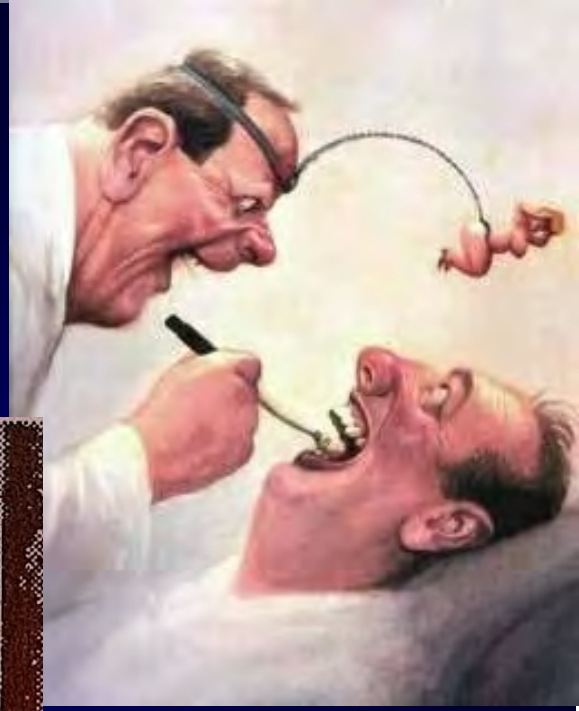
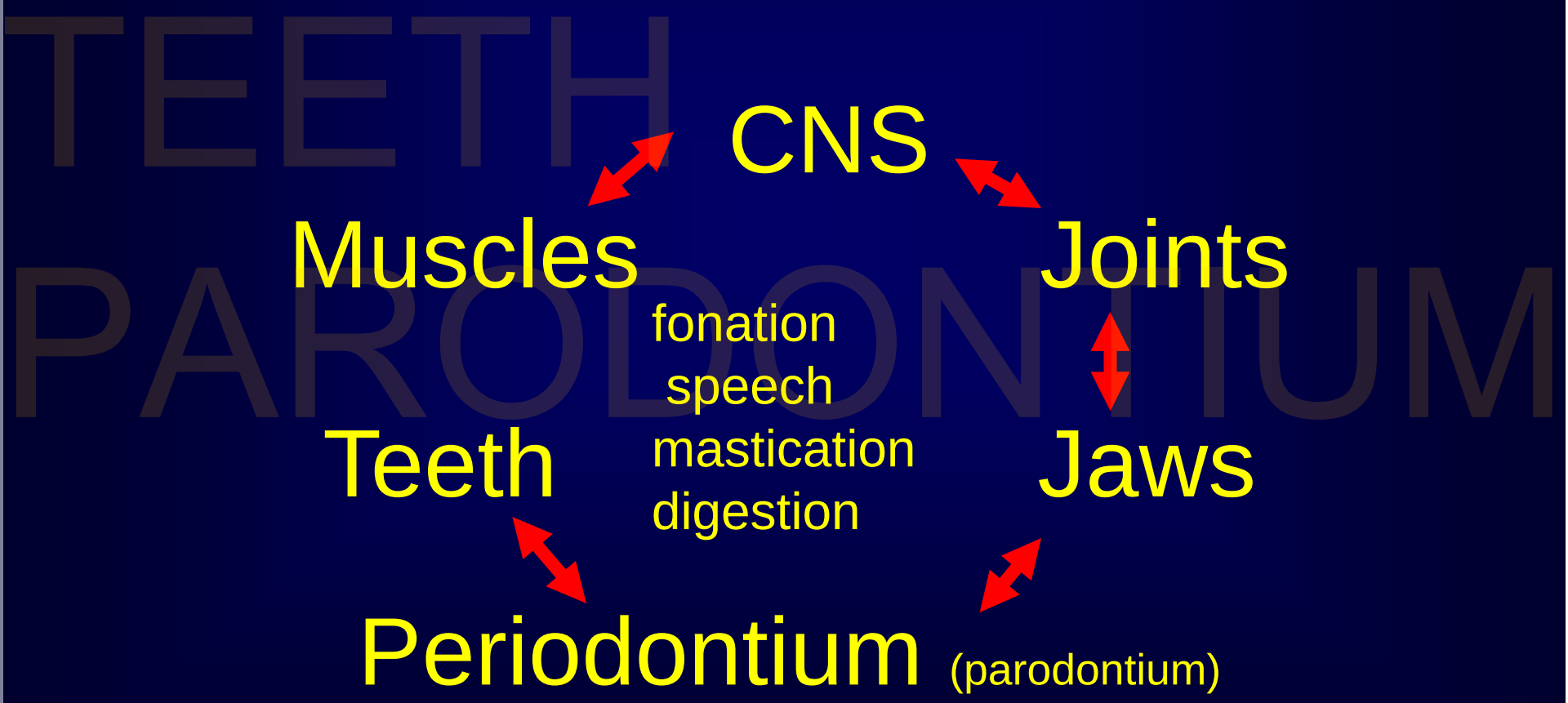
Teeth and **Parodontium**
structure, development



Ivo Klepáček

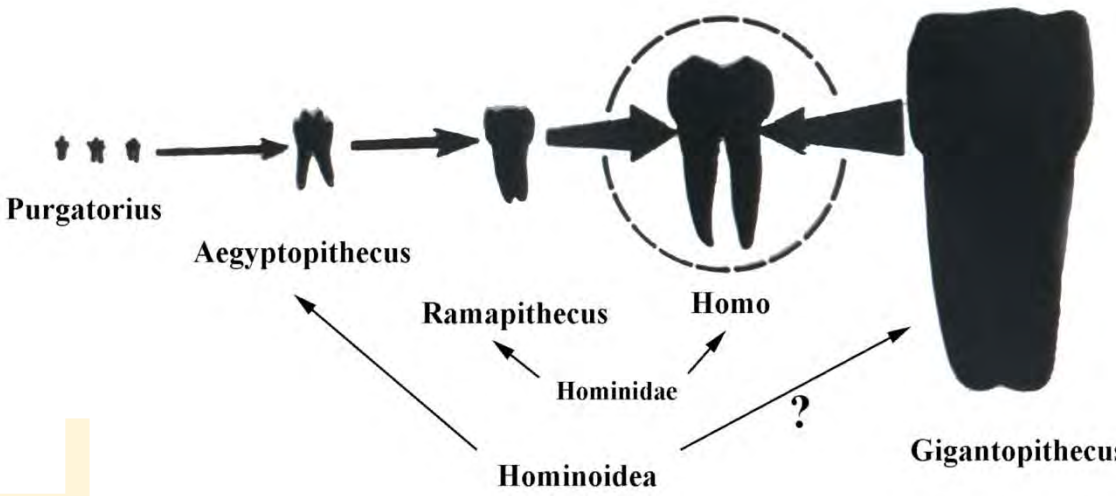
OROFACIAL SYSTEM

Multifunctional complex of structures



TEETH

DENTES

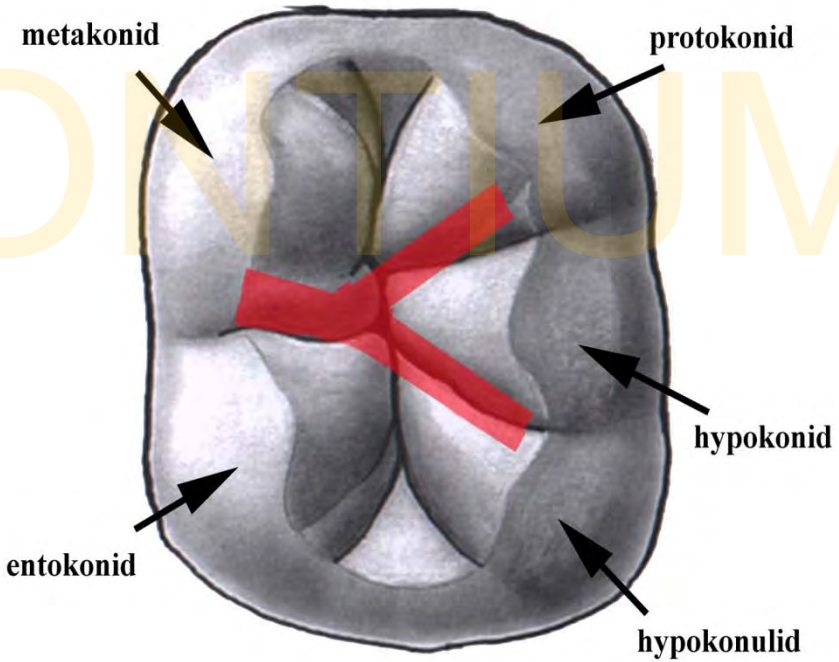


tooth

Dens, dentis lat.

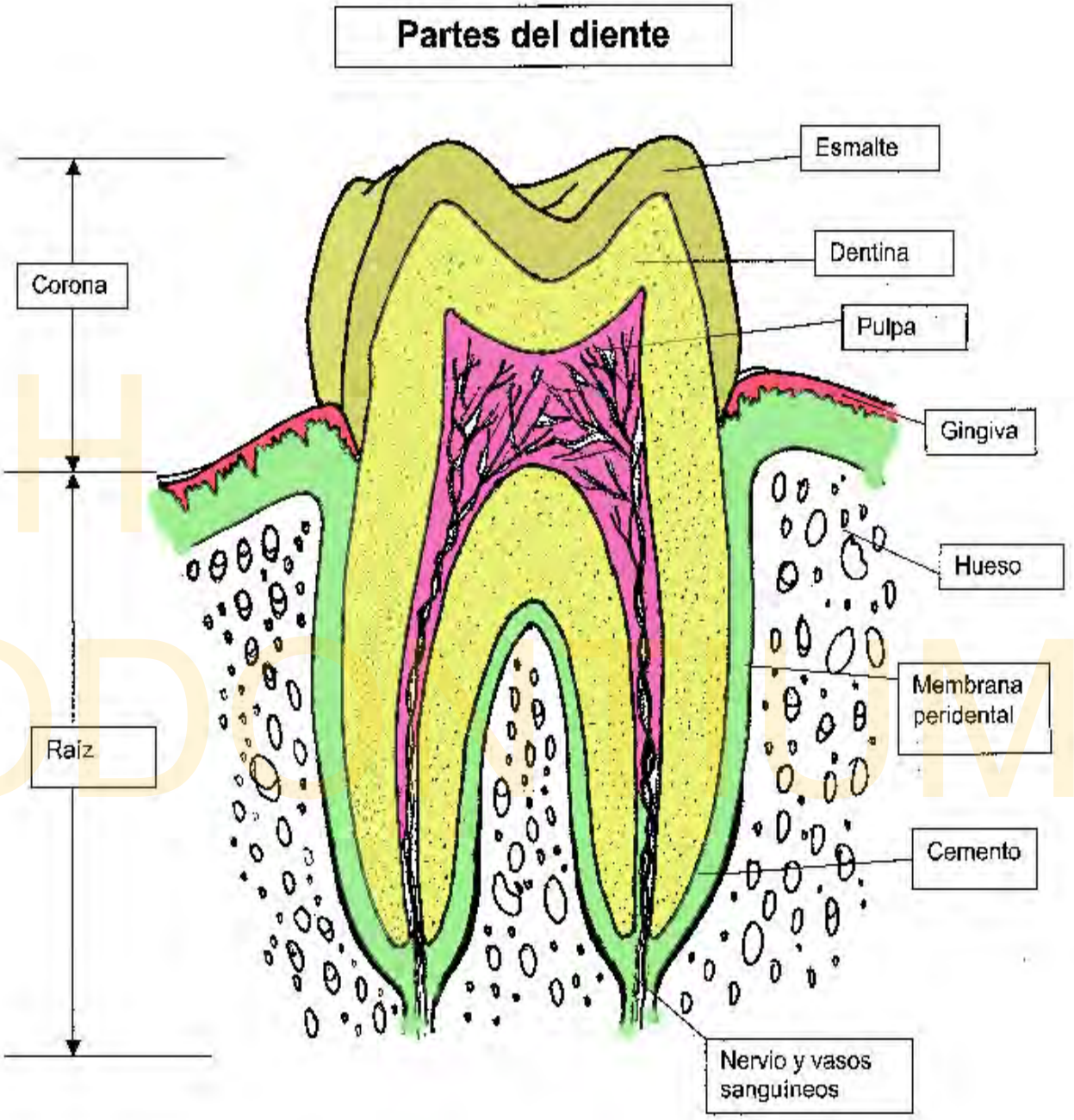
Odus, odontos gr.

(dens incisivus, caninus, premolaris, molaris (Y5 formula)

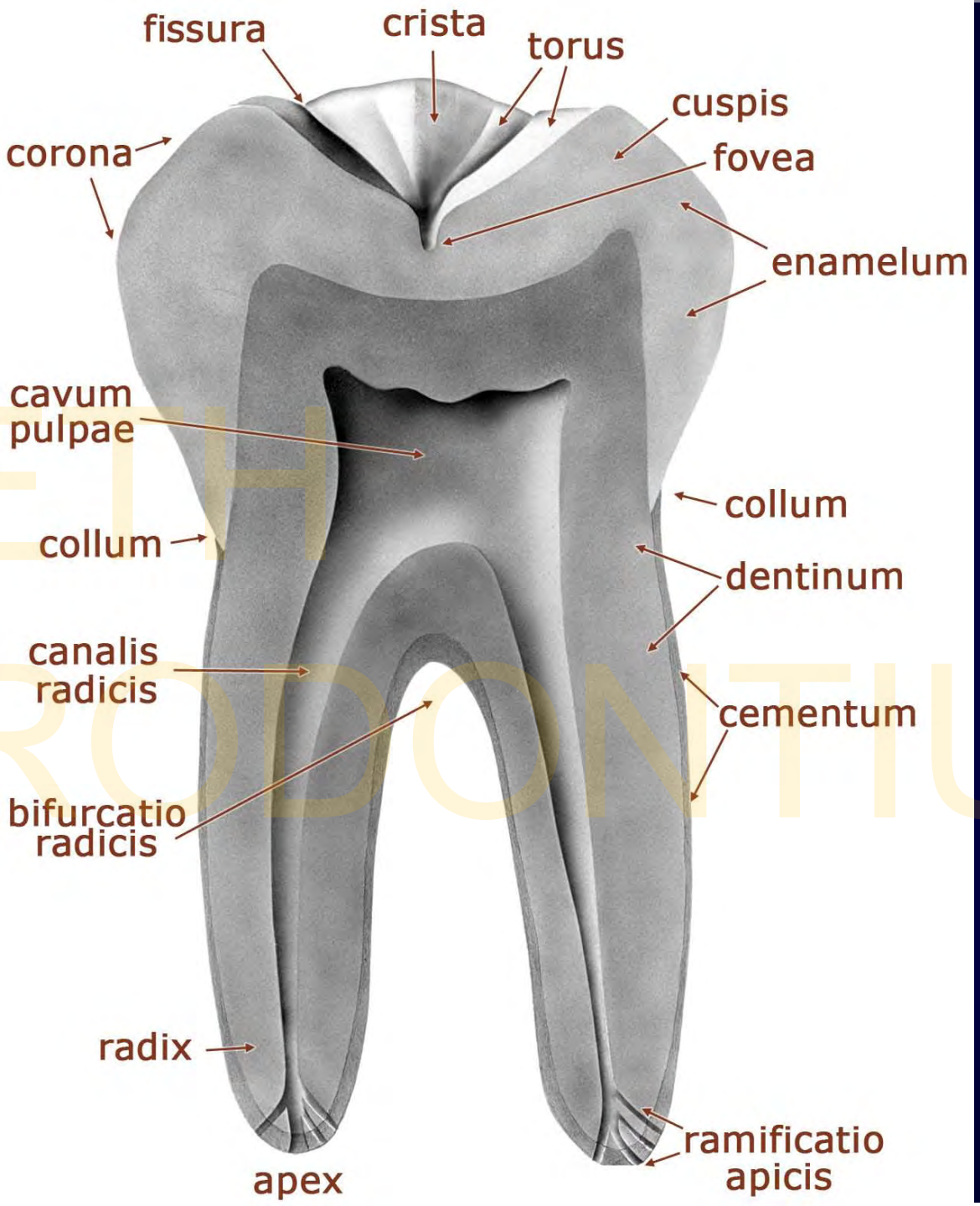


Zuby – teeth *části parts*

- Korunka crown (corona)
- krček neck (cervix)
- kořen root (radix)
- dřeň pulp (pulpa)



Main terms



ODONTIUM

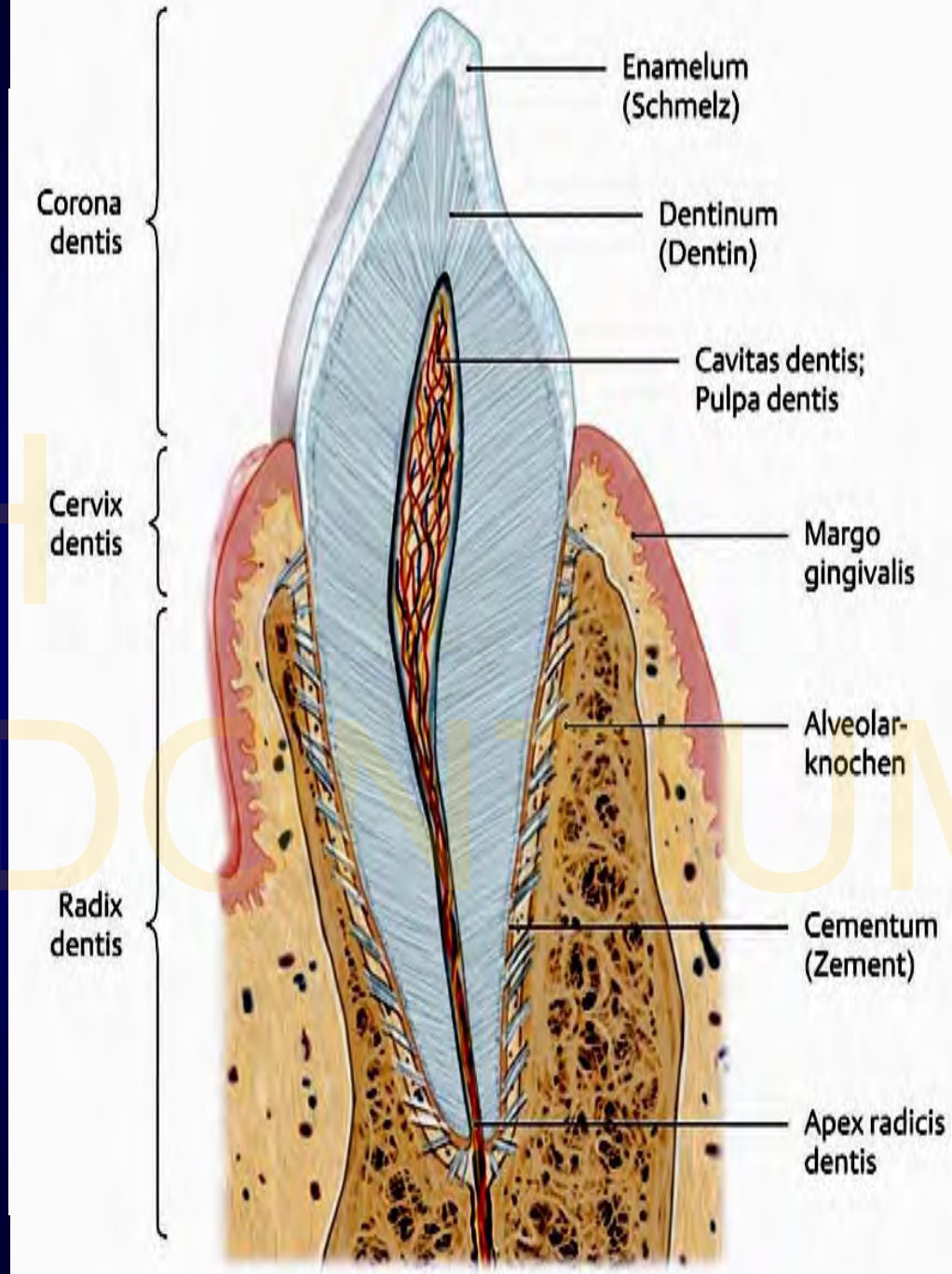
Endodontium

Ektodontium

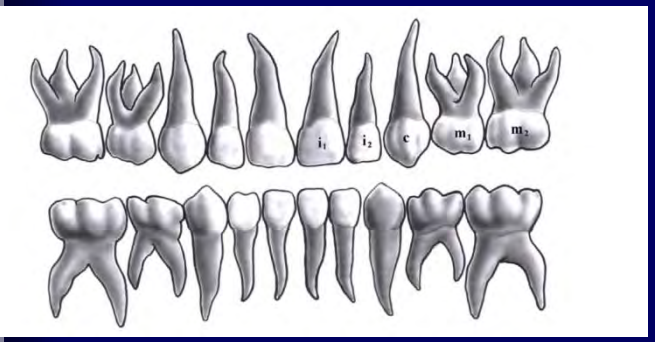
Periodontium

Hard tissues:
Enamelum
Dentinum
Cementum

Soft tissues:
Pulpa dentis
Periodontium

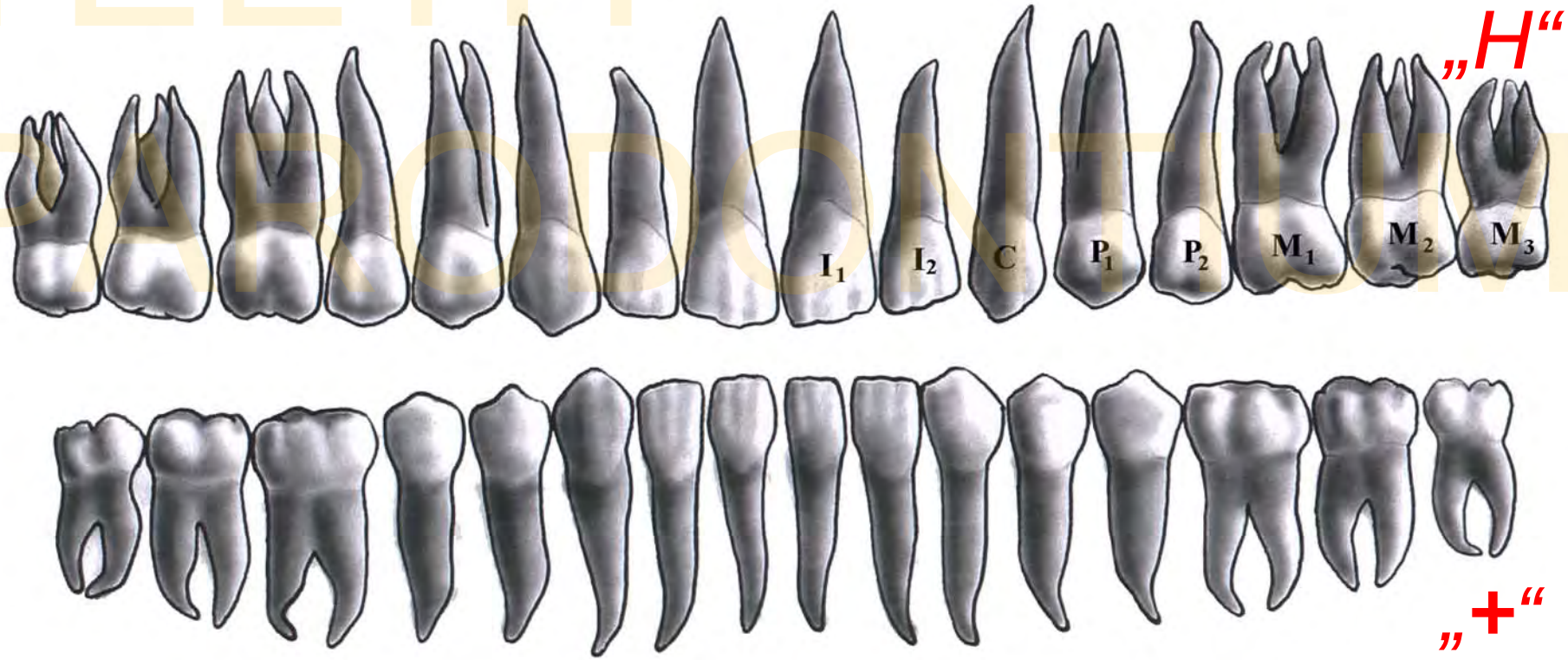


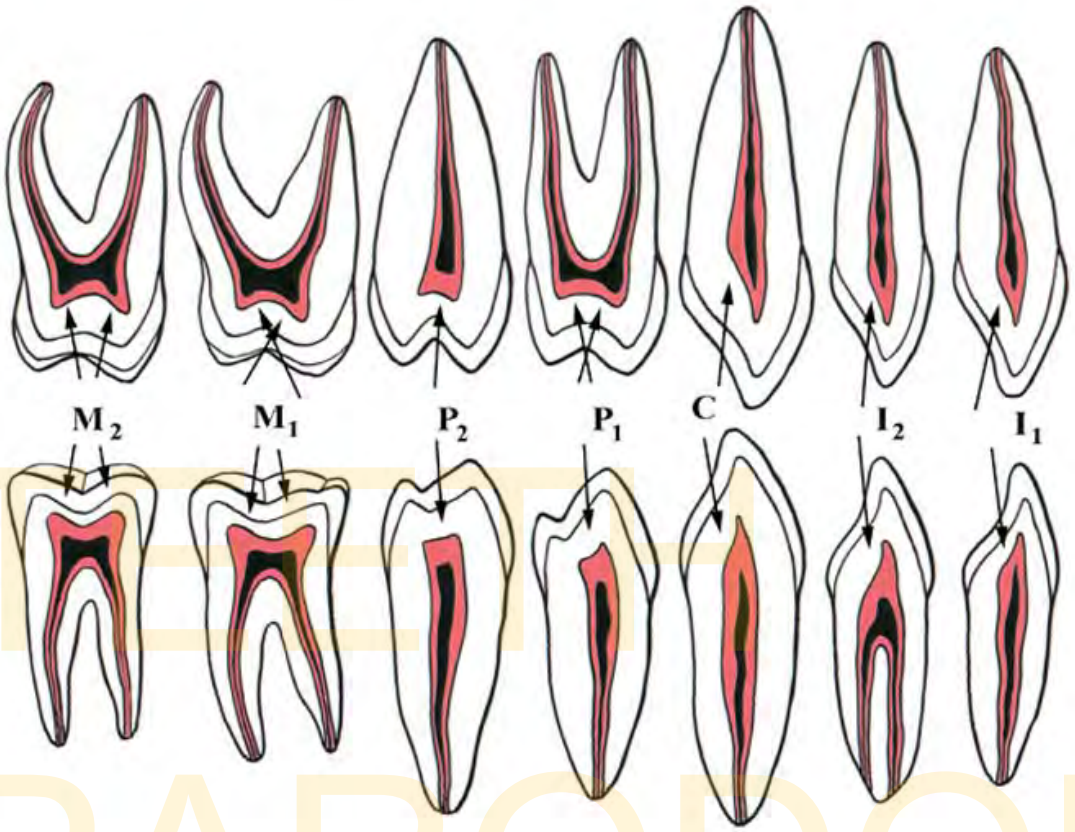
Teeth

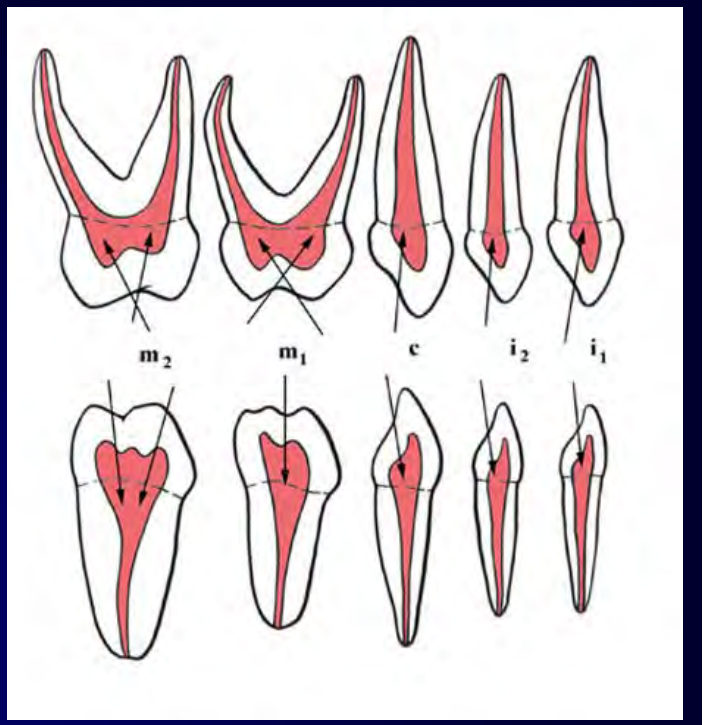


tooth	masticating cusps	roots
I	incisal crest	1
C	2 oblique crests	1
P	2 cusps	1 (2)
M - upper	4 ; fissures „H“	3
- lower	4 (5) ; fissures +	2

- Firast and second dentition dentes decidui (lactales), permanentes



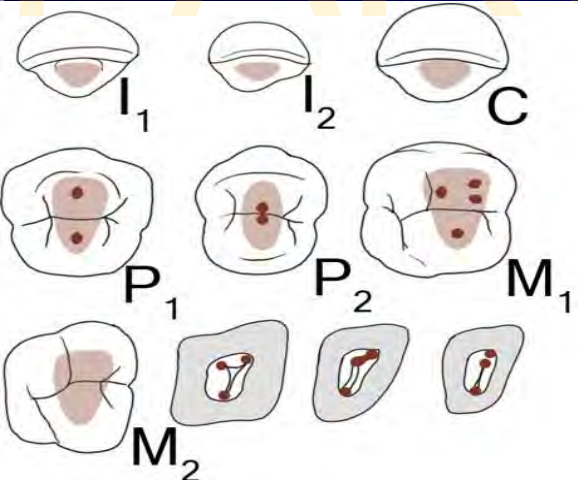


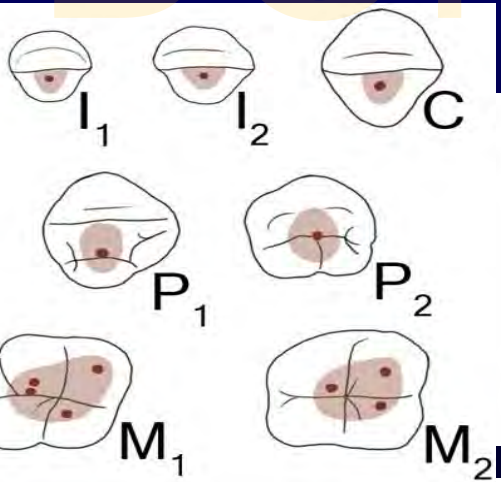


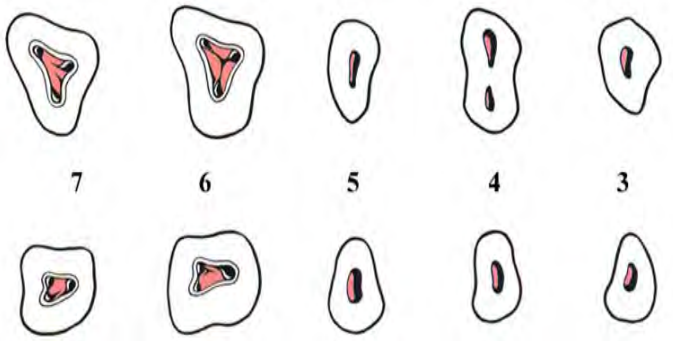
upper teeth

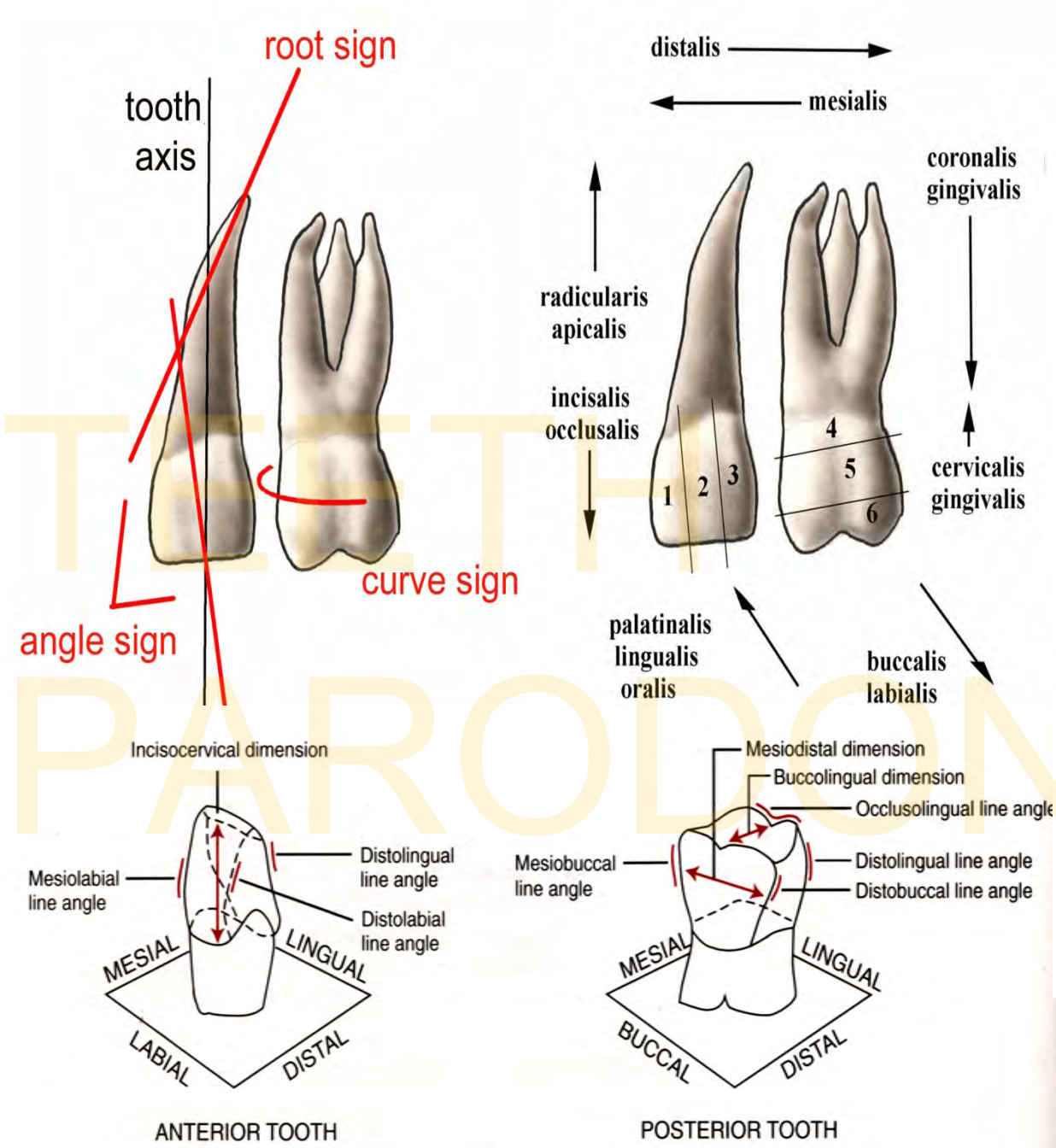
lower teeth

Pulp changes through life

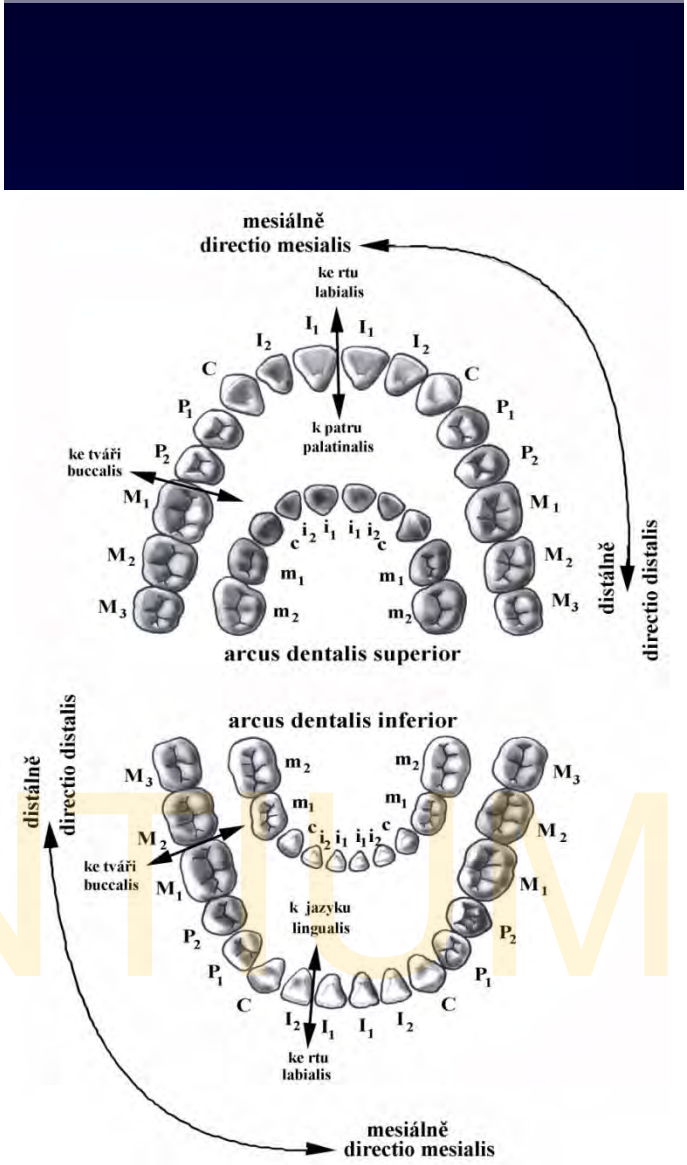






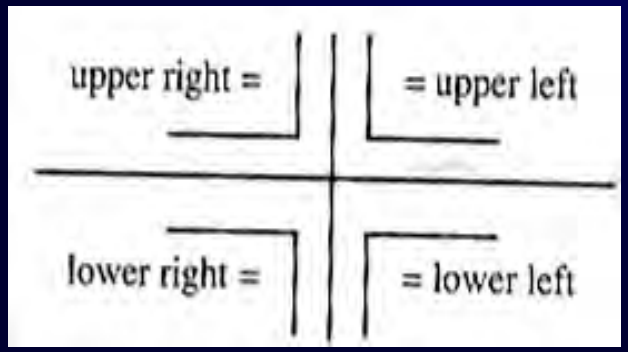


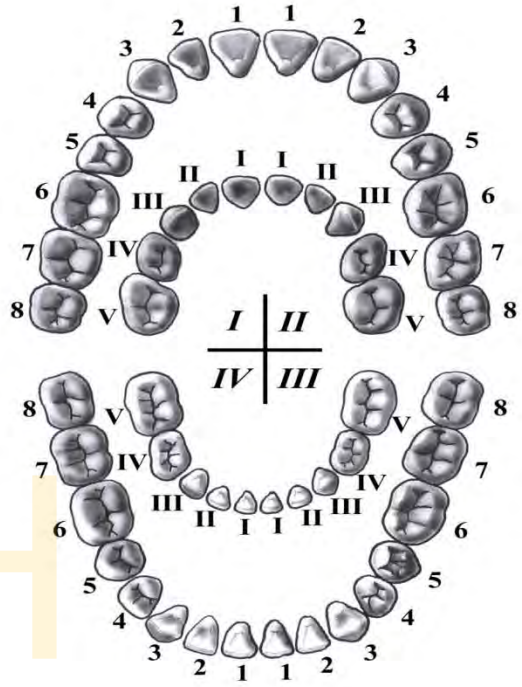
Diagrammatic representation of an incisor and molar crown showing the surfaces and external tooth *line angles* and *indications for dimensions*.

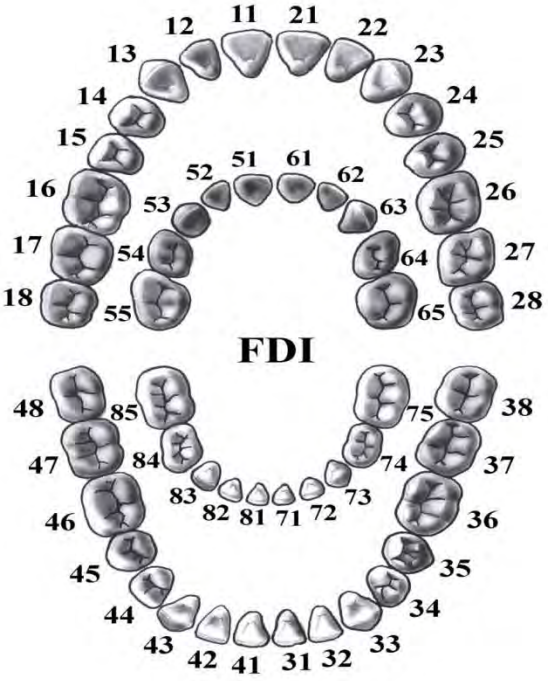


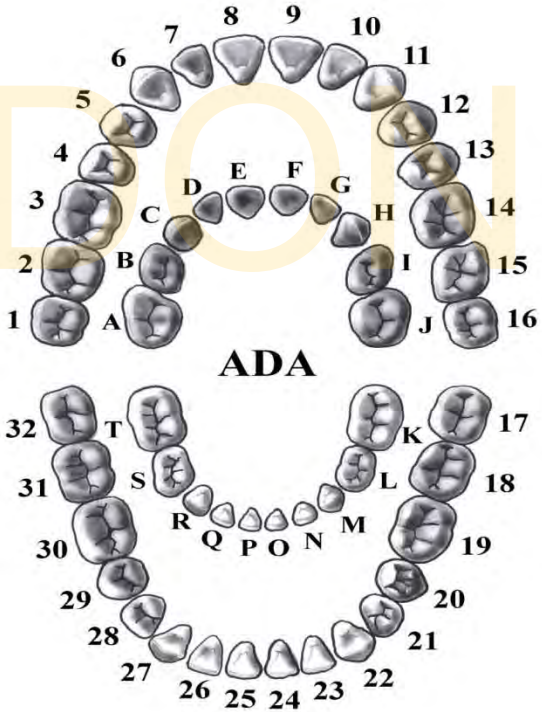
FDI
Fédérale Dentaire Internationale

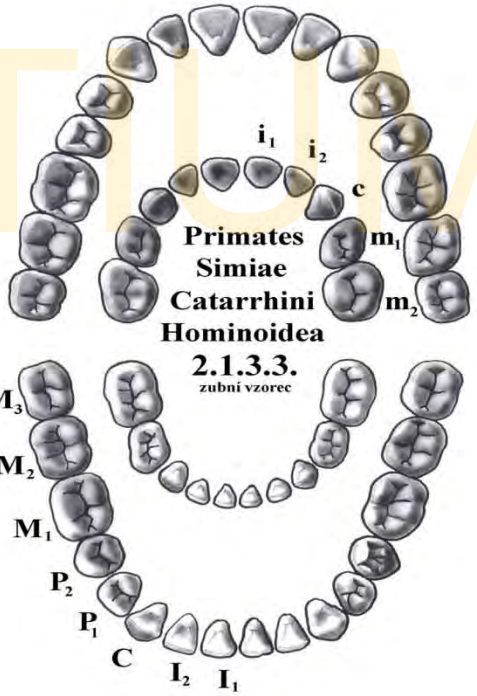
ADA
American Dental Association

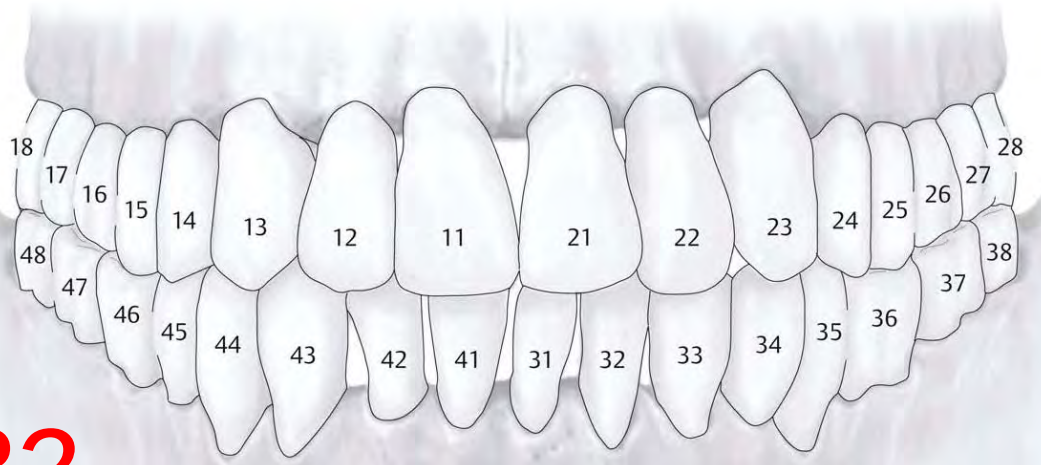












32

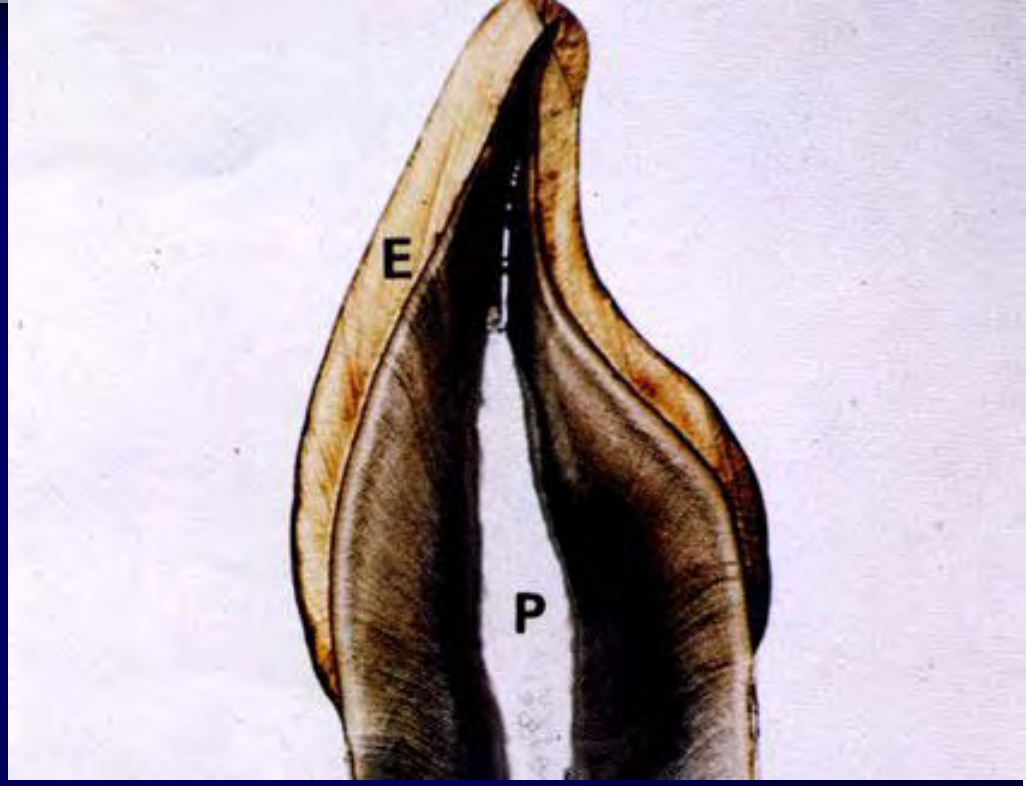
Stálé Dočasné

20

Permanentes Lactei

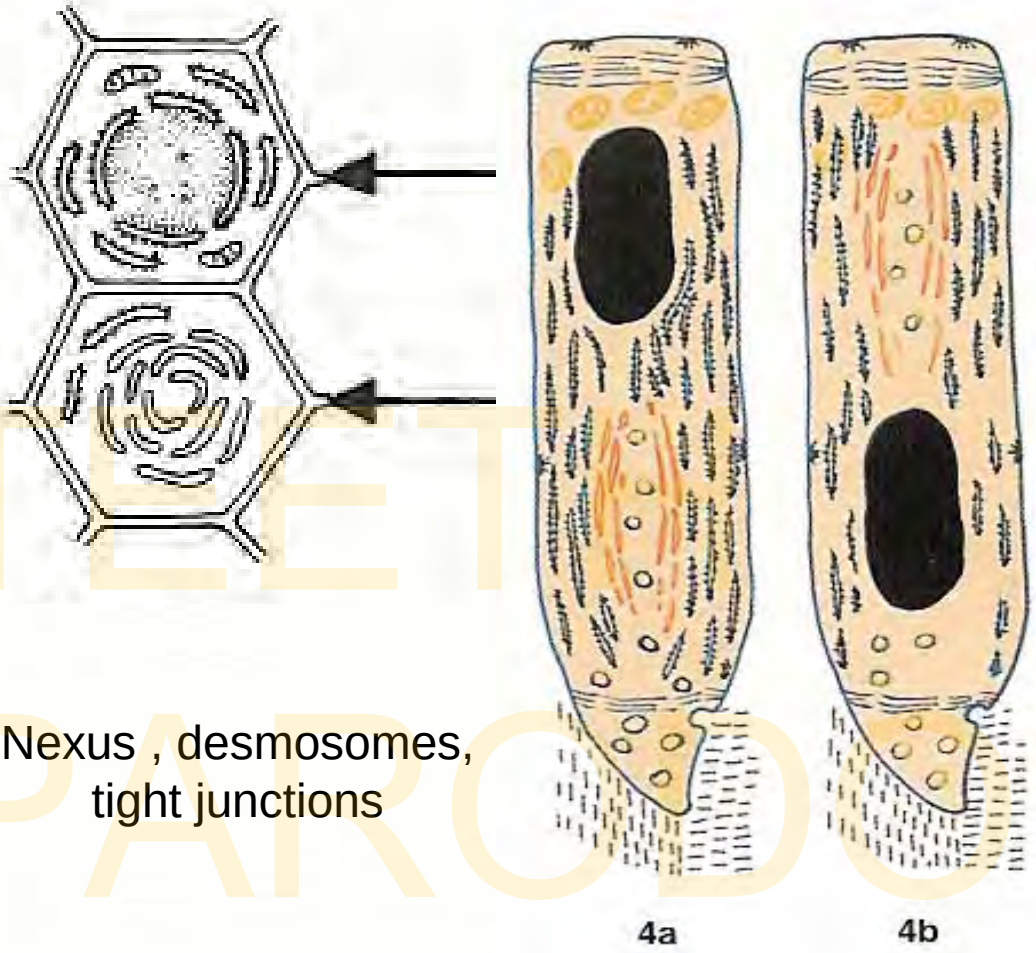
Enamel
substantia adamantinosa

- The most firm body part
- **Organic part**
  - Formed by ameloblasts
  - glykoproteins (amelogenins, enamelins)
- **Anorganic part 95%**
  - hydroxyapatite
    - Arranged in prisms
    - Among them there is the interprismatic substance

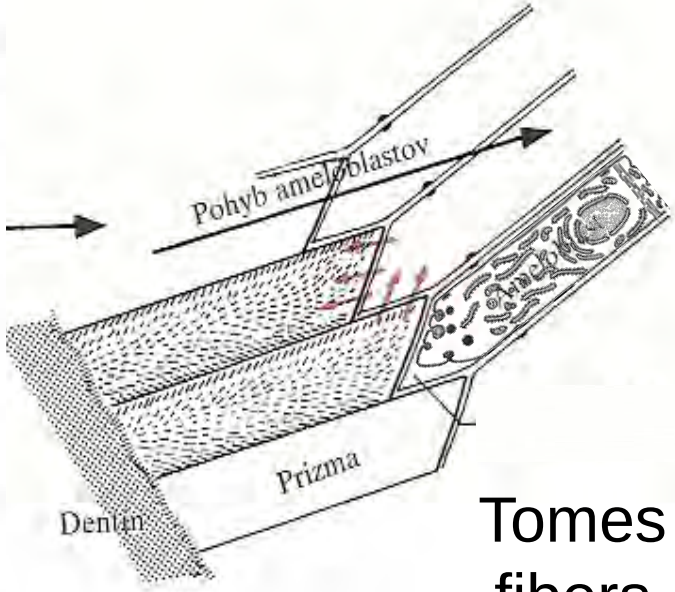


Ameloblasts

Prisms; interprismatic substance, crystals

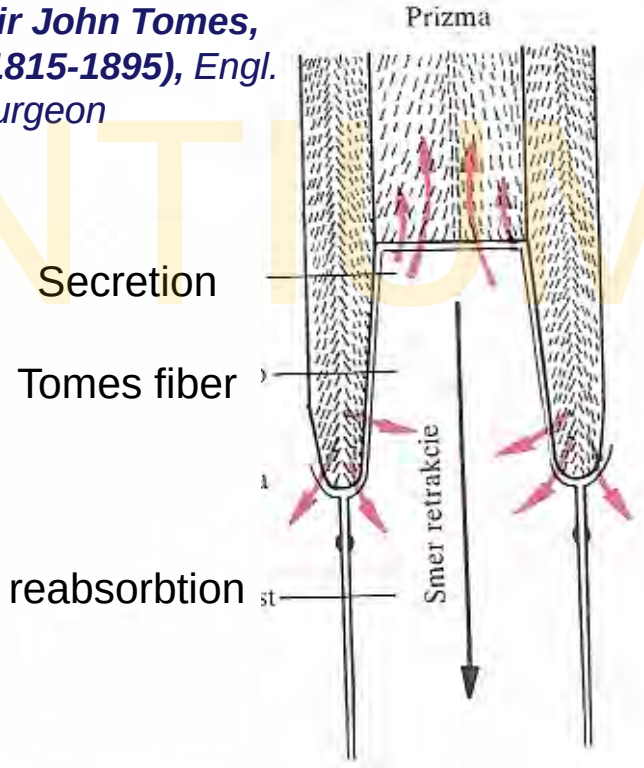


Nexus , desmosomes,
tight junctions



Tomes fibers

Sir John Tomes, (1815-1895), *Engl. surgeon*



Ameloblast: structure

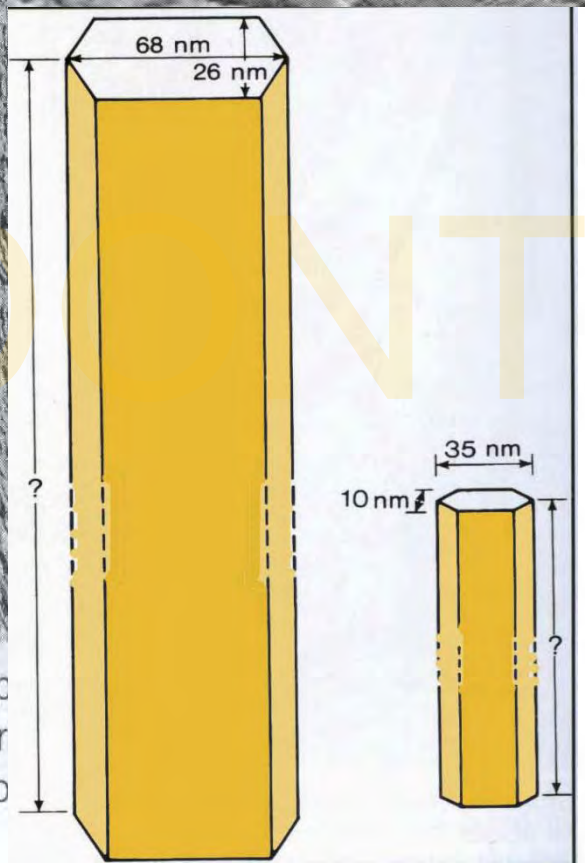
Secretion and reabsorbtion during enamelic matrix formation

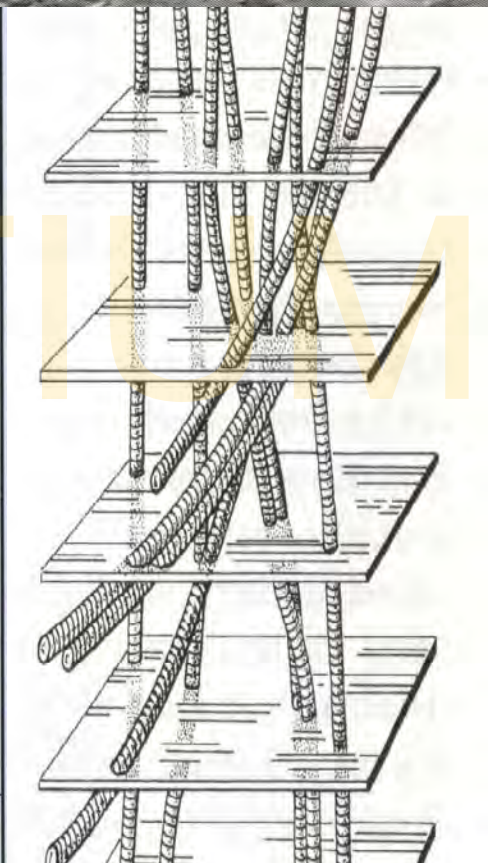
Enamel structure

Crystals, prisms and interprismatic substance (short and long molecules)

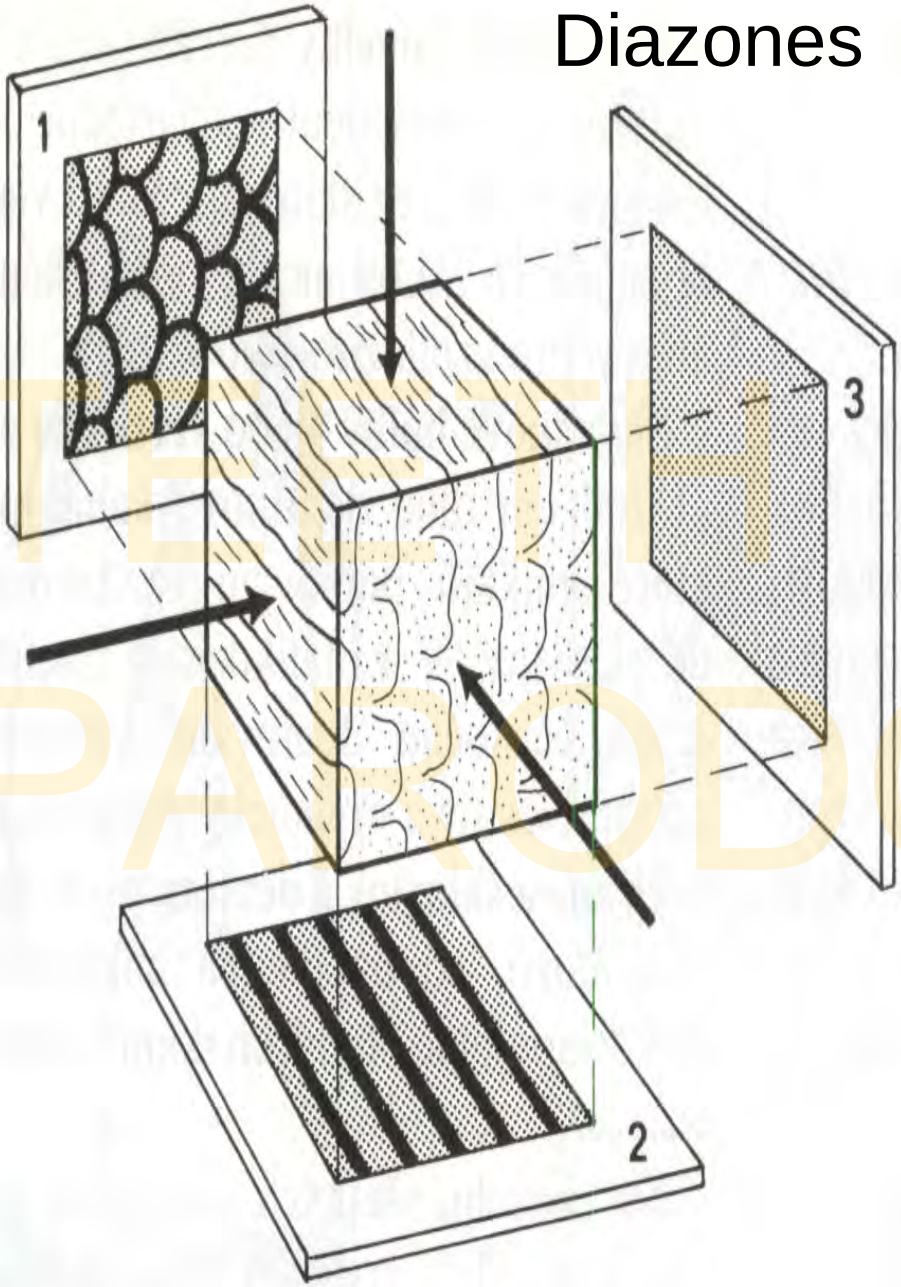
Prisms proceed to surface in various angles

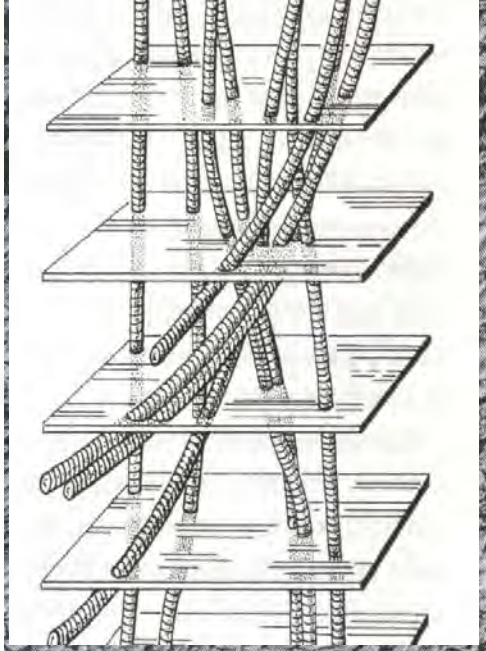
Fig. 7.17 SEM showing the orientation of enamel p
occlusal fissure. Note the acute angle at which the pr
surface in this region (× 100) Courtesy of Dr R.C. Sho
CRC Press.

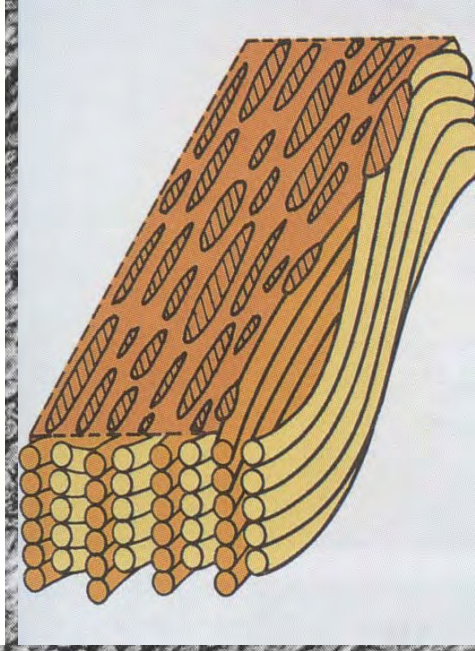




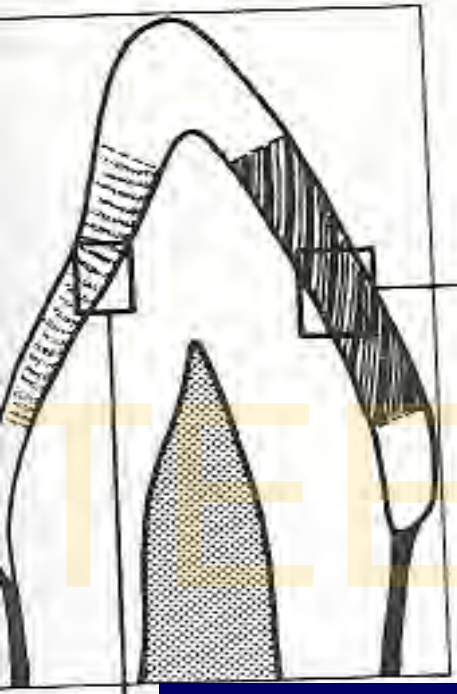
Parazones
Diazones

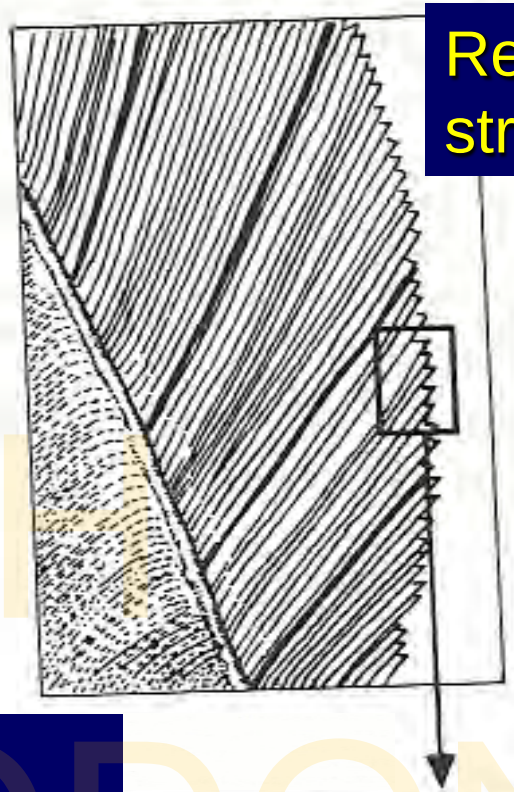




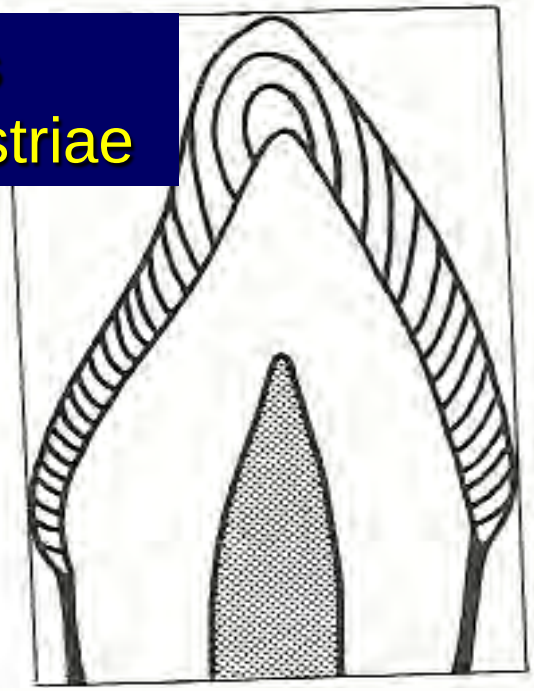


8 SEM of longitudinally sectioned enamel lightly etched to
ternating bands of transversely sectioned (diazones) and
linally sectioned (parazones) prism. (× 160). Courtesy of
Shore and the CRC Press.

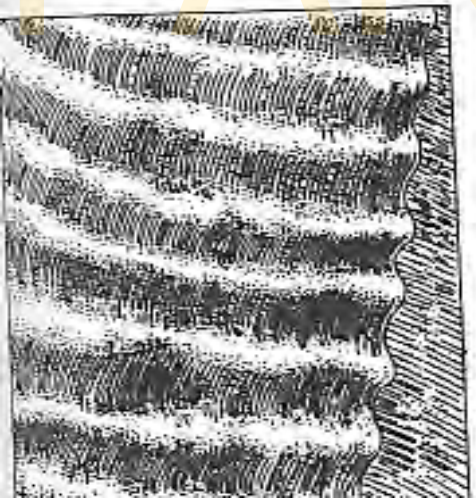


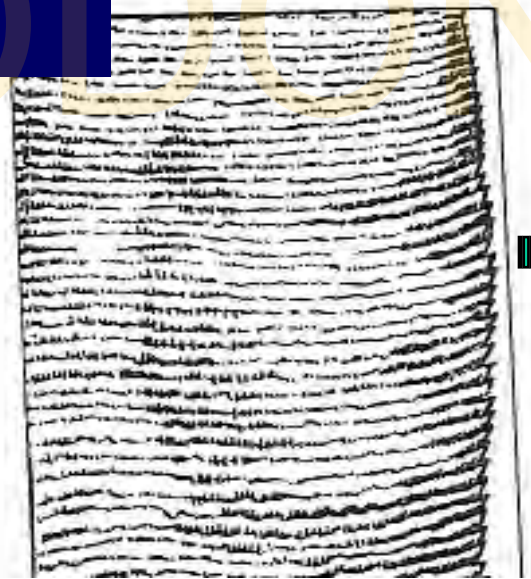


Retzius
strips, striae



Hunter-Schreger
strips, striae





Perikymata ridges,
grooves

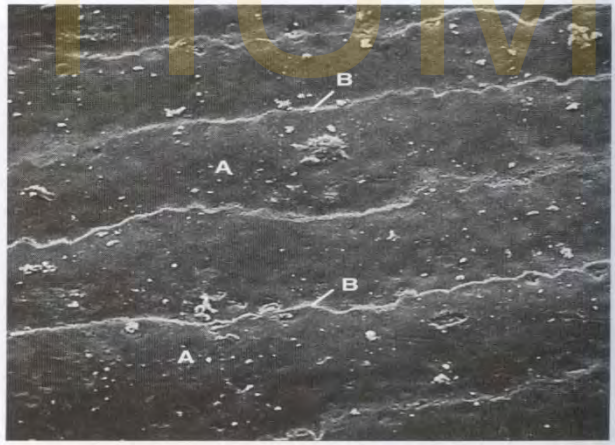
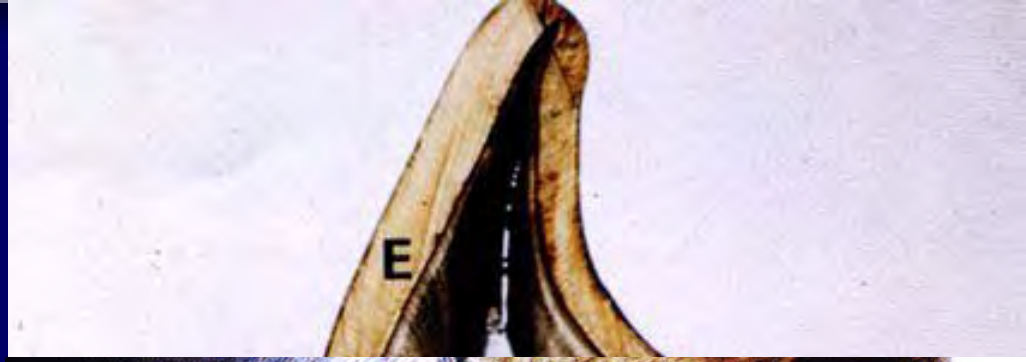
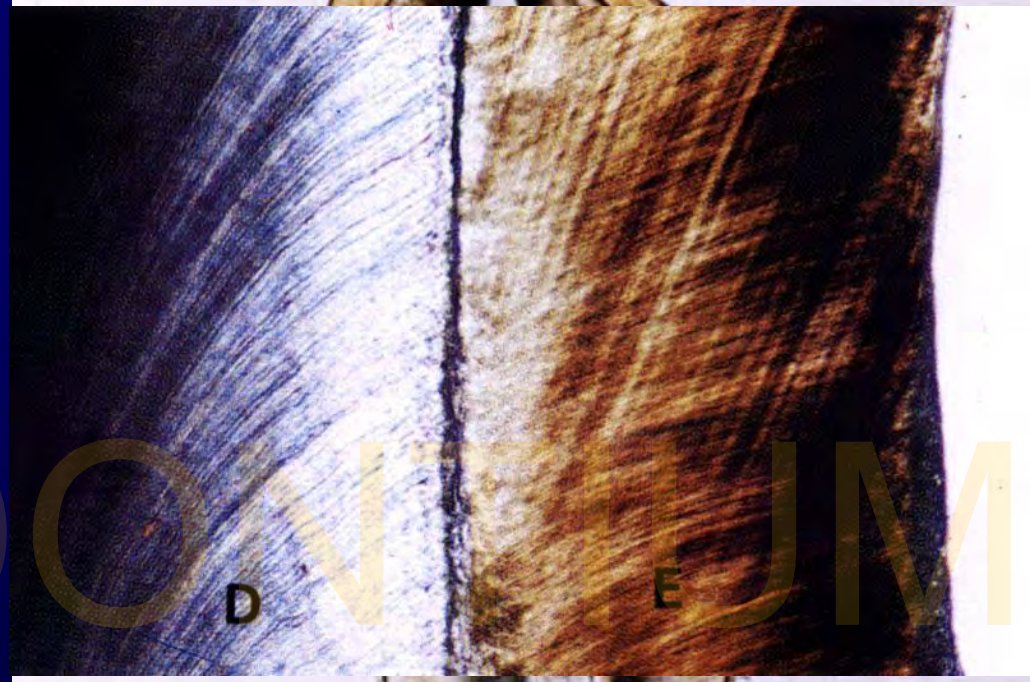


Fig. 7.39 SEM of enamel surface showing perikymata groov
separated from each other by perikymata ridges (B) (× 500).
Courtesy of Professor H.N. Newman.

Dentine substantia dentinum

- calcified connective tissue
- Organic part
  - colllagen I, proteoglycans
  - Formed by odontoblasts
    - Located on the inner dentine surface
    - Tomes fibers
- Anorganic part
  - hydroxyapatite
- No-calcified dentine
    - predentin
    - Closely to the enamel and cementum





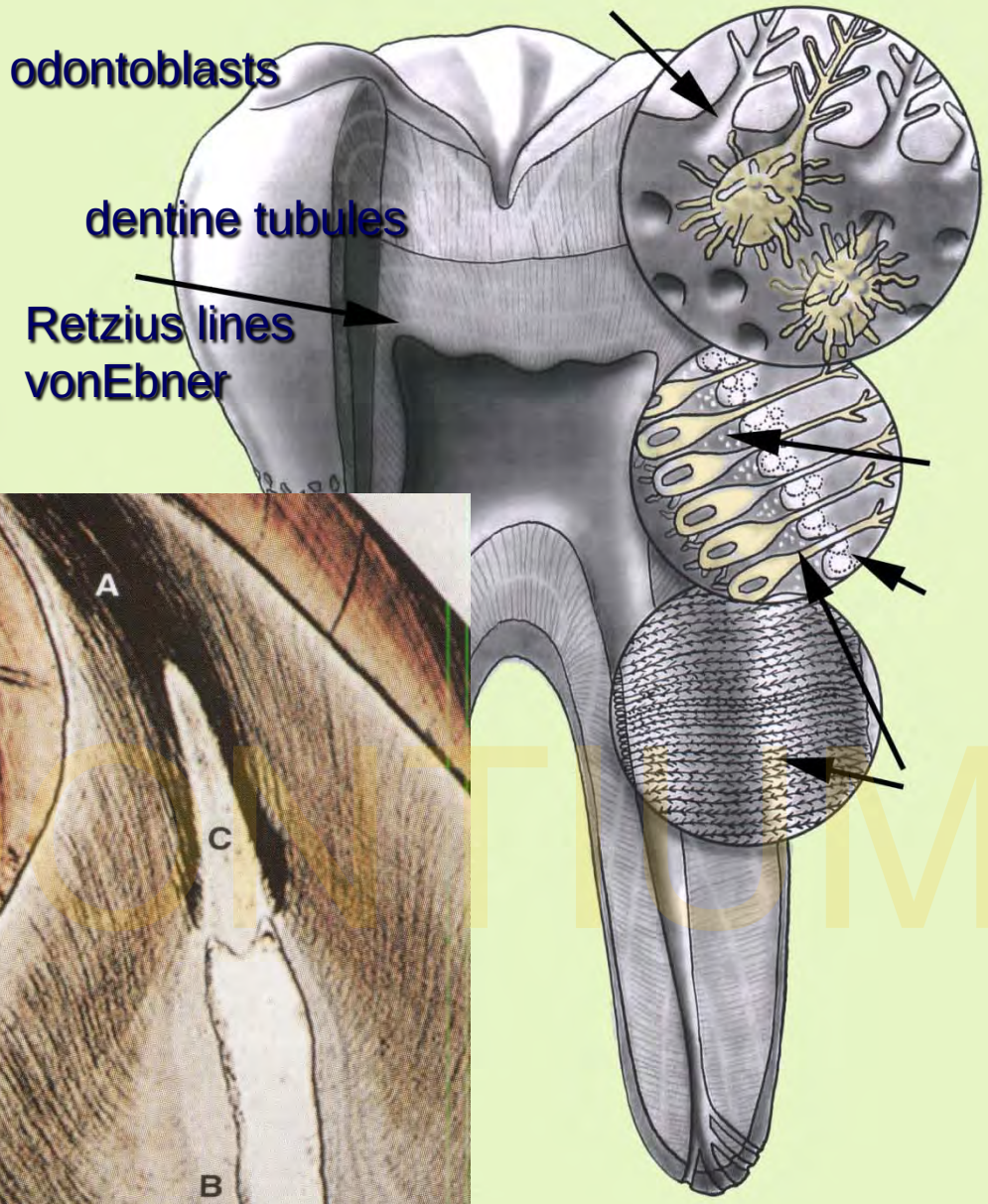
Dentin

Developmental order:

Primary
Secondary
Terciary

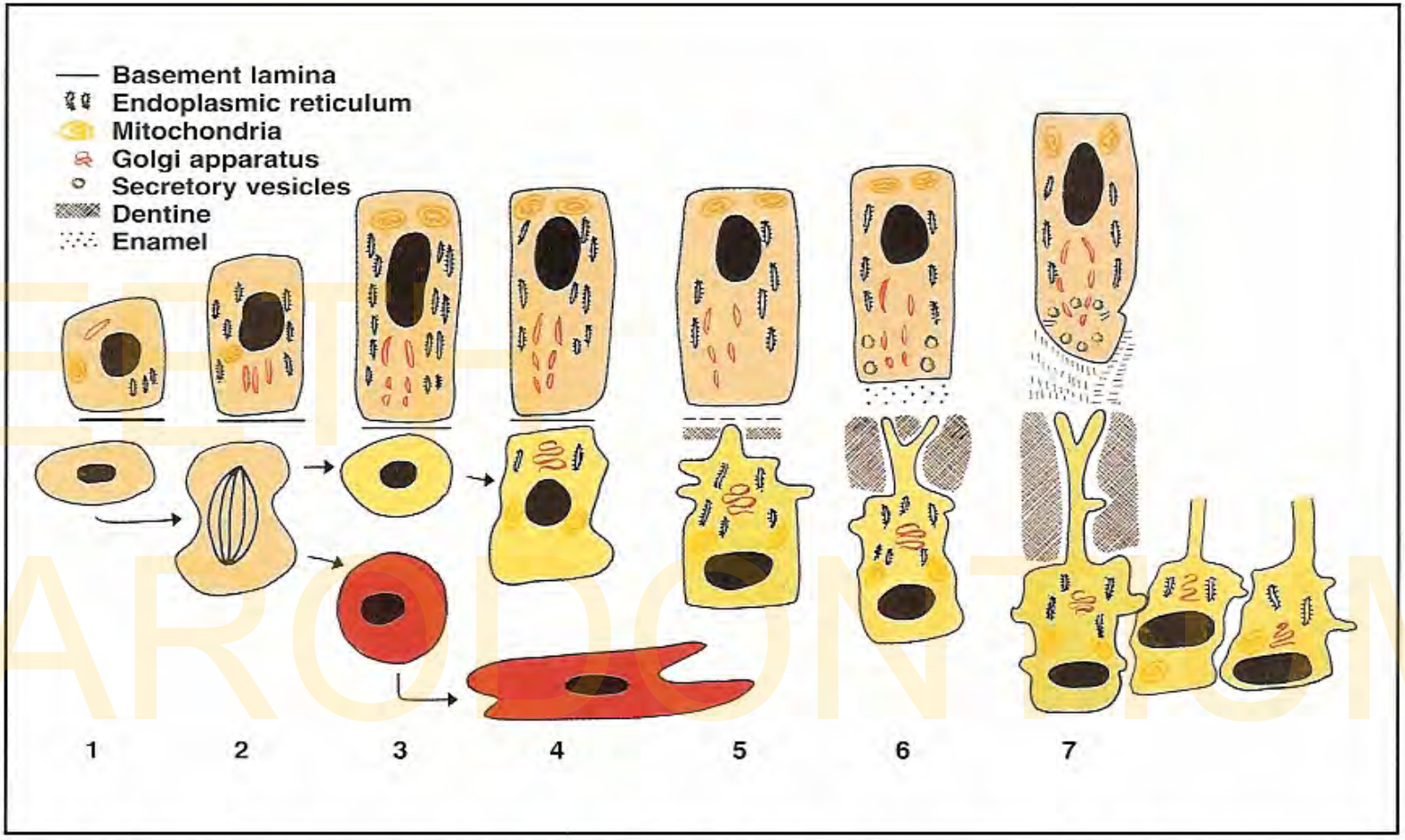
Folowing location:

Mantle
Circumpulpal
Interdentin
Globular
Predentin

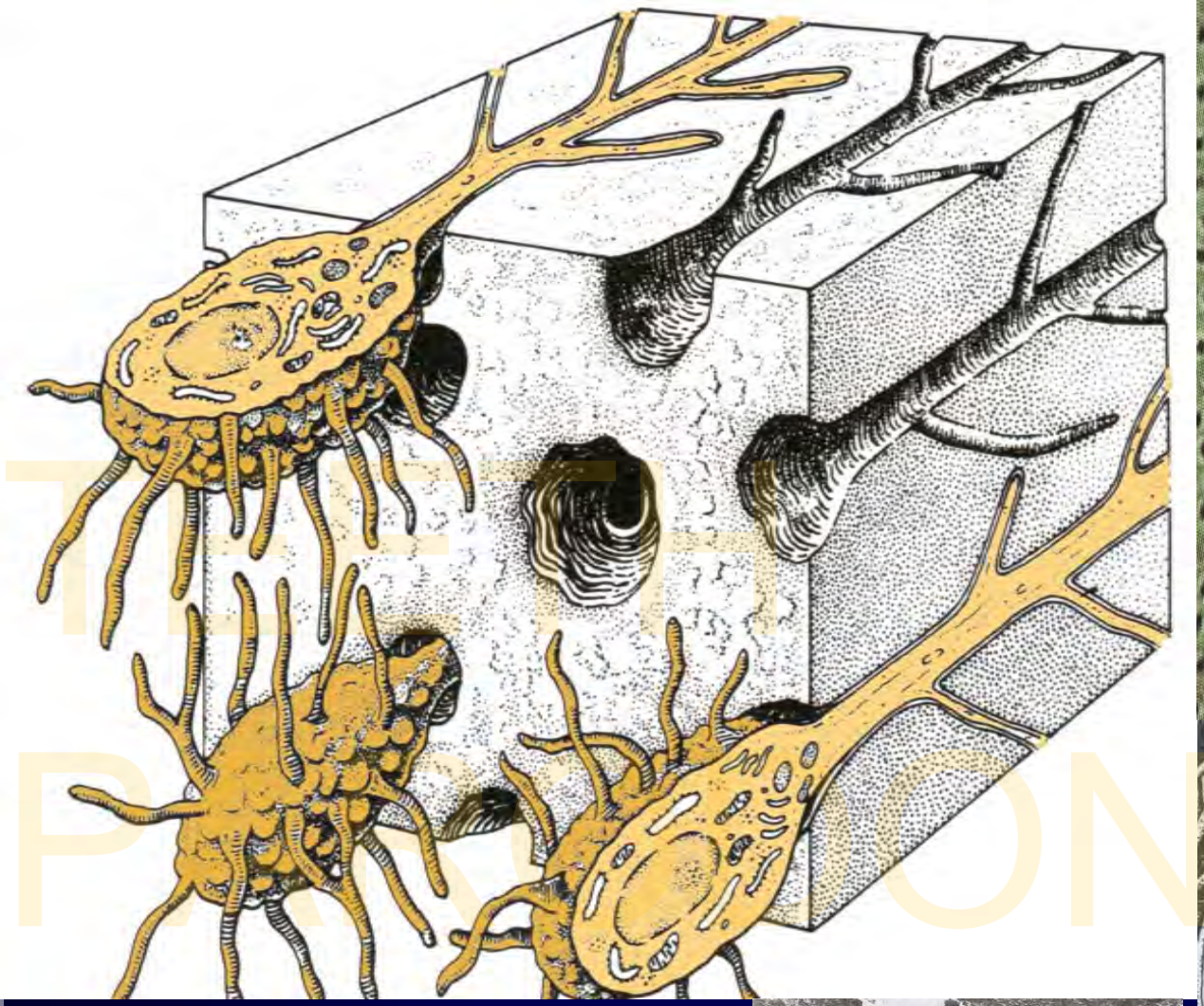


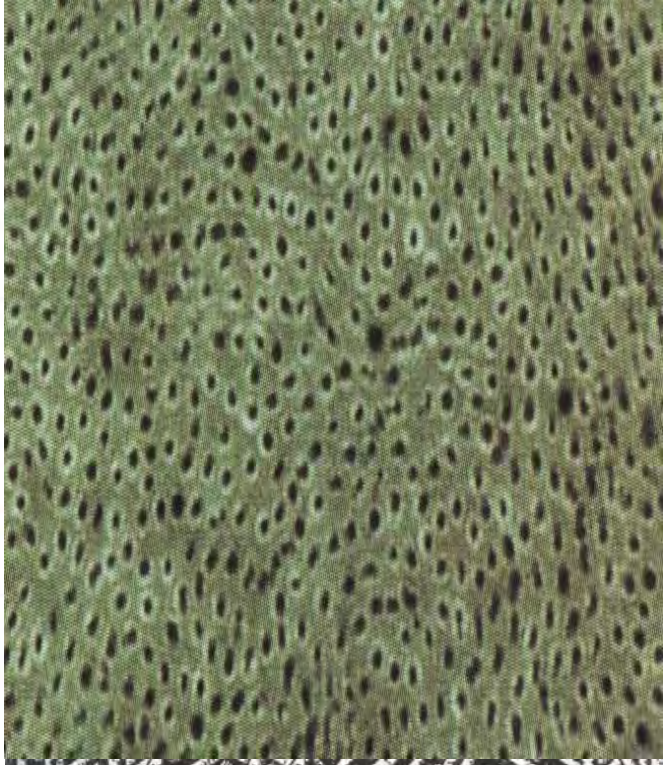
Odontoblasts, matrix, fibers

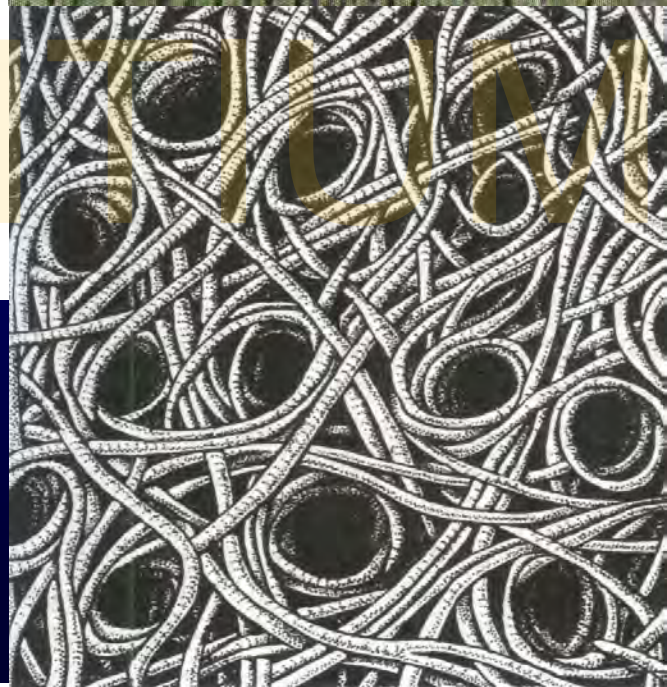
ODONTOBLASTS AND AMELOBLASTS



Life cycle of the odontoblast (lower cell line) related to that of the ameloblast (upper cell line). 1 = Ameloblast begins to differentiate first. 2 = Peripheral ectomesenchymal cells divide, with some daughter cells migrating below the odontoblast layer. 3 = Actin a signal from the ameloblast, the preodontoblasts begin to differentiate. 4 = Synthetic organelles increase in size and number, especially G apparatus and rough endoplasmic reticulum. 5 = Nucleus moves basally as the cell becomes polarised. A number of odontoblast processe begin to form. One odontoblast process becomes enlarged and begins to secrete matrix. 6 = The odontoblast retreats as matrix is laid do leaving behind a single main process. Once a narrow layer of matrix is laid down mineralisation commences. 7 = Once the first layer of dentine is laid down the differentiated ameloblast begins to deposit matrix.







Dentine tubules
Tomes fibers
Naumann sheath /sheet/

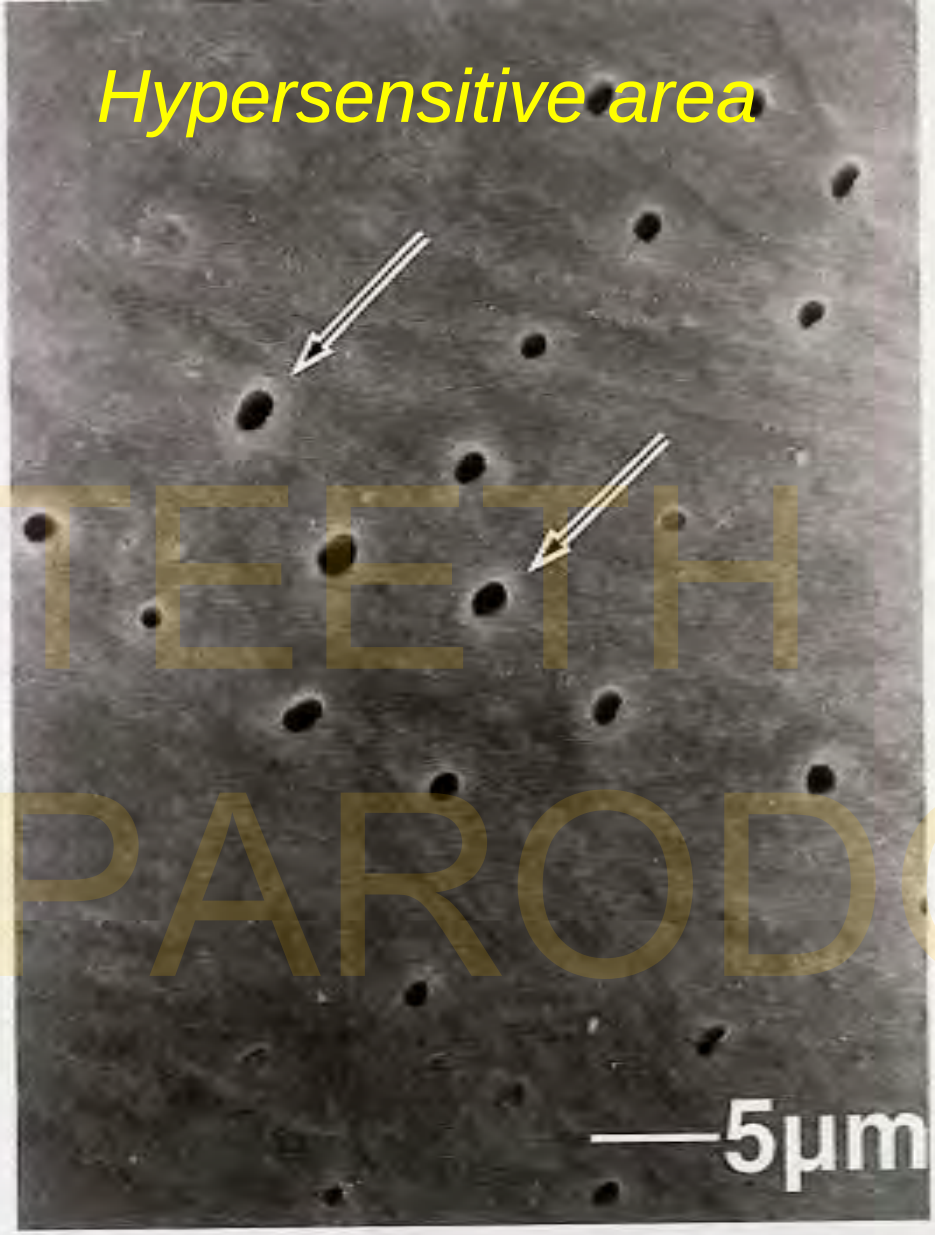


Fig. 9.68 SEM of an exposed dentine surface of a hypersensitive area. A large proportion of dentinal tubules (arrows) are seen to be open (× 2400). Courtesy of Dr M. Yoshiyama and the editor of the *Journal of Dental Research*.

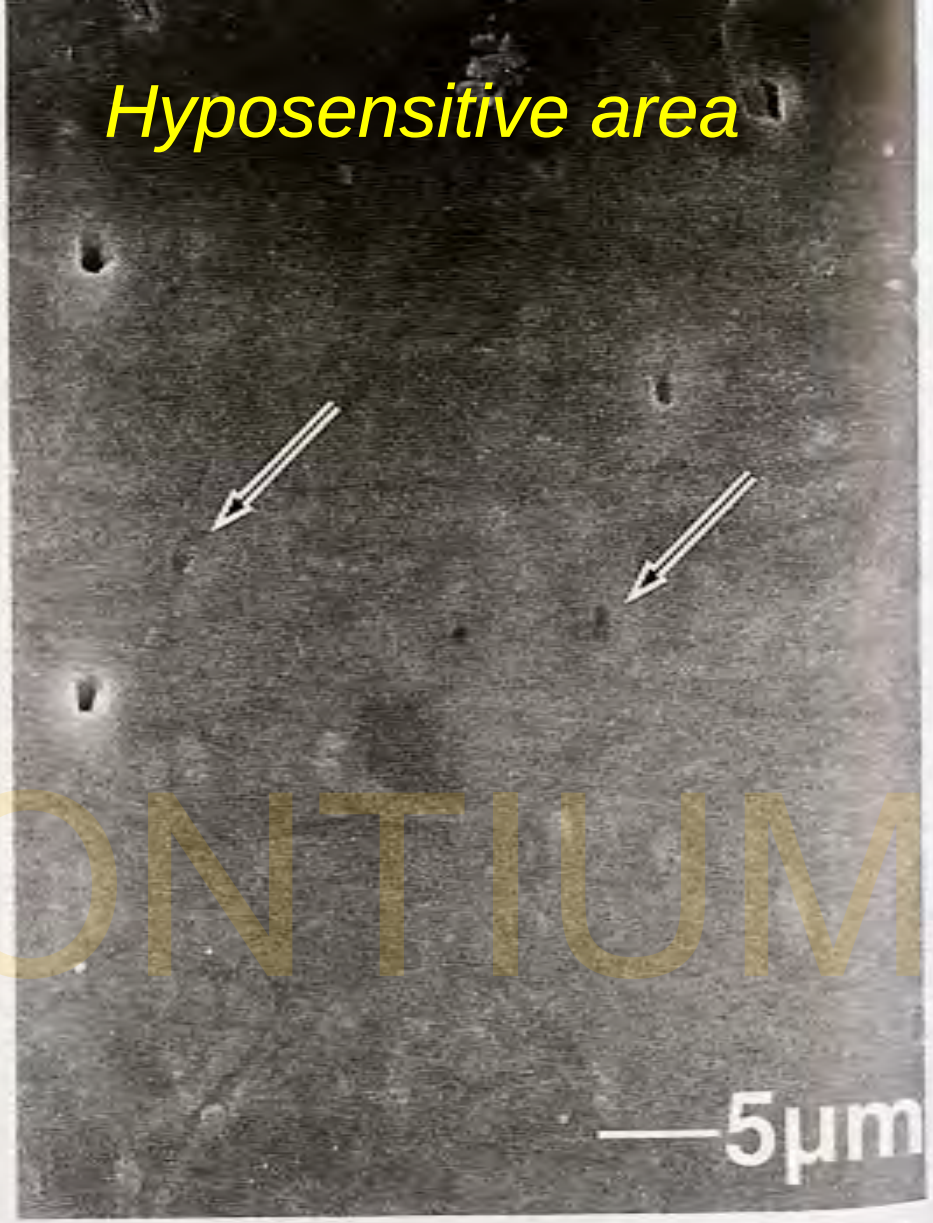


Fig. 9.69 SEM image of the exposed dentine surface of a naturally desensitised area. The lumens of dentinal tubules (arrows) are mostly occluded (× 2400). Courtesy of Dr M. Yoshiyama and the editor of the *Journal of Dental Research*.

Dentine structure

External coat
Mantle dentine

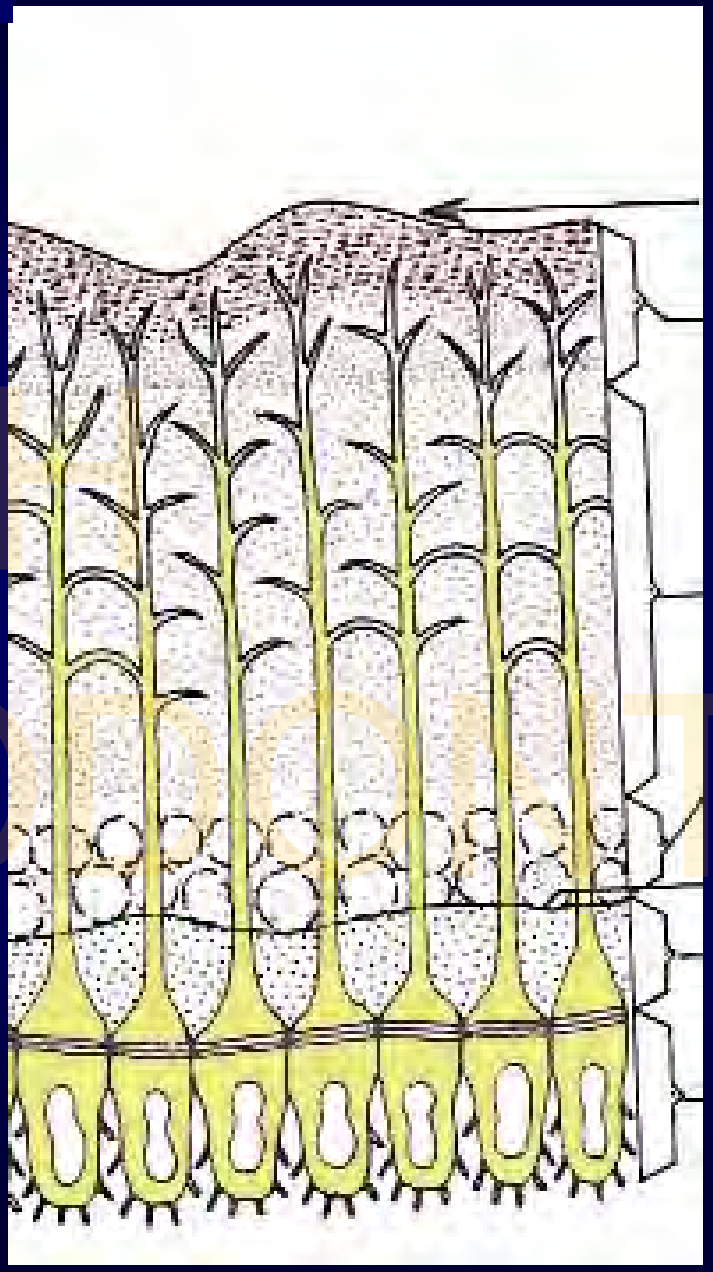
10-30um; contains alfa-fibrills

Inner dentine
Circumpulpal dentine

Stripped; exhibits regular secretion and mineralization layers

Predentine

Amorphous; area of synthesis; polymorphous, contains proteoglycans, tropocollagen, glycoproteins



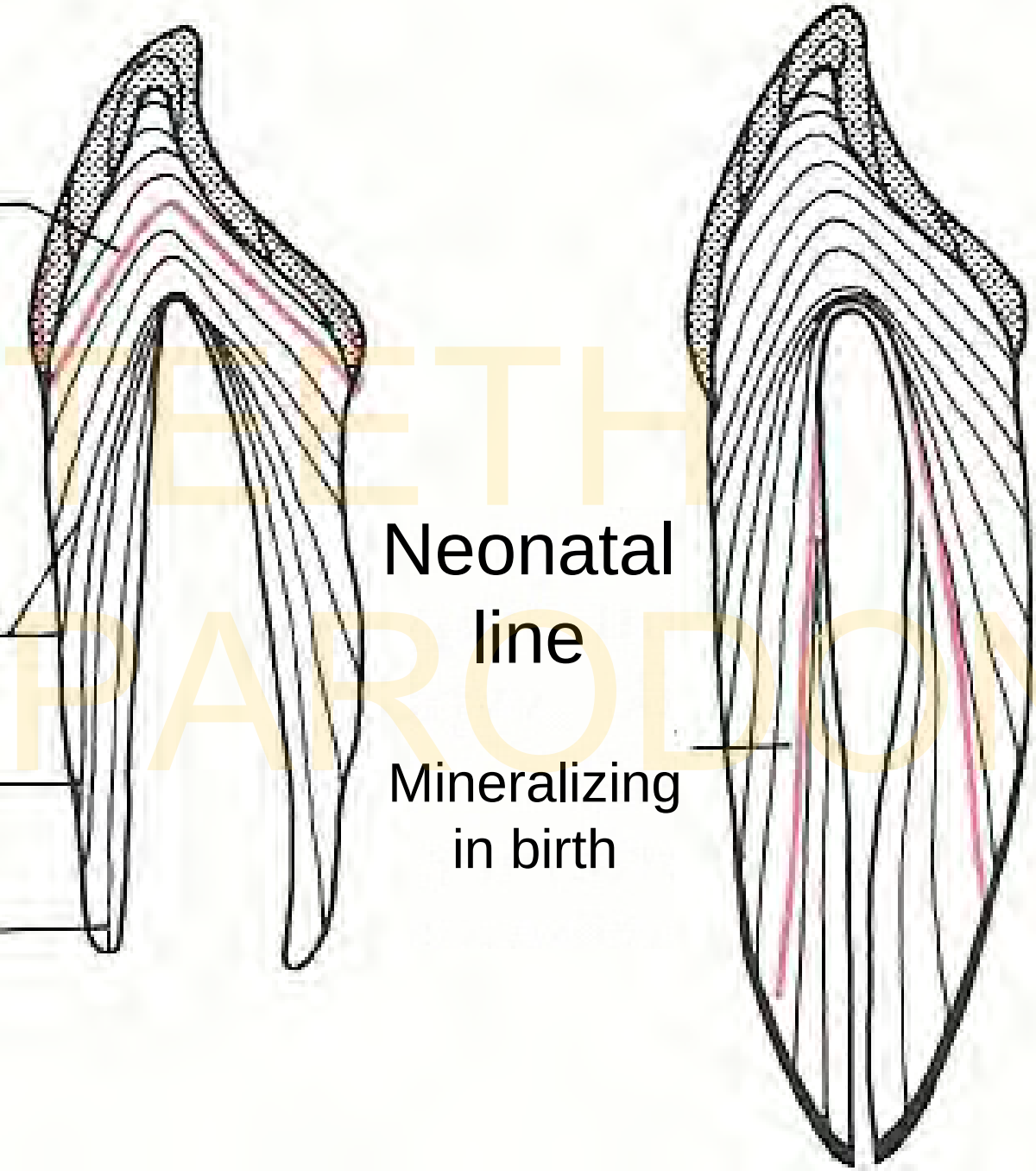
Mantle dentine
Intermingling processes
granular

Circumpulpal dentine
matrix rich

Interdentine
interglobular

Predentine
matrix poor

odontoblasts



Neonatal line

Mineralizing in birth

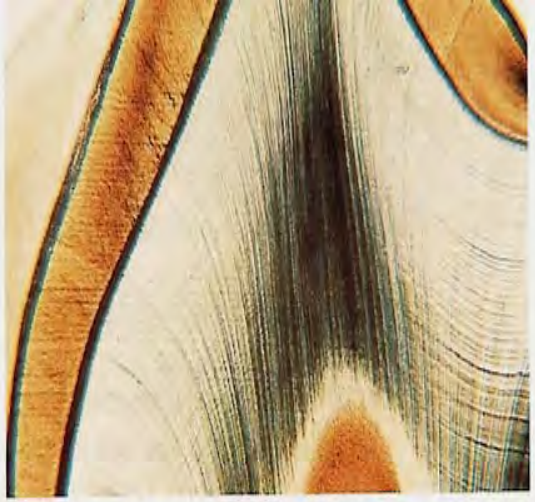


Fig. 9.40 Ground longitudinal section of a crown showing, on the right side, horizontally running long-period incremental lines (× 12). Courtesy of Dr B.A.W. Brown.

Incremental lines (associated with dentine maturation)

Von Ebner

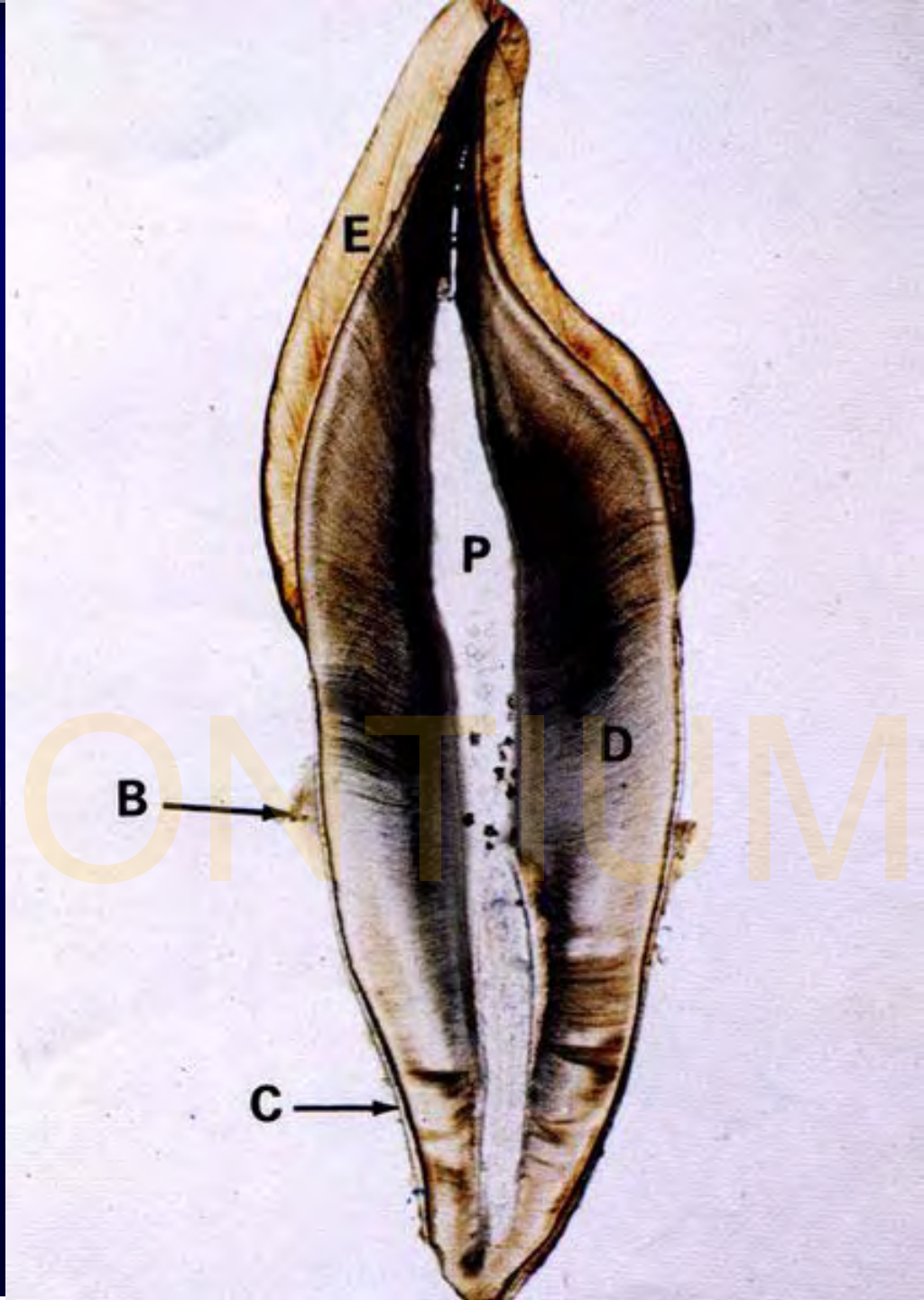
Adresen

Neonatal

Relation between primary and secondary dentine

Cementum = substantia ossea

- Thin layer on the root
- Similar to the spongy bone
- Cellular part – cementocytes



Cementum

Cementoblasts, mucoprotein substance, fibers

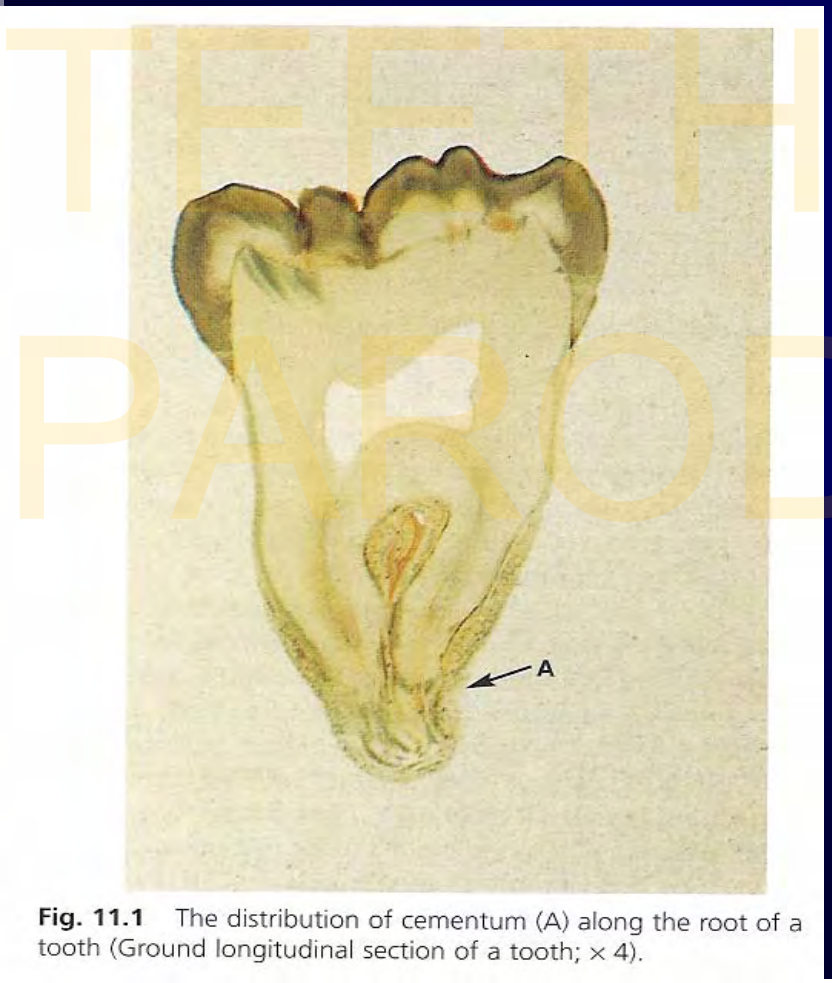
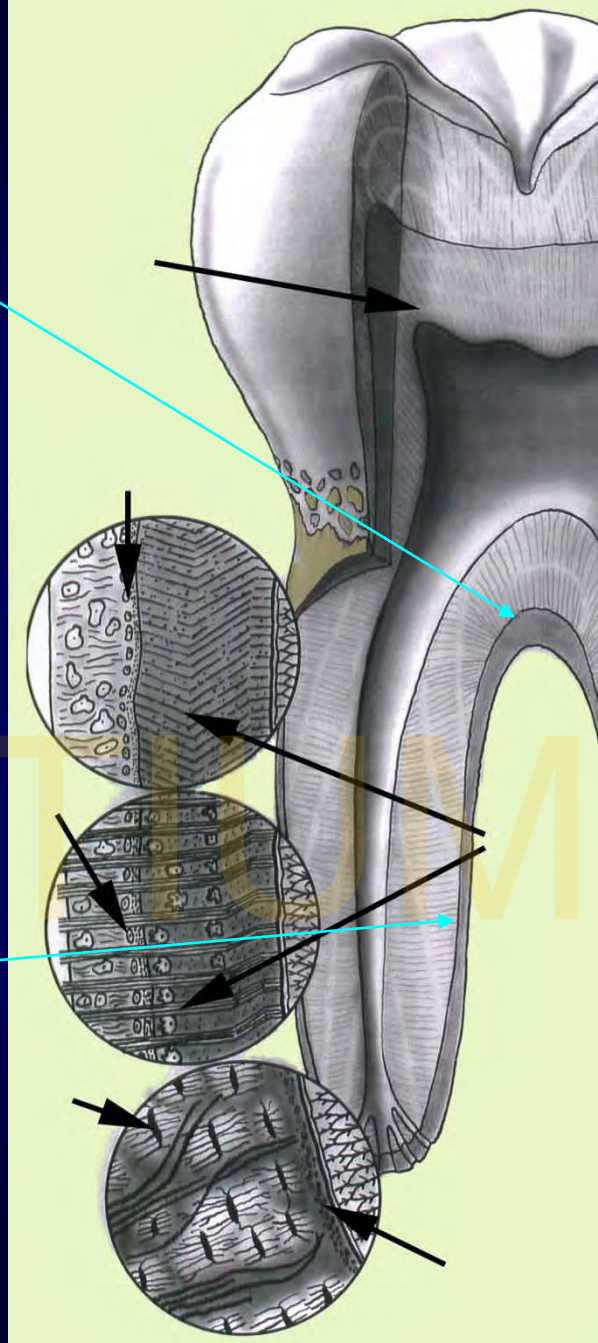


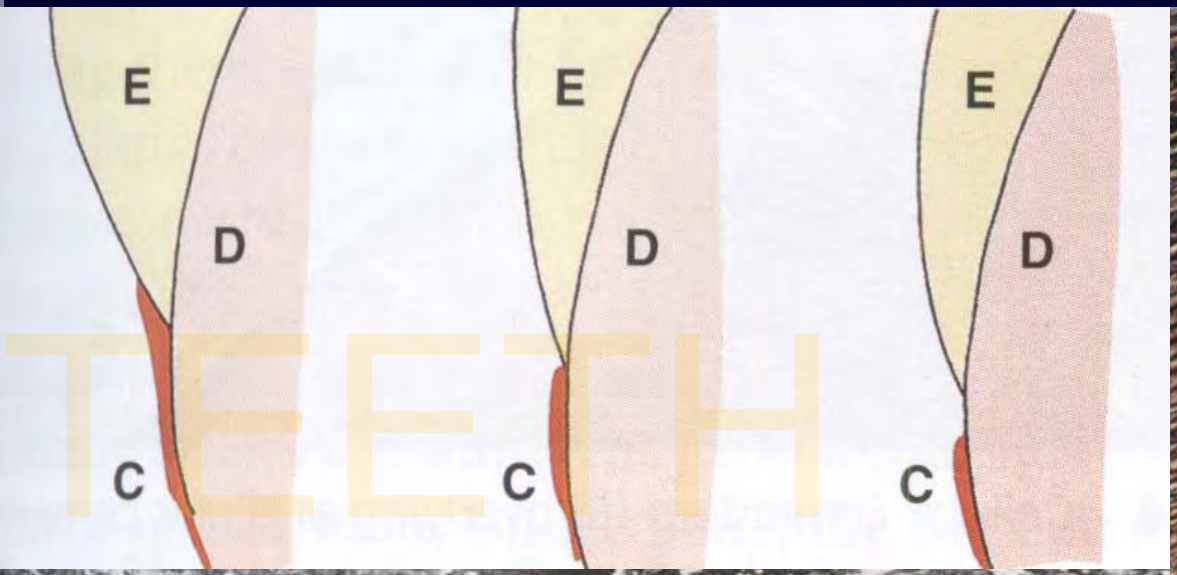
Fig. 11.1 The distribution of cementum (A) along the root of a tooth (Ground longitudinal section of a tooth; × 4).

Cellulare:
Collagen fibers + intercellulare substance + cementocytes

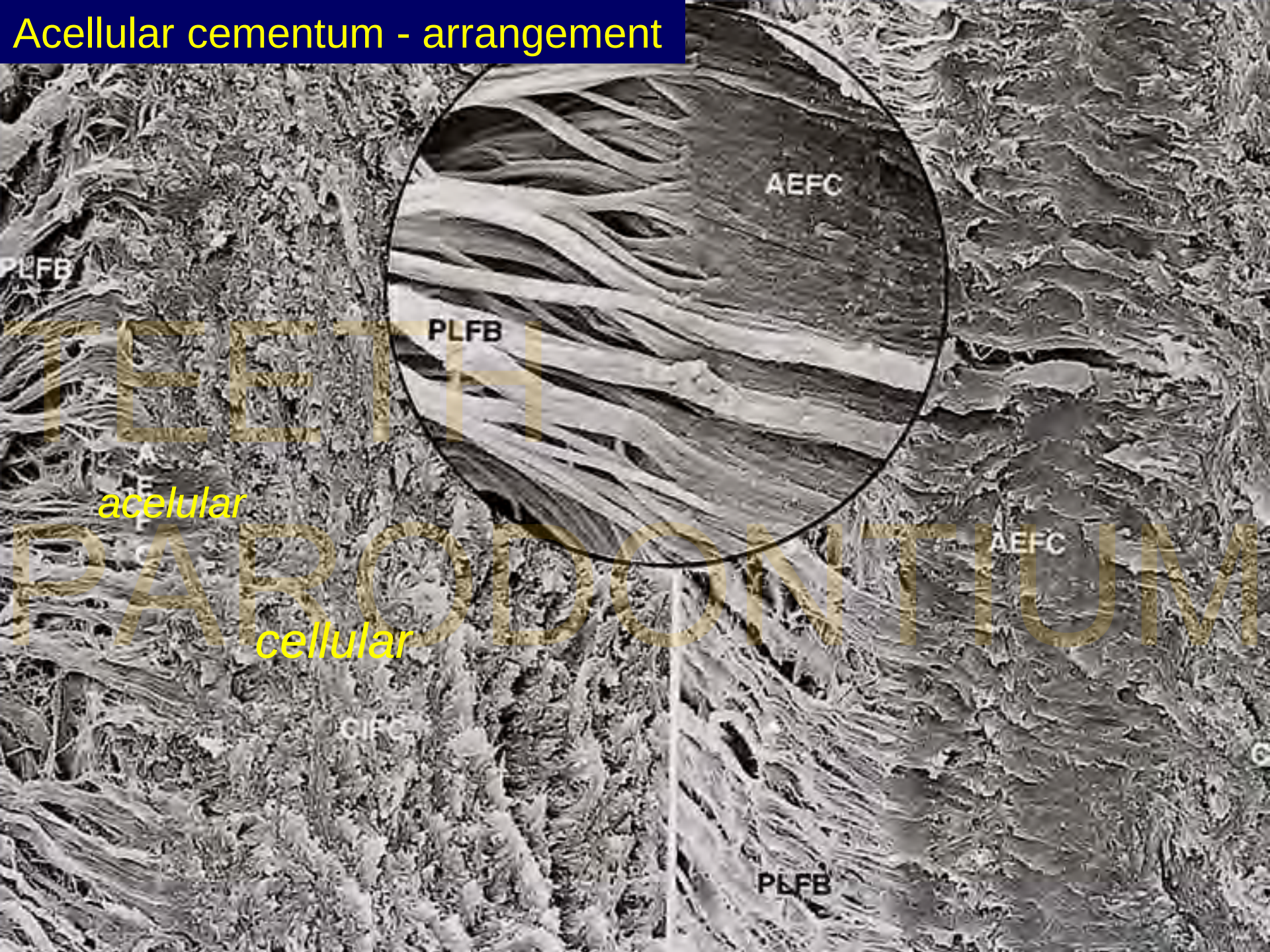
Non cellulare:
Collagen fibers + intercellular substance



Relation between cementum, dentine and enamel

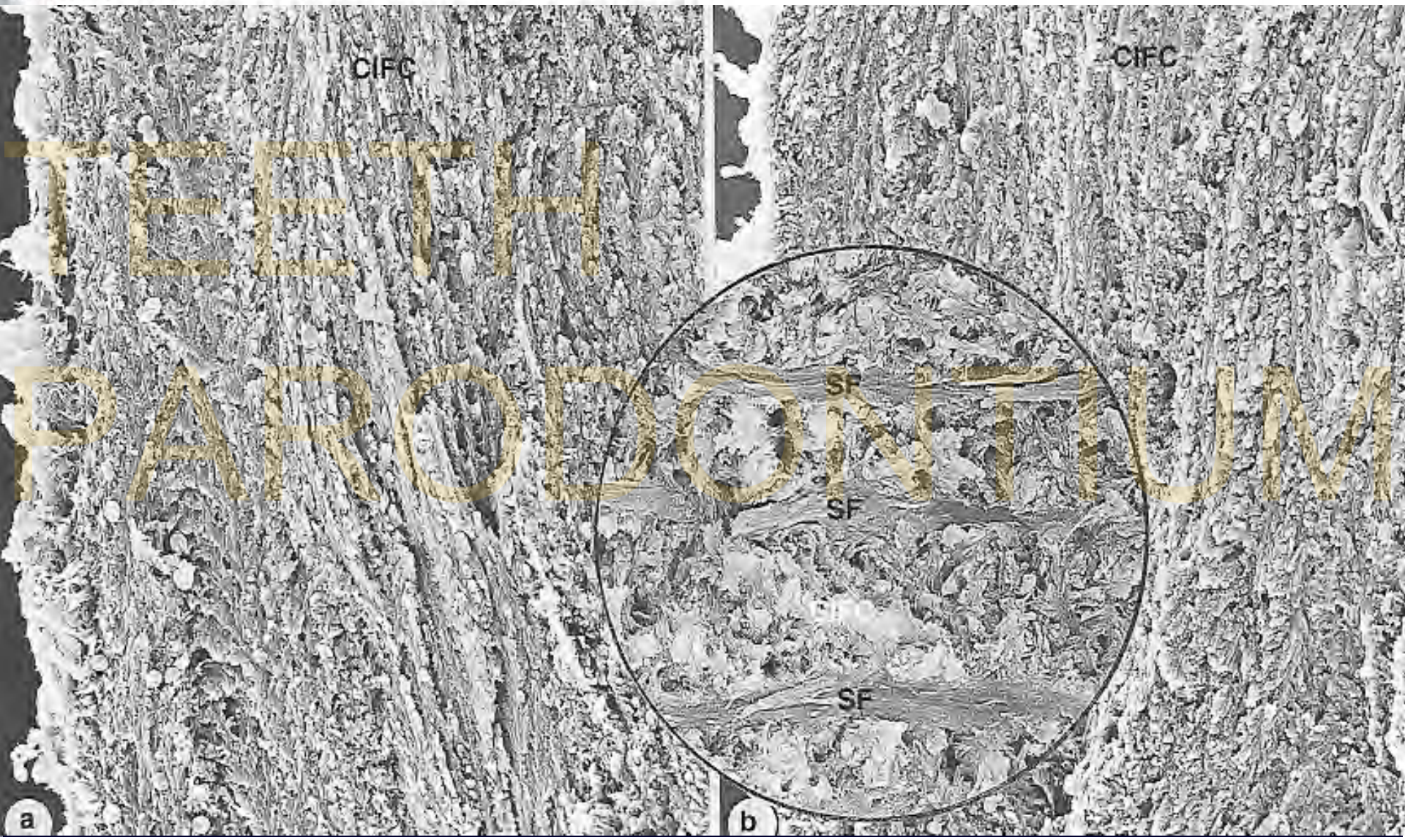


Acellular cementum - arrangement



Cellular cementum - structure

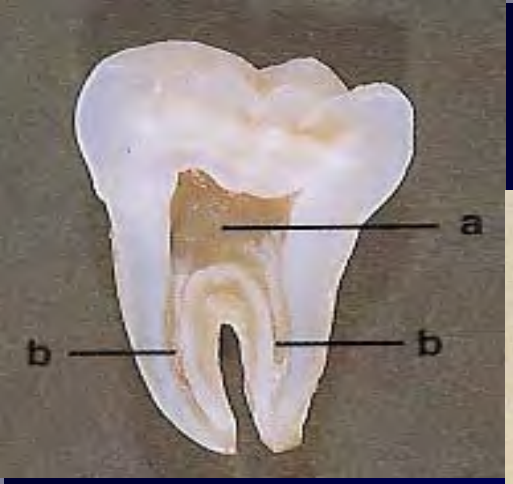
11.17 SEMs of fractured surface of root showing the appearance of cellular intrinsic fibre cementum (CIFC). Note the absence of ›ey's fibres and the parallel distribution of the bundles of mineralised intrinsic fibres (a and b × 470; inset × 1650). Courtesy of Professor Schroeder and the editor of *Schweizer Monatsschrift für Zahnmedizin*.

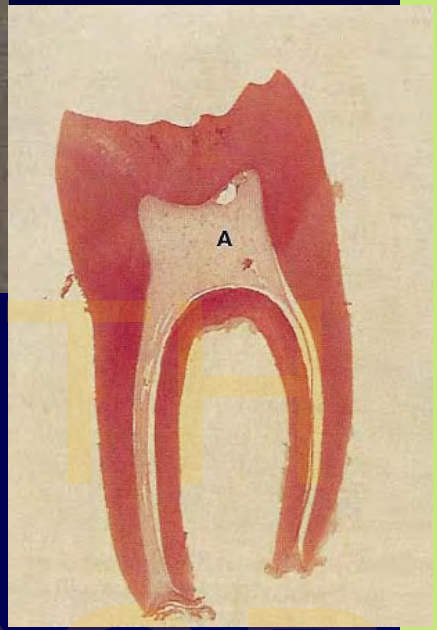


Hypercementosis

Fig. 11.31 (a) Hypercementosis at root apex (arrow). Courtesy of Dr J. Potts. (b) Ground section near the root apex showing hypercementosis. Arrow shows cement – dentine junction (× 25).

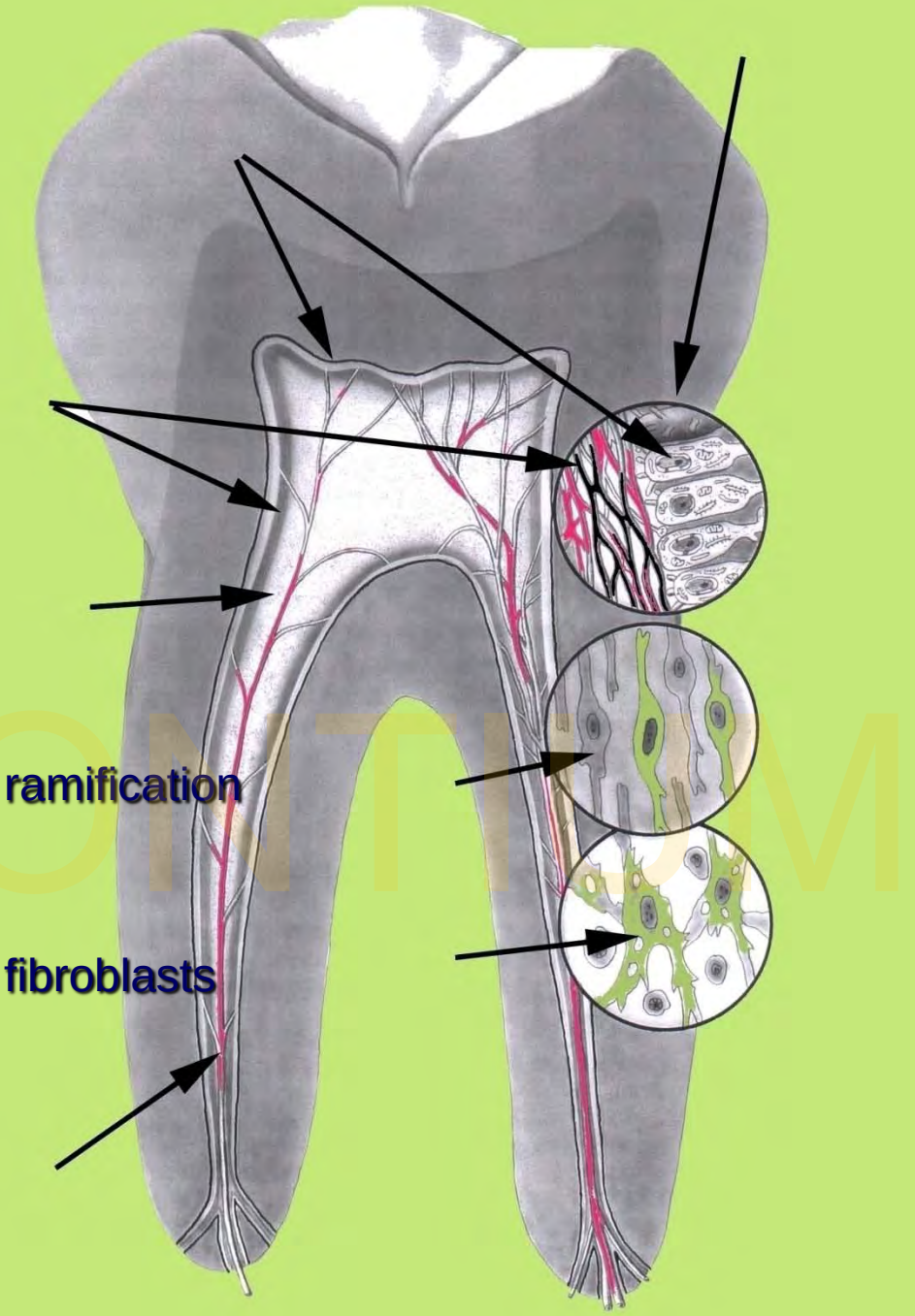
Pulp

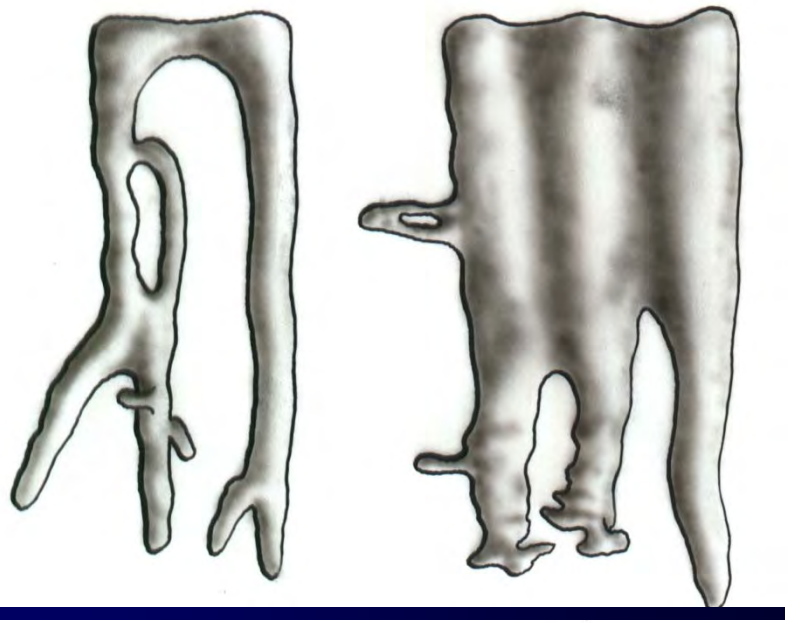


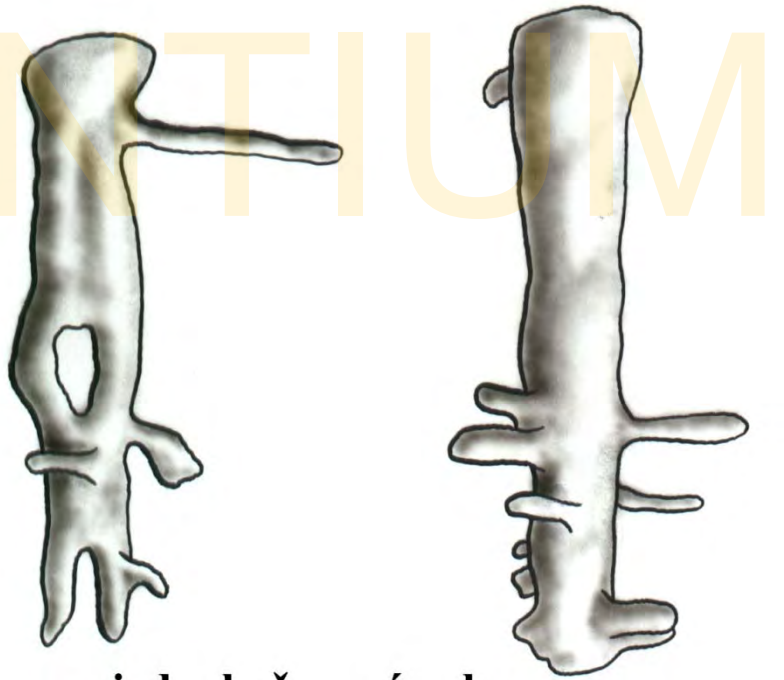


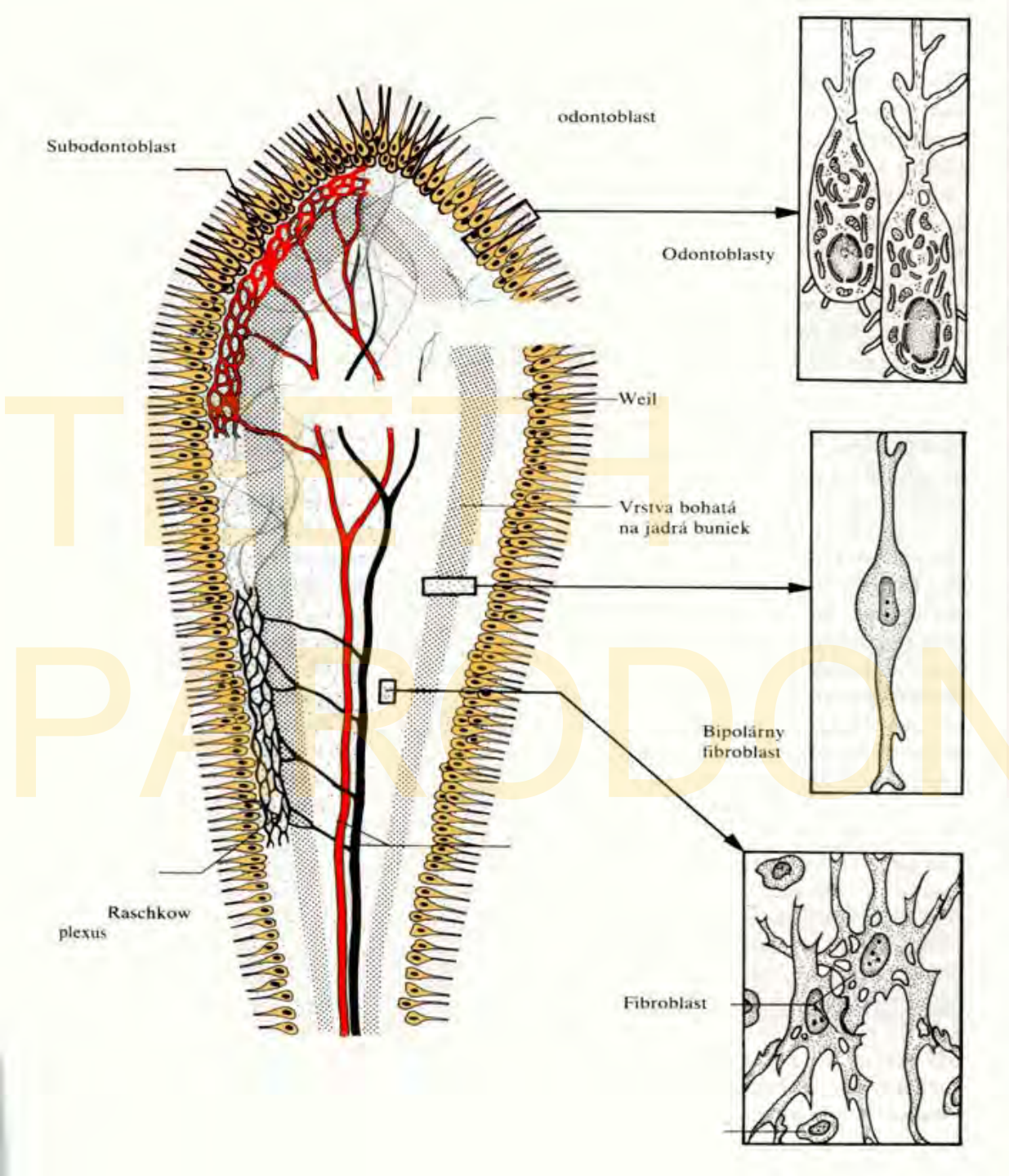
- Odontoblasts,
- Weil subodontoblastic layer
- Layer rich by nuclei

Pulpocytes (mesenchymal cells, fibrocytes)
basic substance (collagen fibers, sugars, elastic fibers)
free cells (histiocytes, monocytes, plasmatic cells)









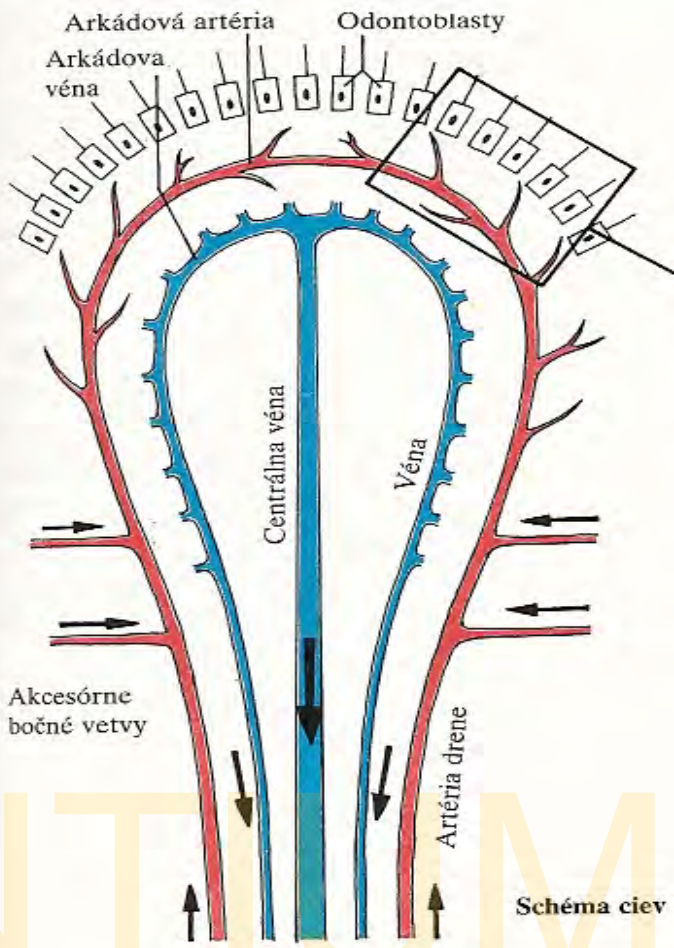
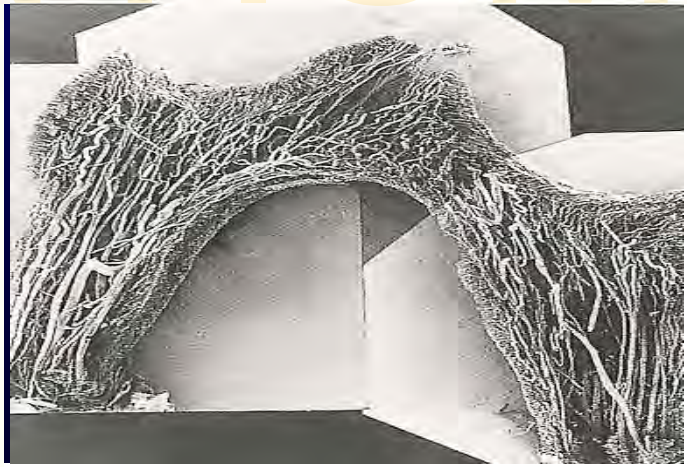
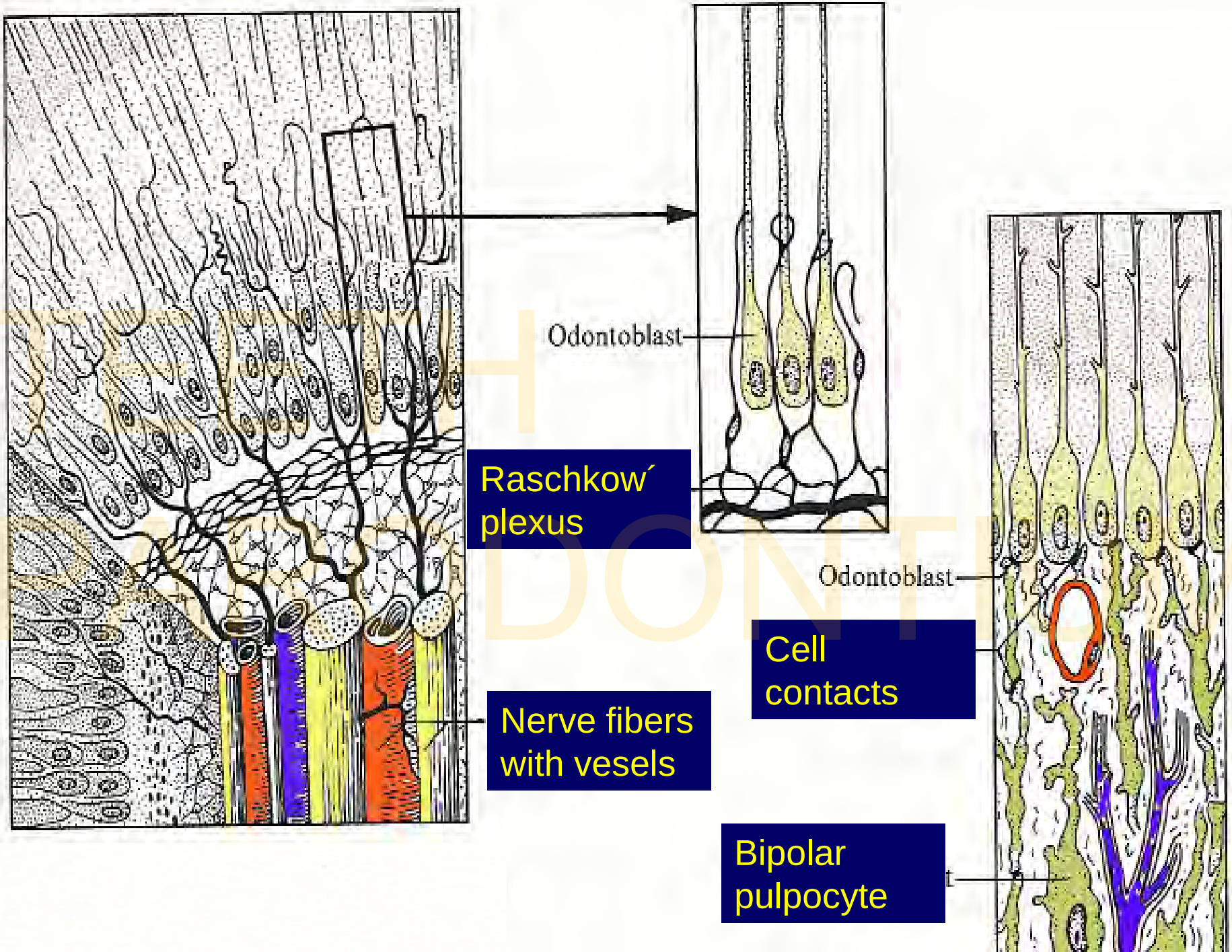


Schéma ciev




Odontoblast
Raschkow´ plexus
Odontoblast
Cell contacts
Nerve fibers with vesels
Bipolar pulpocyte

Epitelové ostrůvky Malassez´
epithelial islets
Hertwig´ epithelial sheet

Louis-Charles Malassez *(1842-1909), frc. vědec*

Oscar Hertwig *(1849- 1922) něm. zoolog a anatom*

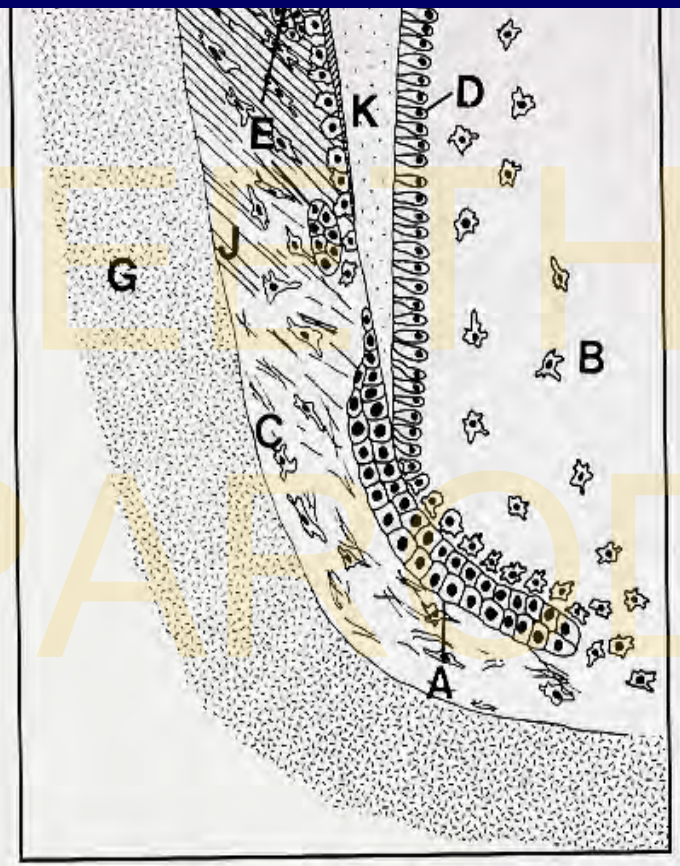


Fig. 25.4 Schematic drawing of the developing root. A = Epithelial root sheath; B = dental papilla; C = dental follicle; D = odontoblasts; E = epithelial rests; F = cementoblasts; G = developing alveolar bone; H = developing cementum; J = developing periodontal ligament; K = root dentine.

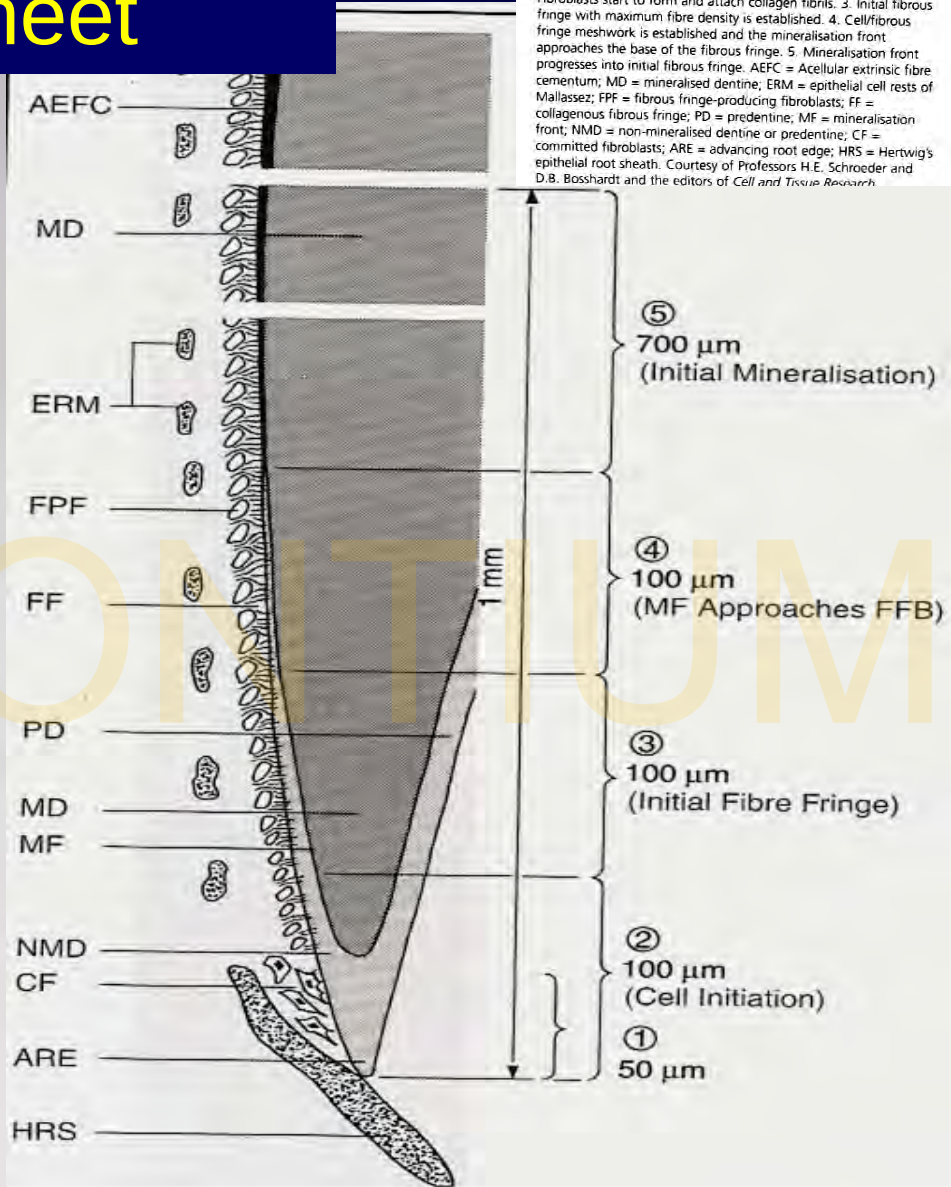


Fig. 25.23 The initial stages of root development on human premolars developed to 50–60% of their final root length. 1. fibroblasts contact root/predentine and become committed.2. Fibroblasts start to form and attach collagen fibrils. 3. Initial fibrous fringe with maximum fibre density is established. 4. Cell/fibrous fringe meshwork is established and the mineralisation front approaches the base of the fibrous fringe. 5. Mineralisation front progresses into initial fibrous fringe. AEFC = Acellular extrinsic fibre cementum; MD = mineralised dentine; ERM = epithelial cell rests of Mallassez; FPF = fibrous fringe-producing fibroblasts; FF = collagenous fibrous fringe; PD = predentine; MF = mineralisation front; NMD = non-mineralised dentine or predentine; CF = committed fibroblasts; ARE = advancing root edge; HRS = Hertwig's epithelial root sheath. Courtesy of Professors H.E. Schroeder and D.B. Bosshardt and the editors of *Cell and Tissue Research*.

Teeth: Vascular and nervous supply

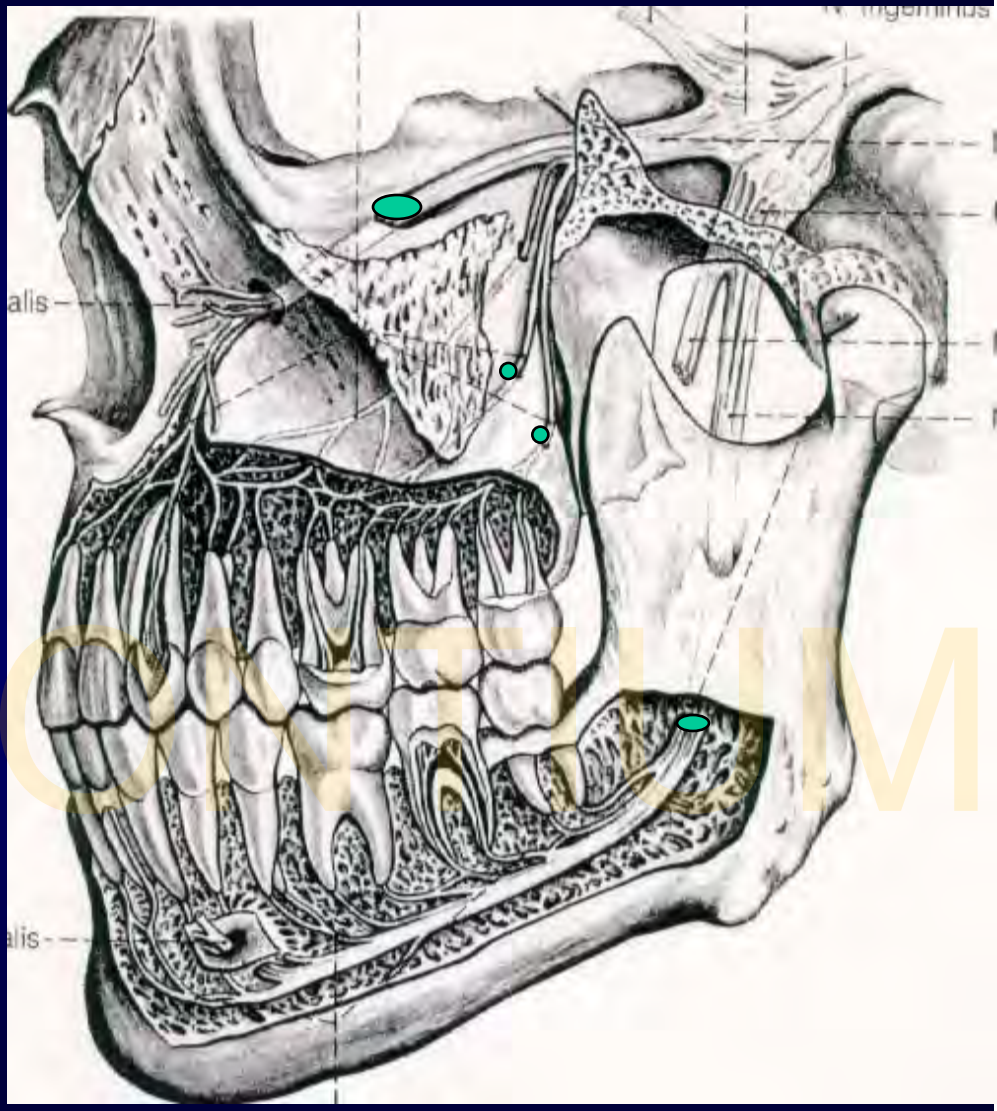
n.V/2 br.alveolares sup. post.
br.alveolares sup. ant.
n.V/3 n. alveolaris inf.

plexus dent. (sup., inf.)
br. dentales, gingivales

aa. alveolares sup. post.
aa. alveolares sup. ant.
a. alveolaris inf.

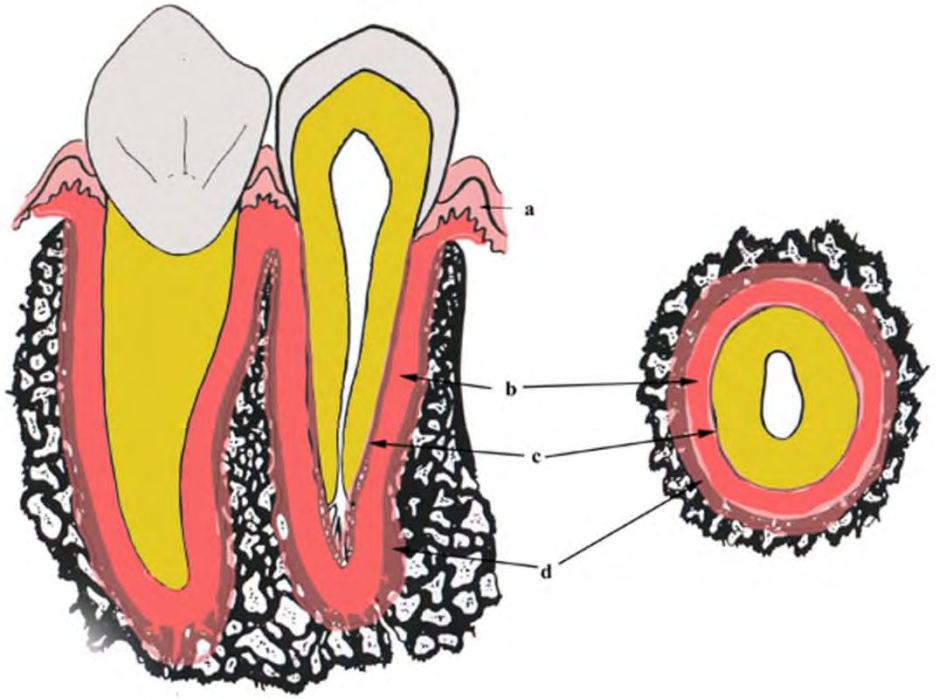
vv. – follow arteries
to the pterygoid plexus

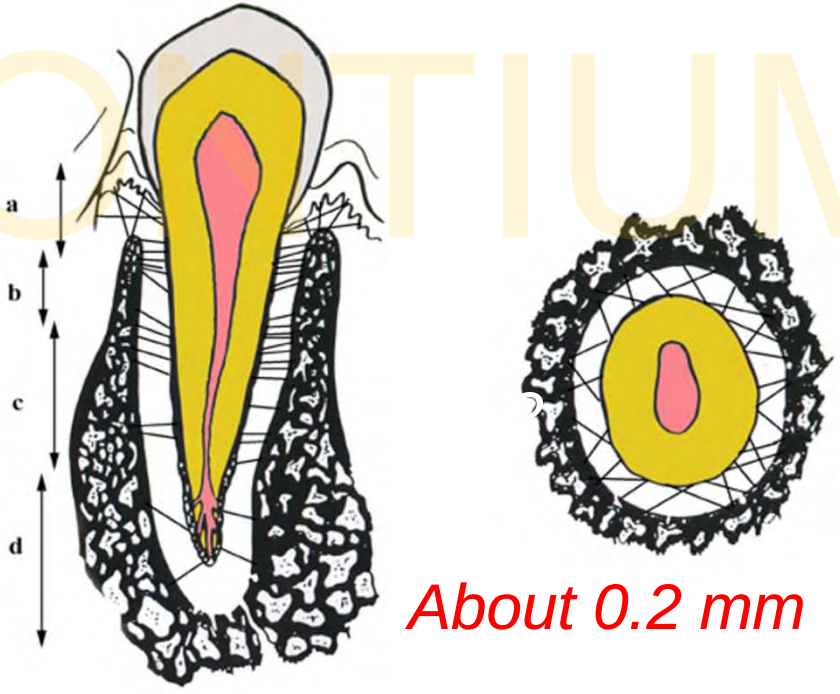
lnodi. submandibulares (x M_3)



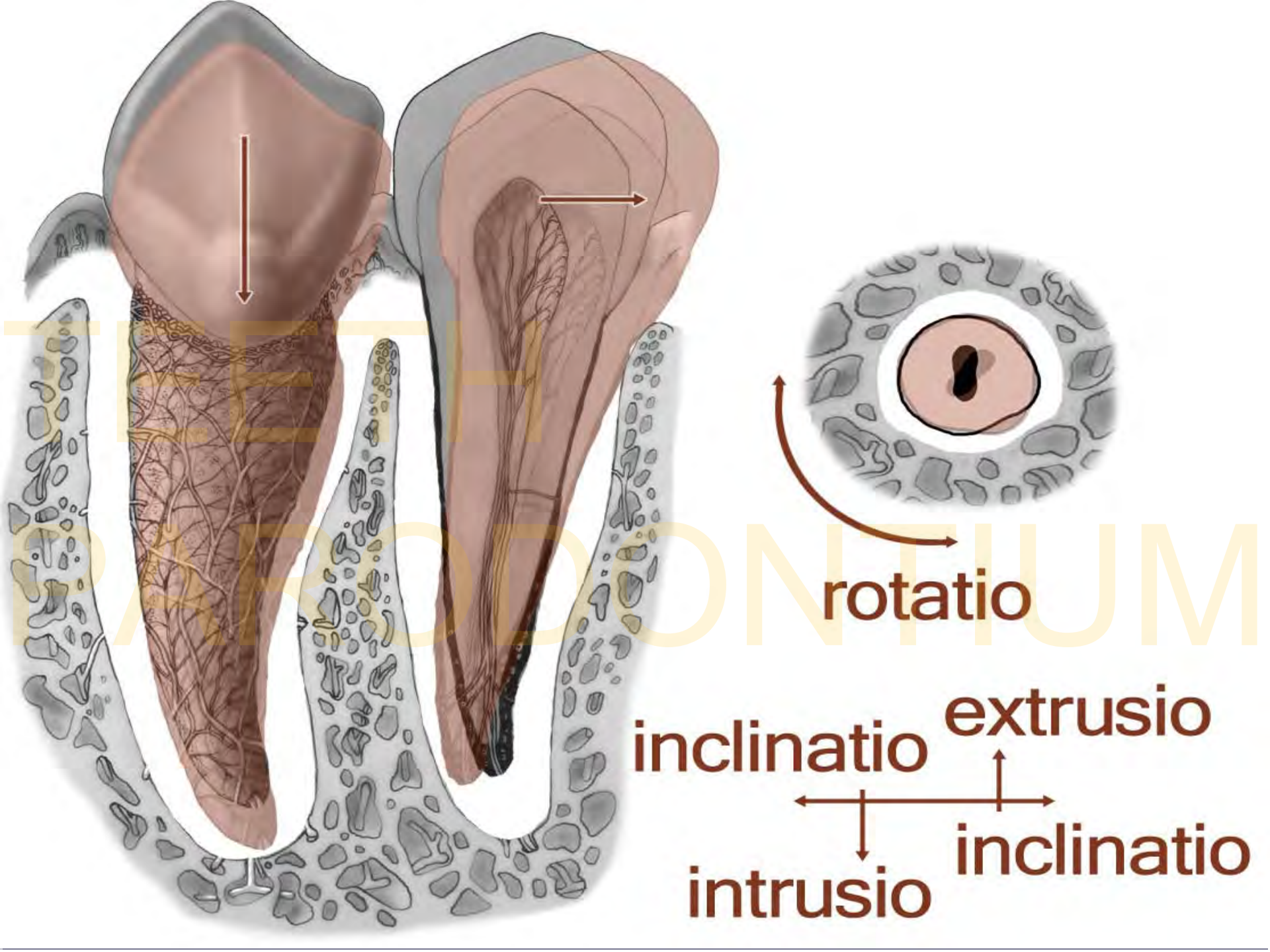
Function of the Tooth fixation system

Tooth fixation, elasticity, (hydroelastic cushion) nutrition, asistance during eruption





About 0.2 mm

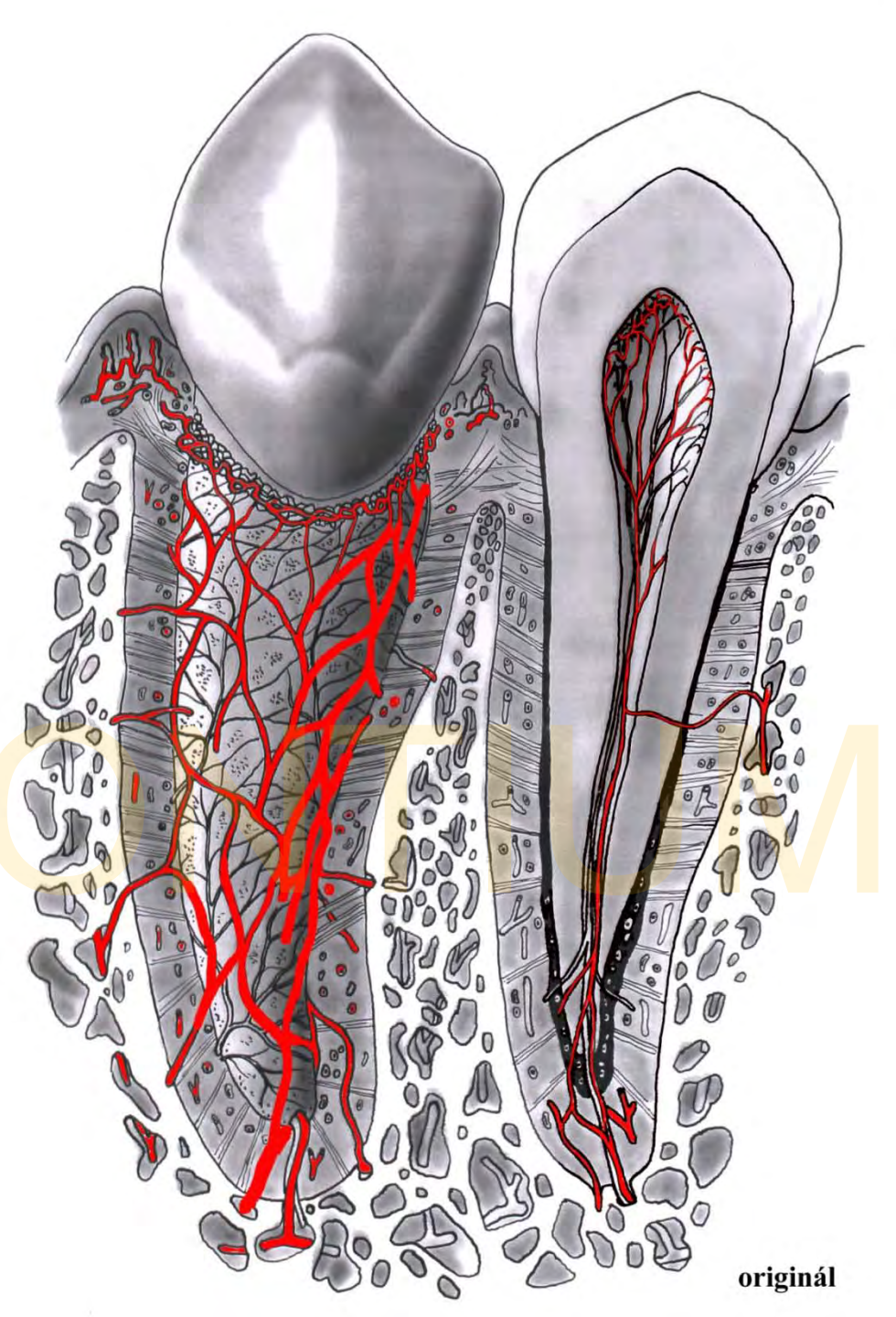

rotatio
extrusio
inclinatio
inclinatio
intrusio

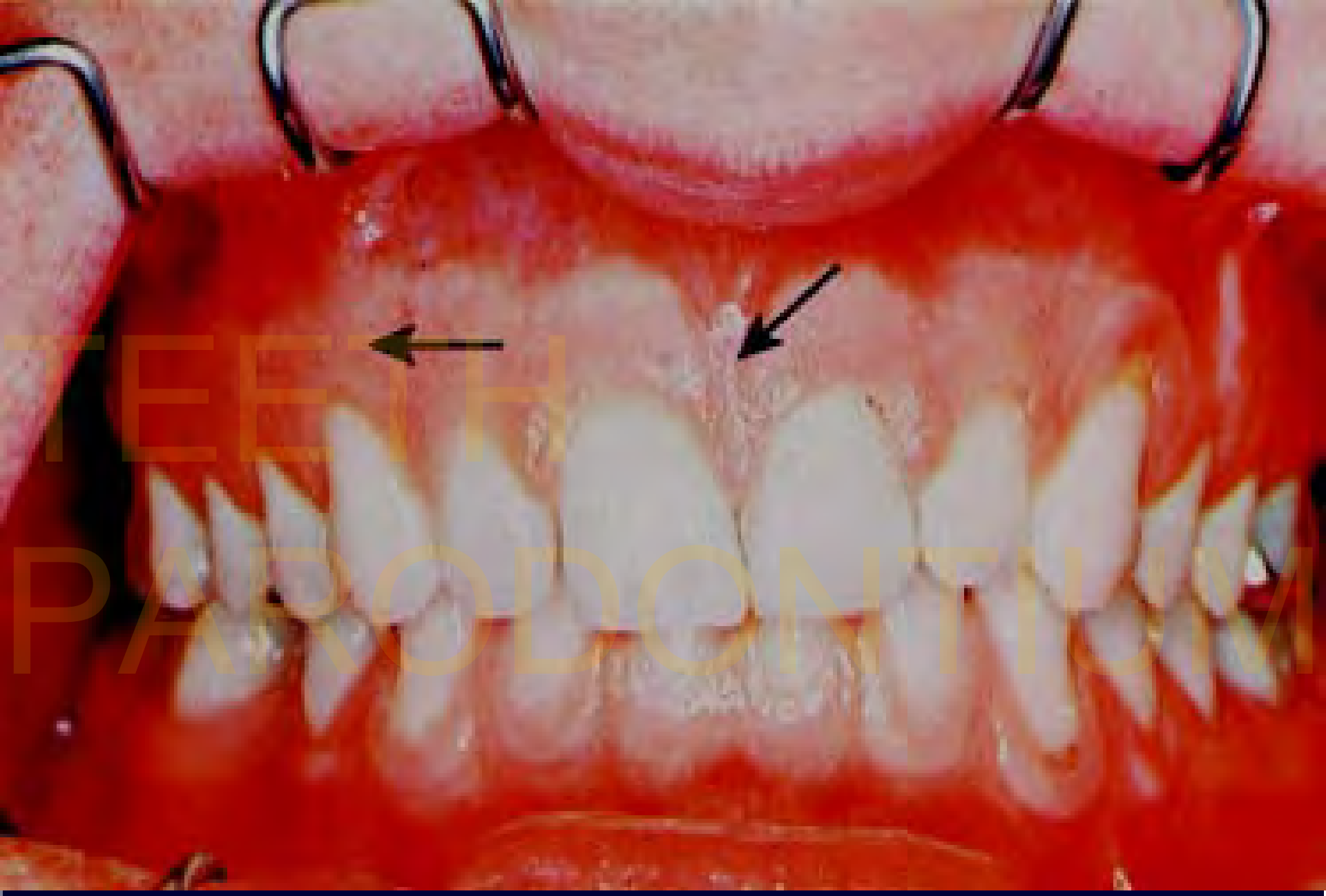
Periodontium (suspensory system)

Cementum,
Lamina corticalis
Ligg. periodontalia
Gingiva
(Mucoperiosteum)

Cells, fibers, nerves, matrix, plasma, vessels,

“hydroelastic pillow“



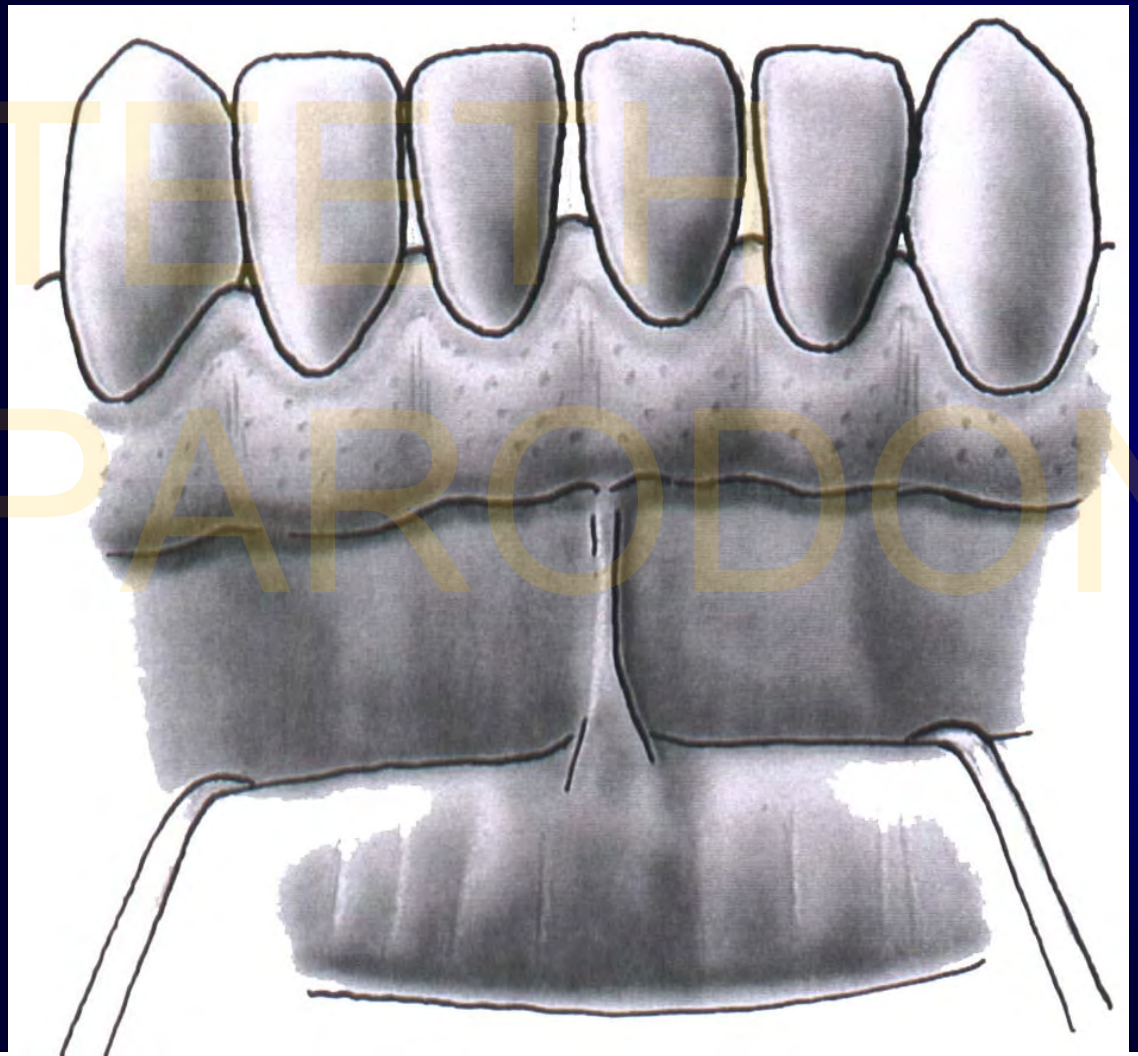


PARODONTIUM *Periodontium*

Gingiva = fibrous tissue + mucous membrane

Free: *Interdental; embrasured; circumdental*

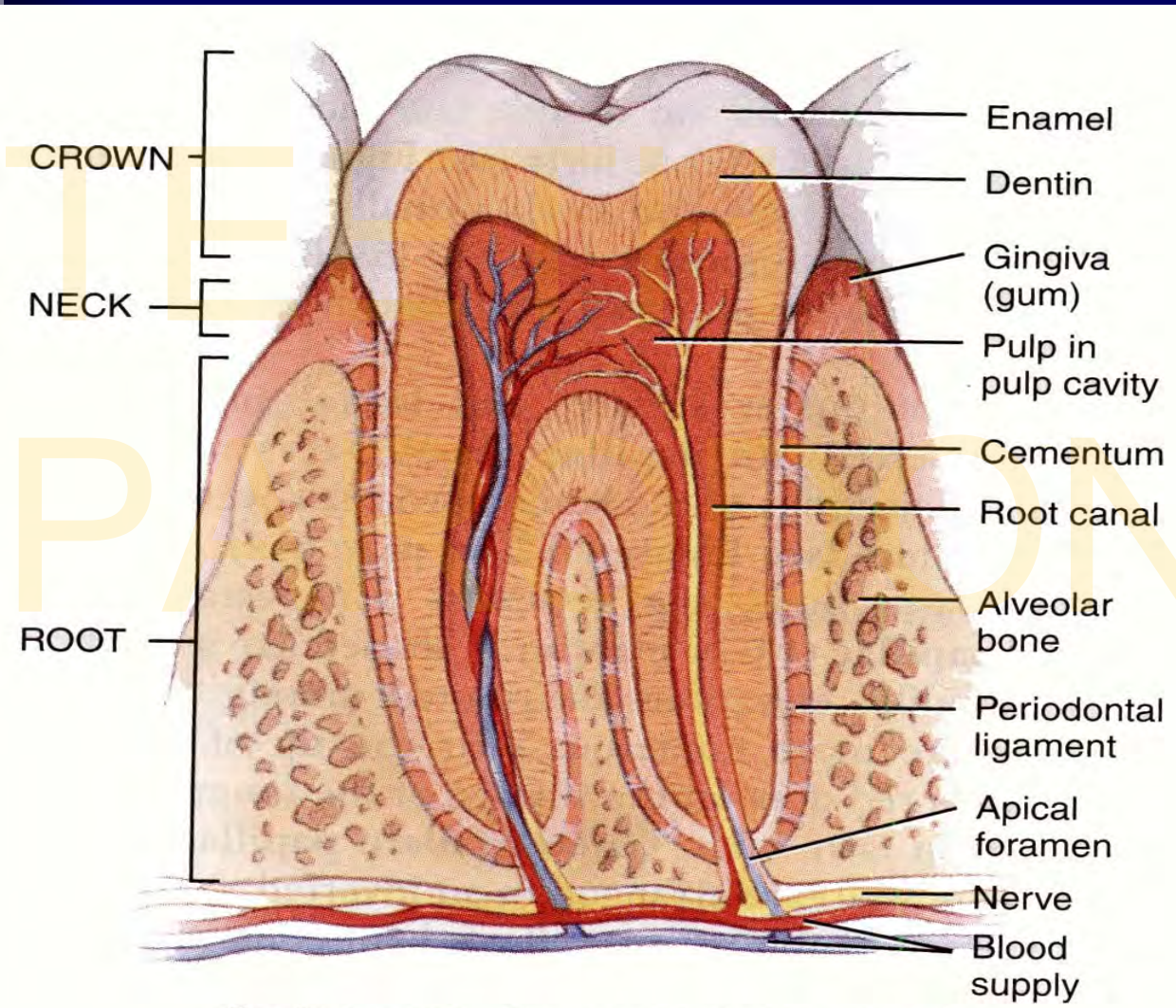
Attached: *Adjacent,fixed*



Gingiva proper (attached) = pink, stippled, keratizing

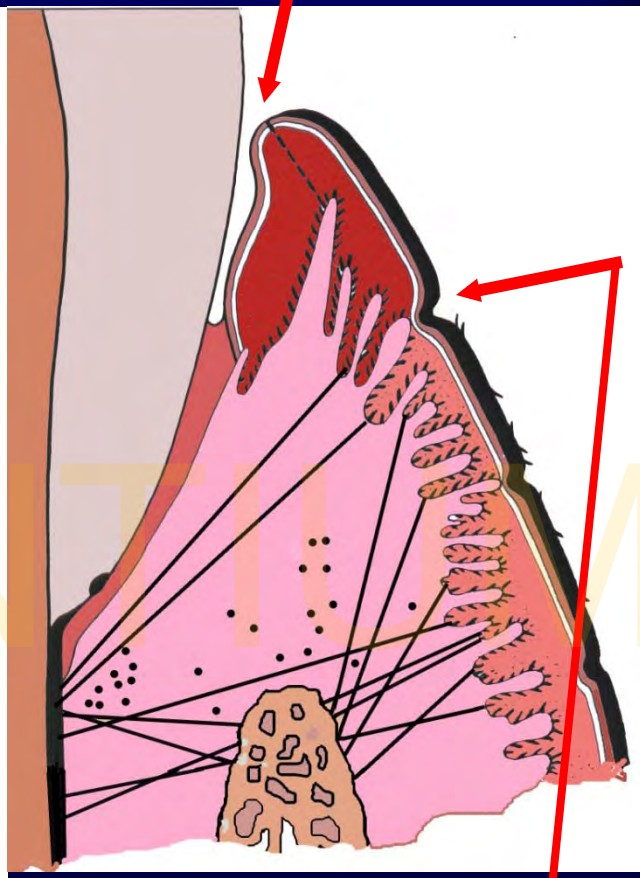
Alveolar mucosa ("loose gingiva") = shiny red, nonkeratizing

Gingiva = relation to the teeth – "cuff (collar) attachment"



Sagittal section of a mandibular (lower) molar

Sulcus gingivae

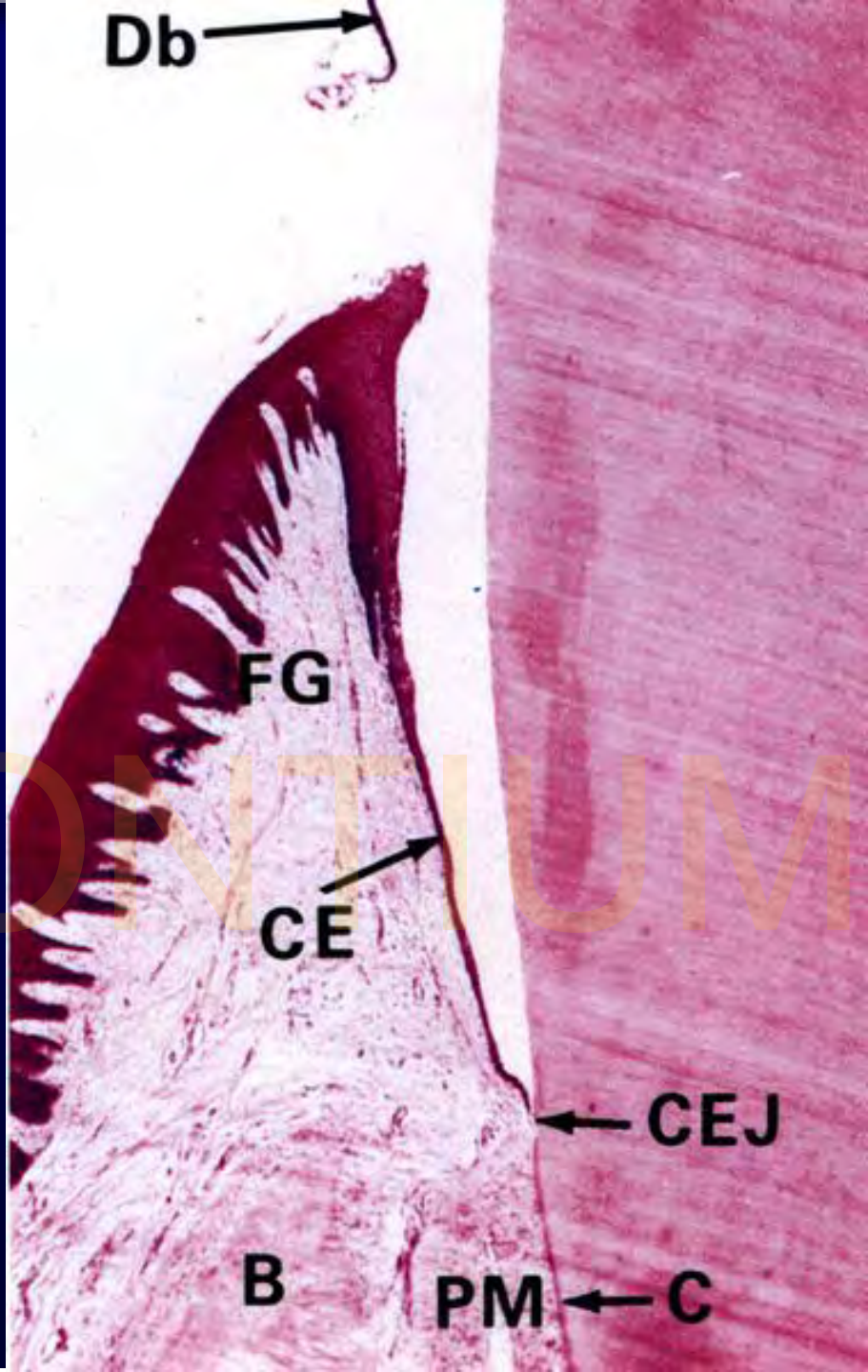


Paramarginal sulcus

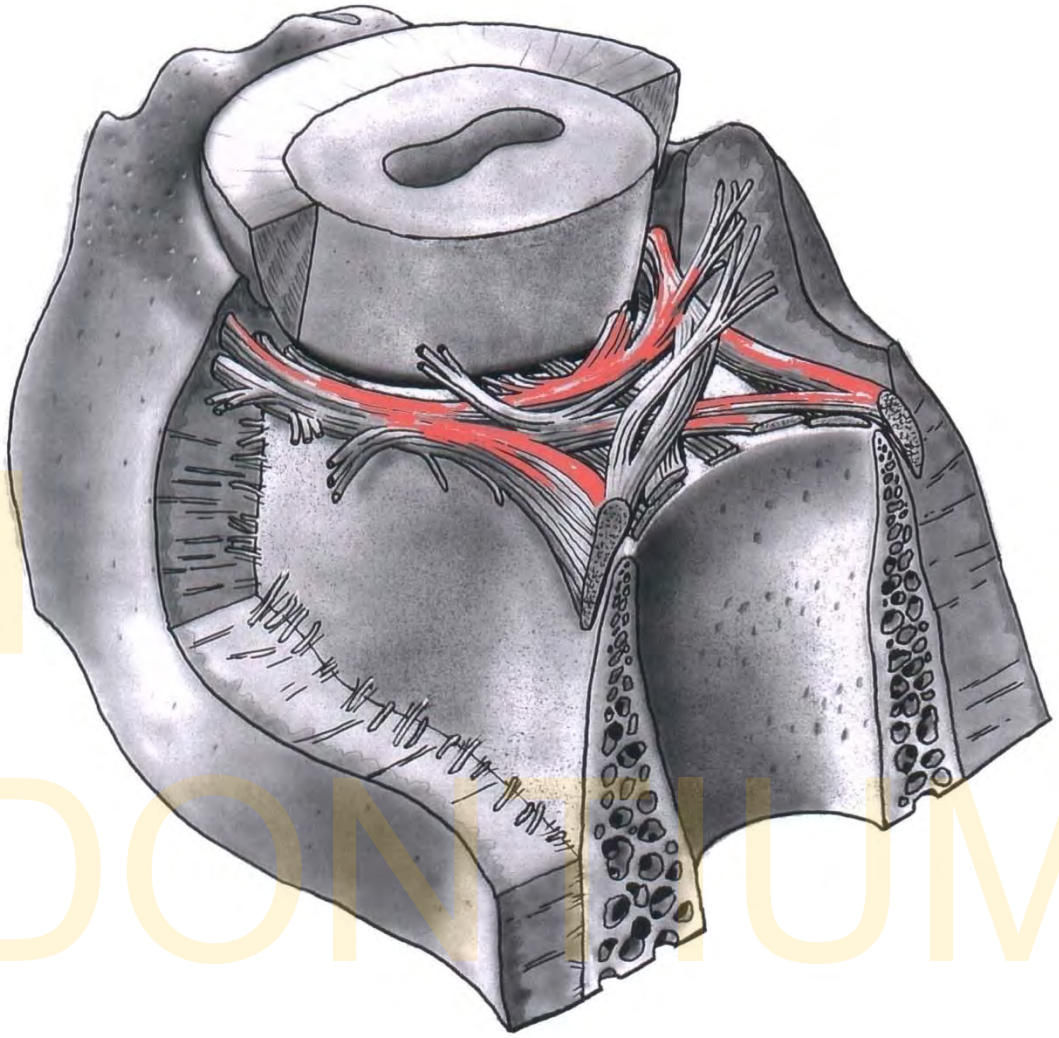
Gum = Gingiva

- Non-keratinized epithelium - parakeratosis
- Multilayered epithelium

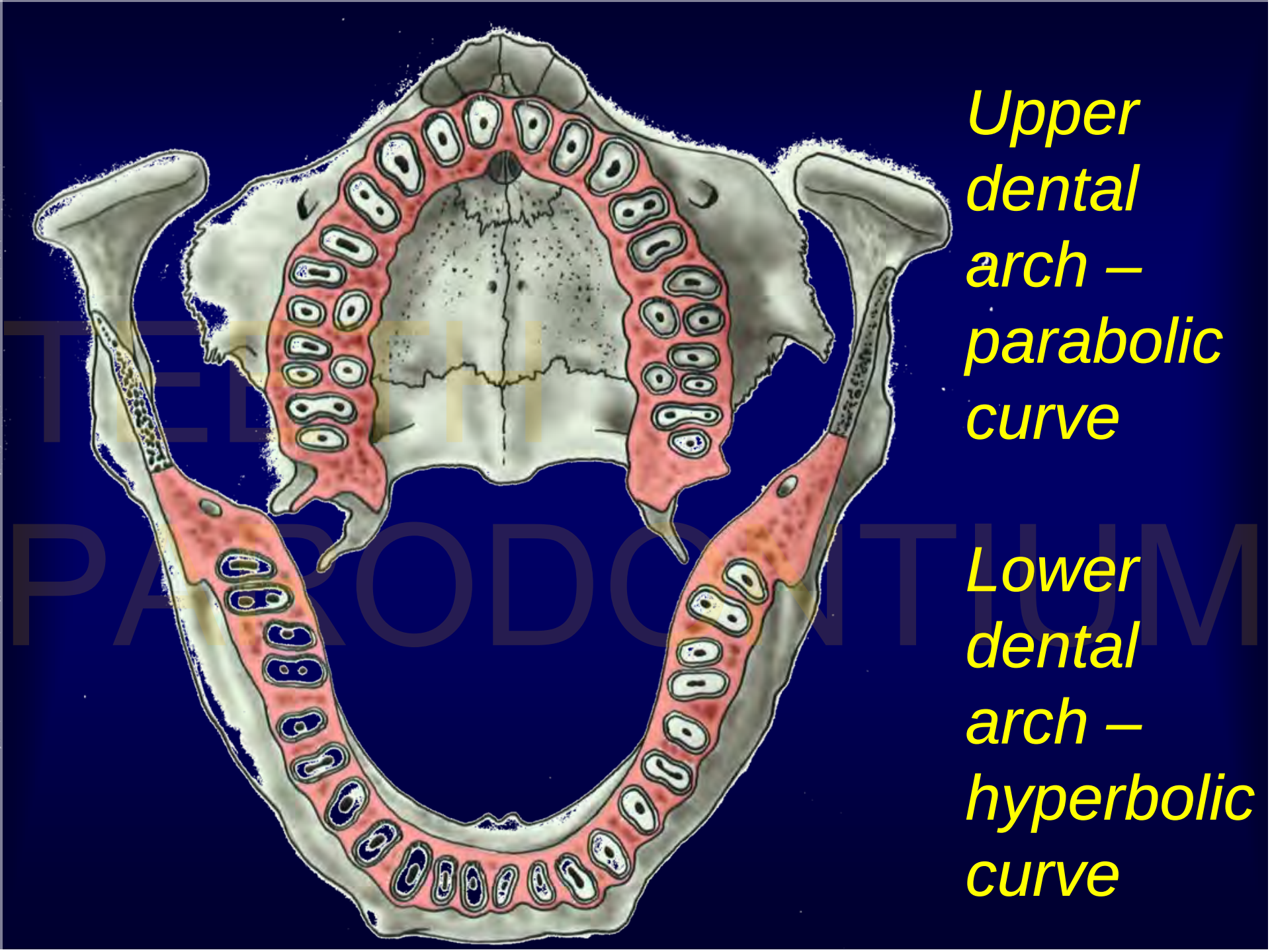
- Gingival groove
- Junctional epithelium – *gingivodental junction / closure*



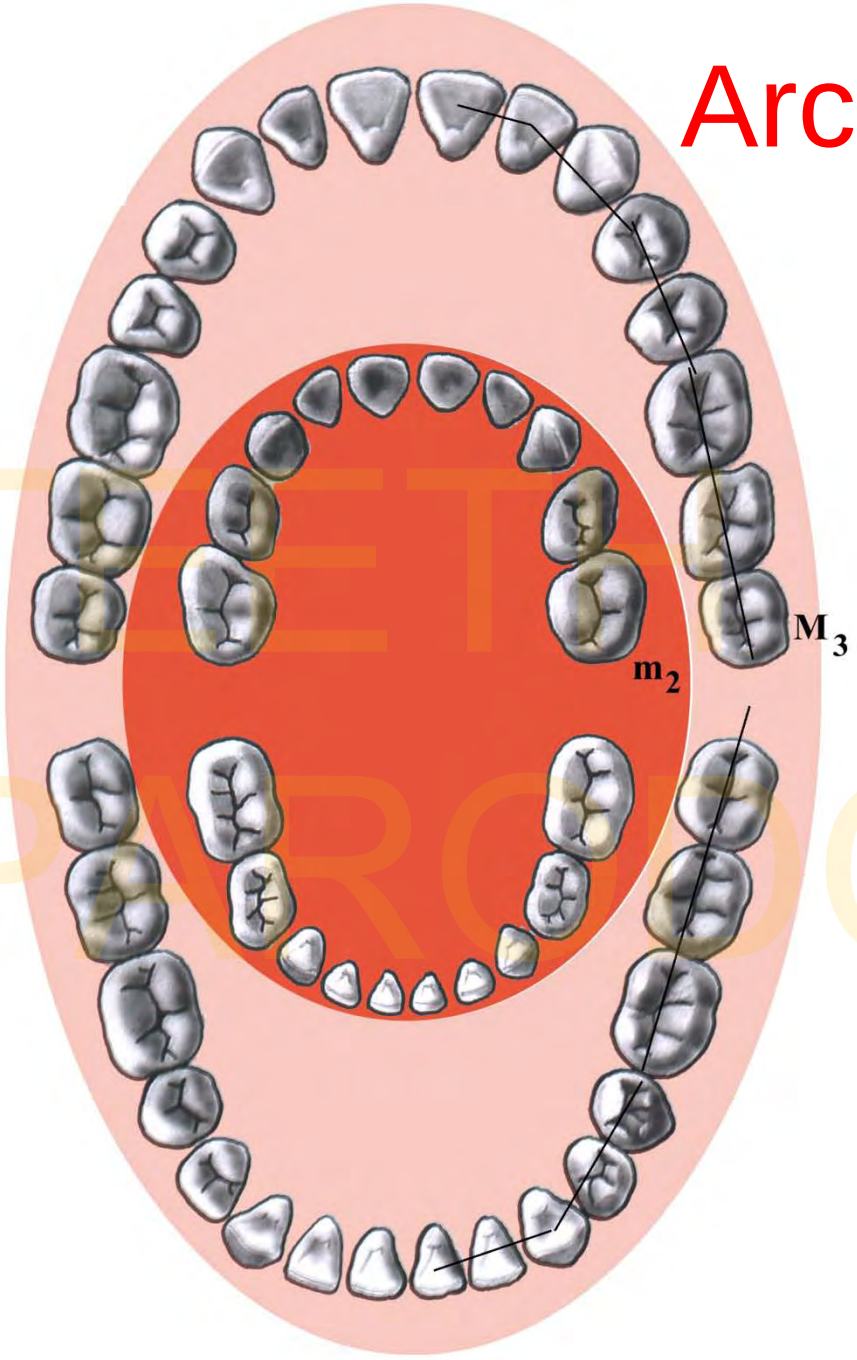
Interdental, circumdental, dentoalveolar, interalveolar ligaments

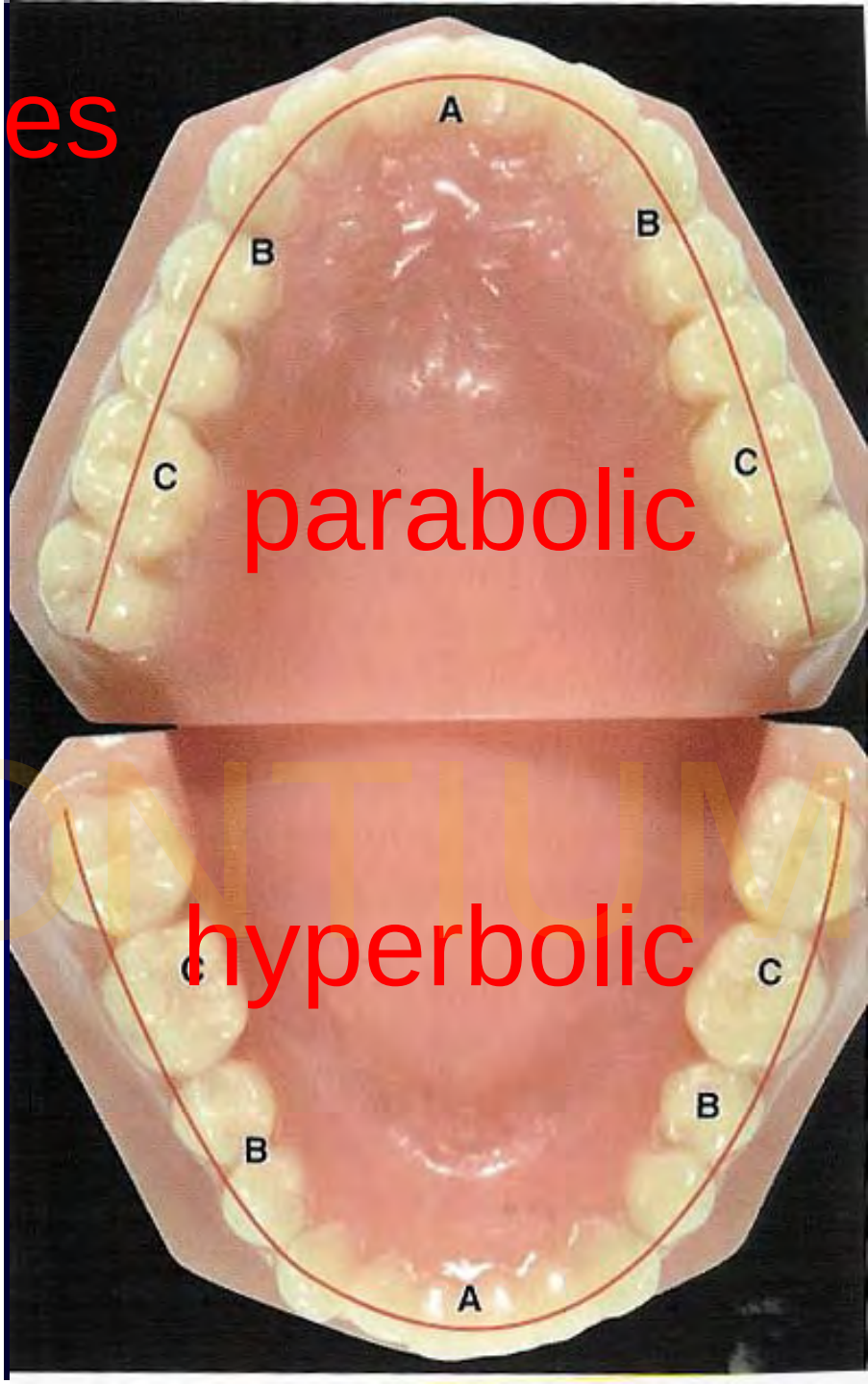


Ligamentous slings and circles help to tight attachment between gingiva and tooth

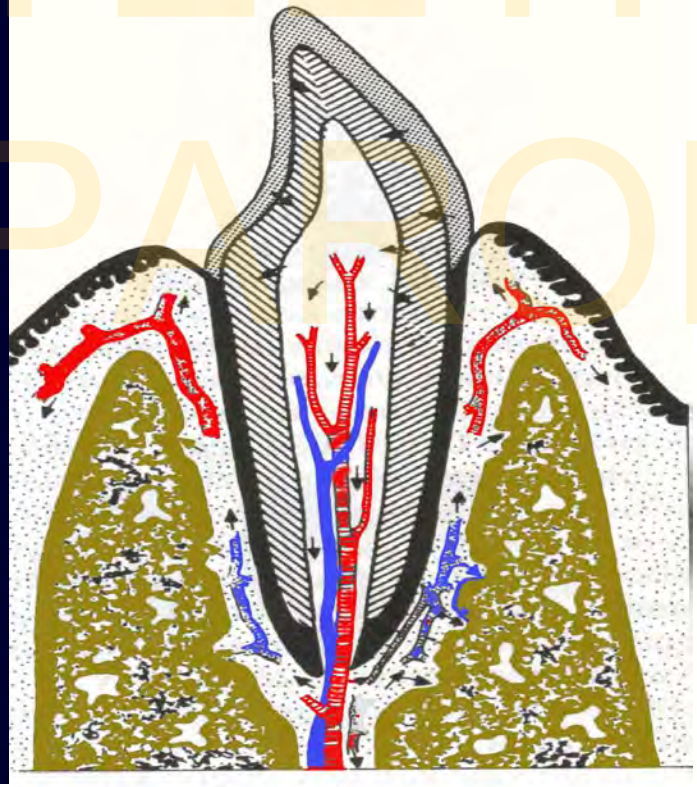

Upper dental arch – parabolic curve
Lower dental arch – hyperbolic curve

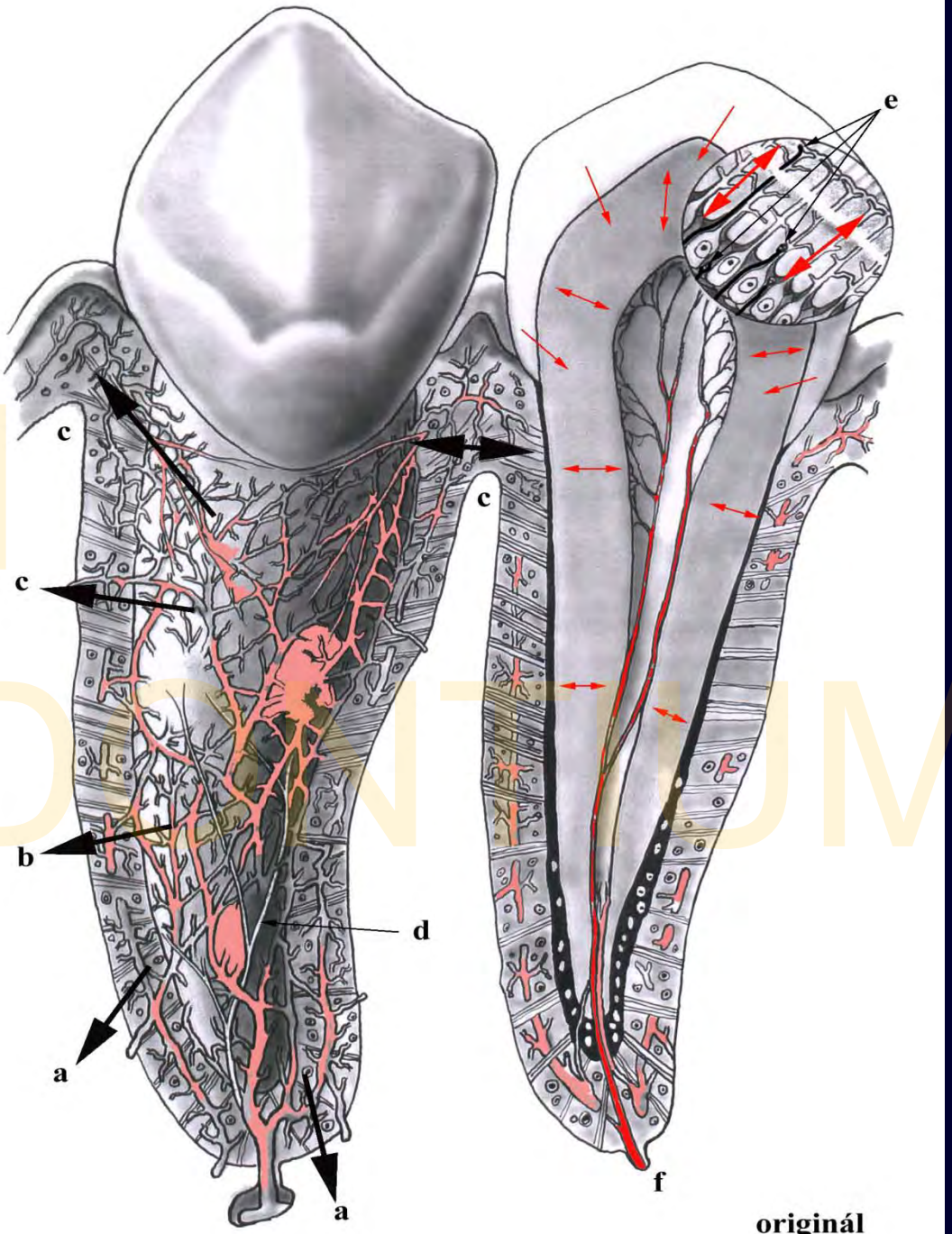
Arches

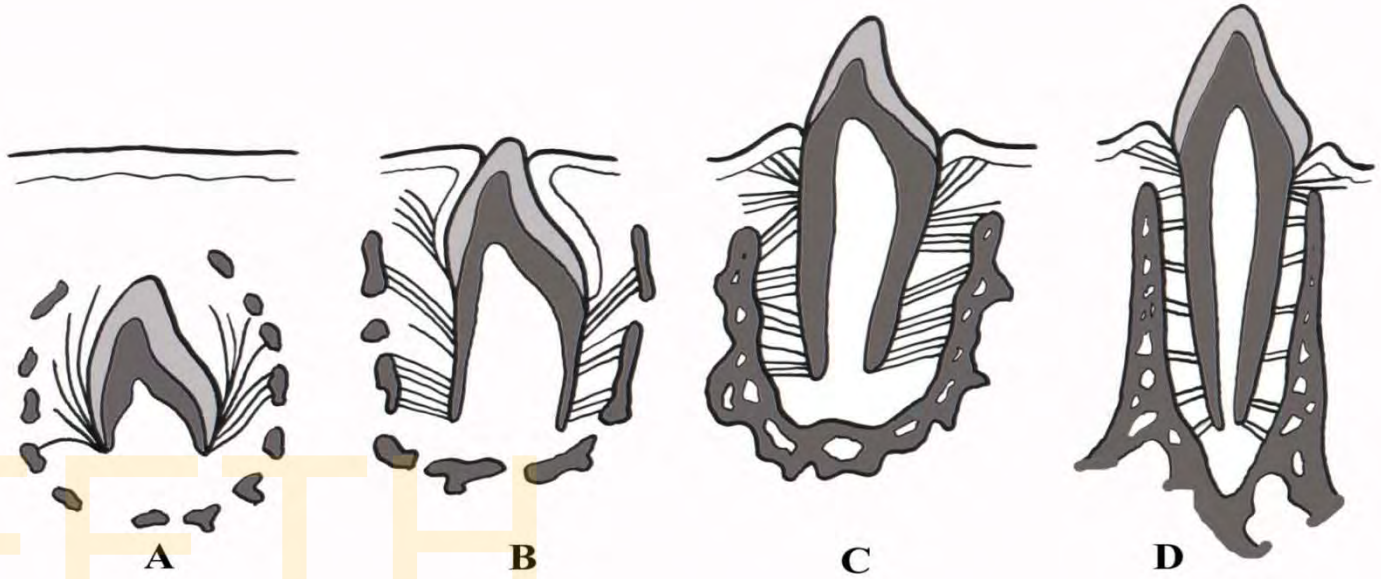


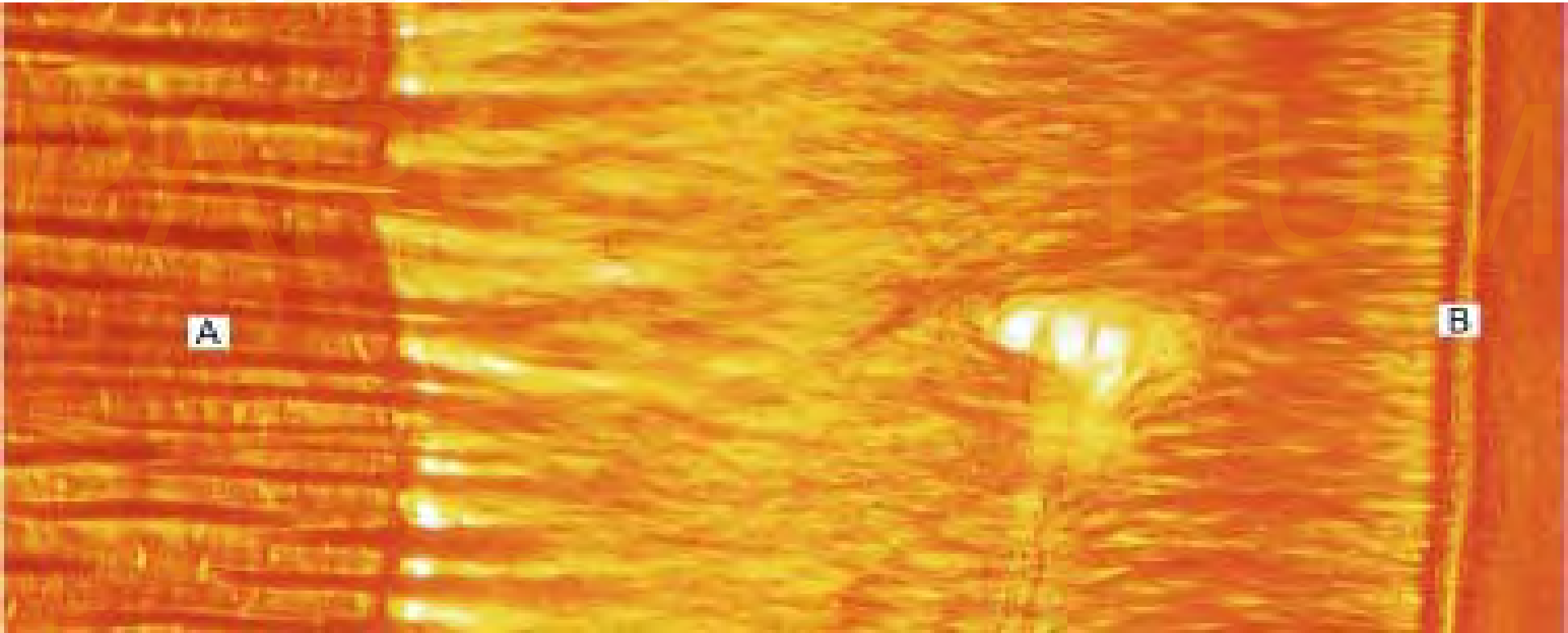


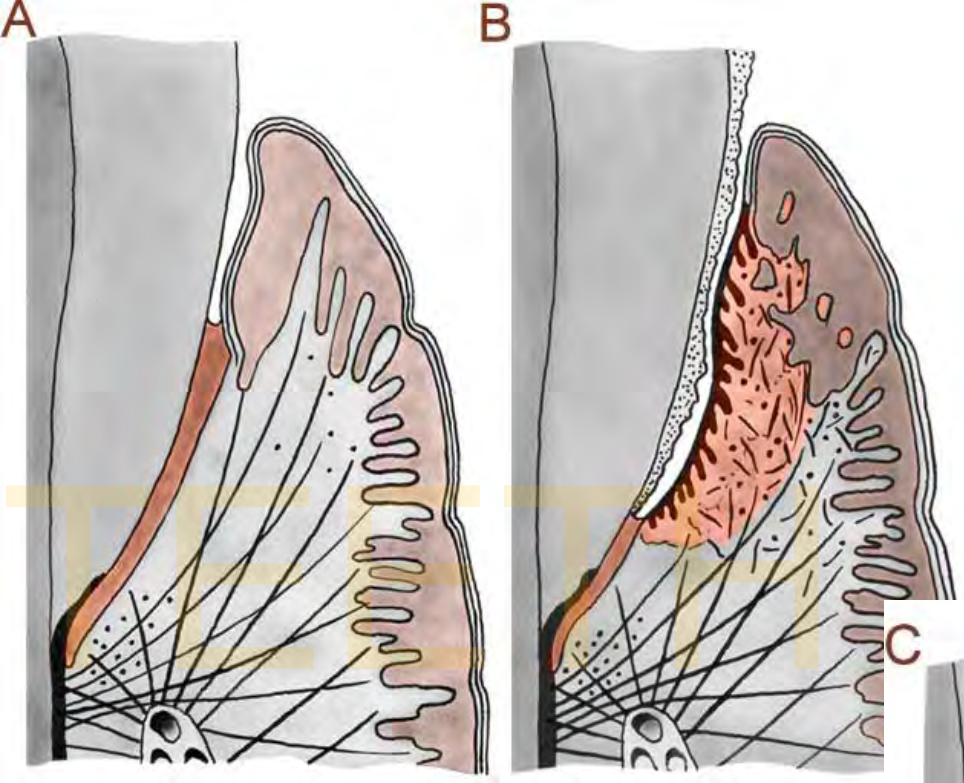
Exchange of ionts between external environment and pulp



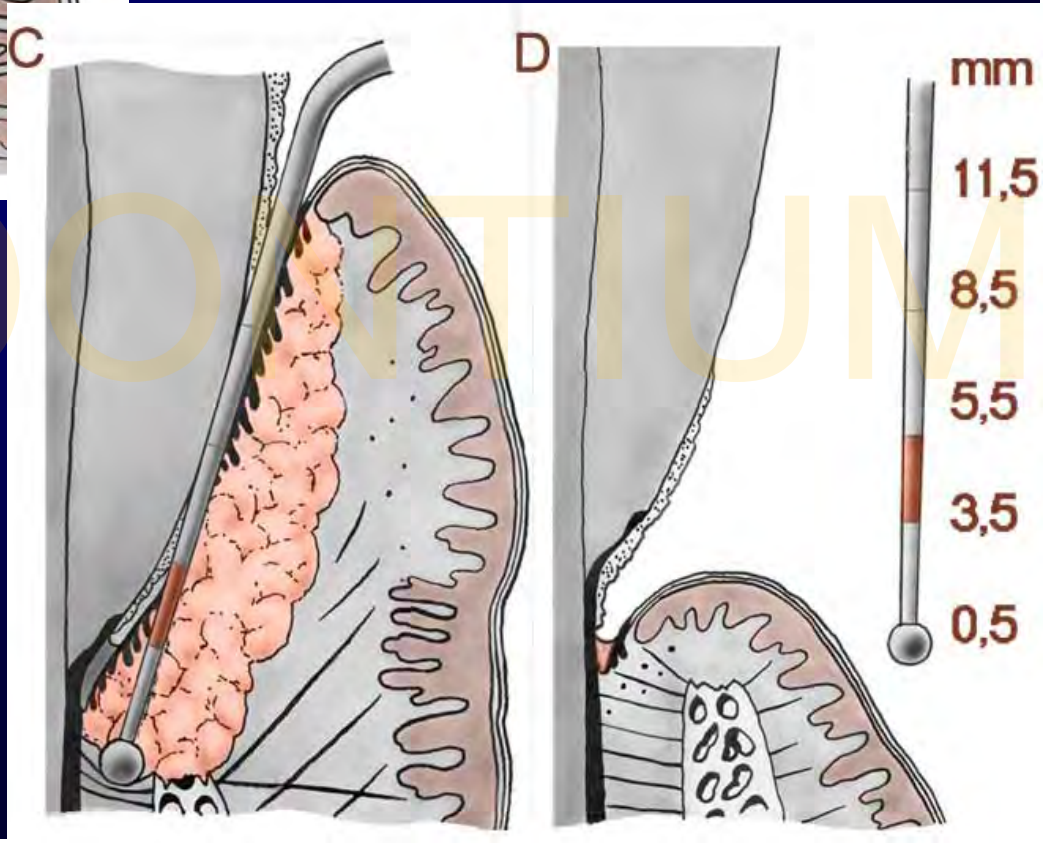



A
B
C
D


A
B



True pocket



False pocket

compression

sucking

bite actions:

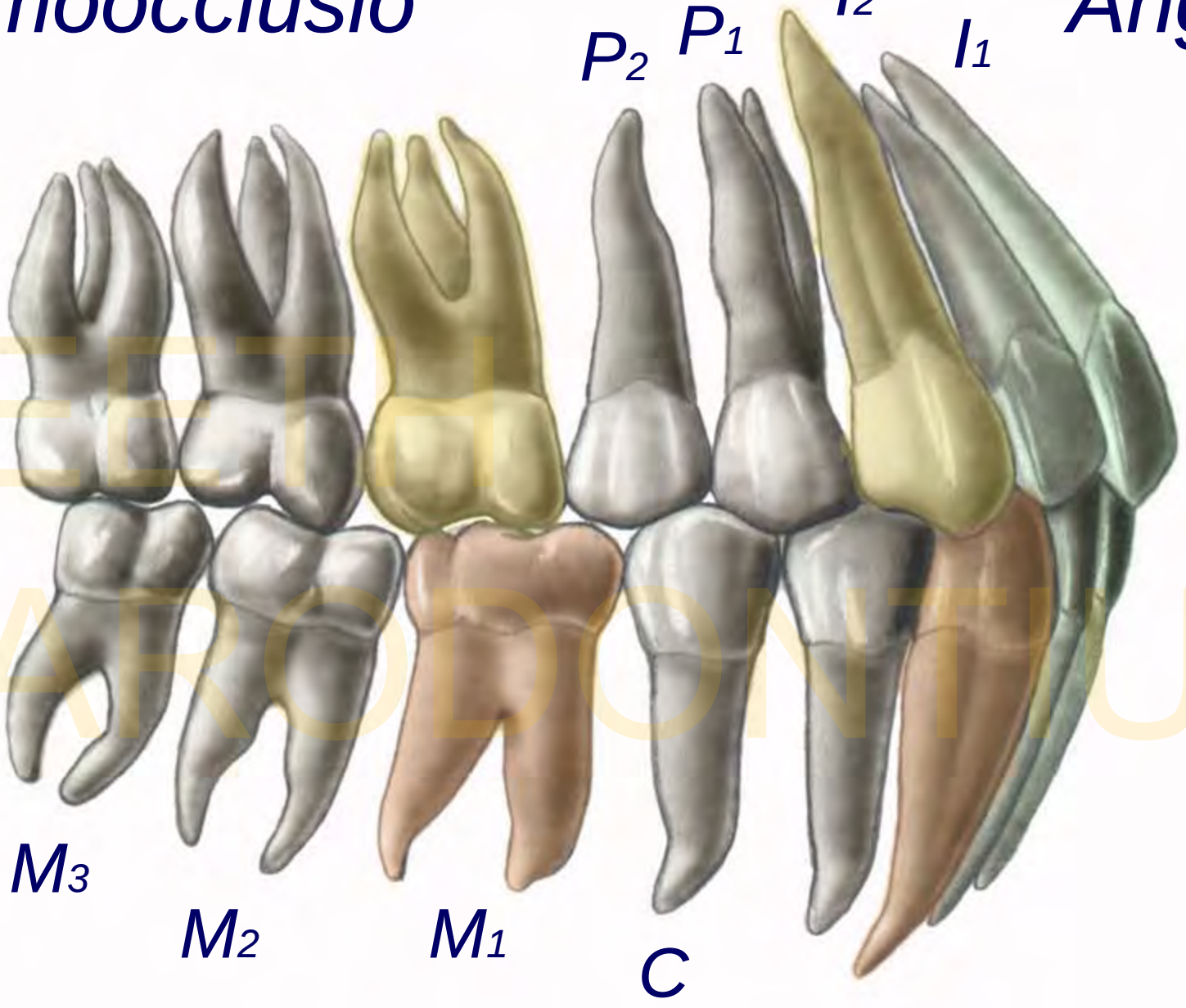
“tops on platform“

“tops on tops“

“combined“

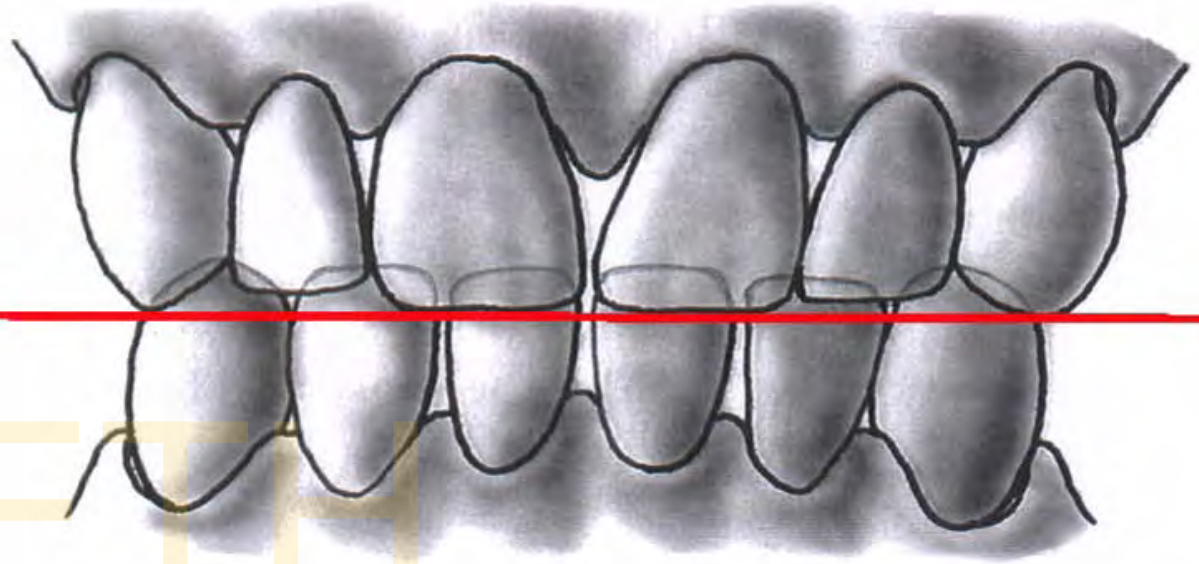
Normoocclusio

Angle I



Edward Hartley Angle (June 1, 1855 - August 11, 1930) American dentist

frontal

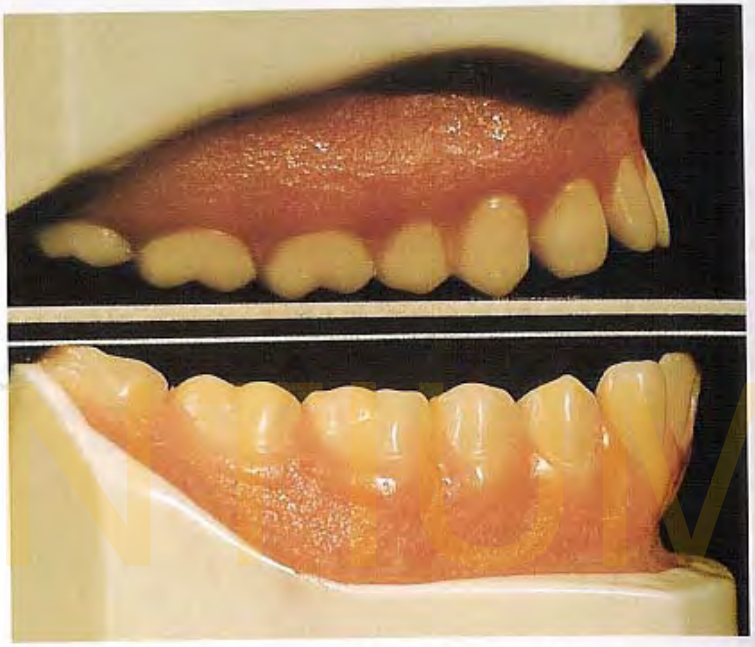


lateral

Spee curve

Wilson curve

Monson



Curvatures of the occlusal plane – the curve of Spee.

Teeth: Variations and anomalies

- *Mesiodens*
- *Paramolare*
- *Tuberculum Carabelli*
- *Divergency or convergency of roots*
- *Root fusion*
- *Dens in dente*
- *Hyperplasia of teeth*

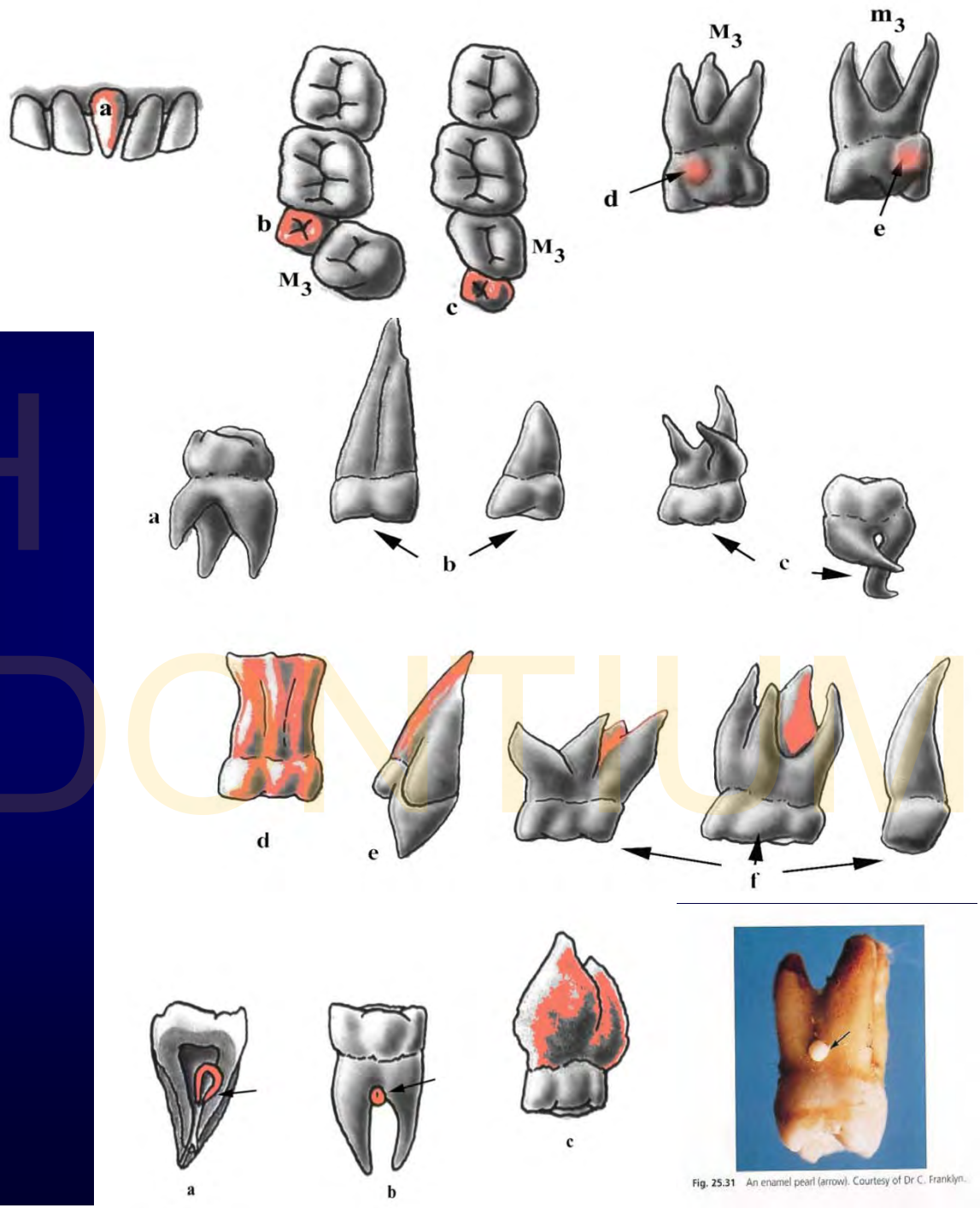
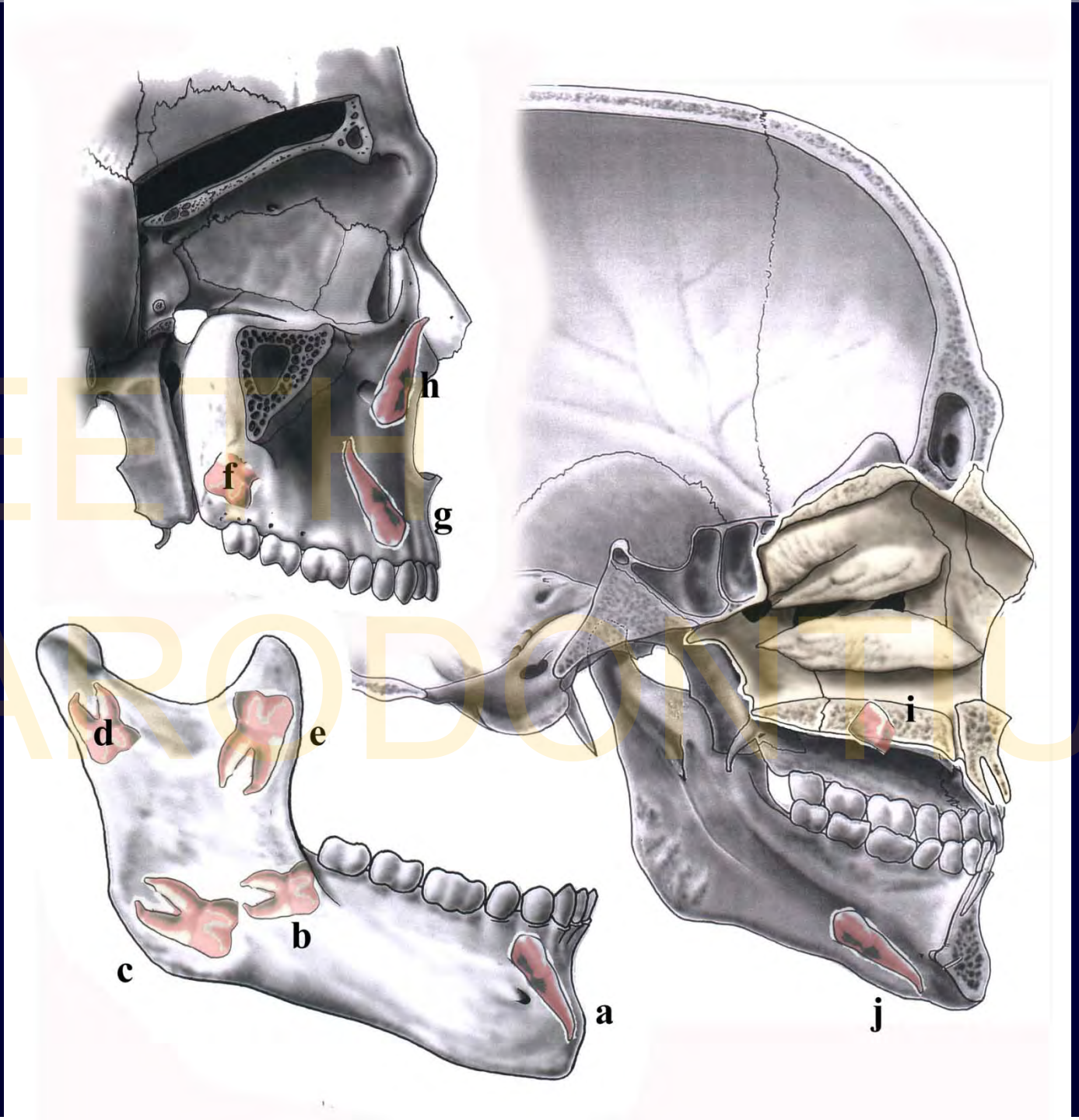


Fig. 25.31 An enamel pearl (arrow). Courtesy of Dr C. Franklyn.

Maxillary first and second molars, each with a Carabelli cusp. It is *unusual* to have this Carabelli cusp on the second molar. (Courtesy of Dr. Jeff Warner.) Georg von Carabelli

NORMAL LOCATION OF FURCATIONS

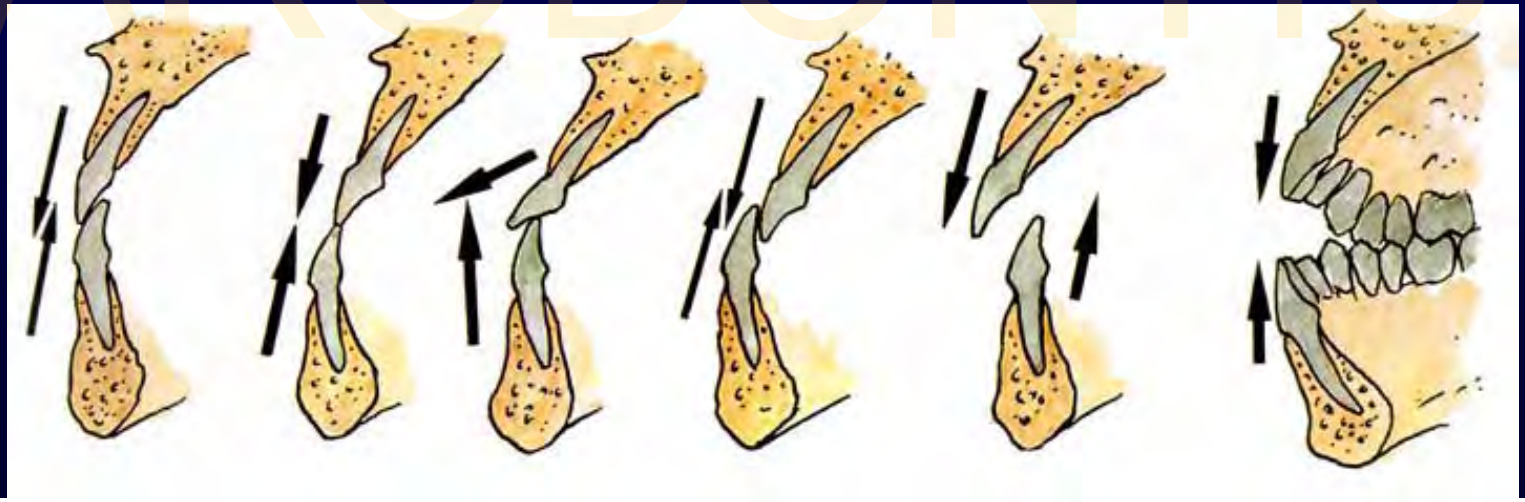
TOOTH TYPE	POTENTIAL FURCATIONS
MAXILLARY MOLARS	Mid-buccal
	Mesial (accessed from the lingual)
	Distal (accessed from the lingual)
MANDIBULAR MOLARS	Mid-buccal
	Mid-lingual
MAXILLARY PREMOLARS (with buccal and lingual roots)	Middle of mesial
	Middle of distal

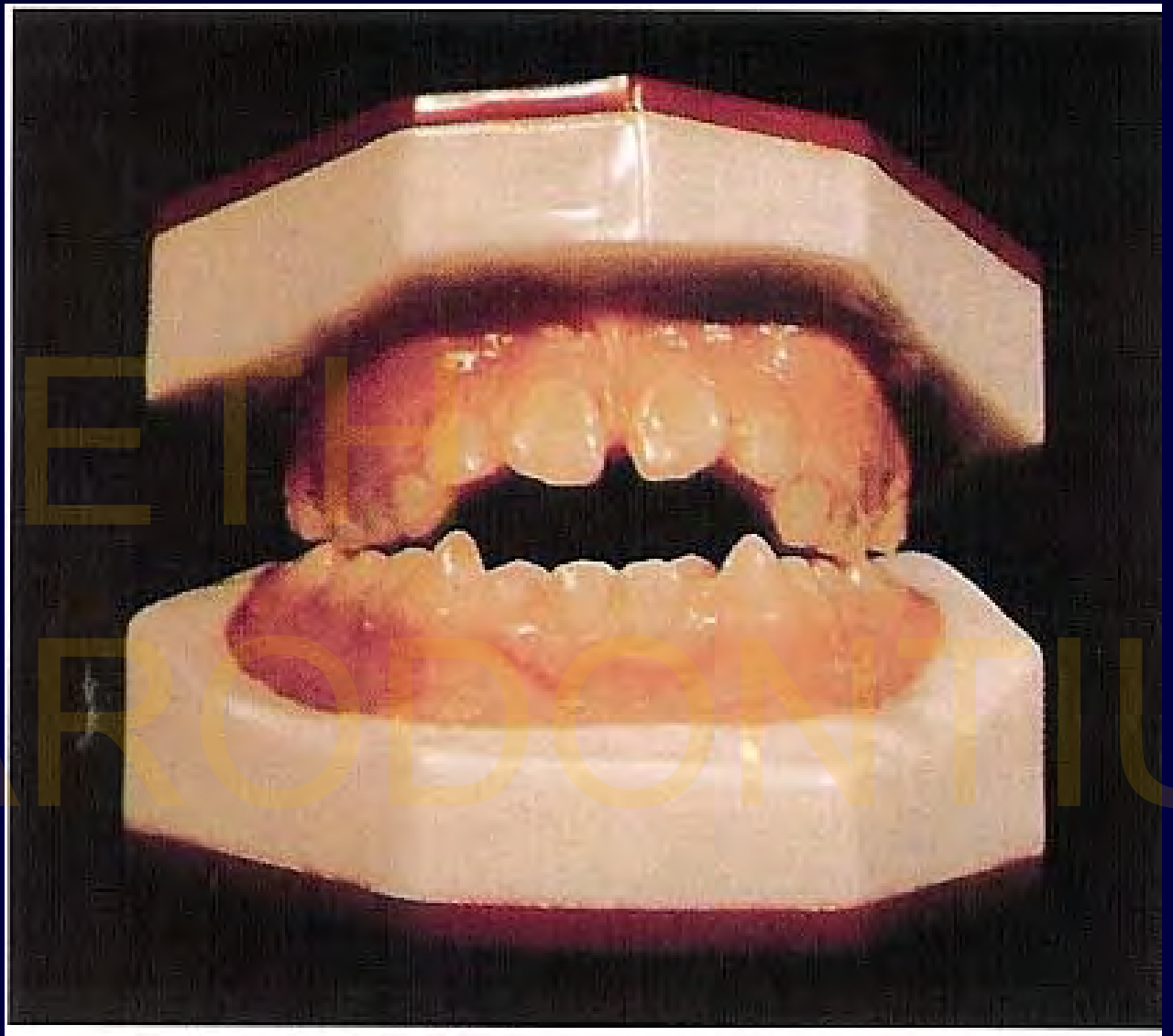


Teeth as a whole complex

mordex = dentition

- ortodental position (vertical axes of teeth)
- articulation = occlusion
  - 80% psalidodontia (scissor-like occlusion) = norm
  - progenia = lower teeth in front of the upper ones
  - (hiatodontia (= mordex apertus), stegodontia, prognathia, opisthodontia)





Anterior open bite.

Anodontia;

hypodontia;

diastema

Abnormality tvaru a polohy; Tooth abnormalities in shape and position;

Gingivitis

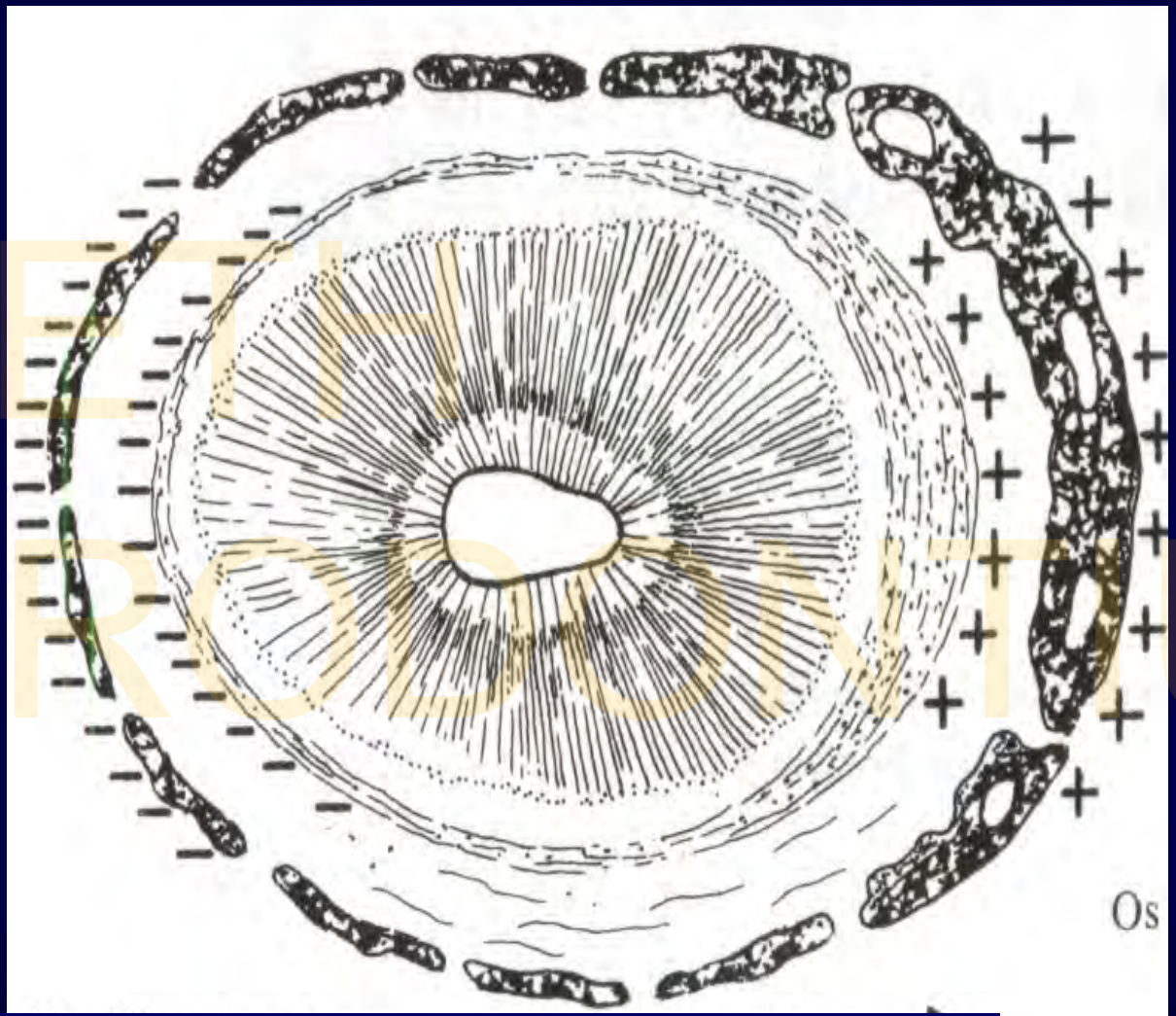
Resorbtion

-

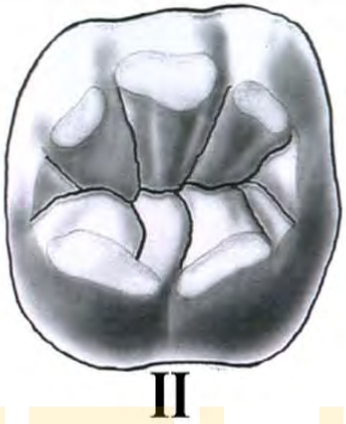
Bodily shift

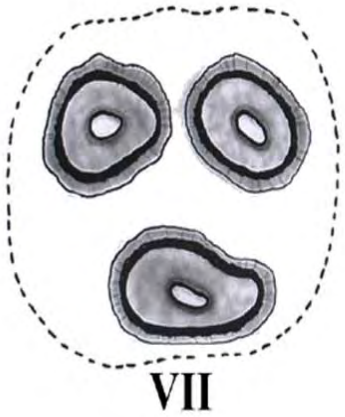
Apposition

+



Mesial shift

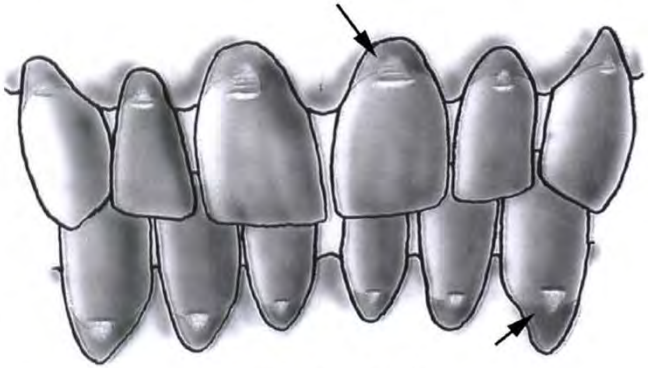




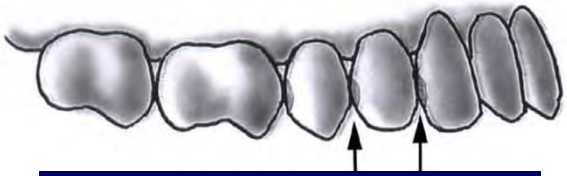
Abrasion

VII classes

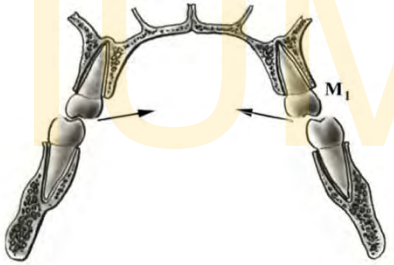
“to palate“
“to tongue“

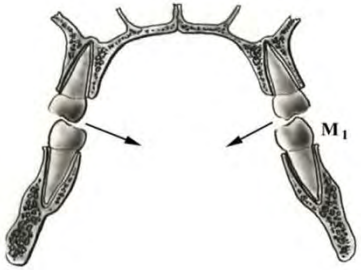


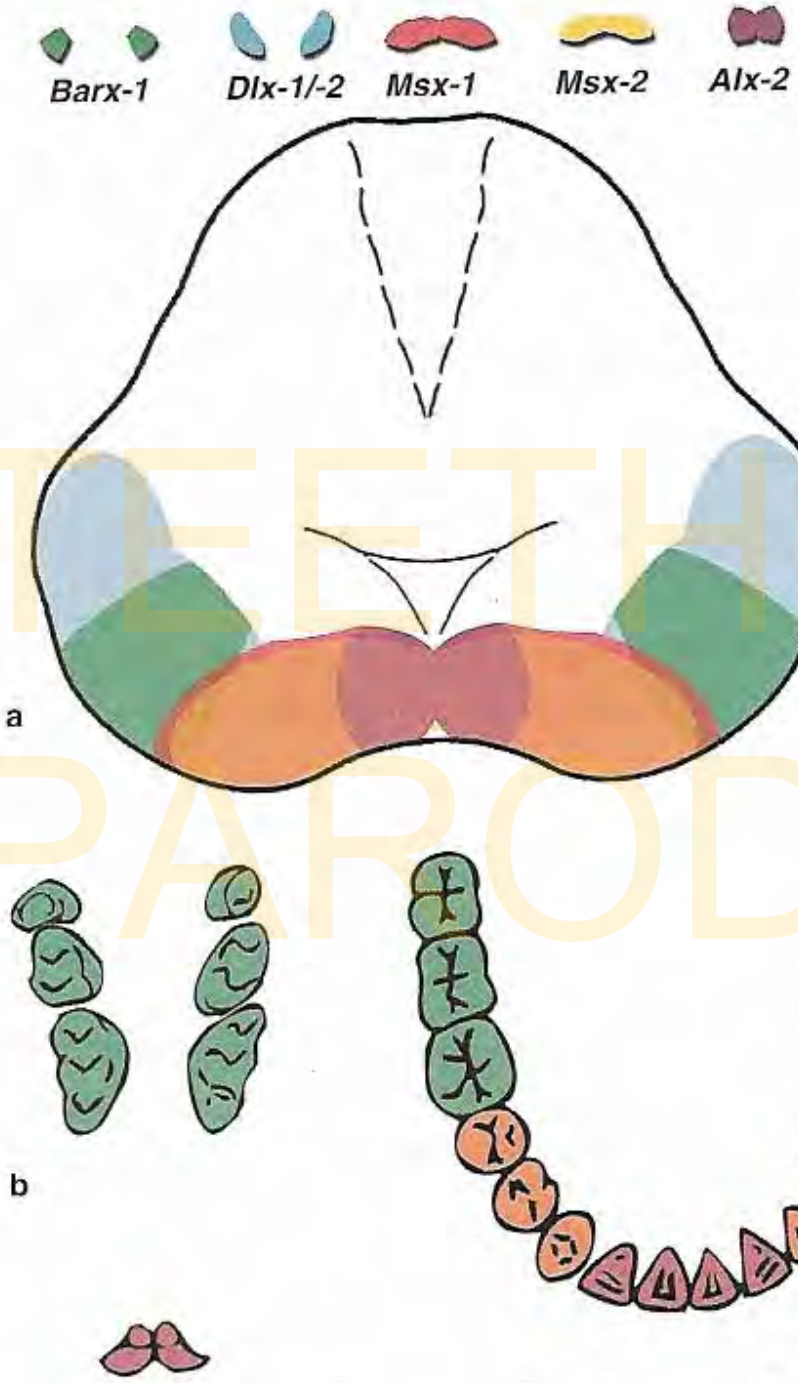
“wedge from“



“contact form“







Schematic diagrams to show the mesenchymal odontogenic homeobox gene code. (a) Diagram illustrating the lower jaw of the mouse. Note the overlap (orange) between the domains of *Msx-1* (red) and *Msx-2* (yellow). (b) Model representing the mouse dention. Note that molars develop from cells expressing *Barx-1* and incisors from cells expressing *Msx-1*, *Msx-2* and *Alx-3*. (c) Model representing the human dentition, where it is predicted that incisors develop from cells expressing *Msx-1*, *Msx-2*, and *Alx-3*, canines and premolars from cells expressing *Msx-1* and *Msx-2* and molars from cells expressing *Barx-1*. Courtesy of Professor P.T. Sharpe and the editor of *Bioessays*.

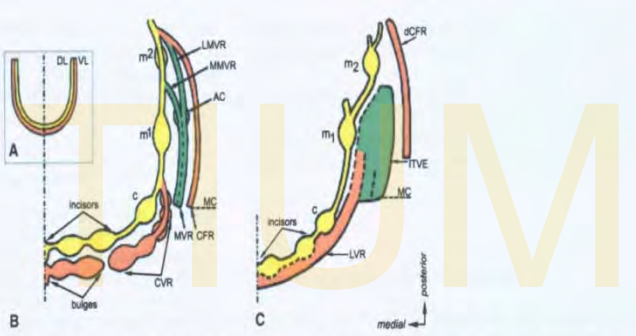


Fig. 1. Schemes of the spatial relationship between the dental and vestibular epithelium in human embryos. Yellow, dental epithelium; orange, base of the oral vestibule. The remaining vestibular epithelium is green. (A) According to the generally accepted concept, the oral vestibule arises from a vestibular lamina (VL), which is a continuous structure running externally and parallel to the dental lamina (DL). (B) Data on the upper jaw (14) have shown epithelial bulges that initially emerge externally to the dental epithelium in the lip region. They fuse, being transformed into the canine vestibular ridge (CVR) in the posterior direction. The CVR fuses with the dental mound behind the deciduous canine primordium (c). In the cheek region, the vestibular epithelium forms the molar vestibular ridge (MVR) and the cheek-furrow ridge (the CFR is the epithelium lining the mucosal inflection between the alveolus with teeth and cheeks). The MVR splits posteriorly into the medial (MMVR) and lateral (LMVR) branches. The fornix of the oral vestibule originates from the bulges and the CVR in the lip region and from the CFR in the cheek area (14). AC, accessory epithelial cap; m^1 and m^2, the upper first and second deciduous molars, respectively. (C) Present data on the lower jaw. The level of the mouth corner (MC) is labeled. Different vestibular structures are shown: the area of irregularly thickened vestibular epithelium (ITVE), the labial vestibular ridge (LVR), and the mandibular cheek furrow ridge (dCFR). The deciduous lower tooth primordia are labeled: m_1, first molar; m_2, second molar.

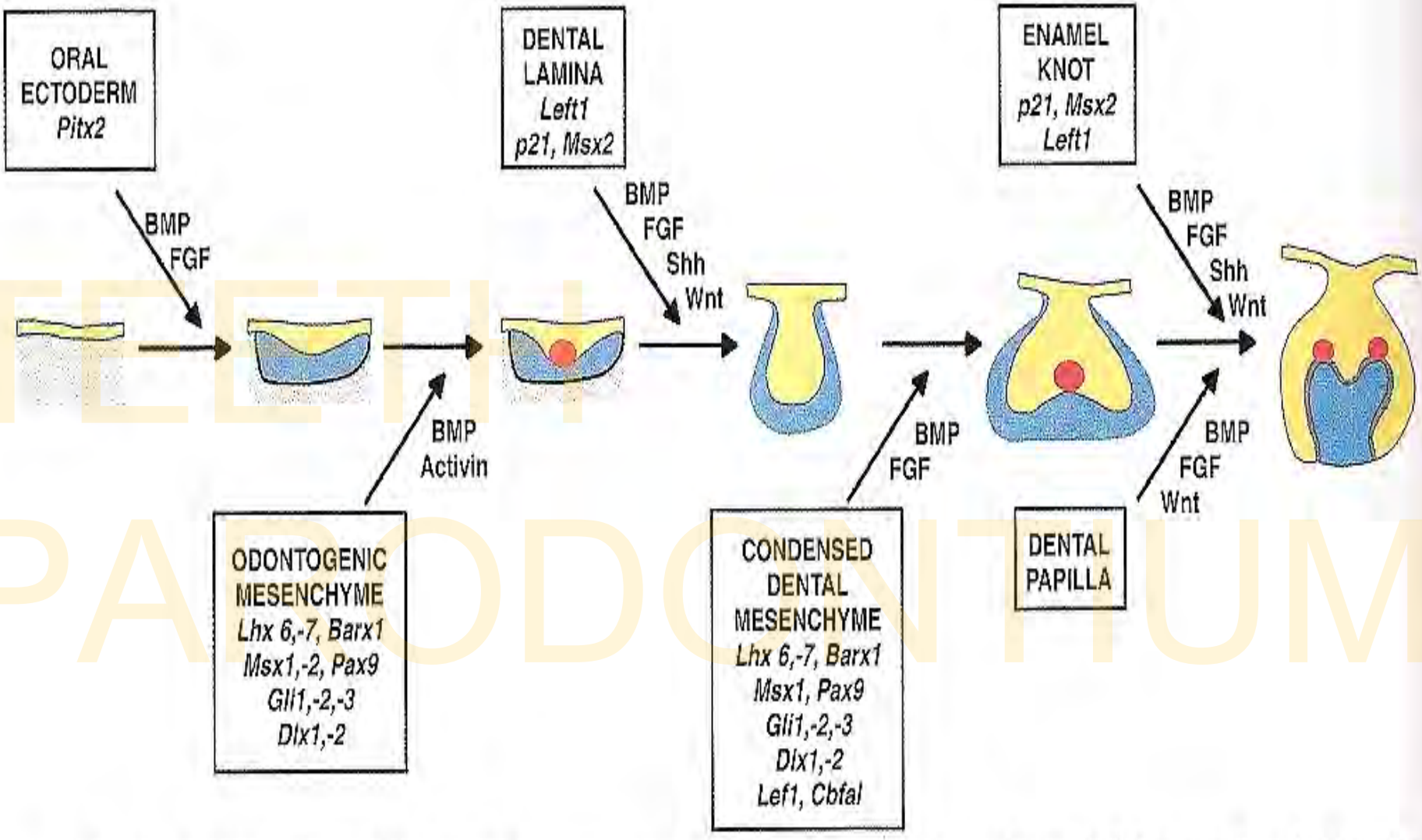
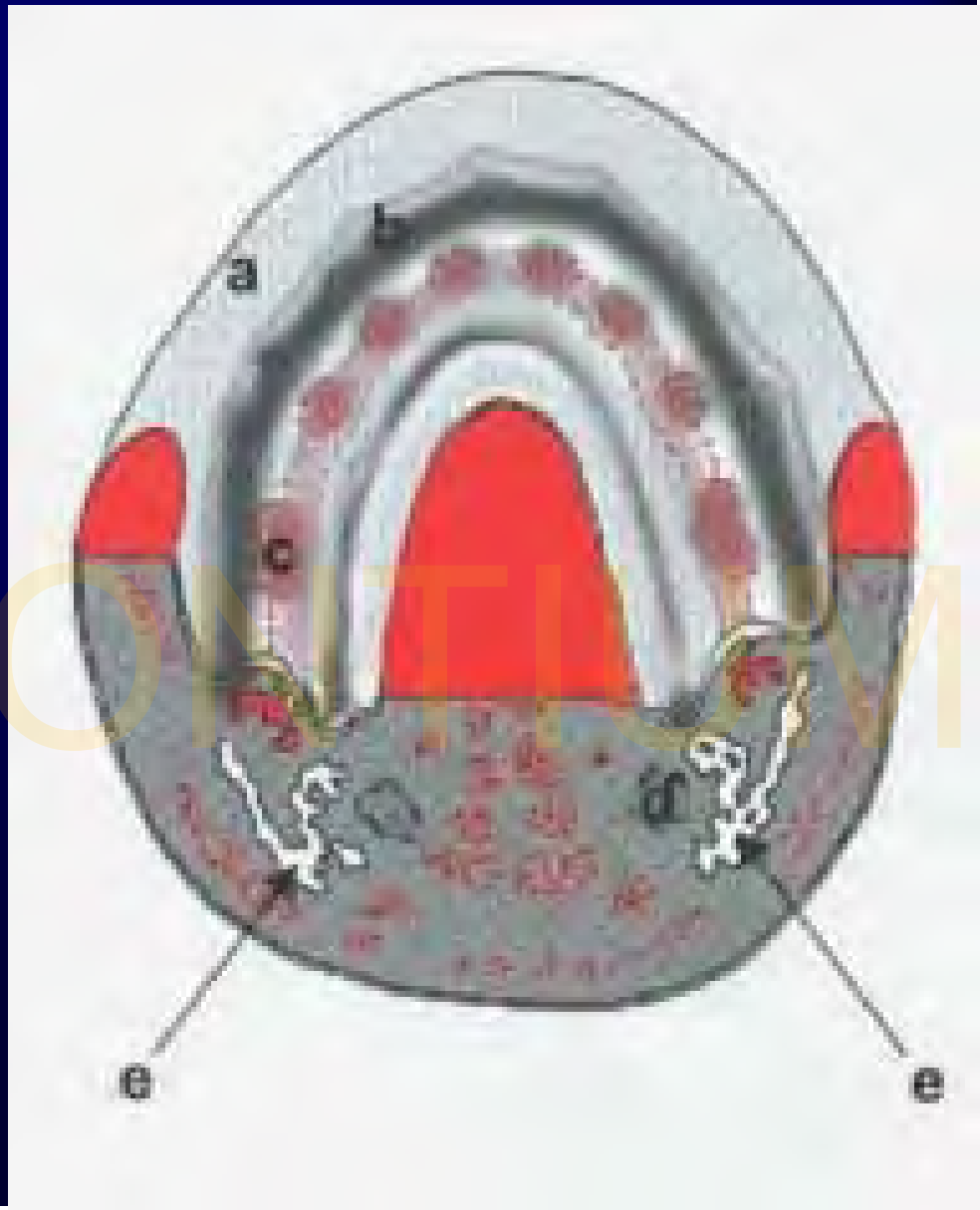


Diagram illustrating some of the homeobox genes and growth factors present during the epithelial–mesenchymal interactions occurring during the early stages of tooth development. Courtesy of Professor I. Thesleff.

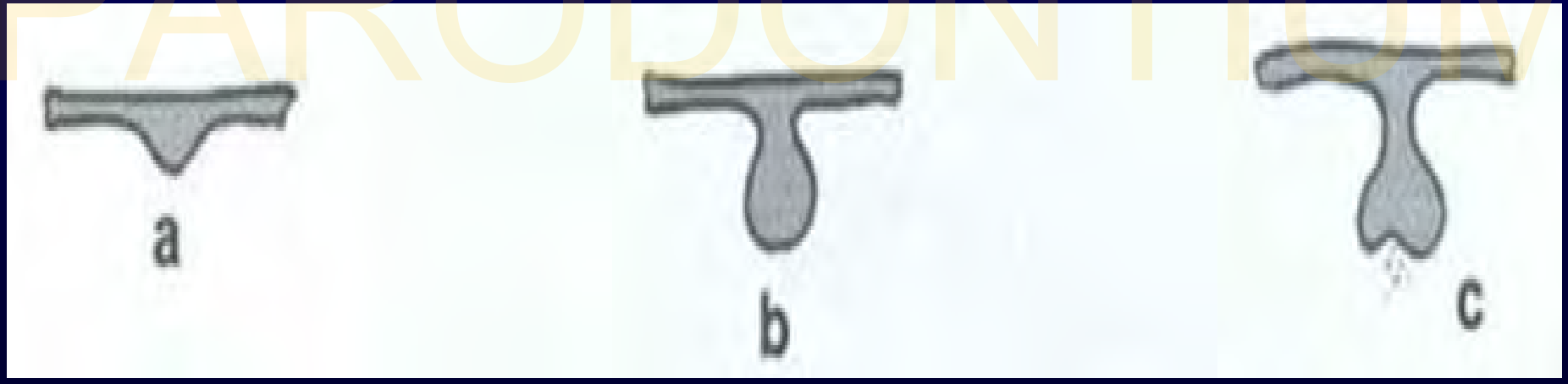
Tooth development

- week 6 development of the dental lamina (dental molding)
  - Thick epithelium inside oralmucous membrane
- Each molding has about 10 center of the proliferations
  - Dental buds



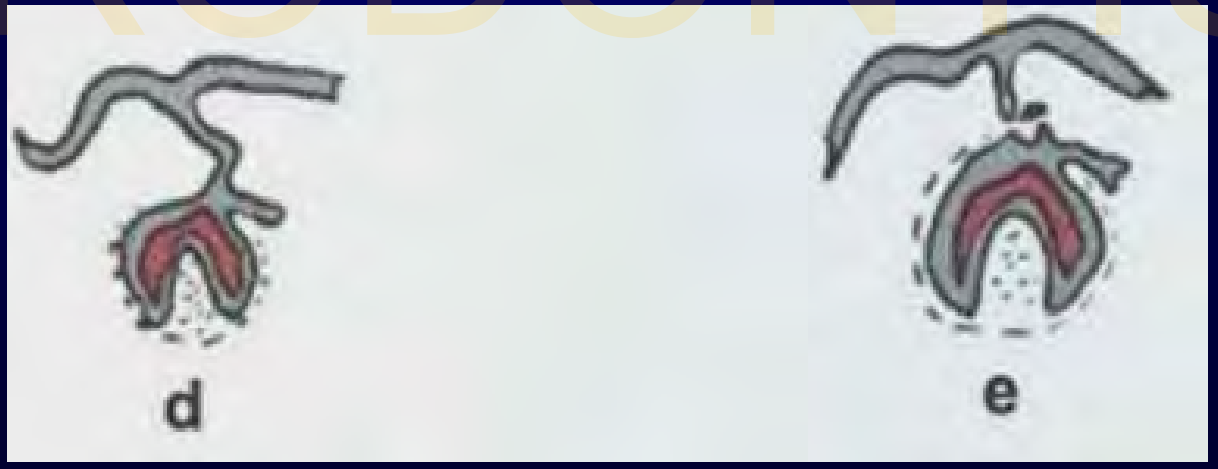
Tooth developmental stages

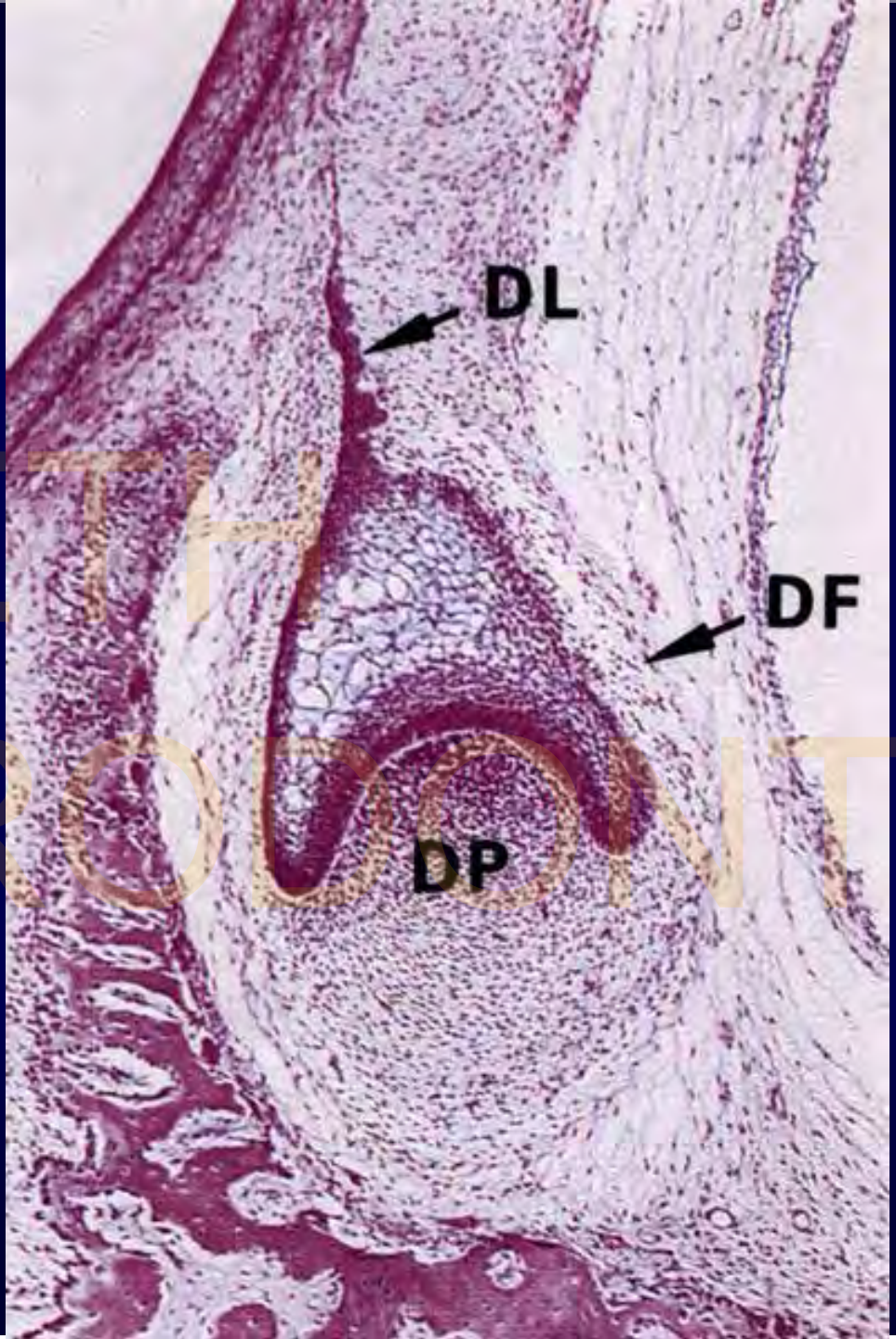
- Dental bud
  - Local thick epithelium, 10 in each jaw
- Dental cap
  - Ectoderm part → enamel organ
  - Invagination of the mesenchyme → dental papilla



Tooth developmental stages

- Dental bud (hat) → bell
  - External dental organ
  - Dental reticulum
  - Inner dental organ
  - Dental papilla → dental pulp
  - Dentl sac → cementum, periodontal ligaments



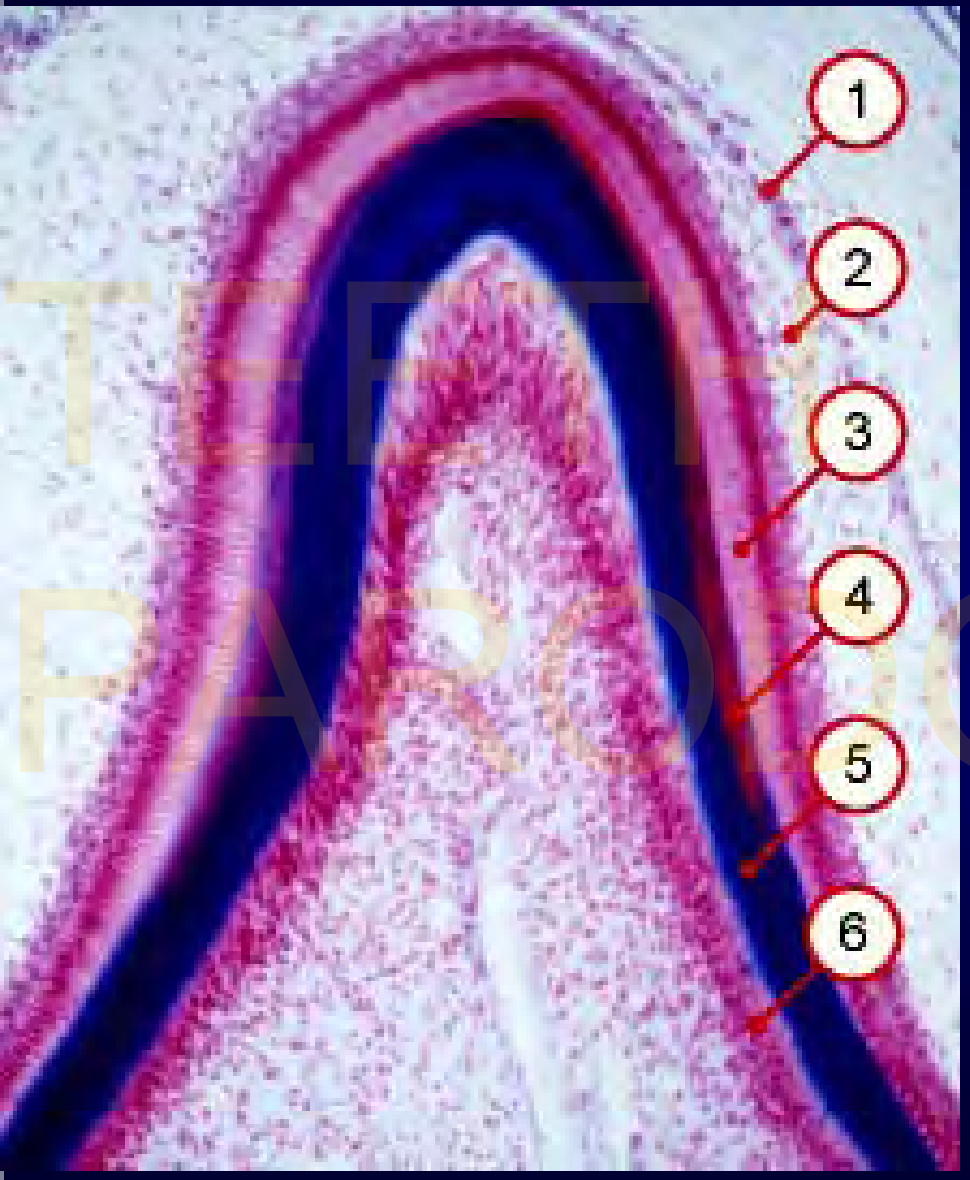


Tooth developmental stages

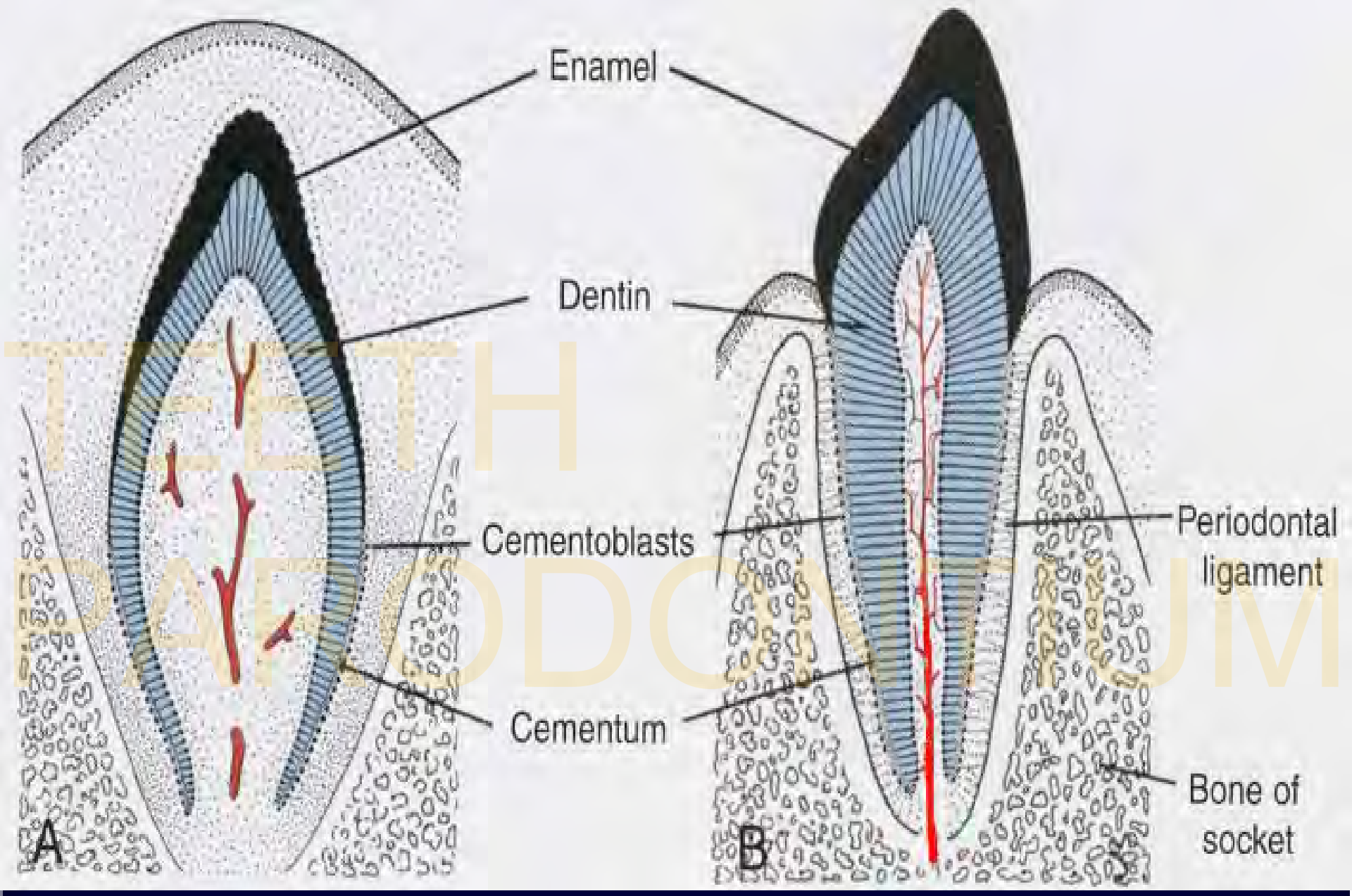
- Epithelial dental sheath (cervical sling)
  - Area of the contact between inner and outer enamelic epithelium
  - Ingrowth to the mesenchyme; root induction

month 3

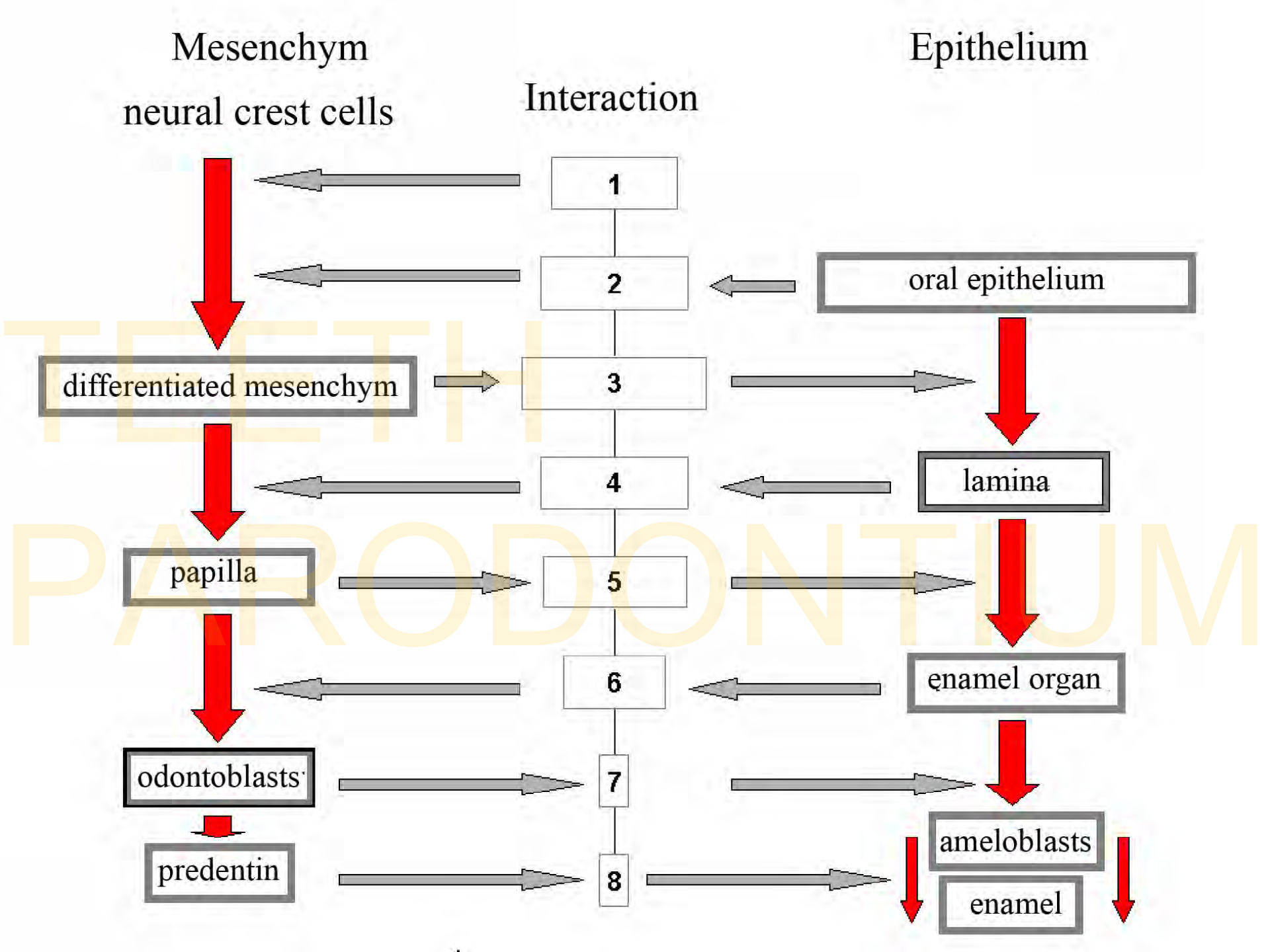
Tooth developmental stages



1 Outer layer of the enamel organ
2 Enamel pulp
3 Inner layer of the enamel organ (ameloblasts)
4 Enamel
5 Dentin
6 Odontoblasts


Enamel
Dentin
Cementoblasts
Cementum
A
B
Periodontal ligament
Bone of socket

month 6



Eruptio - eruption

Teeth appear in jaws as buds in the dental lamina

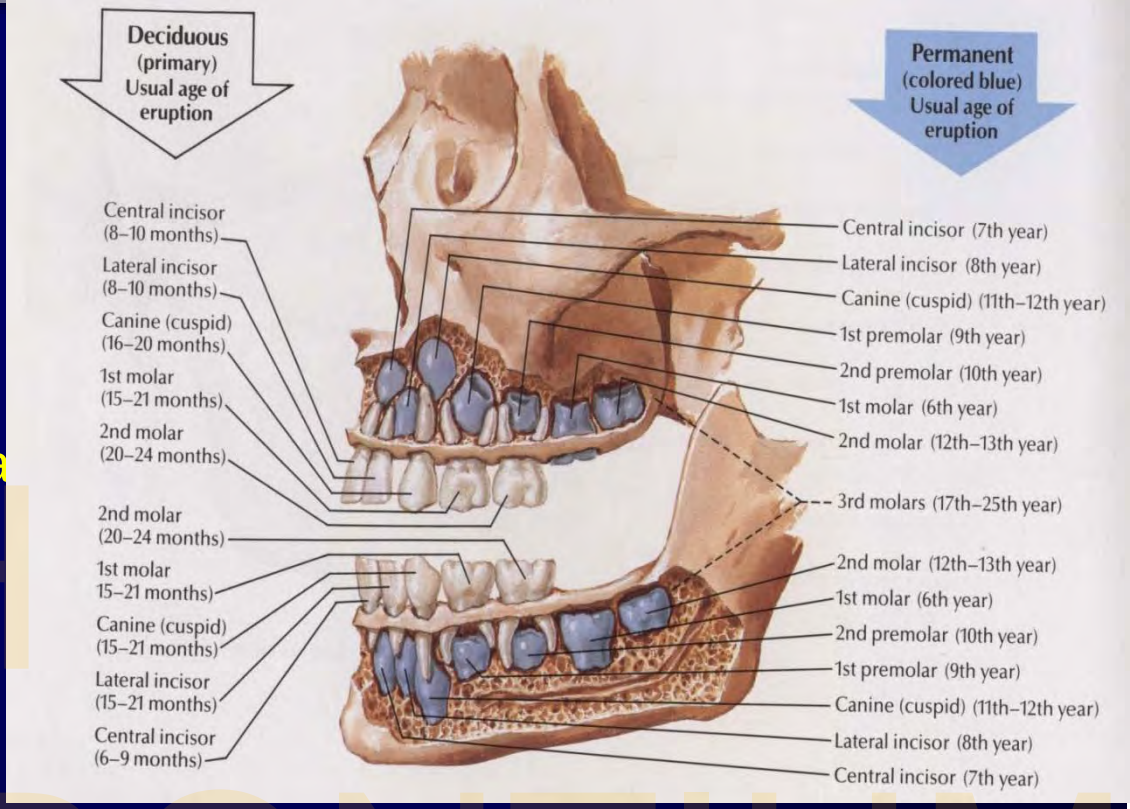
Tooth penetrates through gingiva to the oral cavity

Deciduous teeth – *from month 6. to year 2*

$i_1\ i_2\ m_1\ c\ m_2$

Permanent teeth – *from year 6. to year 30*

$M_1\ I_1\ I_2\ P_1\ C\ P_2\ M_2\ M_3$



Deciduous Teeth	Medial Incisor	Lateral Incisor	Canine	First Molar	Second Molar
Eruption (months)[a]	6 to 8	8 to 10	16 to 20	12 to 16	20 to 24
Shedding (years)	6 to 7	7 to 8	10 to 12	9 to 11	10 to 12

[a]In some normal infants, the first teeth (medial incisors) may not erupt until 12 to 13 months of age.

Permanent Teeth	Medial Incisor	Lateral Incisor	Canine	First Premolar	Second Premolar	First Molar	Second Molar	Third Molar
Eruption (years)	7 to 8	8 to 9	10 to 12	10 to 11	11 to 12	6 to 7	12	13 to 25

deciduous teeth

central I - 6-8 months
Lateral I - 8-10 months
first molars - 1 year
canines - 18 months
second molars - 2 years

permanent teeth

first molars - 6 years
central i - 7 years
lateral I - 8 years
first premolars - 9 years
second premolars - 10 years
canines - 11 years
second molars - 12 years
third (wisdom) M - 30 years

Examination pictures - examples