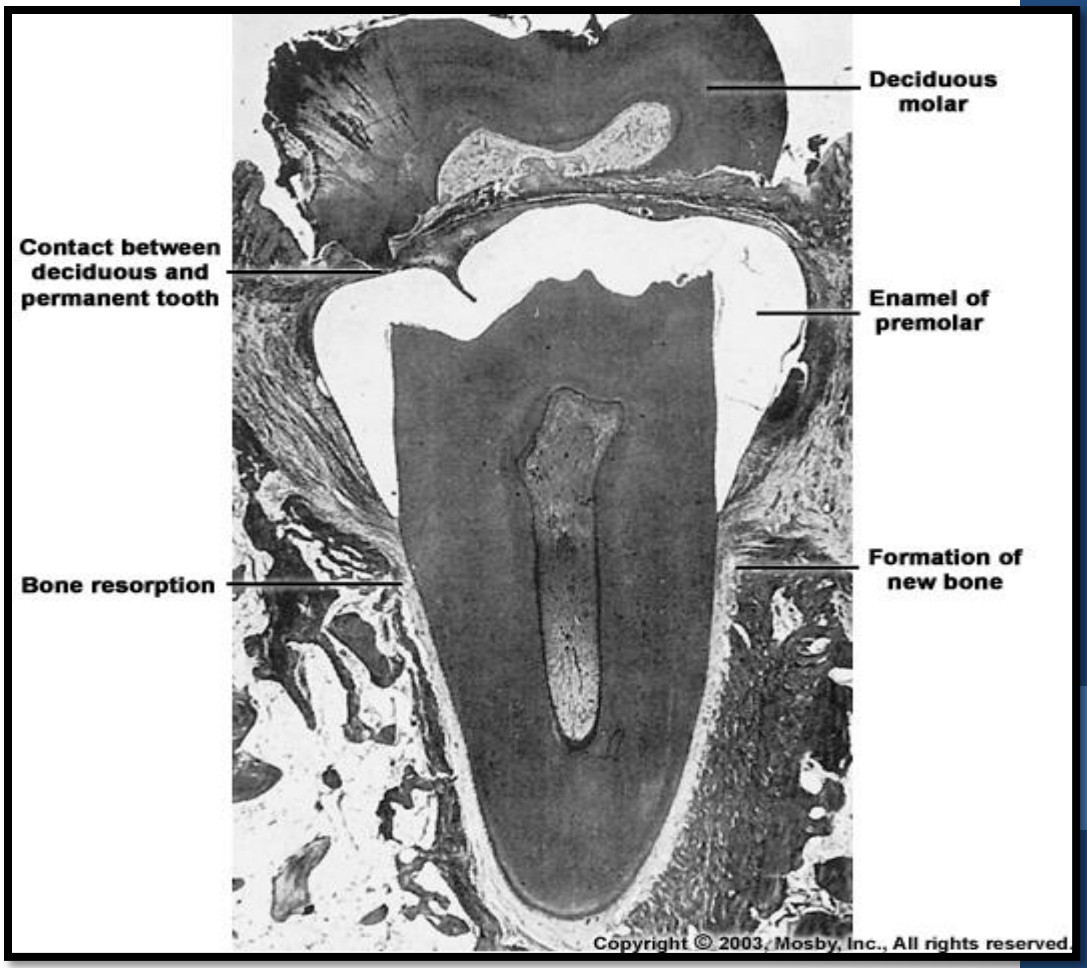
Erupt in an occlusal and vestibular direcion

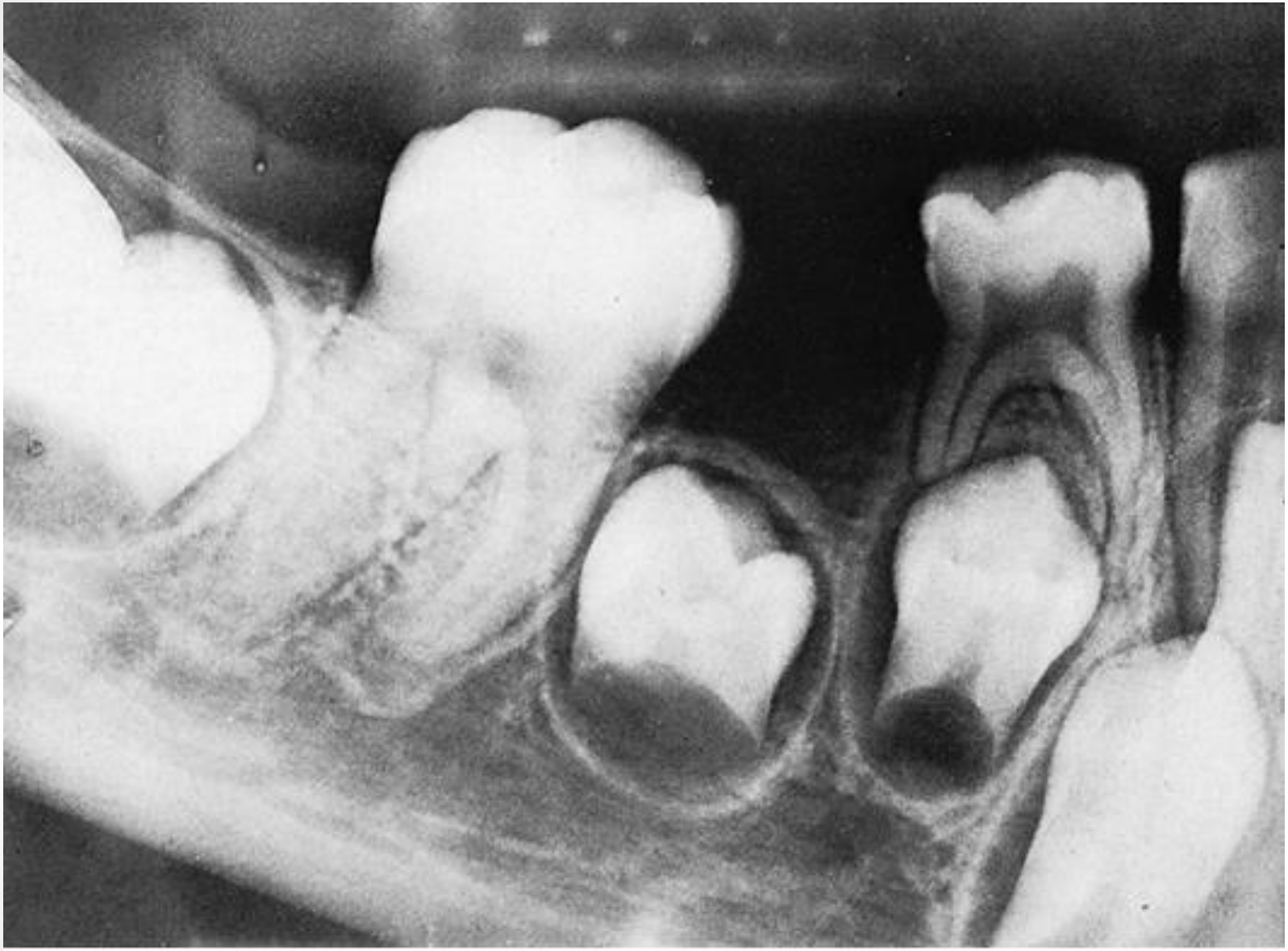
- Resorption of deciduous tooth roots occurs on lingual surface, and these teeth are shed with much of pulp chamber intact.



- **Permanent premolars** develop between the divergent roots of deciduous molars and erupt in an occlusal direction.

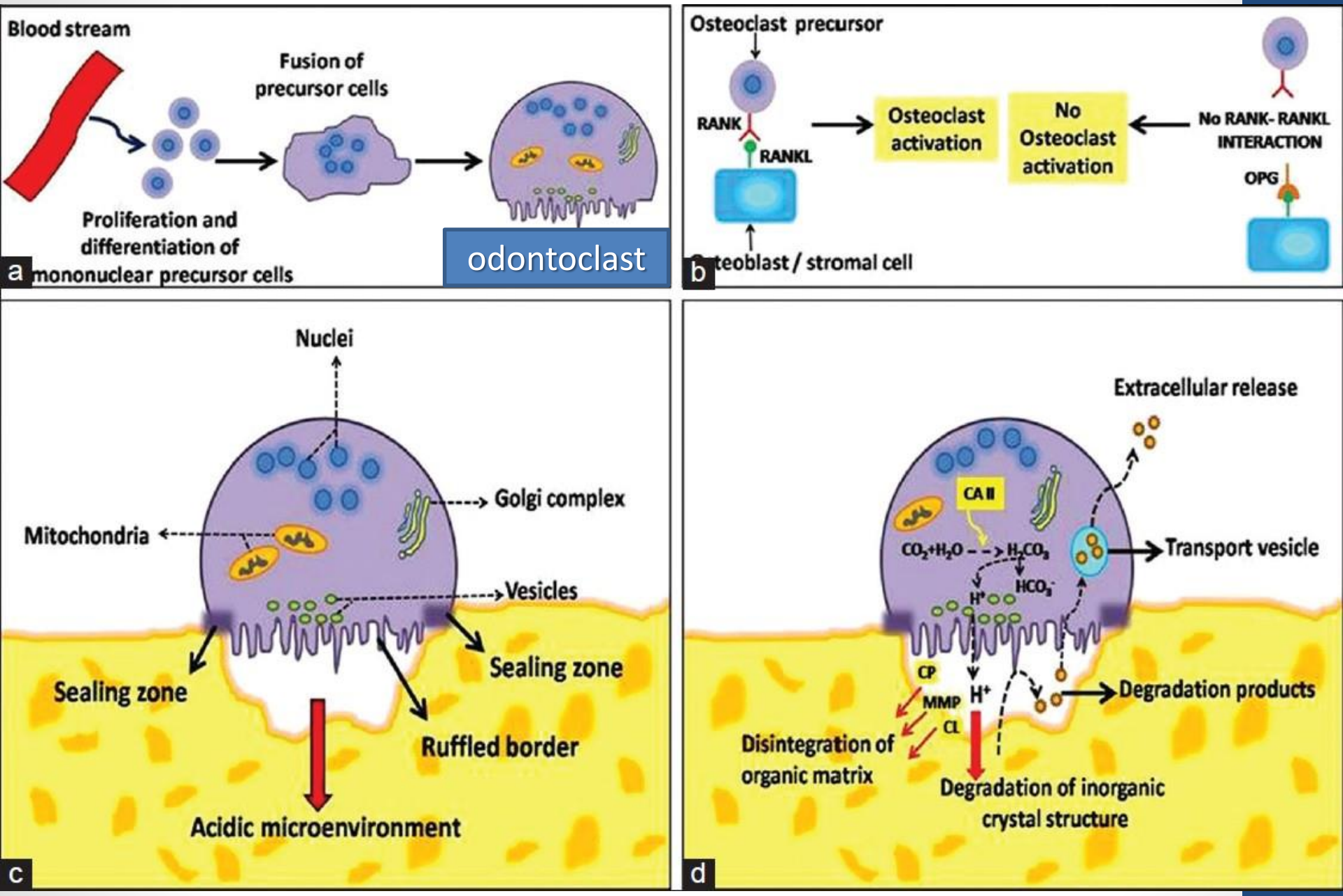
- Resorption of interradicular dentin takes place with resorption of pulp chamber, coronal dentin and sometimes enamel.

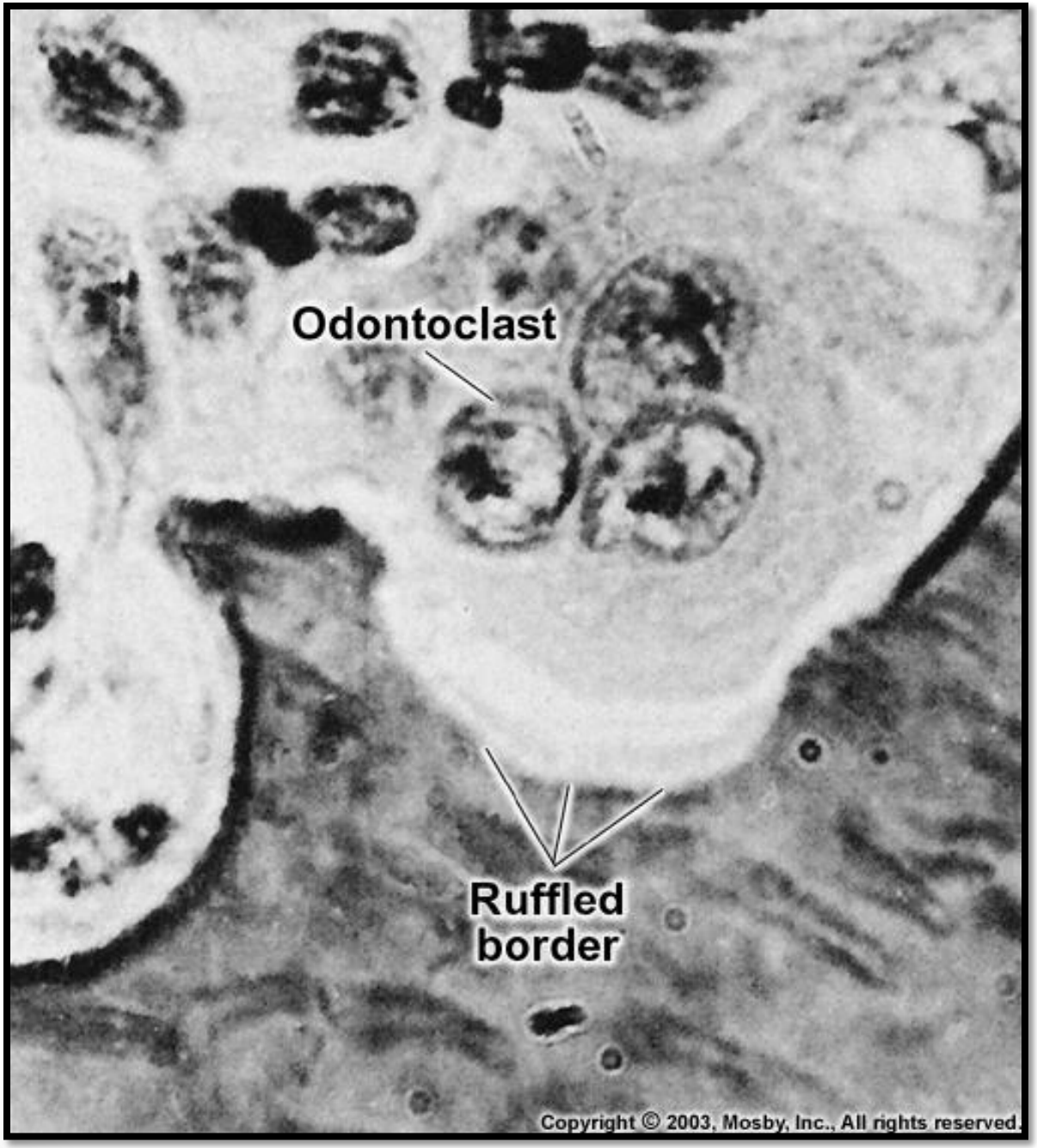




Odontoclast

- Histologic nature similar to osteoclast
- Involved in removal of dental tissues– odontoclast
- Derived from monocyte and migrate from blood vessels to the resorption site.
- Where they fuse to form multinucleated odontoclast.
- Clear attachment zone and ruffeled border.


Blood stream
Fusion of precursor cells
Proliferation and differentiation of mononuclear precursor cells
odontoclast
a
Osteoclast precursor
RANK
RANKL
Osteoclast activation
No Osteoclast activation
No RANK- RANKL INTERACTION
OPG
teoblast / stromal cell
b
Nuclei
Golgi complex
Mitochondria
Vesicles
Sealing zone
Sealing zone
Ruffled border
Acidic microenvironment
c
Extracellular release
CA II
CO_2+H_2O H_2CO_3
HCO_3^-
H^+
Transport vesicle
CP
MMP
CL
H^+
Degradation products
Disintegration of organic matrix
Degradation of inorganic crystal structure
d


Odontoclast
Ruffled border
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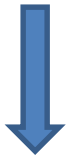
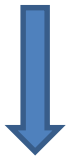
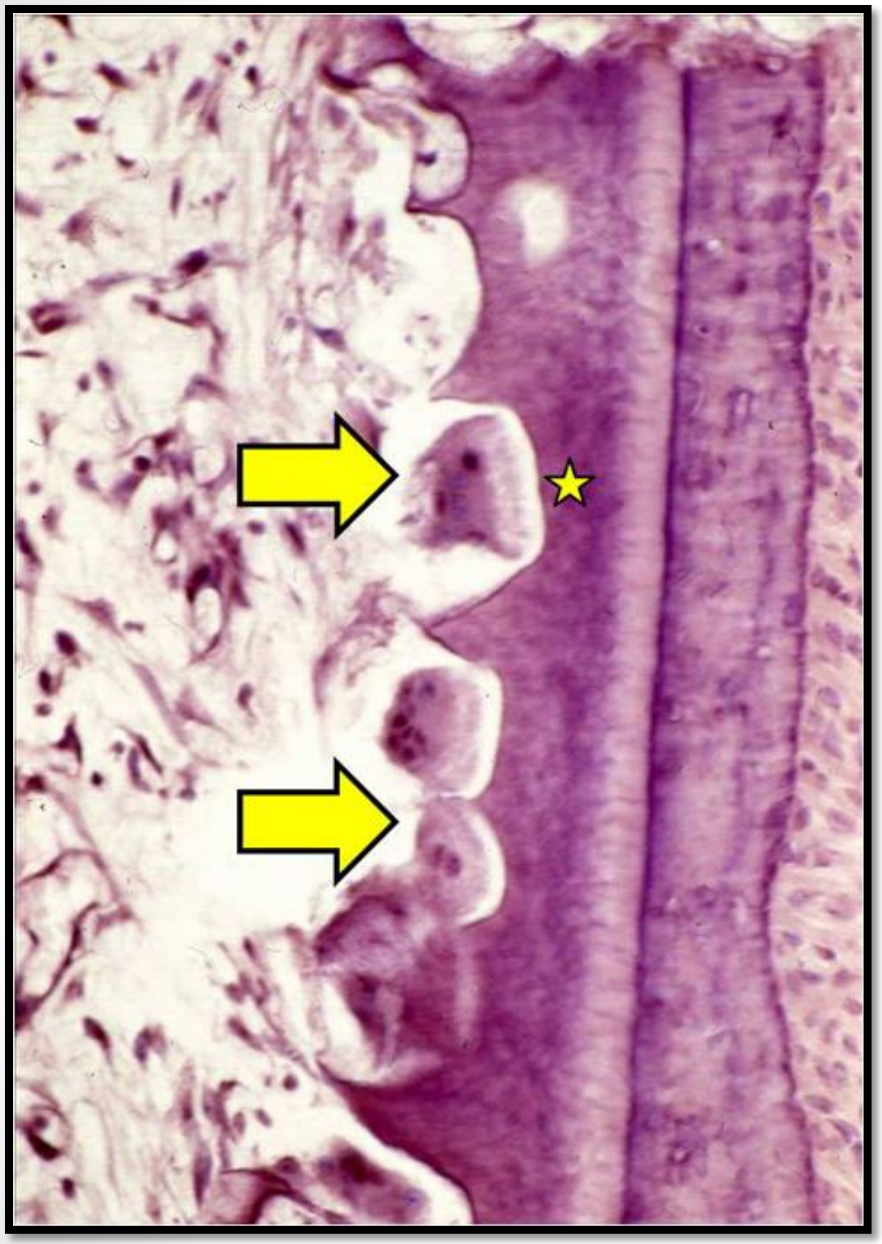
- Although active root resorption is taking place, coronal pulp appears normal and odontoblast still lie at surface of predentine.

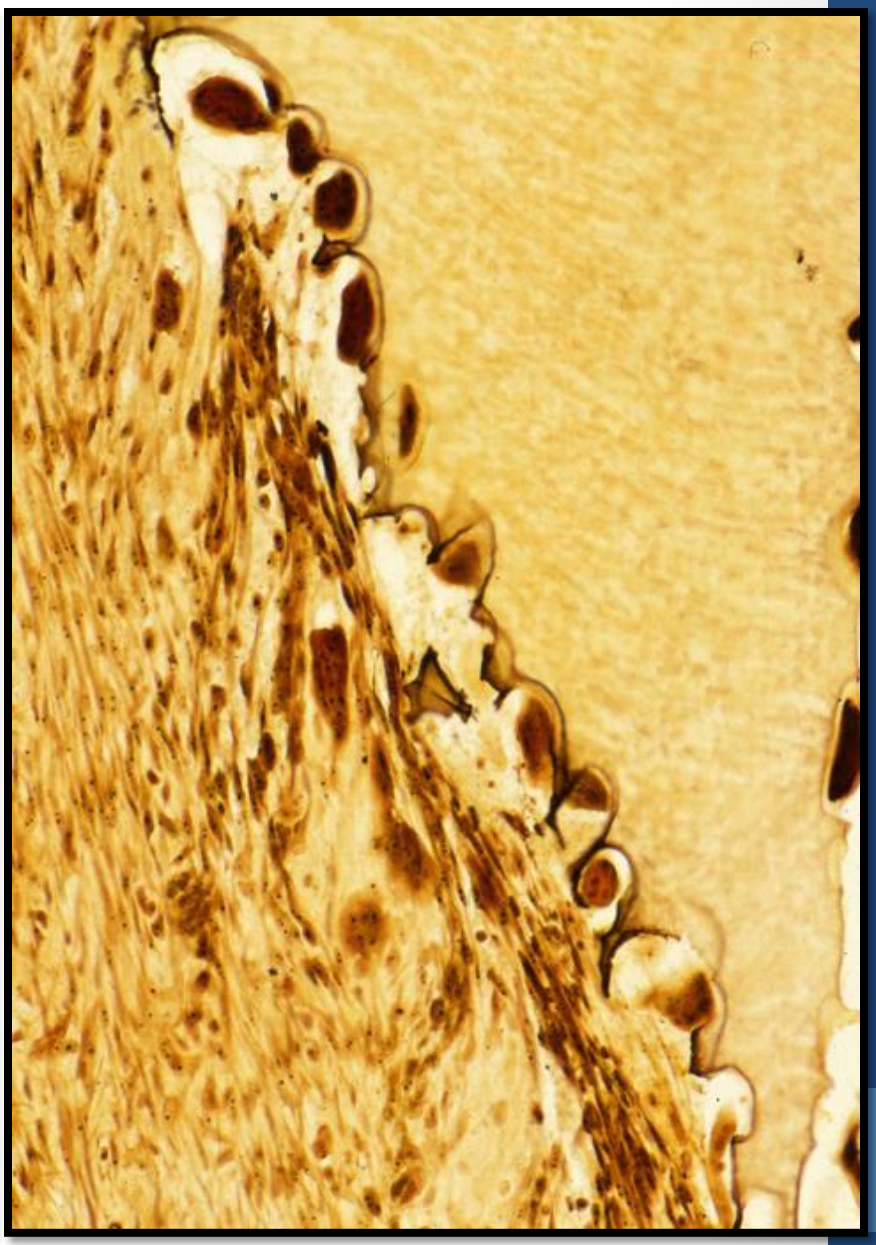


- When root resorption is complete, these odontoblasts degenerate, and mononuclear cells emerge from pulpal vessels and migrate to the predentin surface,



- Where they fuse with other mononuclear cells to form odontoclast actively engaged in removal of predentin and dentin

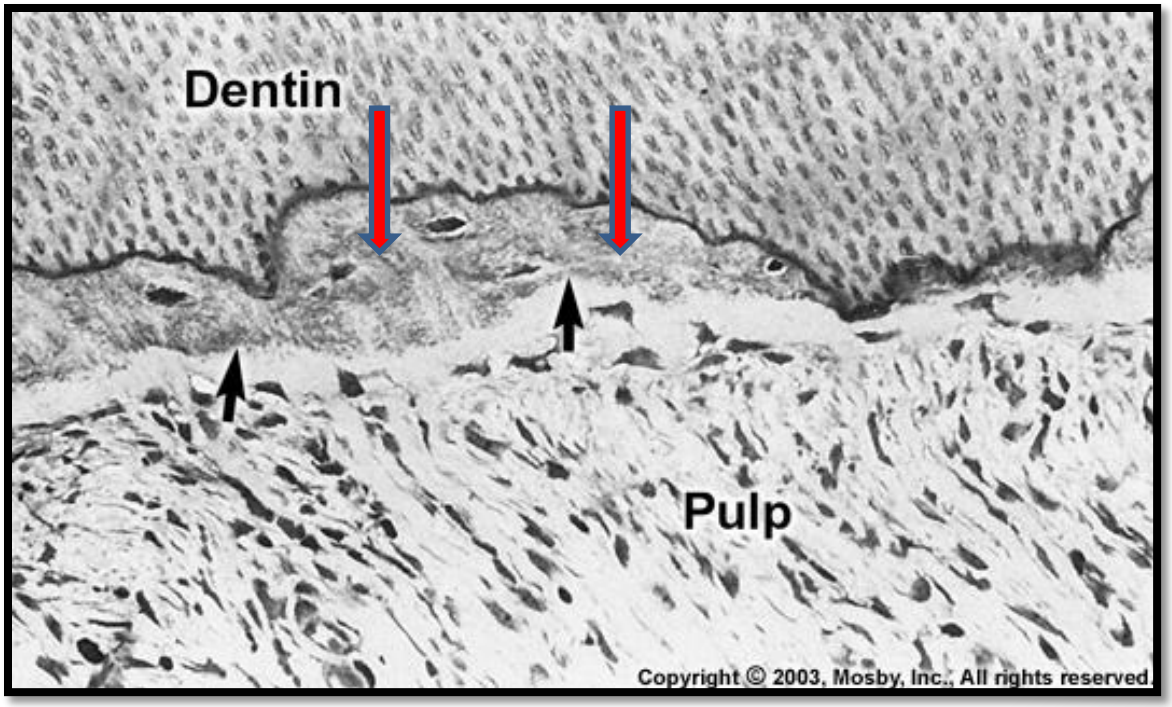


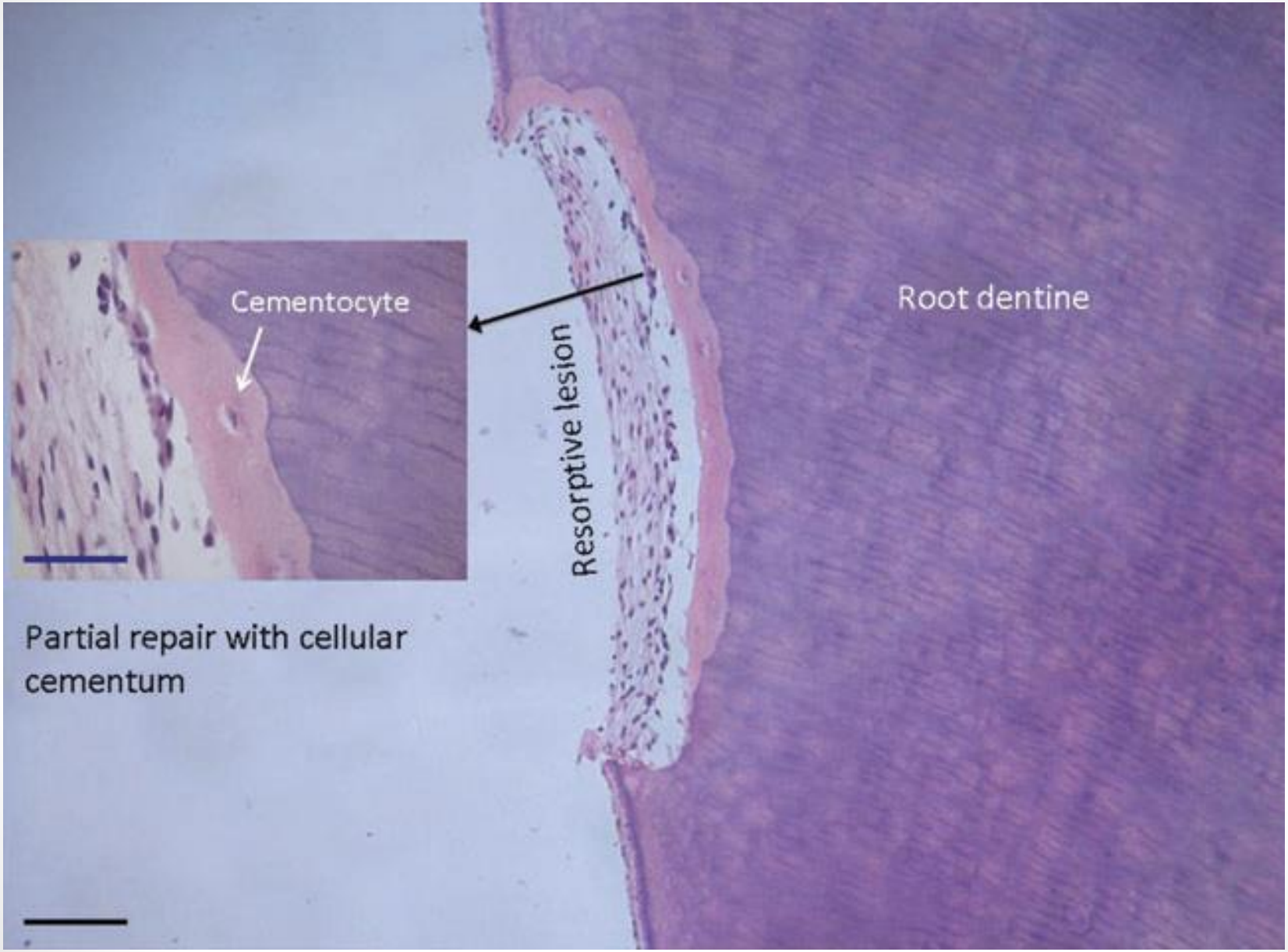


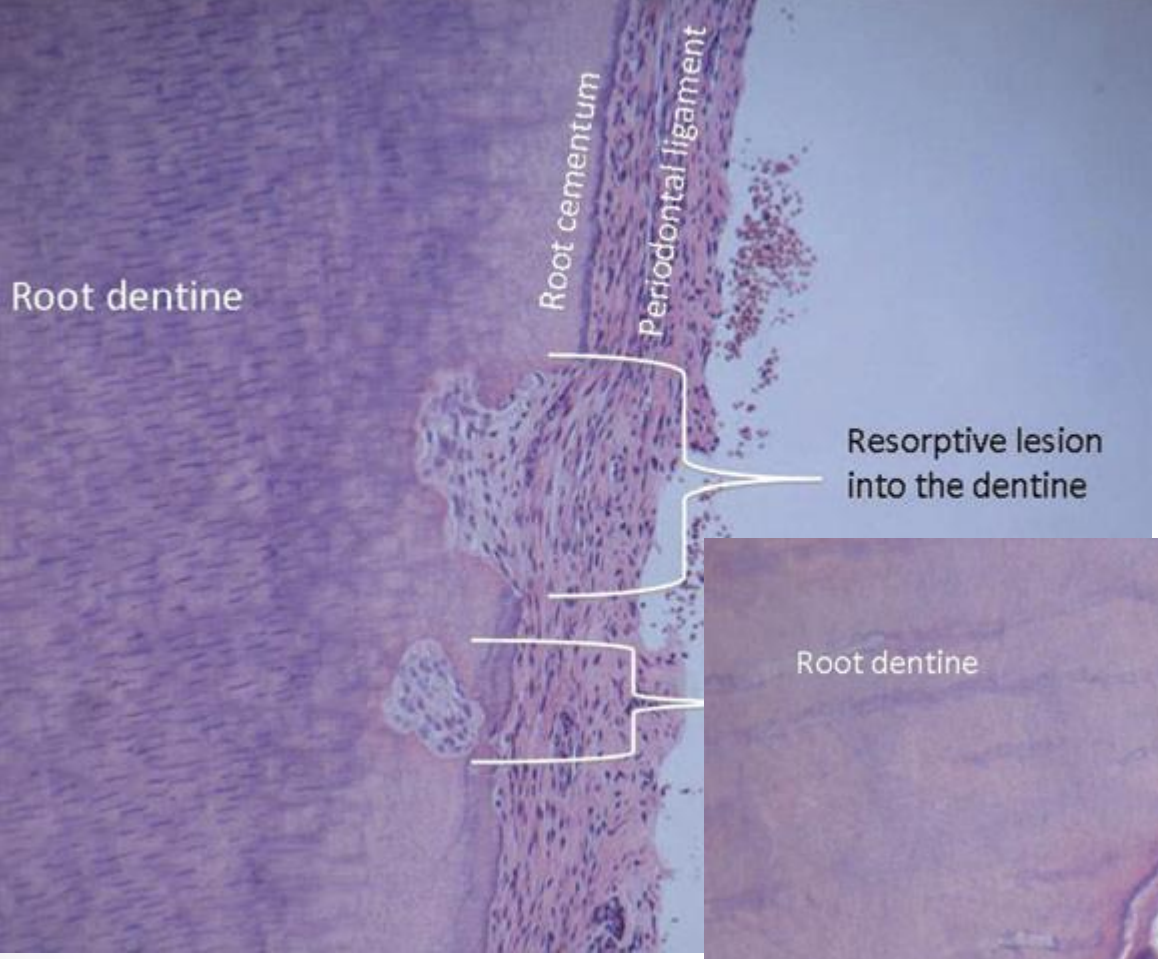
- Just before exfoliation, resorption ceases as odontoclast migrate away from the dentin surface.

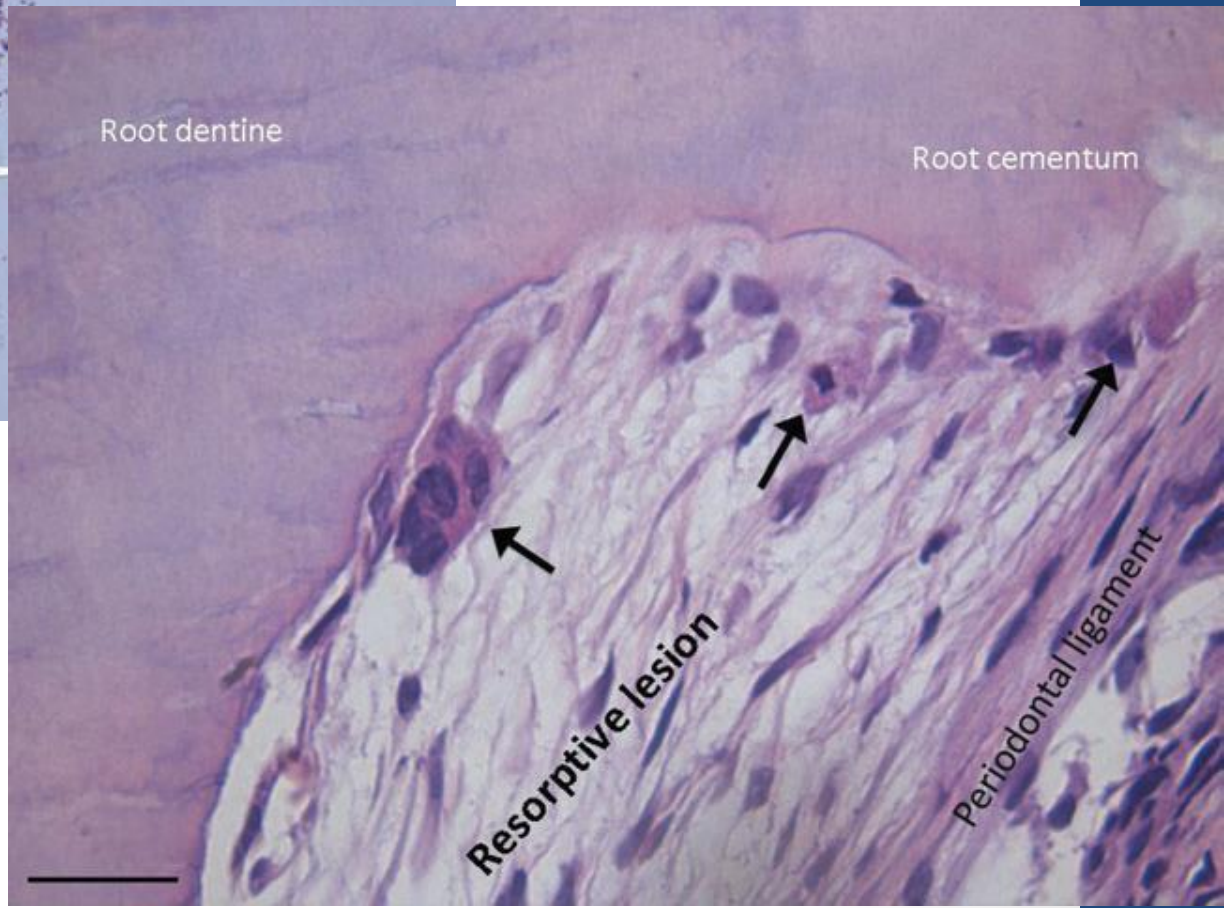
- Remaining odontoblasts deposit cememtum like tissue on it.

- Tooth then sheds, with some pulpal tissue intact.




Cementocyte
Resorptive lesion
Root dentine
Partial repair with cellular cementum


Root dentine
Root cementum
Periodontal ligament
Resorptive lesion
into the dentine


Root dentine
Root cementum
Resorptive lesion
Periodontal ligament

Loss of PDL:

- Cell death in PDL: 2 forms

1. Interference in normal cellular functions & cytotoxic alterations

- Necrosis and cell death

2. Apoptosis

Apoptotic cell death in PDL resorption suggests that "**shedding is a programmed event**".

Role of pressure:

- Pressure from erupting successional tooth
- Eg: missing successional tooth → delayed shedding

- Growth of jaws, musculature → increased forces on the deciduous teeth → supporting apparatuus i.e PDL is damaged

- Tooth resorption initiated

Pattern of shedding:

1. Symmetrical for right and left side of mouth
2. Except for 2nd molars, mandibular primary teeth are shed before their maxillary counterparts
3. Exfoliation of all 4 primary 2nd molars is simultaneous
4. Exfoliation occurs in girls before boys.
5. Sequence of shedding in mandible: anterior to posterior
6. Sequence of shedding in maxilla: 1st molars exfoliate before canines

THANK YOU!!!