

enamel

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Lec 9

Review to enamel

- In the previous lecture we discussed the :
- How is the enamel forms ?
- What are the ccc of it ?

Life Cycle of the Ameloblasts

According to their function, the life span of the cells of the inner enamel epithelium can be divided into six stages:

(1) Morphogenic stage.

(2) Organizing or histodifferentiation stage.

(3) Formative or secretory stage .

(4) Maturative stage.

(5) Protective stage.

(6) Desmolytic stage.

Enamel structure

Physical Characteristics:

1-Enamel forms a protective covering of variable thickness over the entire surface of the crown.

The structure and hardness of the enamel forming a brittle or bright teeth(its high content of mineral salts and their crystalline arrangement).

The density decreases from the surface to the deeper regions.

2-Enamel has always been observed as a non-electrical conductive material: it is in fact an insulator at room temperature.

3-The color of the enamel-covered crown ranges from yellowish white to grayish white.

Chemical Properties

The enamel consists mainly of inorganic material (96%) and only a small amount of organic substance and water (4%).

The organic material consists of some unique proteins, The proteins found in the enamel are of two main groups— the *amelogenins* and the *nonamelogenins*.

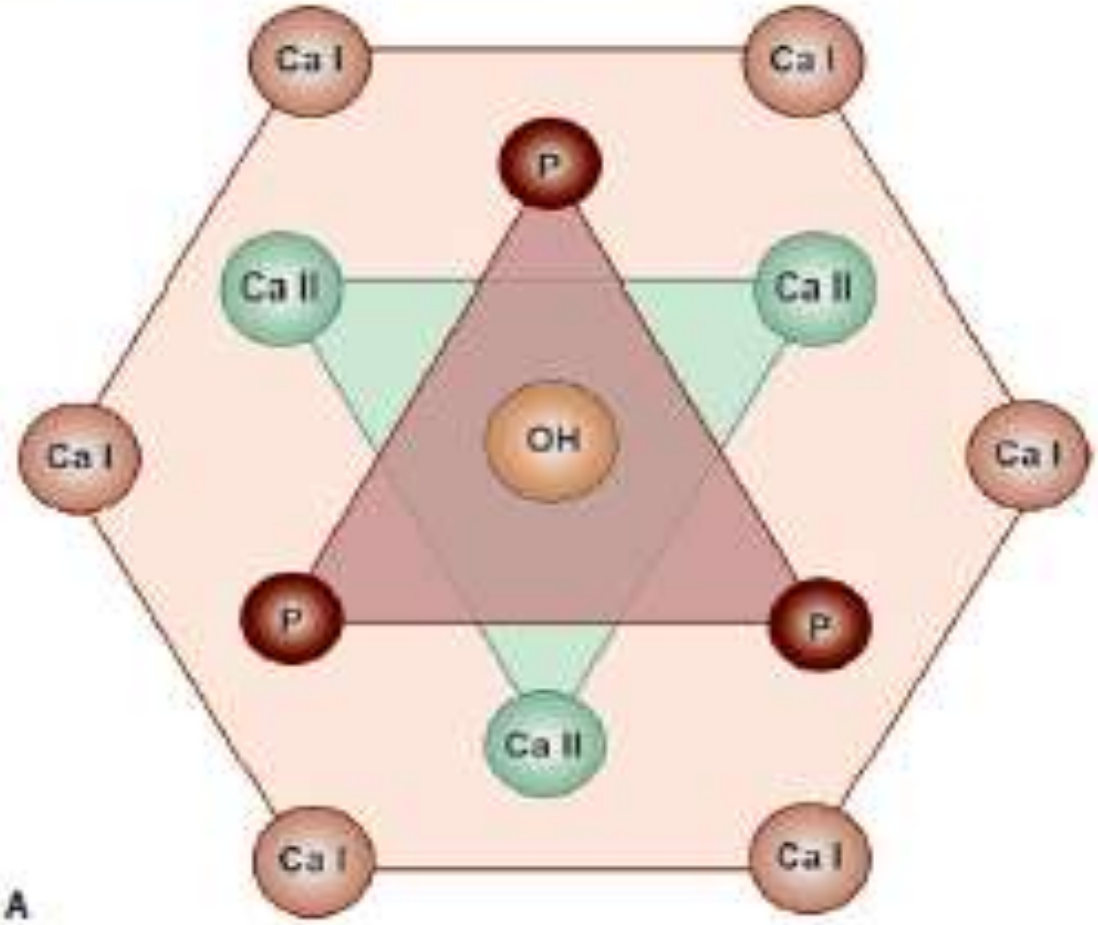
Amelogenins, are a heterogeneous group of low molecular weight proteins, accounting for about 90% of the enamel proteins.

Nonamelogenins constitute about 10% of enamel matrix proteins. *Enamelin, ameloblastin* and amelotin are the important proteins of this group. Nonamelogenins are high molecular weight proteins and are rich in glycine, aspartic acid and serine.

The inorganic material of the enamel is hydroxyapatite. Its chemical formula is

$Ca_{10}(PO_4)_6(OH_4)_2$.

The crystals of hydroxyapatite are hexagonal in cross-section. The shape of a single crystal was observed by high resolution to be a rod with an equilateral hexagon base. The crystals are arranged to form enamel rods or enamel prisms.



A

The average concentrations in dry weight % of human tooth enamel of oxygen, calcium and phosphorus, which are the three major constituents are 43.4, 36.6, and 17.7, respectively. The minor constituents together account for 2.3%, of which Na and carbon and magnesium are the principal constituents. The concentration of carbonate is 3.2% which is important as carbonate rich crystals are attacked by acids in caries.

Water is present as a part of the crystal (hydroxyapatite), between crystals and between rods and surrounding the rods.

Pores are present between the crystals, especially at the boundaries of the rods and these are filled with water.

Structure of enamel

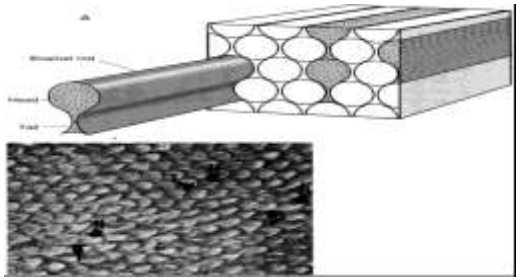
1-Rods 2-Striations

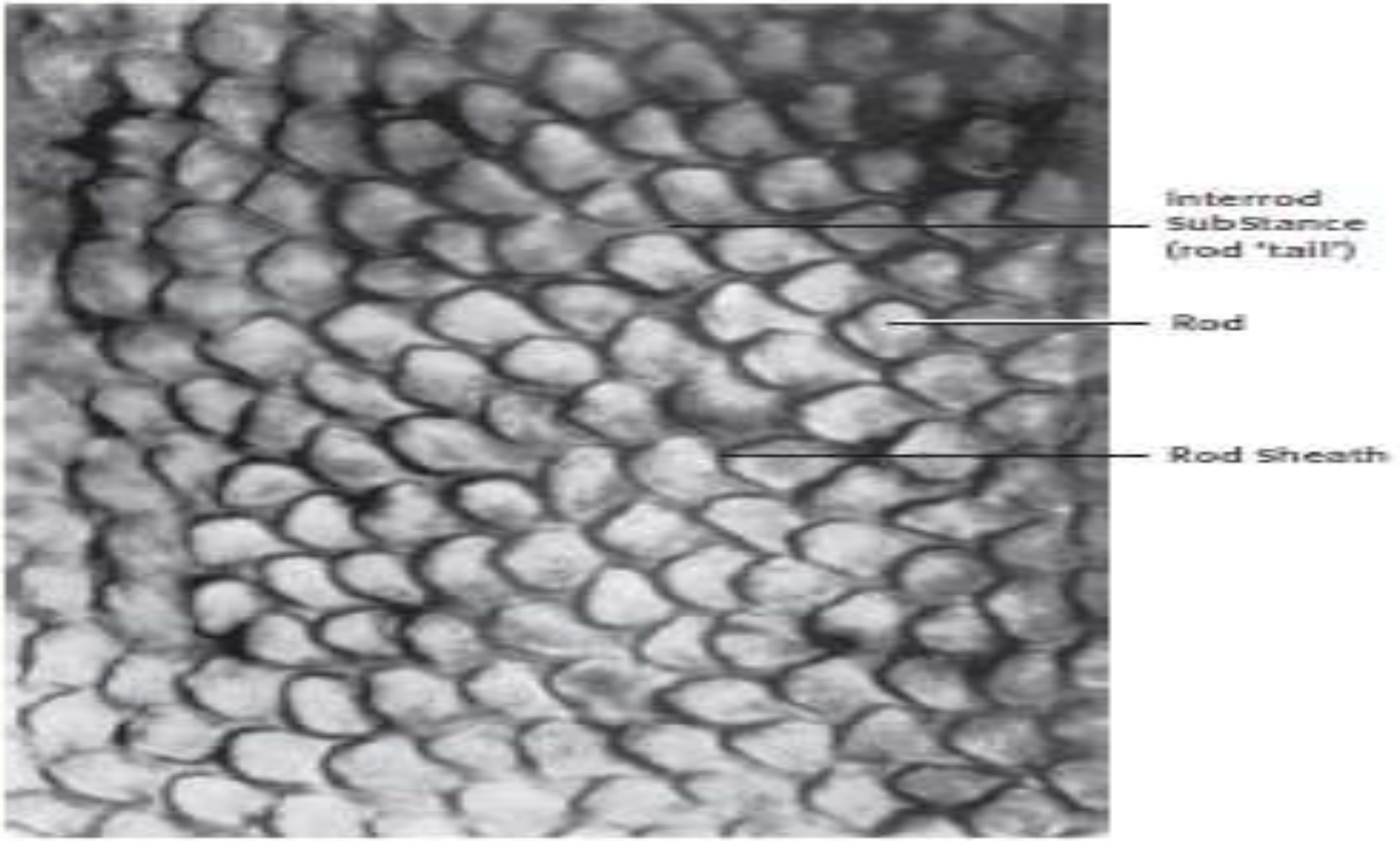
Rods

The enamel is composed of enamel rods or prisms with rod sheaths, and rod tails.

The enamel rods normally have a clear crystalline appearance, permitting light to pass through them.

In cross-section under the light microscope they occasionally appear hexagonal. Sometimes they appear round or oval.

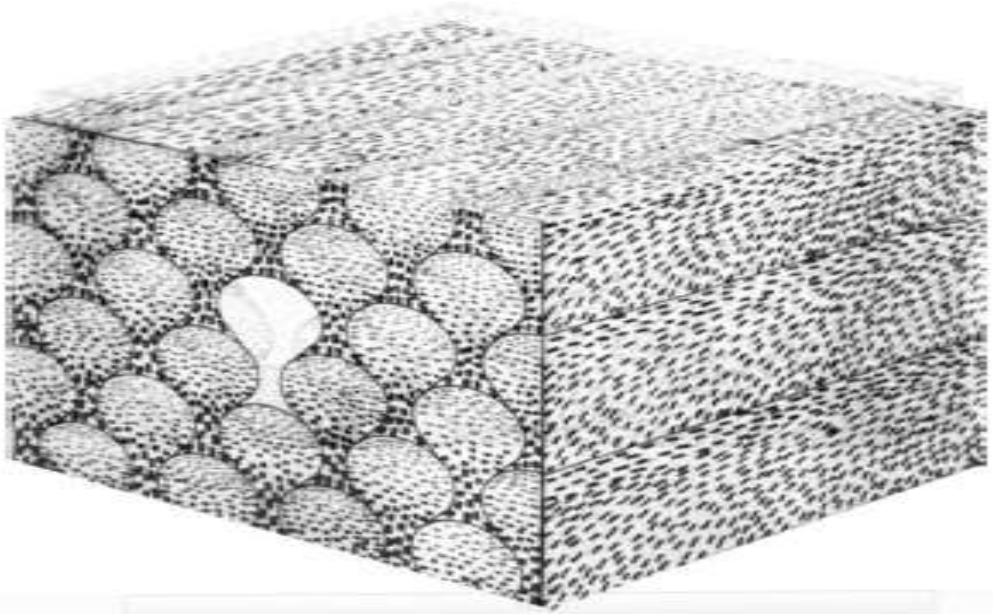


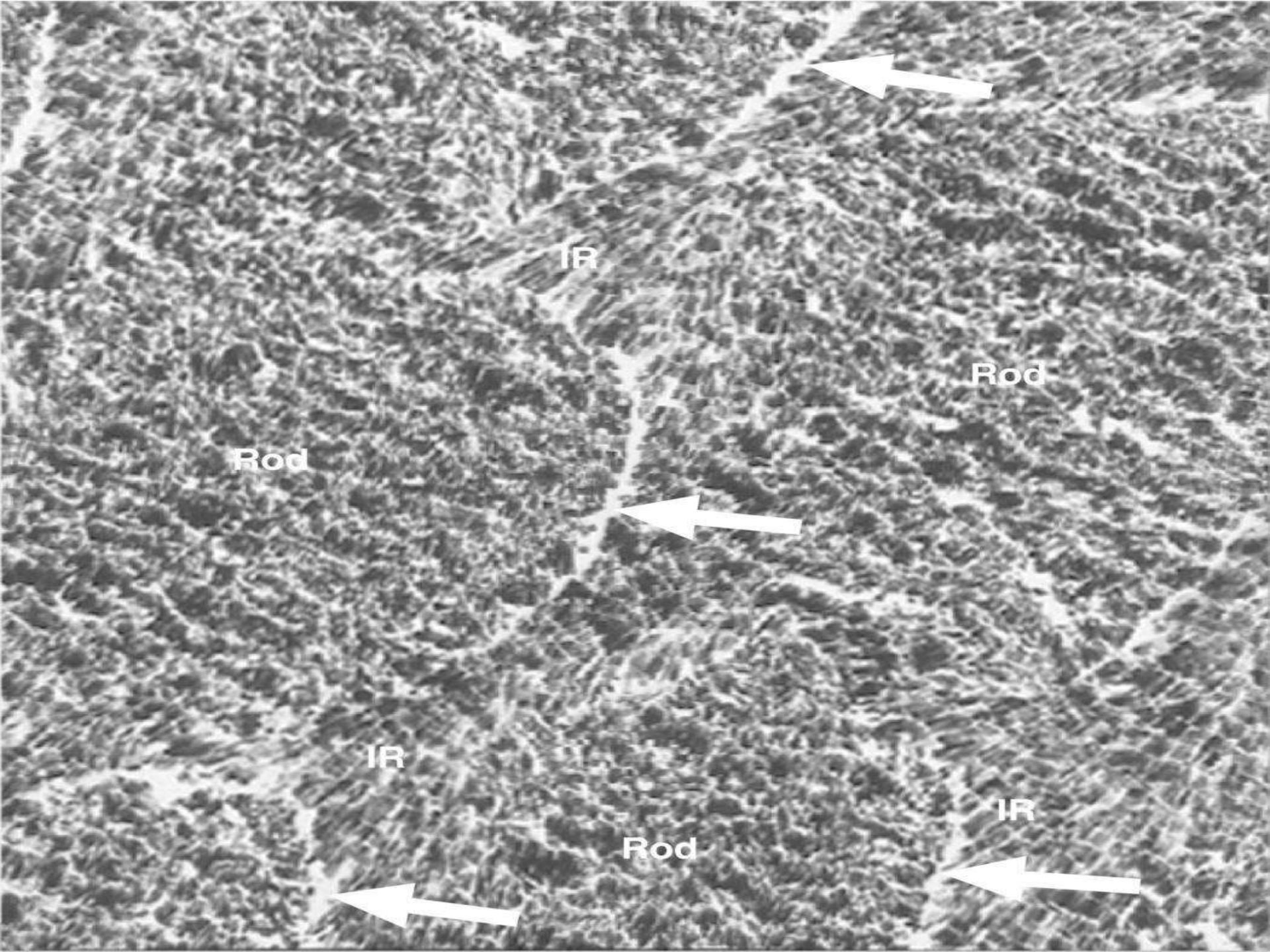


In cross-sections of human enamel, many rods resemble fish scales

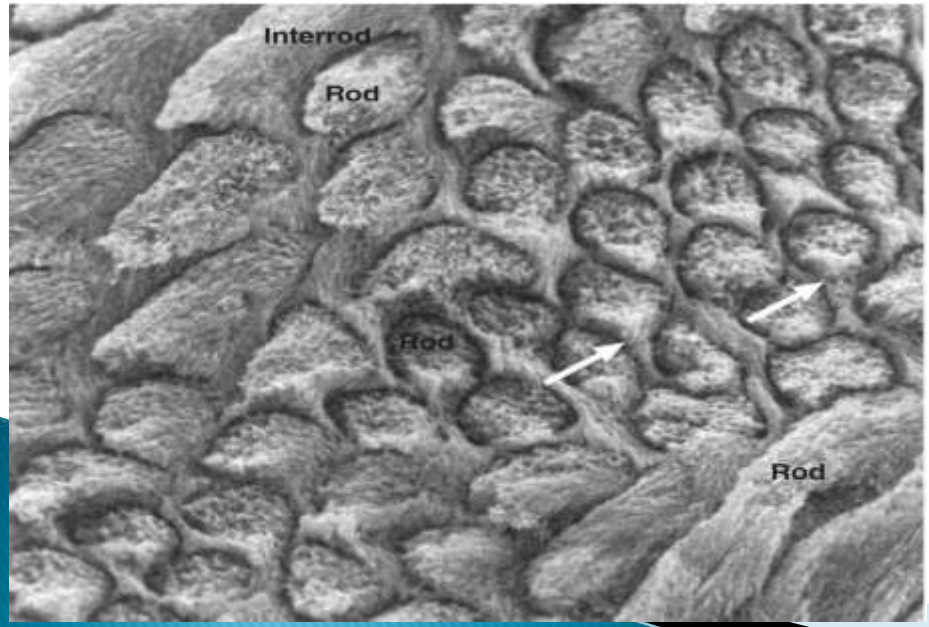
Ultrastructure

Although many areas of human enamel seem to contain rods surrounded by rod sheaths and separated by interrod substance , a more common pattern is a keyhole or paddle-shaped prism in human enamel .




IR
Rod
Rod
IR
Rod
IR

When cut longitudinally , sections pass through the ‘heads’ or ‘bodies’ of one row of rods and the ‘tails’ of an adjacent row. This produces an appearance of rods separated by interrod substance. These rods measure about 4–5 µm in width and 9 µm in length.



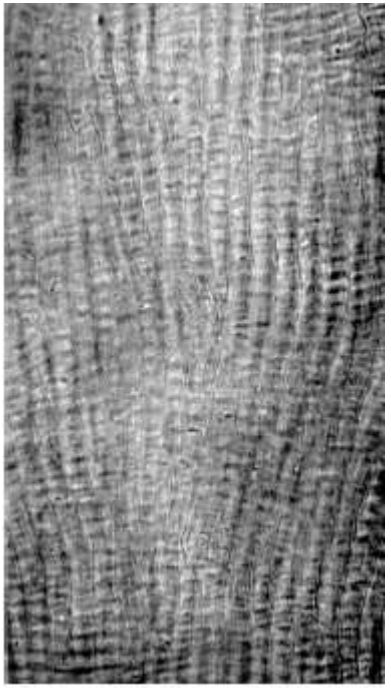
Enamel structure

2-Striations

Each enamel rod is built up of segments separated by dark lines that give it a striated appearance . These *cross striations* demarcate rod segments and become more visible by the action of mild acids. The striations are more pronounced in enamel that is insufficiently calcified.

The rods are segmented because the enamel matrix is formed in a rhythmic manner.

In humans these segments seem to be a uniform length of about 4–5 µm.



Direction of rods

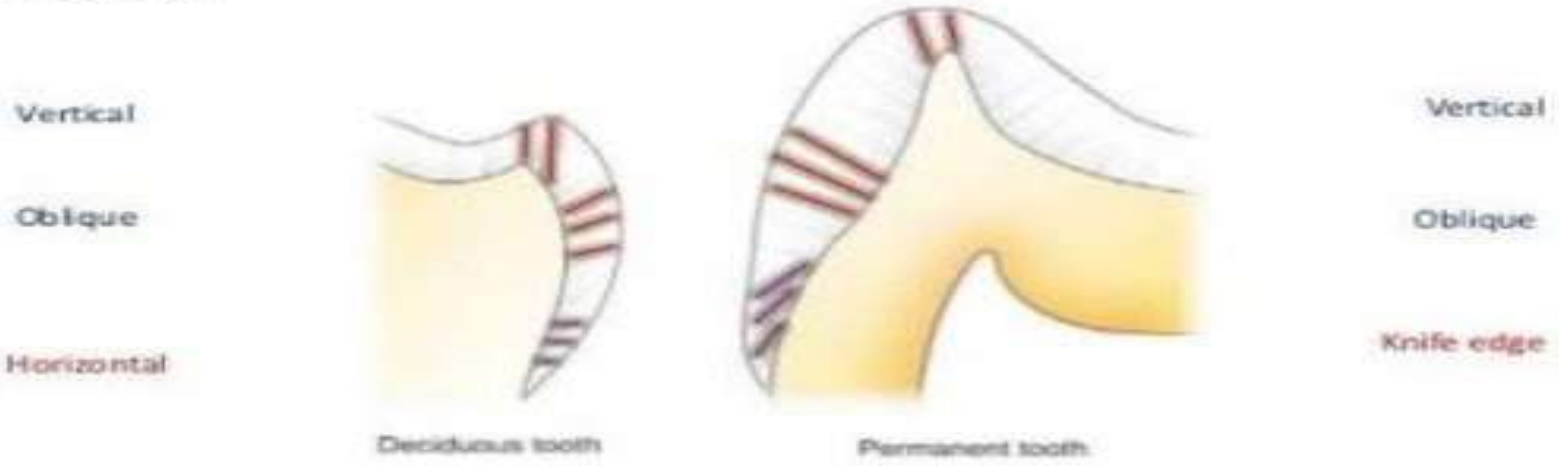
Generally the rods are oriented at right angles to the dentin surface. In the cervical and central parts of the crown of a deciduous tooth they are approximately horizontal , they change gradually to an increasingly oblique direction until they are almost vertical in the region of the edge or tip of the cusps.

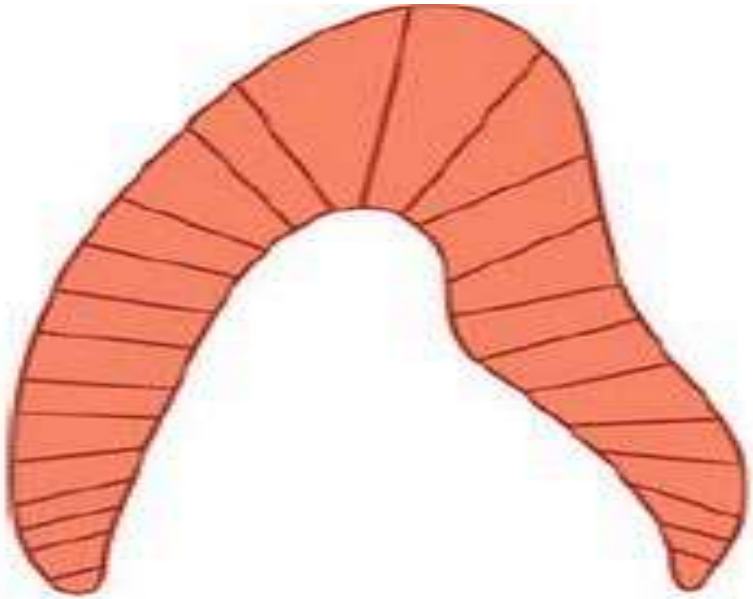
The arrangement of the rods in permanent teeth is similar in the occlusal two thirds of the crown. In the cervical region, however, the rods deviate from the horizontal in an apical direction

Structure of Enamel

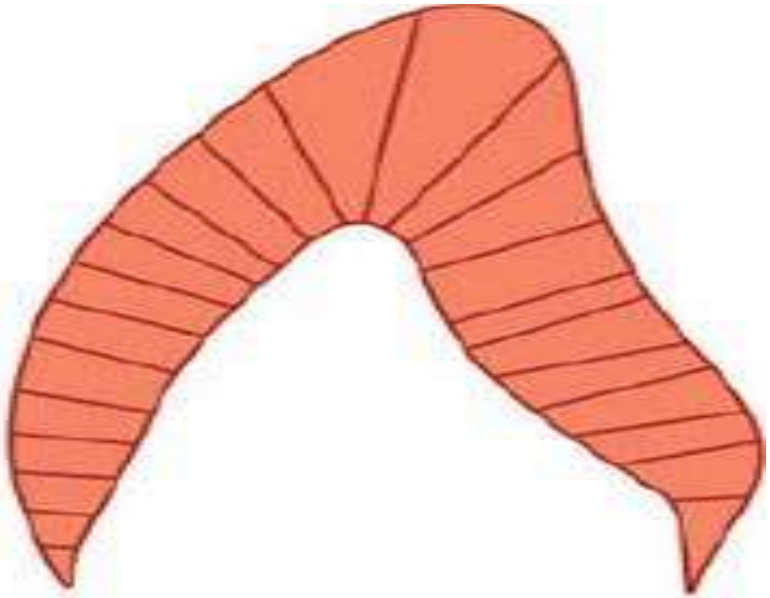
A. Enamel Rod

V. Direction





A Direction of enamel rods in permanent teeth

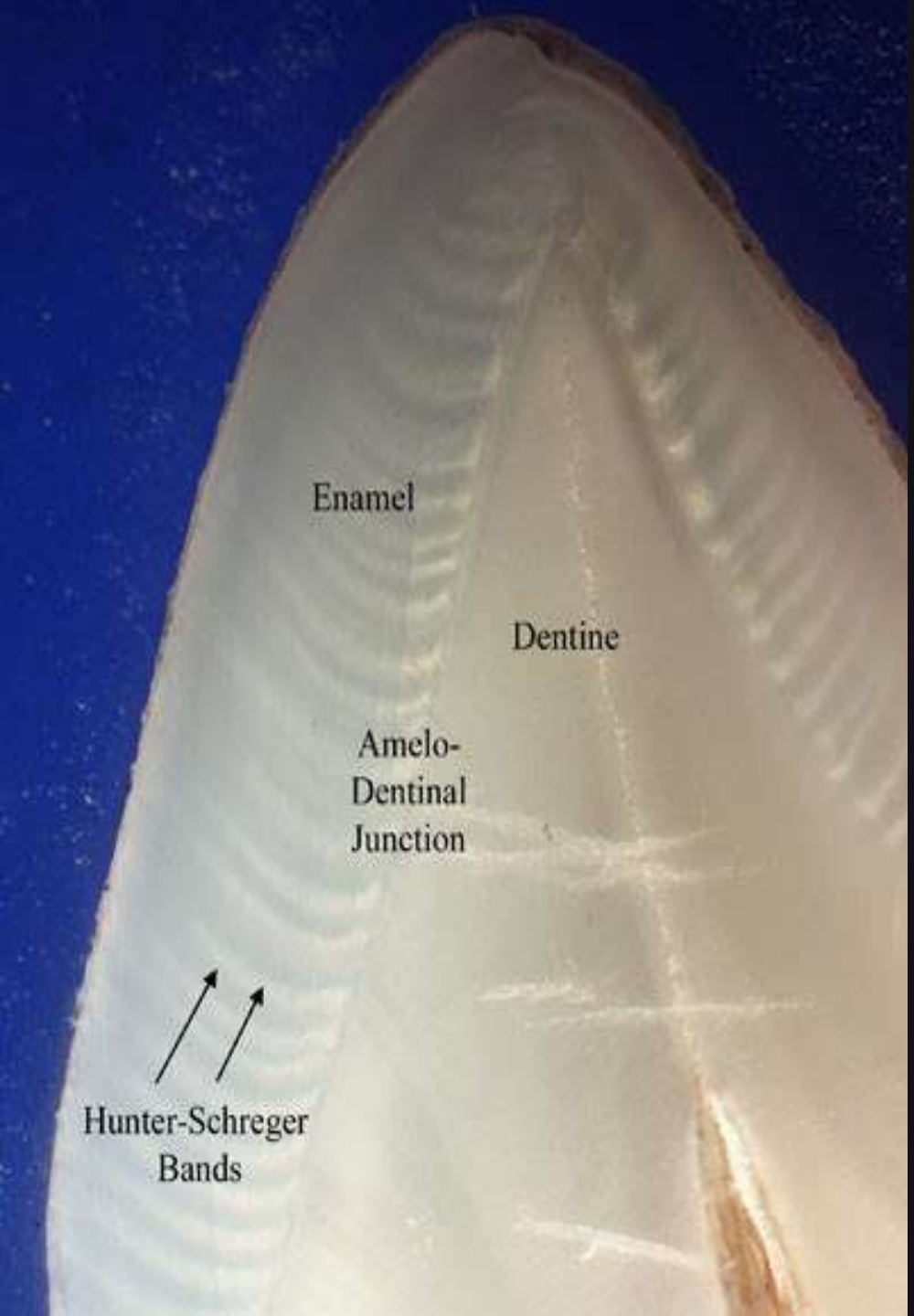


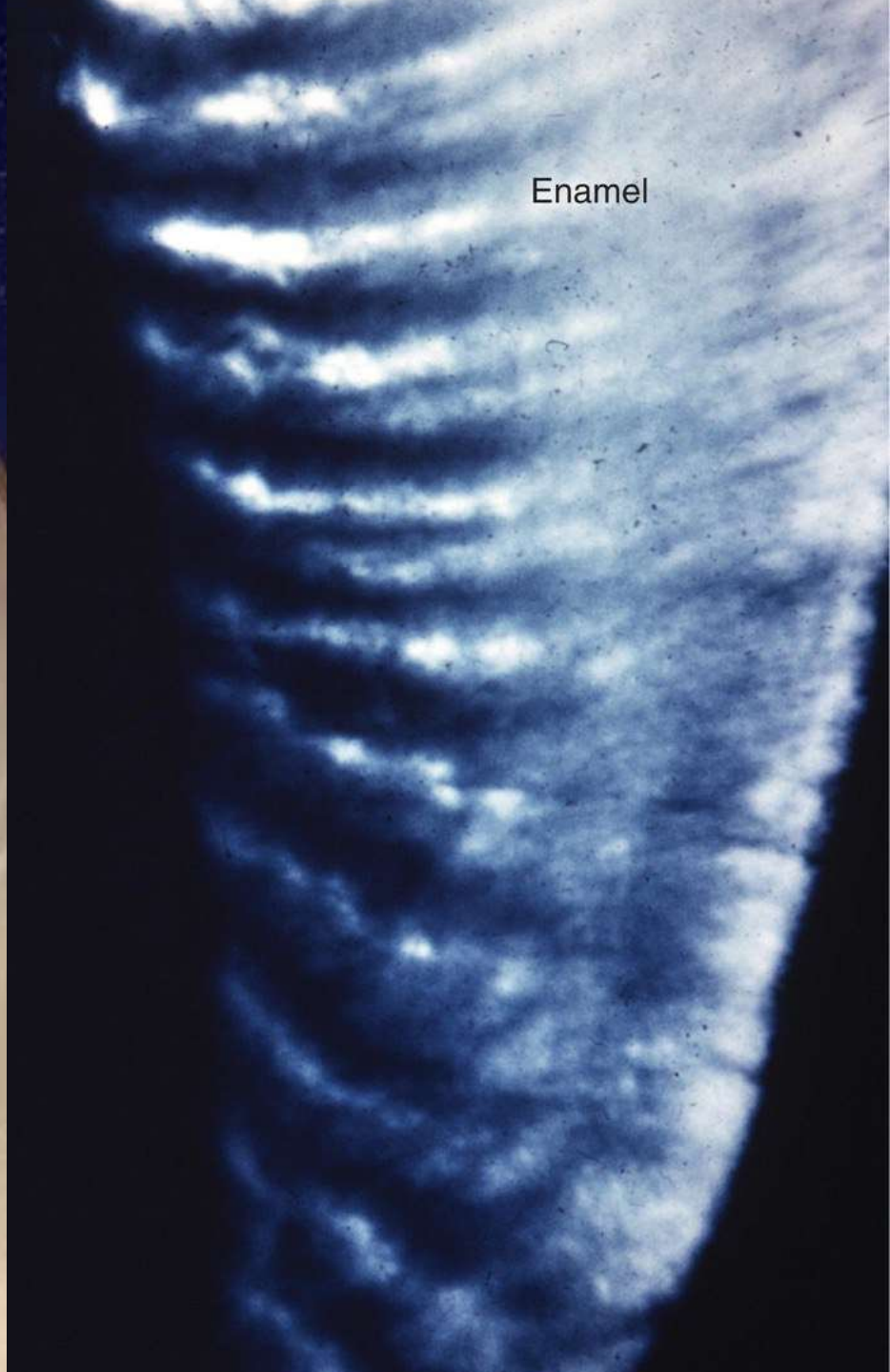
B Upward direction of enamel rods in deciduous teeth

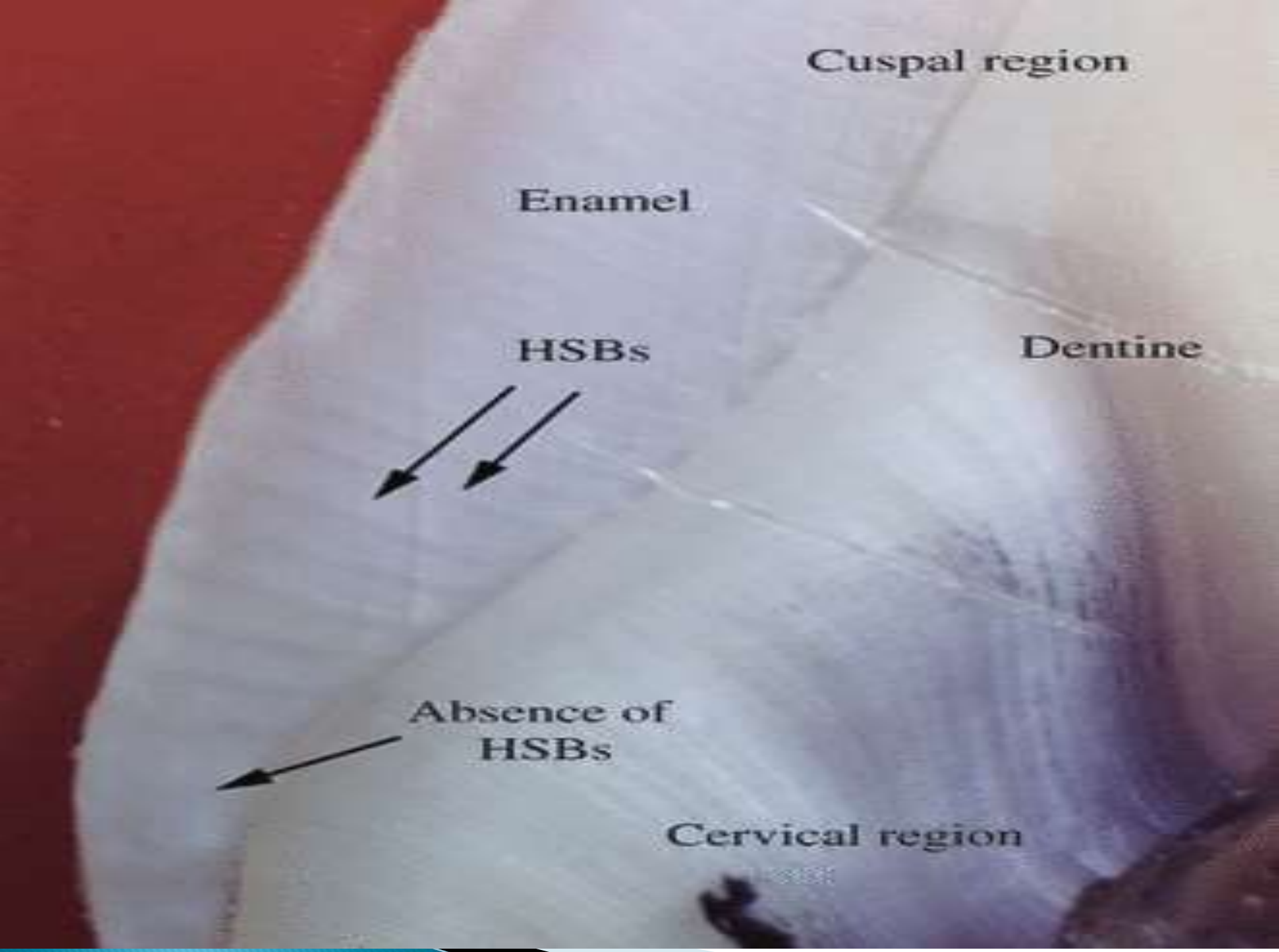
Hunter-Schreger bands

The more or less regular change in the direction of rods may be regarded as a functional adaptation, minimizing the risk of cleavage in the axial direction under the influence of mastication forces.

The change in the direction of rods is responsible for the appearance of the Hunter-Schreger bands. These are alternating dark and light strips of varying widths that can best be seen in a longitudinal ground section under oblique reflected light.

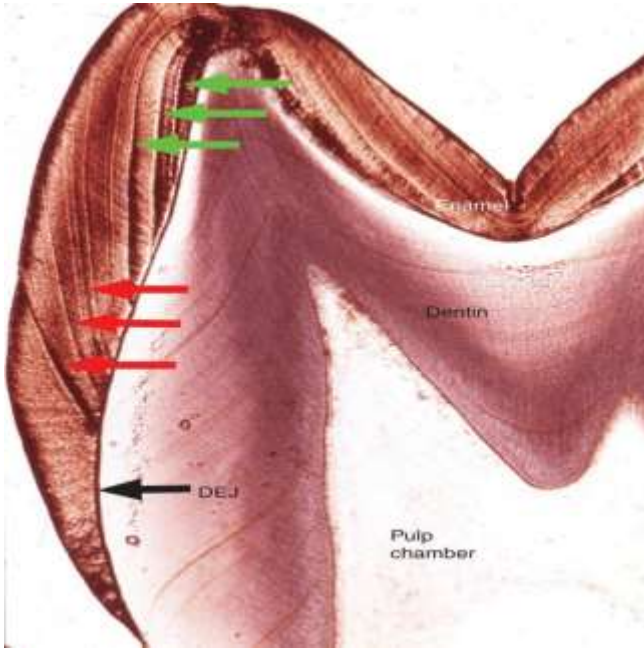

Enamel
Dentine
Amelo-
Dentinal
Junction
Hunter-Schreger
Bands


Enamel

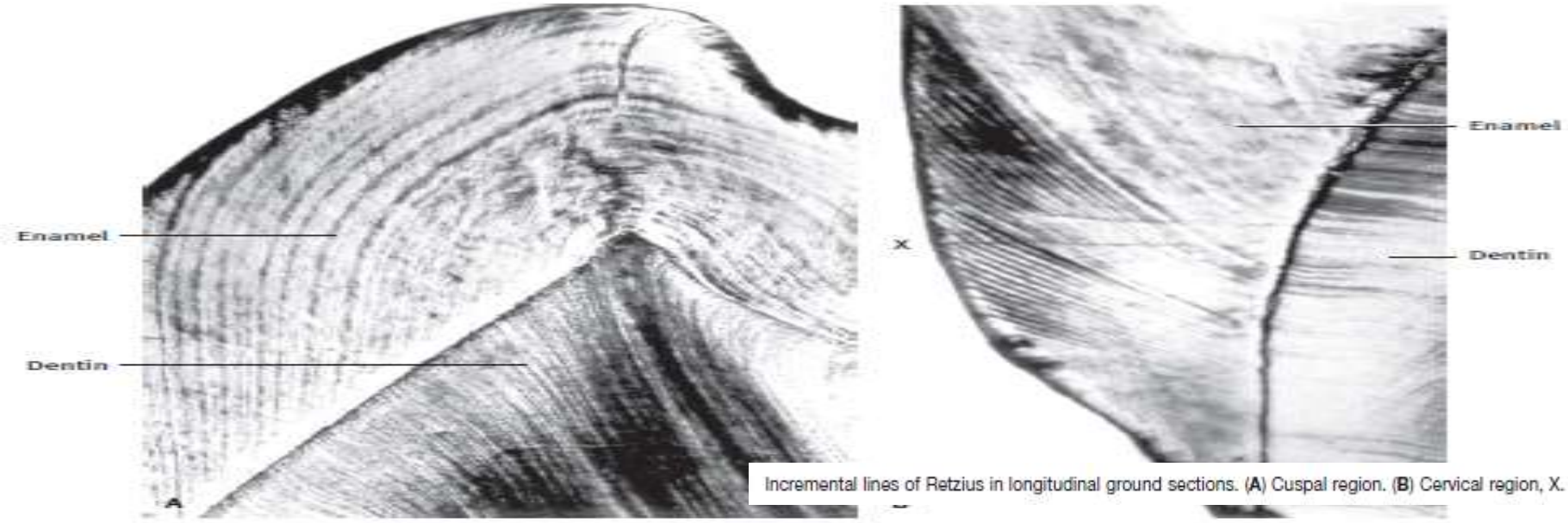

Cuspal region
Enamel
HSBs
Dentine
Absence of
HSBs
Cervical region

Incremental Lines of Retzius

The incremental lines of Retzius appear as brownish bands in ground sections of the enamel. They illustrate the incremental pattern of the enamel, that is, the incremental layers of enamel forms during formation of the crown.



In longitudinal sections they surround the tip of the dentin , In the cervical parts of the crown they run obliquely, From the dentinoenamel junction to the surface they deviate occlusally .

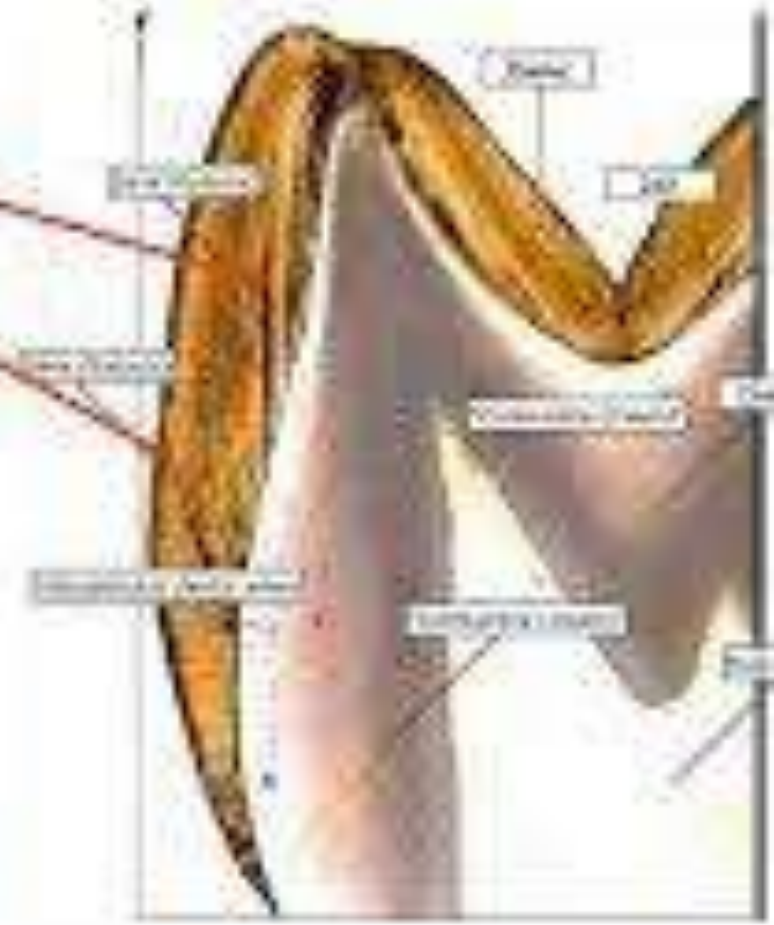


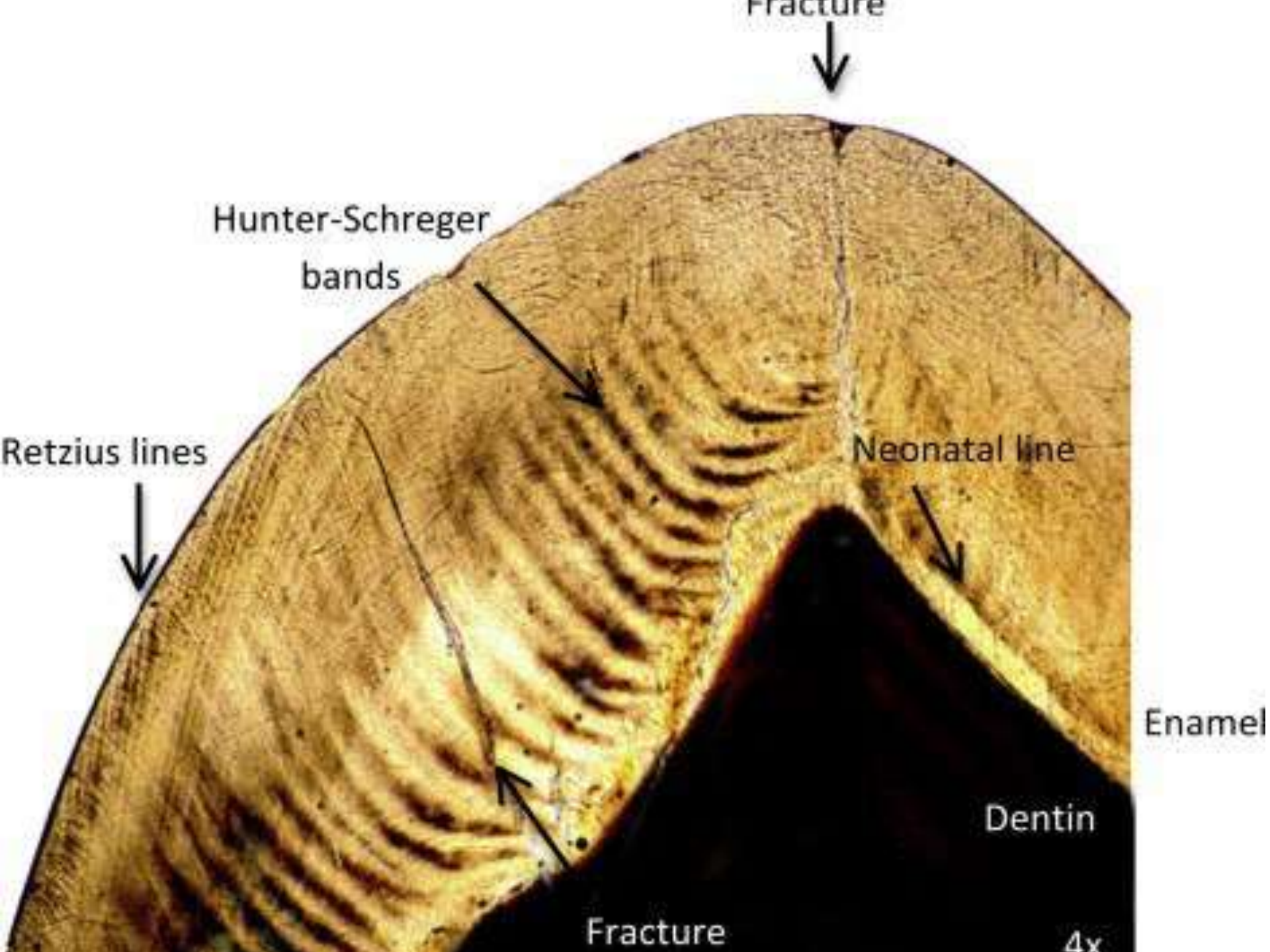
Incremental lines of Retzius in longitudinal ground sections. (**A**) Cuspal region. (**B**) Cervical region, X.

Histological Structure

striae of Retzius

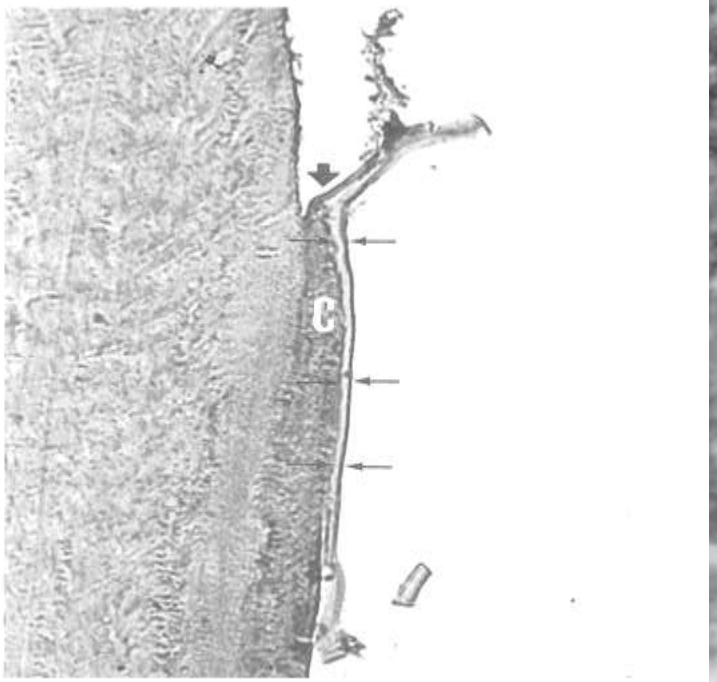


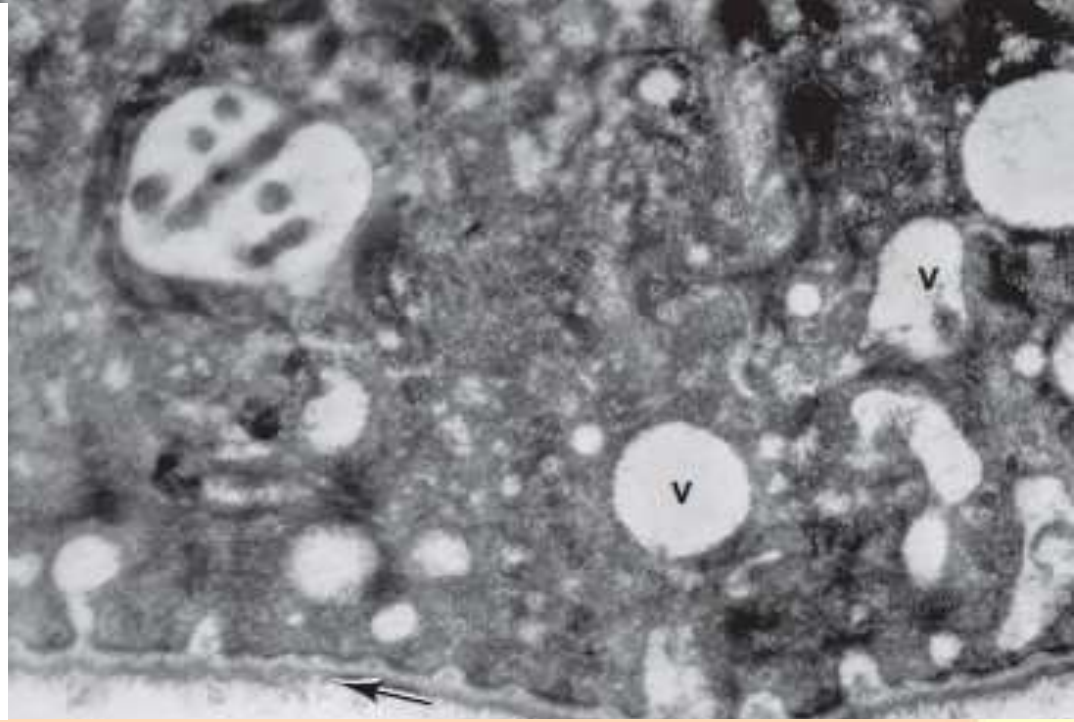



Fracture
Hunter-Schreger bands
Retzius lines
Neonatal line
Enamel
Dentin
Fracture
4x

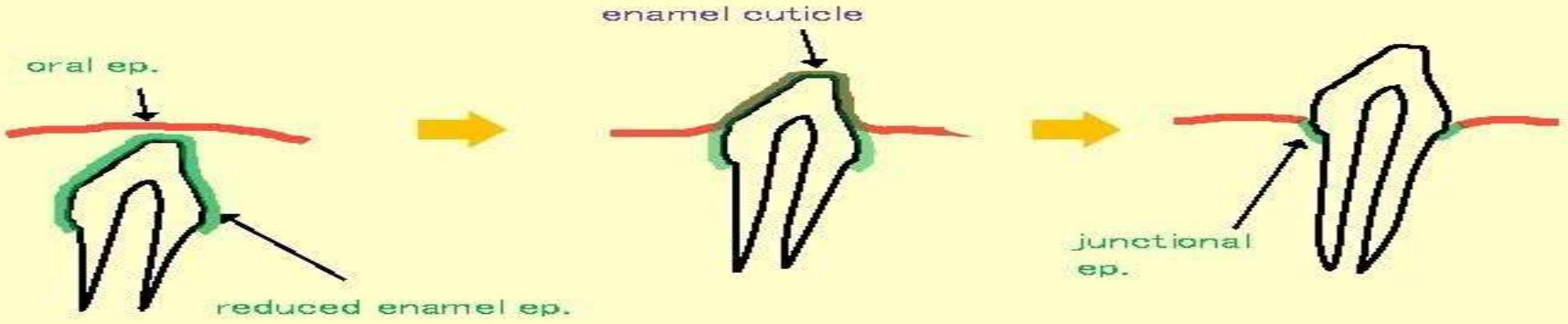
Enamel cuticle

delicate membrane called the *primary enamel cuticle* covers the entire crown of the newly erupted tooth but is probably soon removed by mastication. The function of enamel cuticle is to protect the surface of enamel from the resorptive activity of the adjacent tissues after to the eruption of the teeth.





Changes in epithelium during eruption

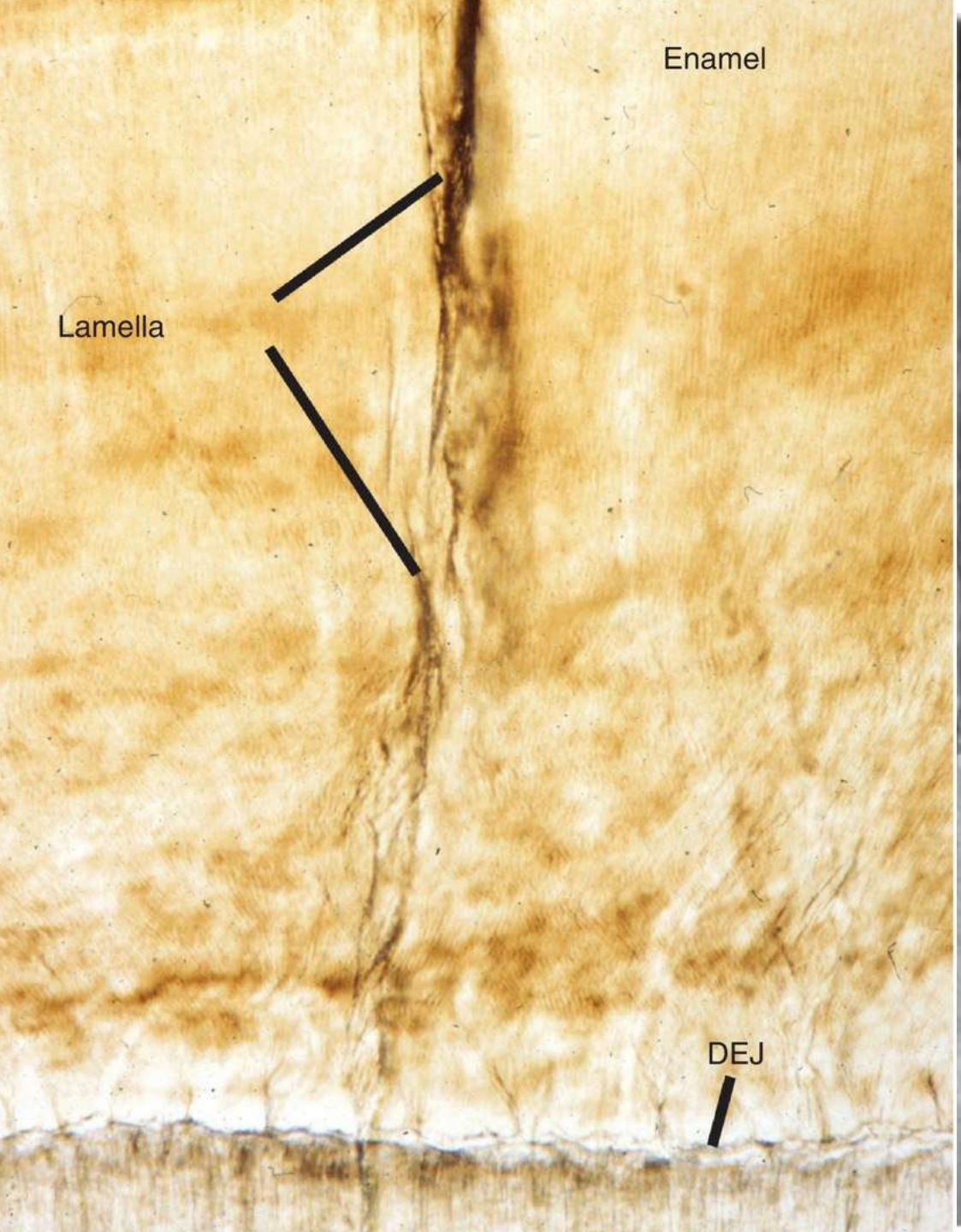


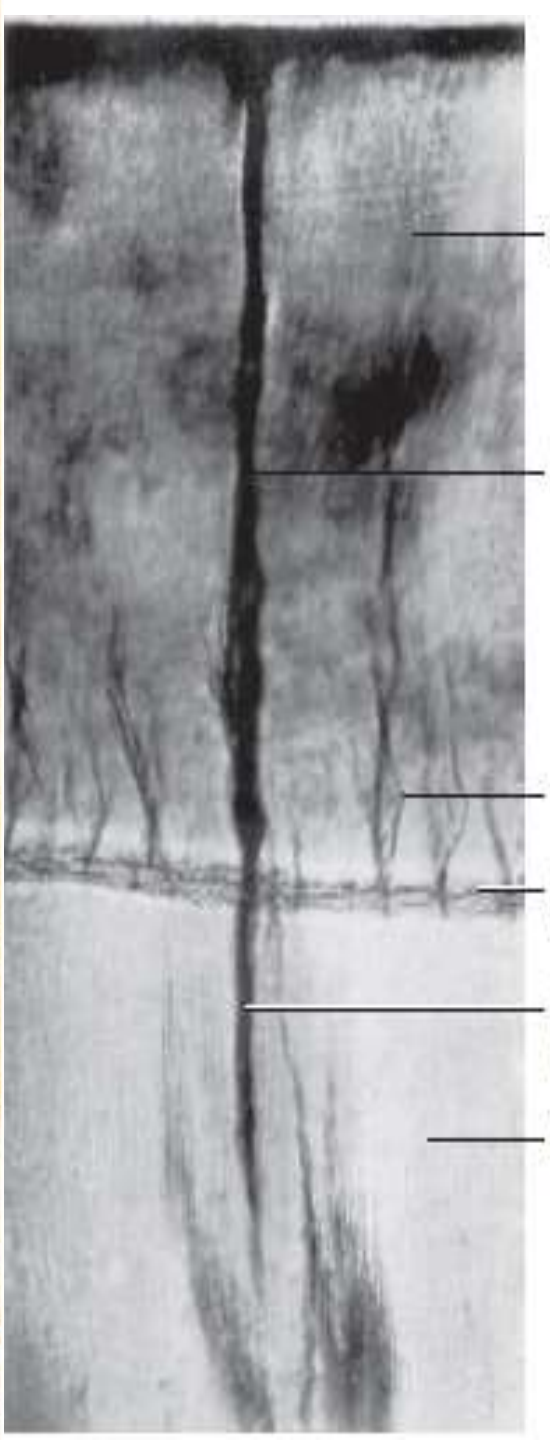
Enamel lamellae

Enamel lamellae are thin, leaf-like structures that extend from the enamel surface toward the dentinoenamel junction .

They may extend to, and sometimes penetrate into, the dentin. They consist of organic material, with little mineral content.

In ground sections, these structures may be confused with cracks caused by grinding of the specimen


Enamel
Lamella
DEJ

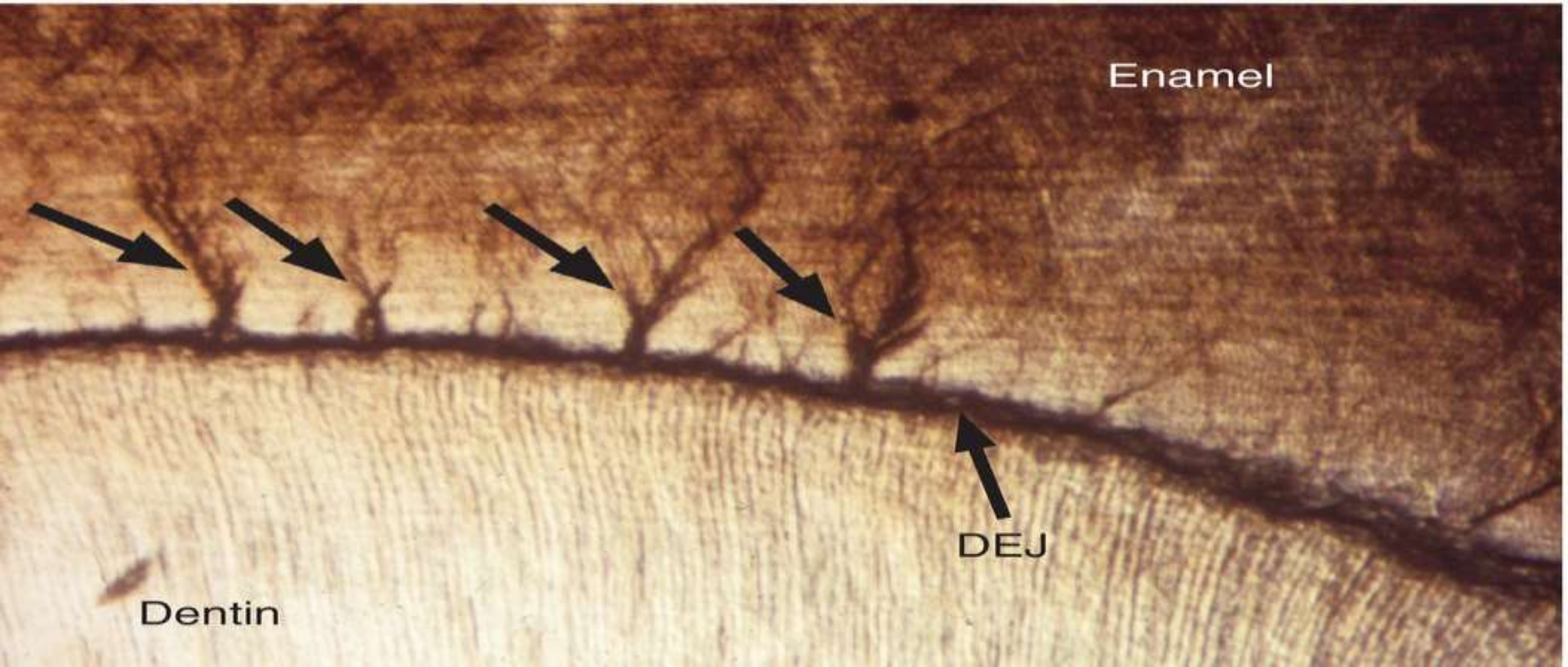

Enamel
Lamella
Tufts
Dentinoenamel junction
Dentinal part of lamella
Dentin

Enamel tufts

Enamel tufts arise at the dentinoenamel junction and reach into the enamel to about one fifth 1\5 to one third 1\3 of its thickness.

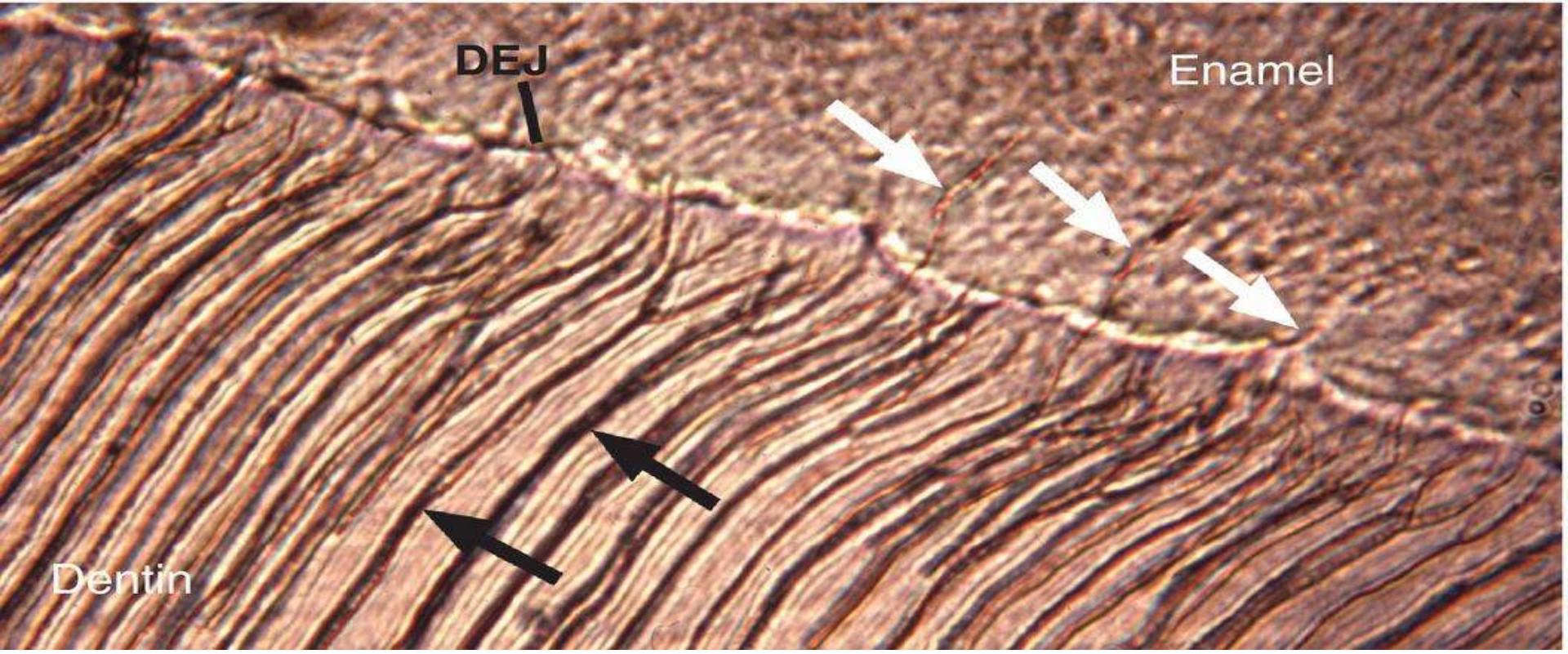
They were so termed because they resemble tufts of grass when viewed in ground sections. Tufts consist of hypocalcified enamel rods and interprismatic substance. Like the lamellae, they extend in the direction of the long axis of the crown.


Enamel
Tufts
Dentinoenamel junction
Dentin


Enamel
DEJ
Dentin

Odontoblast processes and enamel spindles

Occasionally odontoblast processes pass across the dentinoenamel junction into the enamel. Since many are thickened at their end , they have been termed *enamel spindles*. They seem to originate from processes of odontoblasts that extended into the enamel epithelium before hard substances were formed. The direction of the odontoblast processes and spindles in the enamel corresponds to the original direction of the ameloblasts— at right angles to the surface of the dentin.


DEJ
Enamel
Dentin


Enamel spindle
Dentinoenamel junction
Dentinal tubule
Enamel
Odontoblastic process in enamel
Dentin

- Thank you