Enamel

Fatma Rashed

Learning objectives

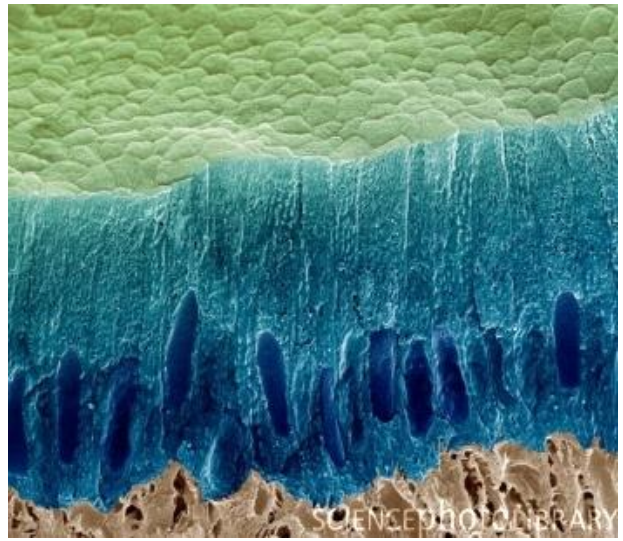
you will learn about:

- Physical and chemical properties of enamel
- Enamel's histological structure: -Rod, Rod sheath, interrod
  -Incremental lines
  -Hunter Schreger bands, gnarled enamel
  -Hypocalcified structure
  -Dentino-enamel junction
  -Surface structures

- Amelogenesis

Important facts

- It is the most calcified and hardest tissue in our body.
- **only seen in ground sections* because it's highly mineralized.
- It covers anatomical crown
- Can undergo dissolution in acid (caries)
- Ectodermal in origin
- Ameloblasts are Lost after eruption, therefore there is No enamel regeneration. However, there is remineralization…to a certain extent



* ***Physical properties:***

1- **Hardness**: -Hardest tissue in the body

due to *a. high mineral content*

b. special crystal arrangement

-permanent teeth are harder than deciduous

-harder at the surface than at ADJ

2- **Brittleness**: -very brittle due to increase mineral content

and must be supported by dentin

- permanent teeth are more brittle than deciduous

* ***Physical properties:***

3- **Permeability:** Semi-permeable (decreases by age)

4- **Color:** Translucent (reflect the color of underlining dentin)

5-**Thickness:** Variable thickness

- maximum at cusp and incisal edge (2-2.5mm)
- minimum at sulcus
-knife edge at cervical margin

* *Chemical properties:*

(by weight) **96% inorganic**:

-hydroxyapatite crystals [$Ca_{10}(PO_4)_6(OH)_2$]

-crystals are the largest of all hard tissues.

(OH) may be replaced by carbonate, Mg, K, Na, **F,** Cl

Fluorapatite is stronger than hydroxyapatite

and resists dissolution

4% Organic +water

Enamel proteins : non-collagenous proteins that represent amorphous gel in which enamel crystals are deposited and grown.

formed of **two protein families** :

a. Amelogenin: low molecular weight 90%

b. Non-amelogenins: high molecular weigh 10%

-During formation organic components constitute the greatest portion then replaced by minerals.

A+B: Inorganic
C: Organic

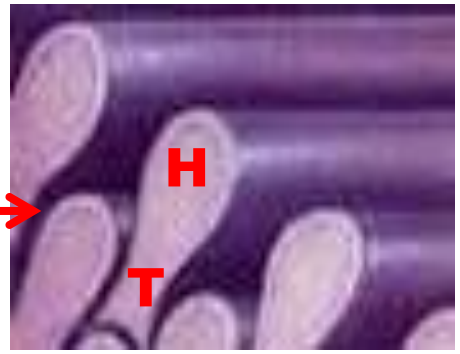
Enamel structure(Keyhole pattern)

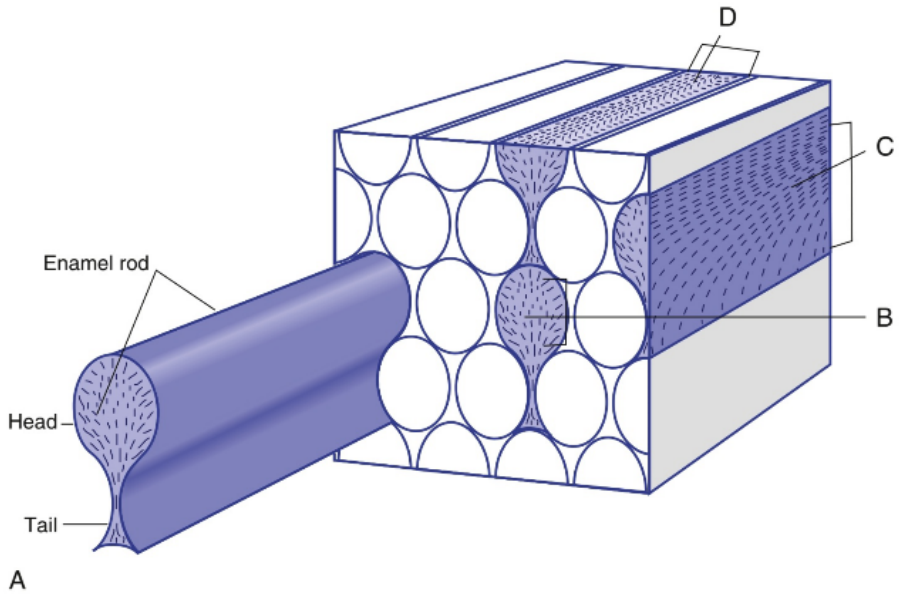
A) Enamel rod or Prism (Head)

B) Inter-rod (Tail)

C) Rod sheath

The interrod is made of crystals, which are oriented in a direction different from those making up the rod.





Rods/prism are the main structural unit of enamel

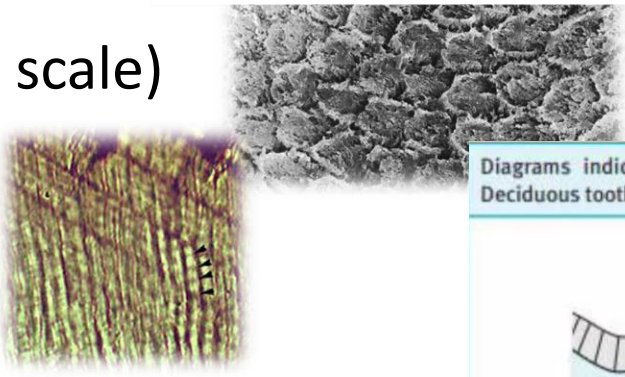
Incisors → In the first molar

-Number (5-12 million)

-Shape in cross section view (hexagon, round, oval, fish scale)

- it has a wavy course through enamel thickness.

-perpendicular to DEJ

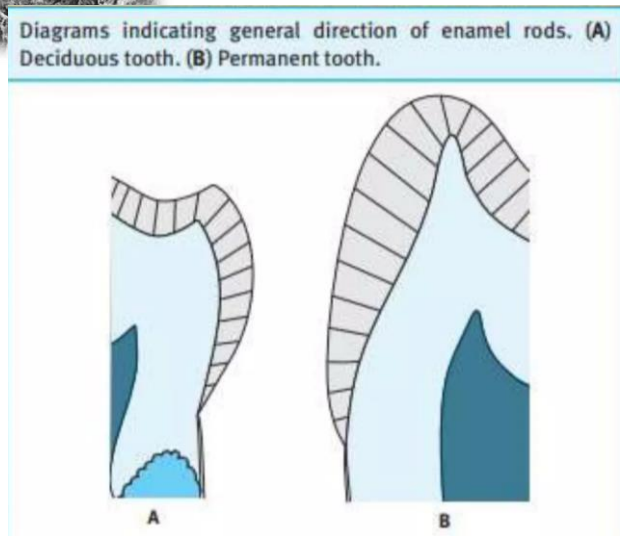


-***Deciduous teeth:*** vertical at incisal edge/cusp tip

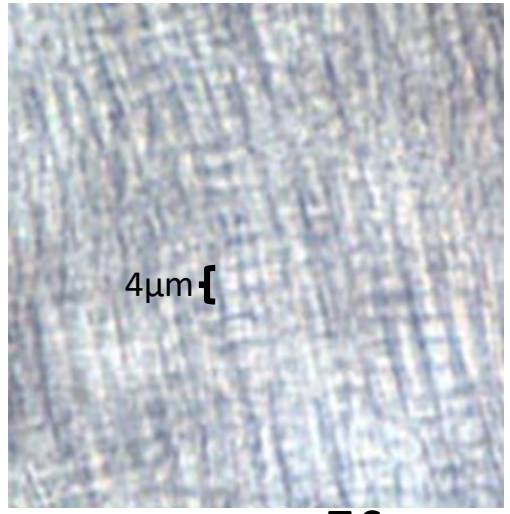
oblique toward occlusal

horizontal in middle and cervical

-***Permanent teeth:*** similar to deciduous but oblique at cervical region.

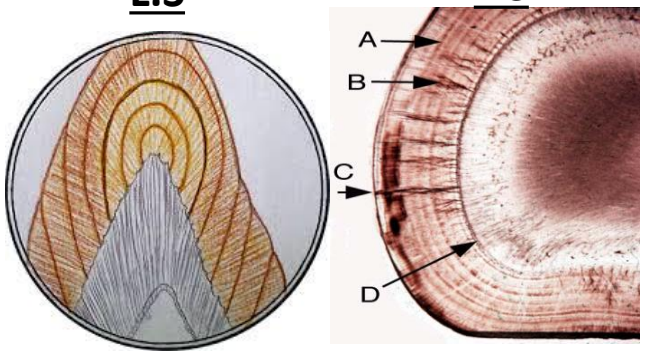


Incremental lines



1. **Cross striations:** dark and light bands of enamel rods
   - uniform length (4µm)
   - due to daily rhythmic apposition of enamel

L.S **T.S**



2. Incremental lines of Retzius (Brown Stria):

-L.S view= concentric half circles

-T.S view= concentric circles (4 days apart)

Due to the weekly rhythm in enamel production

3. Neo- natal line: -one of brown stria, but only seen in deciduous teeth and 1st permanent molar.

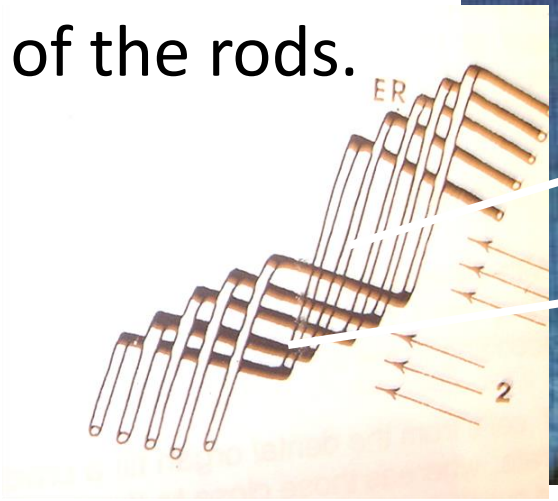
-separates enamel formed after birth and before

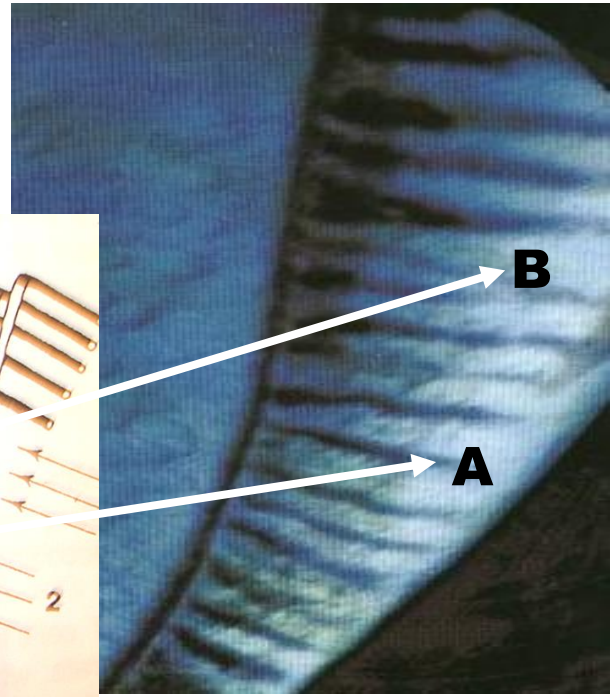
-disturbance of enamel formation at birth due to change in nutrition and environment

-quality of prenatal enamel is much better.

Hunter Schreger bands

- Optical phenomenon due to wavy course of the rods.
- Dark band (A) and light band(B).



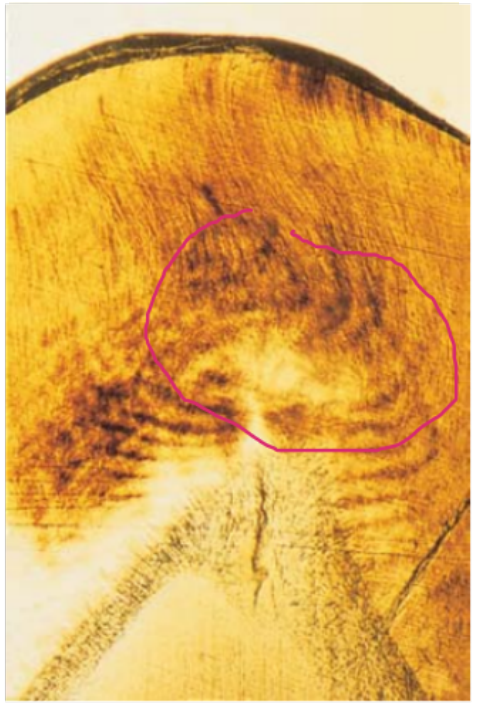


Gnarled Enamel tufts

Enamel rods appear twisted around each other in a complex arrangement

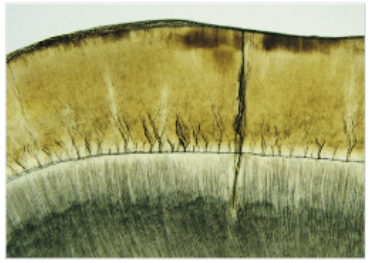
Location: cusp tip and incisal edge

Function: increase the strength of enamel, therefore decrease fracture and increase wear resistance.



Hypocalcified structure

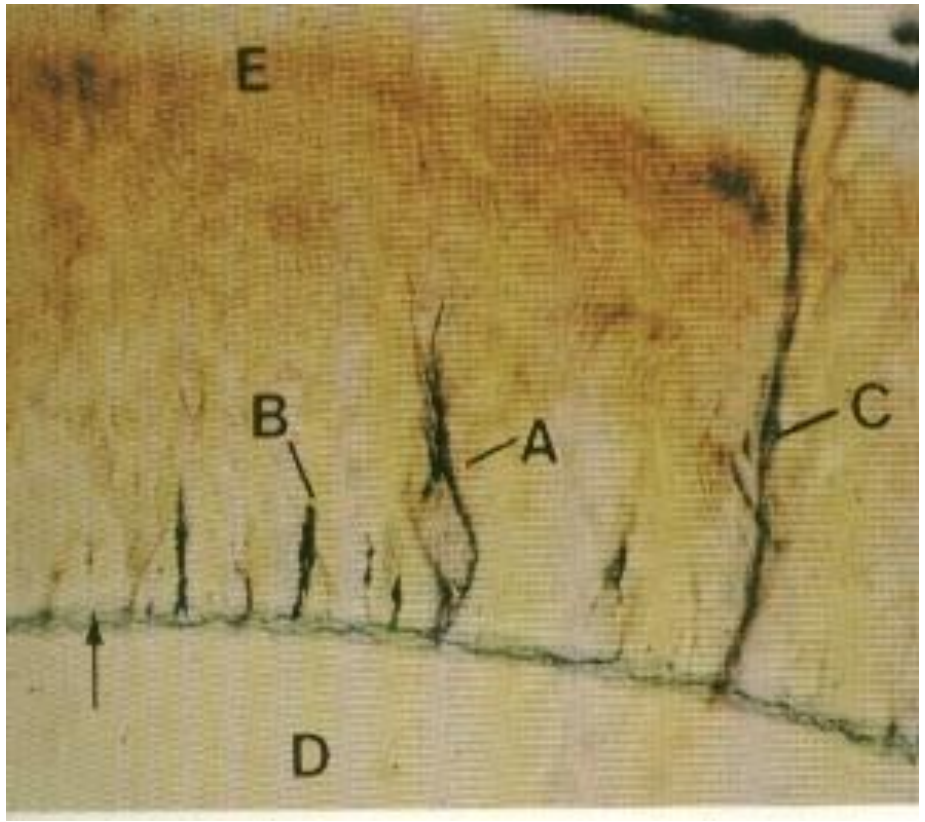
- A + B : from DEJ to the surface
- C : from the surface to the DEJ



A) Enamel tufts: -hypocalcified enamel rods

-resembles grass tufts

-due to changes in direction of groups of rods rising from DEJ. (At the incisal edge and the cusp tip, ameloblasts don't have enough space to deposit crystals).



B) Enamel spindles:- odontoblastic process trapped in enamel

C) Enamel lamellae: **-**hypocalcified enamel rods

P.S it can be a crack during development or eruption.

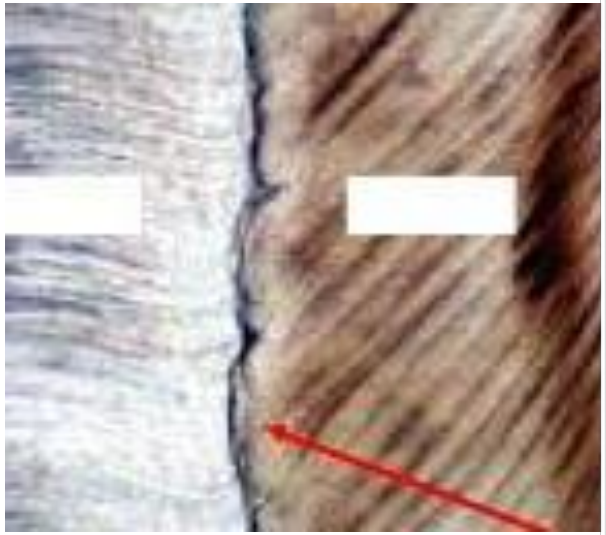
Importance: act as a mean of a fast spread of caries.

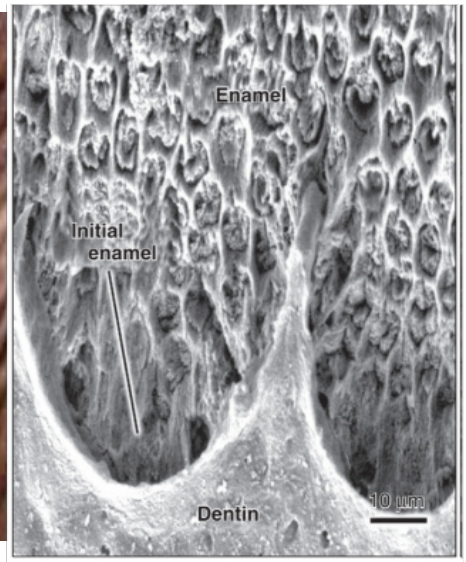
D) Dentoenamel junction (DEJ):-scalloped line

-Convexities toward dentine

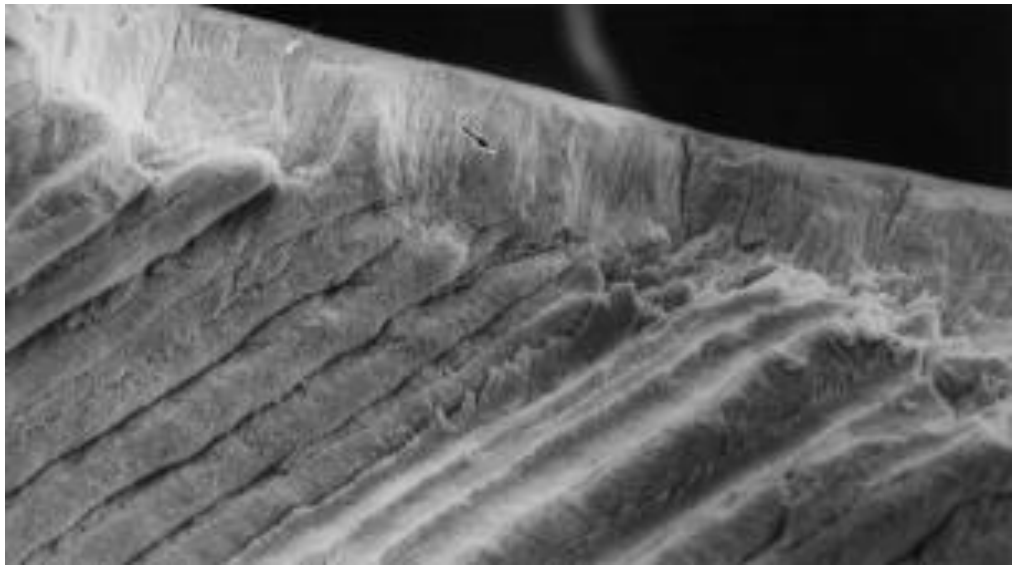
-Increase under cusp of tooth

-Increase surface area and adherence between E &D





Surface structures



1) Rodless enamel: There's no rods, inter-rods and sheath

-found at enamel surface and ADJ

-formed of closely packed parallel crystals

- highly mineralized

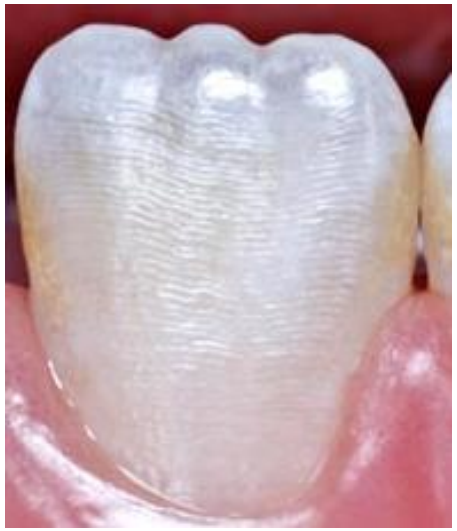
P.S Enamel adjacent to dentin surface (30 µ) lacks prismatic structure , enamel crystals are arranged perpendicular to the surface.

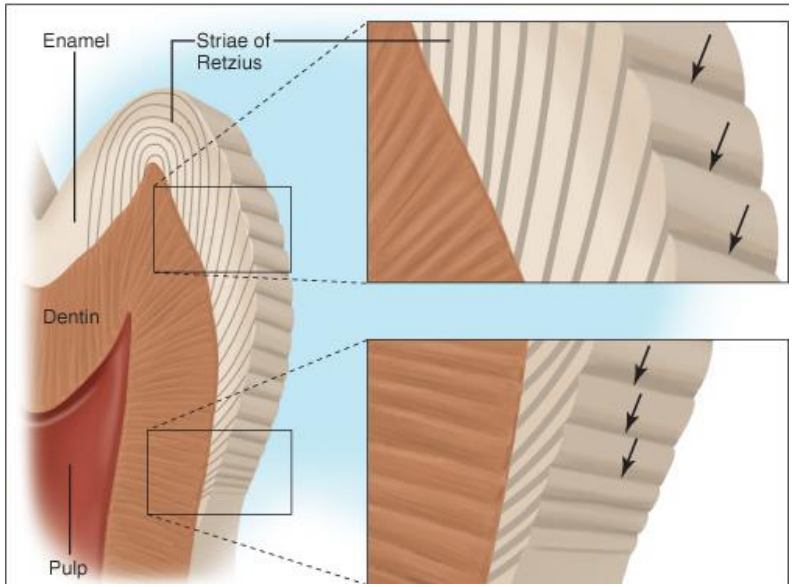
2) Perikymata:

- when stria of retzius reaches the surface

-mainly around the cervical area

-it is transverse/wave like parallel grooves





Amelogenesis

Life cycle of ameloblast

1. Morphogenetic
2. Histodifferentiation

Pre-Formative stage

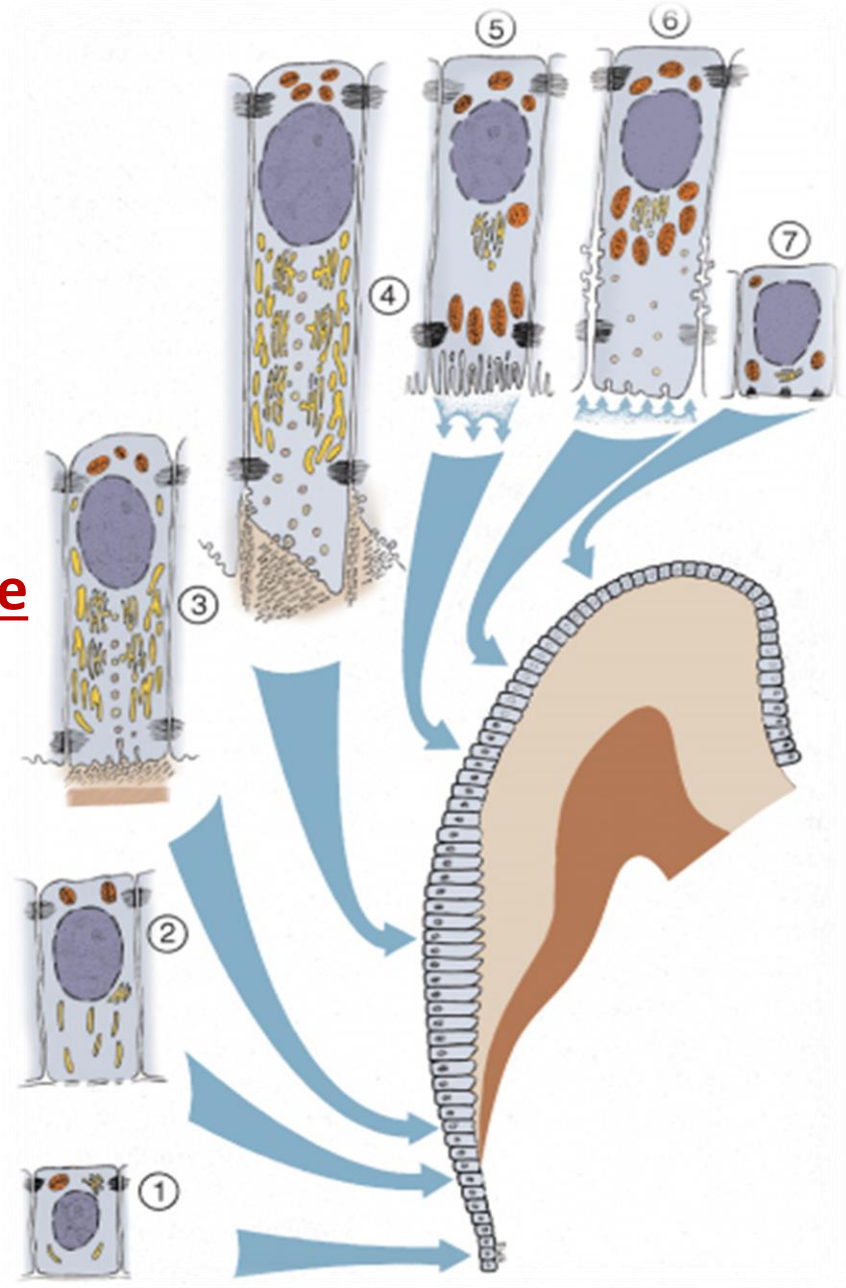
3. Initial secretory stage (no Tomes' process)
4. Secretory stage (Tomes' process)

Formative stage

5. Ruffle-ended ameloblast
6. Smooth-ended ameloblast

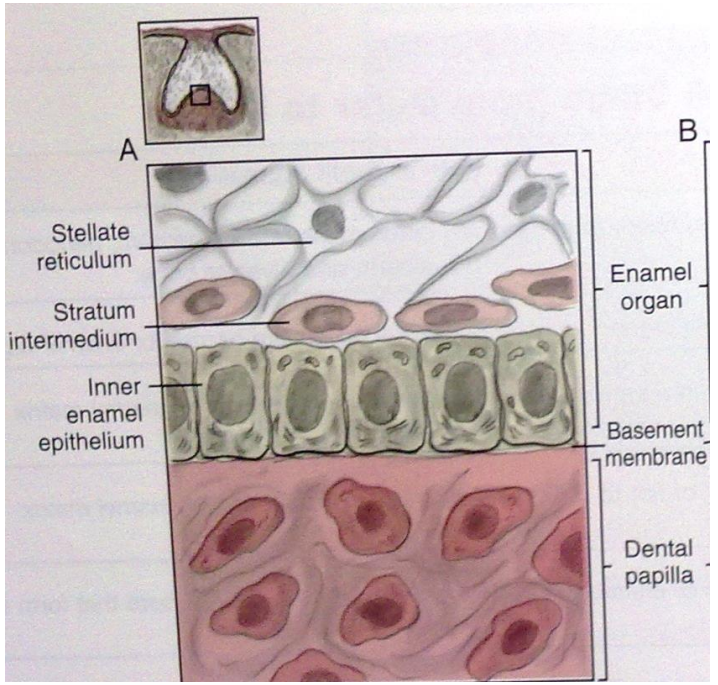
Maturation stage

7. Protective stage

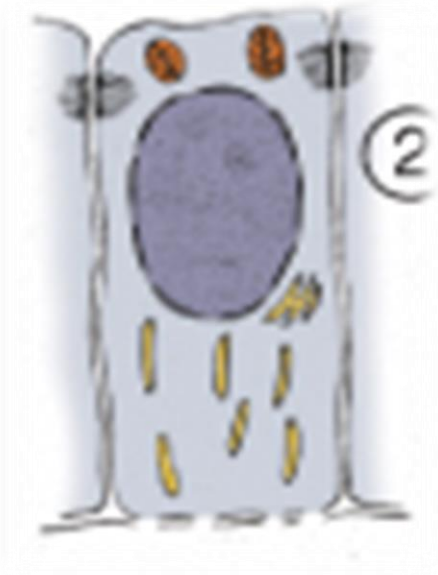


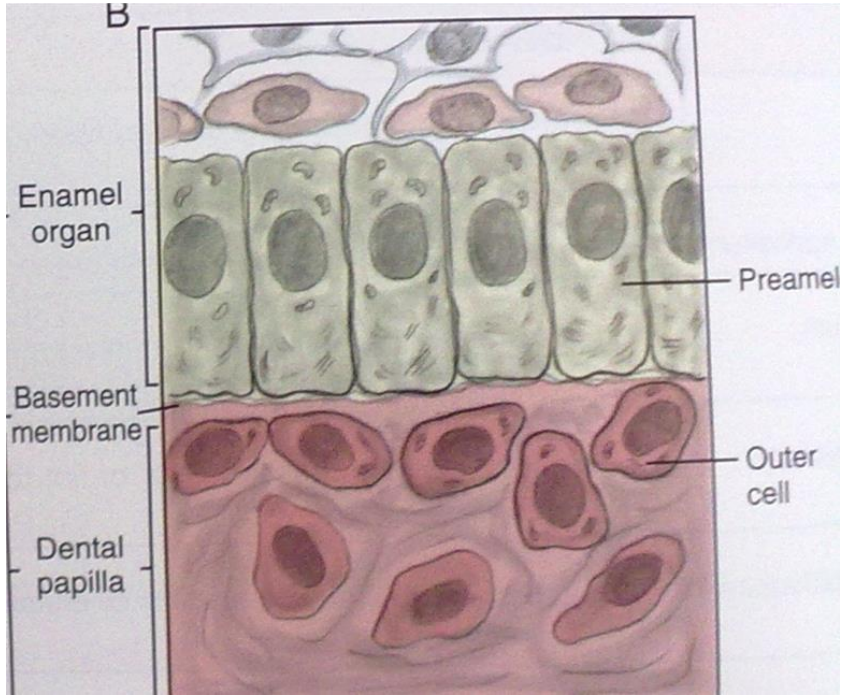
Pre-Formative stage

1. Morphogenetic: -short columnar
-central nucleus



2. Histodifferentiation: - high columnar
- proximal nucleus
(reversed polarity)





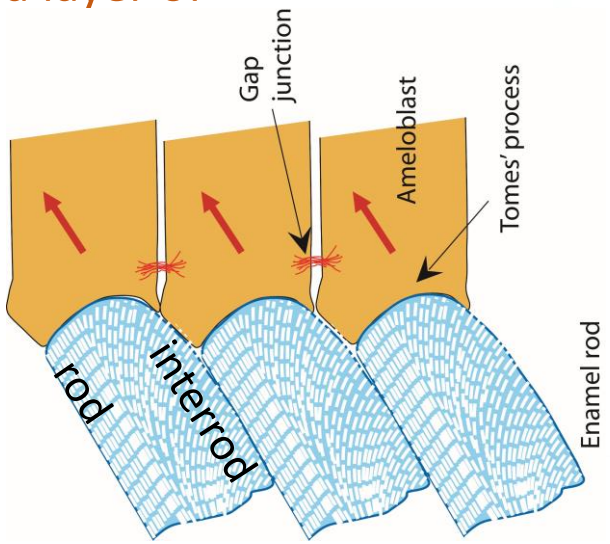
Formative stage

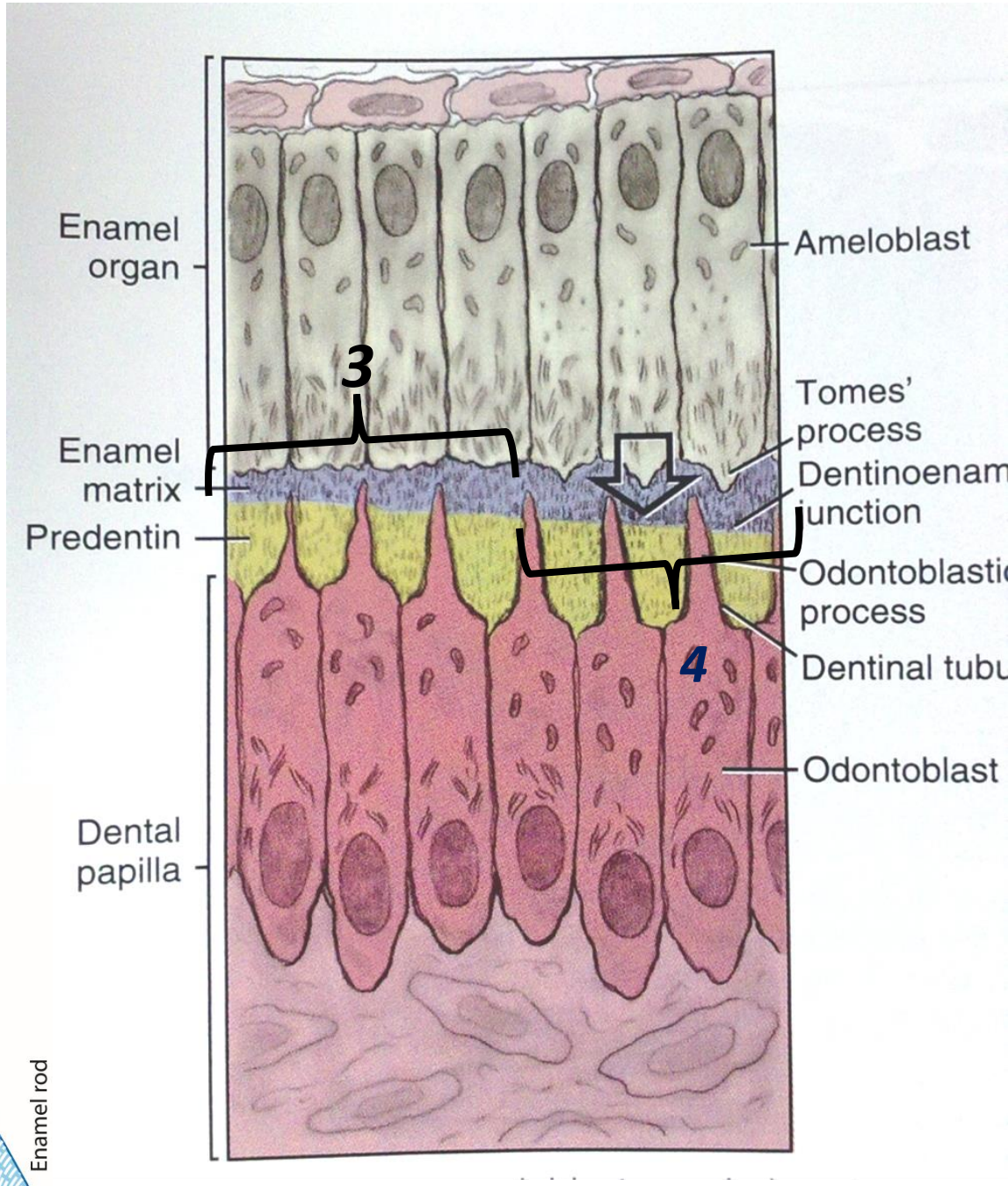
3. Initial secretory stage (no Tomes' process)

- deposit hydroxy apatite crystals that are parallel to each other and integrated with crystals of dentin (rodeless enamel)

4. Secretory stage (Tomes' process)

- tomes process is formed secreting rod and interrod
-at the end toms process retracts and a layer of prismles/rodless enamel is secreted.





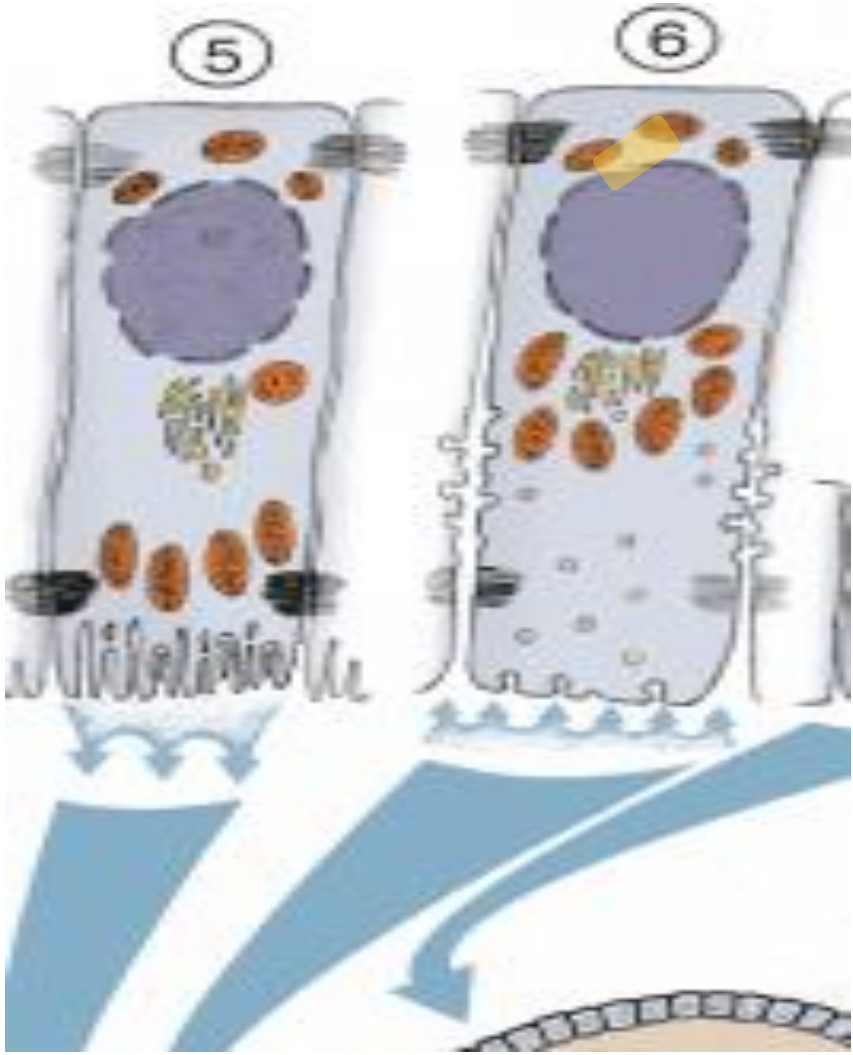
Maturation stage

a- Selective removal of proteins

b- Removal of water

c- Growth of pre-existing crystals

This is done by alternating 2 forms of ameloblast cells…. Hence the name **cyclic maturation**



5. Ruffle-ended ameloblast:

Specialized in pumping Ca+ ions allowing for crystal growth.

6. Smooth-ended ameloblast

Removal of water and proteins to provide space for the growing crystals.

7.Protective stage

Dental organ becomes REE that act as protective covering for mature enamel until eruption.