Histology of the tongue and teeth

Semmelweis University, Faculty of Medicine
Department of Anatomy, Histology and Embryology

Microscopic anatomy I.

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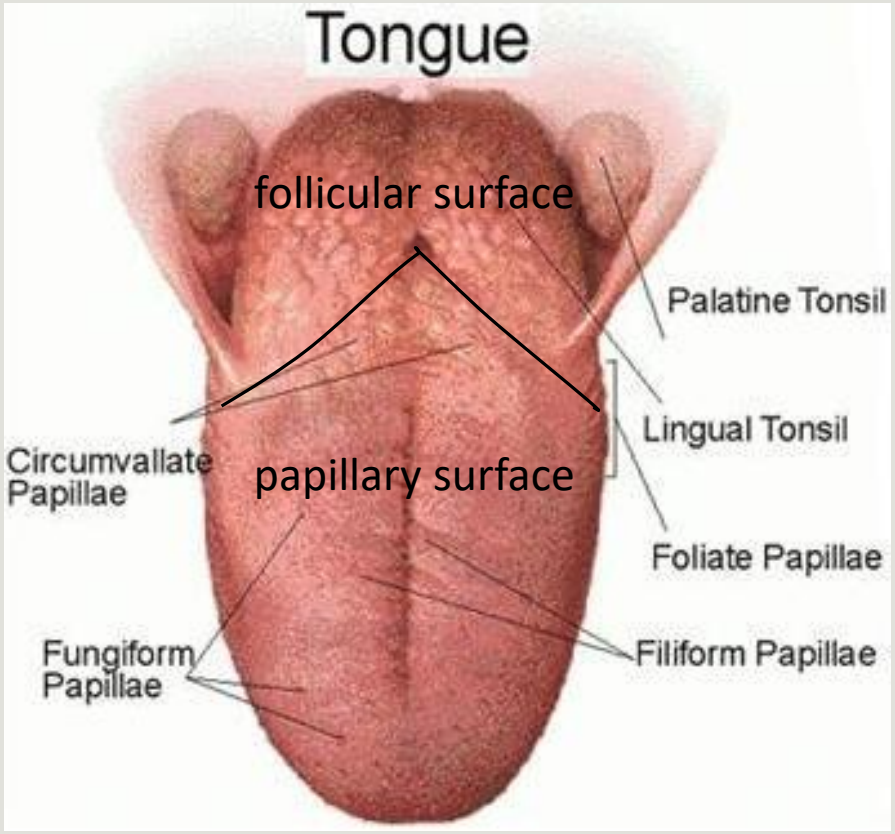
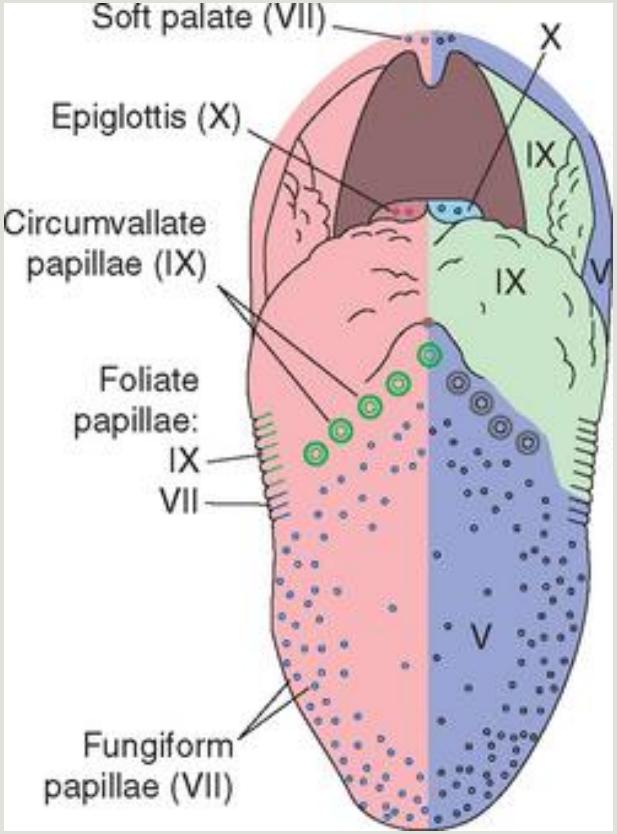
05/03/2020
06/03/2020

TONGUE


Tongue
follicular surface
papillary surface
Palatine Tonsil
Lingual Tonsil
Foliate Papillae
Filiform Papillae
Circumvallate Papillae
Fungiform Papillae


Soft palate (VII)
X
Epiglottis (X)
IX
Circumvallate papillae (IX)
IX
V
Foliate papillae:
IX
VII
V
Fungiform papillae (VII)

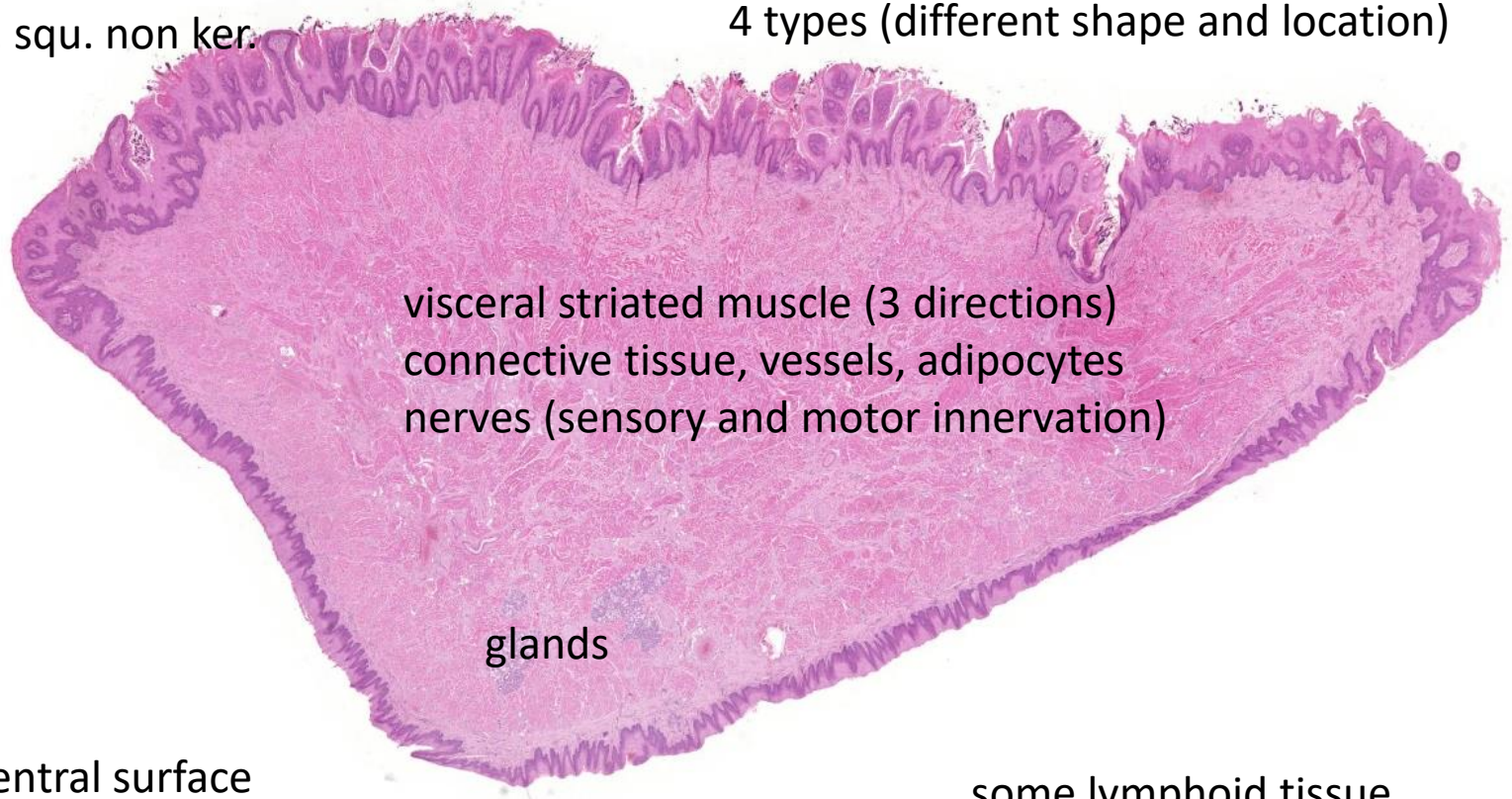
Histology of the tongue

dorsal surface

epithelium
str. squ. non ker.

taste buds

(lingual) papillae:
epithelium + connective tissue core
4 types (different shape and location)



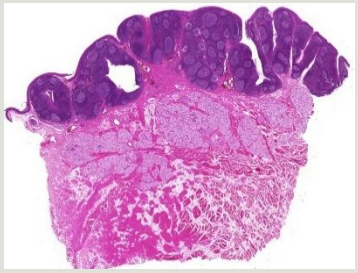
visceral striated muscle (3 directions)
connective tissue, vessels, adipocytes
nerves (sensory and motor innervation)

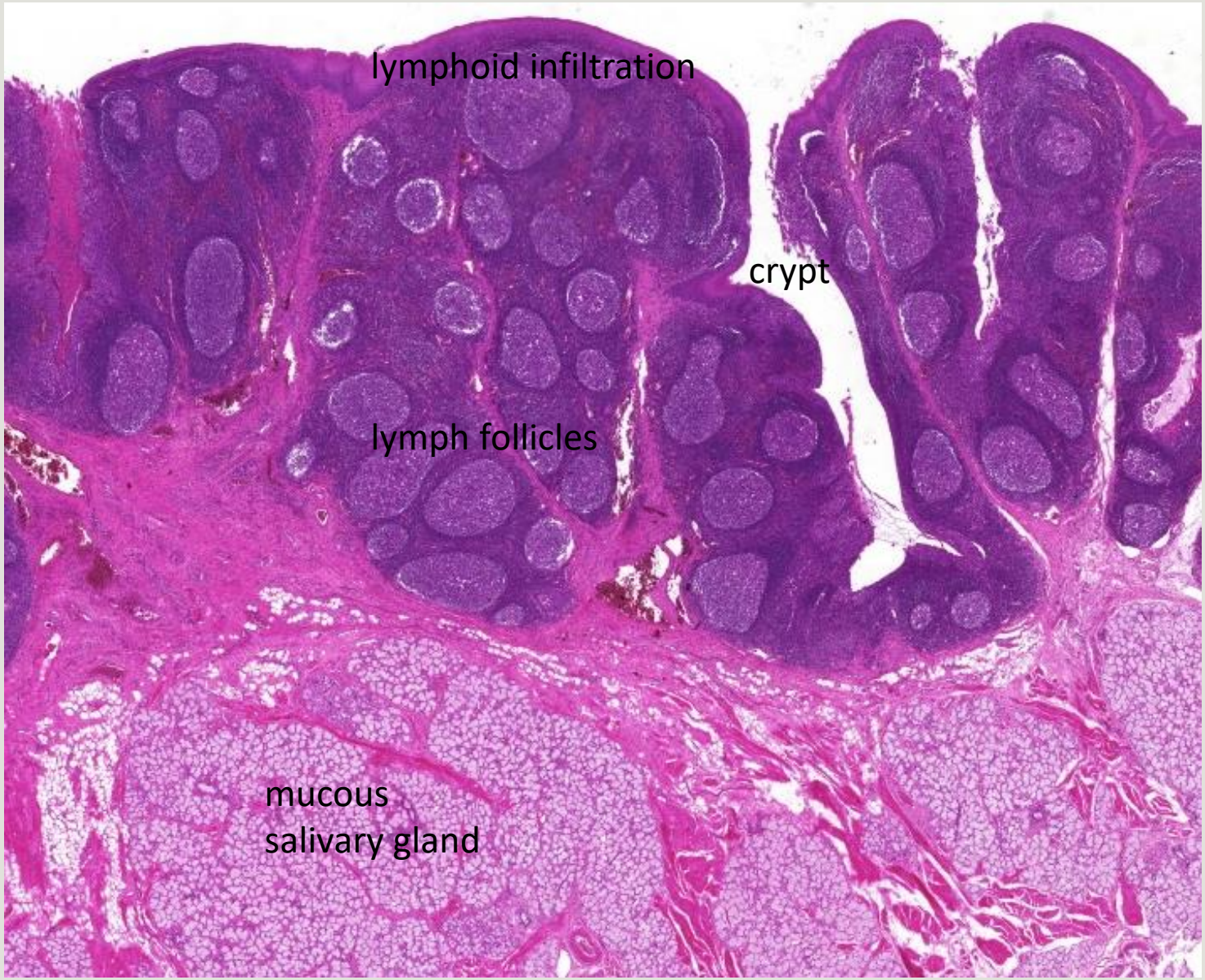
glands

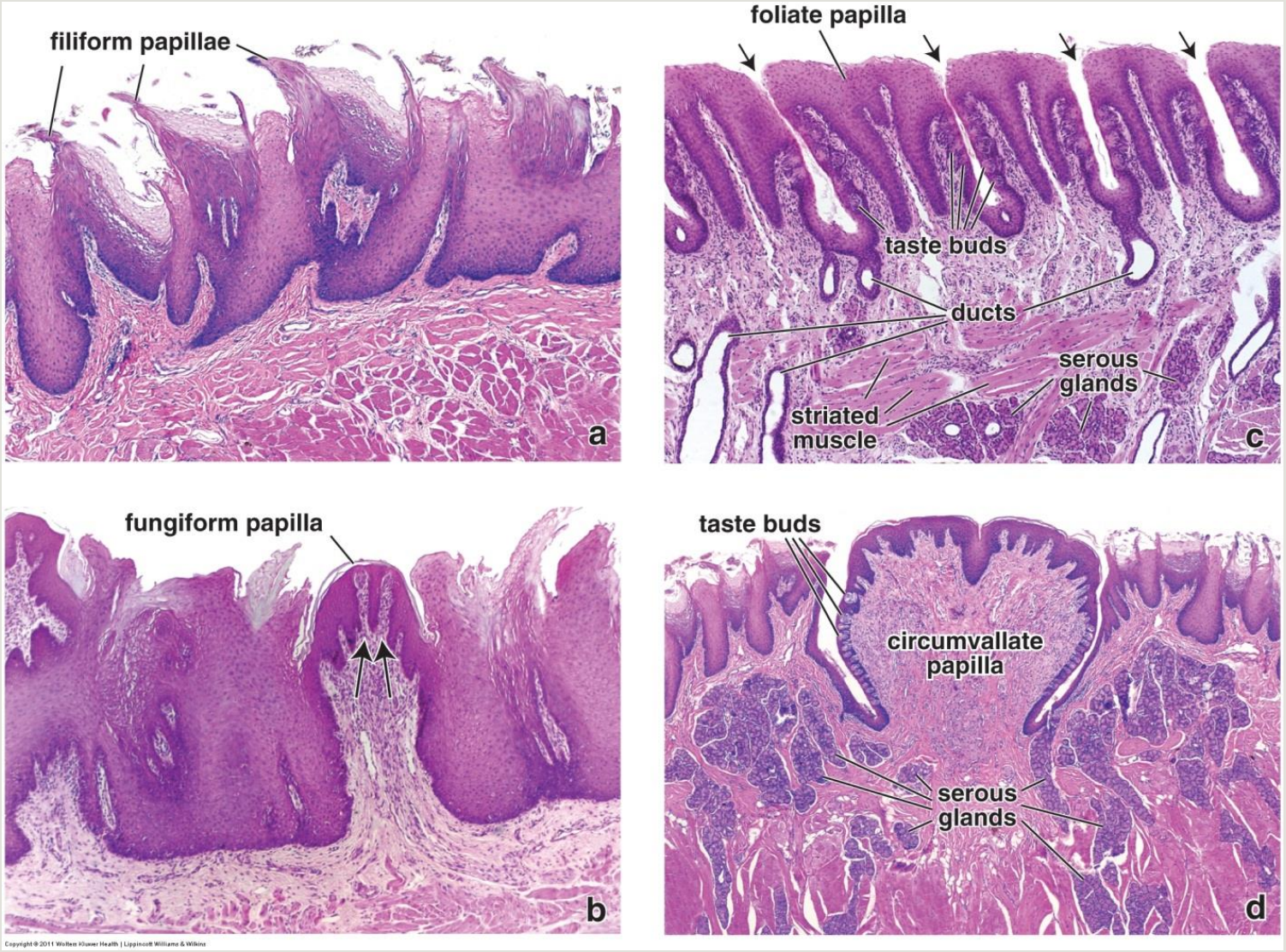
ventral surface

some lymphoid tissue
(lingual tonsil)

lingual tonsil - Micr.Anat.II. subject !







Papillae

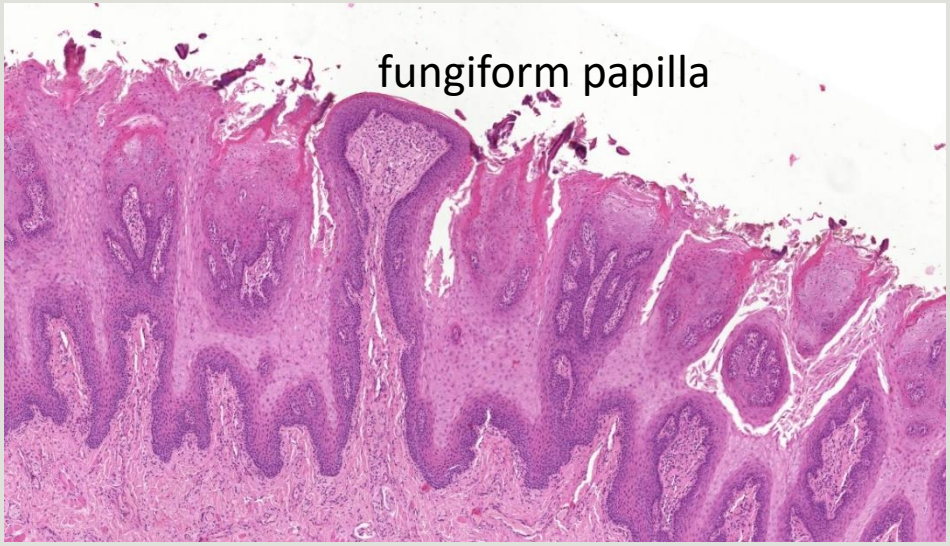
filiform

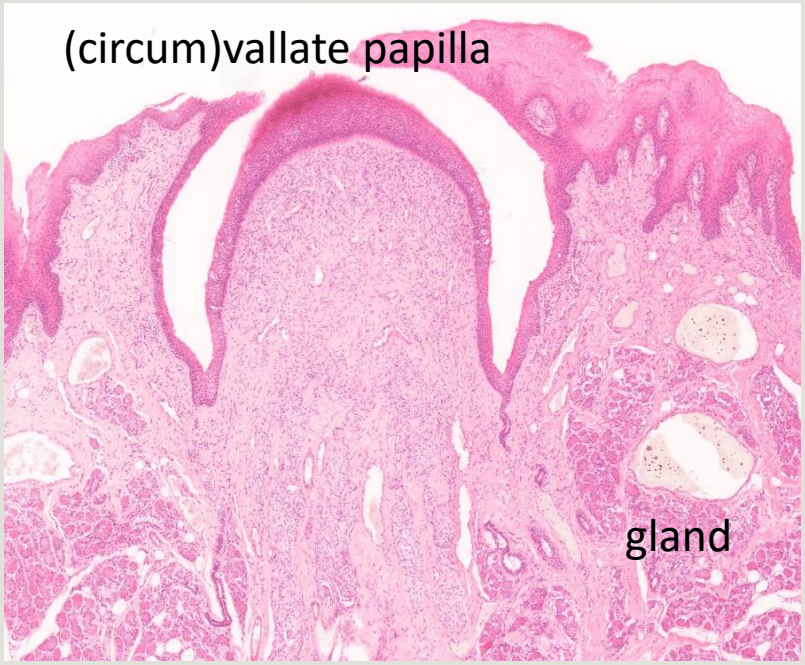
fungiform

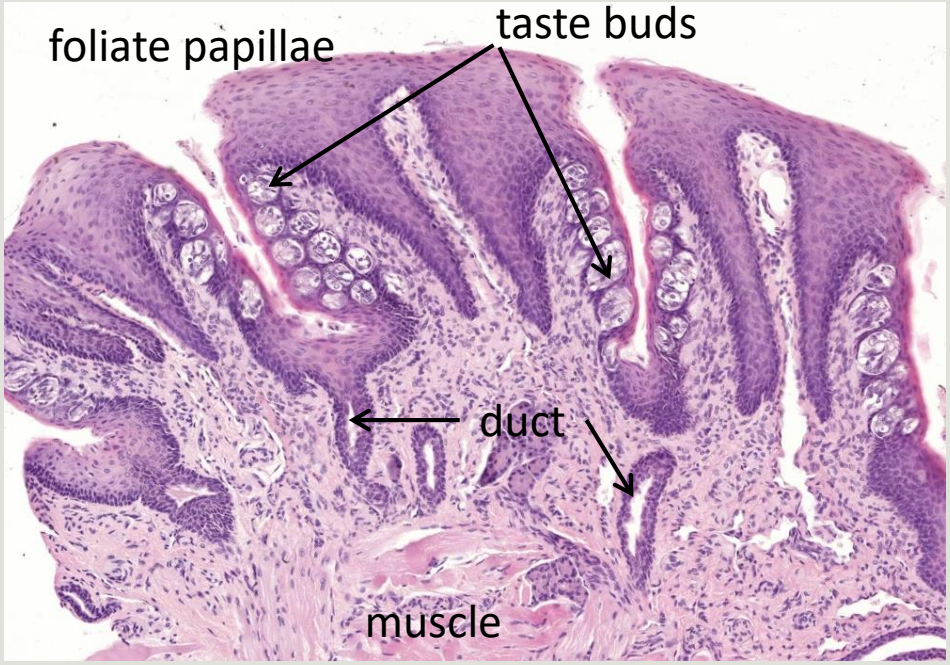
foliate

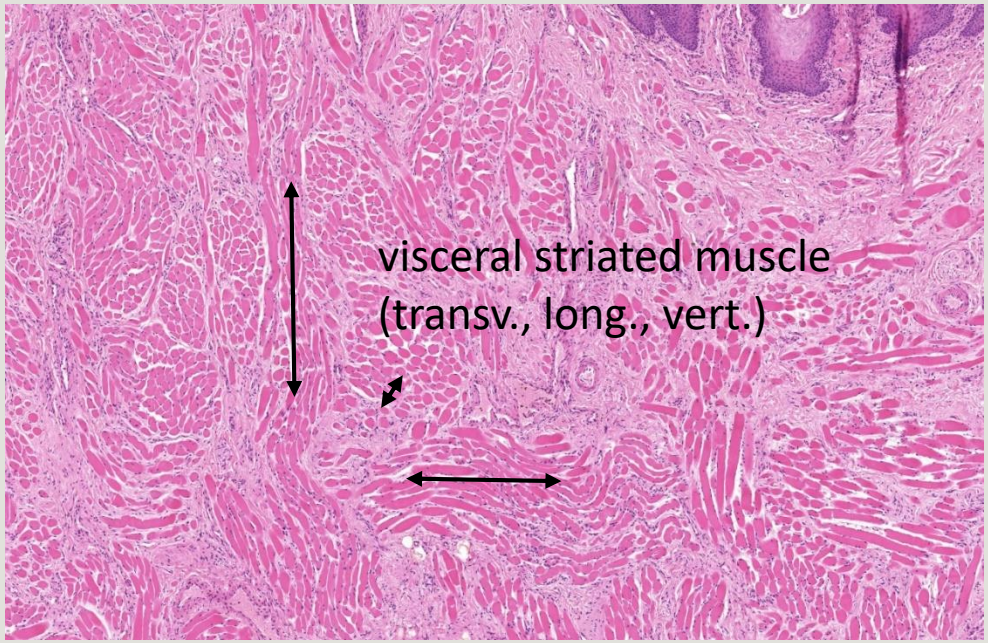
(circum)vallate


filiform papillae

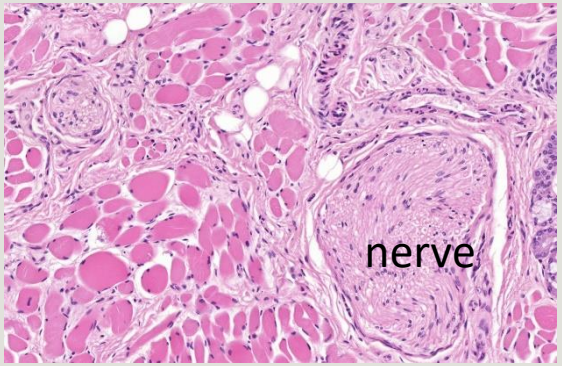

fungiform papilla

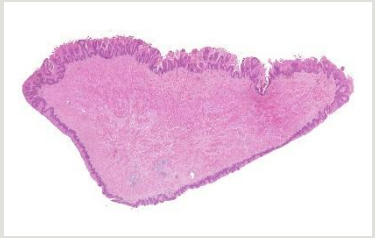

(circum)vallate papilla
gland


foliate papillae
taste buds
duct
muscle

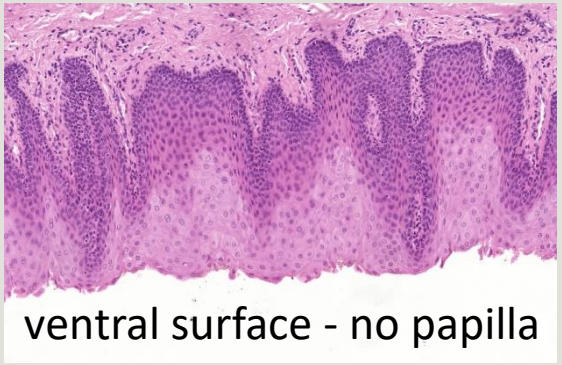

visceral striated muscle
(transv., long., vert.)

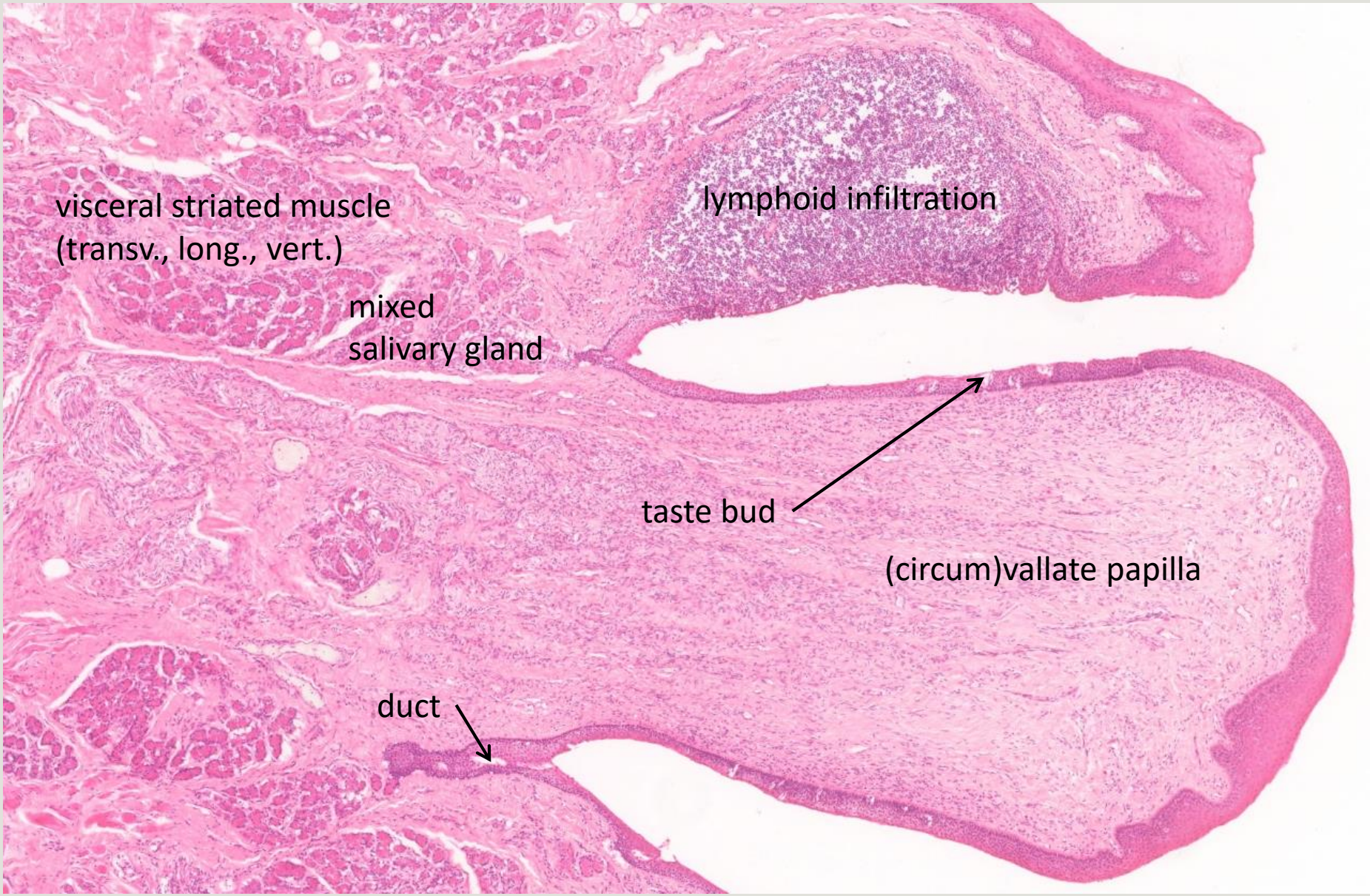

vessel


nerve

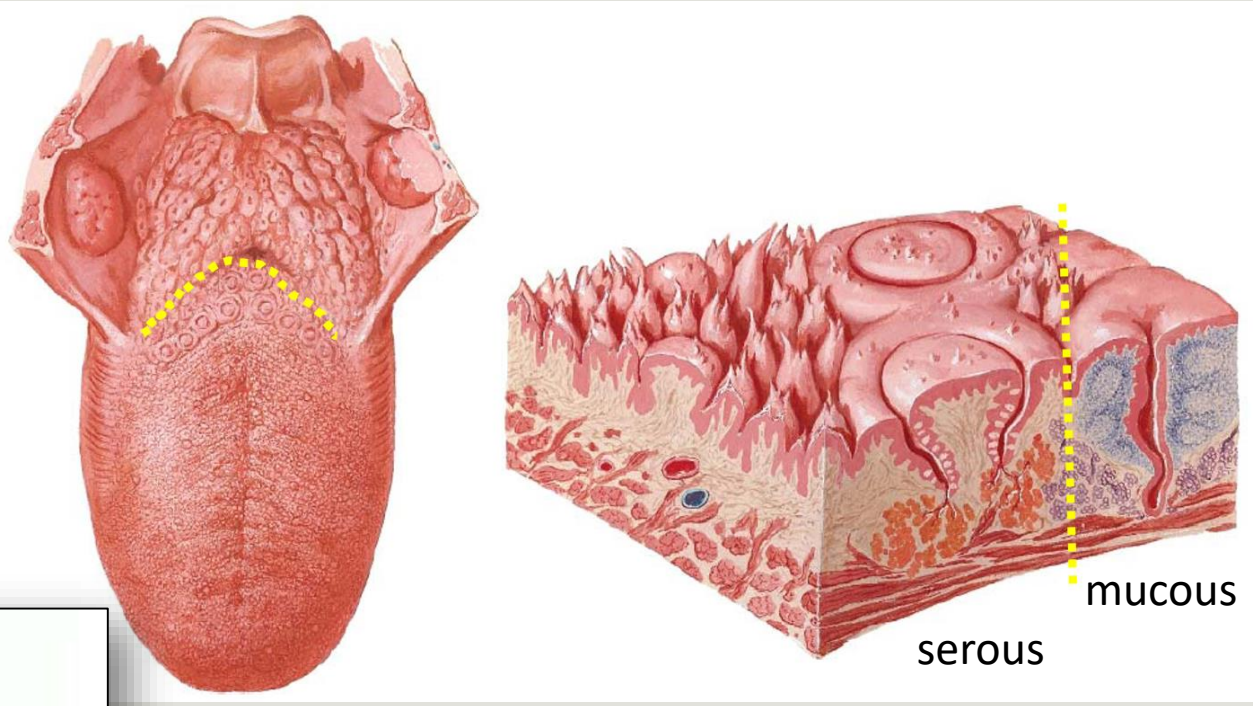


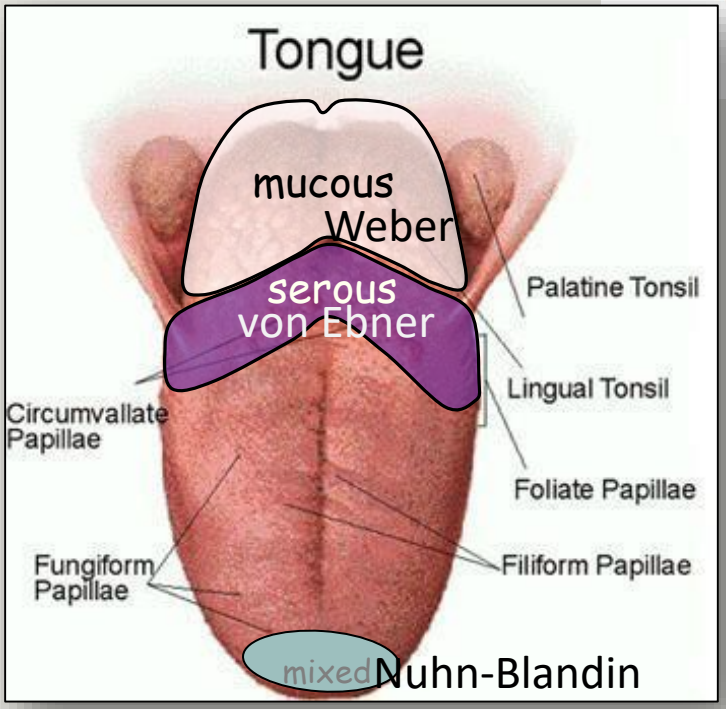

serous
mixed
salivary gland
mucous

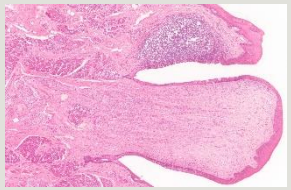

ventral surface - no papilla

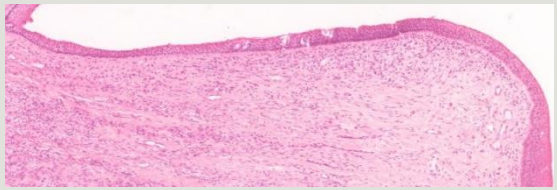

visceral striated muscle
(transv., long., vert.)
mixed
salivary gland
lymphoid infiltration
taste bud
(circum)vallate papilla
duct

Glands of the tongue

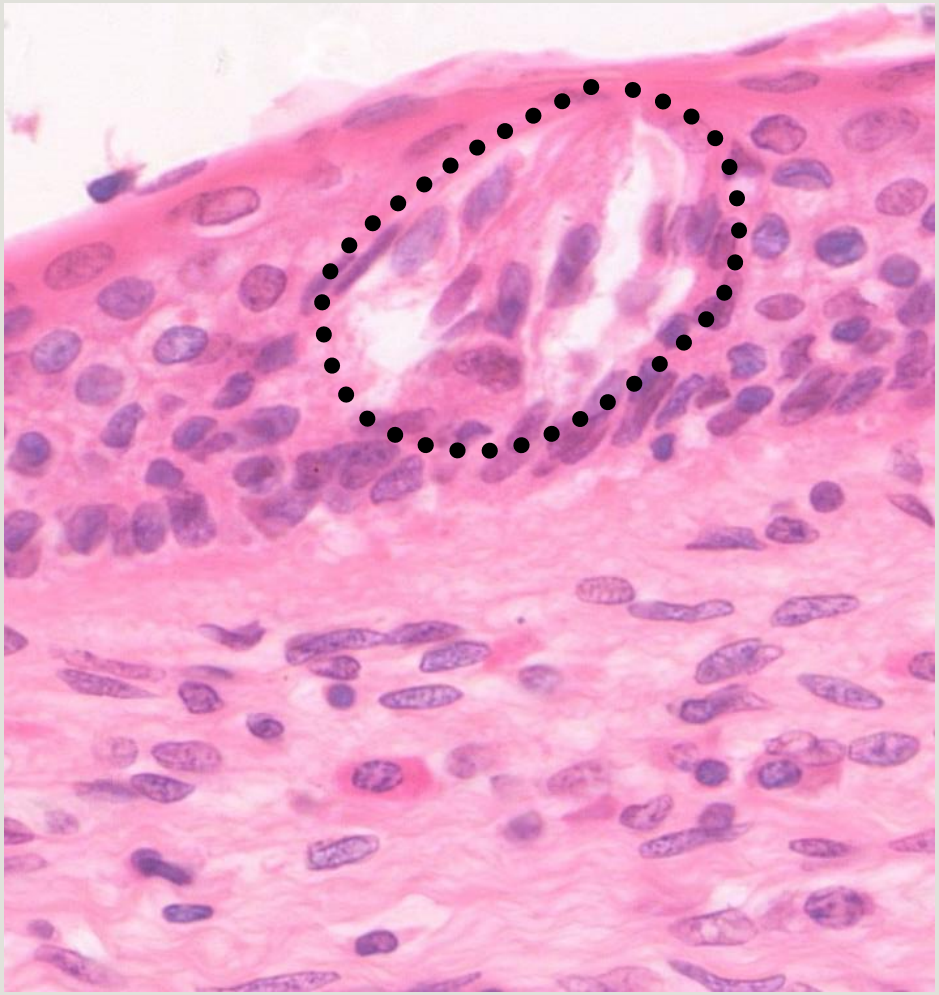


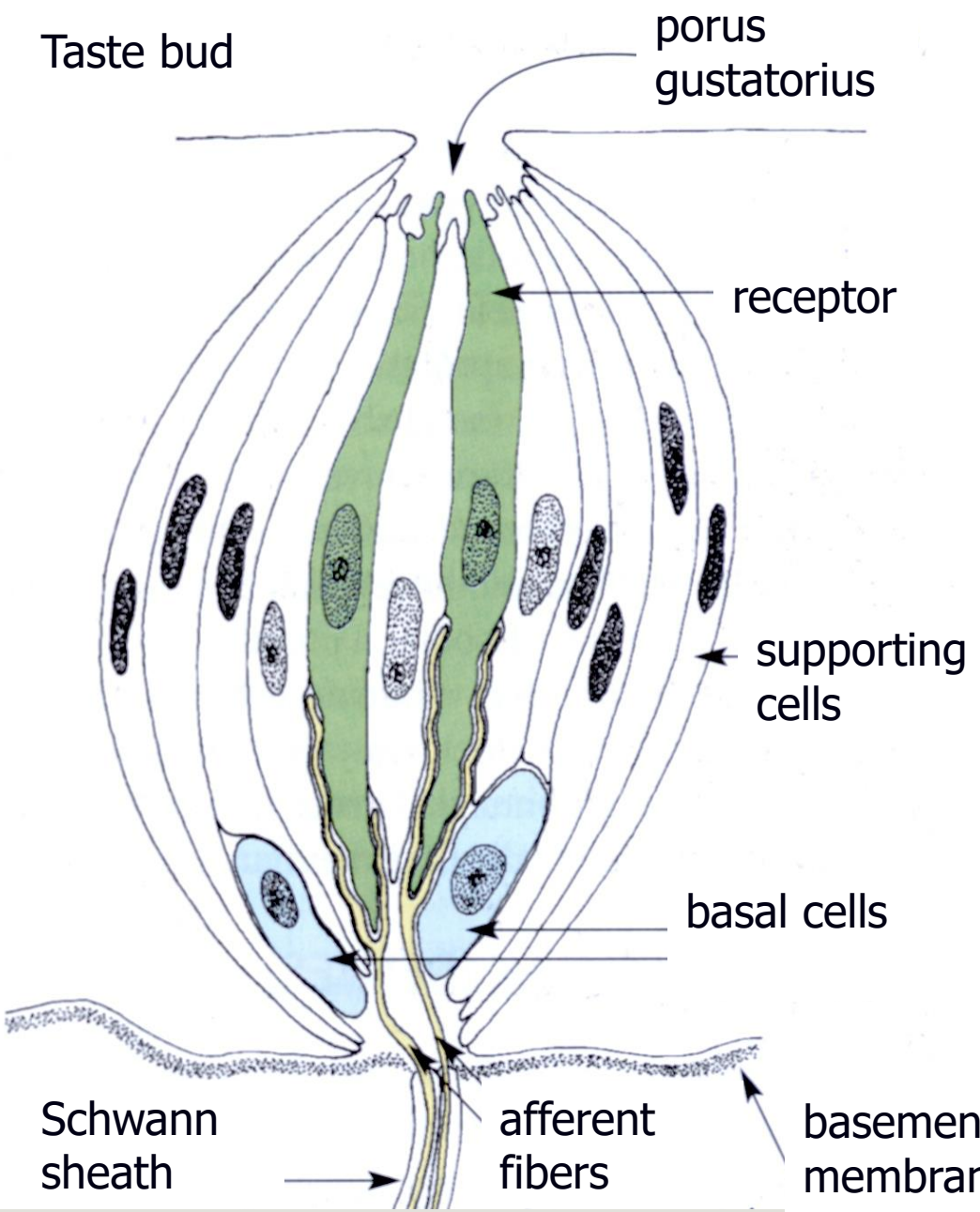






Micr.Anat.II. subject !





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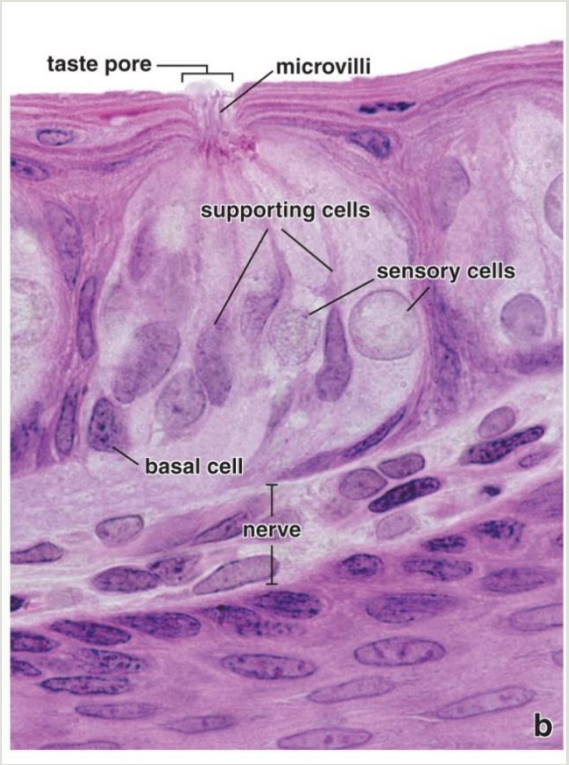


receptors
supporting cells
undifferentiated (basal cells)

Receptors: dendrite-like short processes on the apical plasma membrane
Life time: very short (10-60 days).

topic of Micr.Anat.II. and
perhaps Physiology, Biochemistry

Signal transduction

Four (five, six) basic tastes:

Salty and sour: directly through the apical ion channels

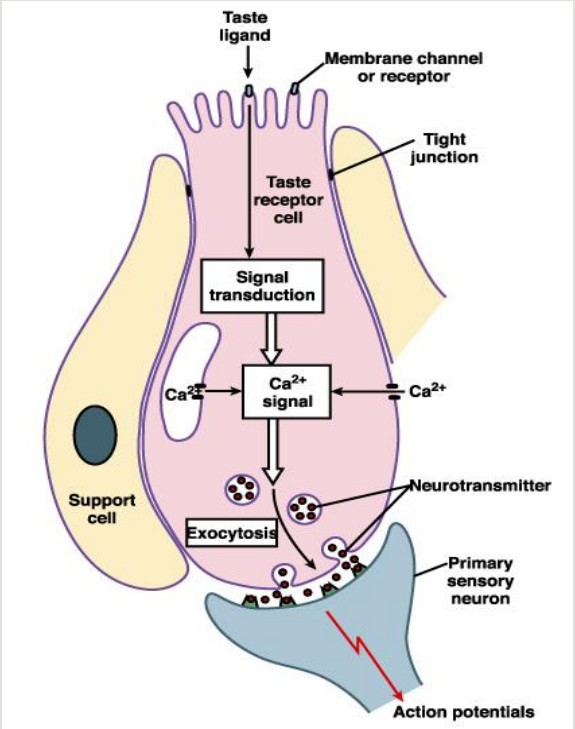
1. **Salty:** – ions binding on the microvilli (inorganic ions)
2. **Sour:** – acids: protons (H+ ions) interact with microvilli

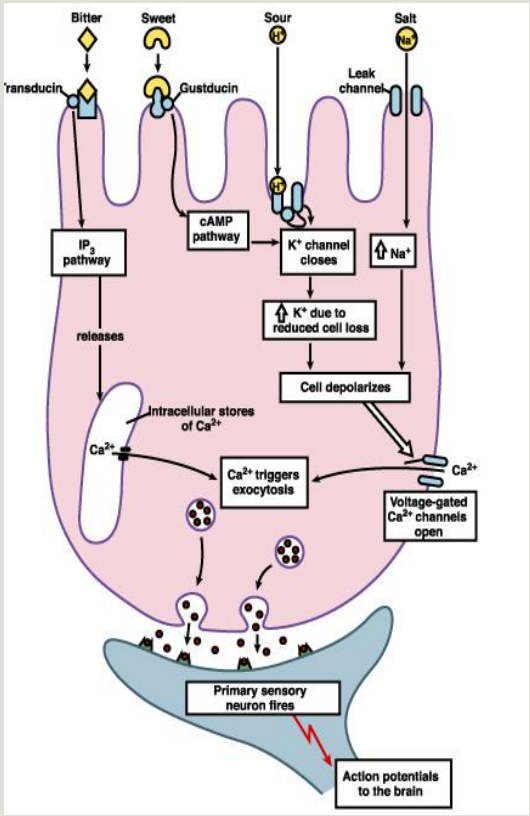
Sweet and bitter: receptor-coupled „second messenger" pathway

3. **Sweet** – G-protein coupled, receptor-mediated transduction pathway; activation of adenyl cyclase → increase the level of cAMP; cAMP activates a PKA (protein kinase) → phosphorylation of the basolateral K+ channel → close → depolarization Ca-channels open
4. **Bitter** – IP3 (inozitol-3-phosphate) pathway → Ca^{2+} release

New and candidate basic tastes

5. **Umami** (yammi, glutamate-rich)
6. ? Fatty (oily) / starch-taste





topic of Micr.Anat.II.

TASTE MAP OF THE TONGUE (??)

Misconception

Based on a publication from 1901

By Hänig, David

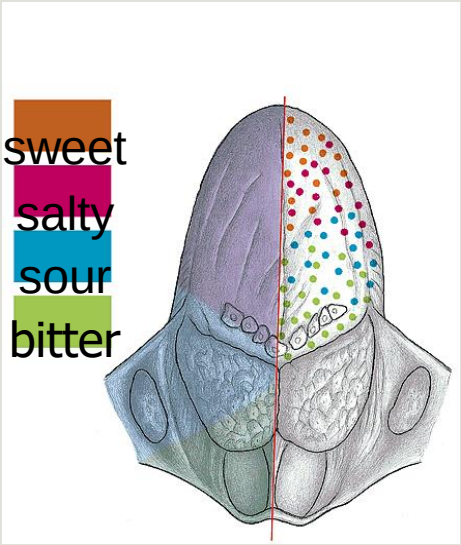
*„Zur Psychophysik des Geschmackssinnes". Philosophische Studien. **17**: 576–623*

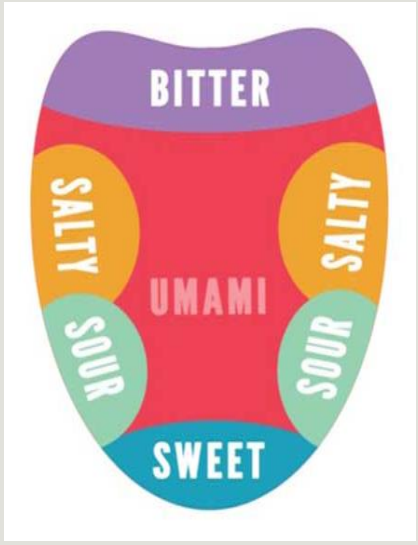
NEVER PROVED TO BE TRUE

„…all taste sensations come from all regions of the tongue, although different parts are more sensitive to certain tastes…"

Collings, V. B. (1974). "Human Taste Response as a Function of Locus of Stimulation on the Tongue and Soft Palate". Perception & Psychophysics. 16: 169–174

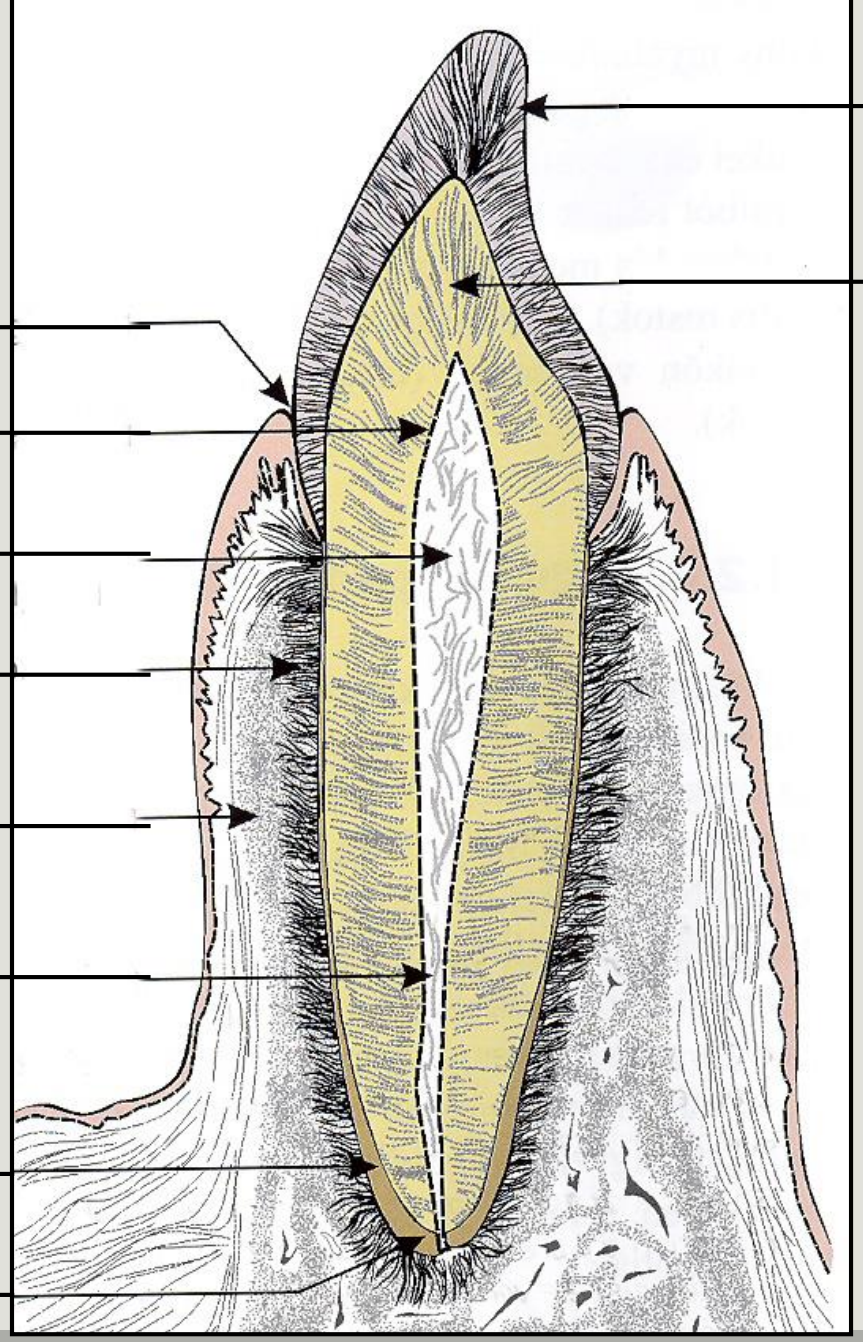
Sensation of basic tastes, arrangement of specific taste buds





TOOTH

Histology of the teeth

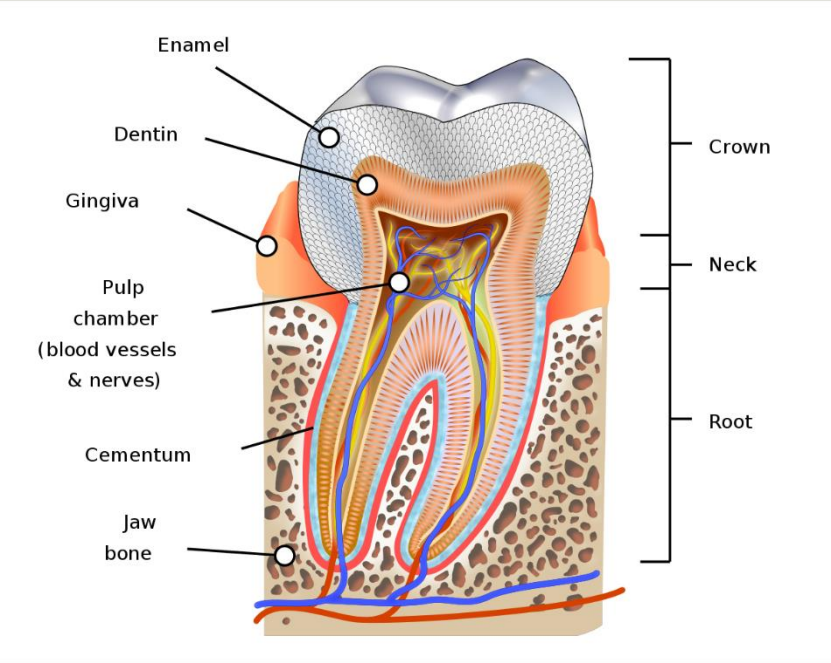


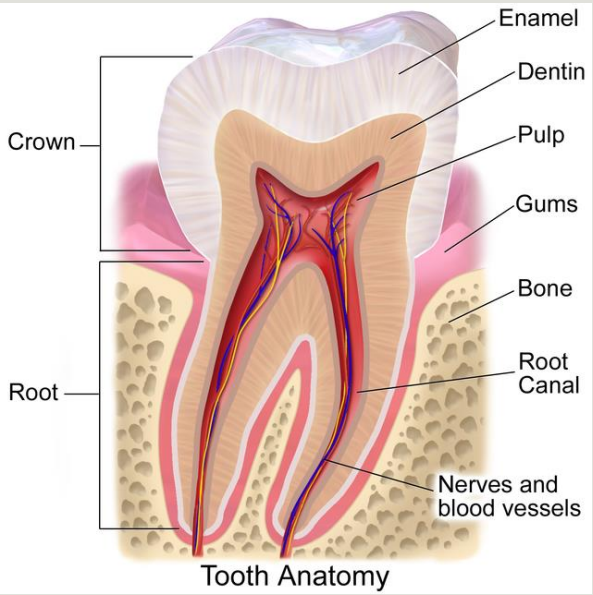
Tissues of the tooth

- enamel
- dentin
- pulp

Parodontium (Periodontium)

- cement
- gingiva
- periodontal ligaments
- alveolar bone





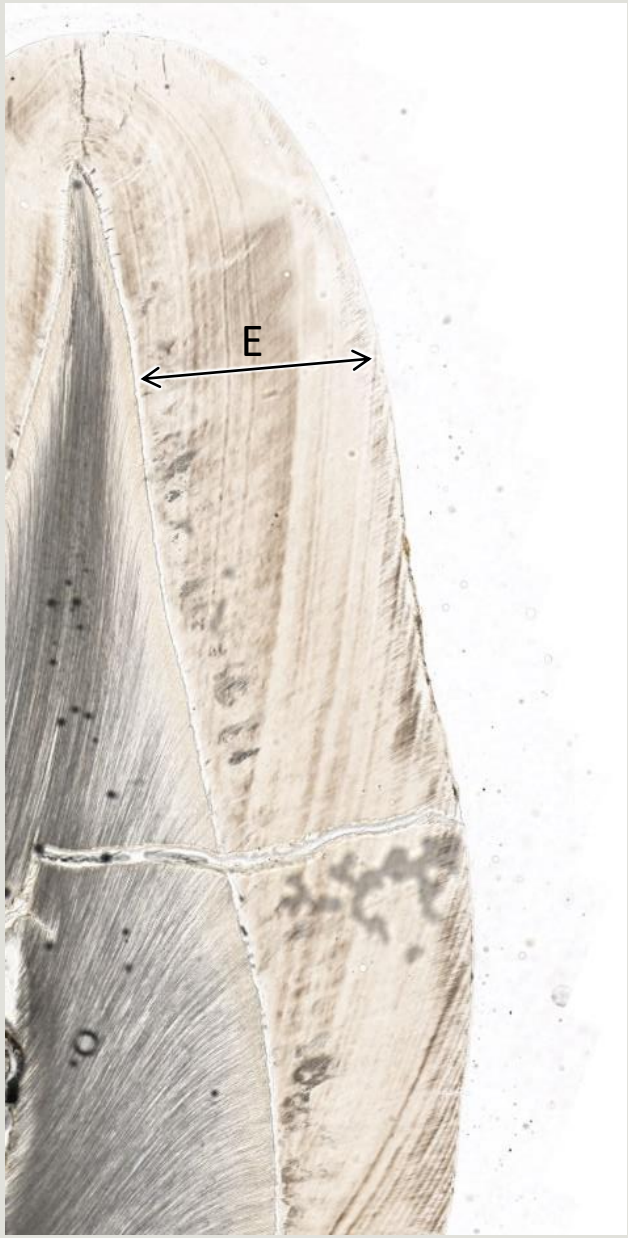
ENAMEL

Enamel is the most highly calcified and hardest tissue in the human body.

It covers the anatomical crown of the teeth.

It forms a protective covering of the teeth to resist the stress during mastication.

Enamel is produced by cells of ectodermal origin.



Thickness: the enamel thickness is variable over the entire surface of the crown.

Maximum thickness of about 2- 2.5 mm on the cusps.

Minimum thickness at the bottom of sulcus and at cervical margin of the root.

Color:

The color of enamel ranges from yellow to gray or gray- blue.

ENAMEL

Chemical components of the enamel

Inorganic components 98%

principal :

calcium and phosphate

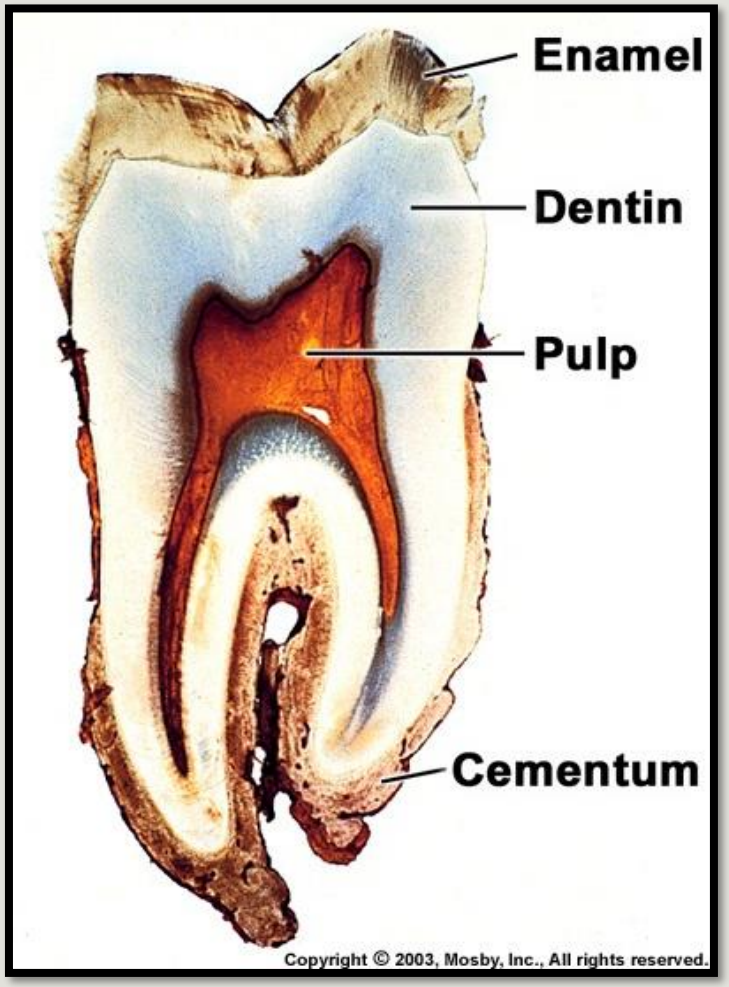
in the form of apatite crystals

$Ca_{10}(OH)_2(PO_4)_6$

minor components: F, Na, Mg, Va, Sr, Pb, Ni, Se, Al etc.

Organic components 2%

proteins, carbohydrates, lipids, citrates, water



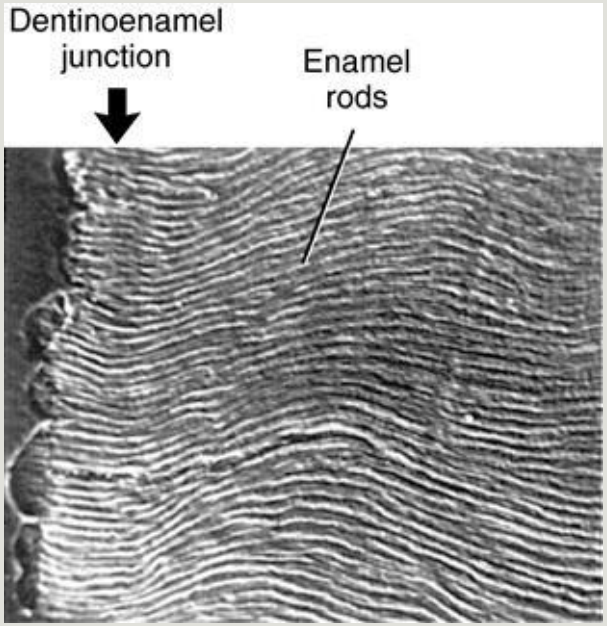
ENAMEL

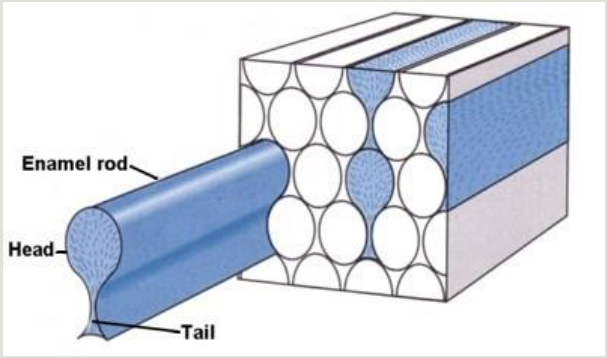
Structural components of the enamel

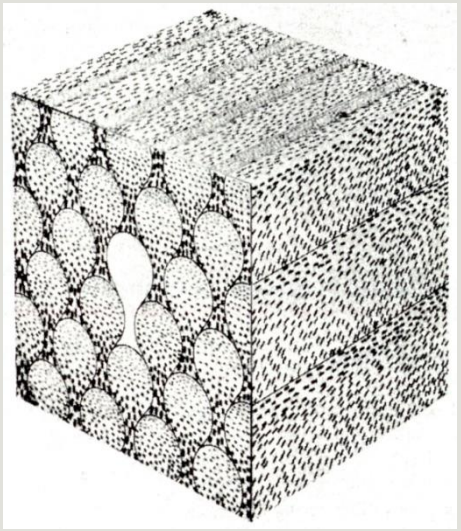
enamel prisms (4-6 µm thick)

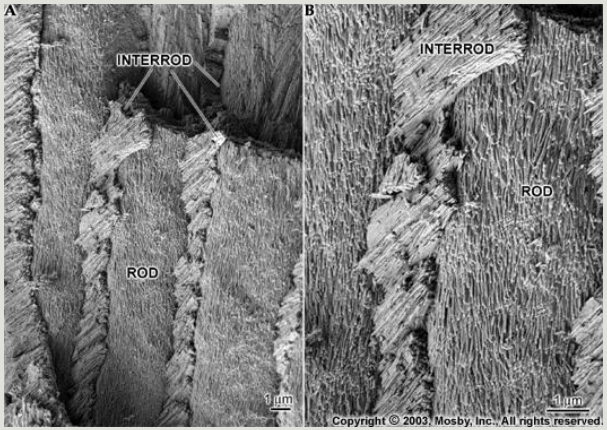
prism sheath

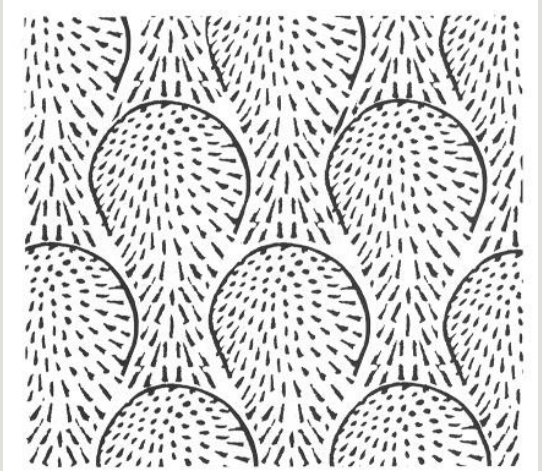
interprismatic substance







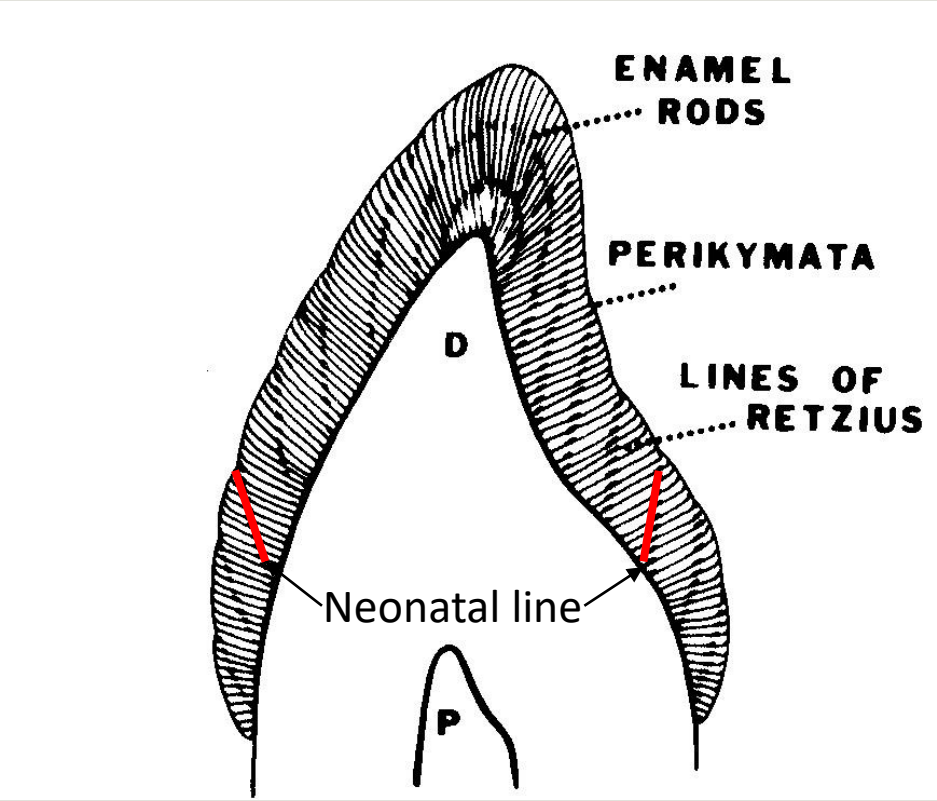




ENAMEL

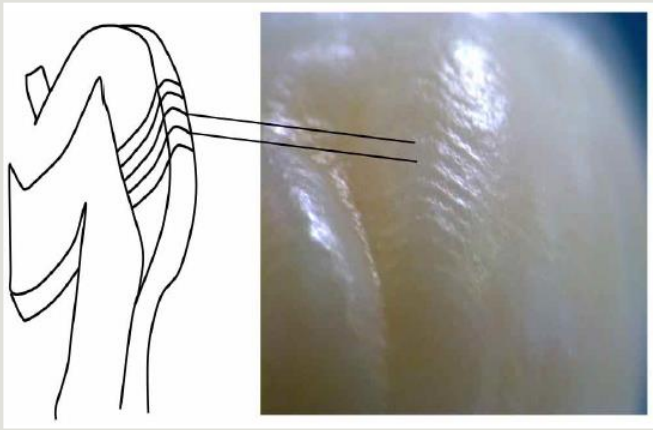
Retzius lines – growth lines

strongest Retzius line – neonatal line



neonatal line:

separates the enamel formed in the fetal life and after the birth



perikymatas

horizontal lines on the anterior surface of the teeth, surface manifestations of the Retzius lines

ENAMEL

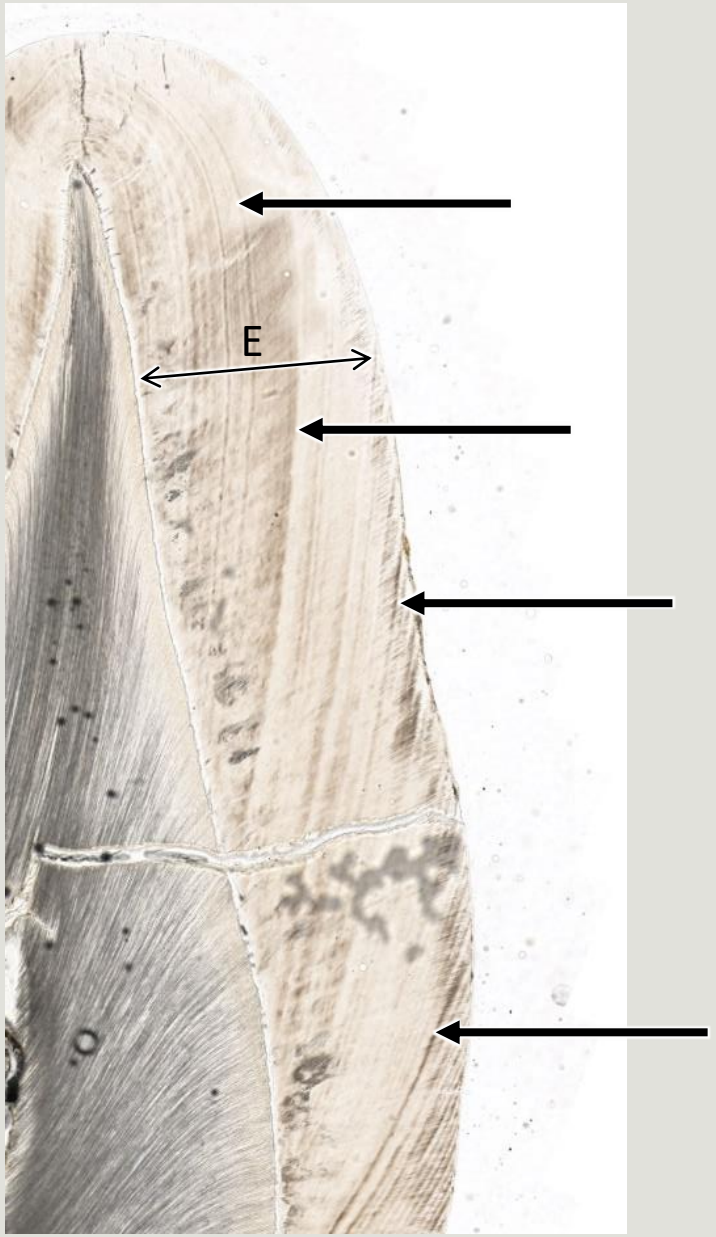
Lines of Retzius

Appear as **brownish bands** in ground sections of the enamel.

Illustrate the successive apposition of layers of enamel during the formation of crown.

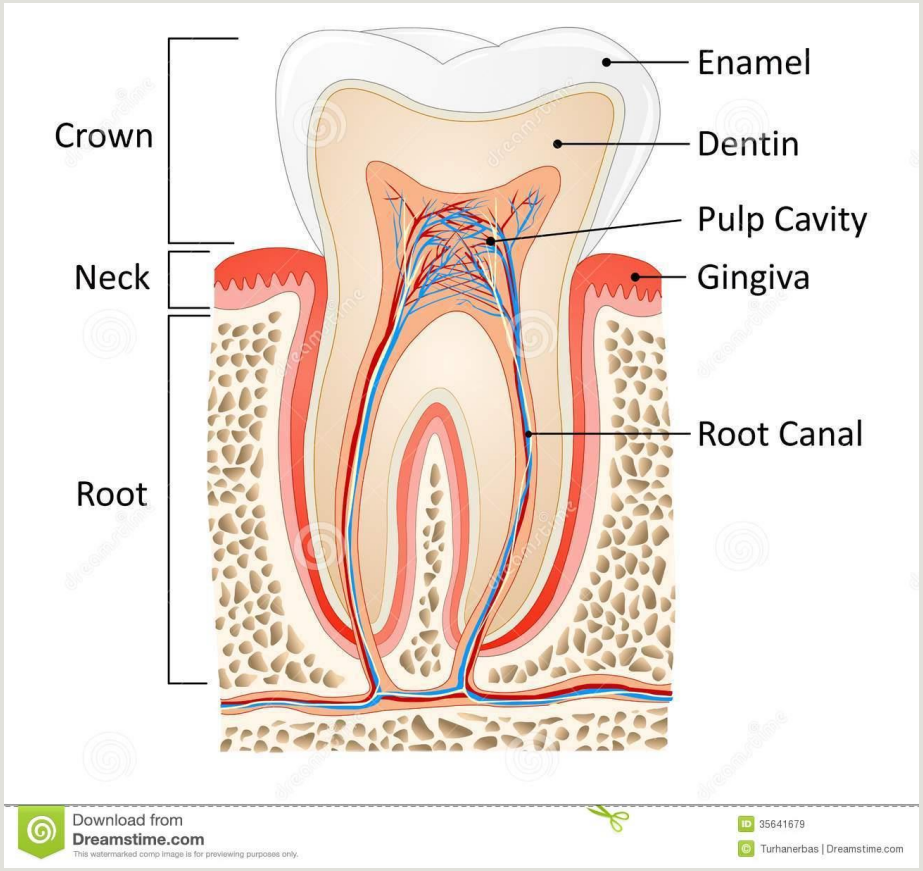
In **longitudinal sections** they surround the tip of the dentin.

In **transverse sections** of a tooth, they appear as concentric circles.



DENTIN


D


Crown
Neck
Root
Enamel
Dentin
Pulp Cavity
Gingiva
Root Canal
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DENTIN

CHEMICAL COMPONENTS OF DENTIN

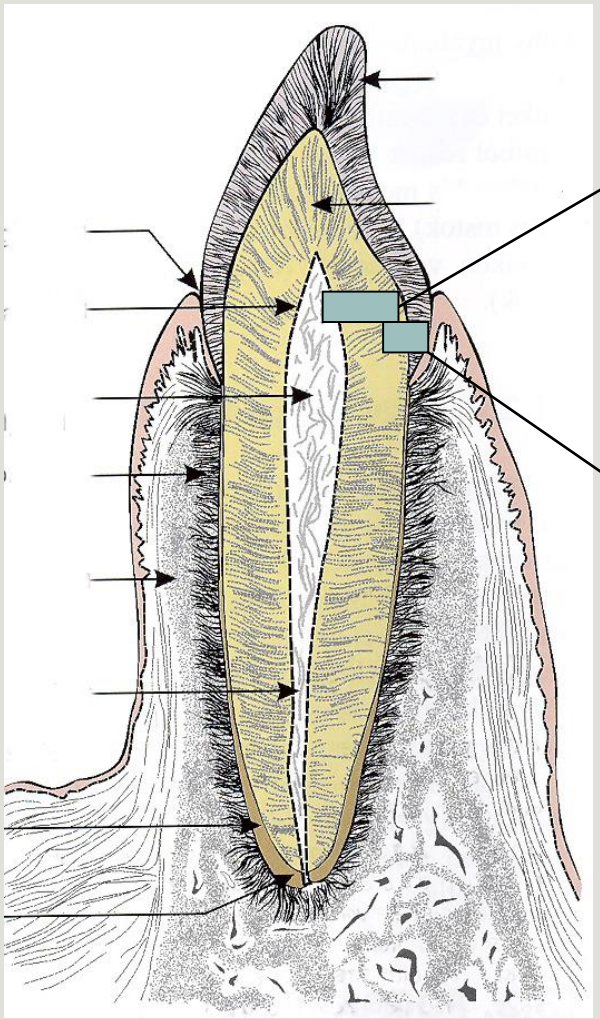
inorganic substances (70-80%):

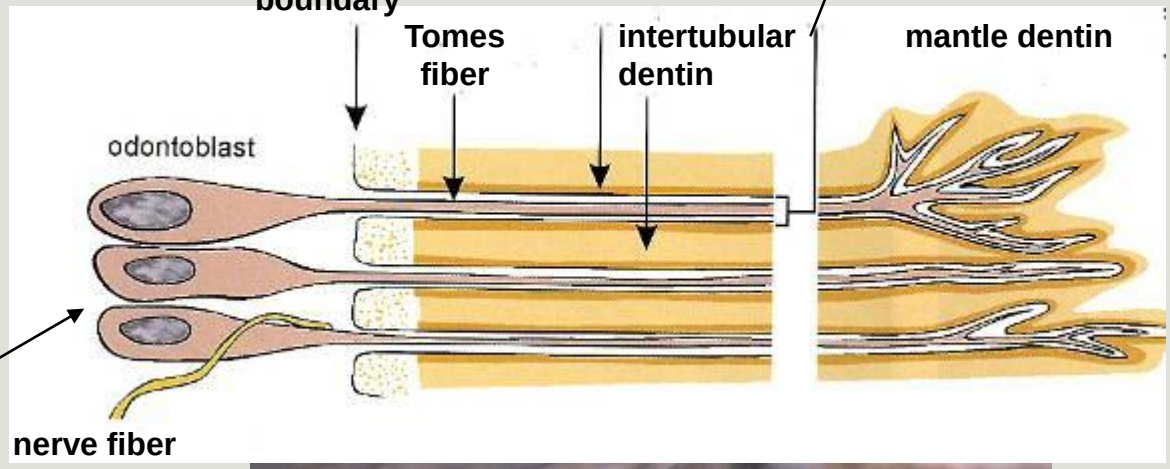
- calcium, phosphor,
- magnesium, carbonate
- sodium, chlorid, fluor

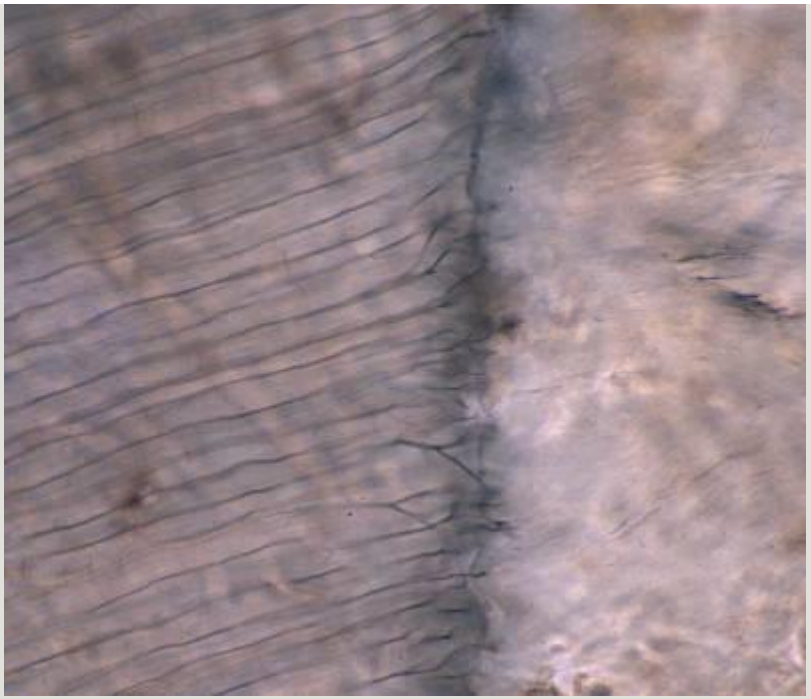
organic substances (20-30%):

- collagen I. (90%)
- proteoglycans (10%)
- phosphophorine
- phospholipides, cholesterin

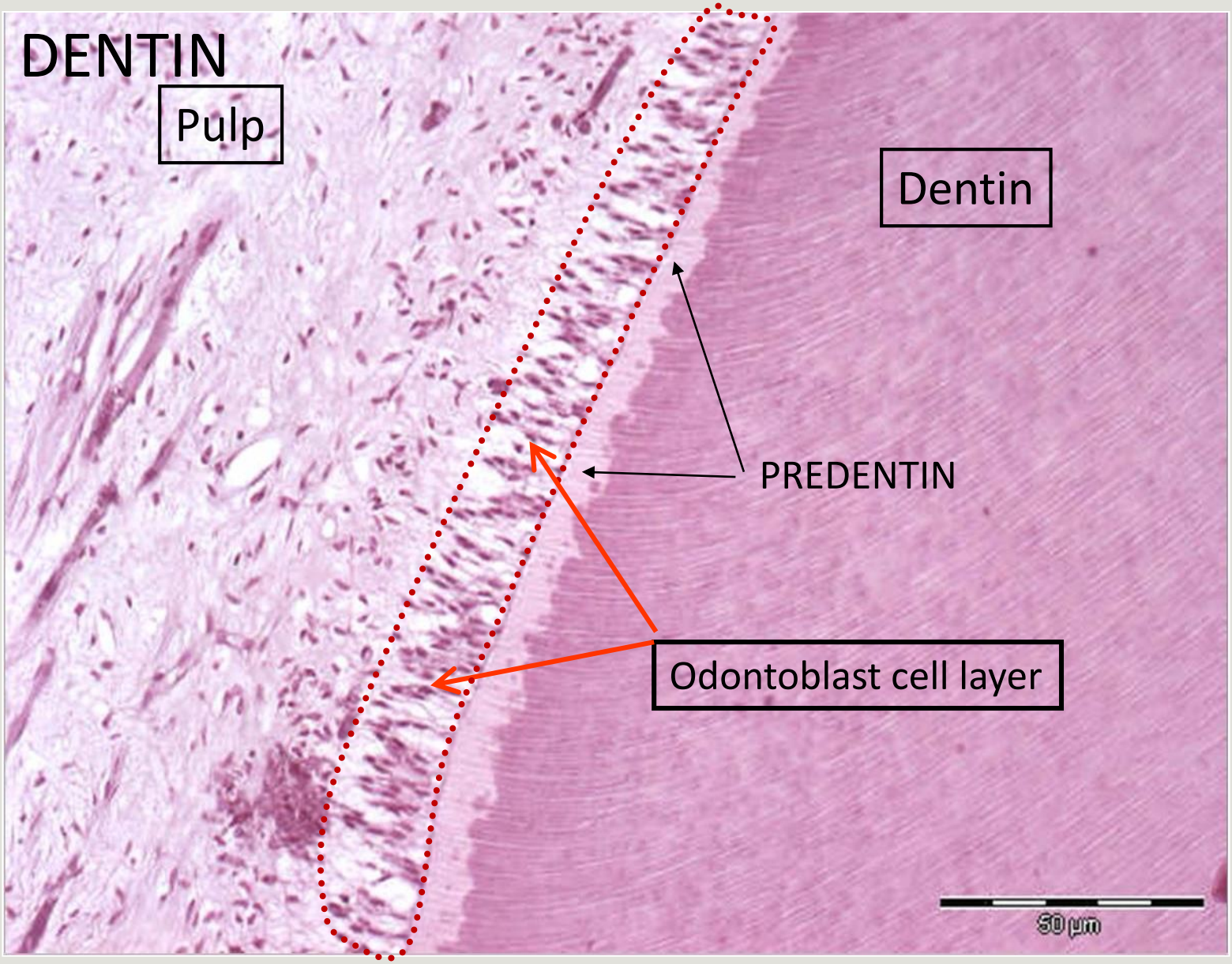
DENTIN







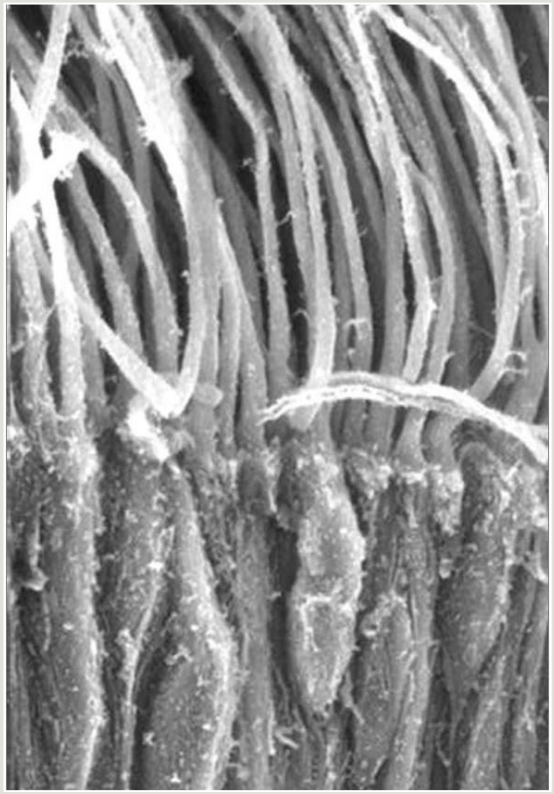
dentin enamel

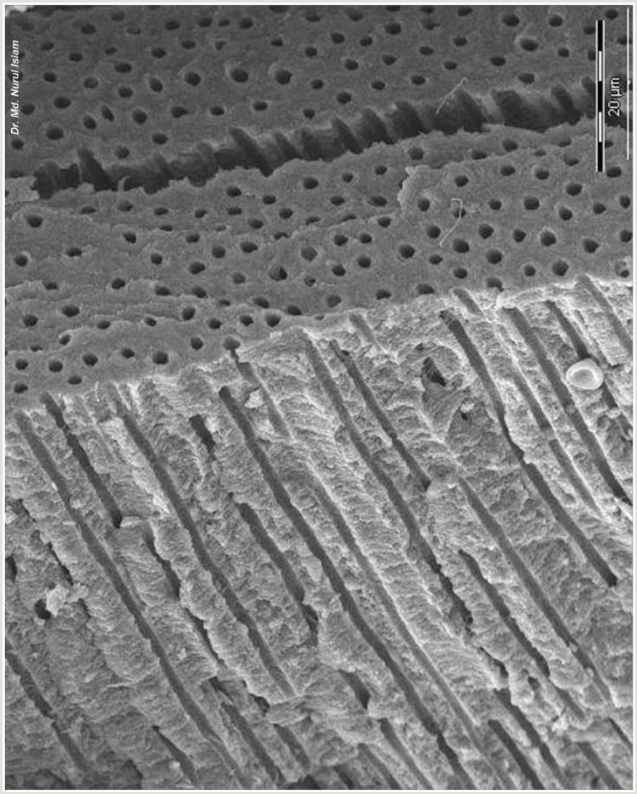

DENTIN
Pulp
Dentin
PREDENTIN
Odontoblast cell layer
50 µm

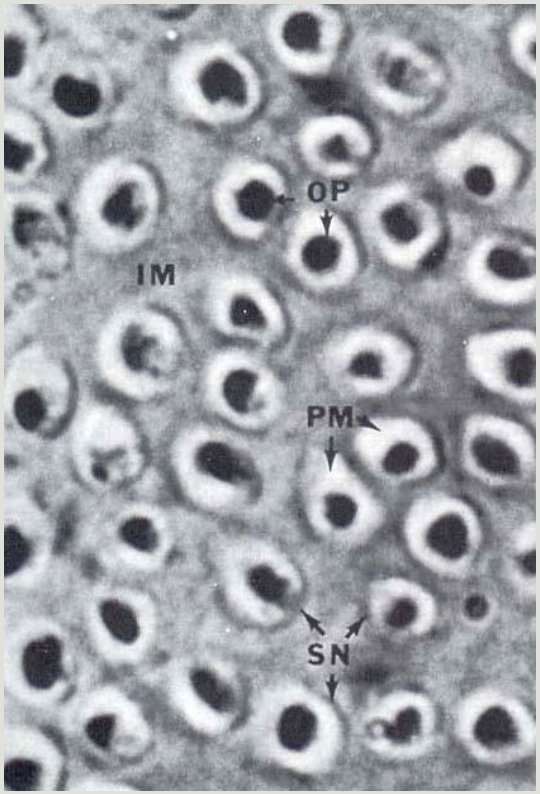
DENTIN

Fine structure of the dentin

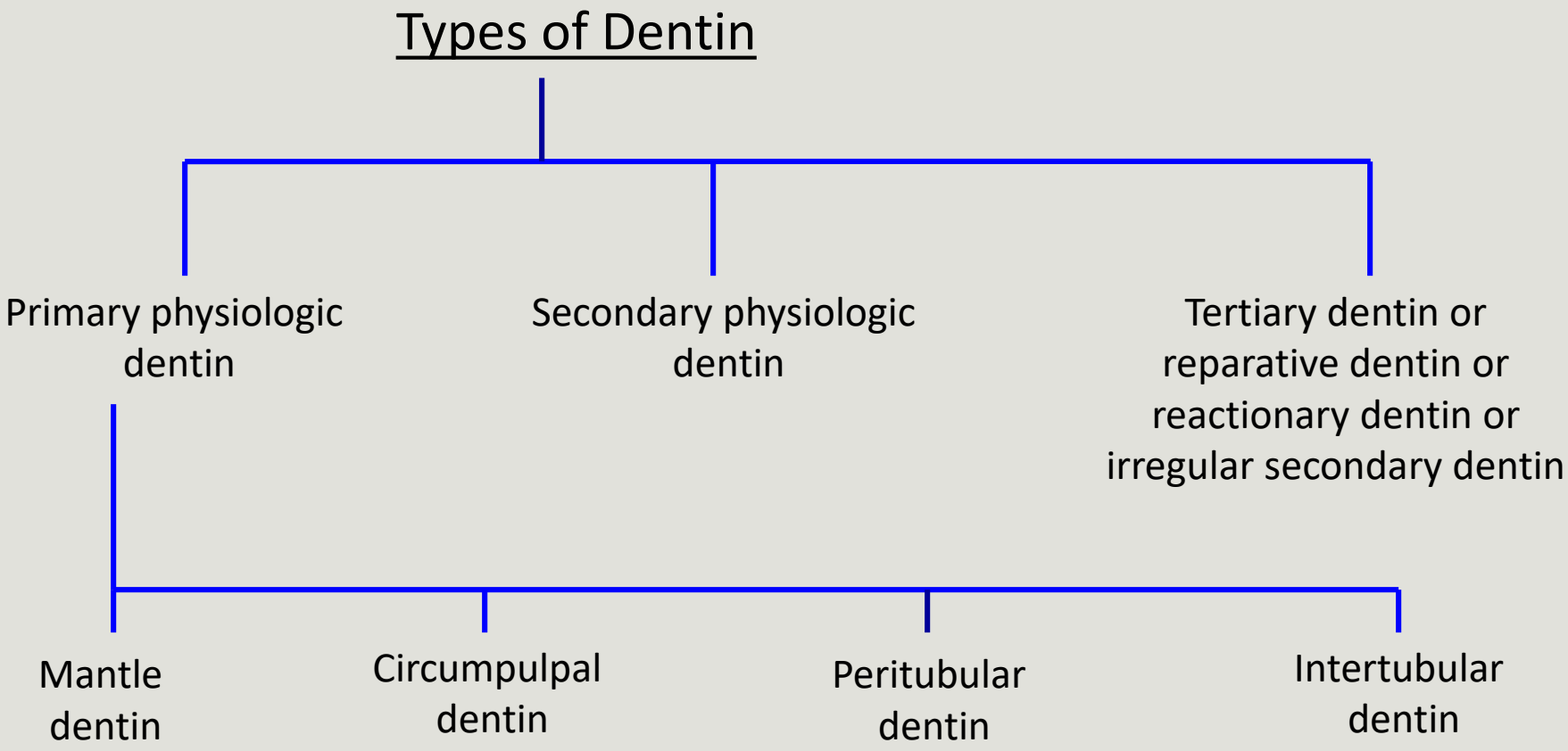
Processes of the odontoblast OP
Peritubular matrix PM
Intertubular matrix IM



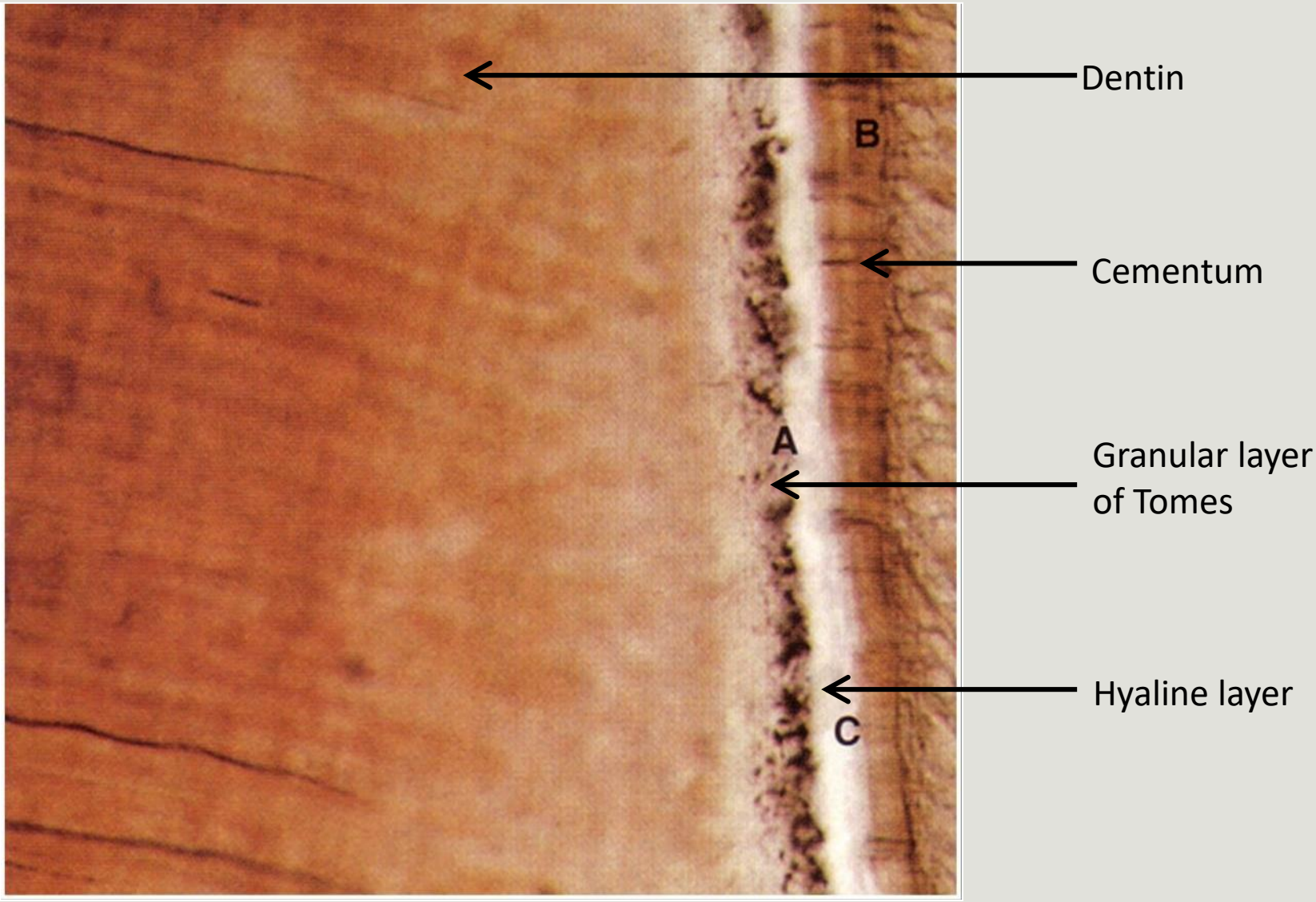




DENTIN


Types of Dentin
Primary physiologic dentin
Secondary physiologic dentin
Tertiary dentin or reparative dentin or reactionary dentin or irregular secondary dentin
Mantle dentin
Circumpulpal dentin
Peritubular dentin
Intertubular dentin

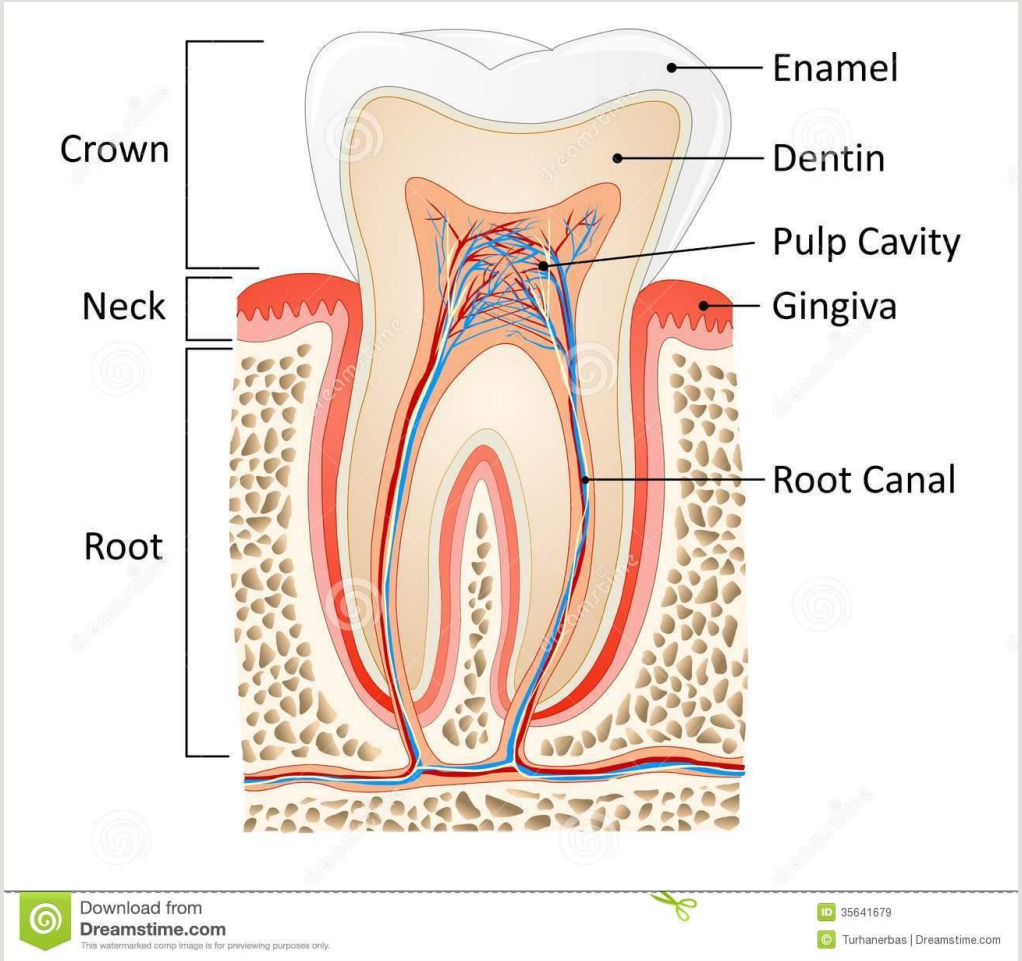
DENTIN



TOOTH PULP

Function of the pulp

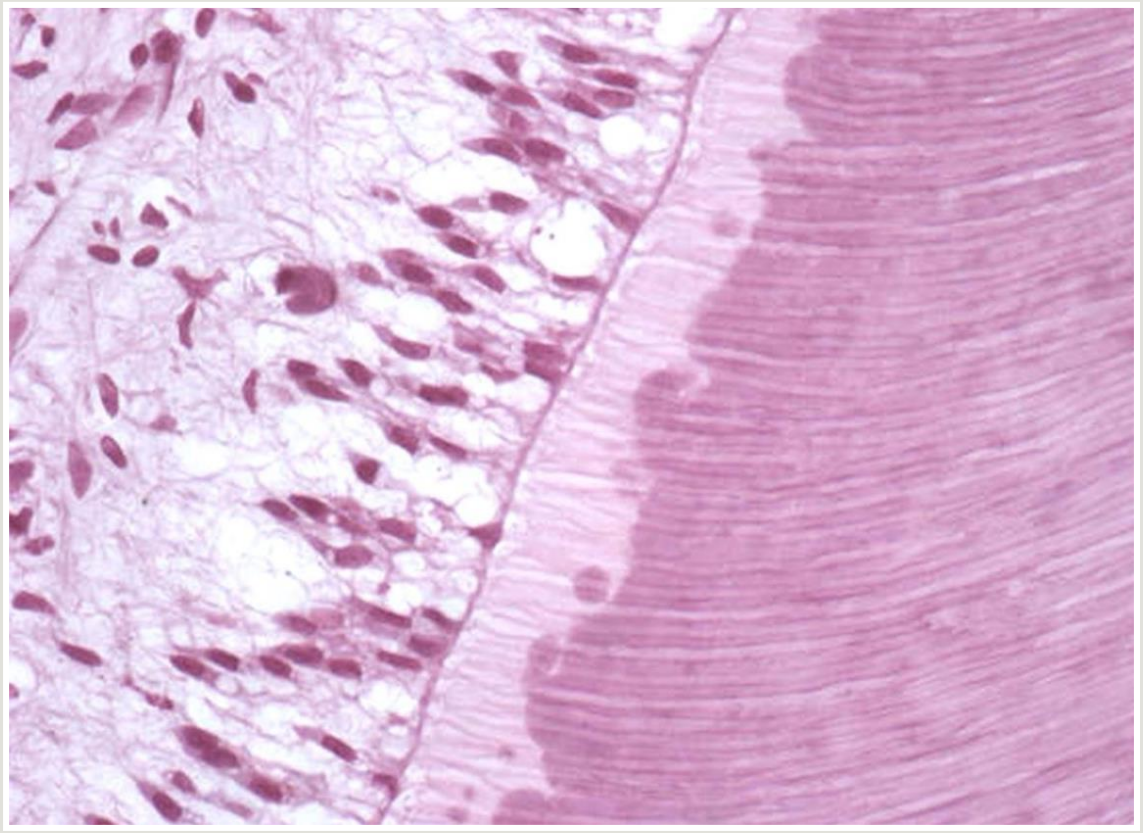
-Formative
-Nutritive
-Sensory
-Defensive
(response to injury)



TOOTH PULP

Layers of the pulp

1. odontoblastic layer
2. cell-free zone, (Weil zone) subodontoblastic plexus
3. cell-rich zone
4. central pulp



CELLS:

- stem cells
- fibroblasts,
- histiocytes,
- plasma cells,
- granulocytes

TOOTH PULP

Immuncompetent cells in the

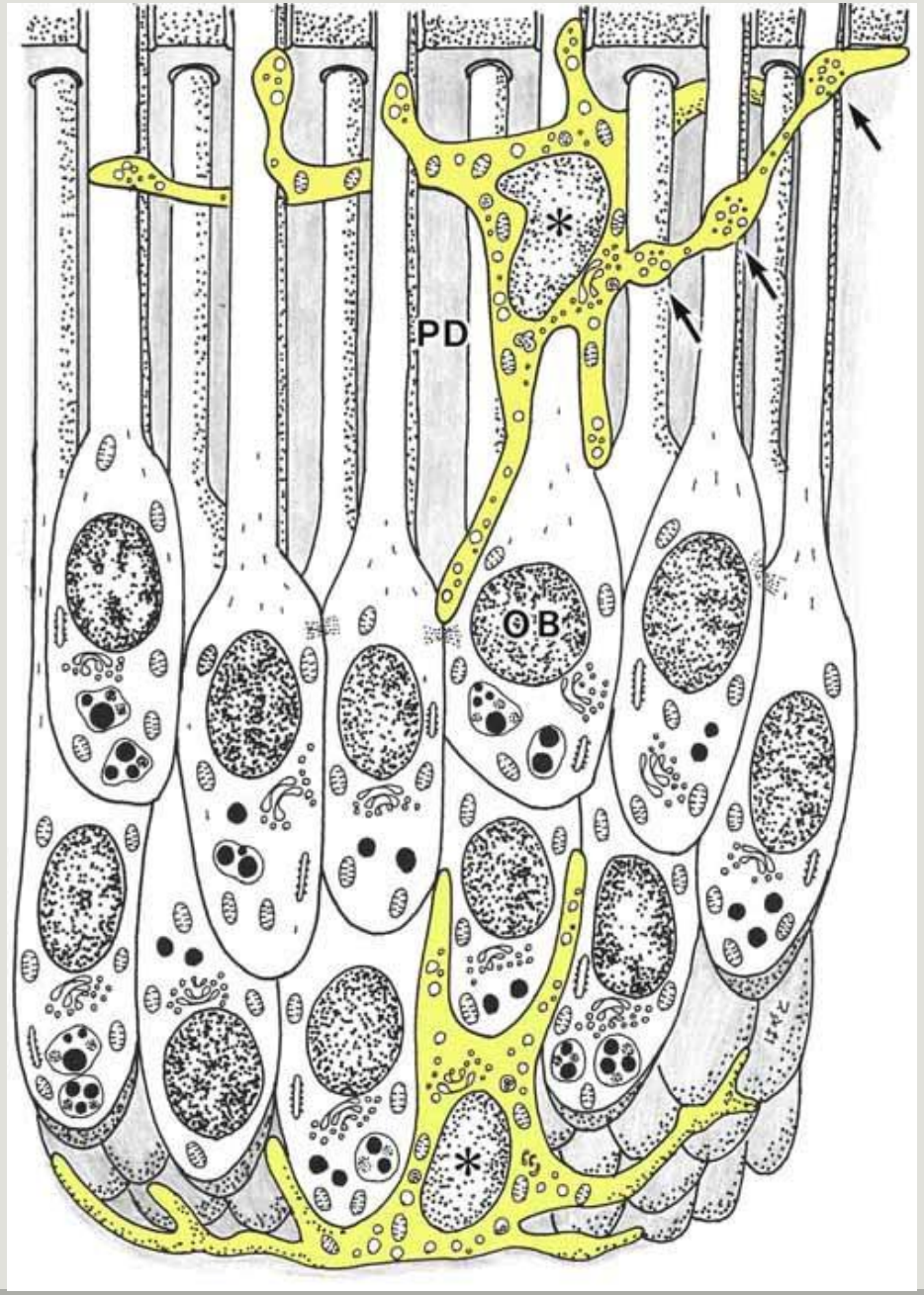
odontoblastic layer

- dendritic cells (antigen representing)

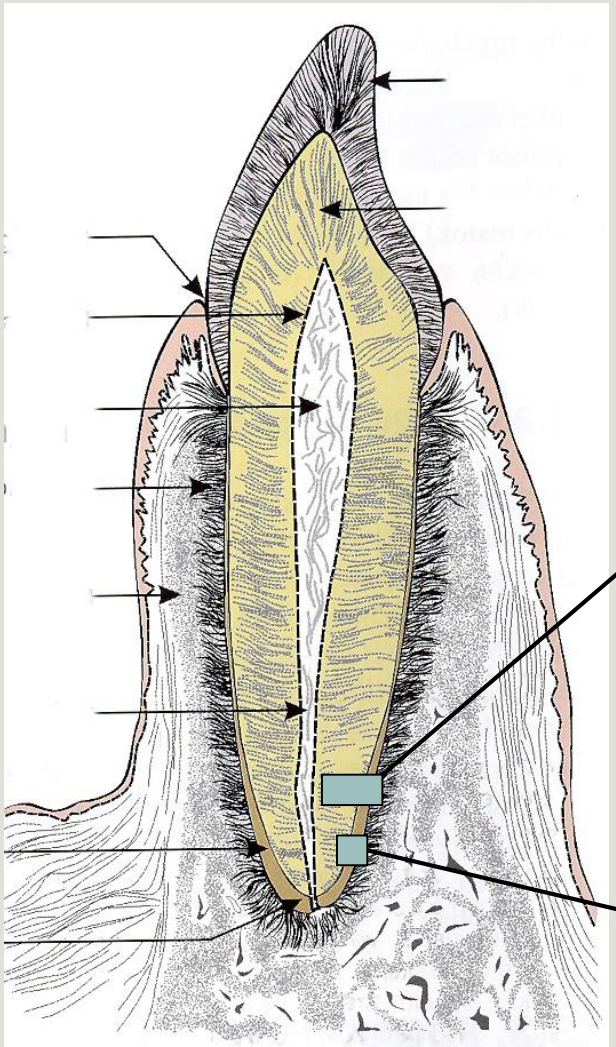
near to the fenestrated capillaries

the belong to the protective system

of the pulp

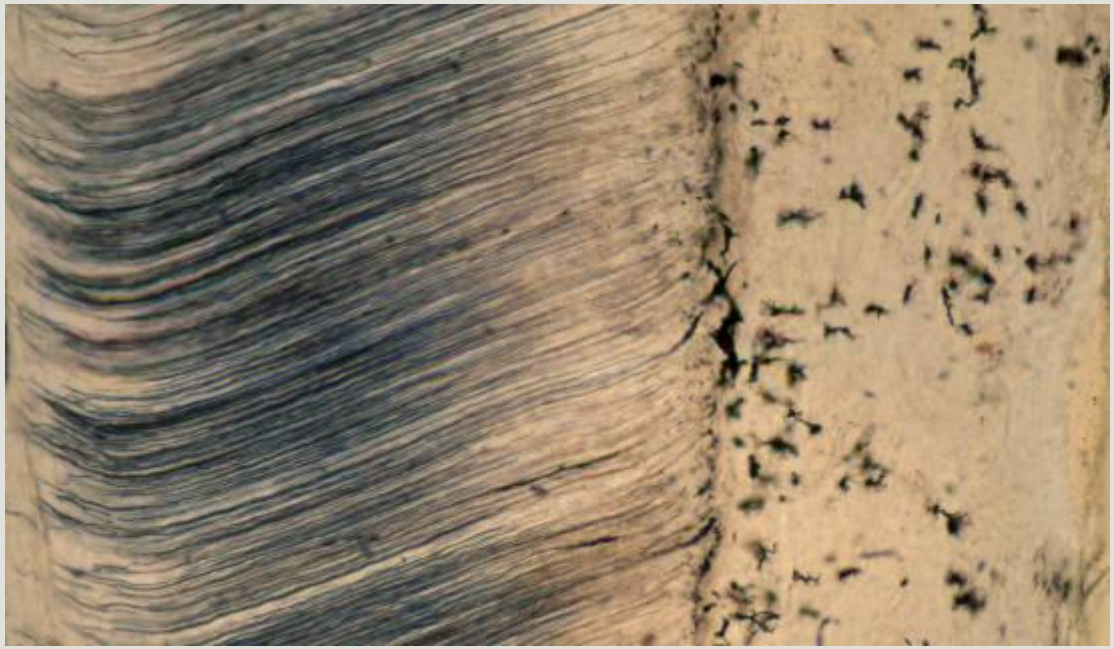


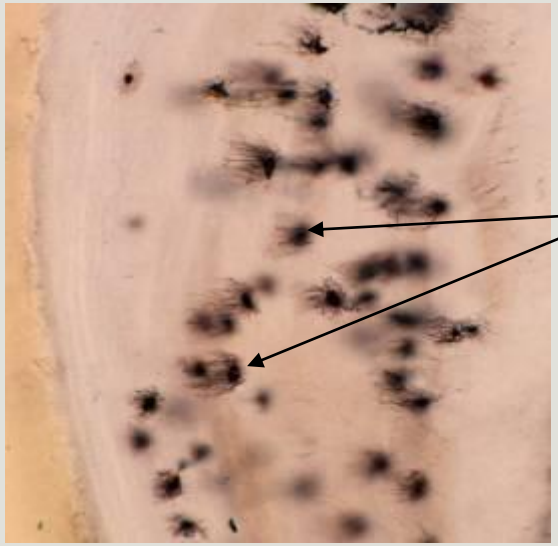
CEMENTUM



Root dentin

cementum





cementoblasts

CEMENTUM

COMPONENTS

45-50% anorganic
(mostly hydroxyapatite)

50-55% organic and water

Most similar to bone !!!

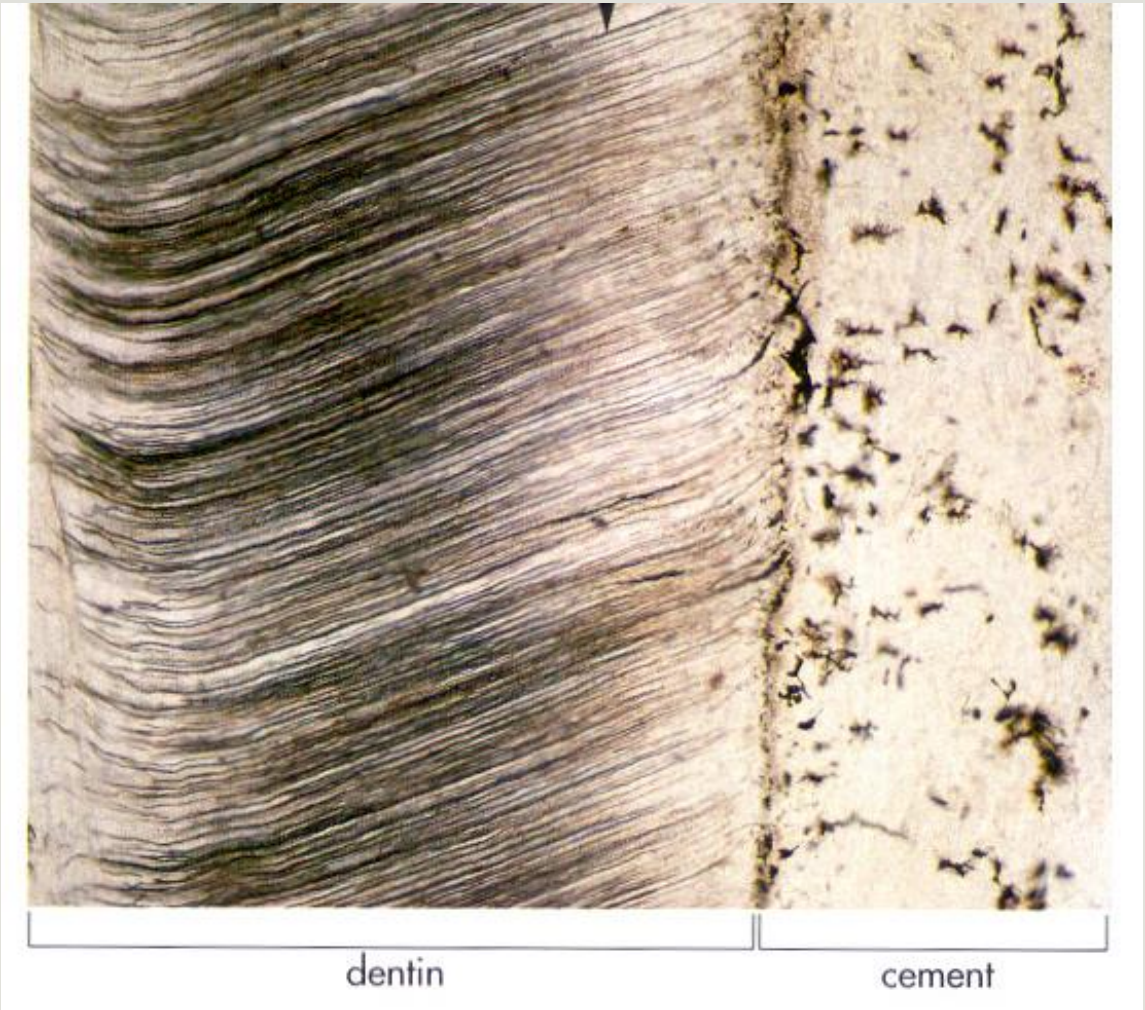
BUT: avascular tissue

Functions

Holding the teeth

Protection

Occlusal plane



CEMENTUM

Composition of cementum

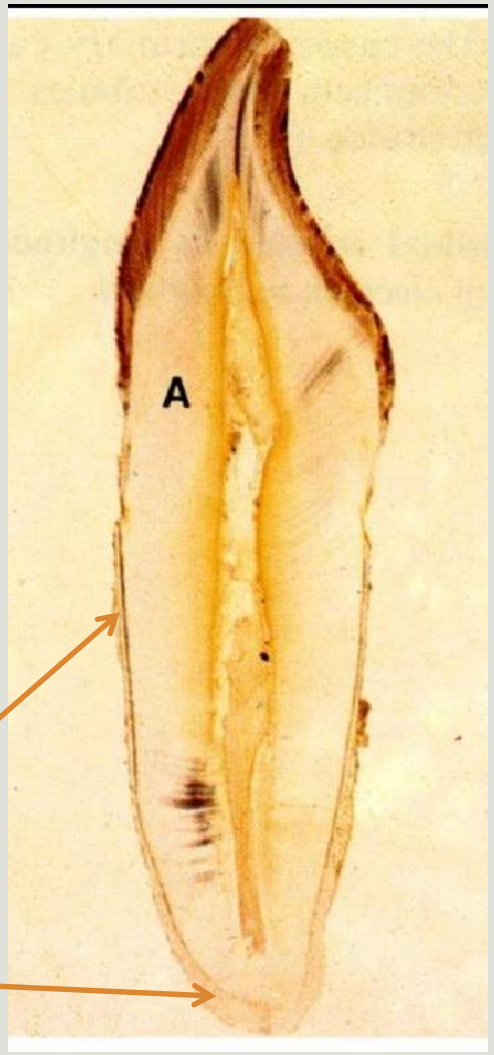
Cementum is composed of 50-55% organic:

- type I and III collagen fibers and mucopolysaccharides

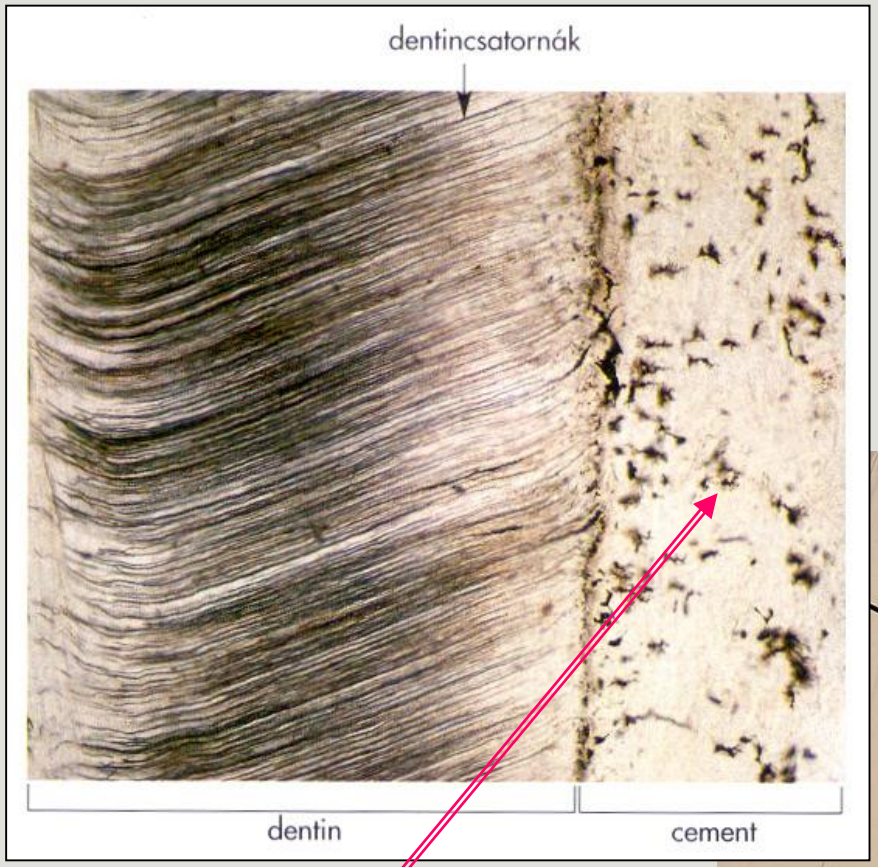
45-50% of cementum is inorganic:

- hydroxyapatite
- calcium
- phosphate

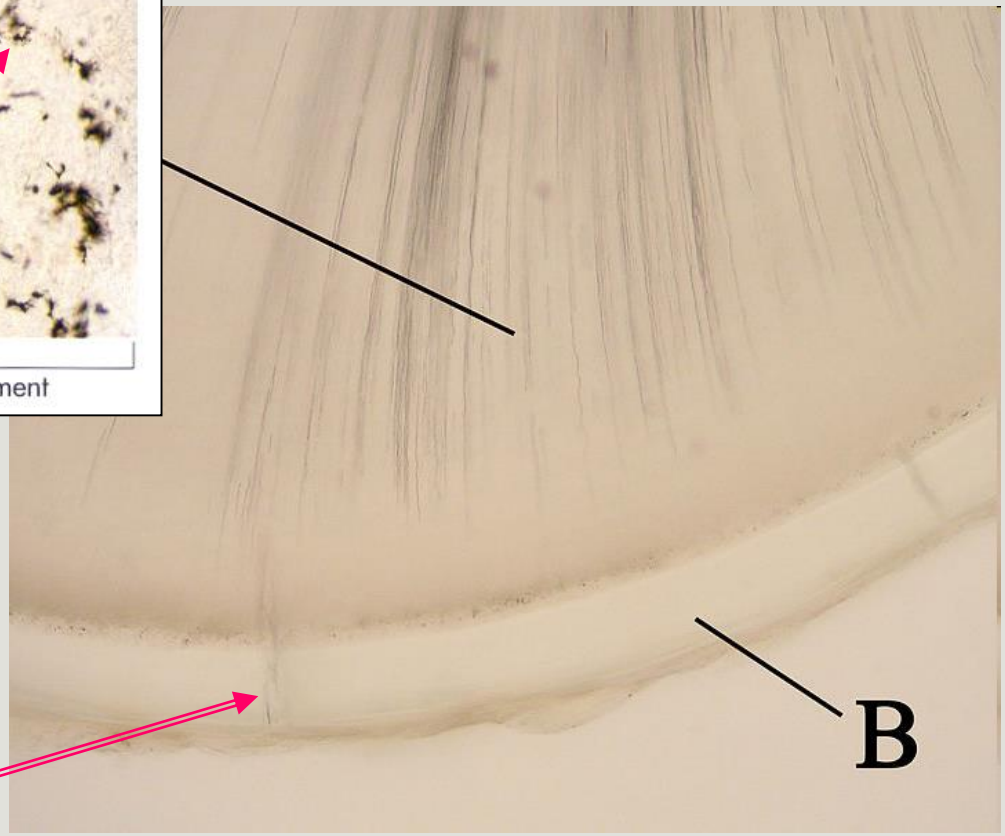
Thin at the CE junction (15-60μm), thicker apically (150-200μm).



CEMENTUM

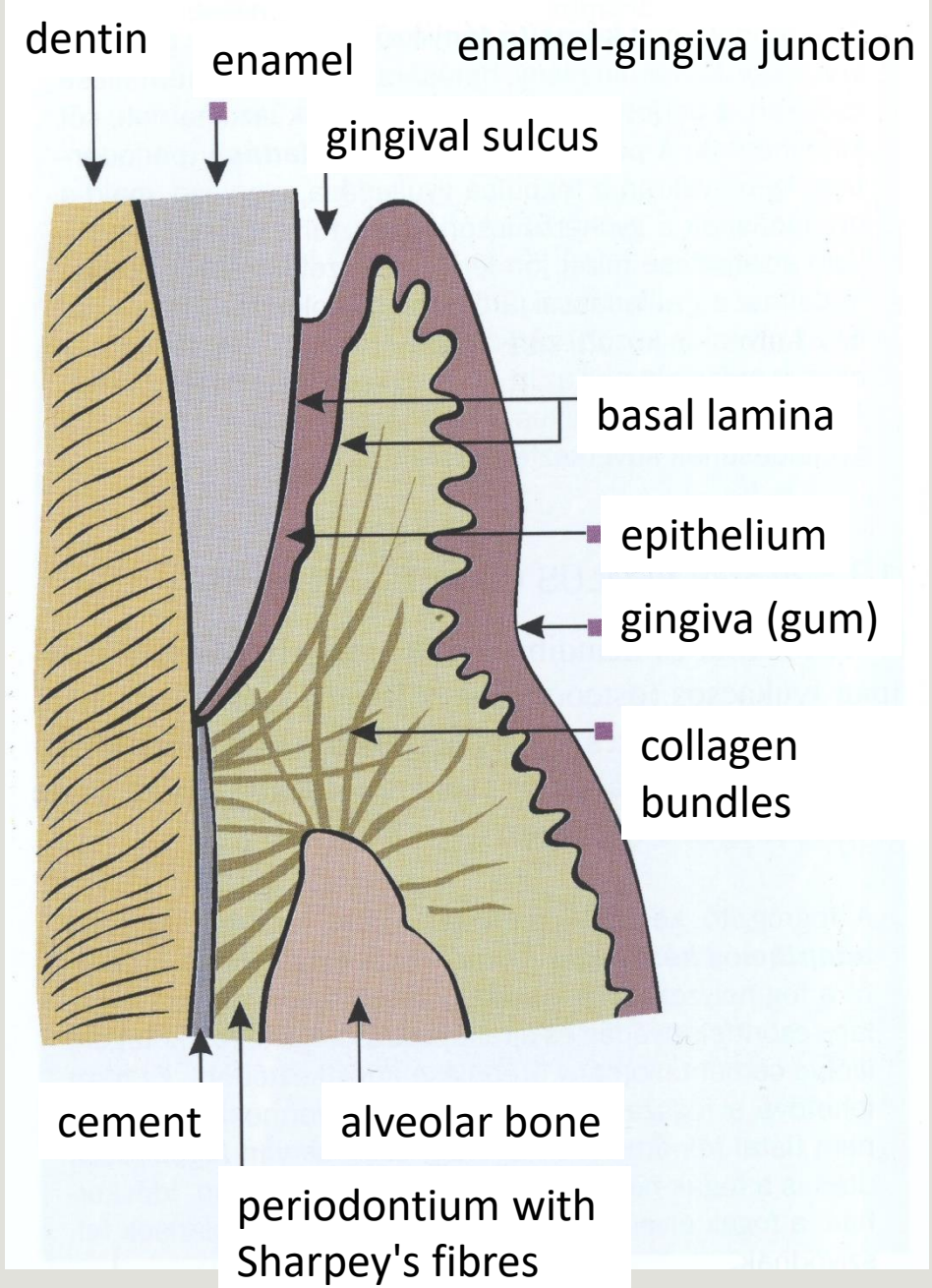


cellular cementum

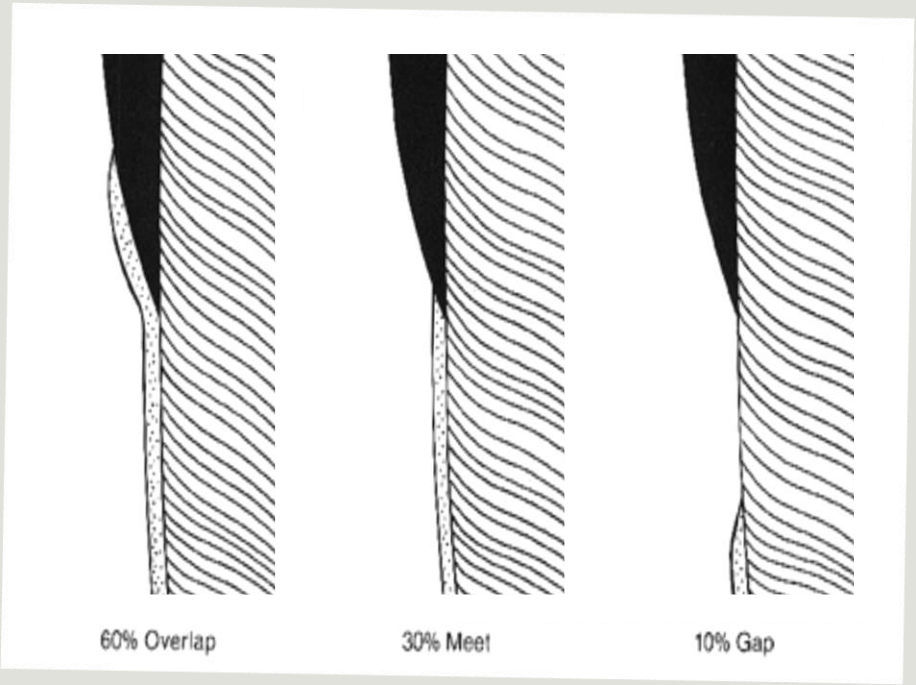


acellular cementum

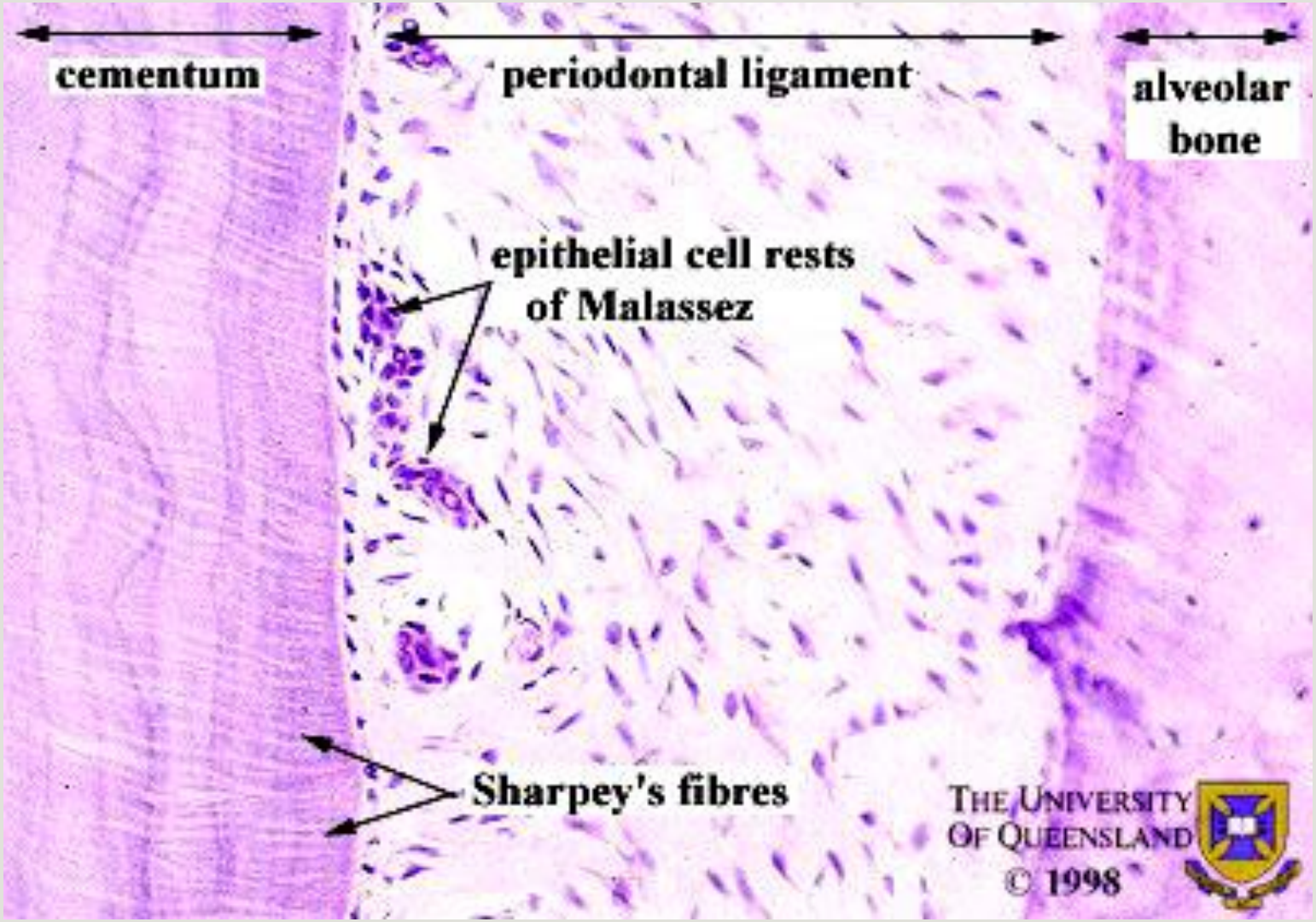
CEMENTUM



Cement-enamel junction

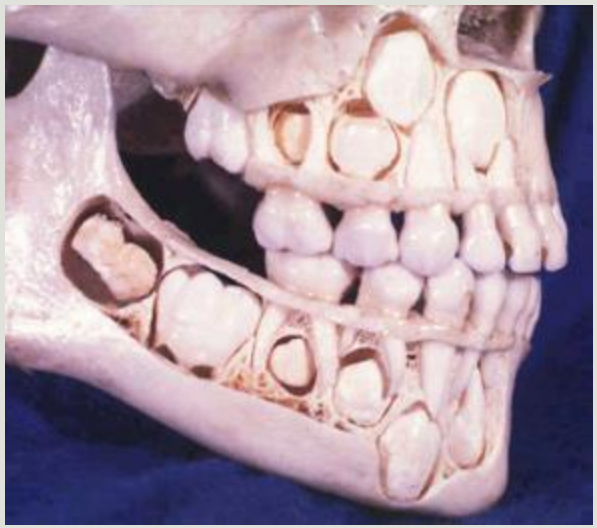


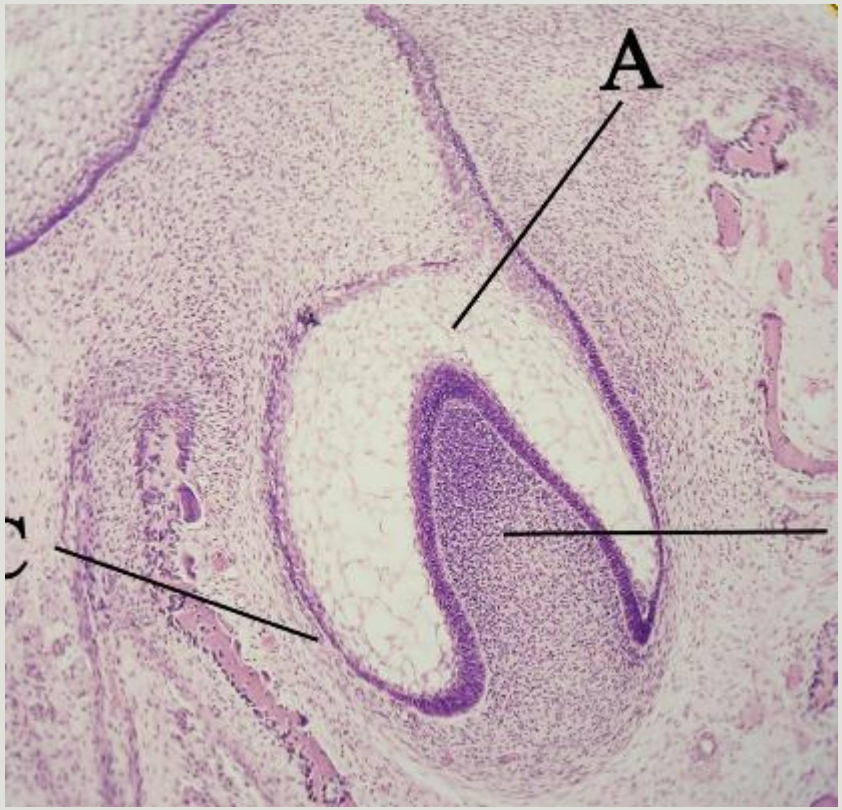
CEMENTUM


cementum
periodontal ligament
alveolar bone
epithelial cell rests of Malassez
Sharpey's fibres
THE UNIVERSITY OF QUEENSLAND
© 1998

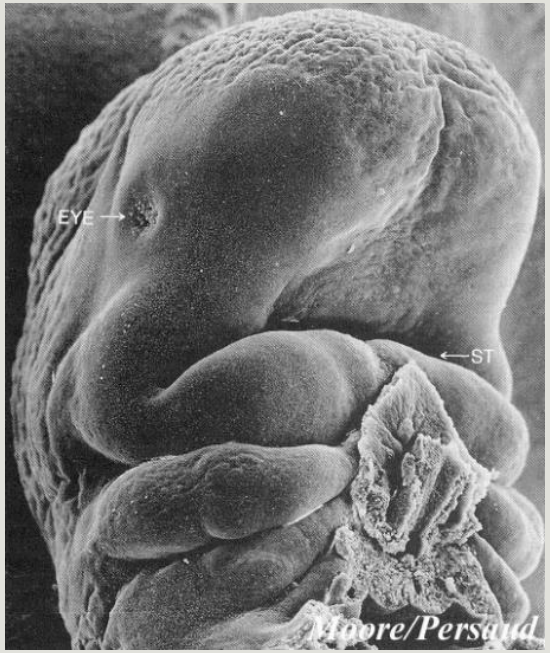
DEVELOPING TOOTH
TOOTH GERM / TOOTH BUD

Histology of tooth germ, development of teeth

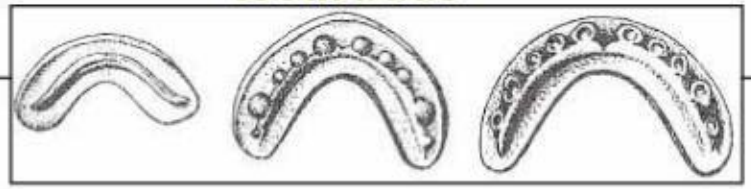




The development of the teeth starts at **6th** week with the proliferation of the ectoderm of the stomodeum (primitive oral cavity)



proliferation of ectodermal cells toward the mesenchyme

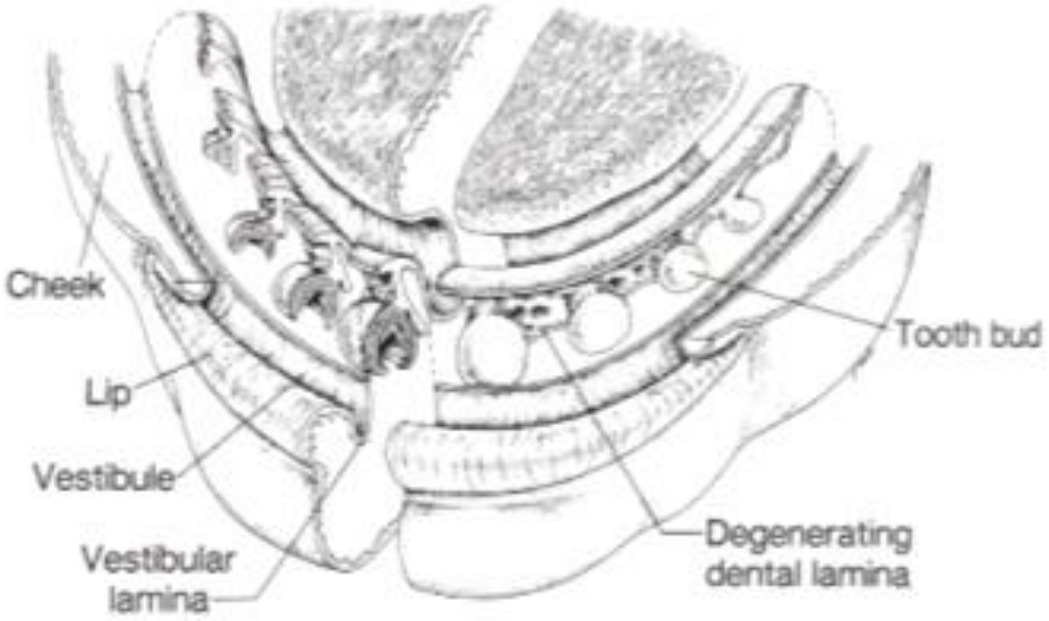


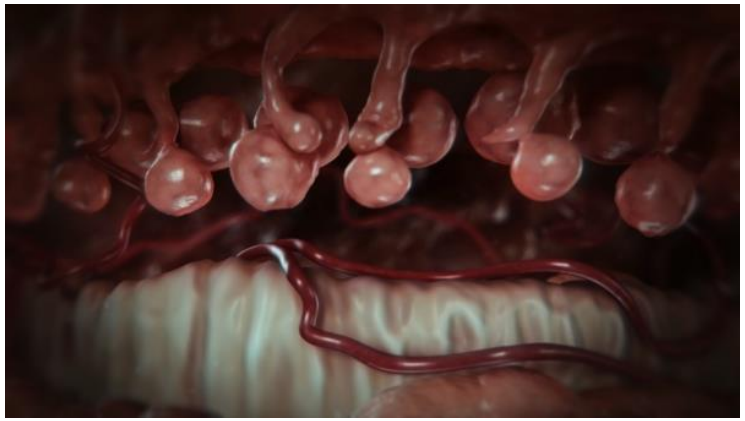
DENTAL LAMINA

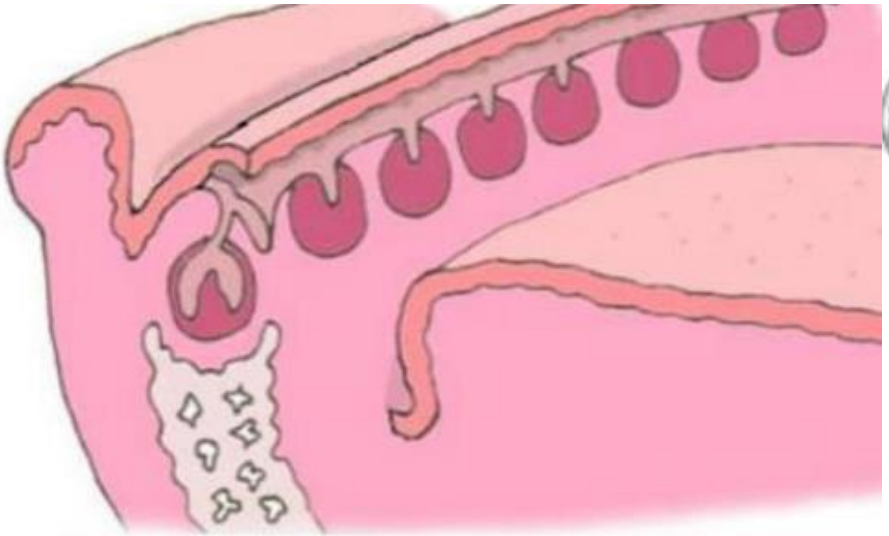
„U"- shaped band

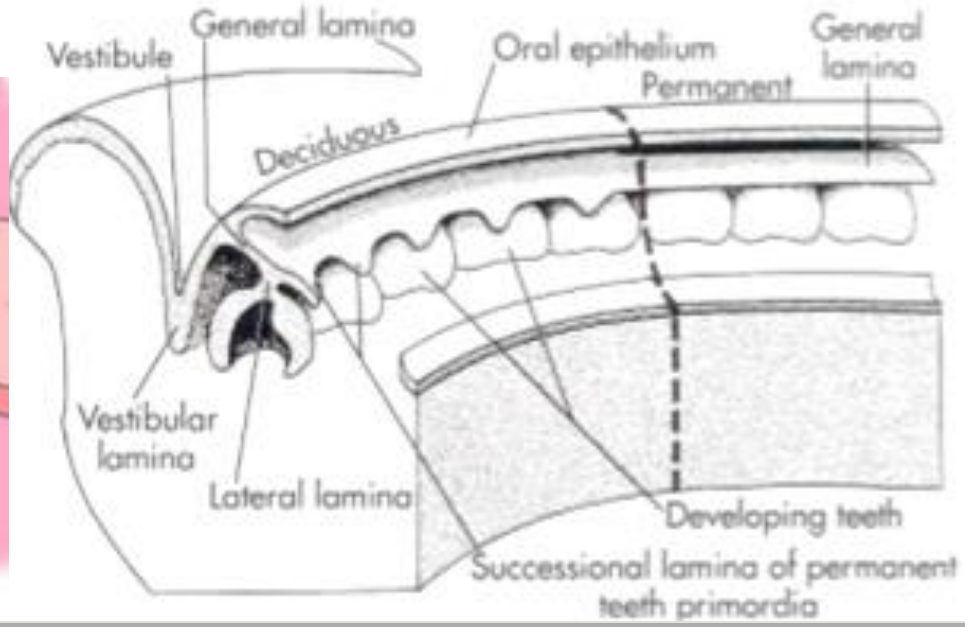
Upper and lower jaw with 10 centers of ectodermal proliferation:

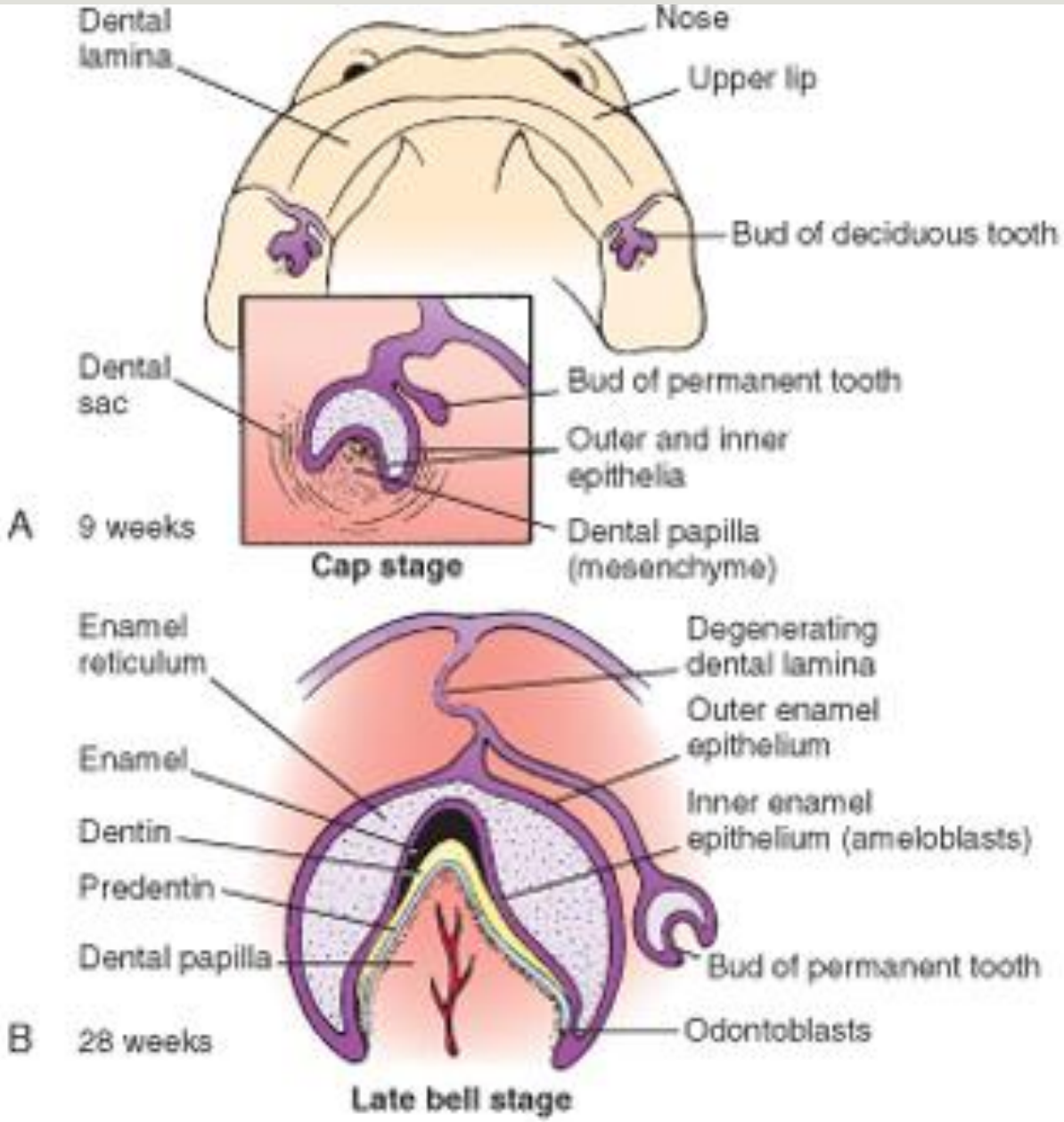
- tooth buds of deciduous teeth develope at 6th w.
- tooth buds for permanent teeth develope at 10th w.

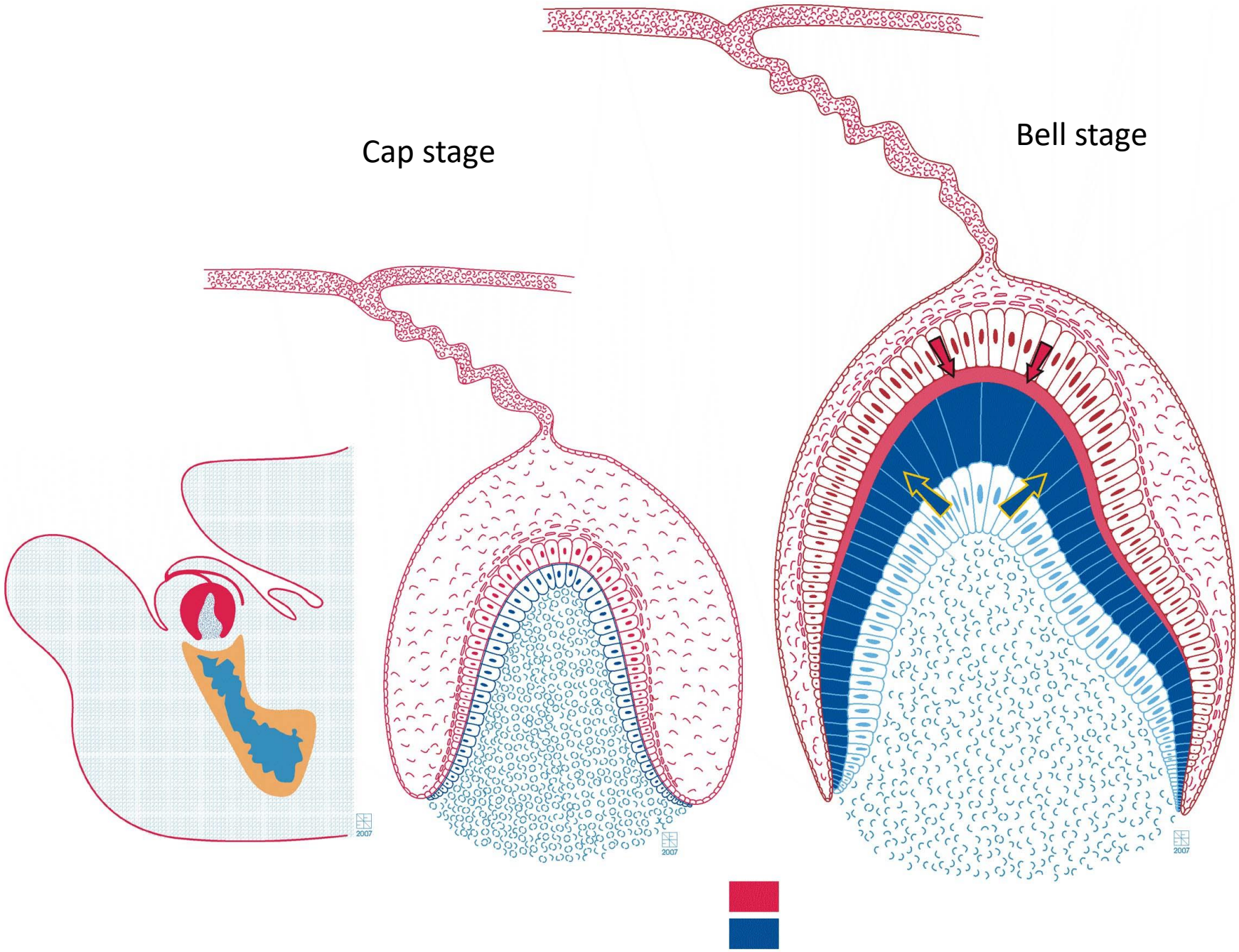

Cheek
Lip
Vestibule
Vestibular lamina
Tooth bud
Degenerating dental lamina



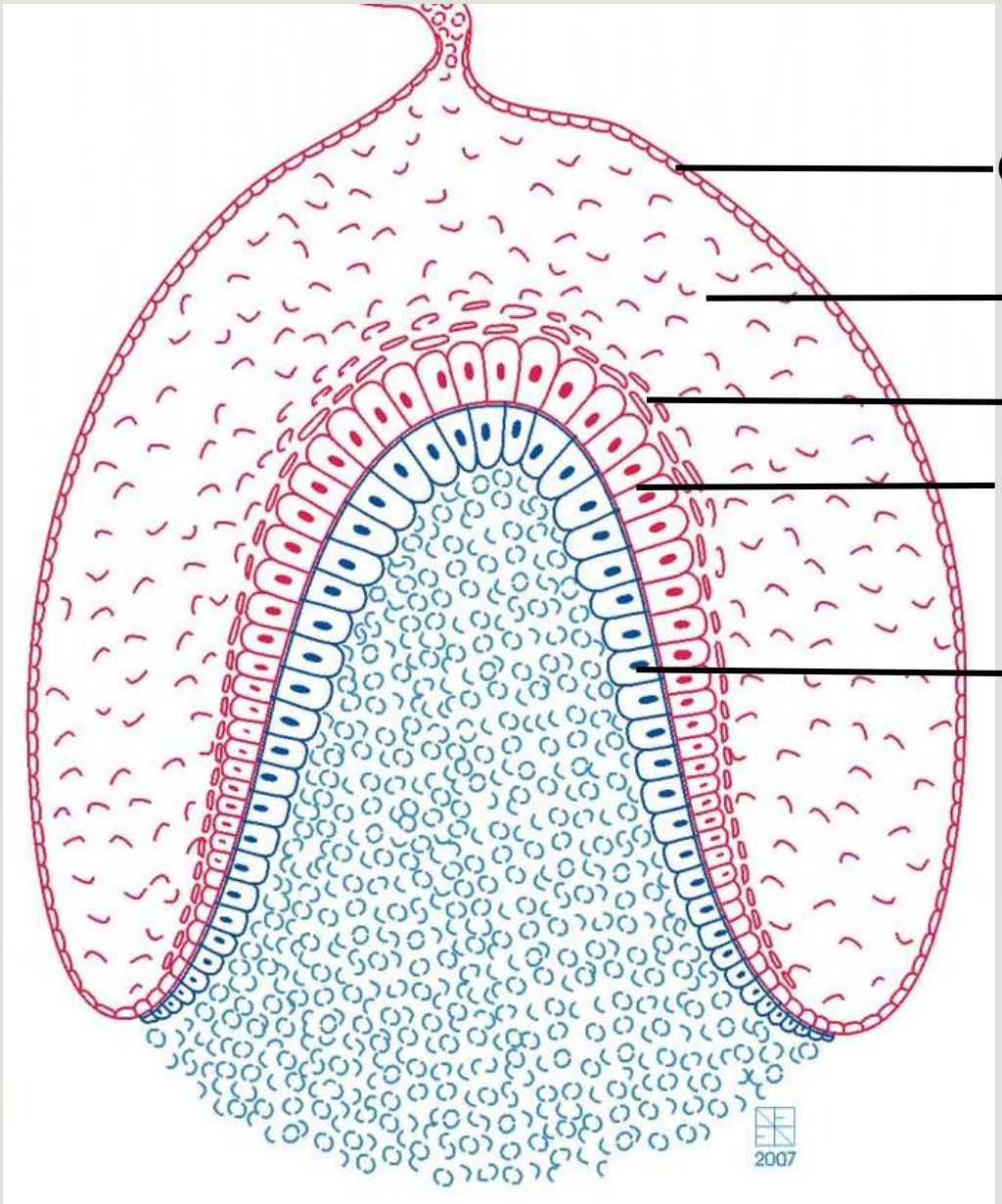



Vestibule
General lamina
Oral epithelium
Permanent
General lamina
Deciduous
Vestibular lamina
Lateral lamina
Developing teeth
Successional lamina of permanent teeth primordia


Dental lamina
Nose
Upper lip
Bud of deciduous tooth
Dental sac
Bud of permanent tooth
Outer and inner epithelia
Dental papilla (mesenchyme)
A
9 weeks
Cap stage
Enamel reticulum
Degenerating dental lamina
Outer enamel epithelium
Enamel
Dentin
Predentin
Inner enamel epithelium (ameloblasts)
Dental papilla
Bud of permanent tooth
Odontoblasts
B
28 weeks
Late bell stage


Cap stage
Bell stage

Cap stage

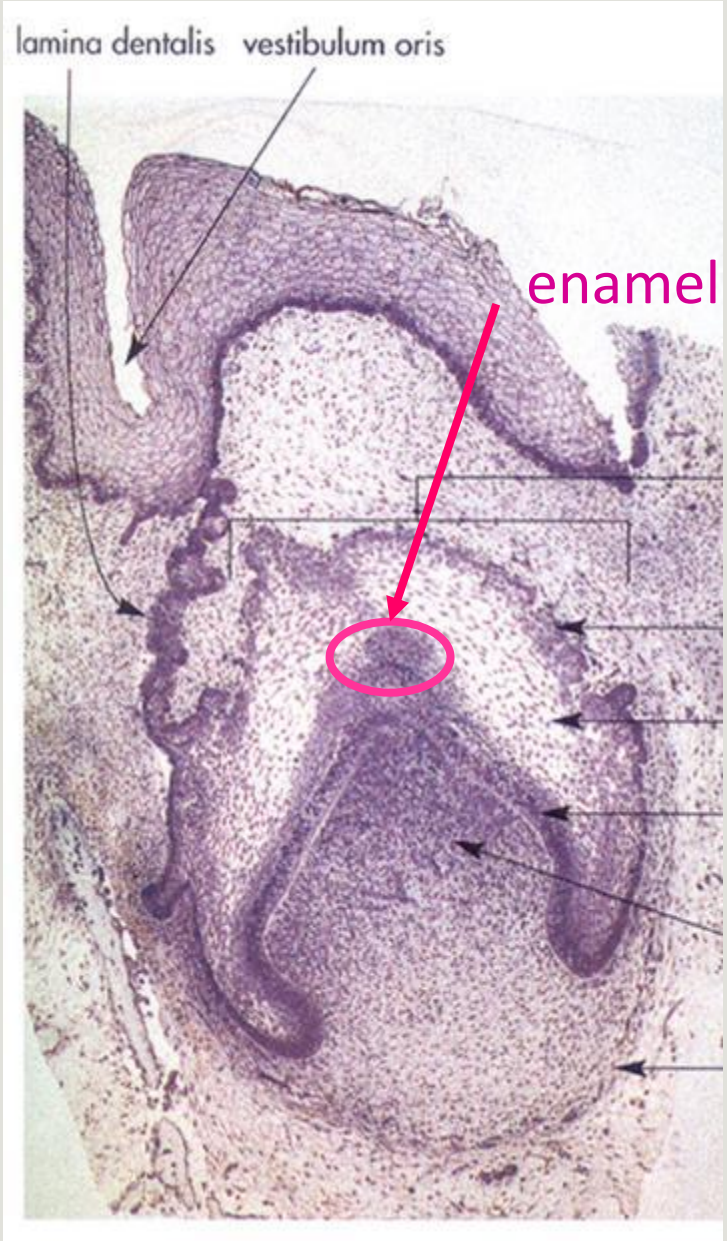

Outer enamel epithelium
Stellate reticulum
Stratum intermedium
Ameloblasts
(inner enamel epithelium)
Odontoblasts
Enamel organ
2007

Parts of the developing tooth

enamel organ
dental papilla
dental sac

ameloblasts – enamel producing cells differentiate from the inner enamel epithelium

odontoblasts – dentin producing cells differentiate from the ectomesenchymal cells of the dental papilla (neural crest origin)



ENAMEL KNOT – SIGNAL CENTER

* Non-dividing cells from the inner enamel epithelium,

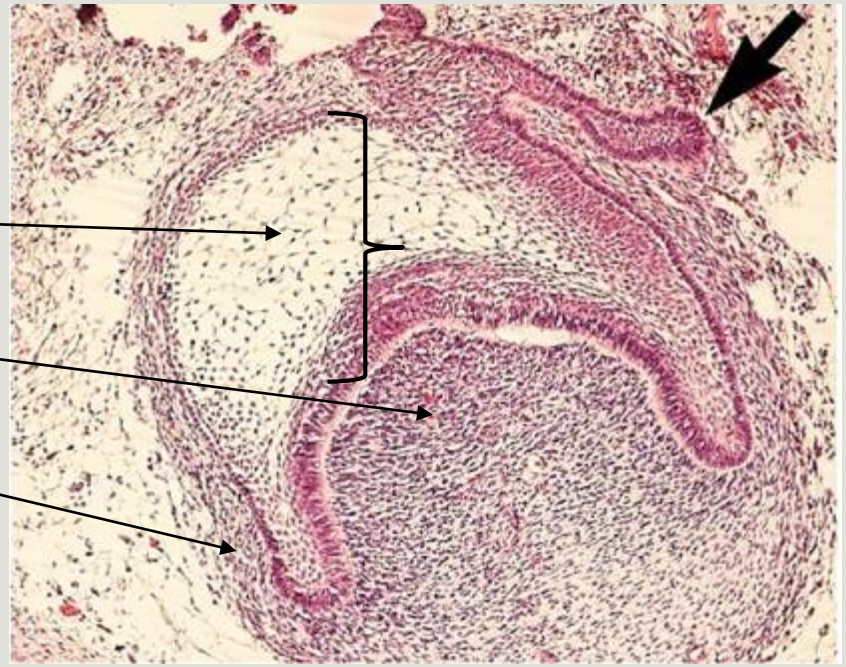
•produce different signal molecules, which transport the information between the ectodermal and ectomesenchymal cells

BMP, FGF,ShH, activin

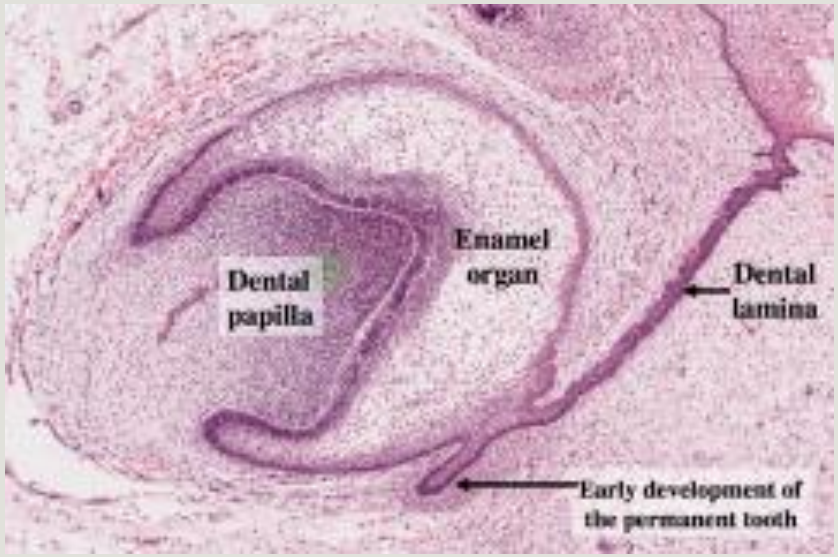
TOOTH GERM
Cap stage

enamel organ + dental papilla + dental sac is considered the developing **tooth germ**

tooth germs are found in the developing dental arches - primary dentition



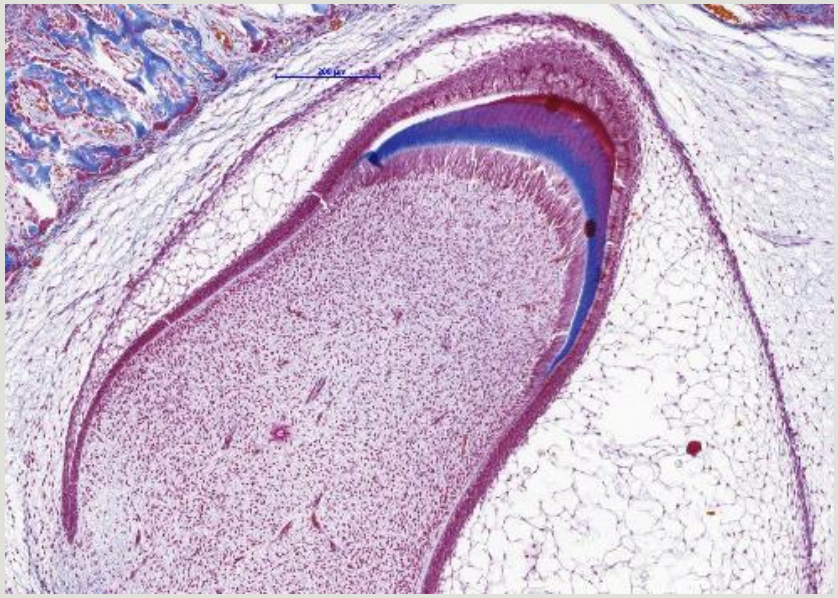
Bell stage



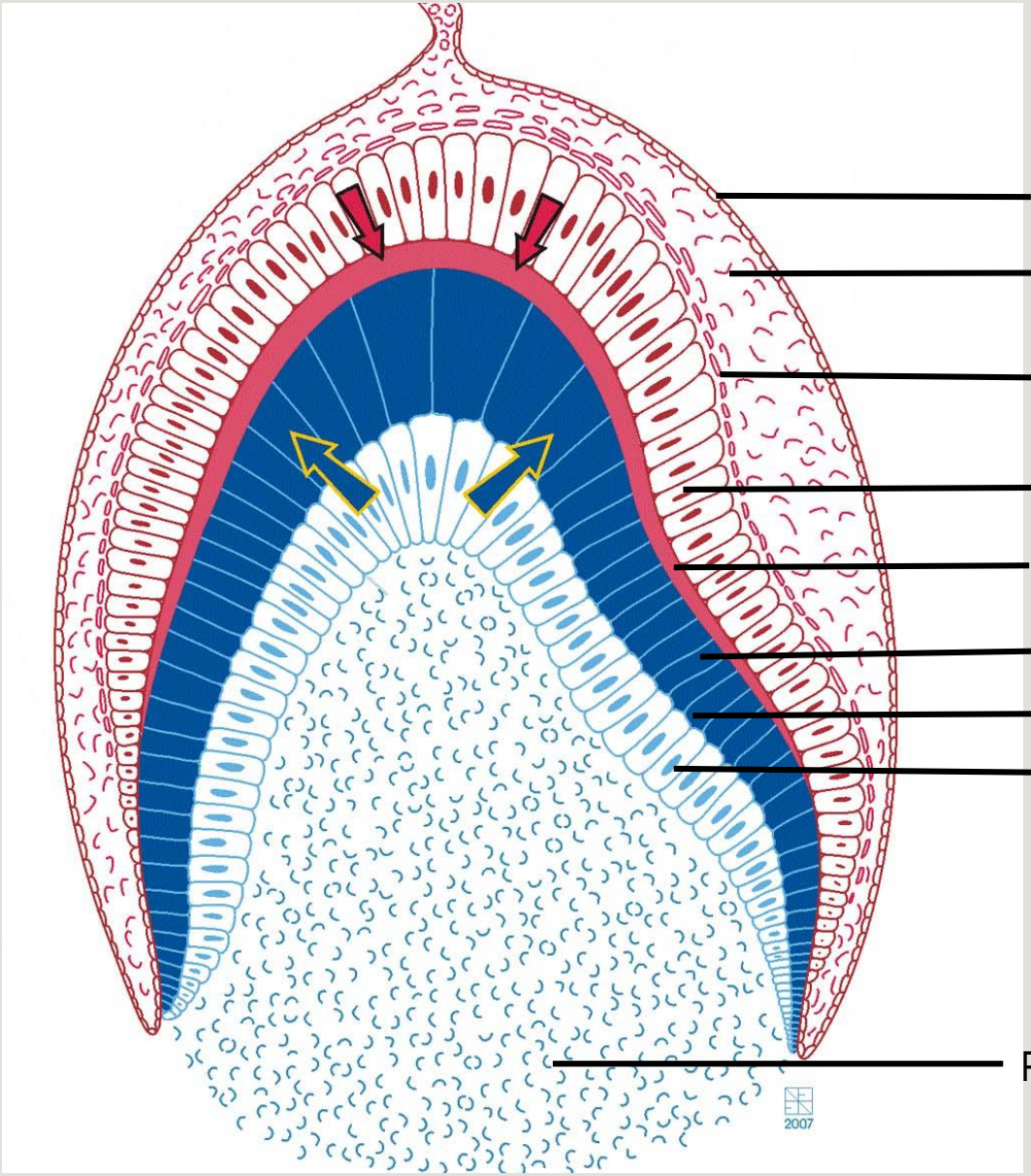
differentiation produces 4 cell layer

within the **ENAMEL ORGAN**

- **1. inner enamel epithelium**
- **2. outer enamel epithelium**
- **3. stellate reticulum**
- **4. stratum intermedium**

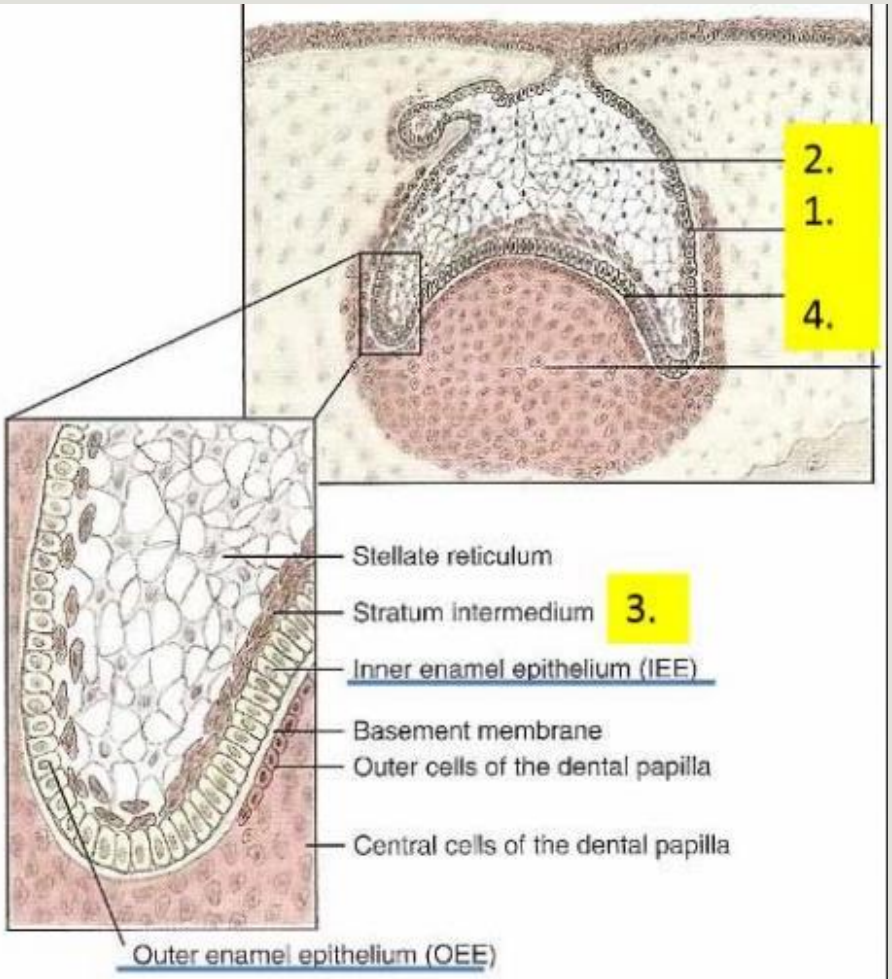


Bell stage

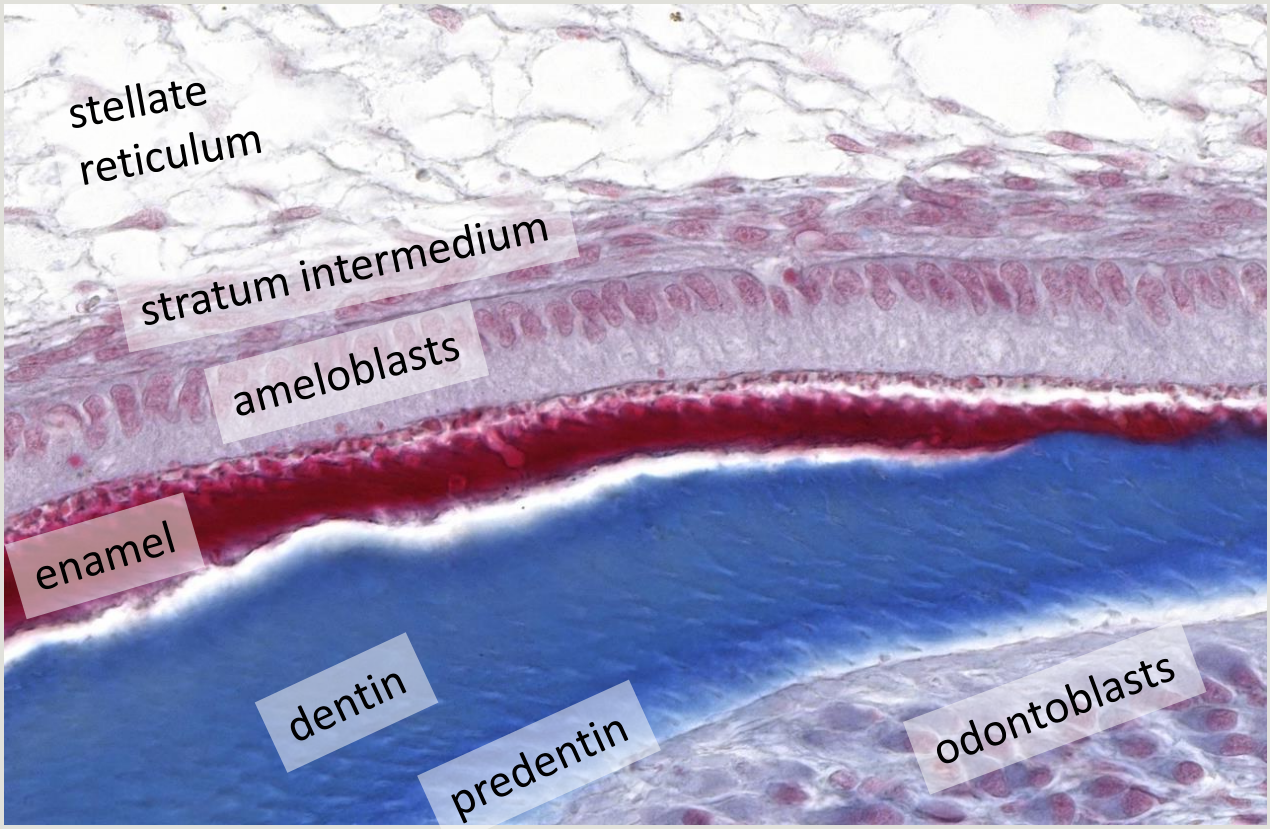

Outer enamel epithelium
Stellate reticulum
Stratum intermedium
Ameloblasts
(inner enamel epithelium)
Enamel organ
Enamel
Dentin
Predentin
Odontoblasts
Pulp
2007

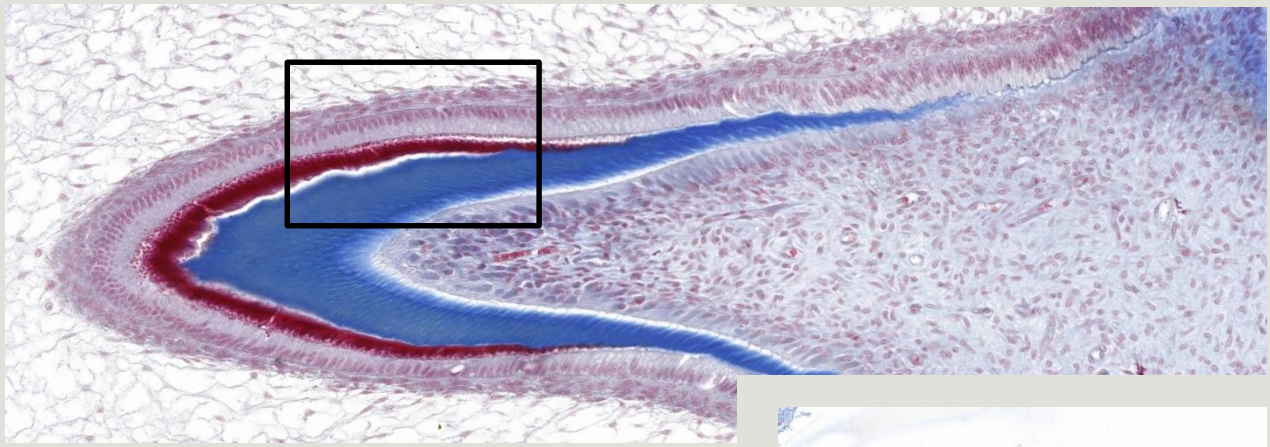
A. Enamel organ (bell stage):

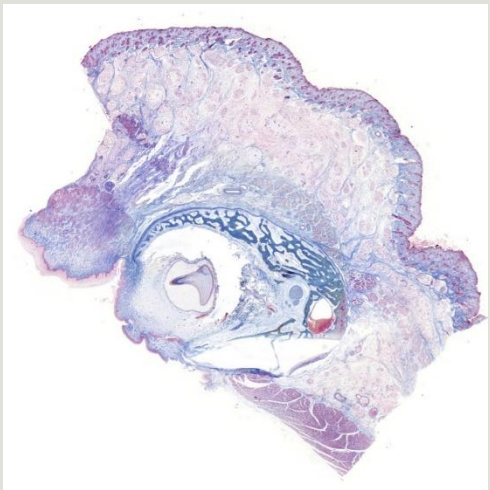
1. **outer enamel epithelium** (convex site) = outer ameloblasts ; cuboidal cells
   protective layer
2. **enamel reticulum** – star shaped cells ,
   glycosaminoglycans, water
   serves for metabolism of ameloblasts
3. **stratum intermedium**
   appears at the bell stage
   2-3 layers of flattened cells
   close to inner ameloblasts;
   transport of material,
   secretion of alcaline phosphatase
4. **inner enamel epithelium** (concave site)
   = inner ameloblasts: **produce enamel**
   on the surface of the crown

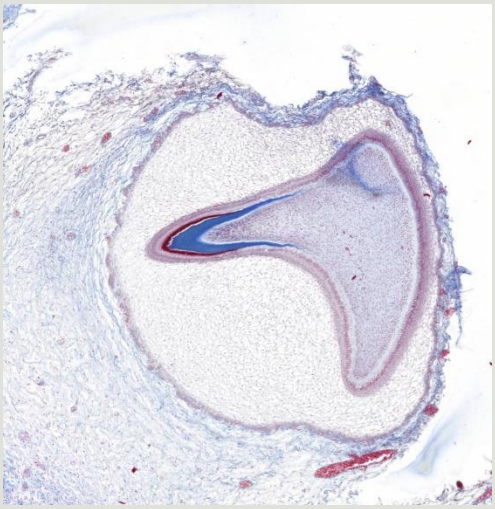


HERTWIG SHEATH = epithelial root sheath:
- **place of contact between outer and inner enamel epithelium**
- **defines the shape and formation of the root**


stellate reticulum
stratum intermedium
ameloblasts
enamel
dentin
predentin
odontoblasts







Bell stage

DENTINOGENESIS:

first the odontoblasts produce predentin (organic material)

↓

mineralization

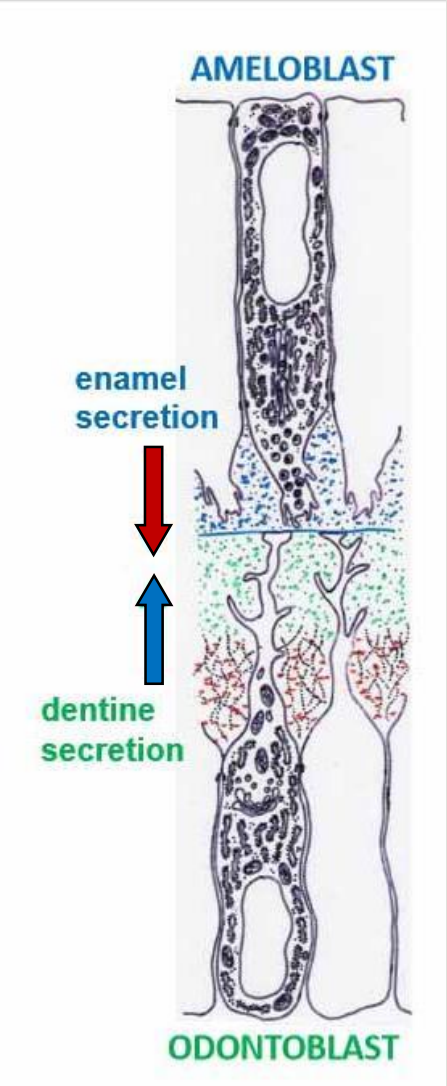
AMELOGENESIS:

the first layer of predentin induces the inner enamel epithelial cells, they differentiate into ameloblasts and secret the organic matrix of the enamel,

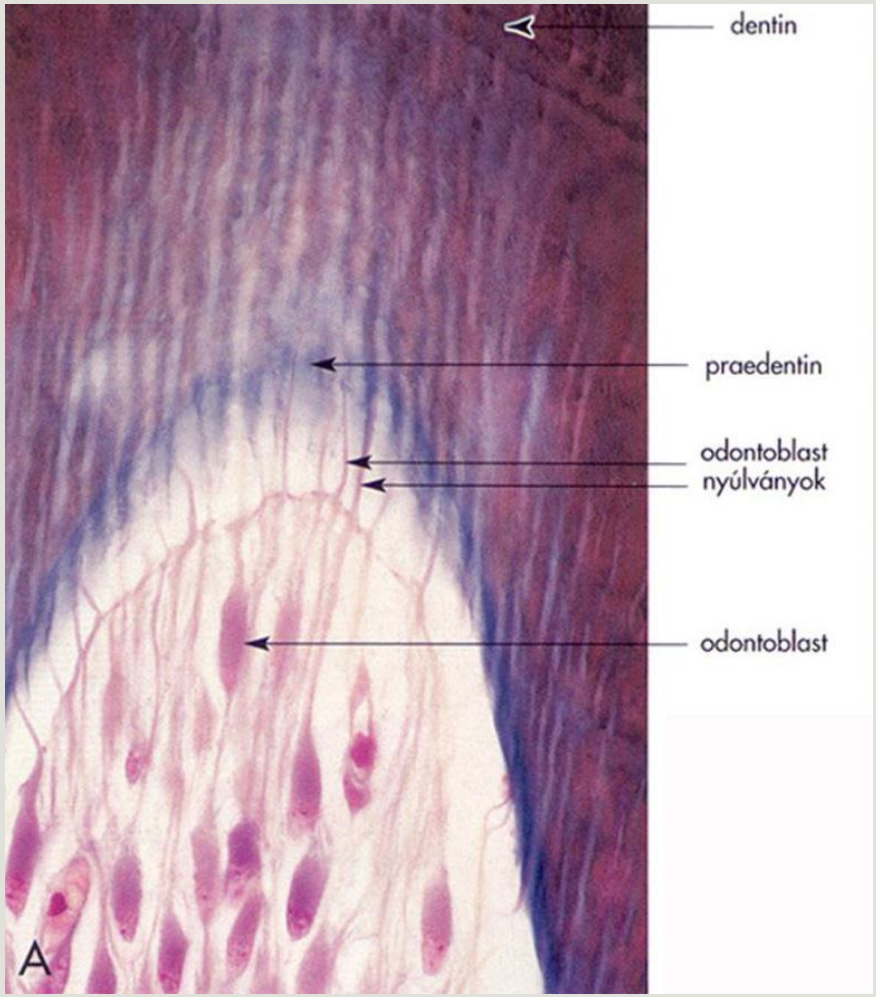
↓

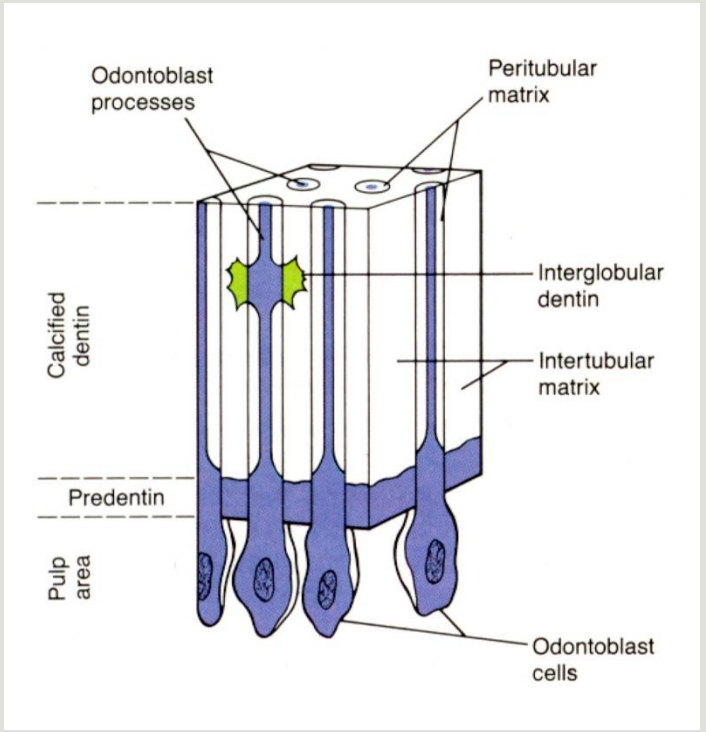
mineralization

ECTO-MESENCHYMAL INTERACTIONS



ODONTOBLAST – DENTIN-PRODUCING CELL

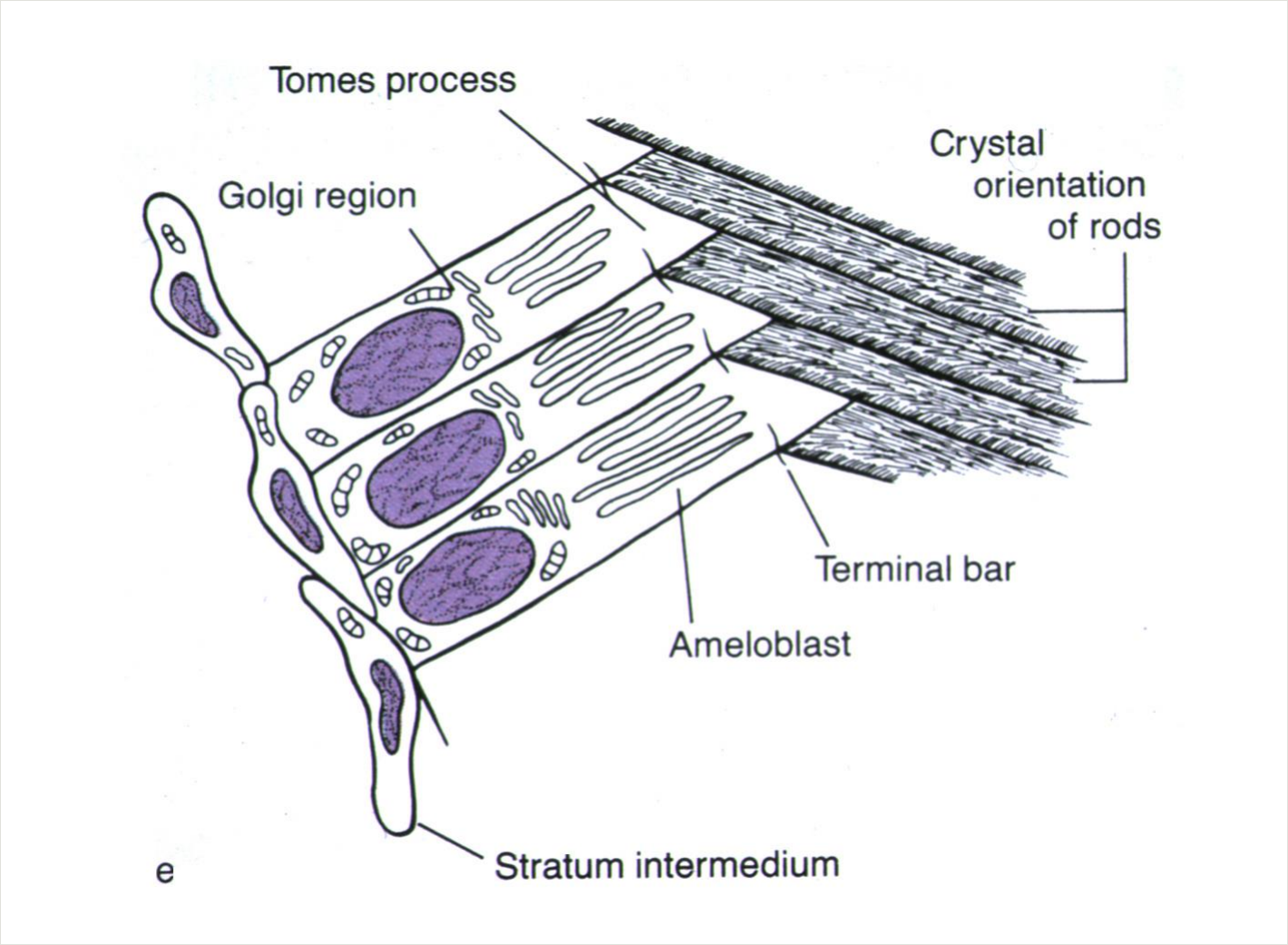




Cell bodies in the pulp

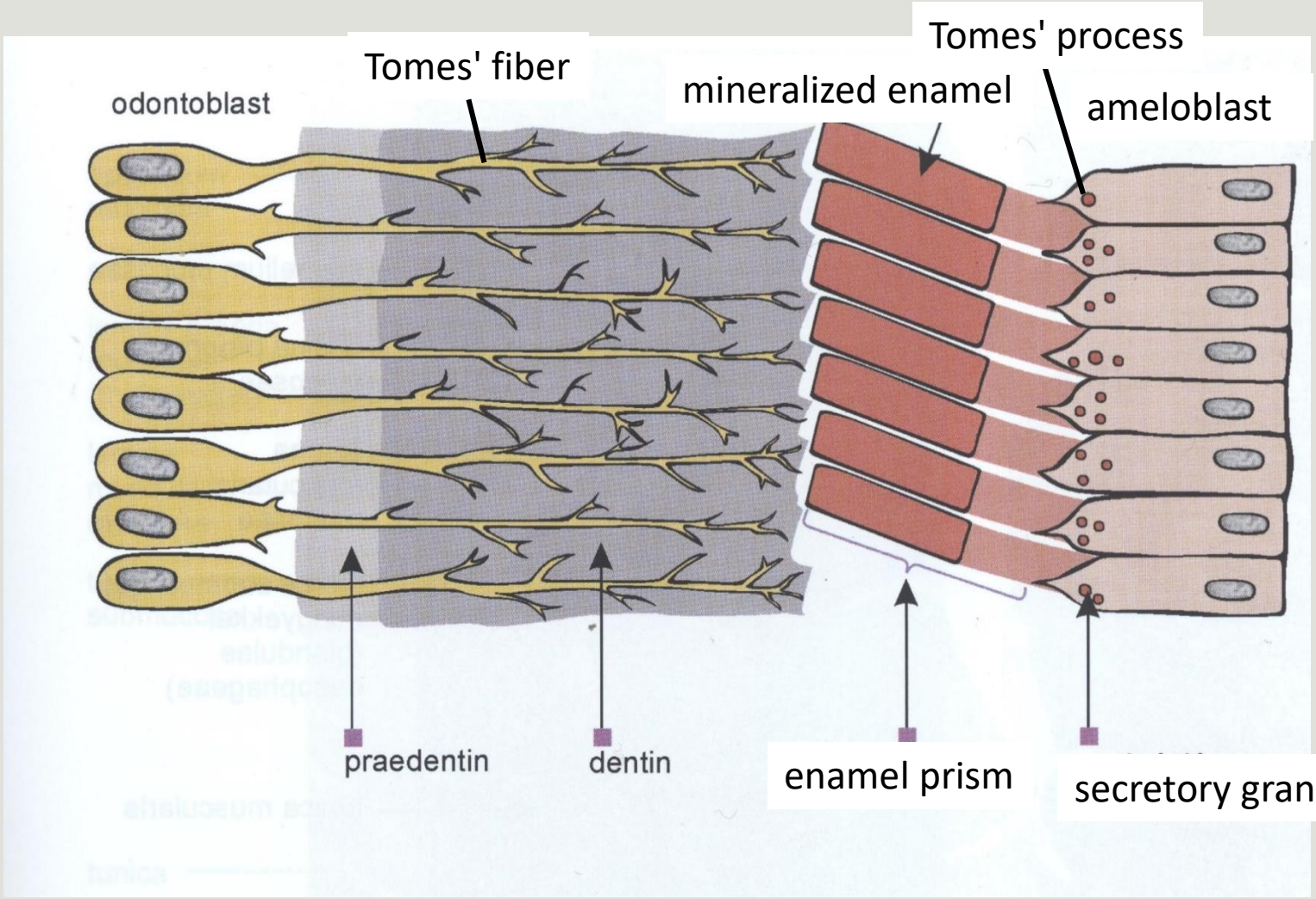
Tomes- fibers in the dentinal tubules

AMELOBLASTS – ENAMEL PRODUCING CELLS

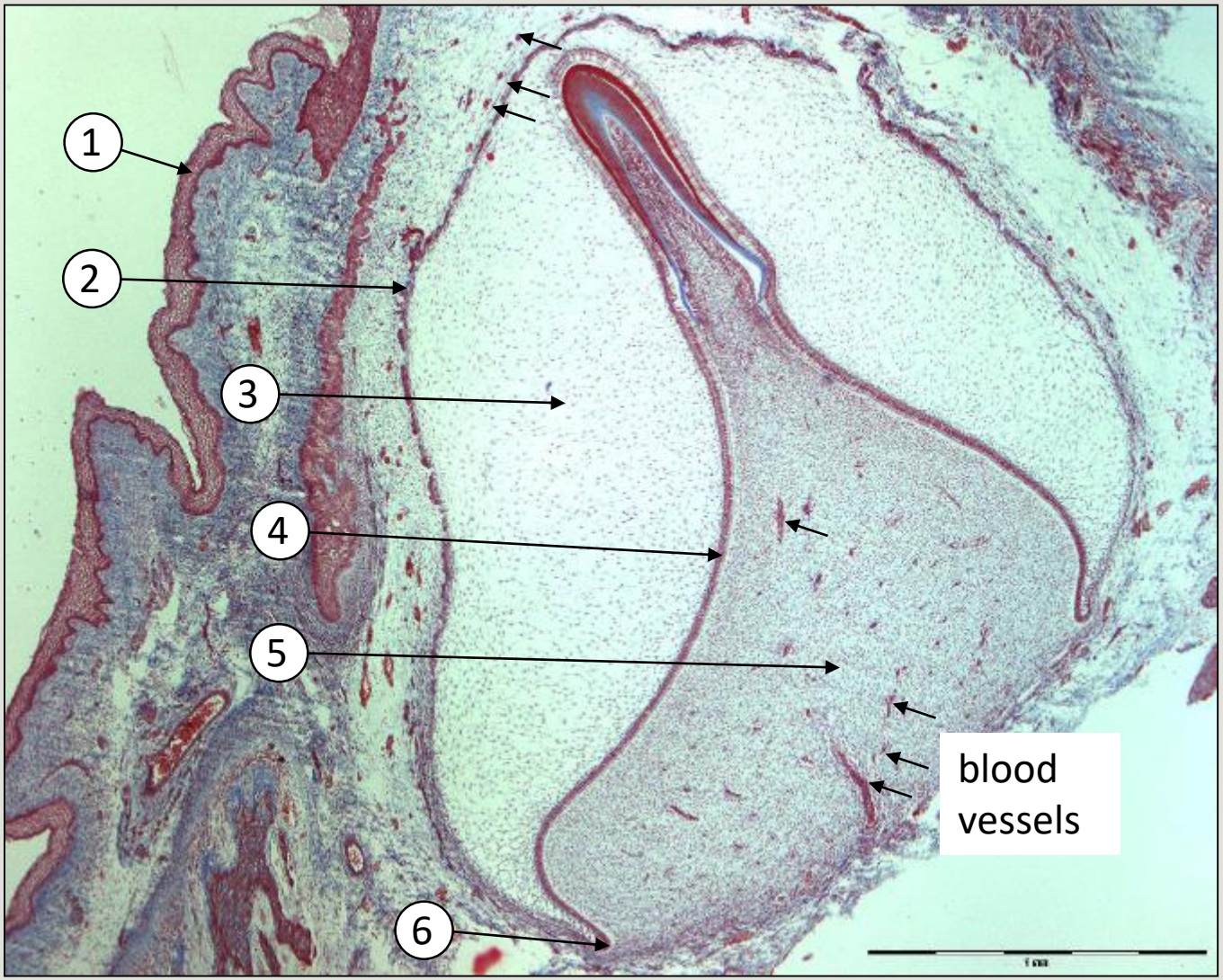


DENTINOGENESIS

AMELOGENESIS



LATER STAGE

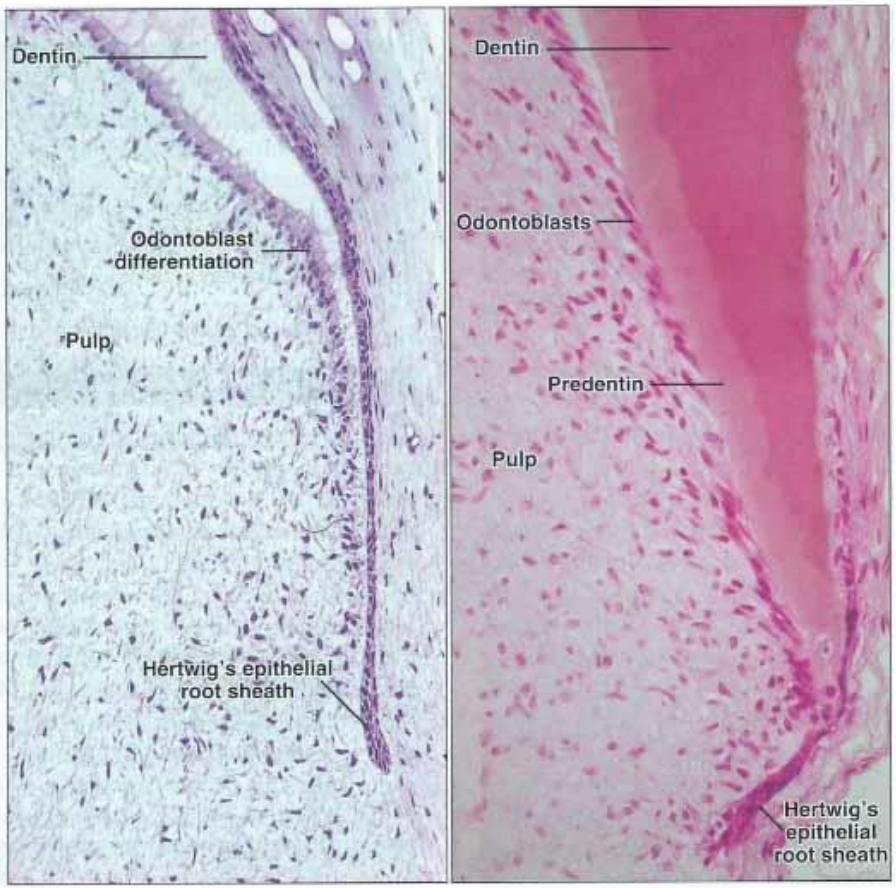


1. oral epithelium
2. outer enamel ep.
3. stellate reticulum
4. inner enamel epithelium
5. dental papilla
6. cervical loop

http://www.iob.uio.no/studier/undervisning/histologi/index.php

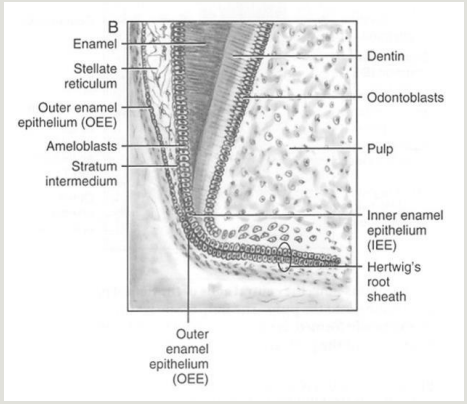
DEVELOPMENT OF THE ROOT

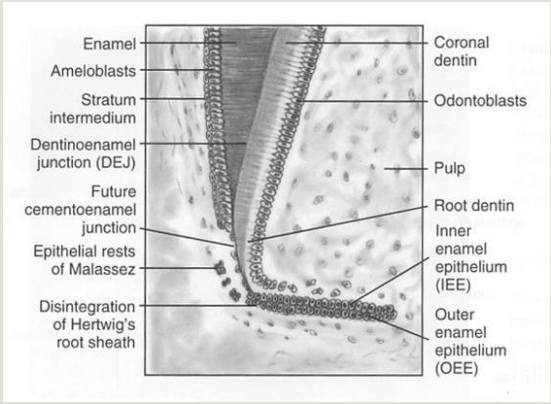
The location where the outer and inner enamel epithelium join is called the cervical loop. The growth of cervical loop cells into the deeper tissues forms Hertwig's epithelial root sheath, which determines the root shape.

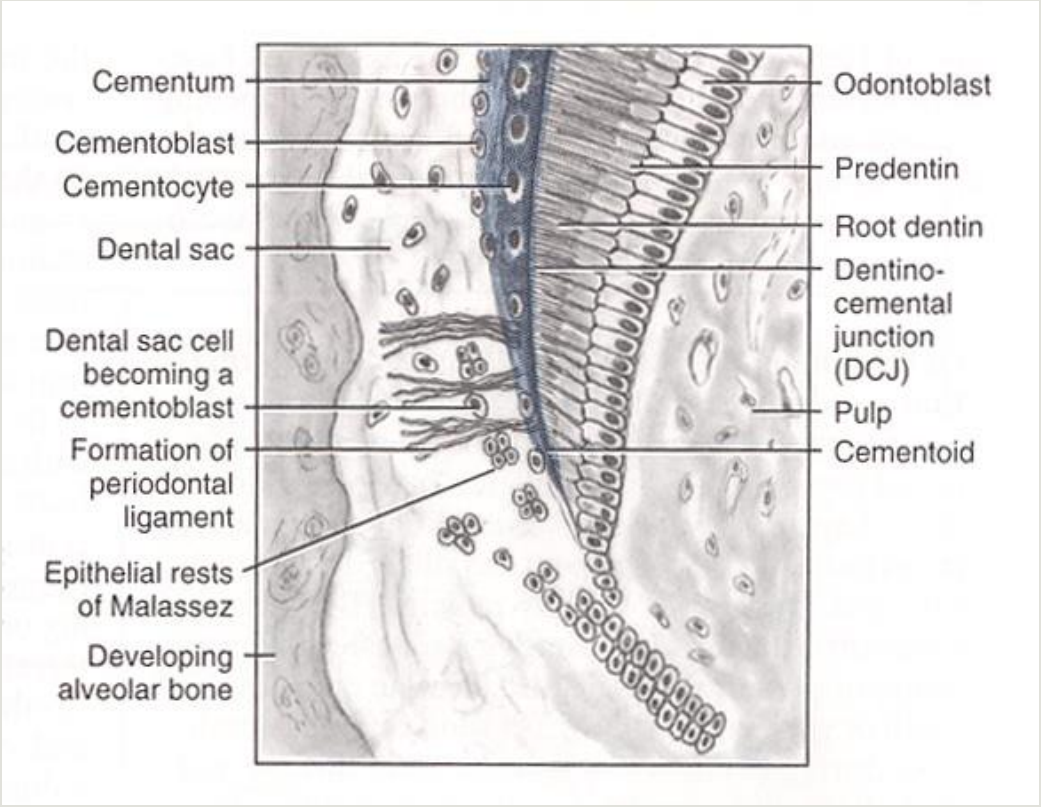


DEVELOPMENT OF THE ROOT

1. formation of the Hertwig's root sheath (inner and outer enamel epithelium)
2. formation of the odontoblasts
3. dentinogenesis
4. desintegration of the Hertwig's sheath
5. formation of the epithelial islands of Malassez
6. cementogenesis







ERUPTION

Axial movement toward oral epithelium starts when the root develops.

http://www.anat.ucl.ac.uk/research/arnett_lab/

TOOTH ERUPTION

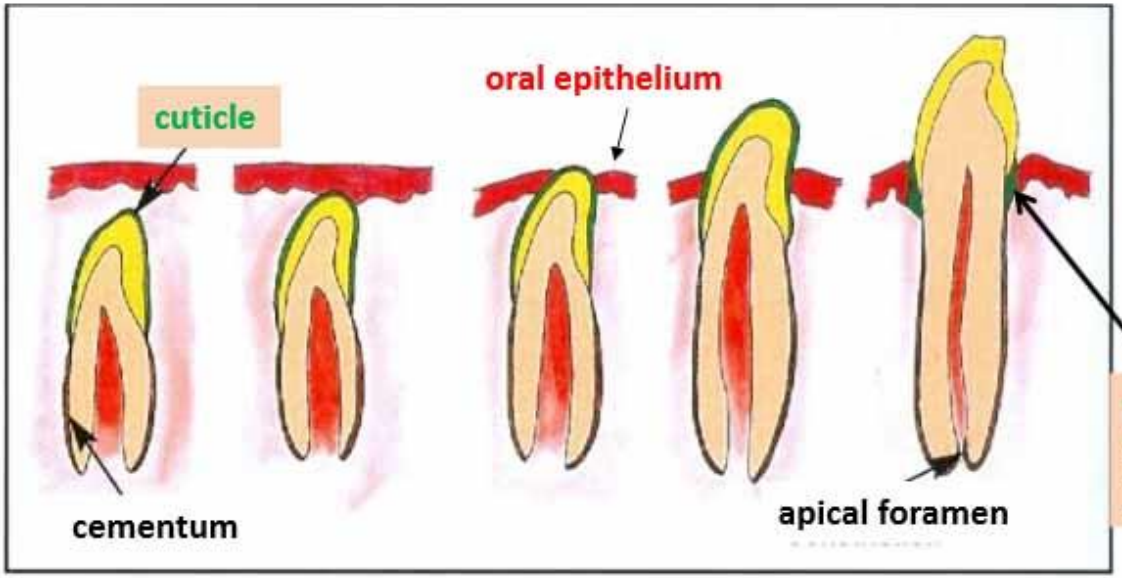
DECIDUOUS TEETH

When the tooth crown is fully developed, enamel organ is reduced. Inner and outer ameloblasts meet each other and form thin layer on the surface of the crown called enamel cuticle or Nasmyth membrane.

Enamel cuticle:

1. protects enamel from resorption by cells of the dental sac
2. secretes enzymes for elimination of the dental sac
3. allows fusion of reduced enamel epithelium and oral epithelium
4. disrupt oral epithelium and allows eruption of the tooth

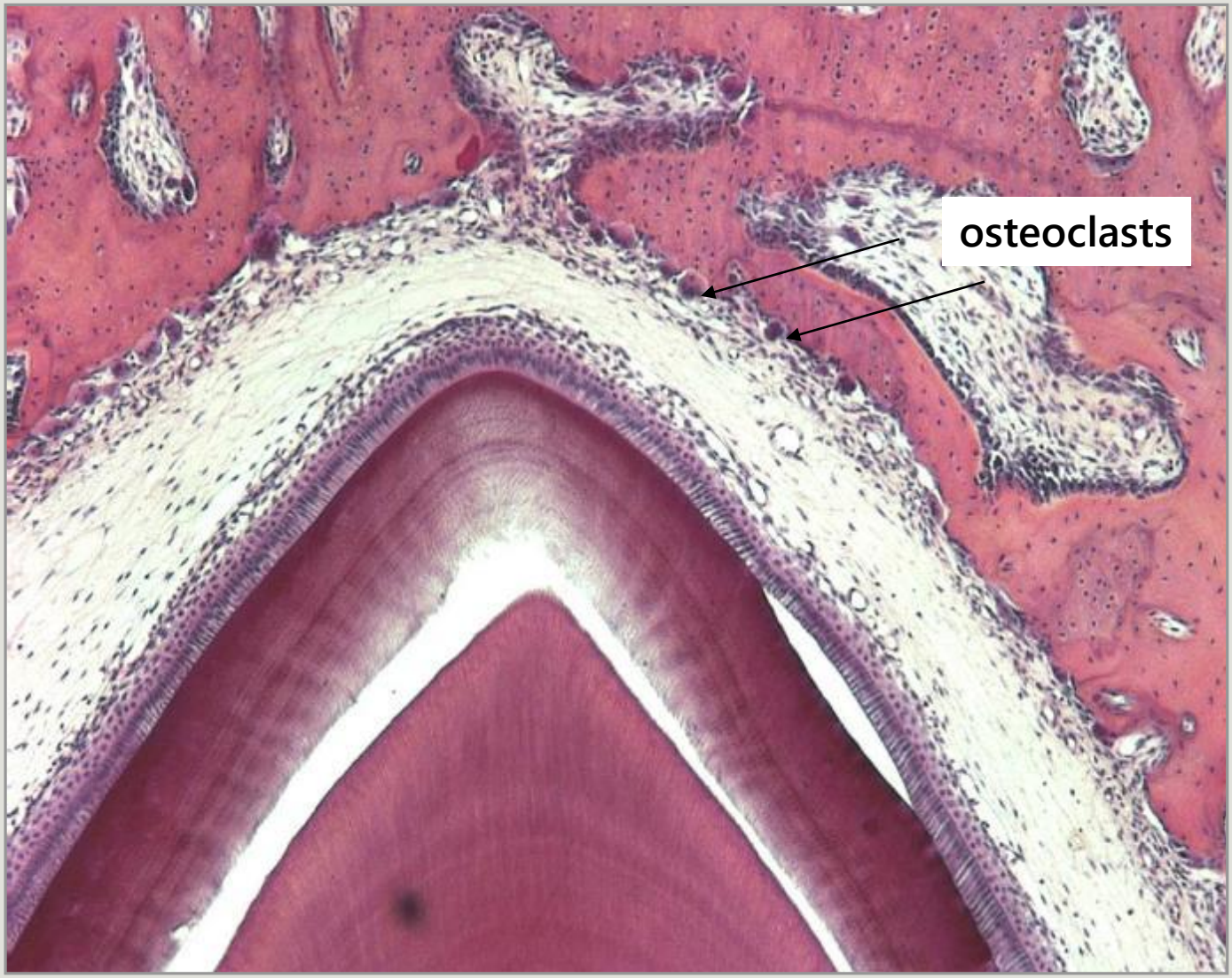
As the root of the tooth grows, its crown gradually erupts through oral epithelium.



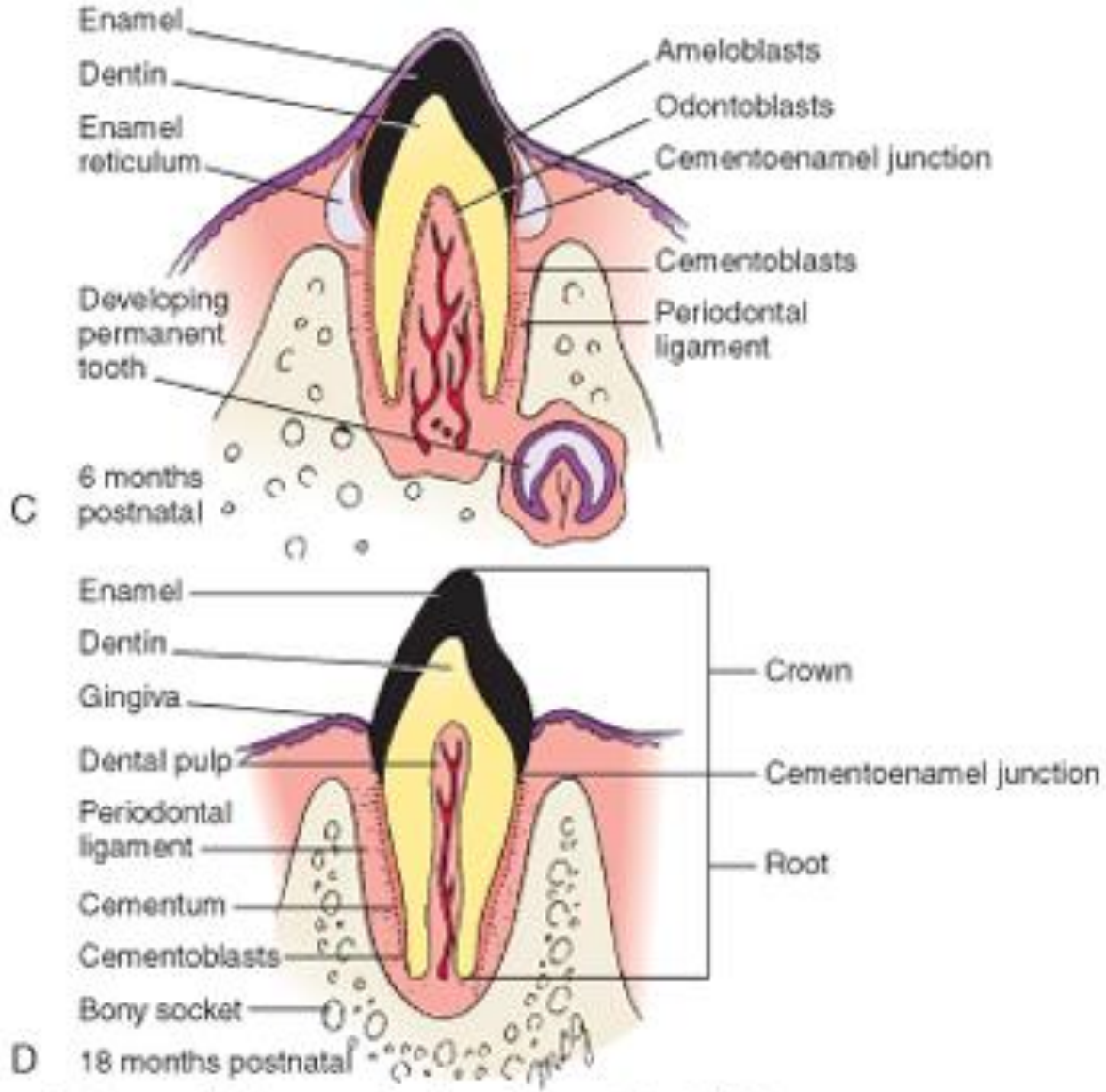
remnants of cuticle – form dentino-gingival junction

ERUPTION

Alveolar bone and connective tissue are resorbed as teeth erupt.



http://www.anat.ucl.ac.uk/research/arnett_lab/



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.