Oral Biology & Histology

Tooth Development II

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Revision

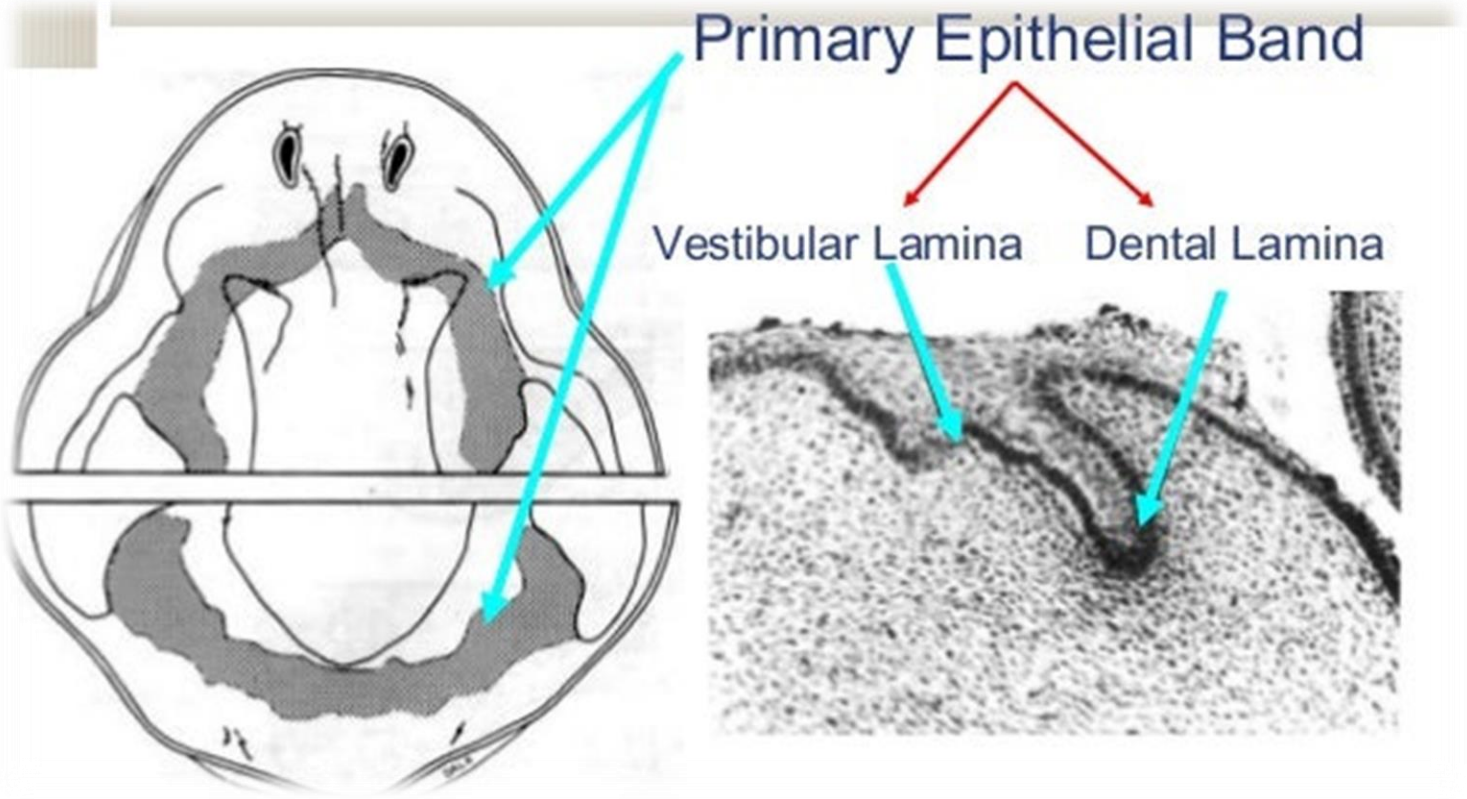
- 1ry inductive event: primitive streak induces ectoderm to form mesoderm.
- 2ry inductive event: notochord induces ectoderm to form neural plate.
- Migration of neural crest cells, from the crest of neural folds during the closure of neural tube, to pharyngeal arches.
- Face is formed from 3 processes: frontonasal, maxillary and mandibular processes.
- Palate is formed from 1ry (fusion of median nasal process) and 2ry palate (palatal shelves from maxillary process)
- Tongue mucosa is formed from lingual swelling and hypopharyngeal eminence

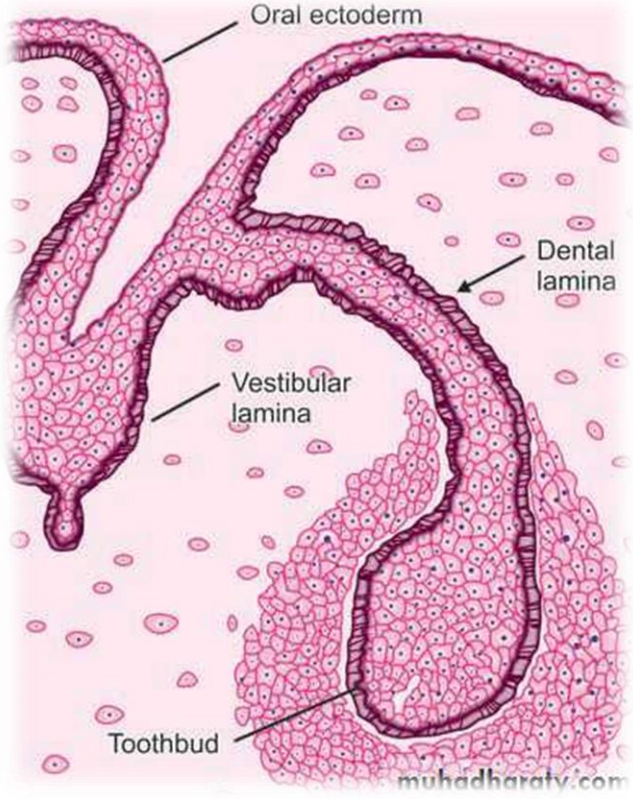
Germ layers derivatives

- **Ectoderm:** 1. Nervous system
  2. Sensory epithelium of eye, ear, and nose
  3. Epithelium of skin and its appendages
  4. Parotid salivary gland
  5. Anterior lobe of pituitary gland.
  7. Mucosal lining of palate and anterior 2/3 of tongue
  8. Enamel of teeth.
- **Mesoderm:** 1. Muscles
  2. Connective tissue (CT) - dermis of skin
     - Lamina propria of oral mucosa
     - bone
     - cartilage
     - blood
     - dentine, pulp, cementum and PDL
- **Endoderm:** 1.epithelium lining of GIT and gland
  2.epith. Of pharyngeal mucous
  3. epith. Of posterior 1/3 of tongue
  4. epith. Of soft palate
  5. Submandibular salivary gland
  6. Sublingual salivary gland.

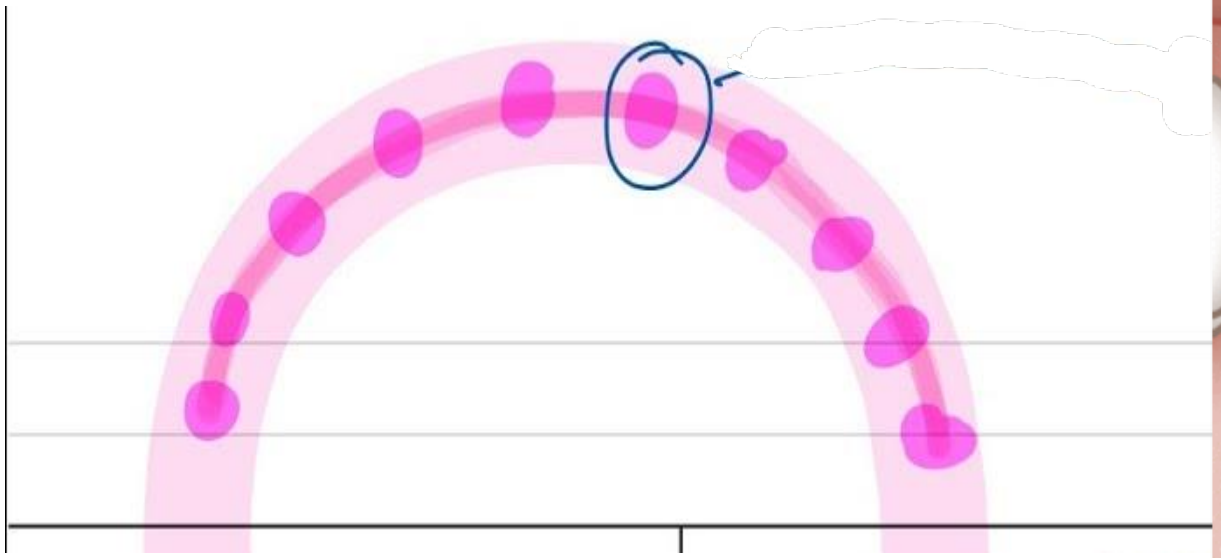
Tooth development

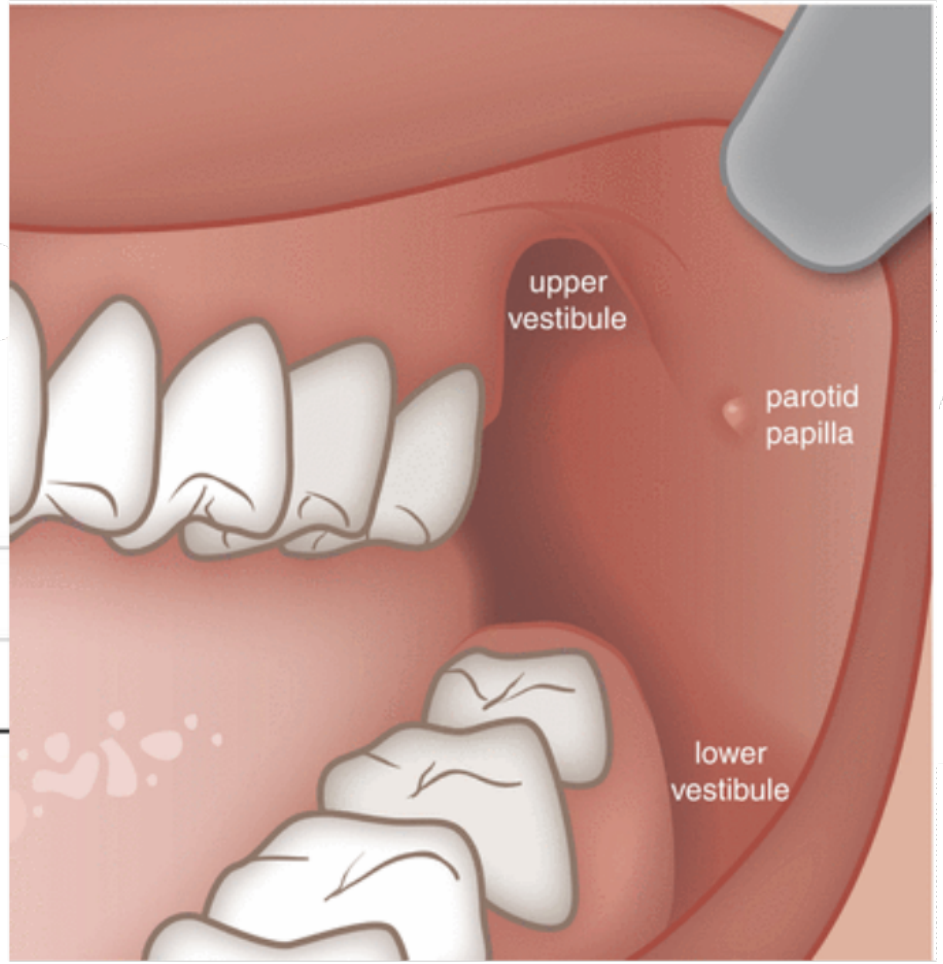
- Teeth develop from the interaction of the oral ectodermal cells & underlying ectomesenchymal cells
- Formation of 1ry epithelial band
- 1ry epithelial band will divide into vestibular lamina and dental lamina.



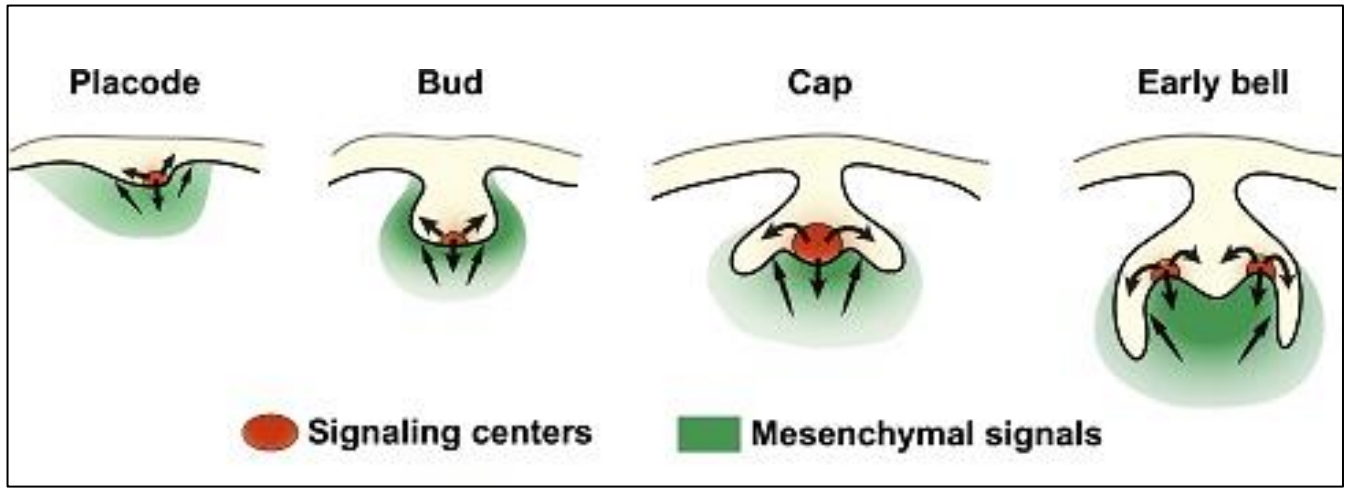


- Vestibular lamina: it’s center will disintegrate, and vestibule is formed
- Dental lamina: 10 dental placodes will develop on the dental lamina





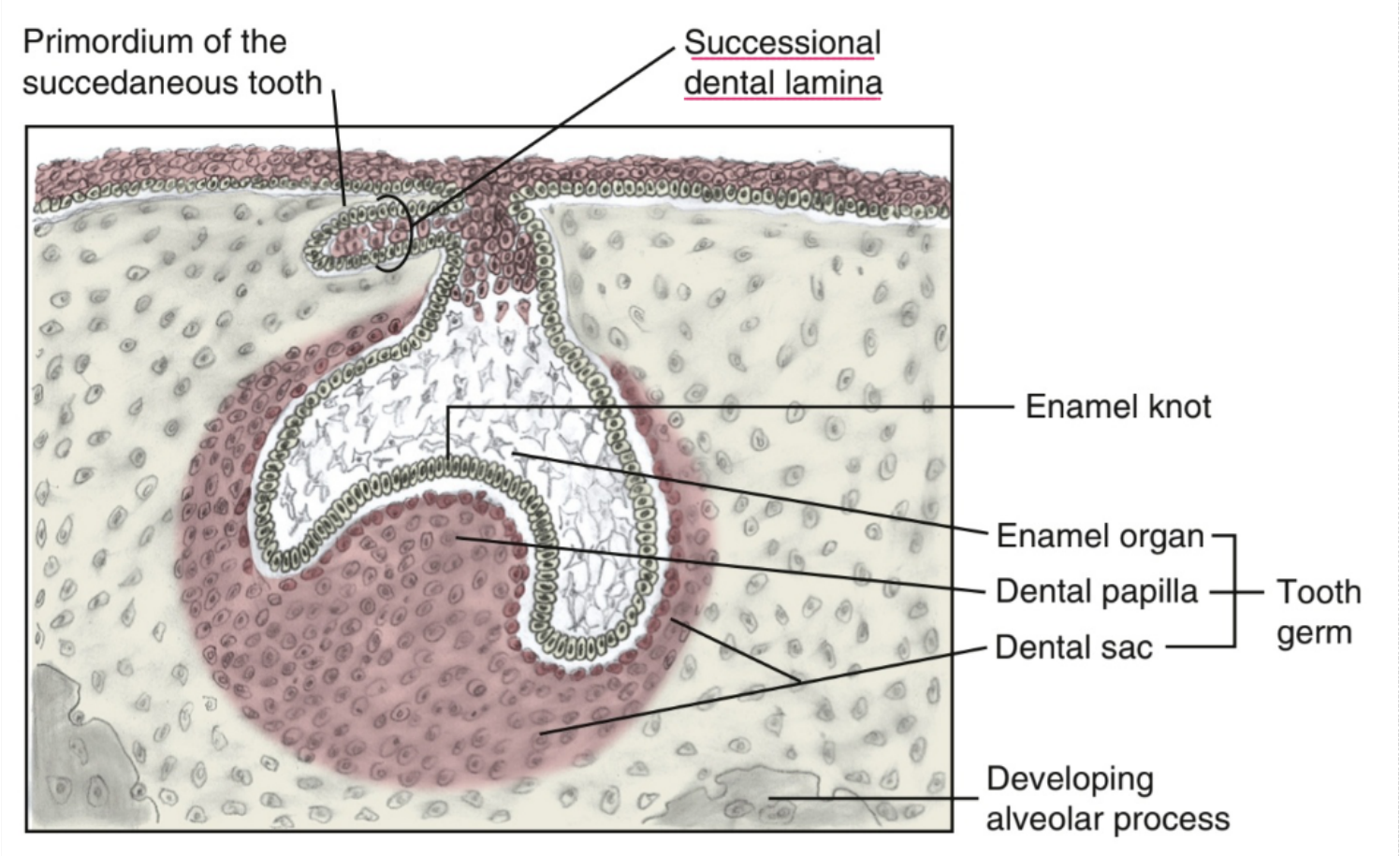
- **Reciprocal inductive interactions:**
- Occurs when the 2 tissues interact, and both are inducers and can respond each other's signals.



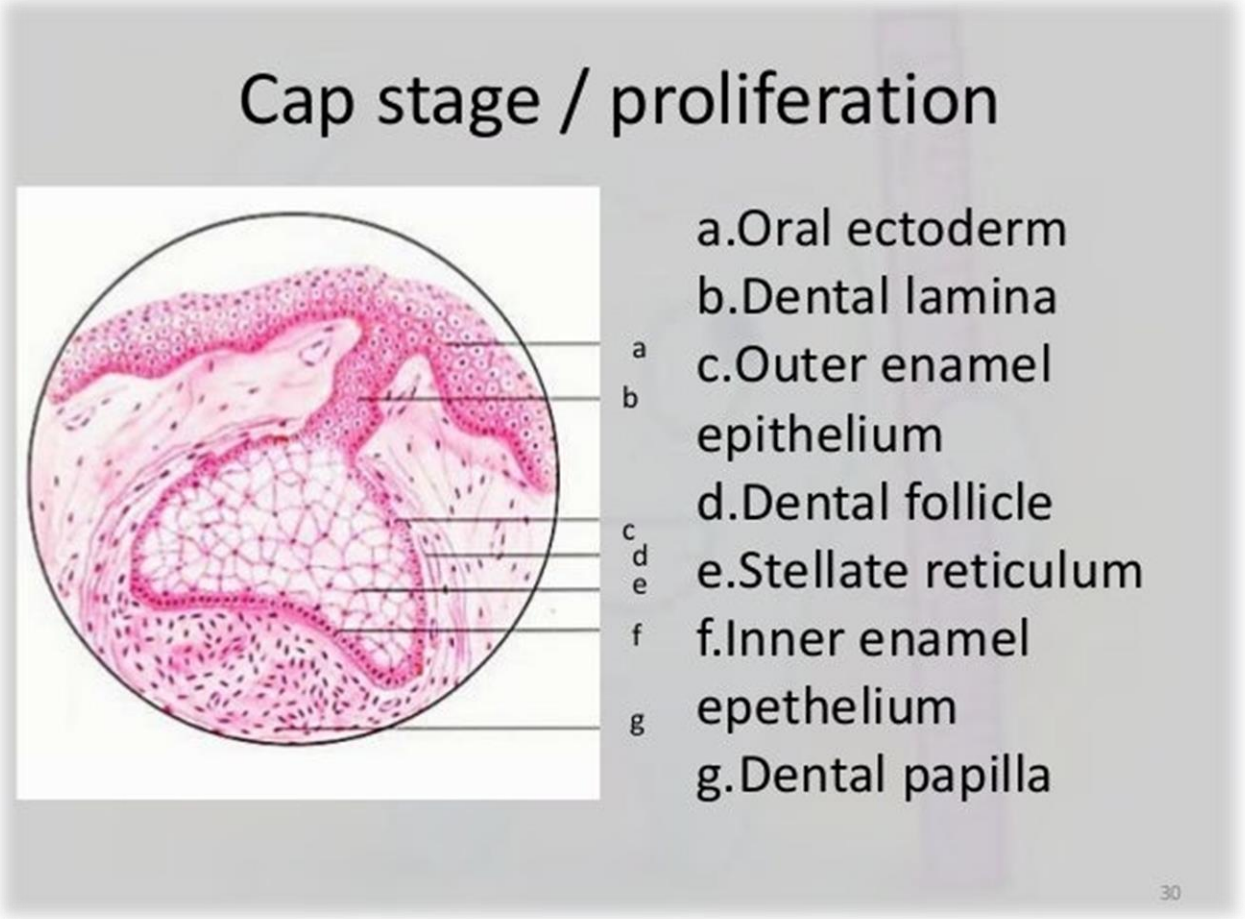
Teeth are formed from:

1) Oral ectoderm ….. enamel.
2) Neural crest (ectomesenchyme)…..Dentin, pulp, cementum, periodontal ligament, and alveolar bone

- All primary teeth & permanent molars arise from dental lamina.
- Permanent Incisors, Canine, & Premolars arise from their successional lamina.



- **Tooth germ** organized into 3 parts:
  - Enamel organ
  - Dental papilla
  - Dental follicle or sac



- **Early Cap Stage**

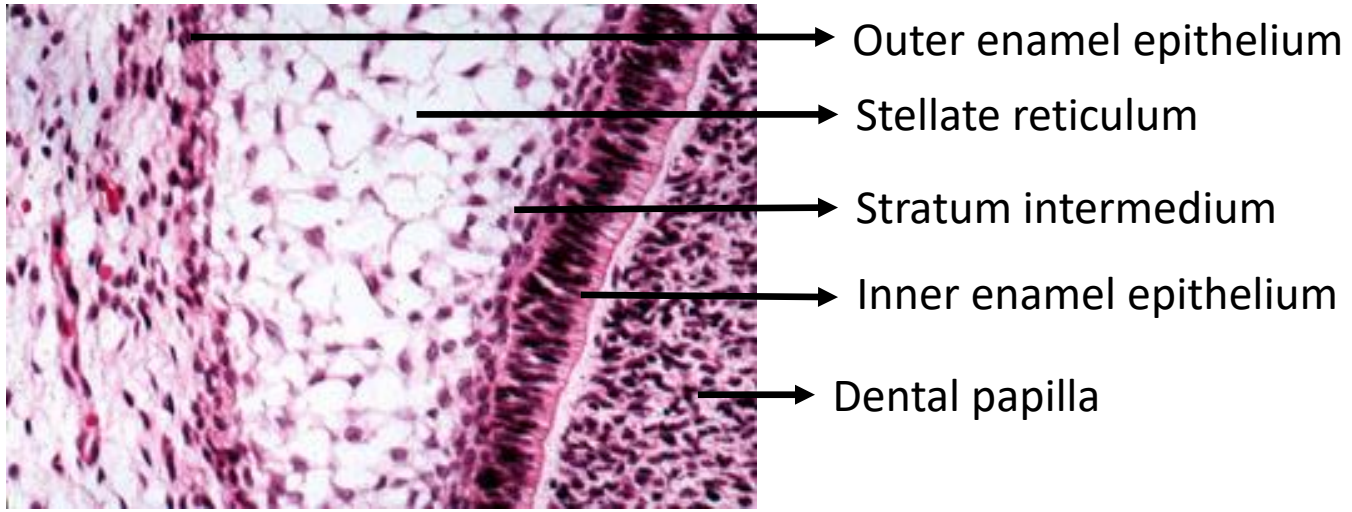
Enamel organ shows 3 types of cells:

1. Outer (external) enamel epithelium: (OEE)
2. Inner (internal) enamel epithelium: (IEE)
3. Stellate reticulum

- **late Cap Stage/early bell stage**

Enamel organ shows 4 types of cells:

1. Outer (external) enamel epithelium: (OEE)
2. Inner (internal) enamel epithelium: (IEE)
3. Stellate reticulum · acts as a cushion
4. **Stratum intermedium** · contains alkaline Phosphatase
   ↳ Helps in enamel maturation



Crown Pattern Determination (early bell stage)

Crown pattern Determination

- Future crown patterning occurs in the bell stage, by unequal cell division and folding of the IEE.
- At certain site (future cusp), cell division ceases at IEE and undergo differentiation to ameloblast.
- IEE folds forming the cusp outline :

Because:

a. IEE is chained at the cervical loop

b. Continued proliferation at both sides will push the cusp up

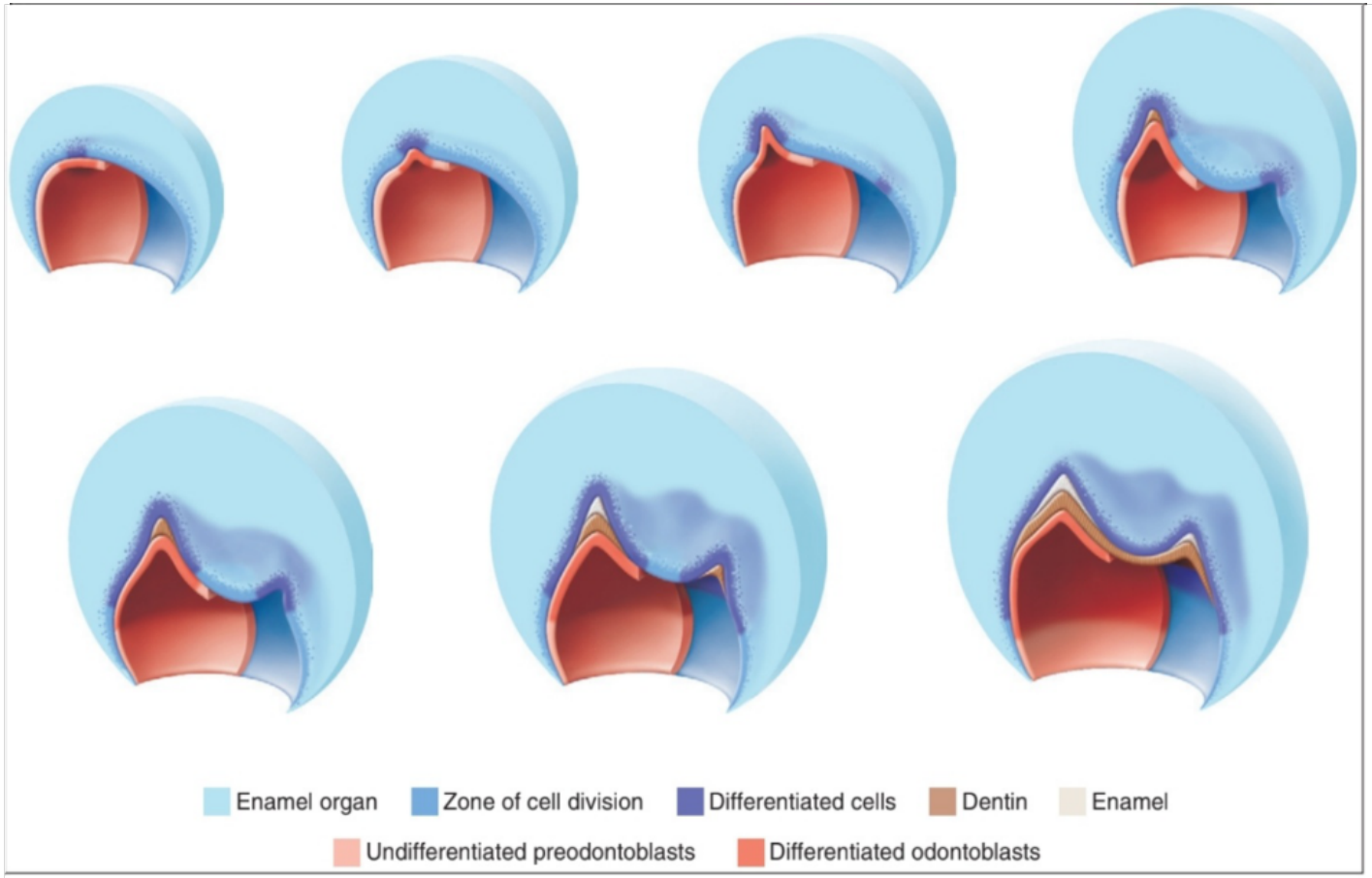


FIGURE 5-22 Summary of crown pattern formation in the inner enamel epithelium.

Hard tissue Deposition (late bell stage)

Hard Tissue Deposition

Hard Tissue Deposition (Apposition)

1. Elongation of inner enamel epithelium
2. Differentiation of odontoblasts
3. Formation of dentin (dentinogenesis)
4. Formation of enamel (amelogenesis)

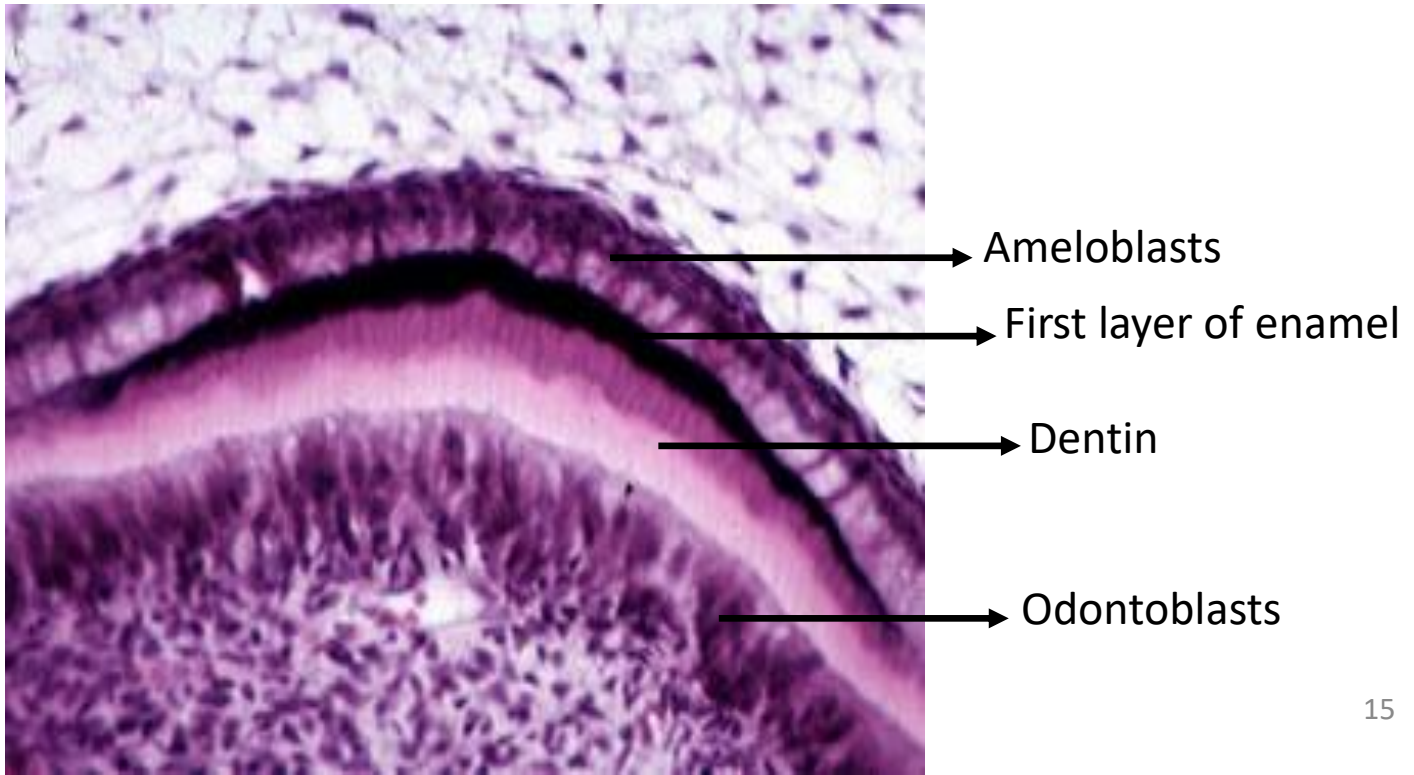
- **"reciprocal induction":** odontoblasts & ameloblasts receive signals form each other

- Odontoblast differentiate only under the influence of IEE and enamel formation cannot begin until dental matrix has formed.

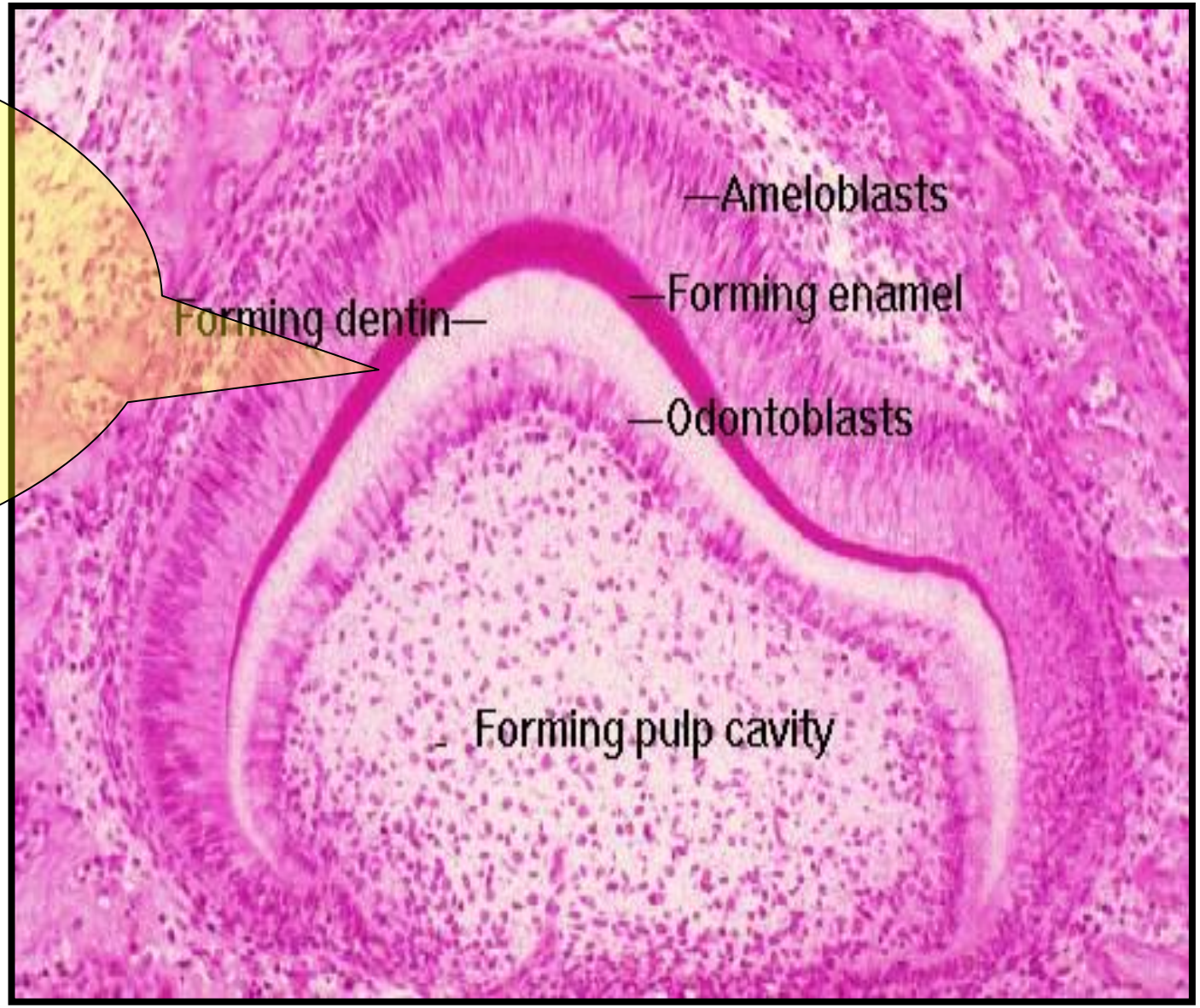
Hard Tissue Deposition

- The first layer of dentin appears at the cusp tips & progresses cervically, and the columnar cells of the IEE become elongated adjacent to the stratum intermediate (ameloblasts).
- Soon after the first layer of dentin (mantle dentin) is formed, basement membrane disintegrate, and the IEE cells differentiate into ameloblasts & secrete enamel proteins

Dentin matrix



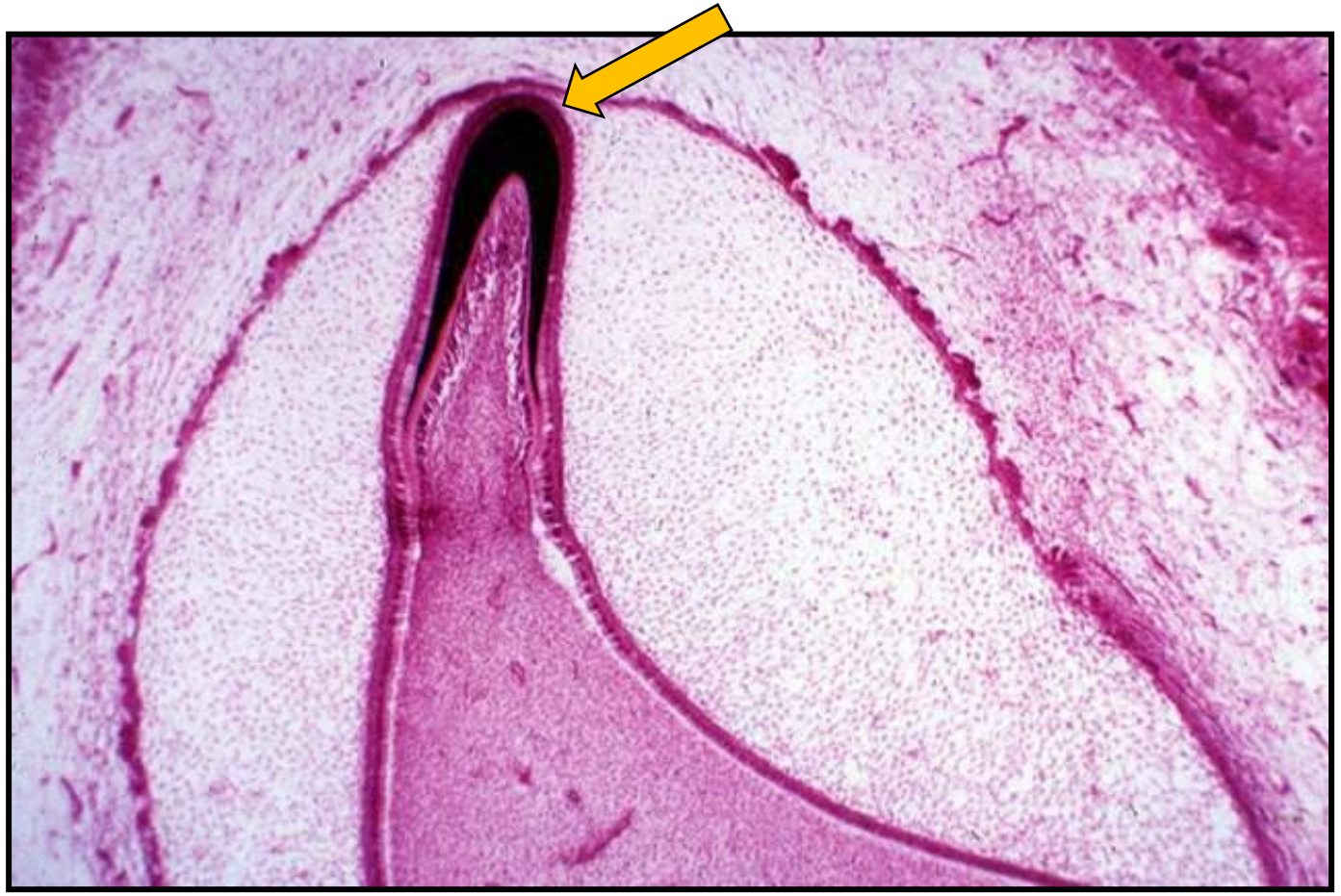
As the mineralization of D starts the main source of **nutritional supply** to the dental organ from the dental papilla is **cut off.**



Remember !! **the dental organ is avascular (epithelium)**

The dental organ reacts to compensate the needs for the nutritive materials by the followings:

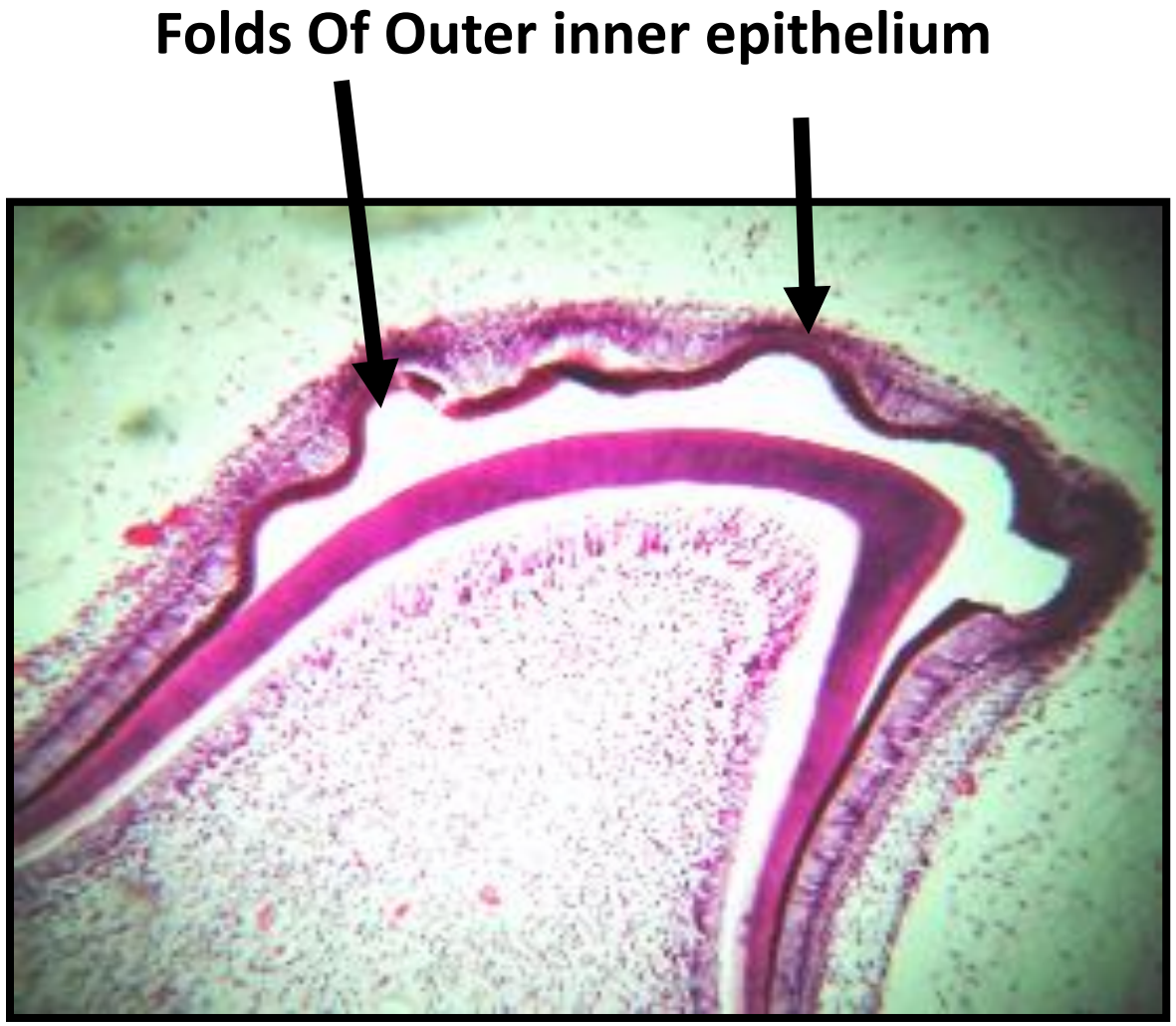
1) Shrinkage/collapse of stellate reticulum due to loss of the intercellular fluid so, the distance between the C.T. surrounding the tooth germ and the ameloblast become shortened.



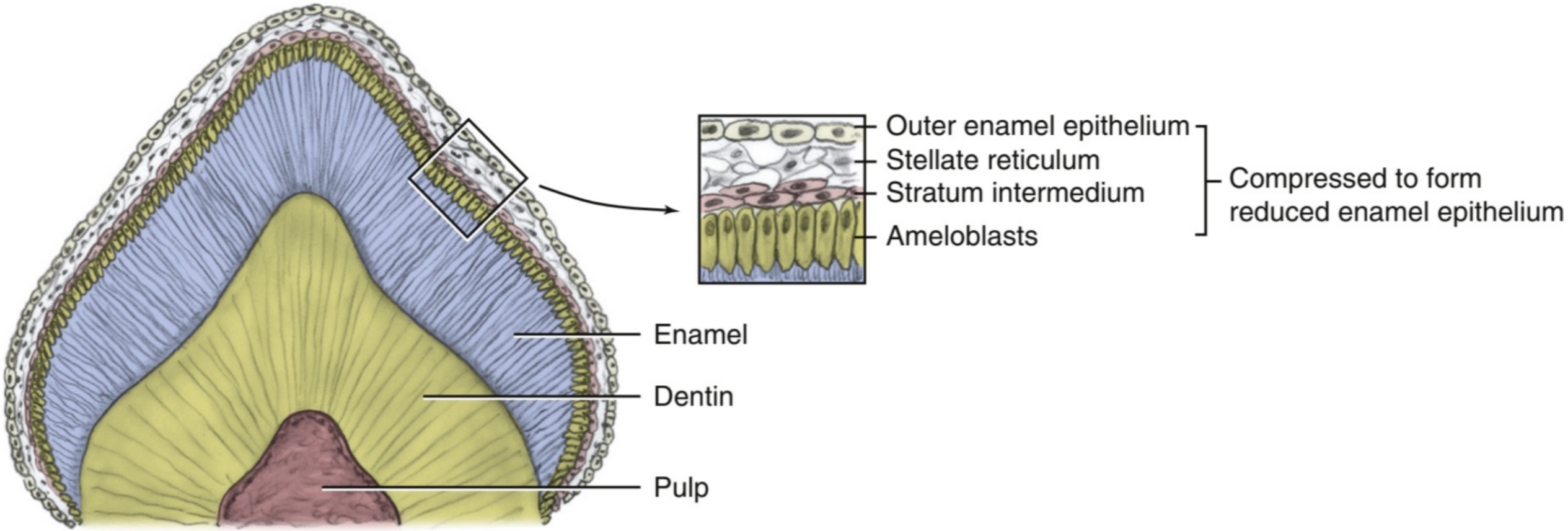
2) The cells of the outer enamel epithelium flattened to a low cuboidal form and are laid down in folds.

3) Then the capillary loops in the dental sac enter between these folds of outer enamel epithelium

Thus, Ameloblasts are closer to blood vessels and nutrients

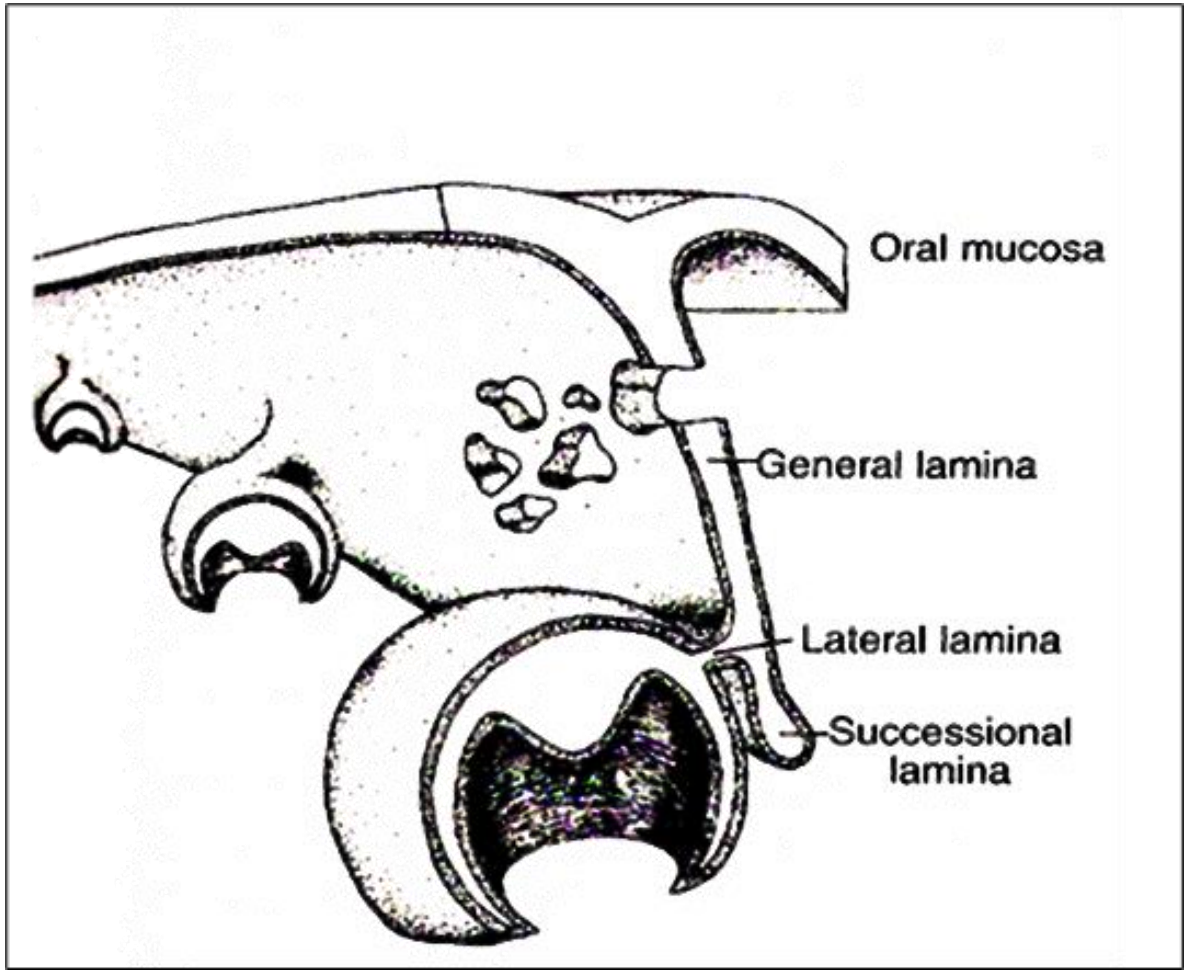


- After completion of crown; OEE, stellate reticulum and stratum intermediate will become one layer of reduced enamel epithelium (REE), which will guide the tooth during eruption and become junctional epithelium.



Fate of dental lamina

- Total activity of DL extends over a period of at least **5 years**.
- After initiation of each tooth development, its dental lamina begins to degenerate.
- May still be active in the third molar region after it has disappeared elsewhere.
- Its remnants persist as epithelial pearls or islands within the jaw and gingiva. (**Cell rest of Serres/epithelial pearls/Serres gland**)



→ Remenants of the dental lamina are called: cell rests of serres
↳ may cause eruption cyst

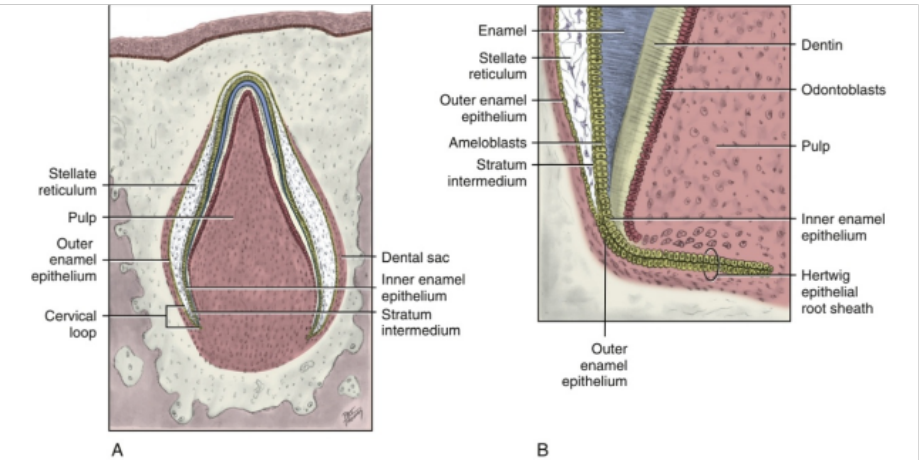
Root Formation

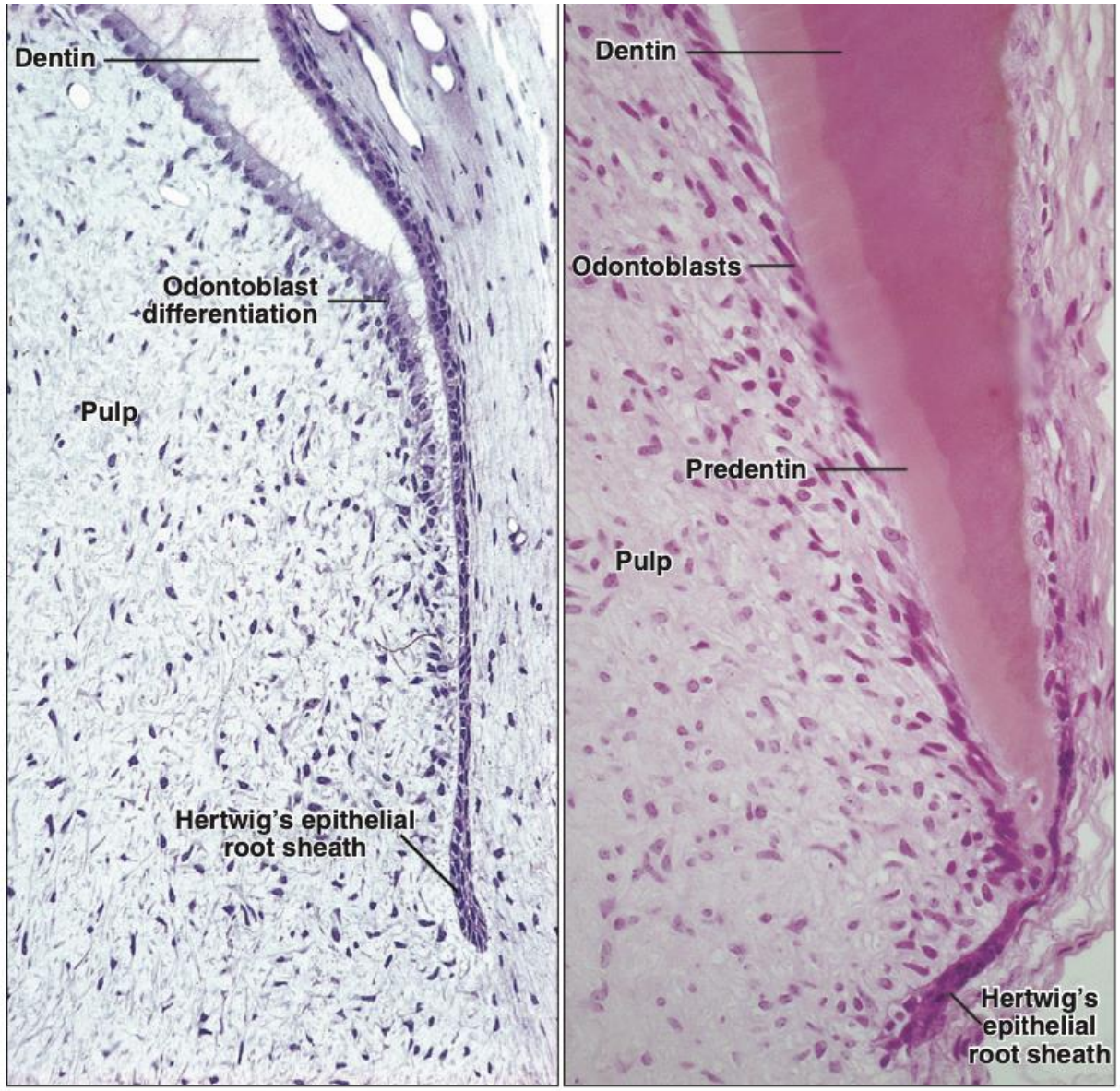
يبدأ تكون الجذر بعد انتهاء تكون الـ crown.

Root Formation

After crown formation:

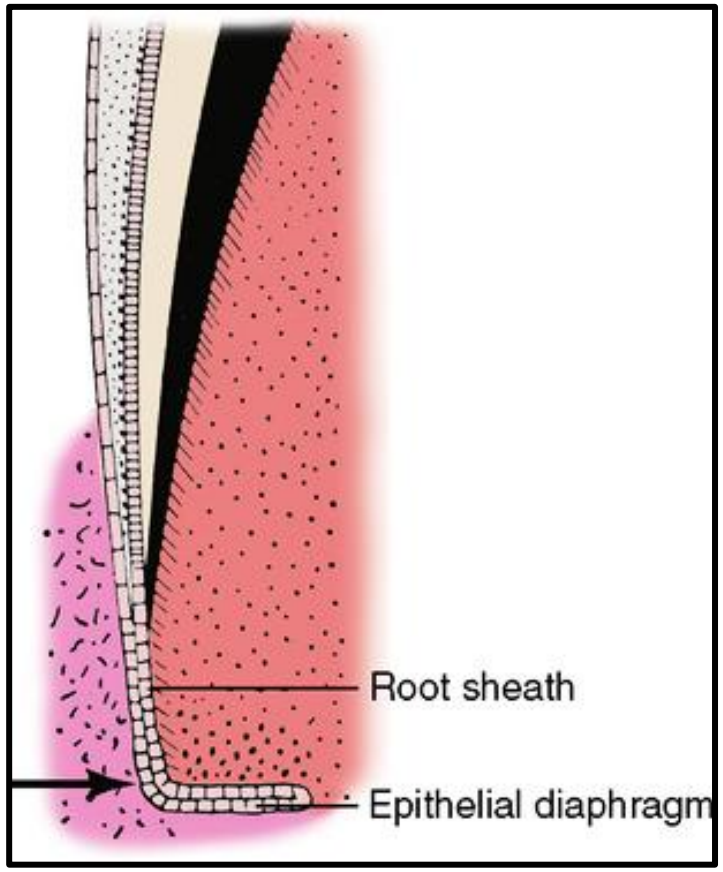
- Cells of OEE and IEE proliferate from the cervical loop of the dental organ to form a double layer of cells known as Hertwig's epithelial root sheath (HERS).

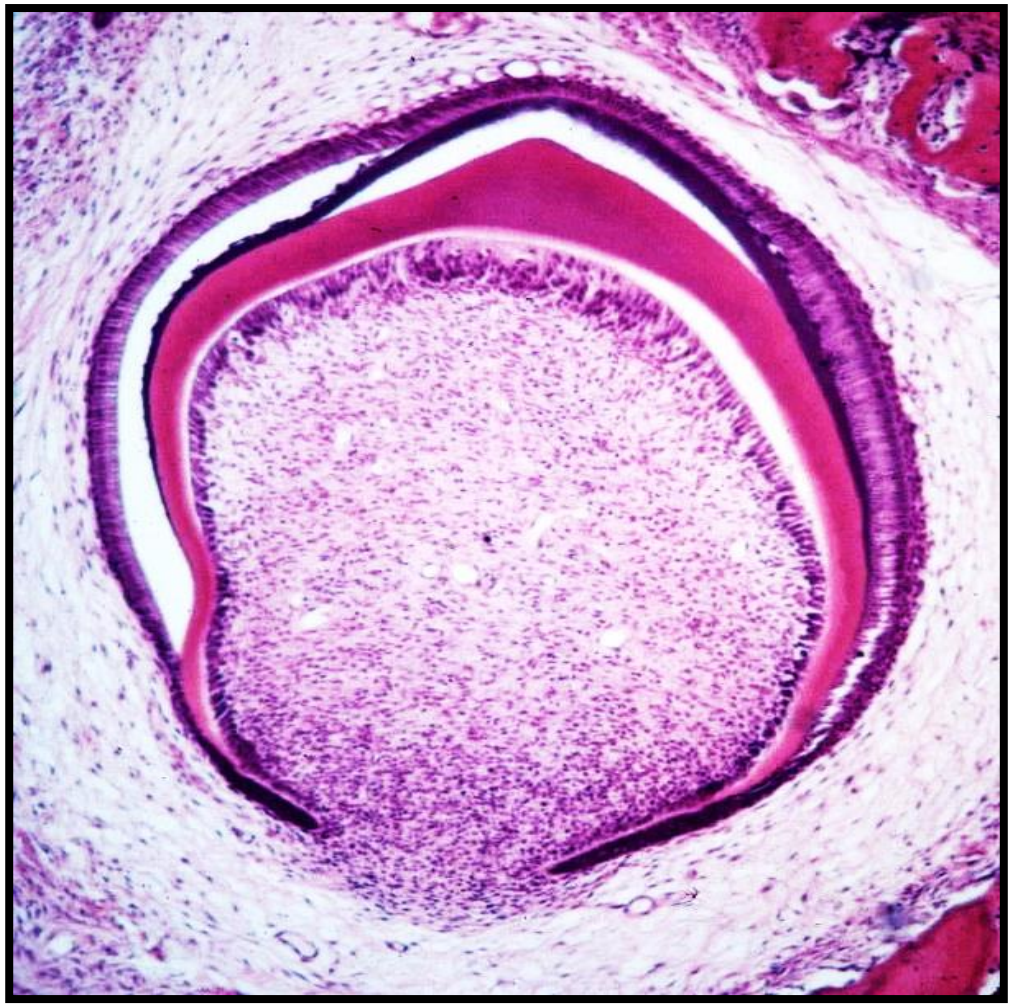




- As the root sheath continues to grow away from the crown, it bends 45 degrees toward the pulp.

-Forming epithelial diaphragm, which surrounding the opening of the pulp, it will become the apical foramen.





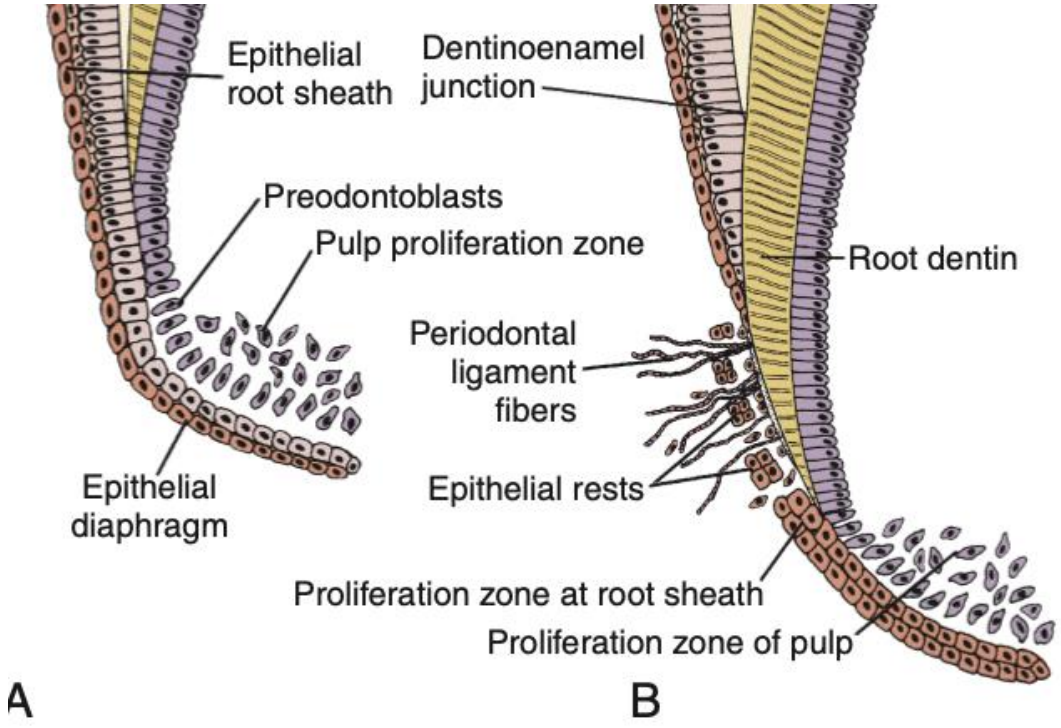
Root Formation

1) Proliferation of HERS coronal to the diaphragm

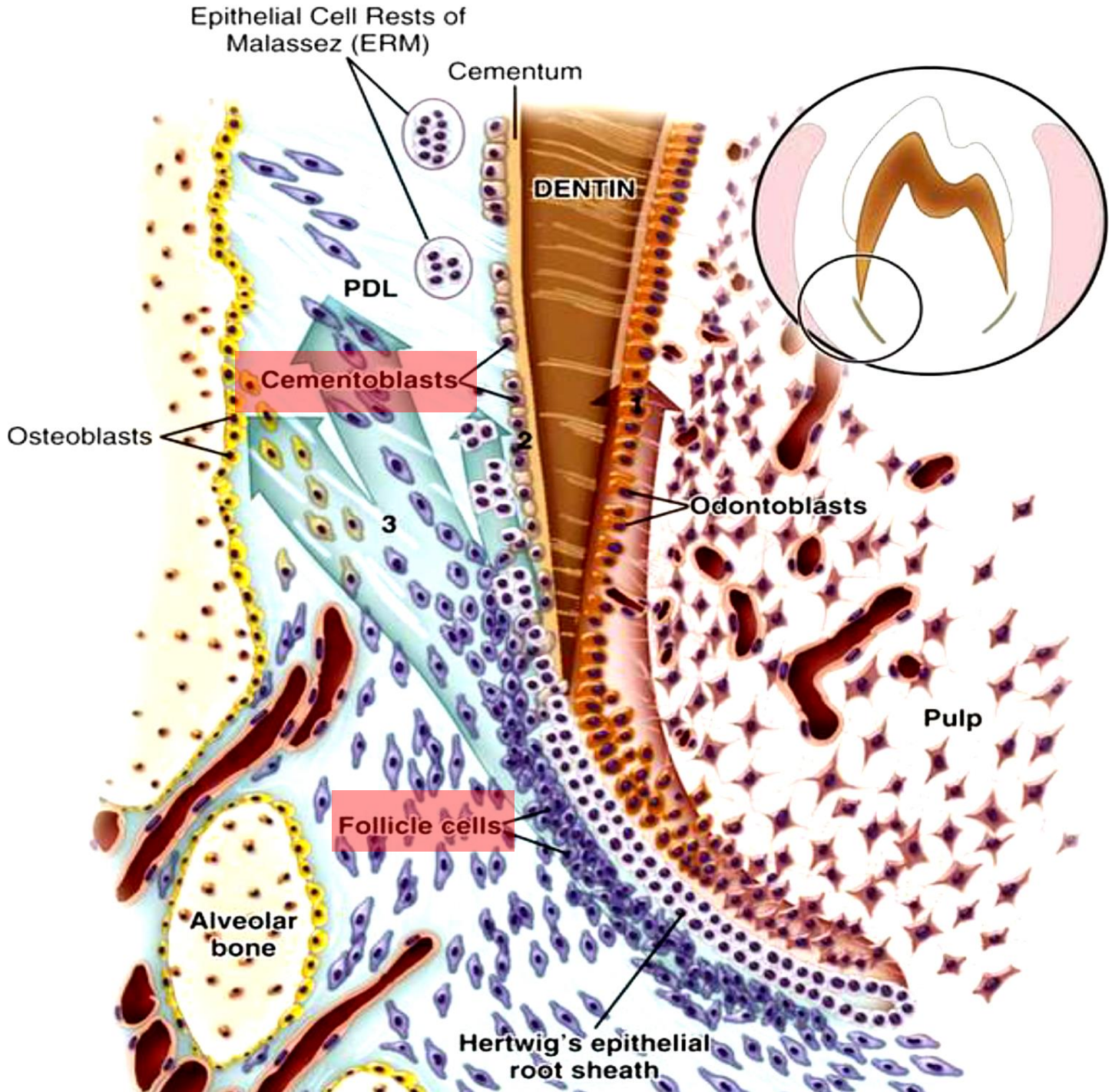
2) Induction of root odontoblasts from dental papilla, and root dentine deposition

3) Defragmentation of HERS

4) Induction of cementoblasts differentiation from dental follicle and Cementum apposition.



-Remnants of HERS after root dentin formation may persist in the PDL next to root surface will be called **Epithelial rests of Malassez**


Epithelial Cell Rests of Malassez (ERM)
Cementum
DENTIN
PDL
Cementoblasts
Osteoblasts
1
2
3
Odontoblasts
Pulp
Follicle cells
Alveolar bone
Hertwig's epithelial root sheath

Root Formation

- The length, curvature, thickness, & number of roots are all dependent on the epithelial root sheath cells.

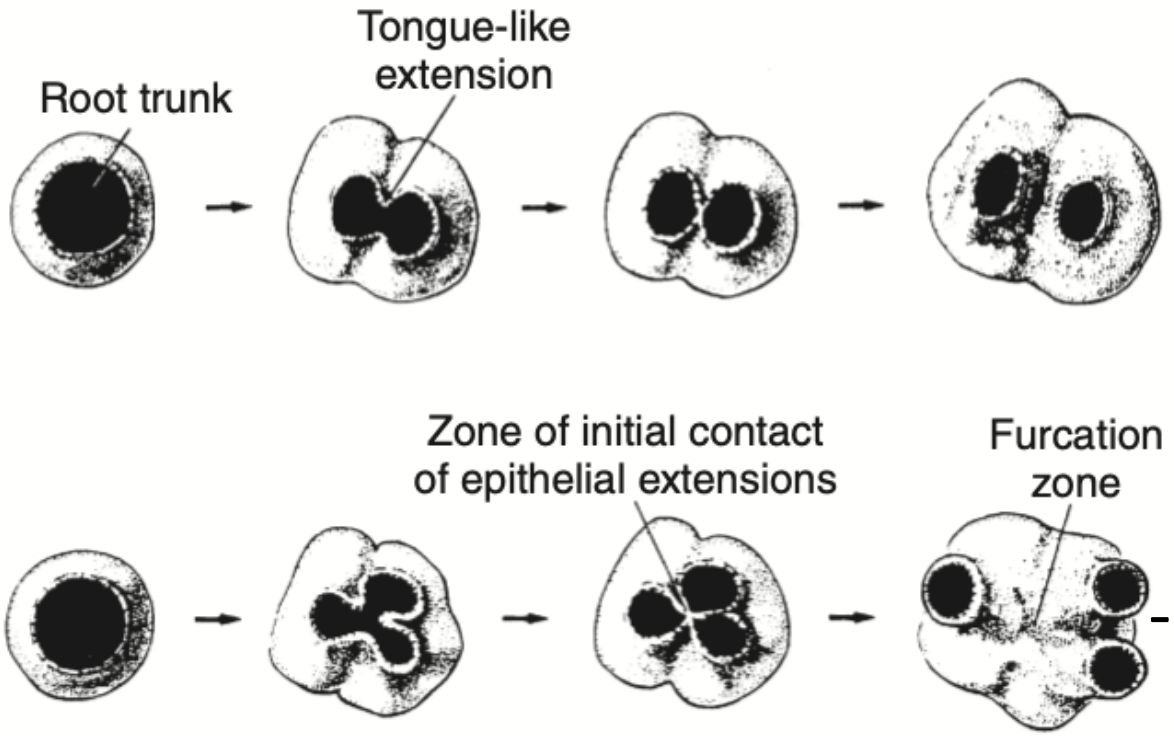


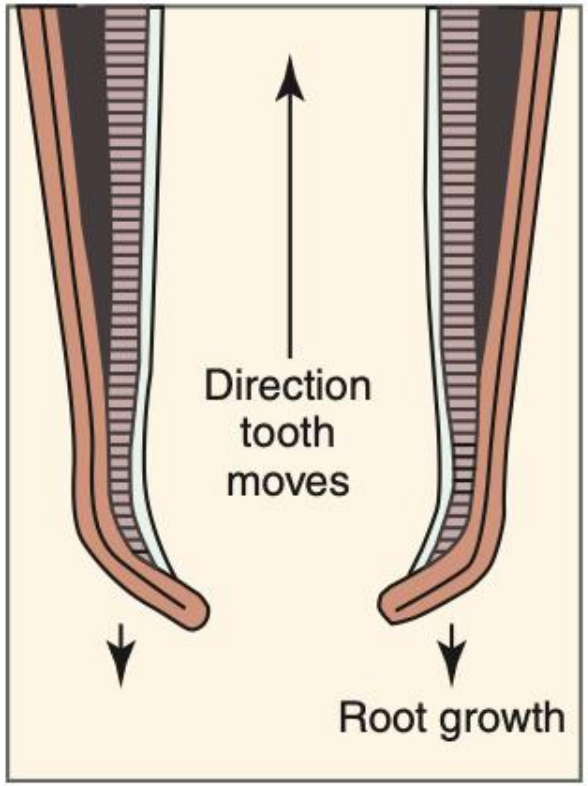
Fig. 5.27 Development of multirooted teeth. As the epithelial diaphragm grows, it may make contact and fuse to develop one-, two-, or three-rooted teeth.

- If the tooth has two roots, the cells of the epithelial diaphragm grow excessively in two tongue like processes. The single opening is divided into two openings.

- If the tooth has three roots, three tongue like processes appeared, and three openings are formed

Root Formation

- With the increase in root length, the tooth begins eruptive movements, which provide space for further lengthening of the root.
- Root lengthens at the **same rate** as the tooth eruptive movements occur.

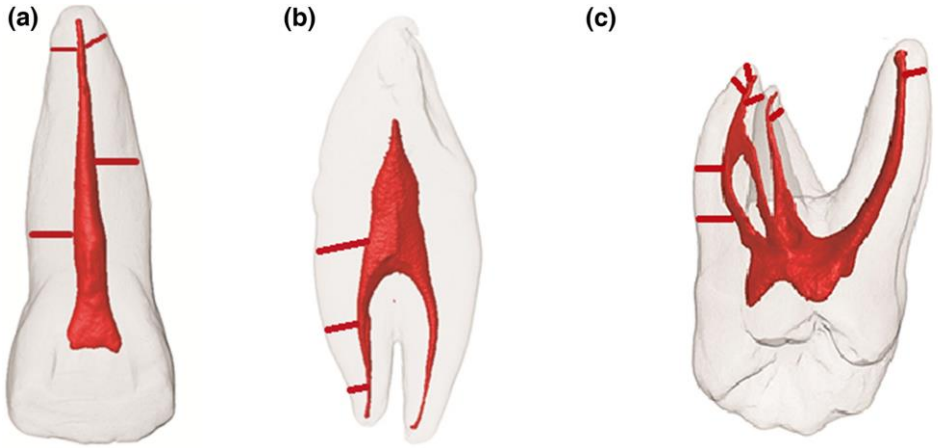


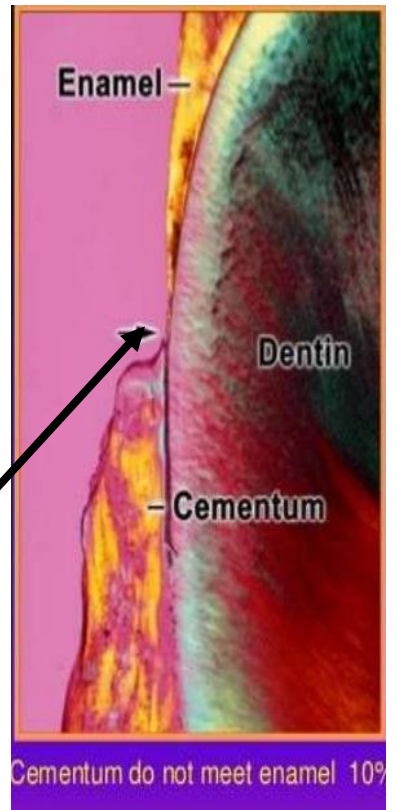
Abnormal developments

A) Enamel pearls: activation of epithelial rest of malassez to form enamel

B) Accessory root canals:

1. Failure of formation of HERS
2. Early degeneration of HERS
3. Incomplete fusion of diaphragm





C) Exposed dentin:1. failure of degeneration of HERS ----------no cementum is formed