



LECTURE

Amelogenesis

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Oral Pathology and Microscopy



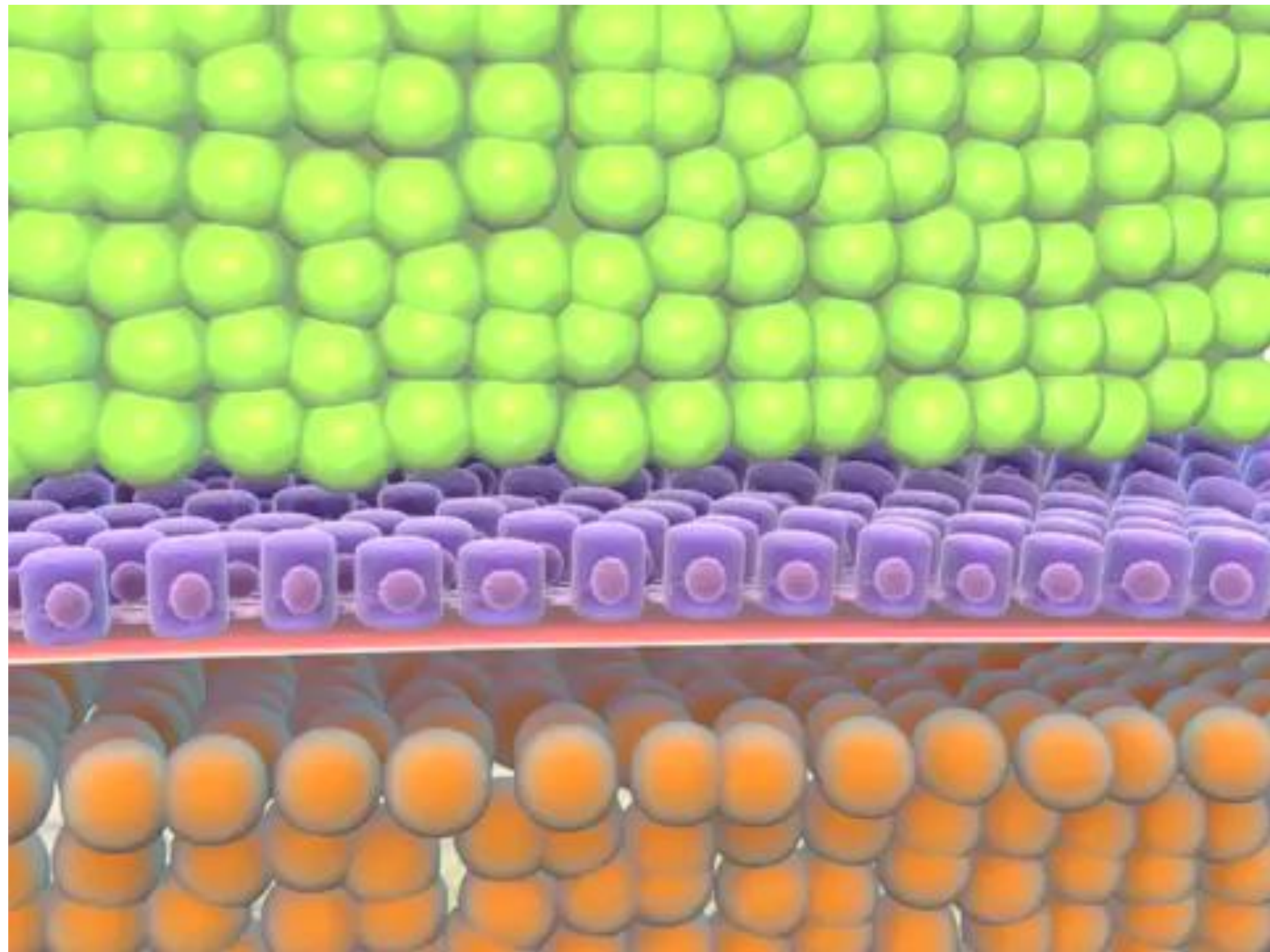
Lecture learning outcome

By the end of this lecture, students should be able to:

1. Enumerate the steps in Enamel Formation
2. Describe stages of amelogenesis
3. Discuss Tome's process and its function

AMELOGENESIS

- It is the process of Enamel formation.
- Amelogenesis begins shortly after dentinogenesis at the advanced bell stage. The delicate basement membrane between IEE and odontoblasts will disintegrate after dentinogenesis and before amelogenesis.
- Cells responsible for amelogenesis are called **AMELOBLASTS**.



Tooth development

1. BUD
2. CAP
3. EARLY BELL
4. **ADVANCED BELL STAGE.**

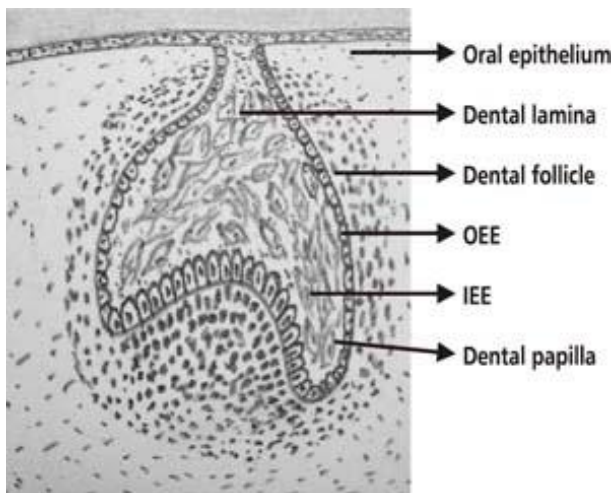
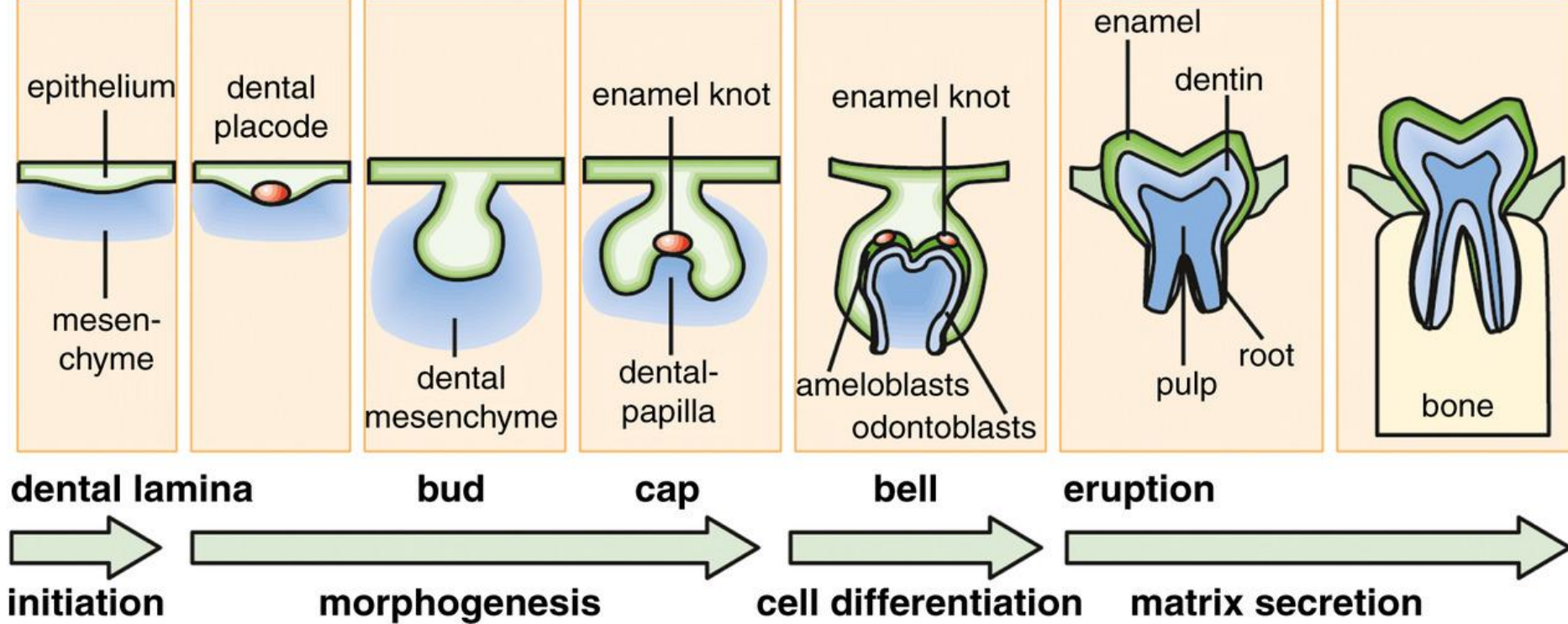


Fig. 2 : Enamel organ in its cap stage of tooth development extending into underlying ectomesenchyme

Amelogenesis is a complex process, it involves 2 stages:
E. matrix deposition and mineralization of the E. matrix

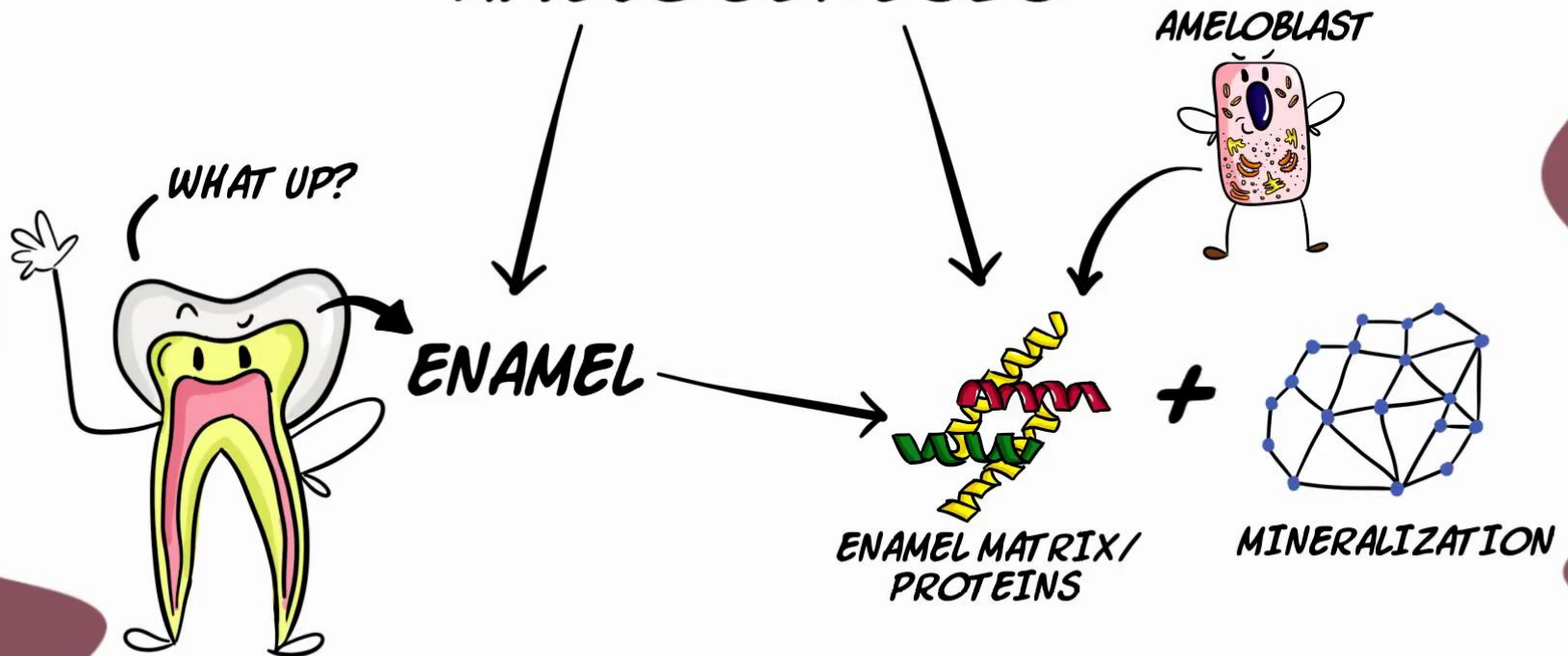
AMELOGENESIS

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graph TD; A[AMELOGENESIS] --> B[1. Enamel (Organic) matrix secretion]; A --> C[2. Mineralization of the E. matrix OR Maturation];
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1. Enamel
(Organic) matrix
secretion

2. Mineralization
of the E. matrix
OR Maturation

AMELOGENESIS



Life cycle of the ameloblasts:

According to their function, the life span of the cells of the IEE can be divided into 5 stages:

- 1. Presecretory stage**

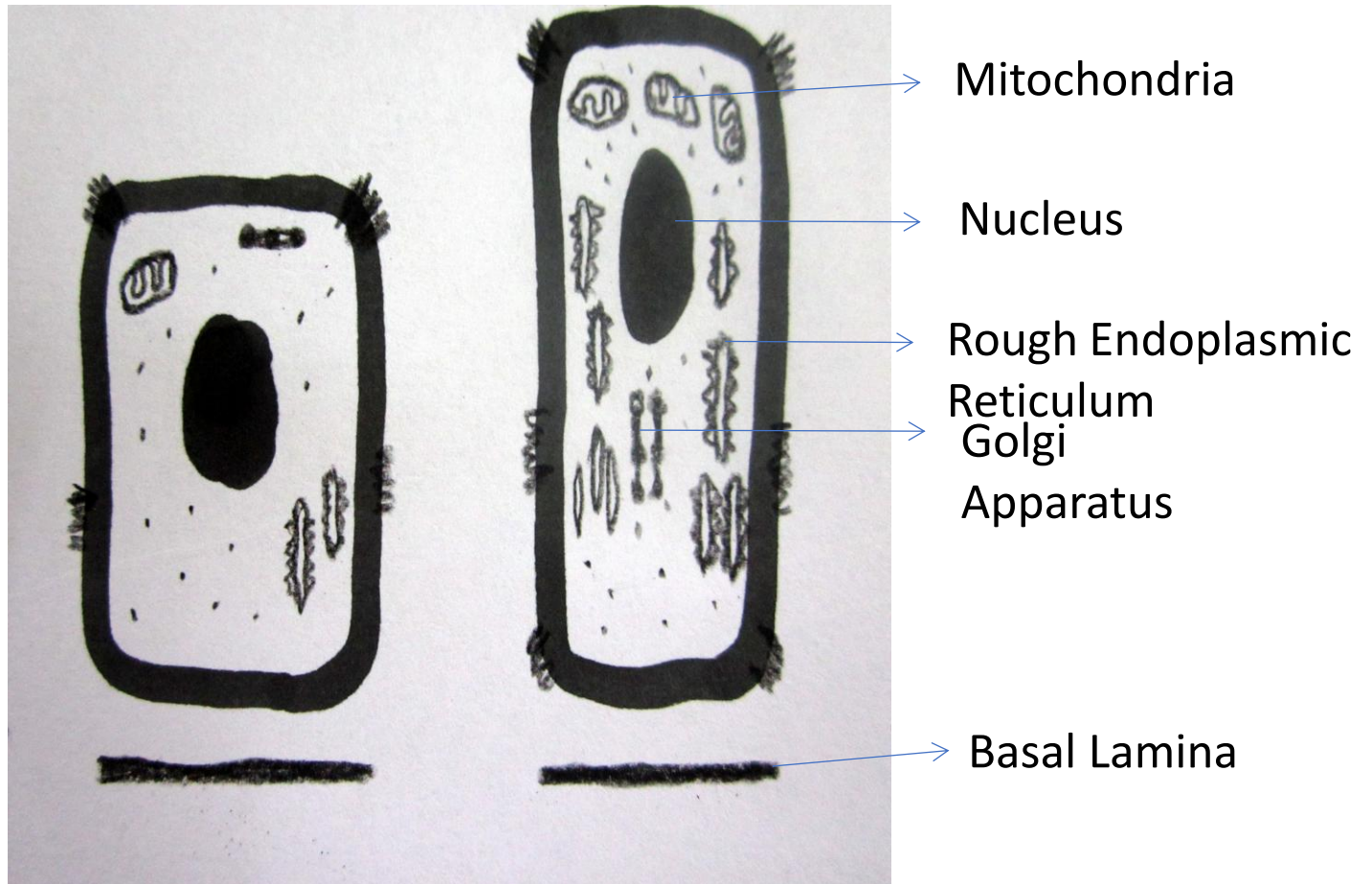
Morphogenetic phase and Differentiation phase

- 2. Secretory (Formative) stage**

- 3. Transitional phase**

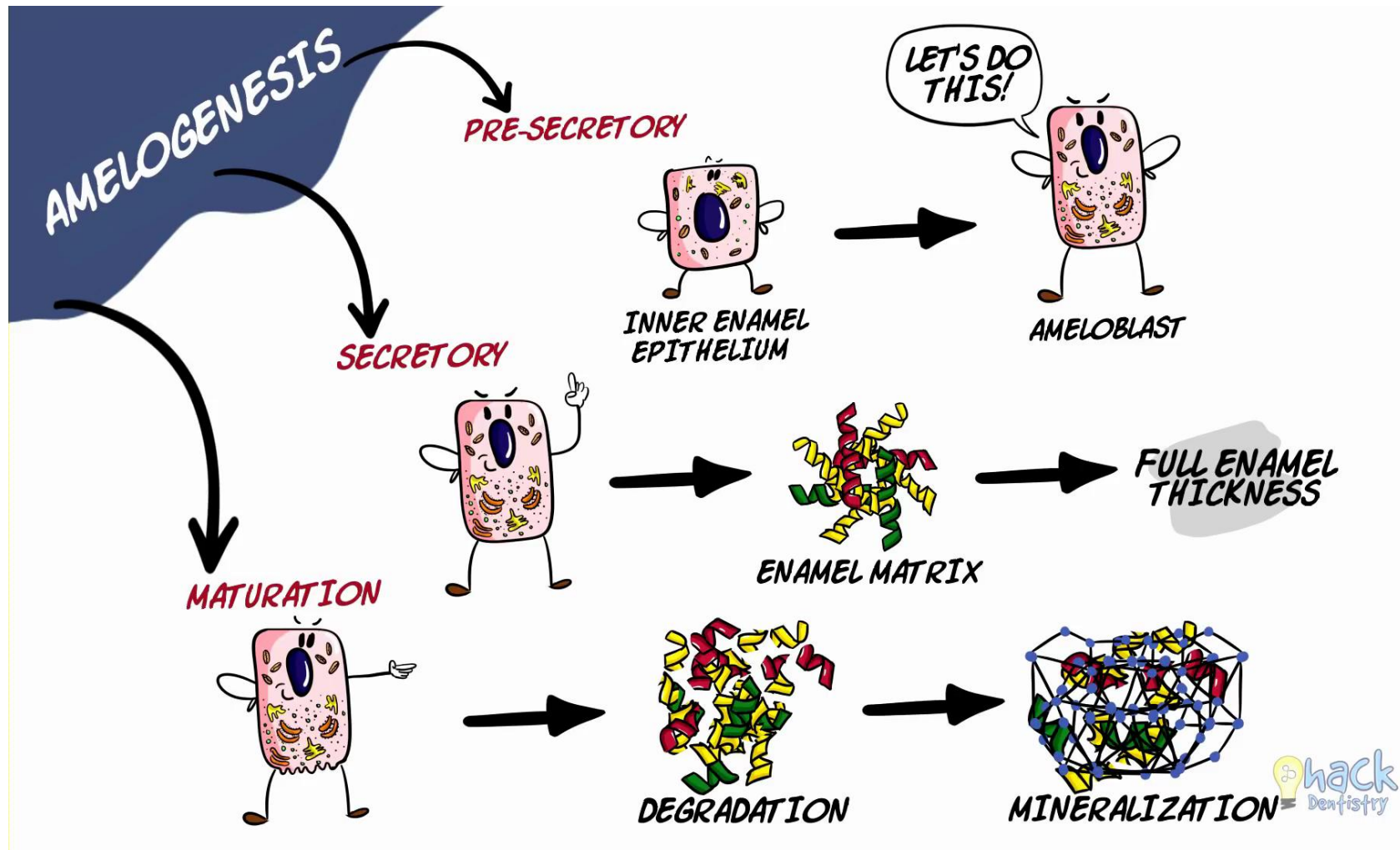
- 4. Maturation stage**

- 5. protective.**

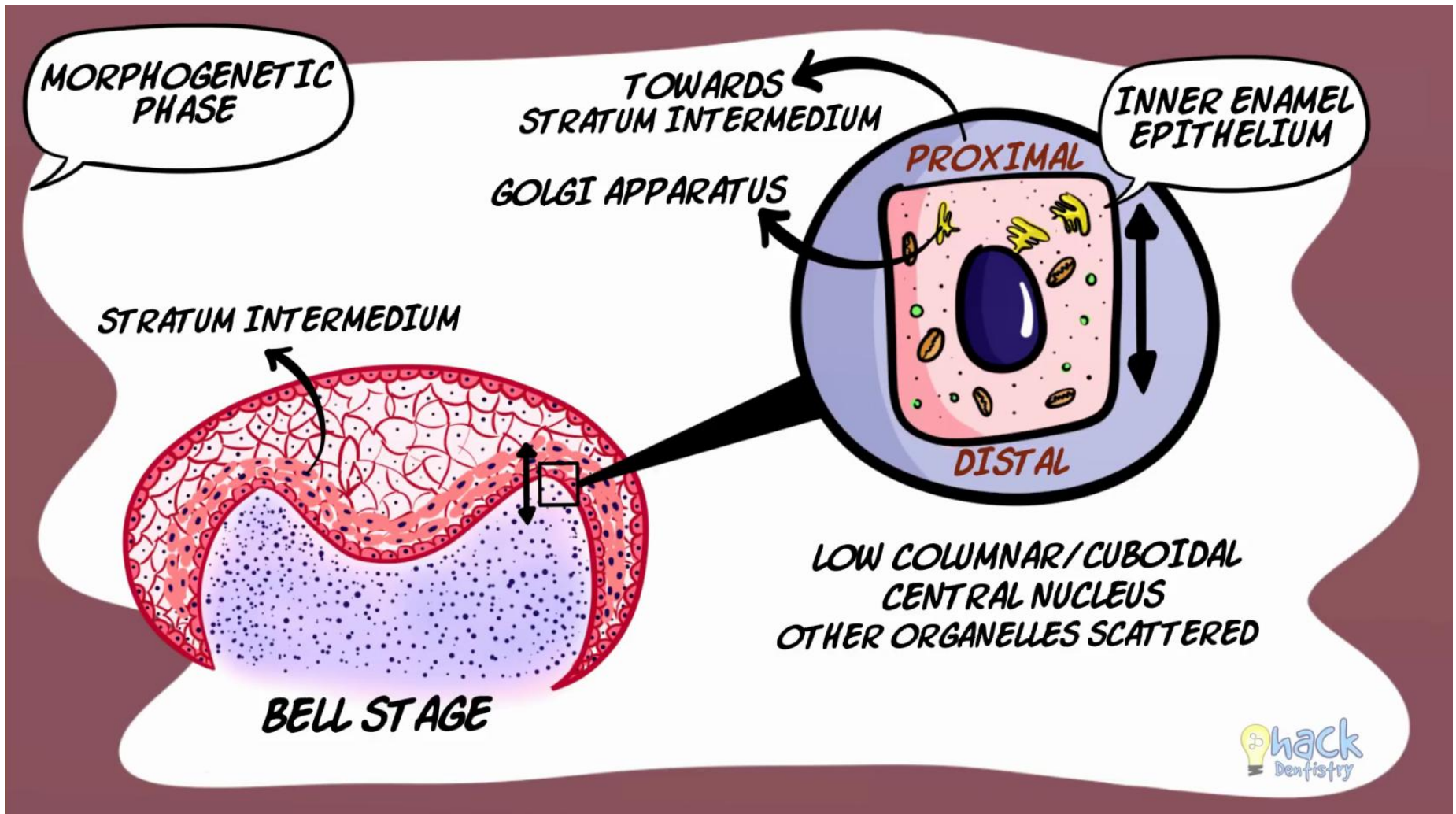


Presecretory stage of ameloblast

STAGES OF AMELOGENESIS

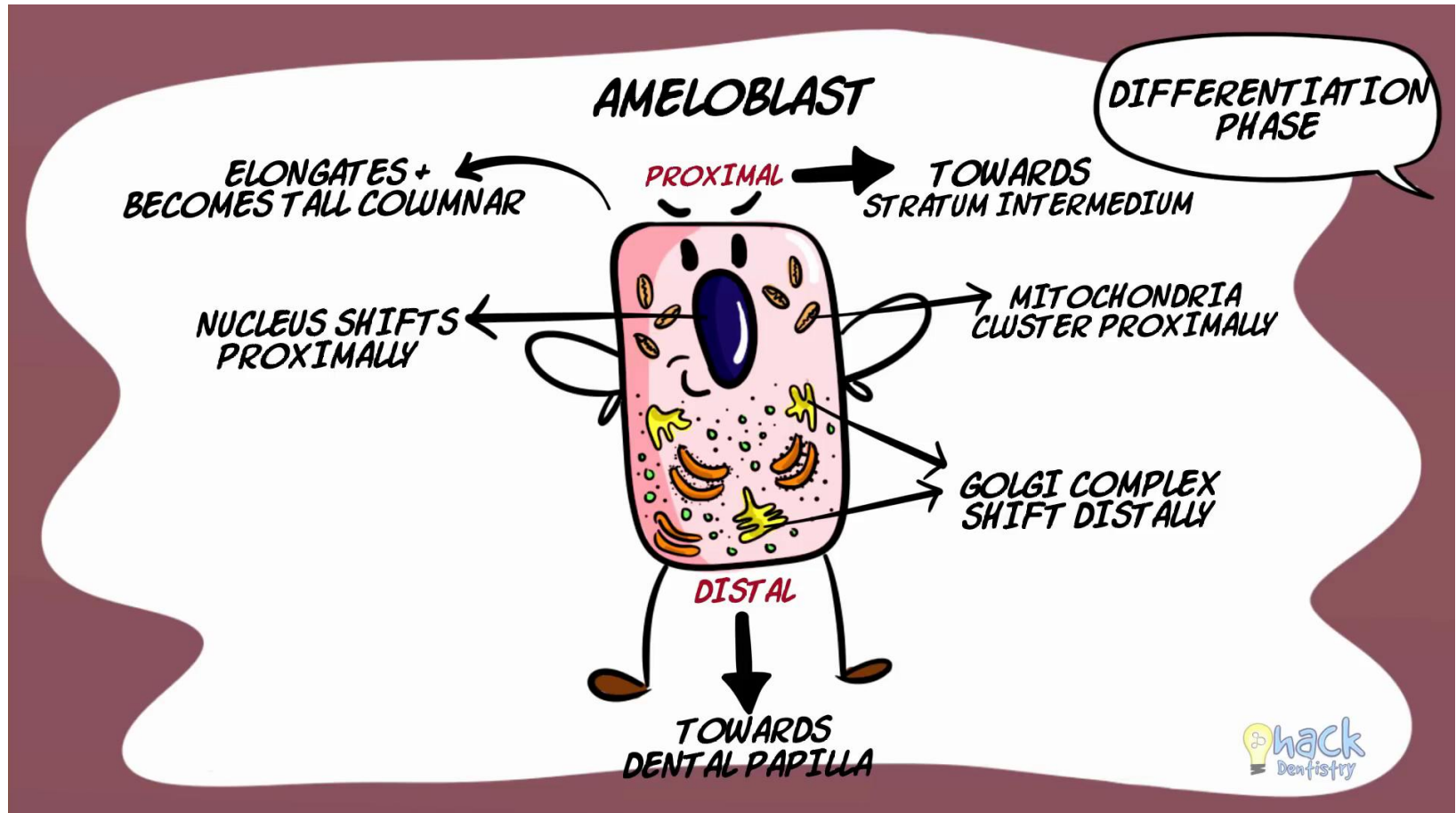


MORPHOGENETIC PHASE



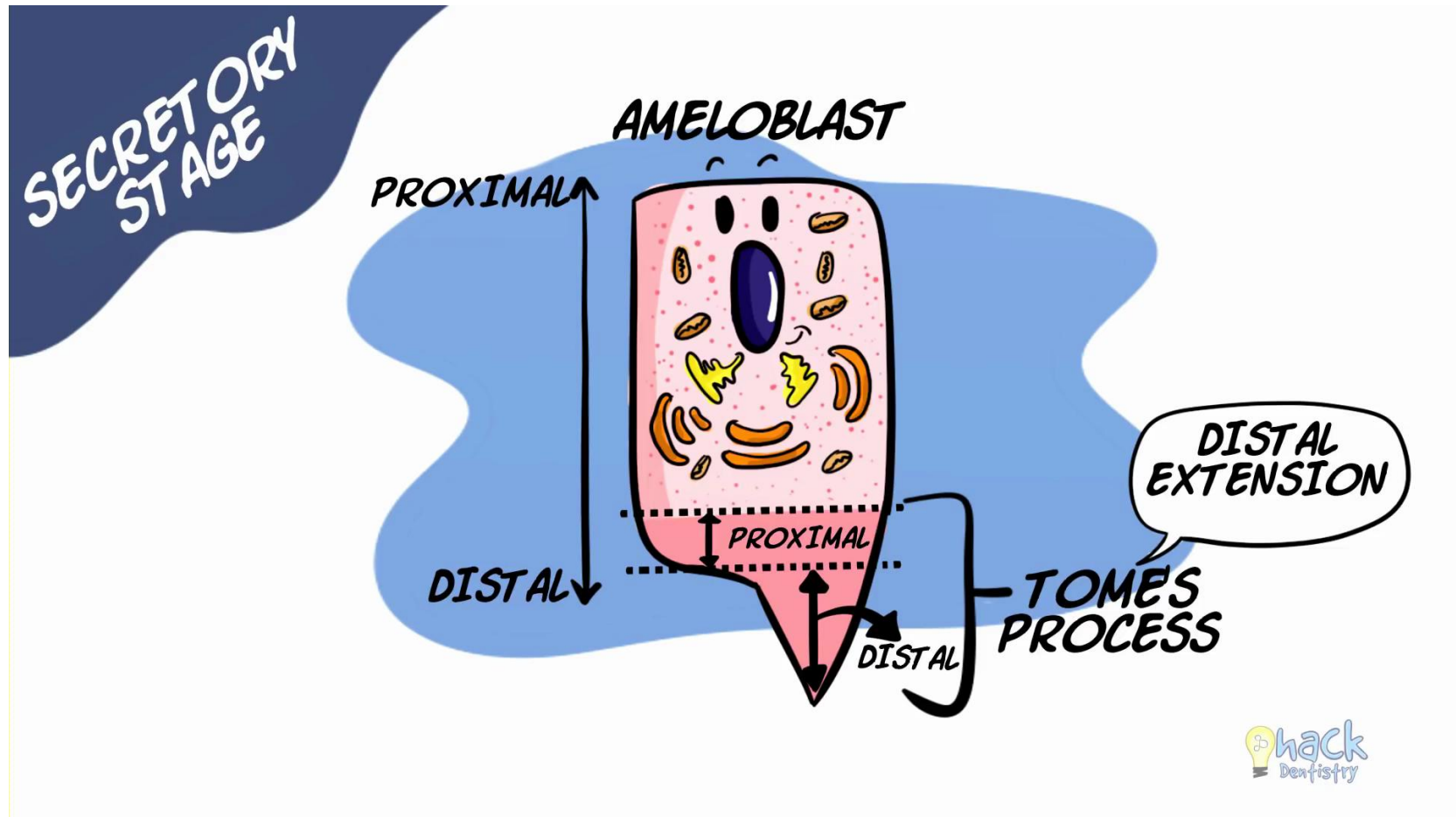
- During this stage of tooth development, the shape of the crown is determined
- During this phase the IEE begins its differentiation first into pre- ameloblasts which induce adjacent dental papilla cells to differentiate into odontoblasts which form dentin.
- At this stage the IEE cells are cuboidal or low columnar, with large, centrally located nuclei and poorly developed Golgi elements in the proximal portion of the cells (facing the stratum intermedium)
- Mitochondria and other cytoplasmic components are scattered throughout the cell. .

DIFFERENTIATION PHASE

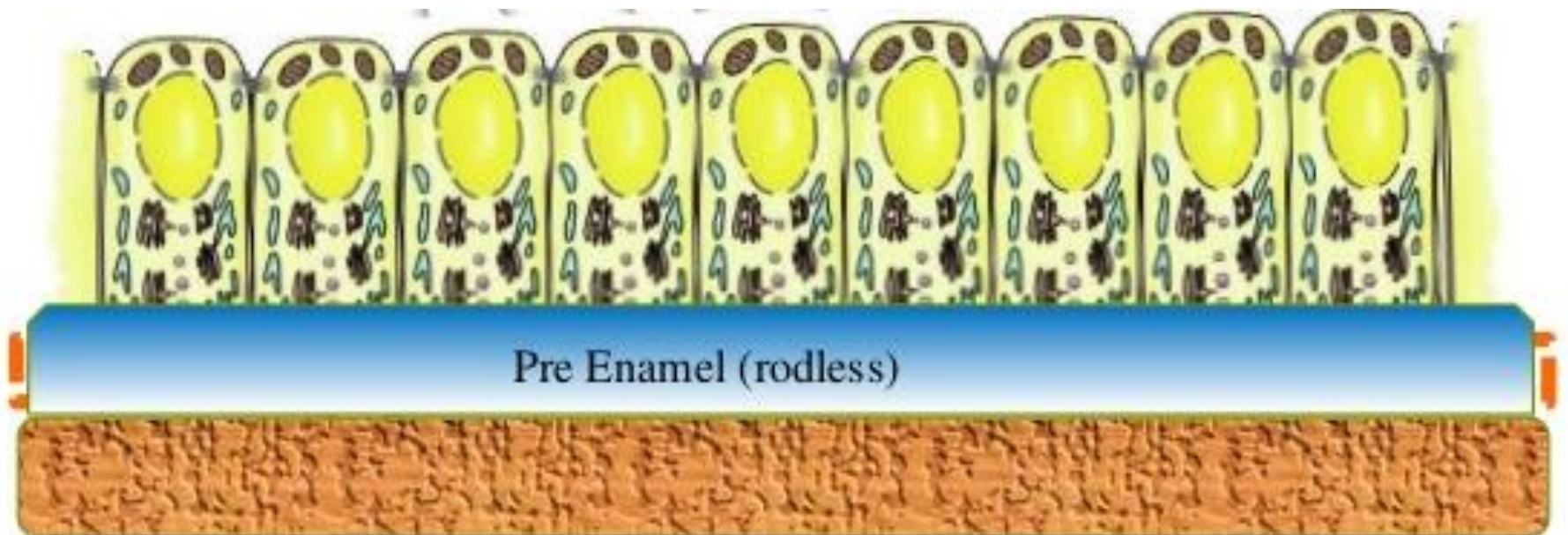


- As the cells of the inner enamel epithelium differentiate into **ameloblasts**, they **elongate and their nuclei shift proximally toward the stratum intermedium**, with more **organelles mostly protein synthesizing organelles (Golgi apparatus, RER, and Mitochondria) in their distal end**.
- These cells can no longer divide.
- During this phase the formation of the dentin by the odontoblasts begins.

SECRETORY (FORMATIVE) STAGE



- The ameloblasts enter their formative stage after the first layer of dentin has been formed
- Enamel matrix formation begins against the newly formed dentin to form initial layer of enamel that does not contain enamel rods.
- Once 1st layer of enamel is formed ameloblast migrate away from the dentin surface and **develop the tomes' process** (conical shaped processes) at their distal ends.
- Tomes' processes interdigitate with the surface of the forming enamel giving it a picket fence appearance.
- **Rods and inter rods are formed from Tomes' process of ameloblast.**
- As the secretory stage is ending Tomes' processes are lost and accordingly the last formed layers of enamel are rodless or prismless E.



Pre Enamel (rodless)

Pre Dentin

**SECRETORY
STAGE**

**SECRETION OF
ENAMEL HAPPENS
FROM TWO SITES**

PROXIMAL

AMELOBLAST

**I ONLY HAVE A
PROXIMAL TOME
INITIALLY**

DISTAL

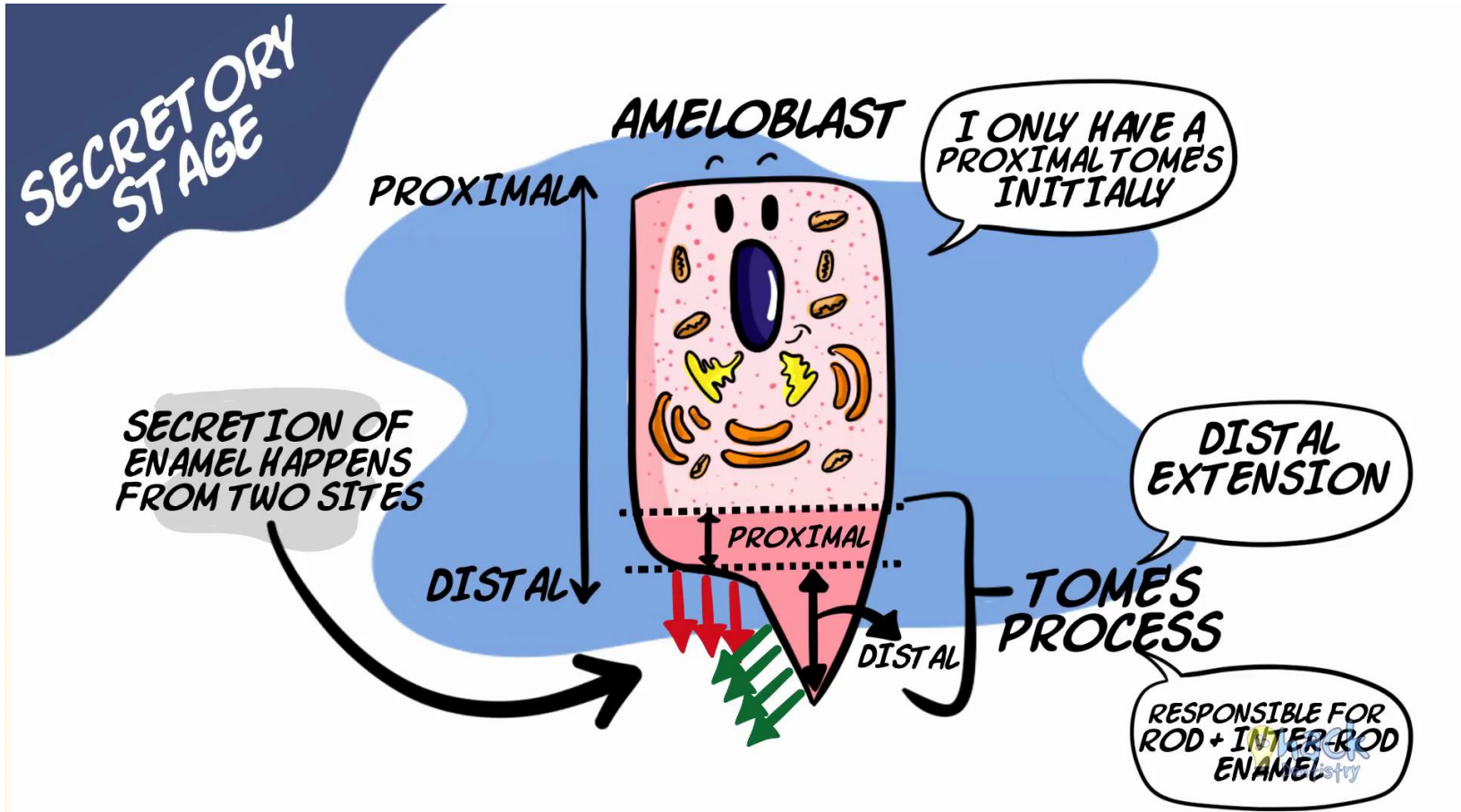
PROXIMAL

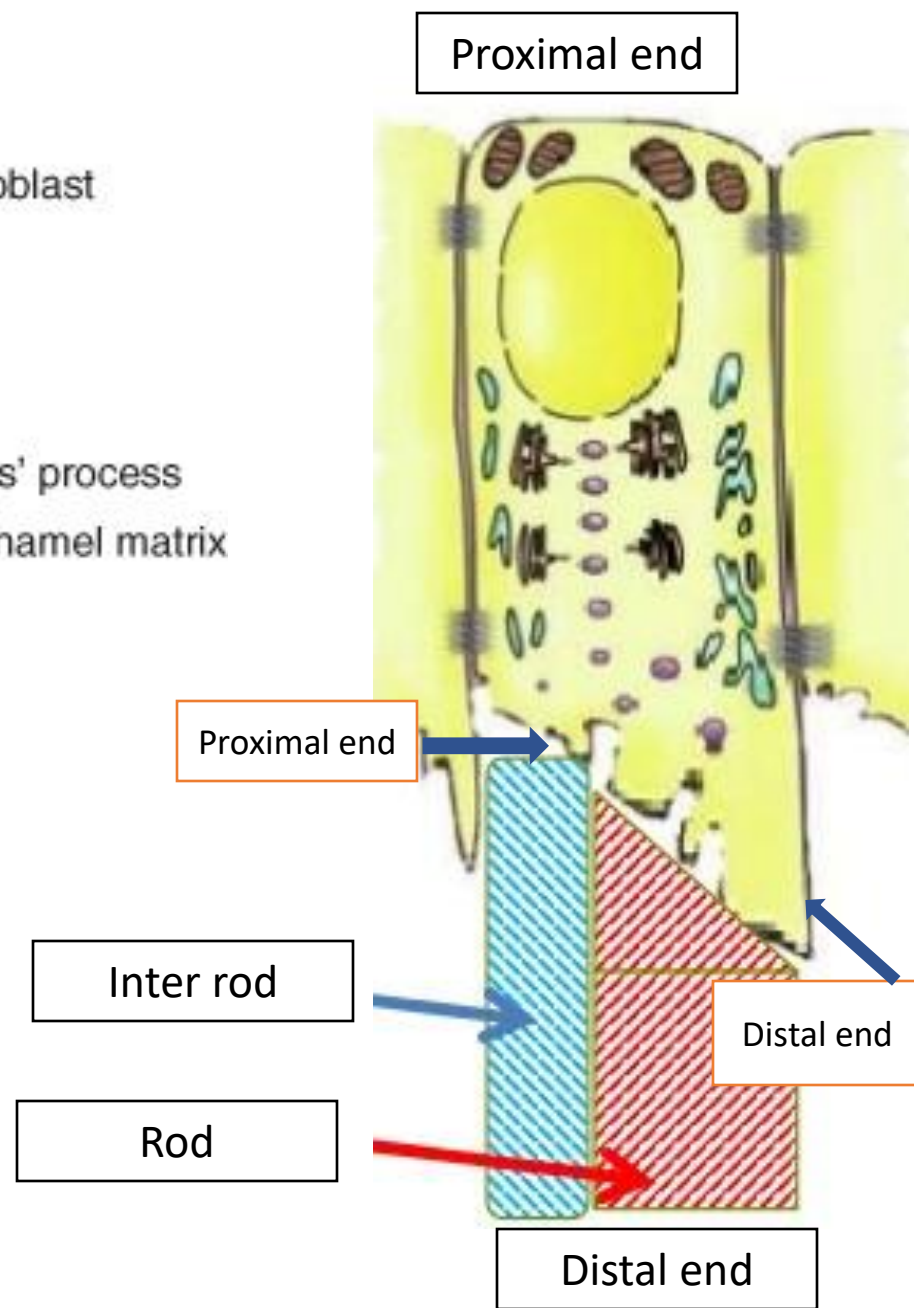
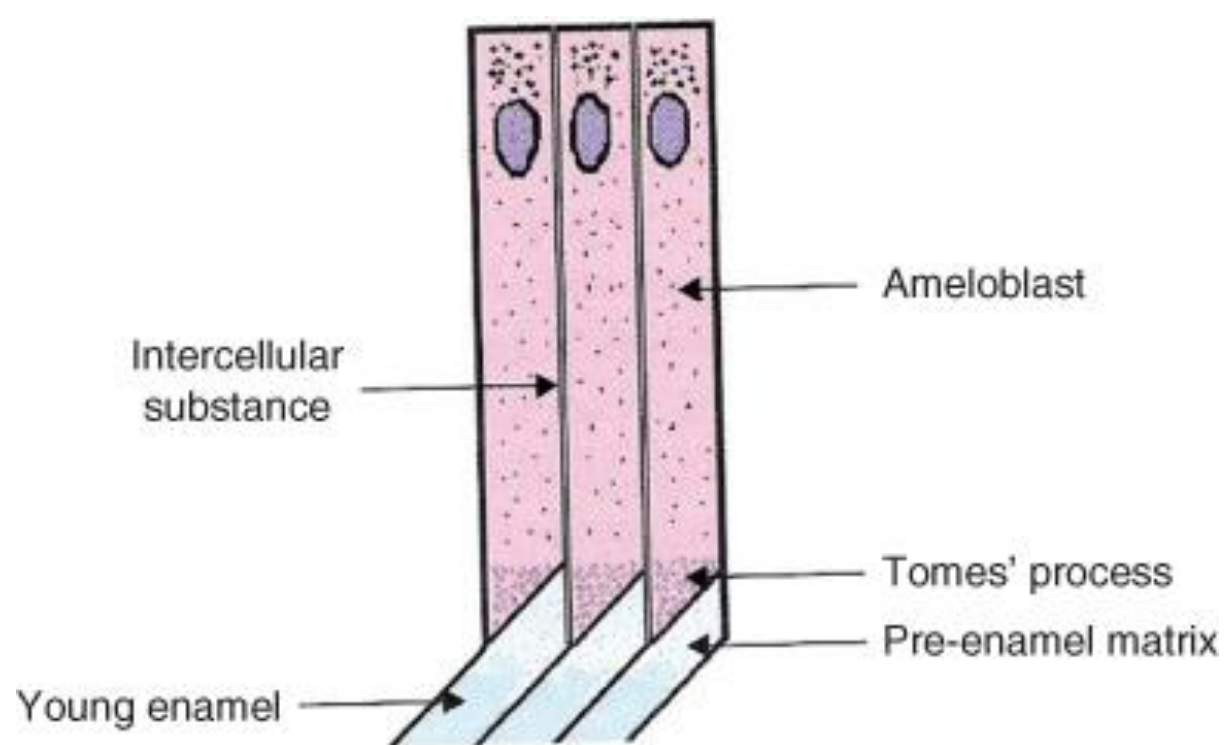
DISTAL

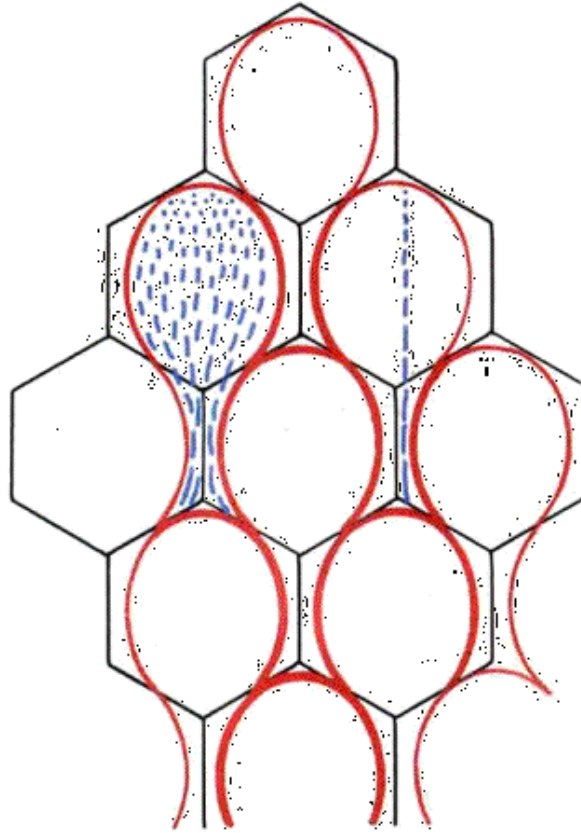
**DISTAL
EXTENSION**

**TOME'S
PROCESS**

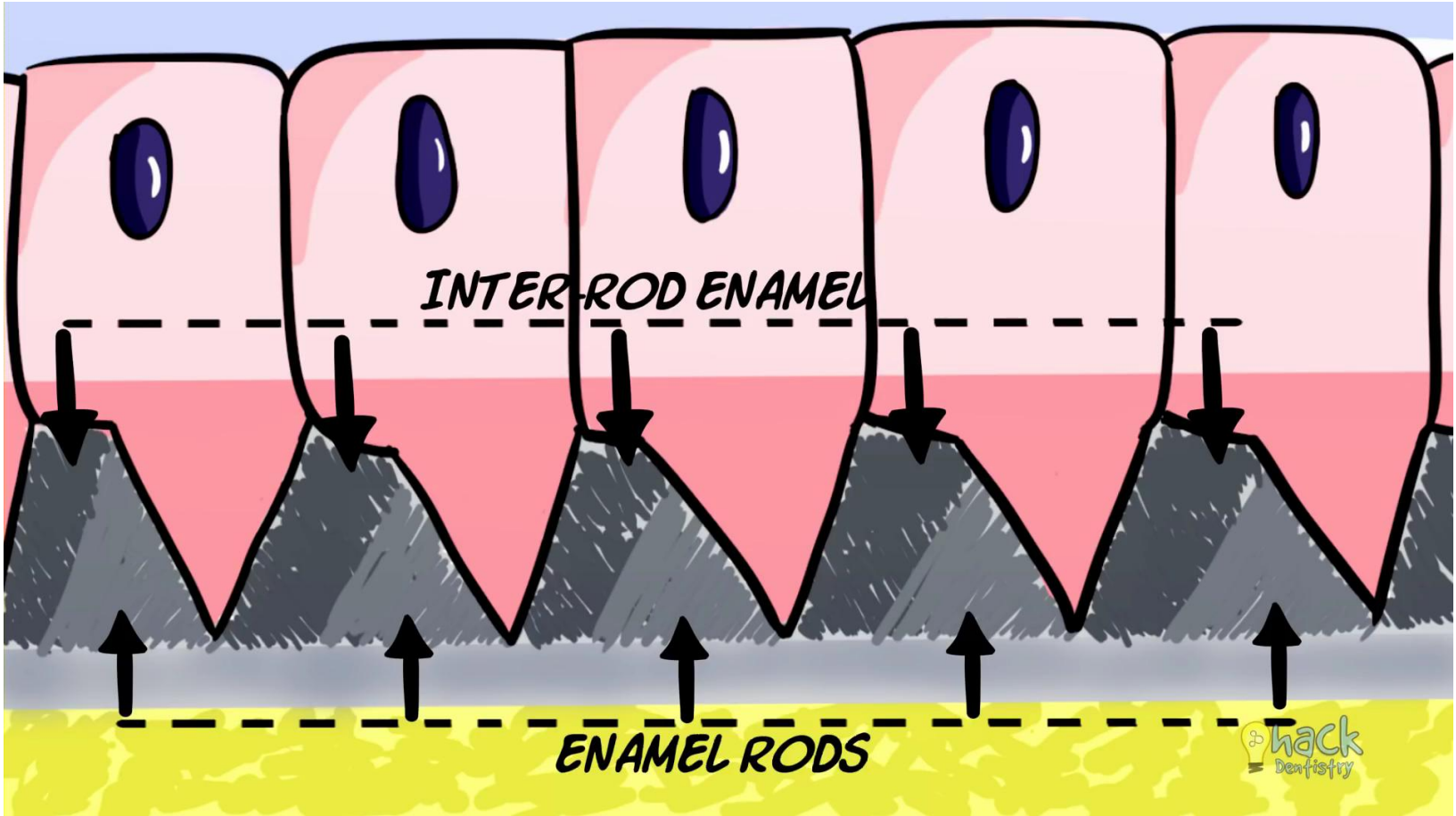
**RESPONSIBLE FOR
ROD + INTER-ROD
ENAMEL**

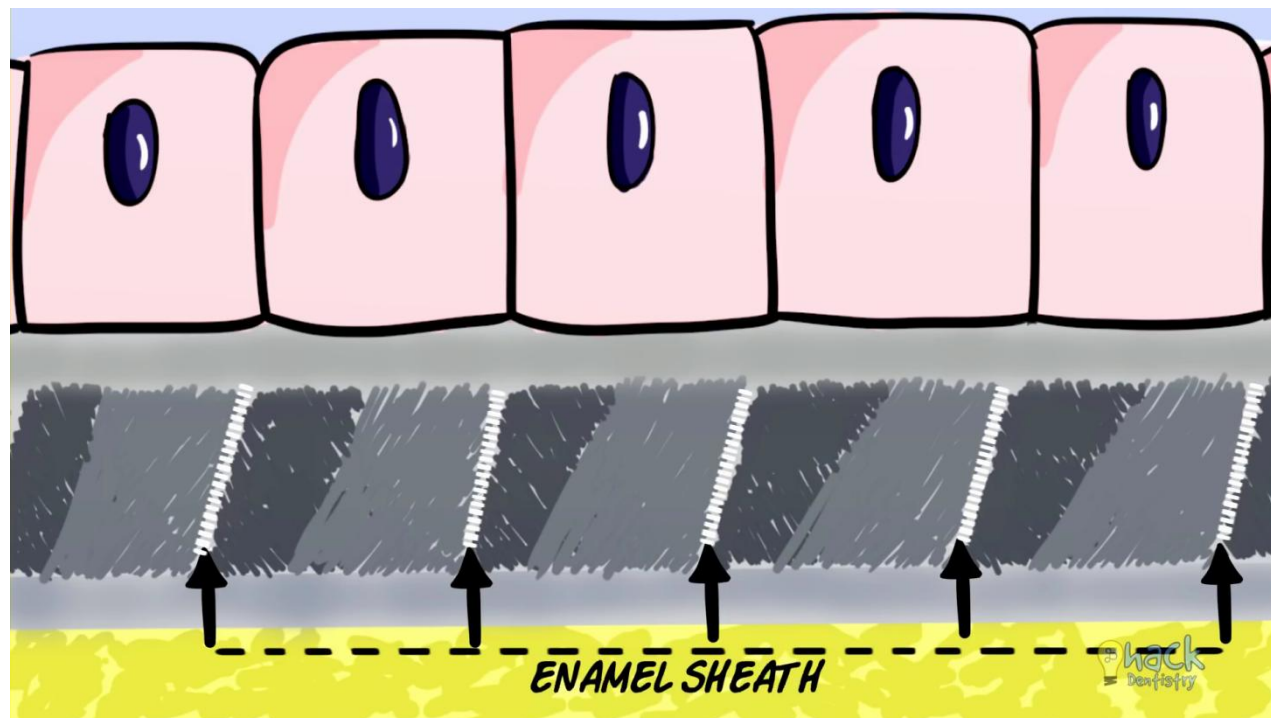
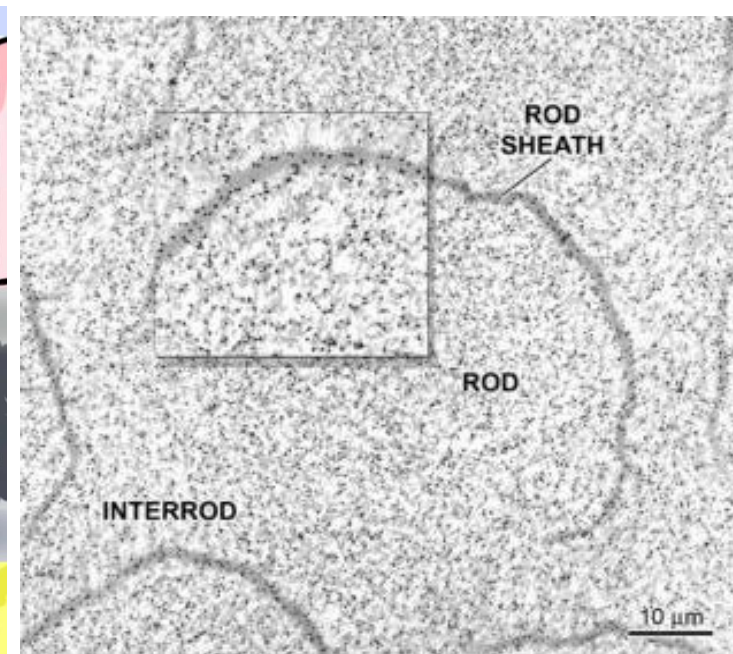
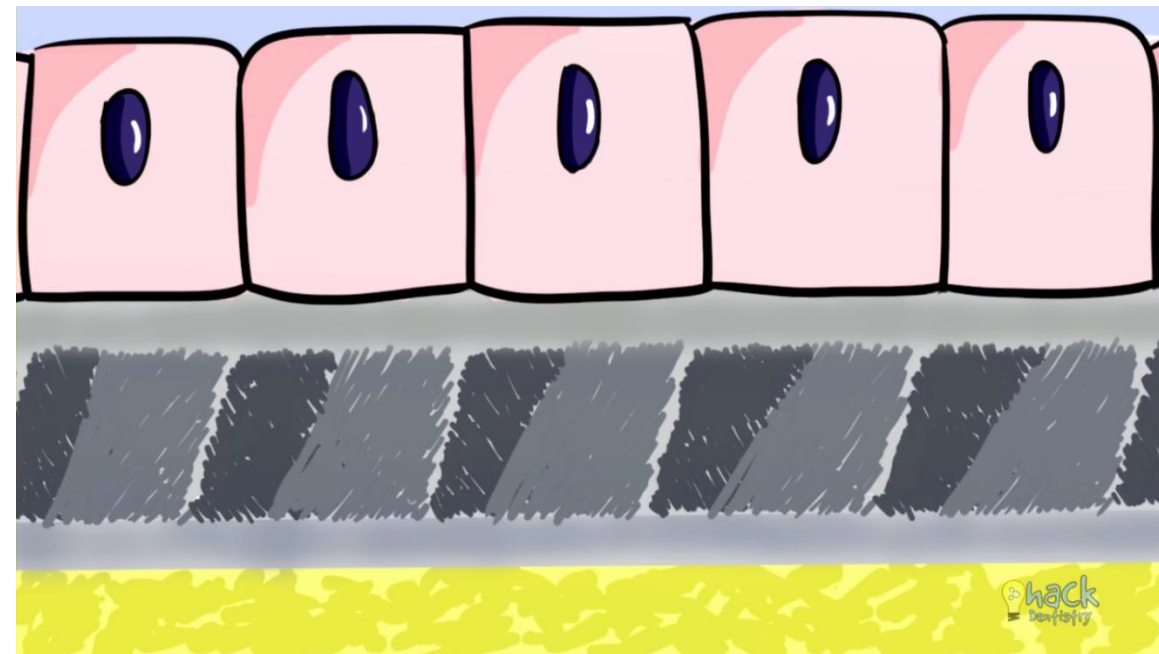




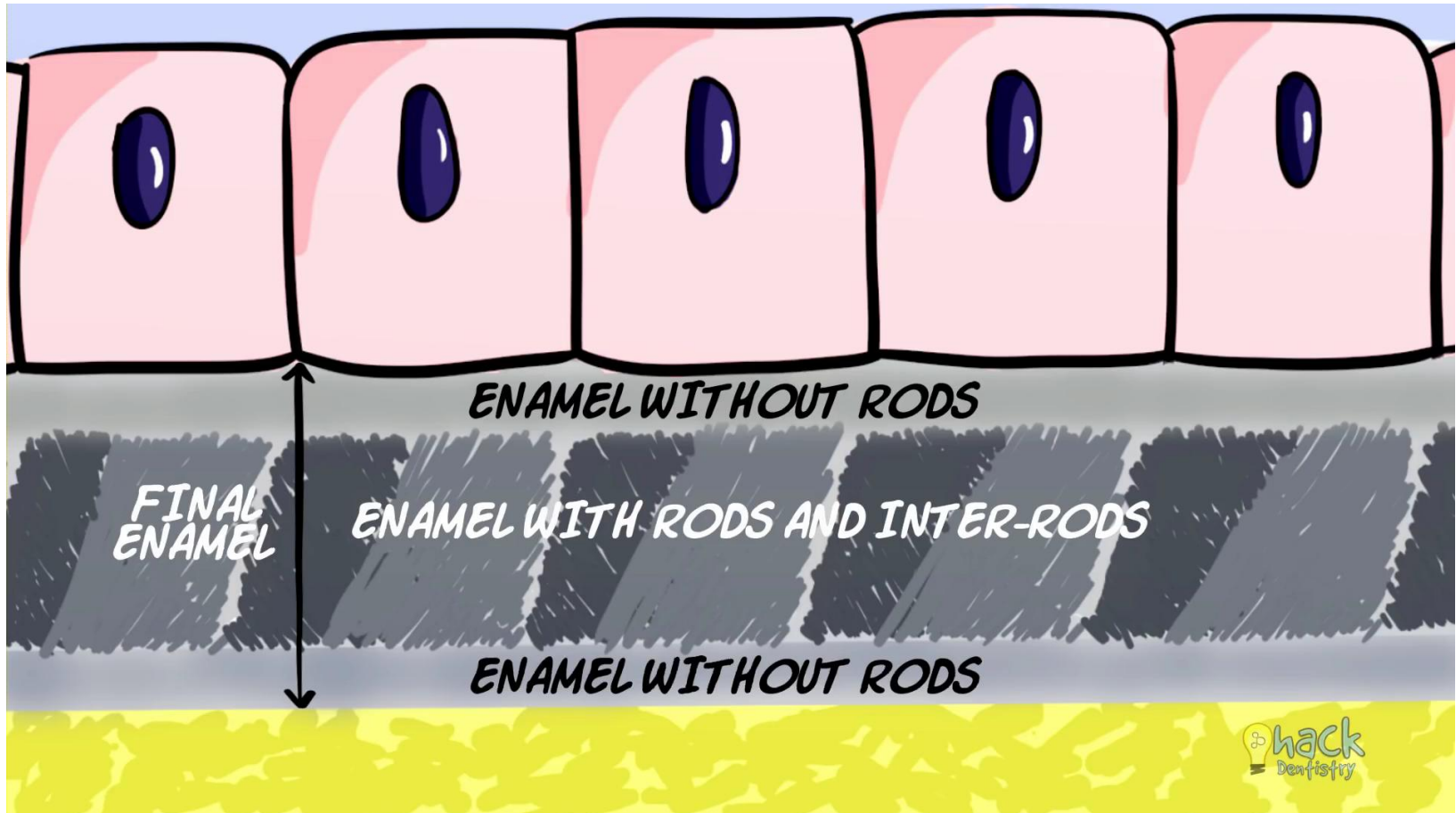


- Each rod is formed by ameloblast.
- Head is formed by 1 ameloblast
- Tail is formed 3 ameloblast
- 1 rod is formed by contribution of 4 ameloblast





Final Enamel



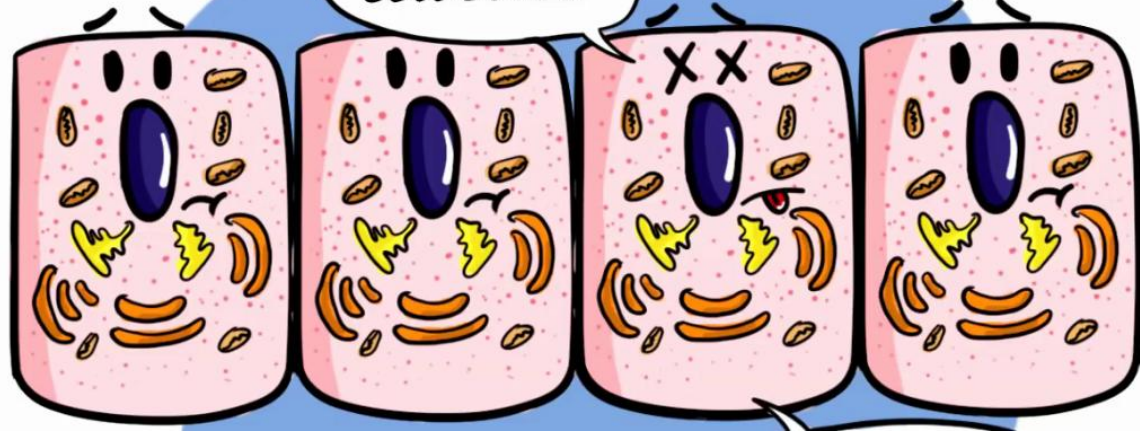
TRANSITIONAL
PHASE

ALSO CALLED
APOPTOSIS

AMELOBLASTS

PROGRAMMED
CELL DEATH

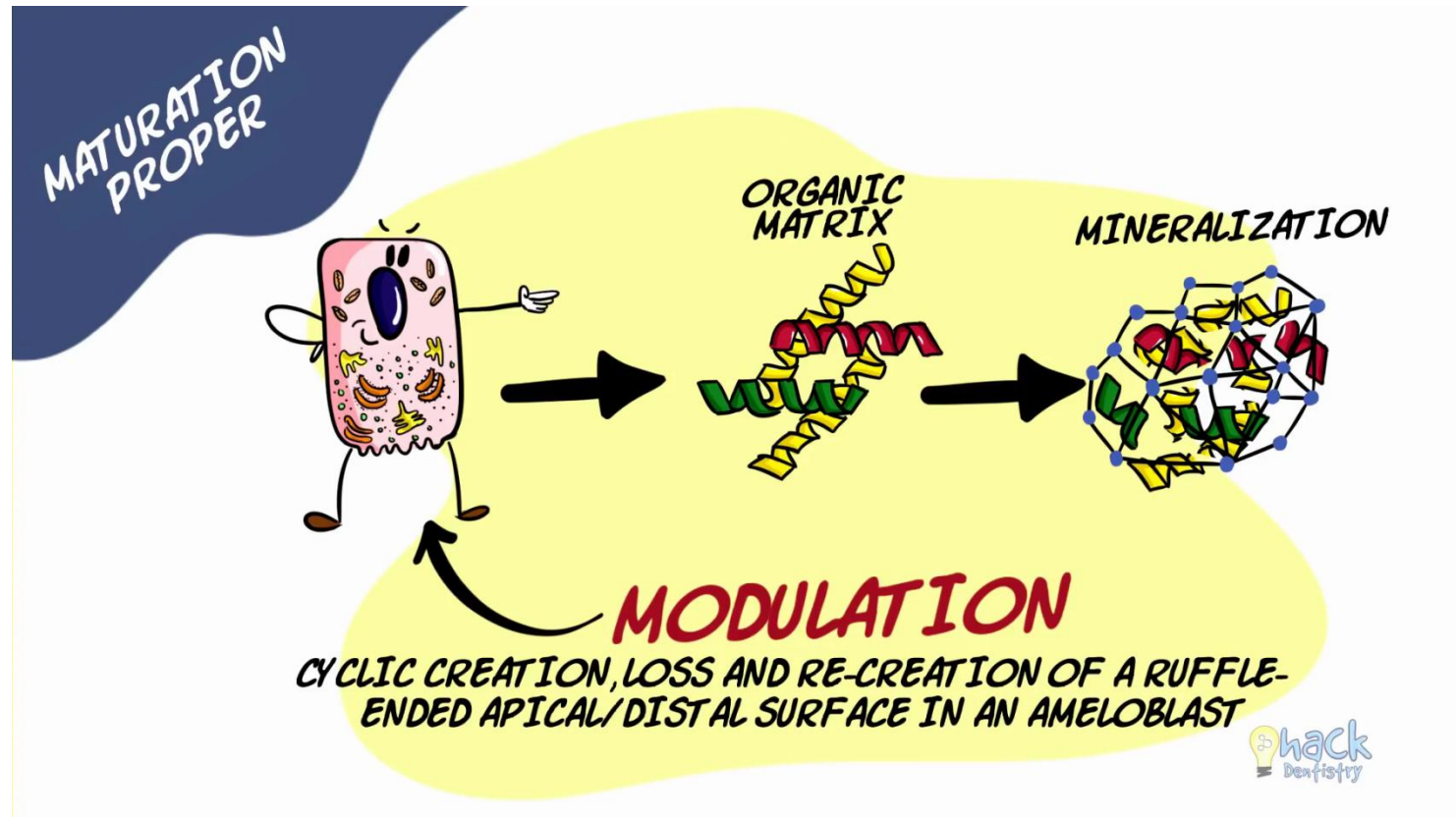
REDUCES IN
HEIGHT +
VOLUME



Transitional stage:

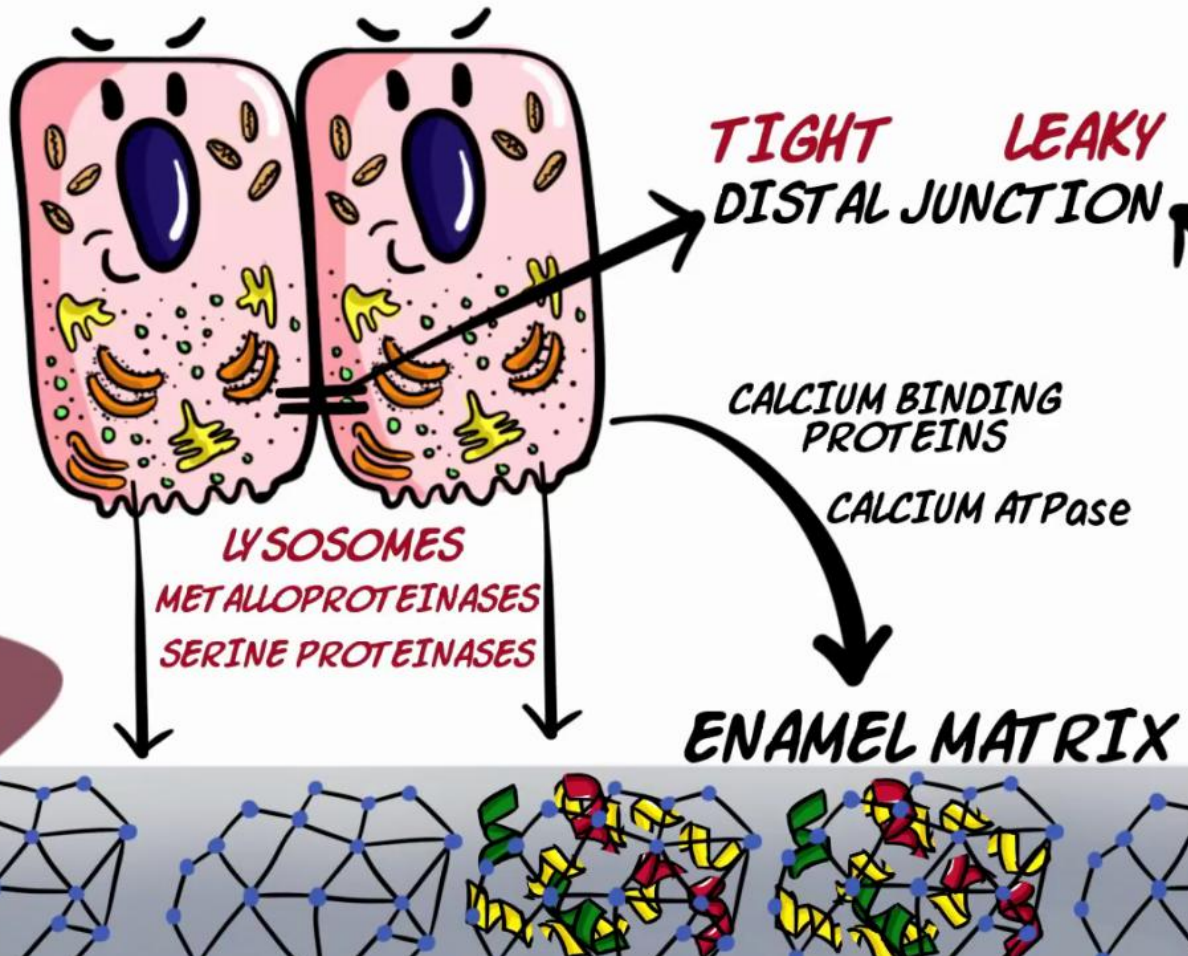
- When enamel reaches its full thickness the ameloblasts enter a brief transitional stage.
- Their height is decreased and protein synthesizing organelles are drastically reduced.
- Many lysosomes and autophagic vacuoles are also present.
- The overall number of ameloblasts is reduced by programmed cell death(apoptosis) and it is estimated that by the end of this stage the ameloblast population is reduced by as much as 50%.

Maturation stage

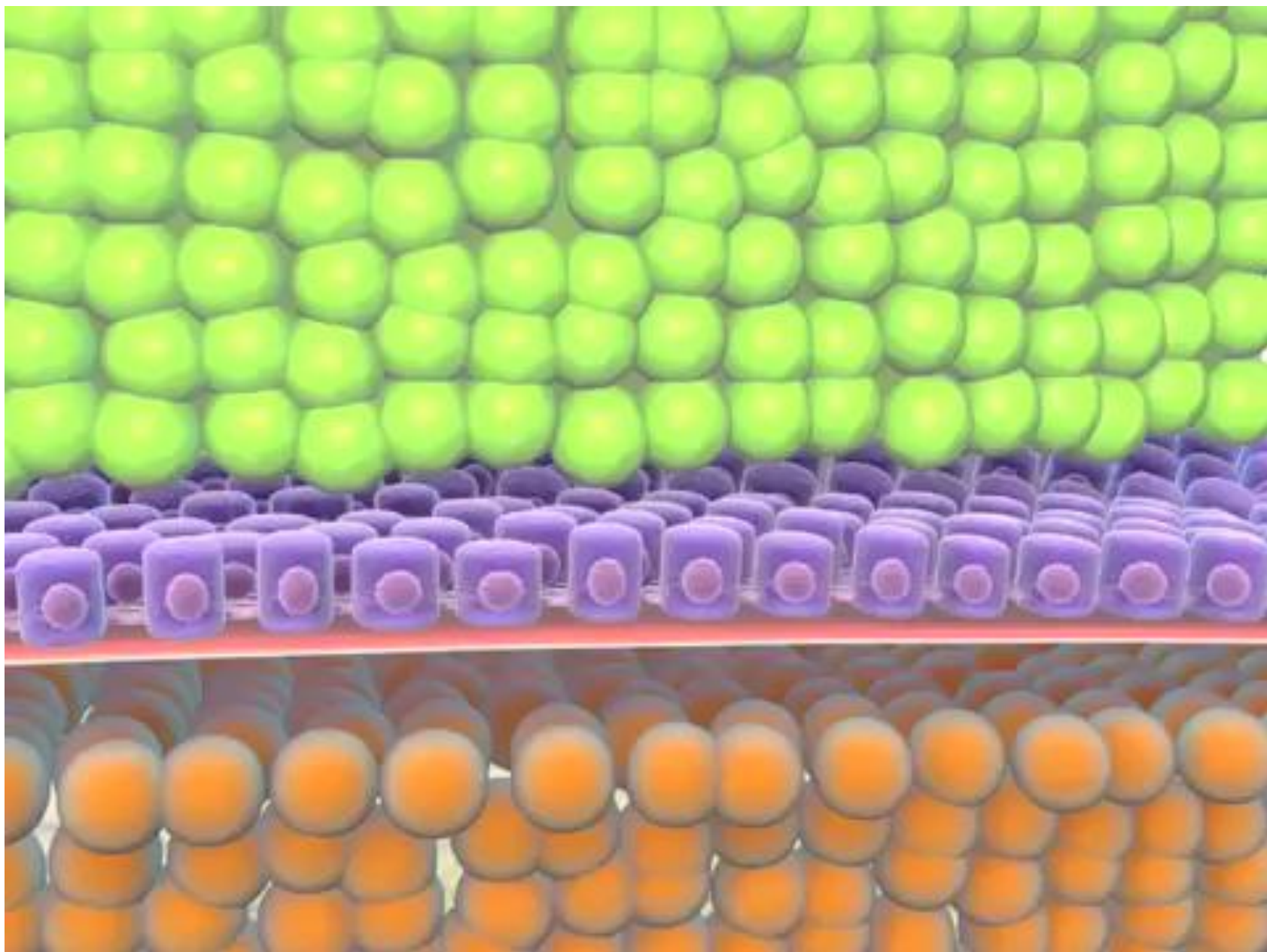


- During maturation **massive influx of calcium and phosphates** occurs and at the same time there is selective loss of enamel proteins, mainly amelogenin and water.
- The ameloblasts modulate (i.e. change their morphology from one type to the other and back) between **two phenotypes depending on the morphology of their distal ends**.
- The ameloblasts either have numerous microvilli forming a ruffled border or their distal ends are even (straight).
- Thus forming two morphologically different types, namely **Ruffled-ended ameloblasts (Cell spends 80% of its lifetime in this form and they incorporate of inorganic material to E. matrix)** and **Smooth-ended ameloblasts (Cell spends 20% of its life time in this form and they exit of protein fragments & water from E. matrix).**

RUFFLE-ENDED AMELOBLASTS

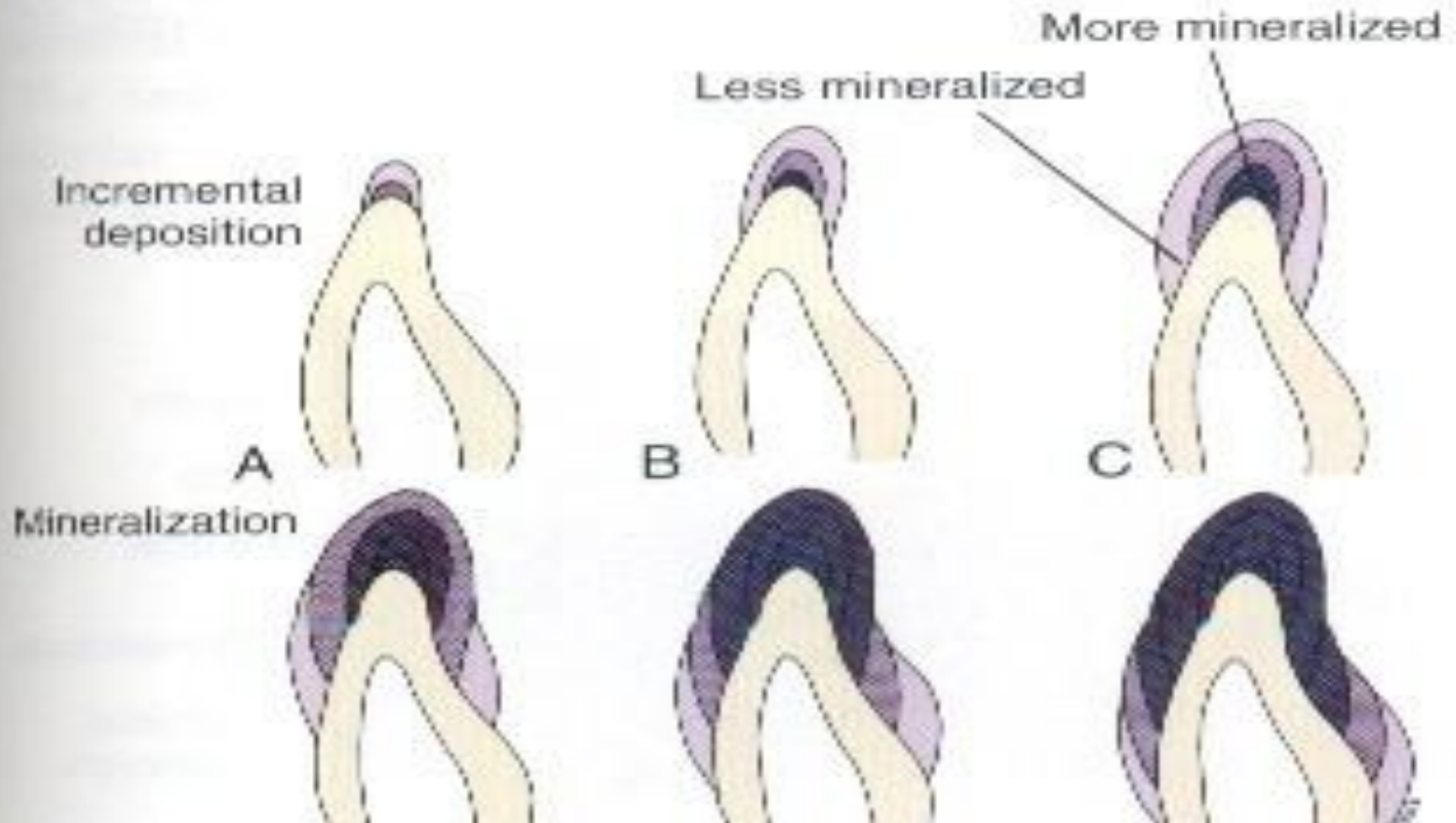


Video



Protective stage

- The ameloblasts lose their differentiation and become short cuboidal cells which together with the remnants of the other layers of the E. organ form a multilayered structure, namely the **reduced enamel epithelium**.
- This structure remains on the surface of fully formed enamel until the tooth erupts.



- Summary of enamel mineralization stages. A – initial enamel is formed; B – initial enamel is calcified as further enamel is formed; C – More increments are formed; D – Matrix deposition and mineralization proceeds; E and F – Matrix is formed on the sides and cervical areas of the crown.

Clinical consideration:

Amelogenesis Imperfecta (AI)

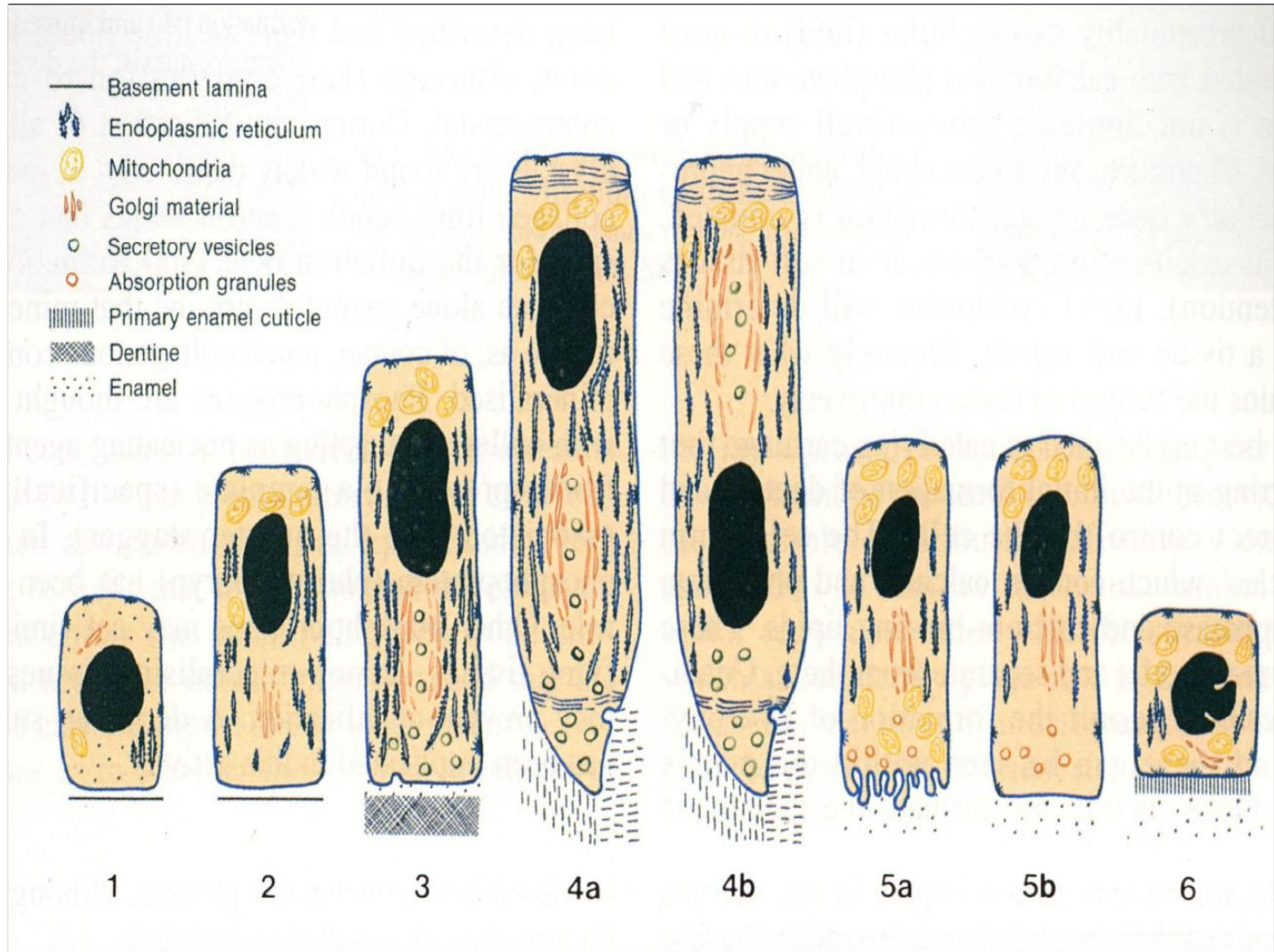
- Represents a group of conditions, genomic in origin, which affect the structure and clinical appearance of the enamel.
- Causes discoloration, while in the most severe presentation the enamel is hypo-mineralized.

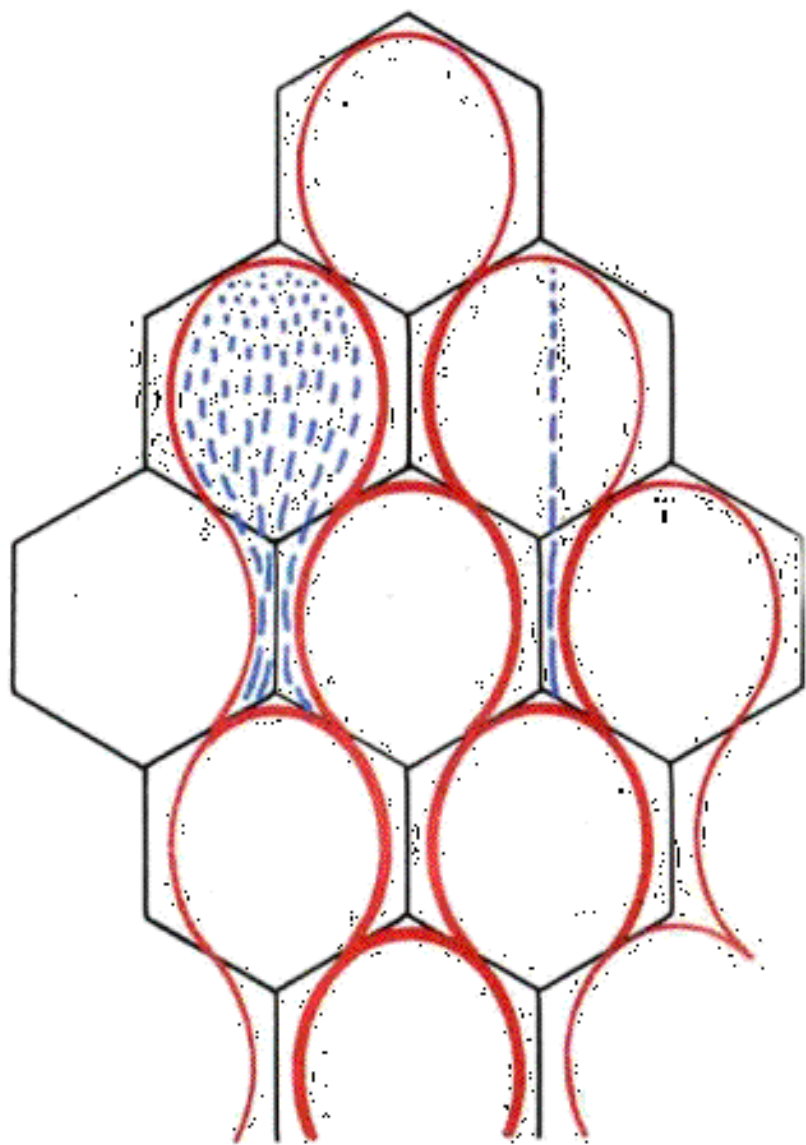




Q & A time







THANK YOU

