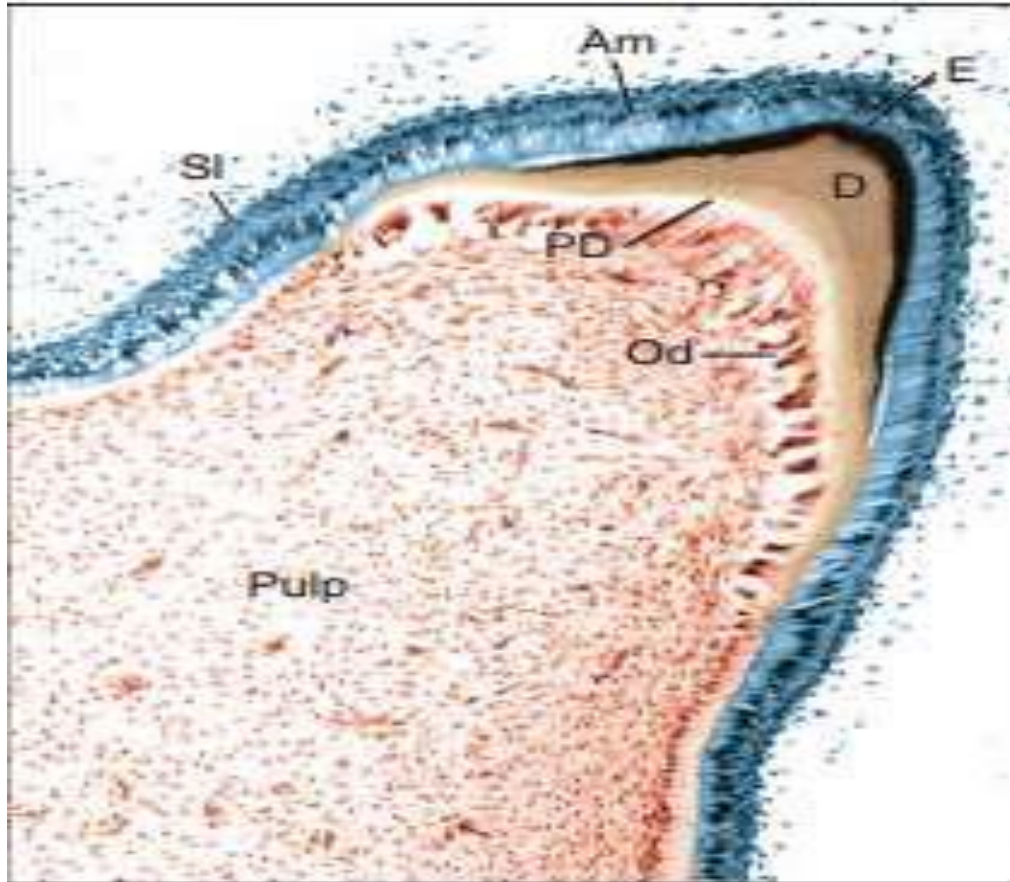




جامعة البصرة

كلية طب الاسنان



Oral histology 2nd stage

Lec. 7 Enamel and amelogenesis (2)

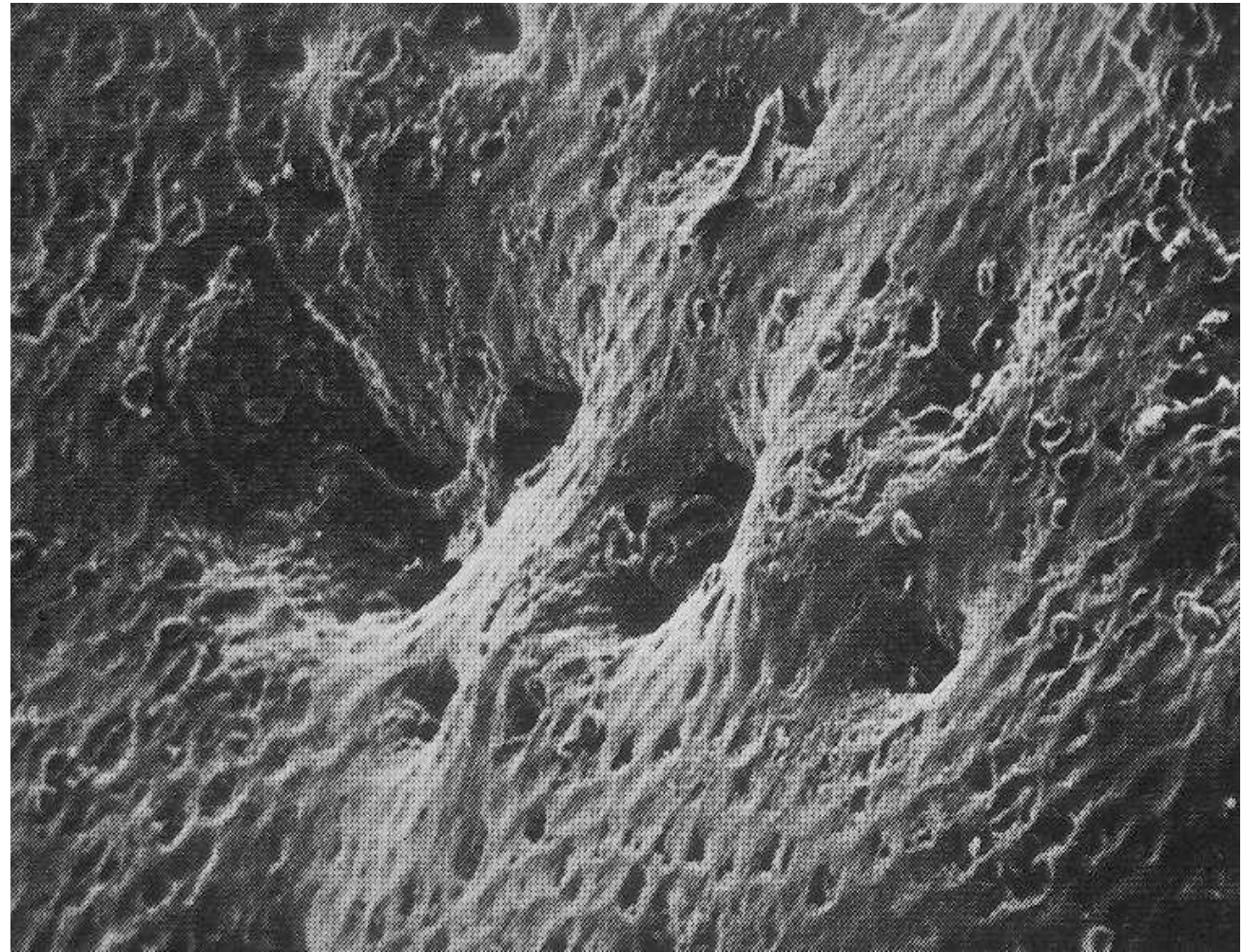
Aseel kamil

college of dentist

Basic science

Surface structure

- **Rod ends:**
 - □ Are concave and vary in depth and shape.
 - □ Are shallow in the cervical regions.
 - □ Deep near the incisal or occlusal edges.

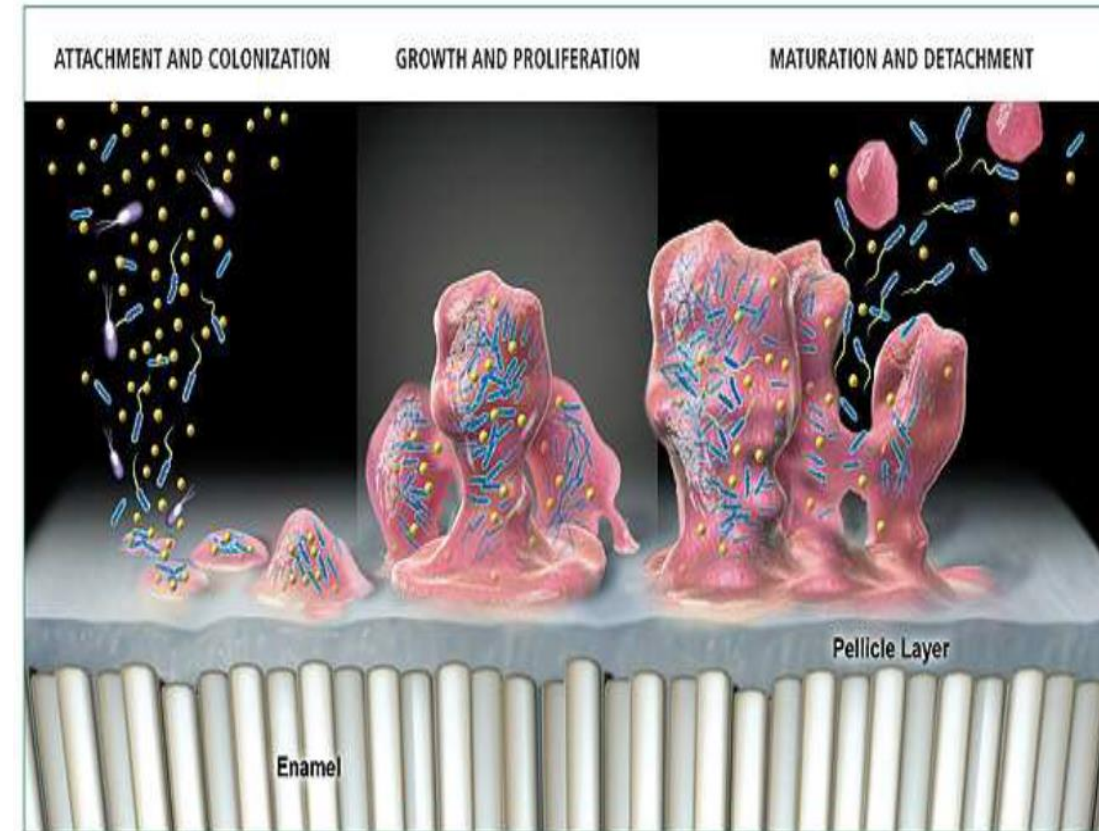


Enamel cuticle

- **1- Primary E. cuticle (Nasmyth's membrane).**
- Covers the entire crown of newly erupted tooth.
- Thickness: 0.2 μm .
- Removed by mastication (remains intact in protective areas).
- secreted by ameloblasts after completion of enamel formation..
- **2. Secondary E. cuticle (afibrillar cementum).**
- Covered the cervical area of the enamel.
- Thickness: up to 10 μm .
- Continuous with the cementum.
- Probably of mesodermal origin or may be elaborated by the attachment epithelium.
- Secreted after E.O. retracted from the cervical region during tooth development.

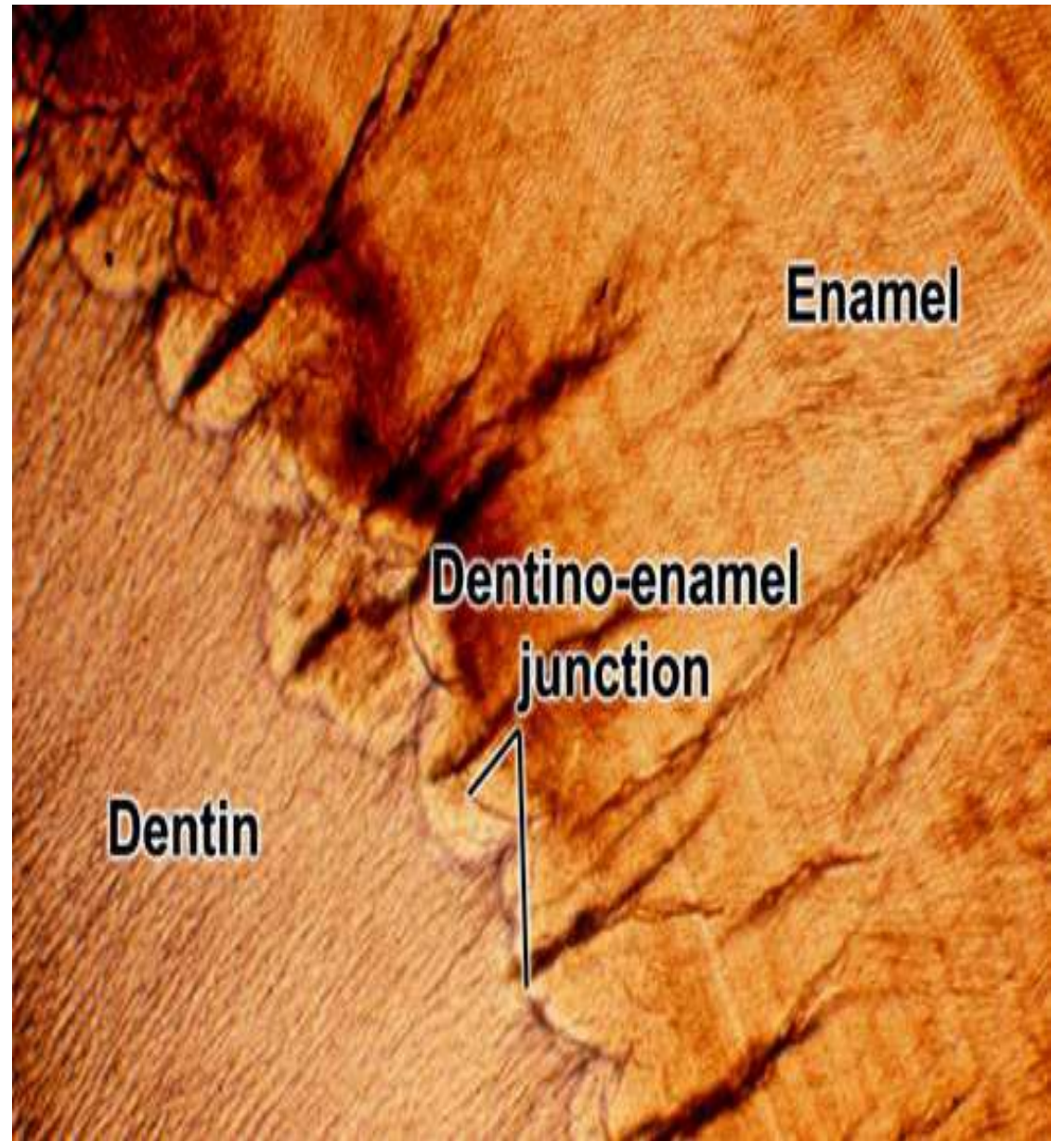
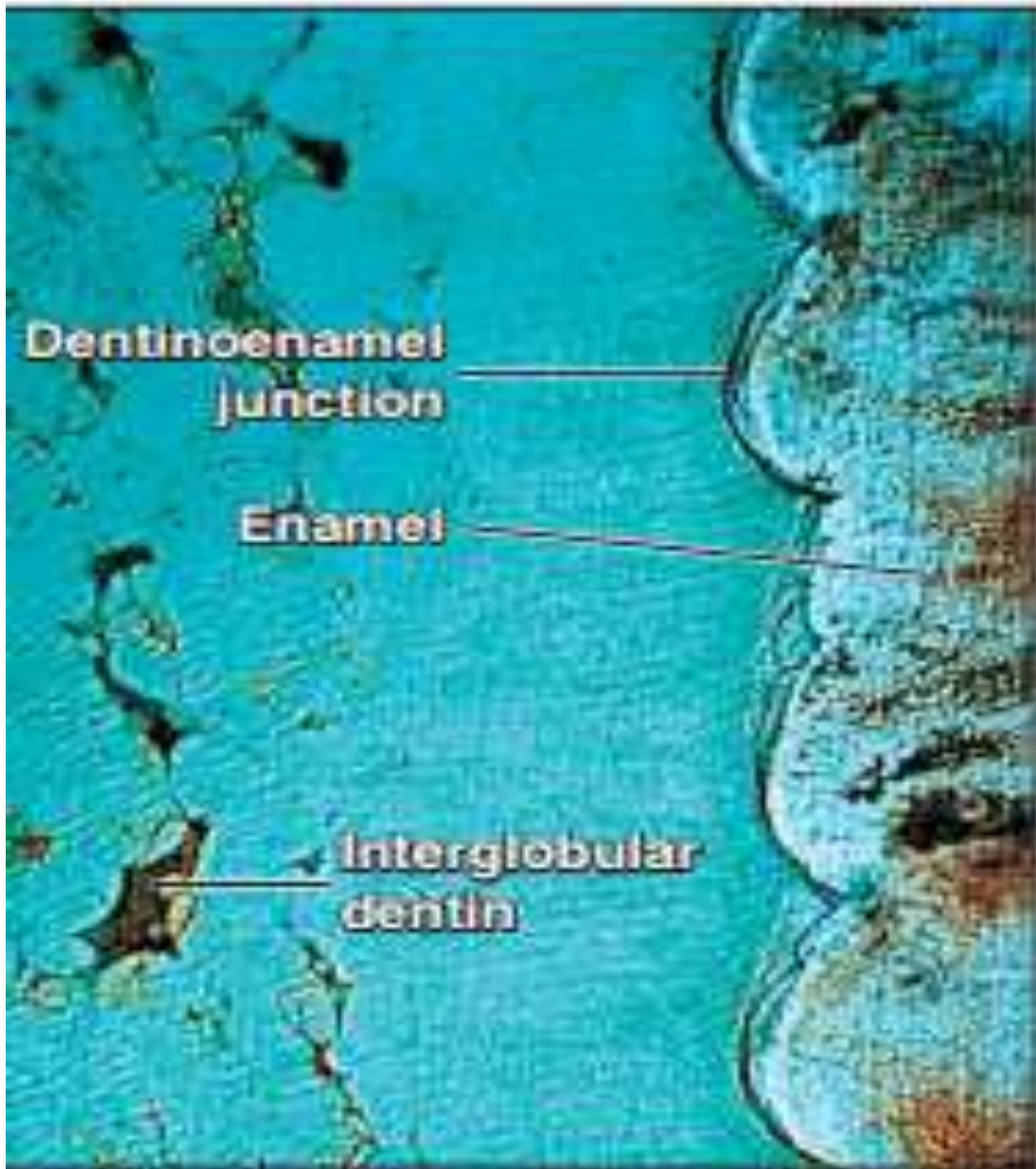
3. Pellicle: (a precipitate of salivary proteins).

- Re-form within hours after mechanical cleaning .
- □ A layer directly on top of enamel 1-3 μm thick (could reach 10 μm),
- free from bacteria, and is not removed by a toothbrush but can be removed by prophylaxis.
- If the pellicle is not cleaned, after one or two days it is colonized by micro organisms to form plaque.



Dentino-Enamel Junction

- The dentinoenamel junction is established as soon as the two hard tissues enamel and dentin begin to form.
- The dentinoenamel junction is a scalloped interface between the enamel and dentin.
- Dentin has pitted surface, which supports the enamel Small curved projections of enamel fit into small concavities of the dentin.
- The dentinoenamel junction is a hypermineralized zone that is about 30 microns thick before mineralisation is complete.

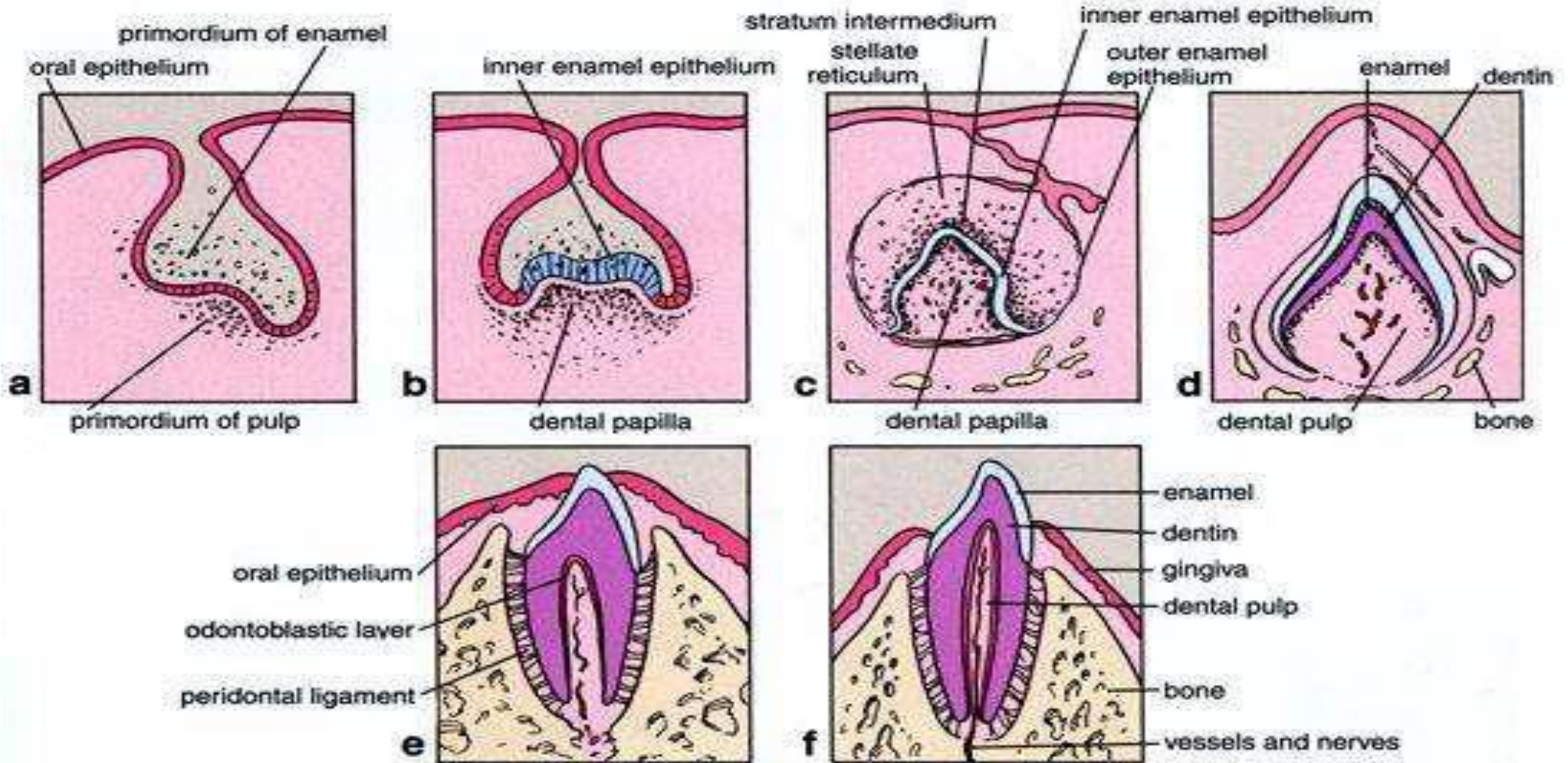


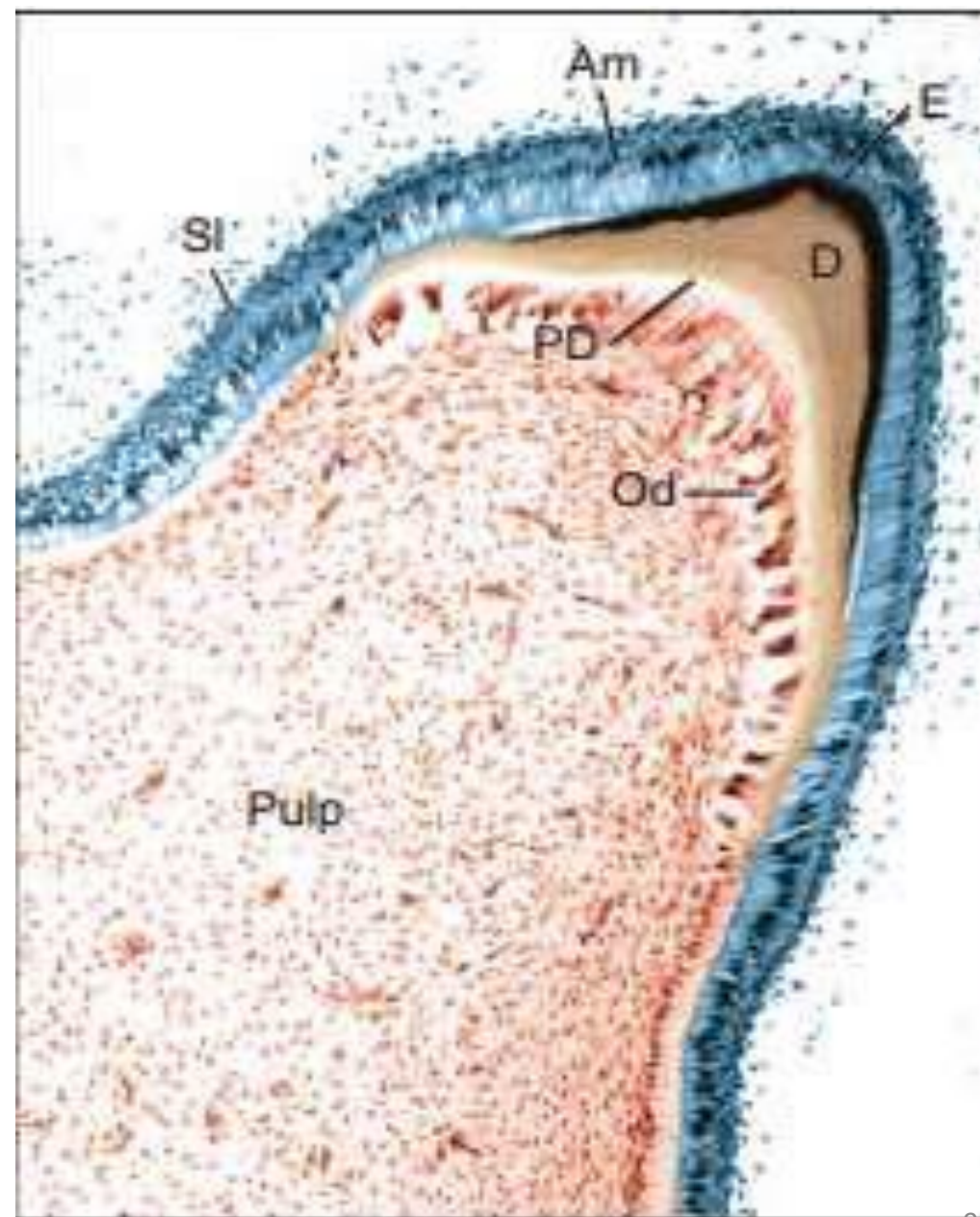
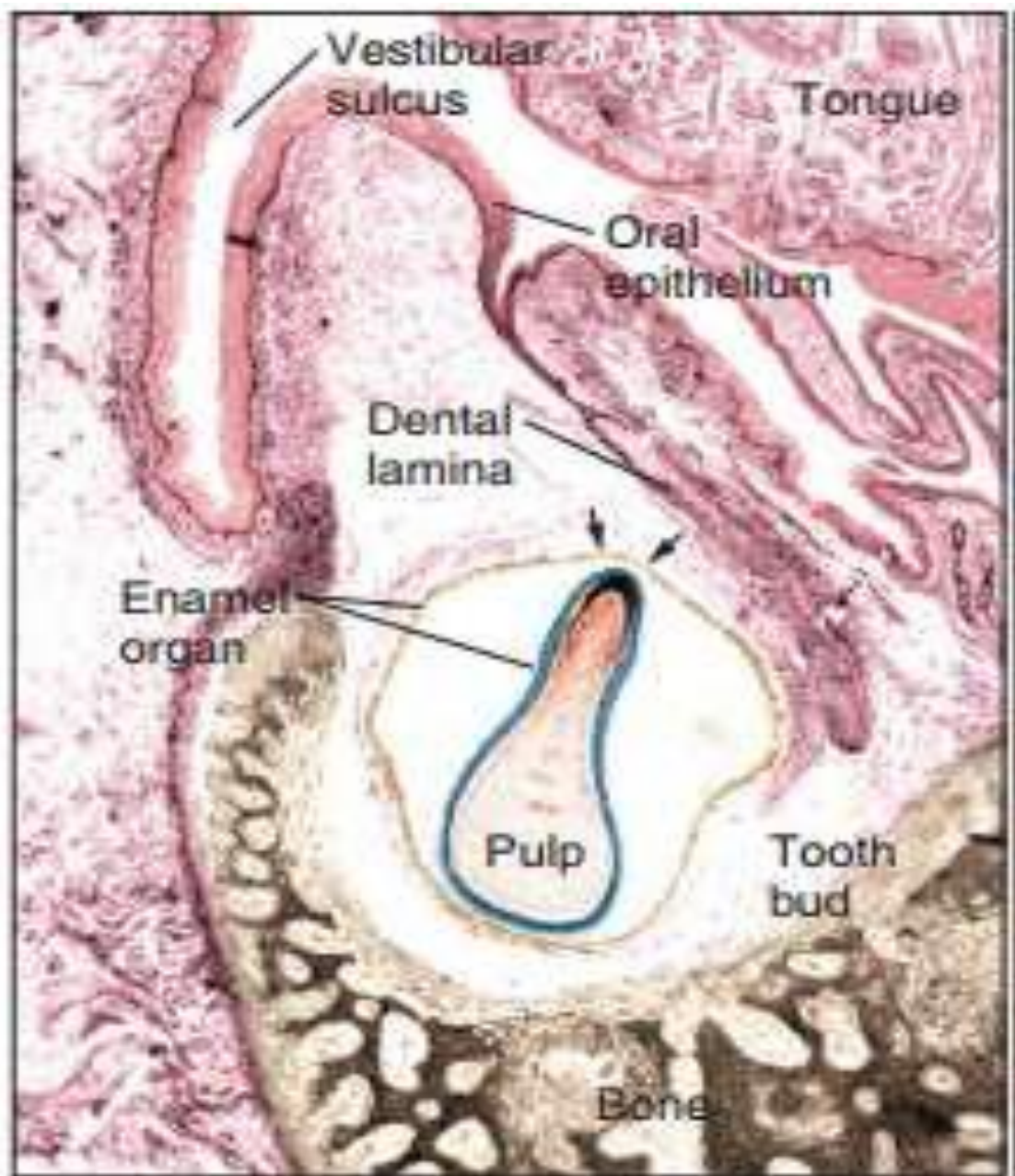
Amelogenesis :

Enamel formation is two steps procedure.

- In first step it deposits partially mineralized enamel (30%)
- After achieving full width of unmineralized enamel: second step involves removal of organic material and water from bulk and influx of mineral.
- The deposition of enamel first begins at cusp tips and incisal areas: then gradually slopes down towards cervical region.
- Reciprocal induction to form enamel, first layer of dentin should be laid down.
- The inner enamel epithelium stimulate dental papilla to form odontoblasts; that form dentin and now dentin act as stimulator for differentiation of ameloblasts.

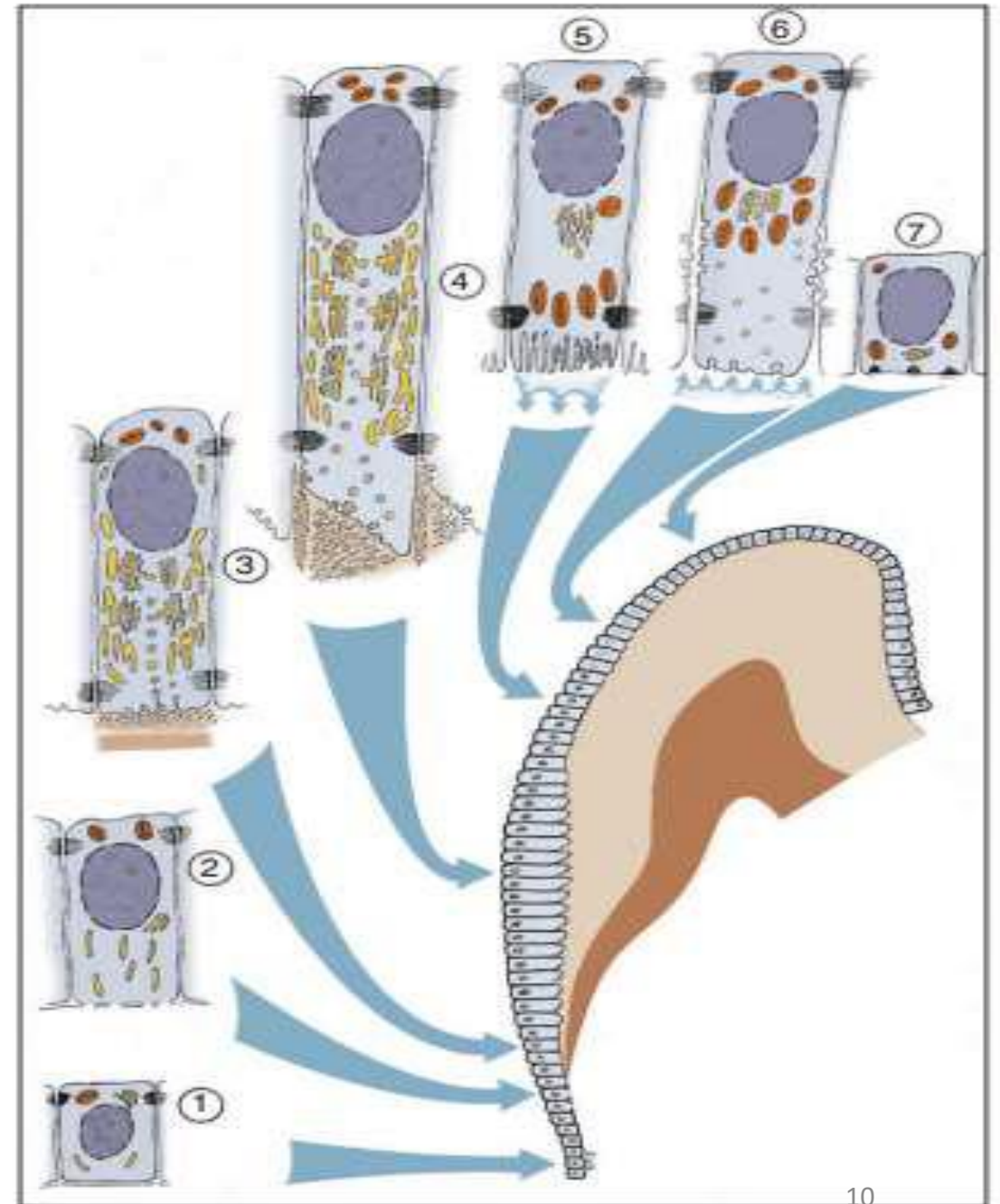
Stages of Tooth Development





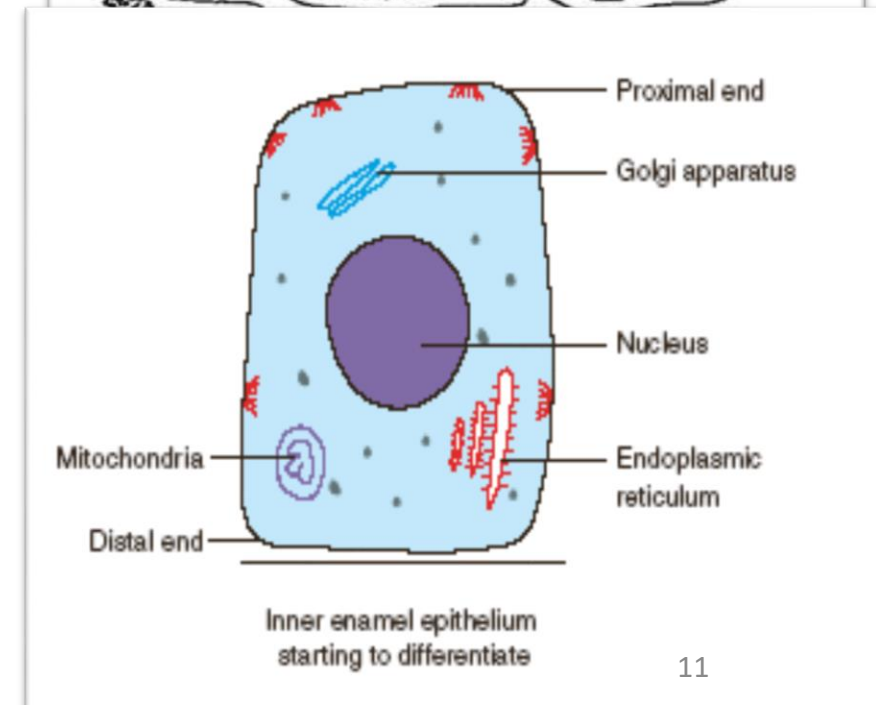
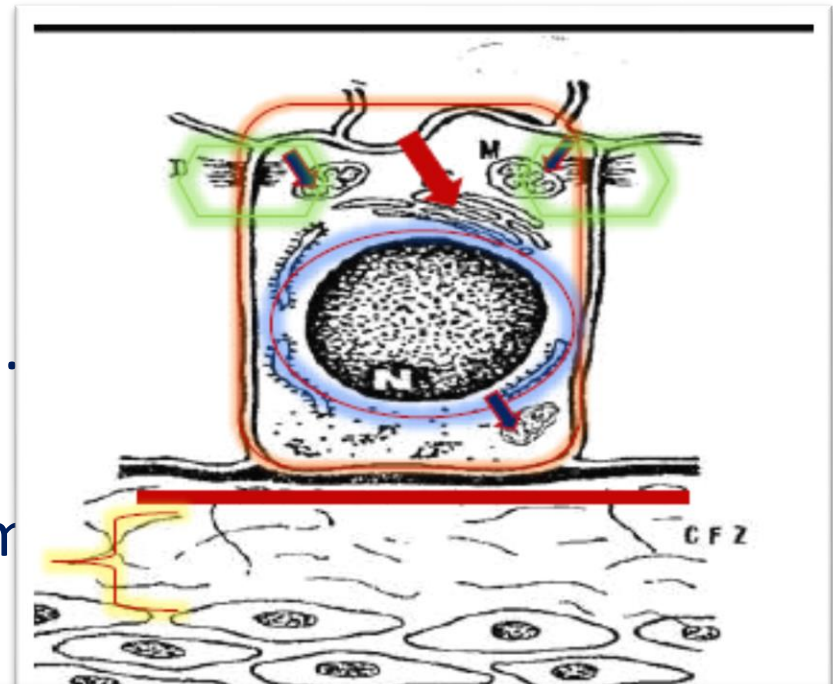
Enamel and amelogenesis:

- Life cycle of ameloblast : According to their function, can be divided into seven stages:
- 1. Morphogenic stage.
- 2. Organizing stage.
- 3, 4 Formative stage.
- 5. Maturative stage.
- 6. Protective stage..
- 7. Desmolytic stage.



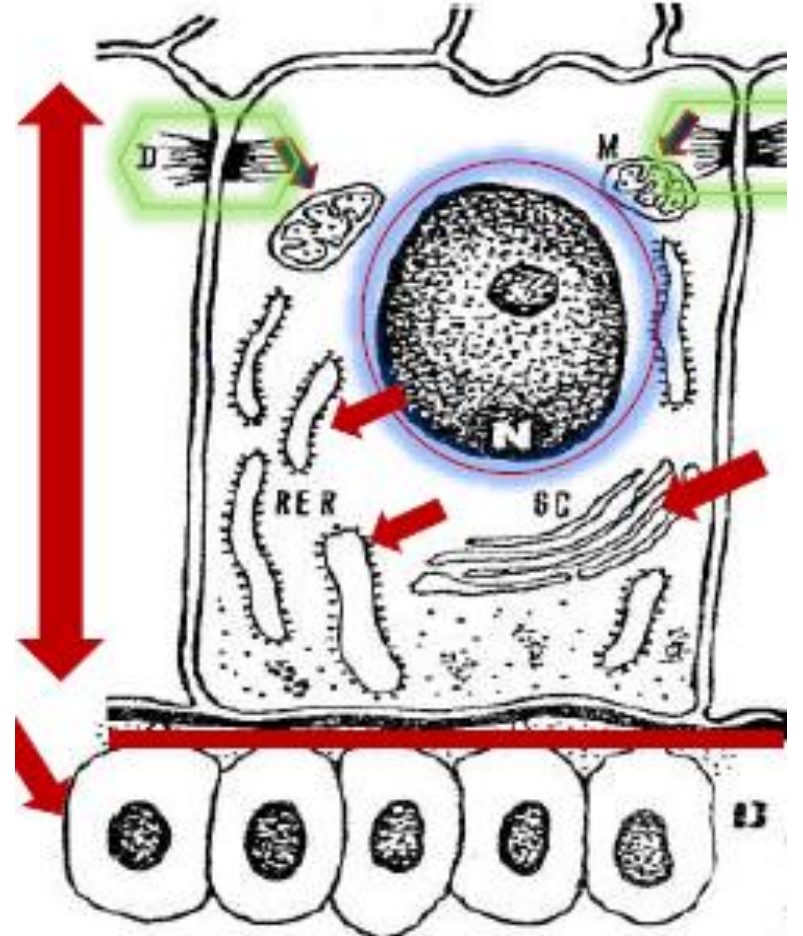
1. Morphogenic Stage:

- ➤ Early bell stage.
- ➤ IEE ; still can undergo mitosis at the cervical region.
- ➤ **Low cuboidal cell**
- ➤ Resting on **basement membrane**; separating it from **cell free zone of dental papilla**.
- ➤ E\M
 - **Large nucleus** filling the cytoplasm.
 - **Golgi apparatus**; **less developed** and centrioles are located in the **proximal end** of the cell (adjacent to the stratum intermedium).
 - **mitochondria** are evenly **scattered** throughout the cytoplasm.
- ➤ Cell attachment.. **Proximal junctional complex**



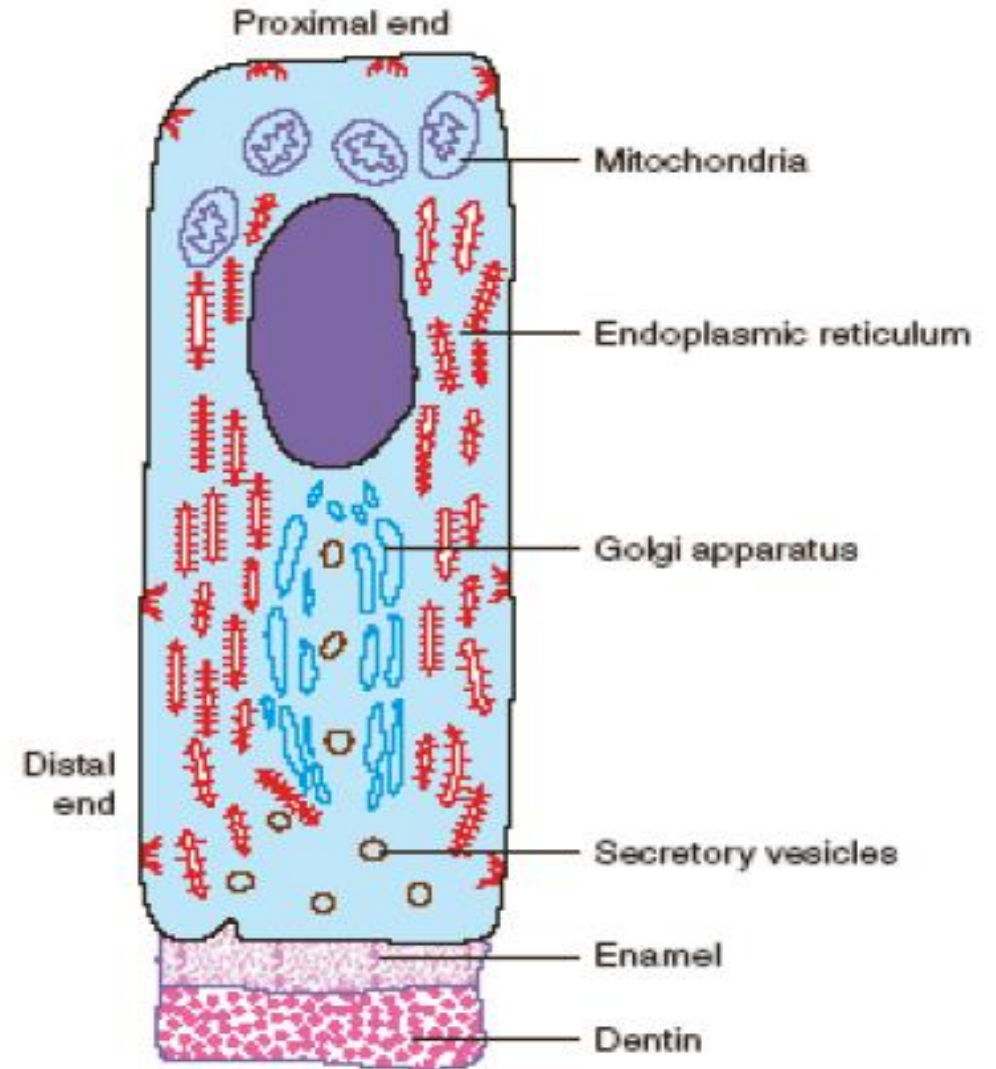
2. Differentiation “organization” Stage.

- ➤ Late bell stage.
- ➤ Ameloblast cell; can't undergo mitosis.
- ➤ Elongated up to 40 microns.
- ➤ Resting on basement membrane; separating it from newly formed odontoblasts.
- ➤ E\M
- ■ Shift of the nucleus to the proximal end.
- ■ Golgi apparatus; developed and condensed and centrioles are moved to the distal end.
- ■ mitochondria clustered infra nucleus (in the proximal region).
- ■ rER increased in number.



3. Secretory “Formative” Stage.

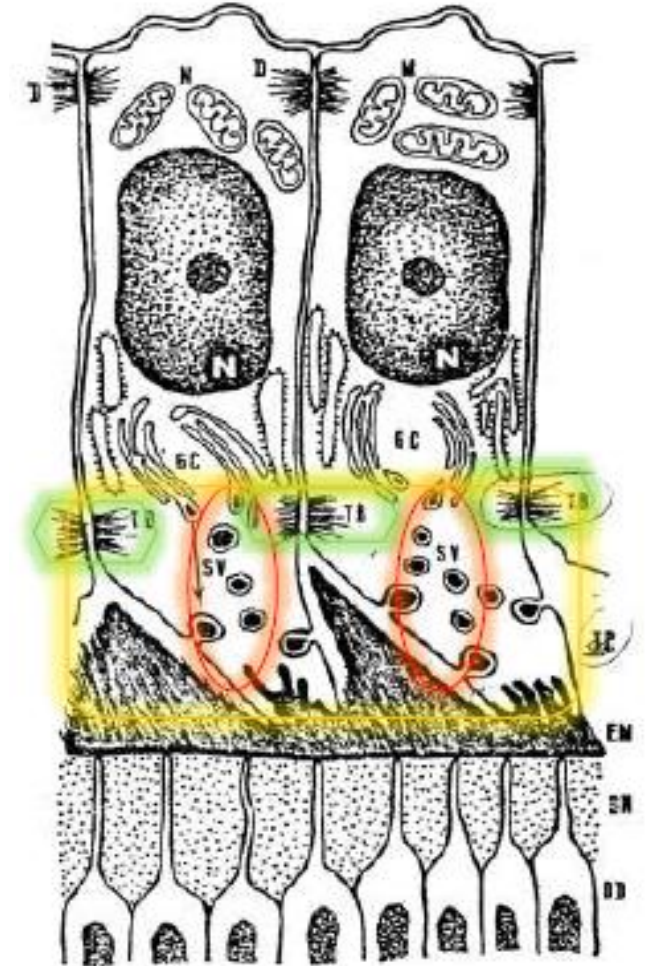
- ■ ➤ At late bell and developing tooth stage.
- ➤ Ameloblast cell.
- ■ Golgi apparatus; developed and condensed
- occupying a major part of the central core.
- ■ mitochondria clustered in the proximal region.
- ■ rER increased in number.
- Cell attachment.. Proximal and distal junctional complexes.
- ➤ The synthesis of enamel protein occurs in rER where passed to Golgi complex to be condensed and packed into membrane bound secretory granules. These granules migrate to distal end of cells to exteriorize their content against newly formed mantle dentine.



Secretory organelles appear at the end of the cell and become the site of secretion of enamel matrix

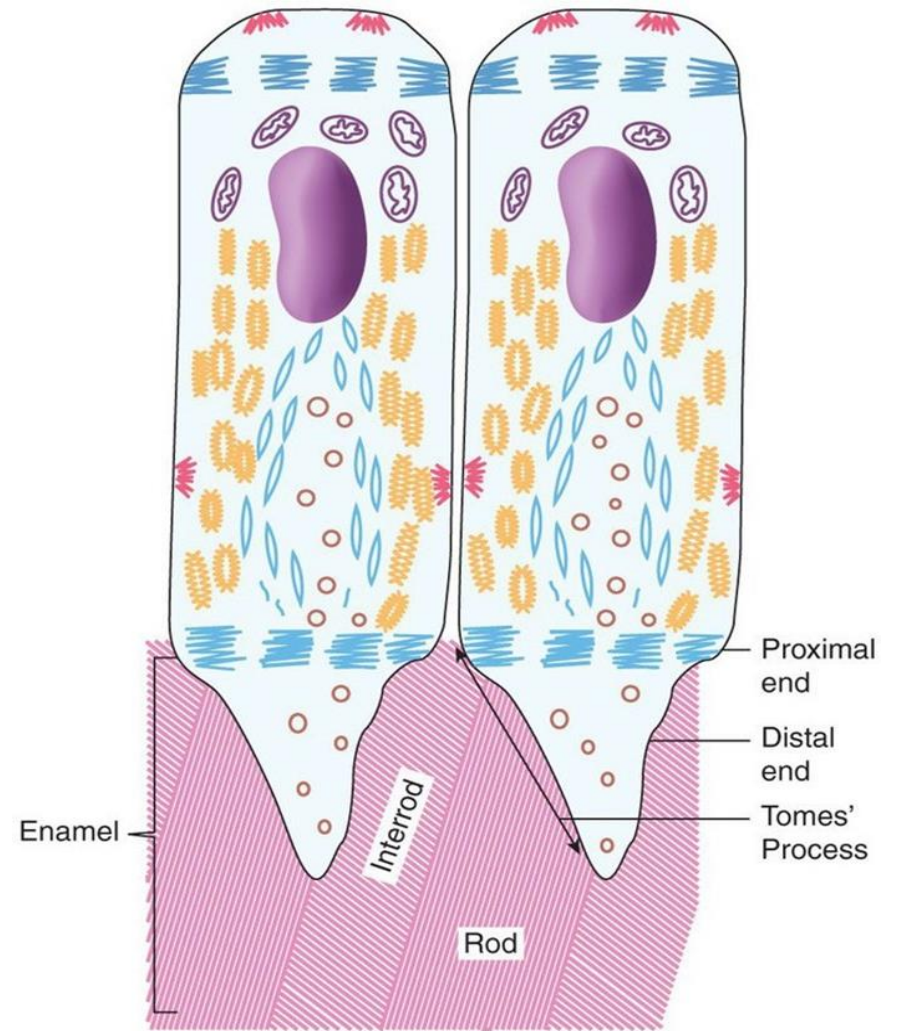
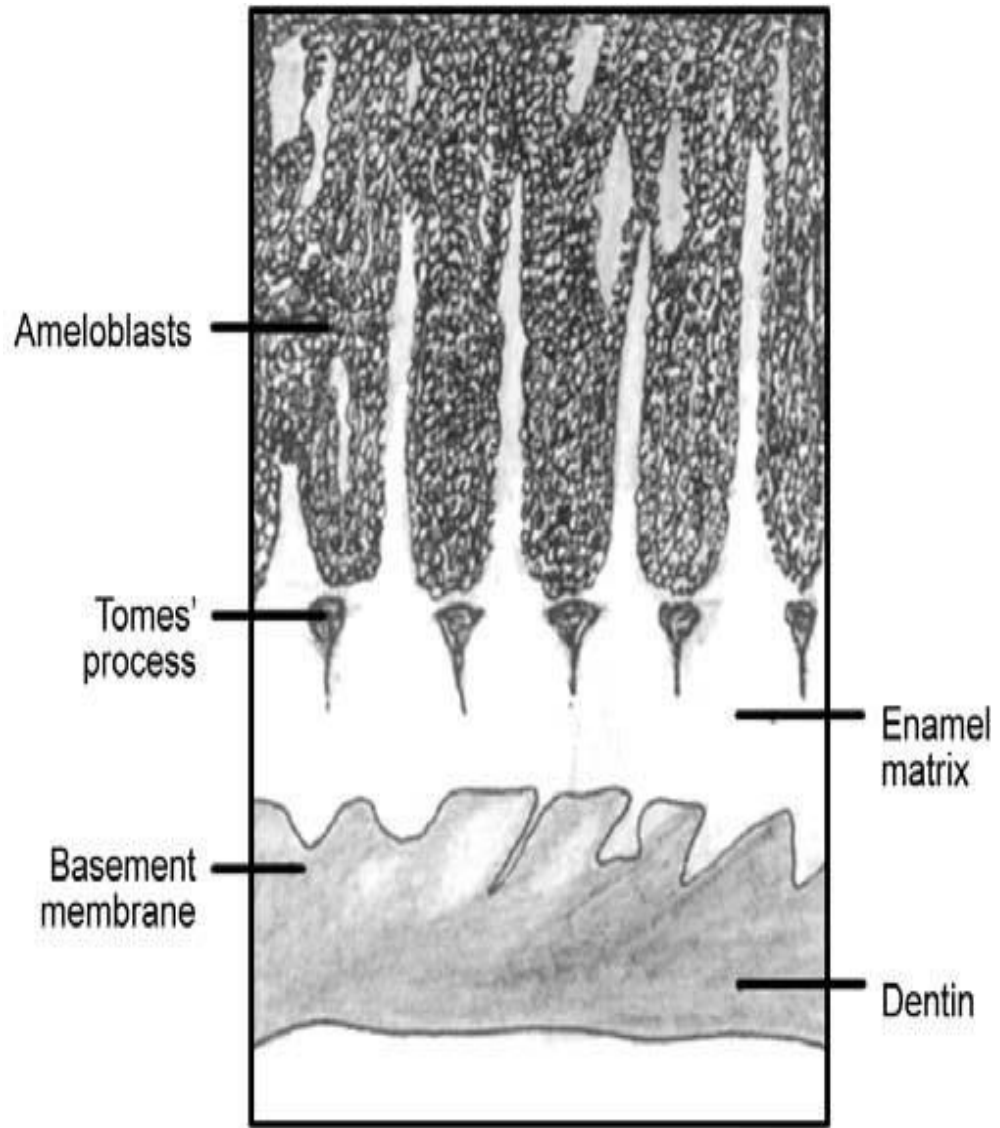
3. Secretory “Formative” Stage.

- ➤ The hydroxyapatite crystals are randomly packed in this first layer of enamel at the ADJ.
- ➤ As the first layer of enamel is formed, the ameloblast migrate away from dentine surface which permits the formation of Tomes’ process.
- ➤ The distinction between process and cell body is clearly marked by distal junctional complex.
- ➤ This Tomes’ process contains primarily secretory granules and small vesicles while cell body contains abundant synthetic organelles.



- Secretion of enamel is confined to two sites:-
- I. Adjacent to proximal part of the process close to junctional complex; resulting in formation of inter rod, this wall encloses a pit in which Tomes' process fits.
- II. Second site involves secretion from the distal sloping portion of Tomes process which later fills this pit with matrix. These pits are called enamel rods.
- So, the crystal orientation and direction in the wall of pit differ from that in the pits giving the inter rod enamel and the filling area become the enamel rods.





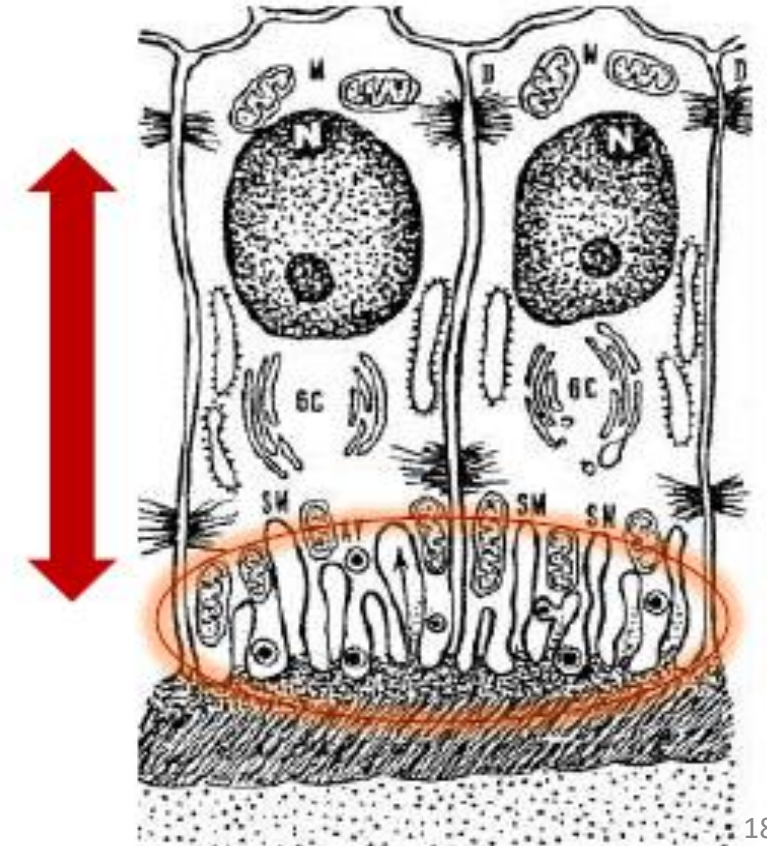
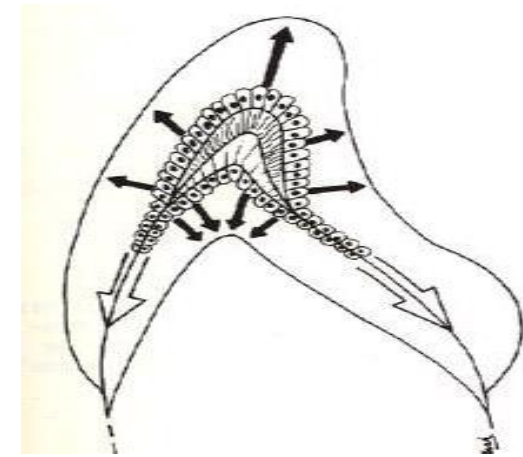
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Transitional stage:

- ➤ Withdrawal of Tomes' processes.
- ➤ Reduction in the height of the ameloblasts and decrease in its volume and organelle content.
- ➤ During this period most probably the structureless (rodless) enamel is formed.

Maturative Stage:

- Enamel maturation (full mineralization) occurs after most of the thickness of the enamel matrix has been formed in the occlusal or incisal area ,
- While at the cervical parts of the crown, enamel matrix formation is still progressing at this time.



Maturative Stage:

- ➤ Ameloblasts are
 - ■ slightly **reduced** in length
 - ■ **closely** attached to **enamel matrix**.
 - ■ cytoplasmic **vacuoles** containing material **resembling enamel matrix**.
 - ■ display **microvilli** at their **distal** extremities forming a **striated border** “**increasing surface area**”
- ➤ These structures indicate an **absorptive function** of these cells.
- Ameloblasts develop **cycles of modulation** of alternating **ruffled** and **smooth** bordered end which is **expressed** like a **wave**.

Maturative Stage:

- Associated with **introduction** of inorganic materials.
- **Distal tight** and **leaky proximal** junctions.

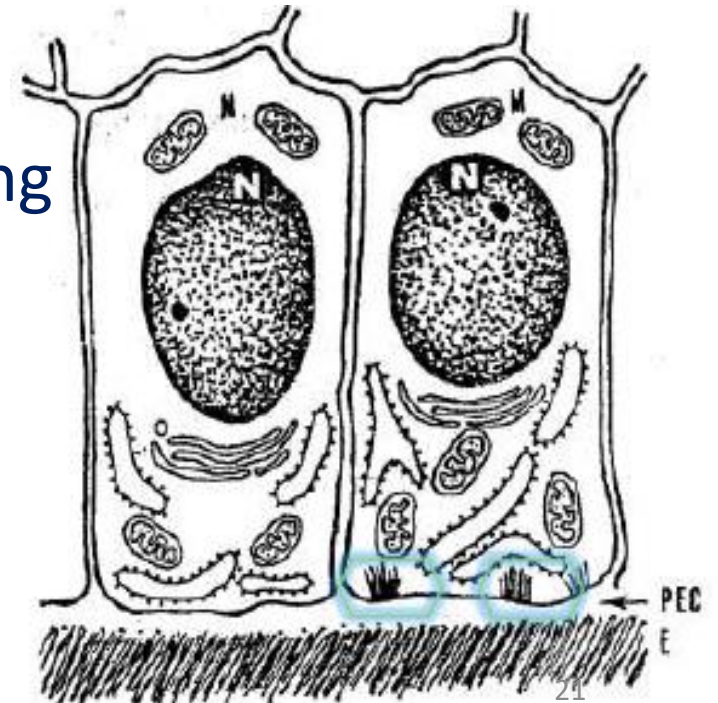


- Associated with **removal** of protein and water.
- **Distal leaky** junction and **proximal tight** junctions.



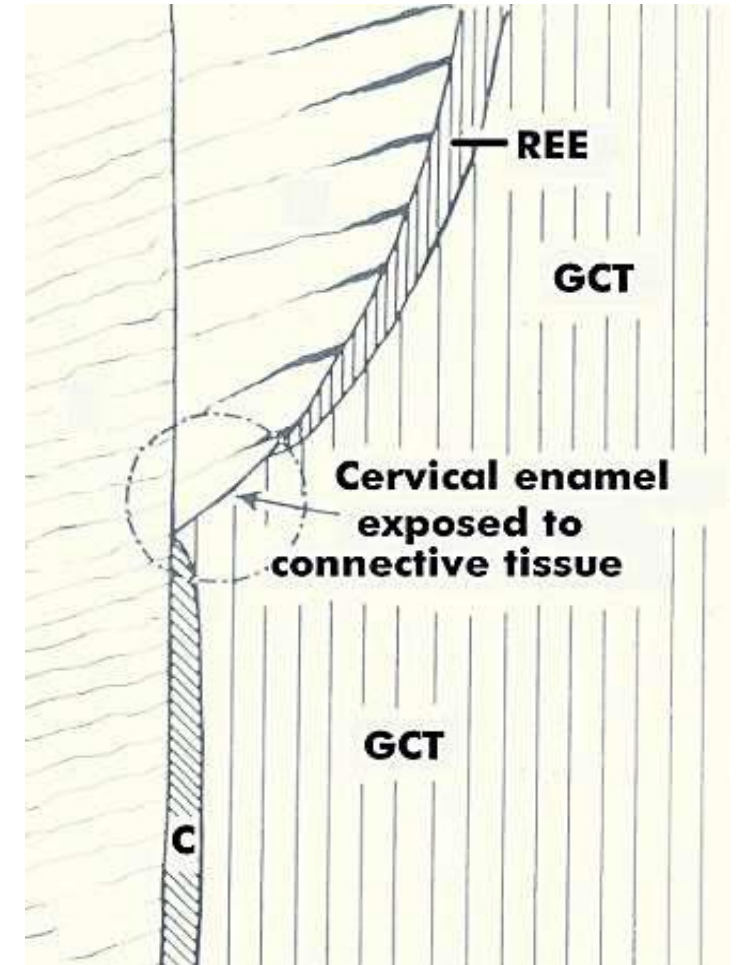
Protective Stage :

- ➤ After complete formation and mineralization of enamel; the ameloblasts secrete a material between distal ends of cells and the enamel surface identical to basal lamina (Hemidesmosomes).
 - ➤ It providing a firm attachment for ameloblasts and enamel surface which establish the dentinogingival junction.
- Ameloblasts can't be differentiated from the cells of the SI, SR and OEE forming a stratified epithelial covering of the enamel, the so called REE (reduced enamel epithelium).



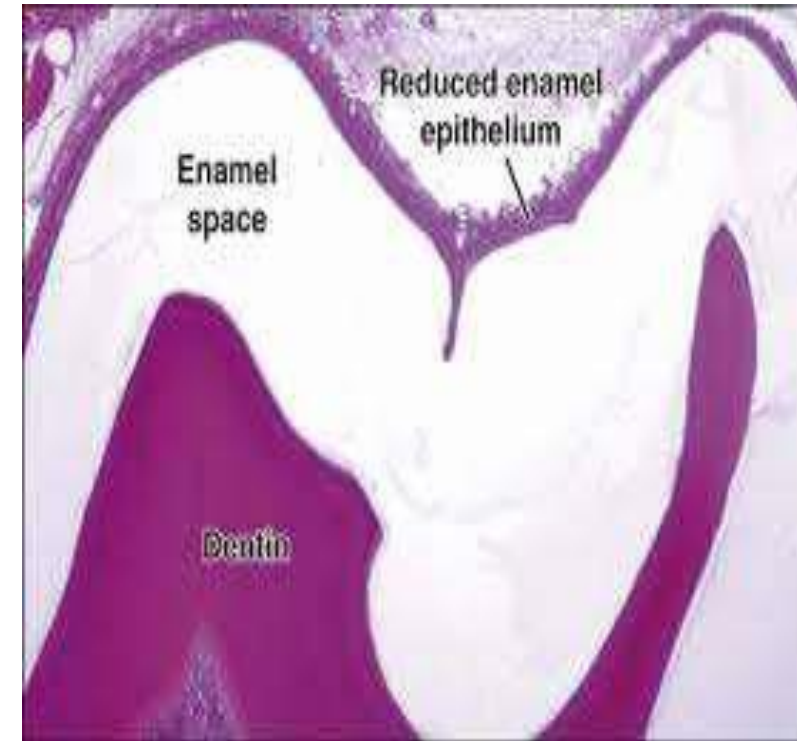
Protective Stage :

- REE protects the mature enamel by separating it from the connective tissue until the tooth erupts.
- If the connective tissue comes in contact with the enamel, enamel may be either resorbed or covered by a layer of cementum.






Desmolitic Stage.

- ➤ The REE (reduced enamel epithelium) proliferates and seems to induce atrophy of the connective tissue separating it from the oral epithelium as pathway for tooth eruption.
- ➤ It is probable that it elaborate enzymes that are able to destroy connective tissue fibers by desmolysis.
- ➤ Premature degeneration of the reduced enamel epithelium may prevent the eruption of a tooth.



Amelogenesis:

I. Formation of enamel matrix.

- Synthesis of E. proteins occurs in rER, moved to Golgi for condensation, glycation and packing into secretory granules. 
- Granules secrete their content against first formed layer of dentine “mantel dentine” 
- Areas of un-mineralized enamel matrix “stippled material”; soon crystals appear. 
- Tome’s process jut into newly formed E matrix giving it saw tooth appearance

- Ameloblasts migrate away from E surface and Tome's process is formed.



- crystals of first layer of E interdigitate with crystals of first formed layer of D which act as nucleation site for E crystals.



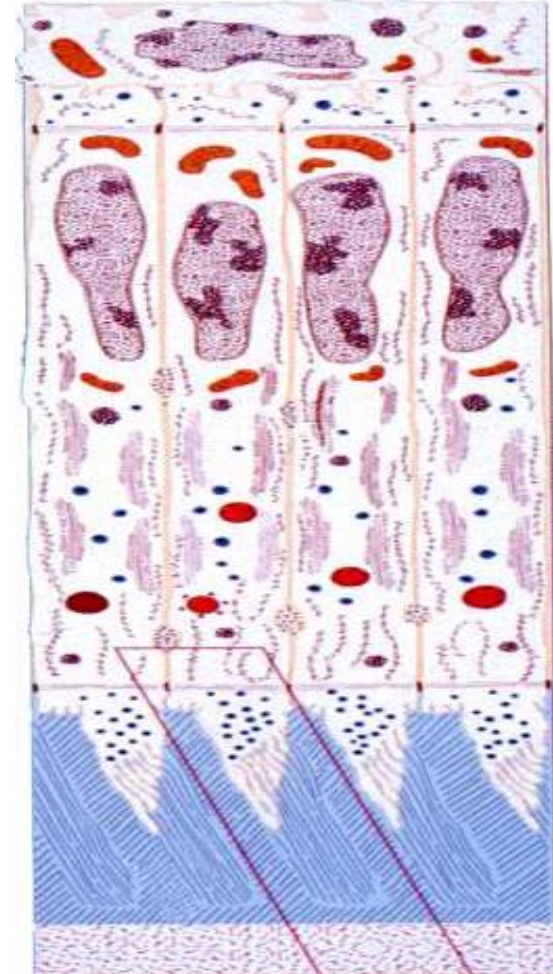
- 2 regions within Tome's process; distal end and proximal extremities.



- Proximal extremities gives inter rod substance; distal end gives rod.

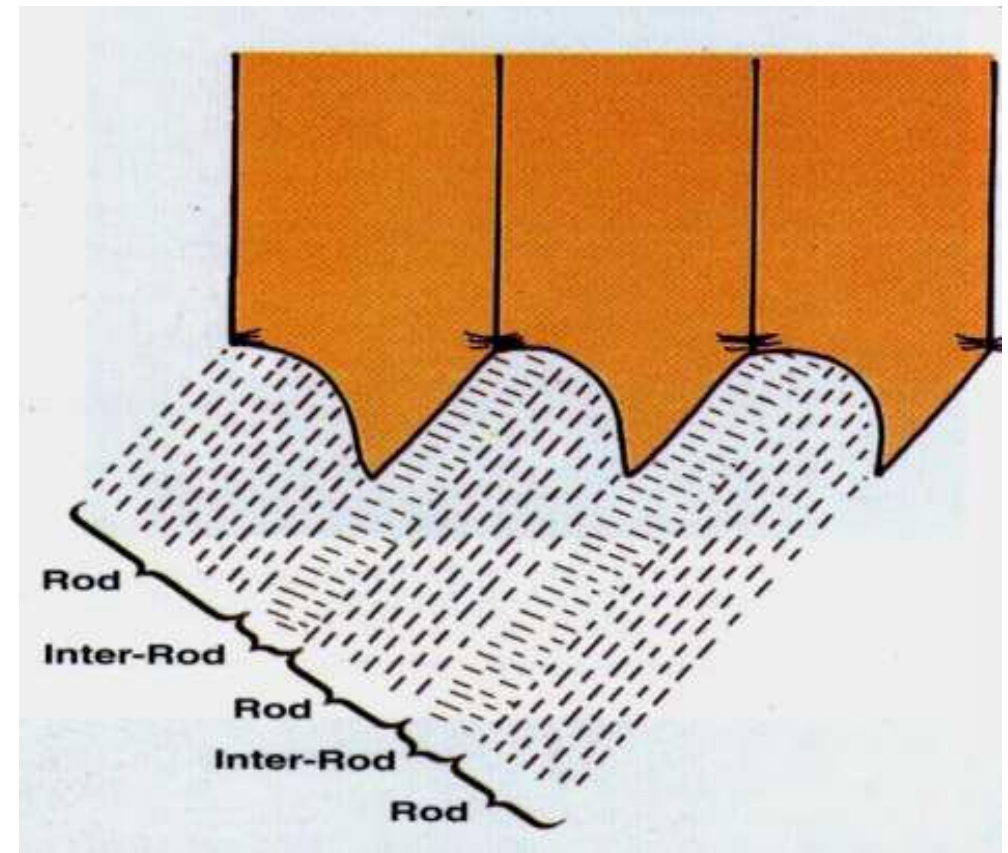
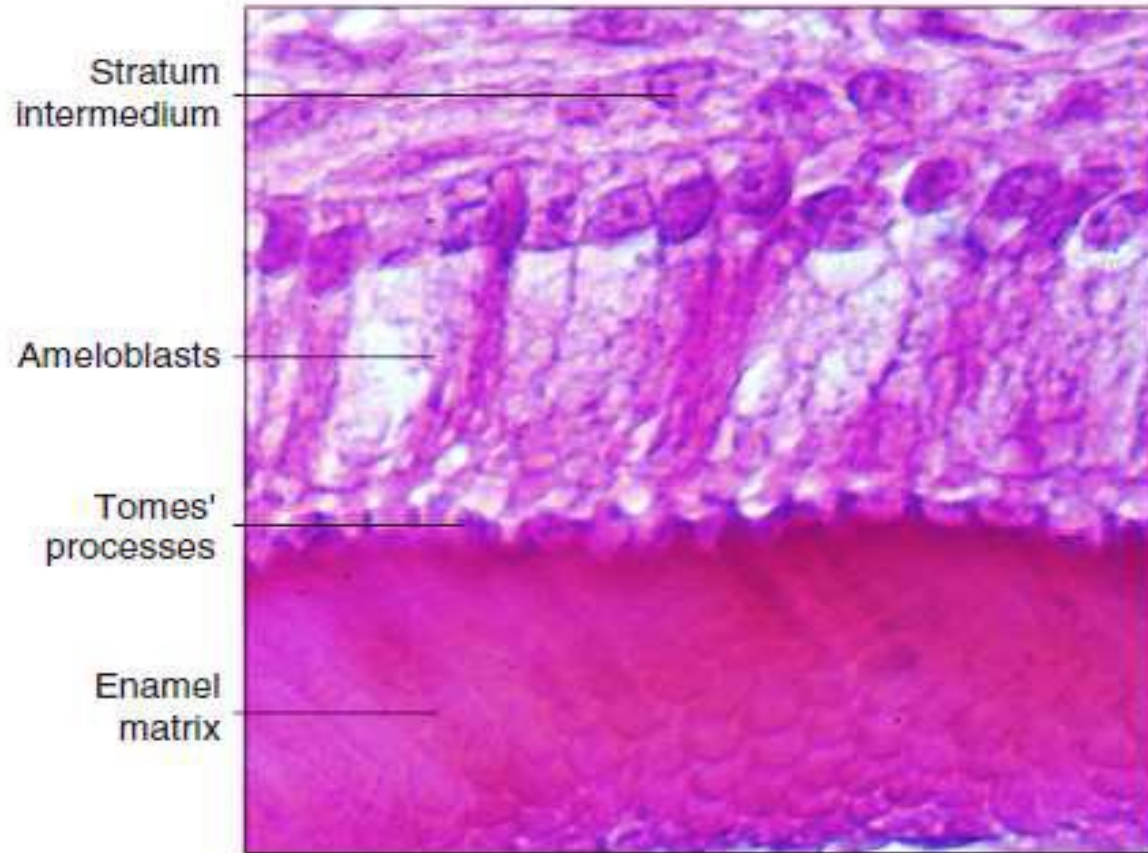


- Crystal has a perpendicular direction on the membrane of Tome's process



I. Formation of enamel matrix.

- Stratum intermedium with ameloblasts form a functional cellular unit responsible for E formation.
- ➤ SI. plays a role in the formation of enamel itself; either through
 - I. The control of fluid diffusion into and out of ameloblasts.
 - II. The actual contribution of necessary formative elements or enzymes “Alk. Phosphatase”.
- ➤ 90% of enamel prs. is amelogenins, the remaining 10% enamelin, tuftsin and amelin.



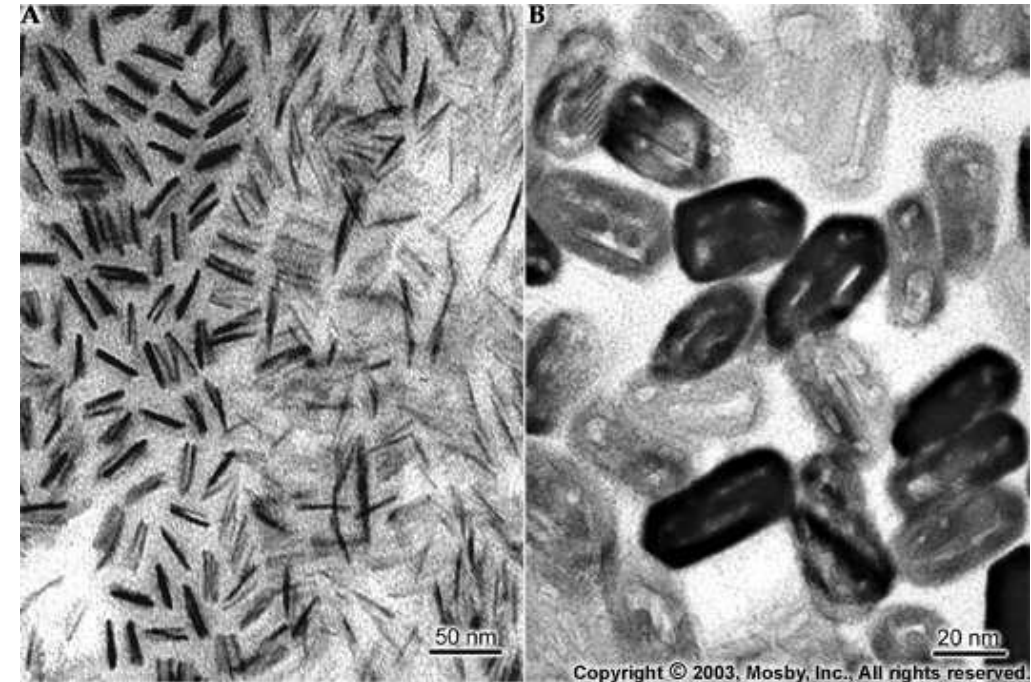
II. Enamel mineralization.

- Partial immediate mineralization; 25-30% Occurs before full thickness of enamel is formed.



- Full maturation occurs after full thickness of enamel is formed.
- ➤ Mineralization commences from the height of the crown and progresses cervically, depth of rod to the surface.
- ➤ The actual process of mineralization involves the removal of large quantities from enamel matrix.

- ➤ At the **final stages** of removal of organic matrix, the ameloblasts show **certain chemical and ultrastructural** features suggestive of an **absorptive function!!!**
- ➤ As the crystals are deposited, **a sudden change** in their **orientation** occurs in the prism outline which is responsible for the presence of the rod sheath.
- The **crystals thicken** rapidly and the intervening **protein is squeezed out.**



Newly
formed
crystals

Mature
crystals

Defects of amelogenesis.

- ➤ **Febrile disease**
- All teeth forming in this time are affected by distinctive bands of malformed surface enamel. On recovery, normal enamel resumed.

- ➤ **Tetracycline**
- It is an antibiotic which incorporated in mineralizing tissues result in **band** of brown pigmentation or even total pigmentation.



- ➤ **Fluoride ion**
- chronic ingestion of F. concentration in excess of 5 parts per million, result in mottled enamel as patches of hypomineralized and altered enamel.



Age changes of enamel.

- **Attrition**
- Physiologic wearing of the tooth substance; as a result of tooth to tooth contact.



- **Discoloration**
- **By food substances, coffee & smoking.**
- **Some cases by trauma.**



- **Modification in surface layer.**
- As a result of **ionic exchanges with oral cavity**, the composition of the surface layer changes.
- **Reduction in caries incidence.**
- Due to **increased F. content by exchange**; the enamel becomes harder.