



# ***ZAHNHISTOLOGIE***

## ***Pulpa und Zementum***

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***Dr. Andrea D. Székely***

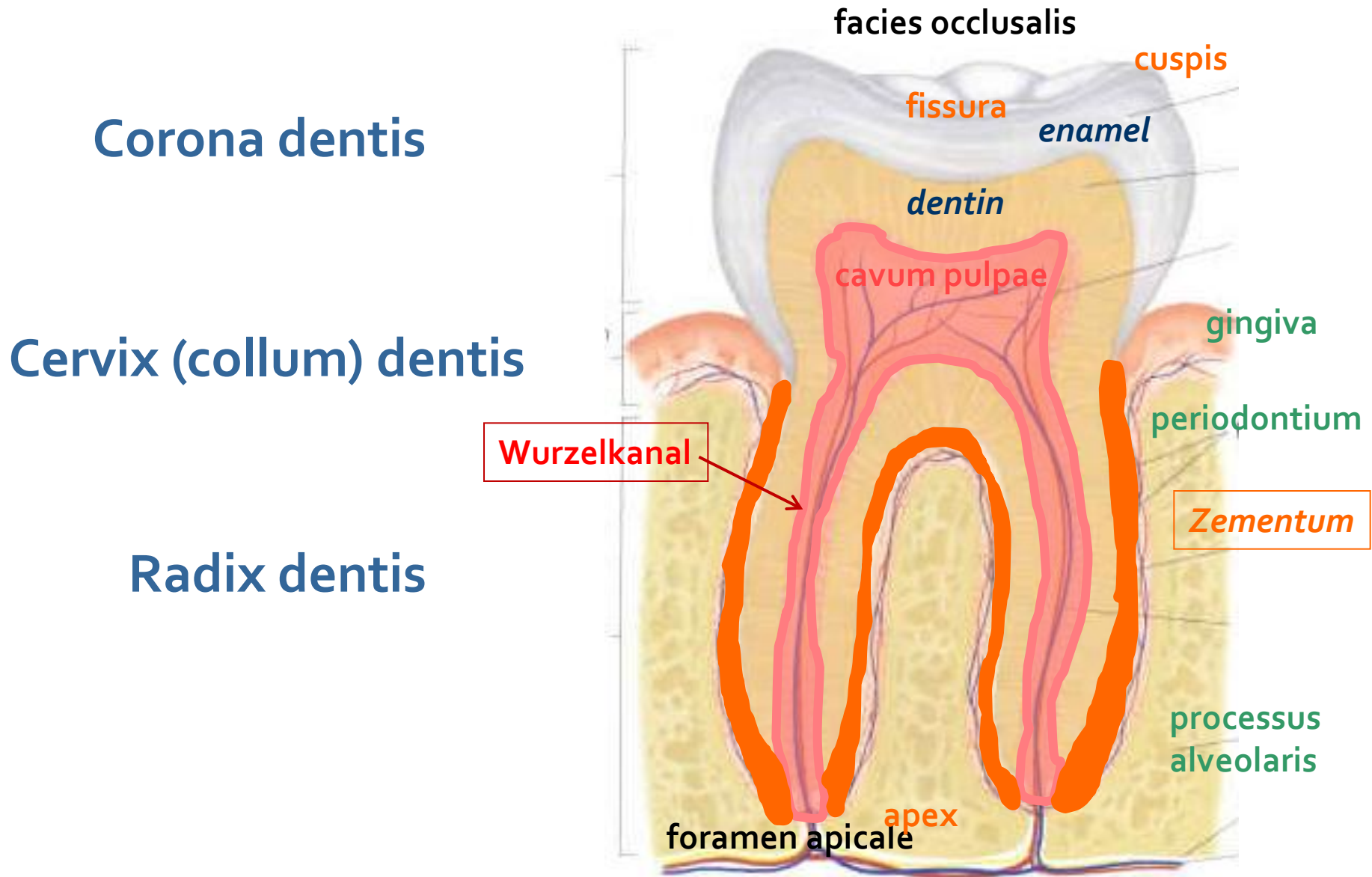
***Semmelweis Universität***

***Institut für Anatomie, Histologie und Embryologie***

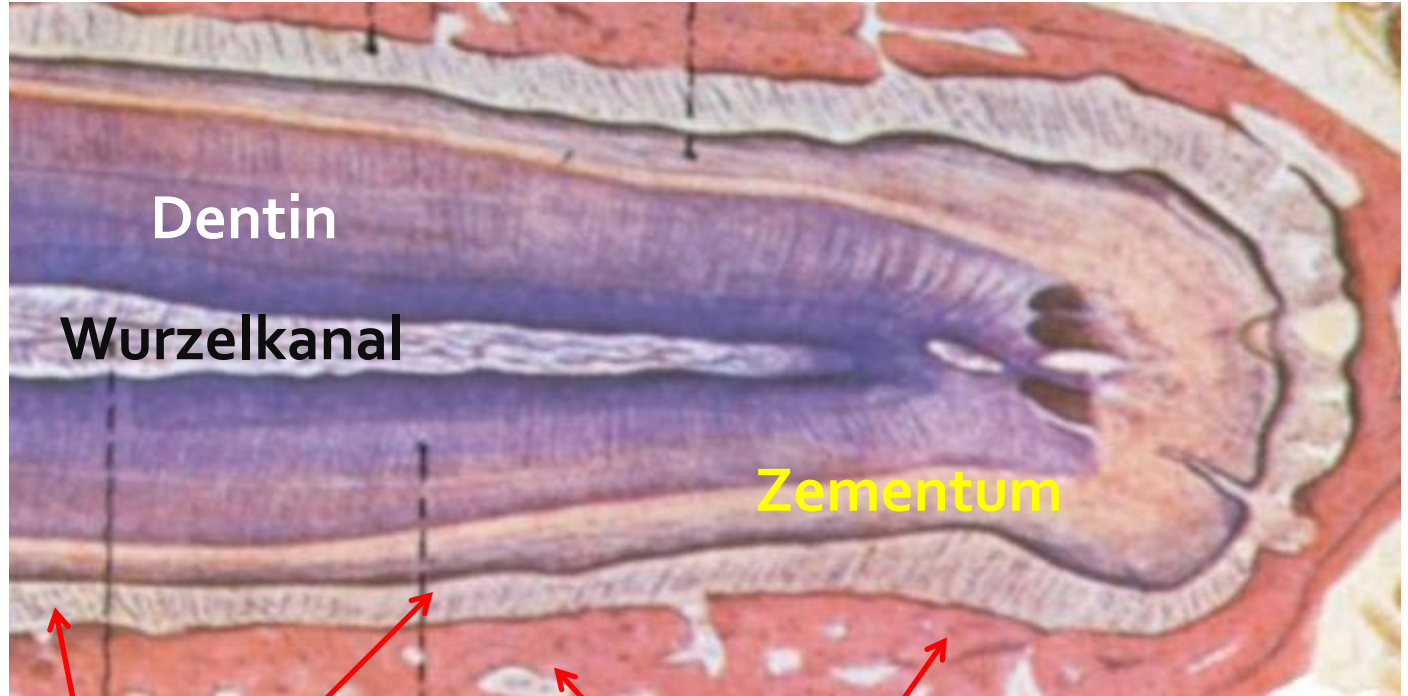
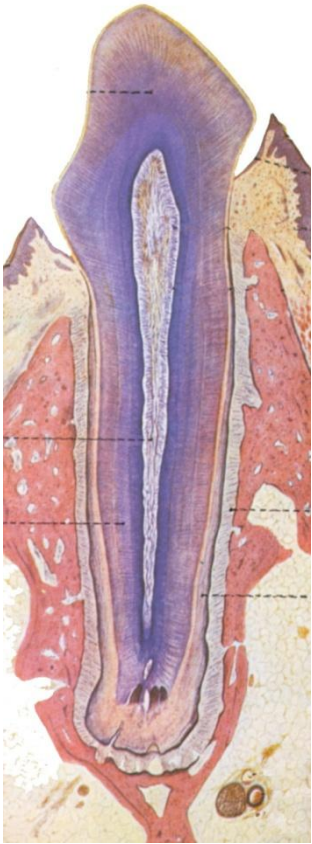
***Budapest***



# ÜBERBLICK DER ZAHNSTRUKTUR



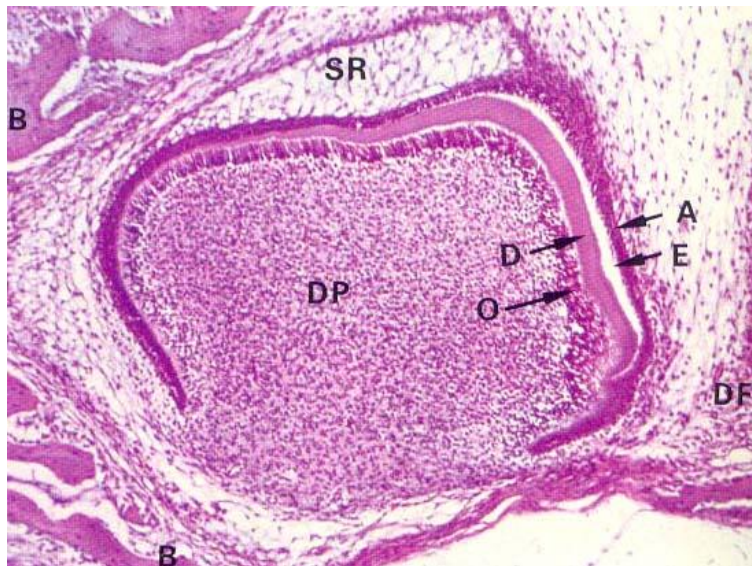
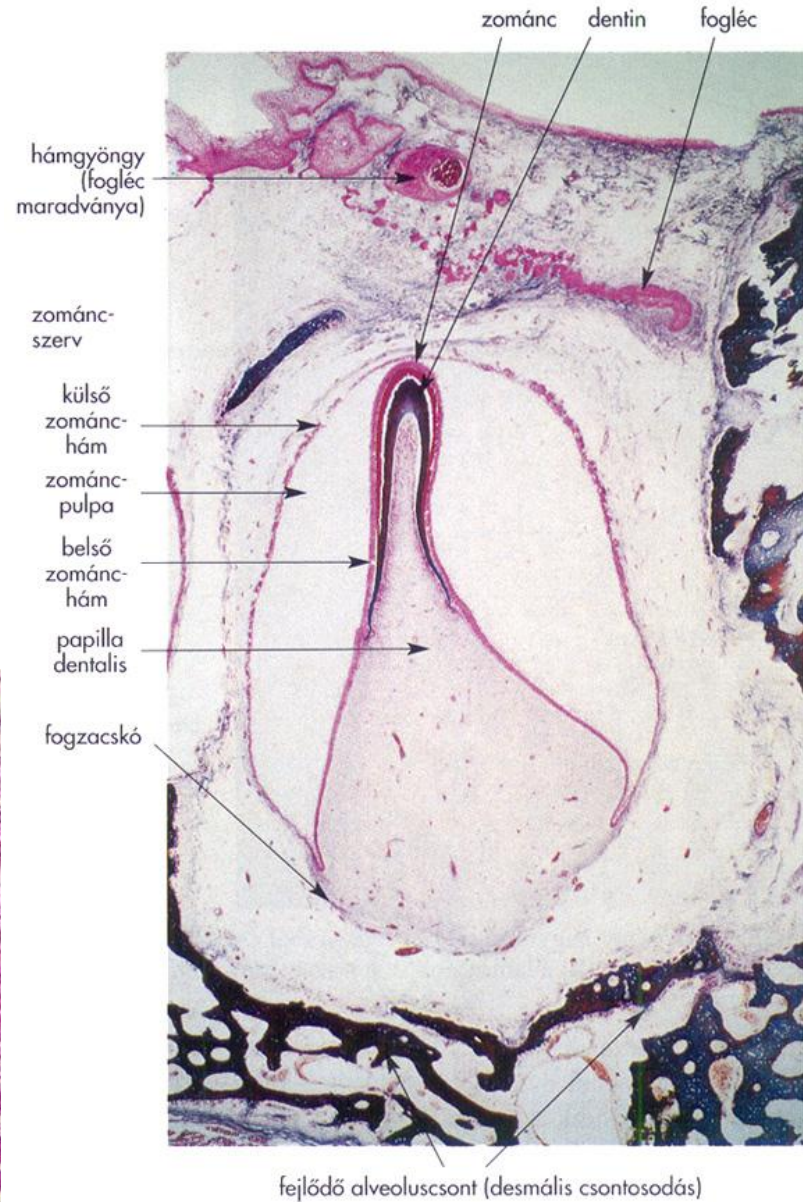
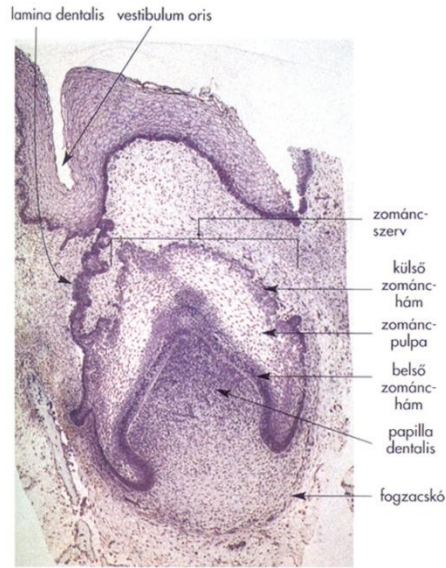
# ZAHNGEWEBETYPEN



Periodontium

Alveolarknochen

# EMBRYOLOGISCHÉ HERKUNFT



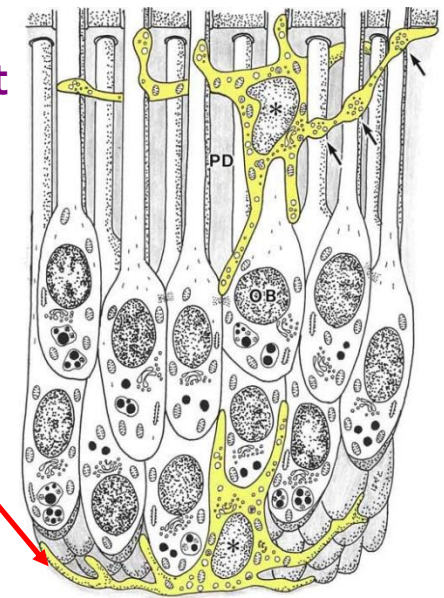
# ZAHNPULPA



- Schmelz
- Dentin
- Pulpahorn
- Cavum pulpae
- Zement
- Canalis radialis
- Foramen apicale

Herkunft: Mesenchym der Zahnpapille  
Füllt die Pulpahöhle aus  
Lockeres Bindegewebe:  
Fibroblasten, Fibrozyten,  
Macrophagen, Lymphozyten,  
Plasmazellen  
Nicht differenzierte Mesenchymzellen  
(Odontoblasten)  
Antigen presentierende Zellen  
Typ I, Typ III Kollagen, keine elastische  
Fasern  
Hyaluronsäure,  
Dermatansulphat  
Leitungsbahnen

Dendritische  
Zellen zw den  
Odontoblasten



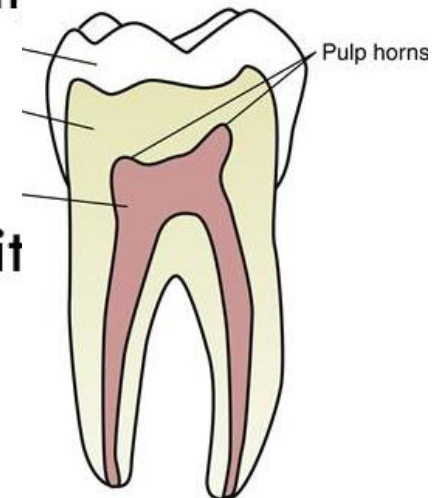
# ZAHNPULPENMORPHOLOGIE

Die *cavitas pulpae* (Pulpenkammer) enthält die Zahnpulpe



## *Kronenpulpe + Pulpenhörner*

- It is the pulp occupying the pulp chamber of the crown of the tooth
- In young teeth it resembles the shape of the outer dentin
- It has six surfaces : occlusal, mesial, distal, buccal lingual and floor.
- Pulp horns are projections into the cusp
- This pulp constricts at the cervical region where it continues as the radicular pulp



# ZAHNPULPENMORPHOLOGIE

Der Pulpenkammer öffnet durch die Wurzelkanäle am Foramen apicale



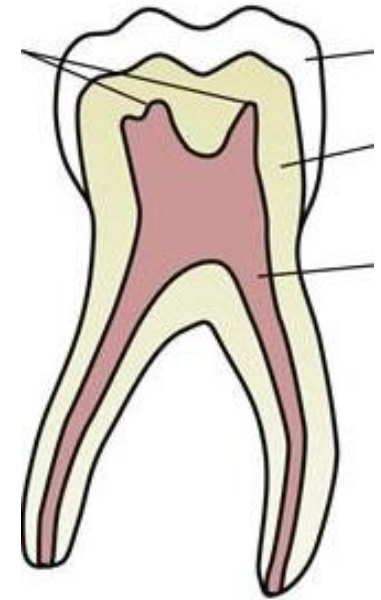
## *Wurzelpulpe*

It is the pulp occupying the pulp canals of the root of the tooth

In the anterior tooth it is single and in the posterior teeth it is multiple

The radicular portions of the pulp is continuous with the periapical tissues through apical foramen

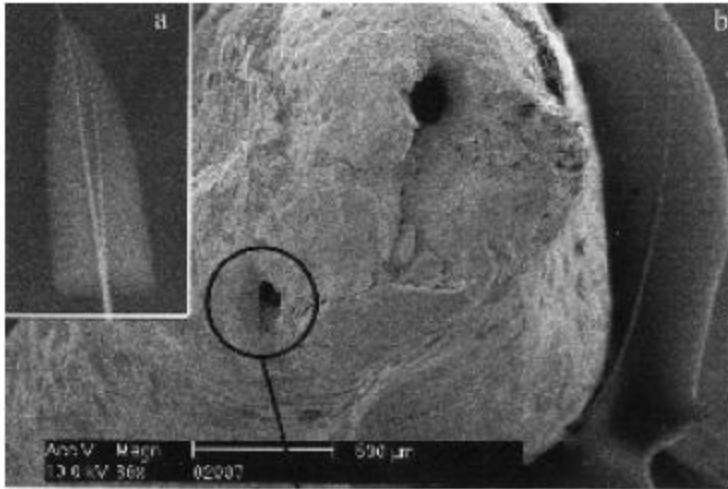
As age advances the width of the radicular pulp is reduced, and so is the apical foramen.



# ZAHNPULPENMORPHOLOGIE

## *Canalis accessorius*

- Leading laterally from the radicular pulp into the periodontal tissue.
- Present in the apical third of the root sheath cells
- Formed due to premature loss of HERS or when developing root encounters a blood vessel.
- Overall occurrence is 33%
- May also be present at the furcation region





# ZAHNPULPENHISTOLOGIE

## PULPA

Die Zahnpulpa beim Erwachsenen hat eine ähnliche Zusammensetzung wie das gallertige BG, besitzt aber eine Innervation und grössere Durchblutung

**ZELLEN:** Fibroblasten

Mobile Immunzellen

**ODONTOBLASTEN!!**

**STAMMZELLEN**

Dendritische Zellen

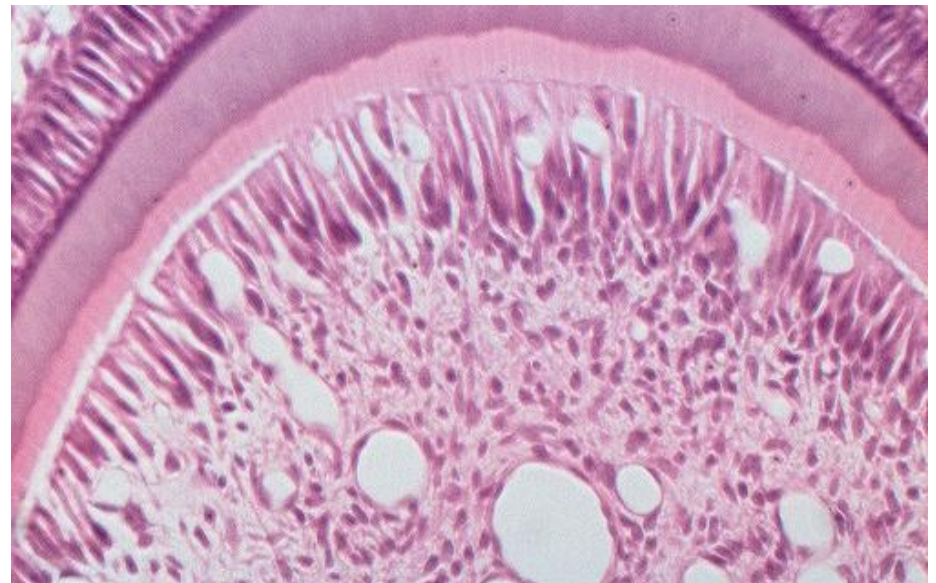
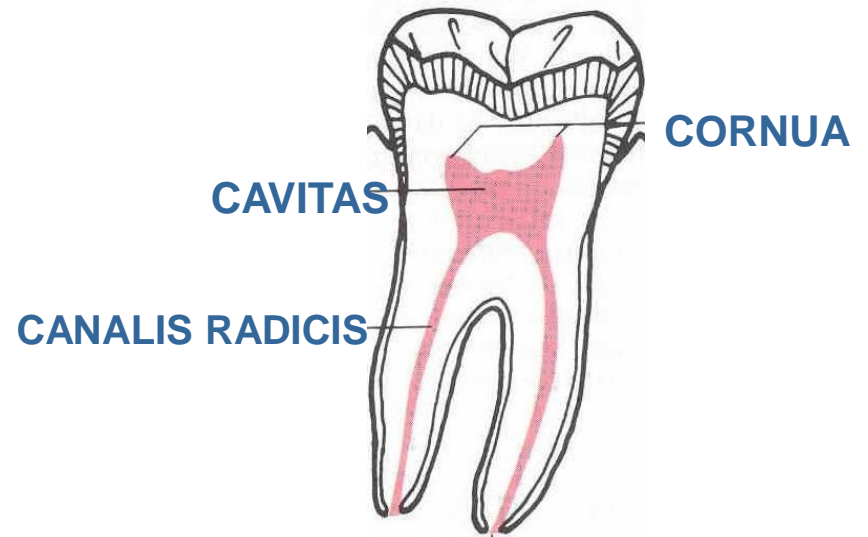
**FASERN:** reticulin

kollagen

(KEIN elastische Fasern)

**PULPAREGRESSION**

- mehrere Wurzelkanäle
- Pulpasteinen
- Pulpenpolip
- verengte Kammer und Kanäle



# ZAHNPULPENHISTOLOGIE

## ROLLE DES EC MATRIX

- *Maintain tissue's physical properties and integrity*
- *Control of growth and development and repairs*
- *Control of cell migration*
- *Control of diffusion of macromolecules*

- **FIBERS AND GLYCOPROTEIN** (collagen type I, III, no elastic fiber, fibronectin)
- **GROUND SUBSTANCES** (glycosaminoglycans, chondroitin sulfate proteoglycan)
- **BLOOD VESSELS, NERVES, LYMPH VESSELS**

Versican  
Syndecan  
Decorin  
Biglycan  
Integrins  
Fibronectin  
Tenascin  
Osteoadherin

Form large hydrated aggregates creating a gel

Binds to type I collagen

May help regulate collagen fibrillogenesis

Cell surface adhesion receptors

Concentrated near the odontoblast layer. Binds cells to extracellular matrix

Associated with cell movement. Concentrated near the odontoblast layer

Associated with mineralization

# ROLLEN DER ZAHNPULPA

- Dentinbildung (lebenslang)
- Dentinernährung
- Sinnesfunktionen
- Abwehr

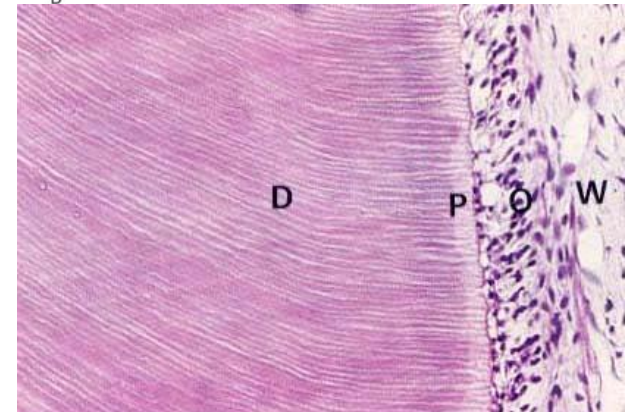
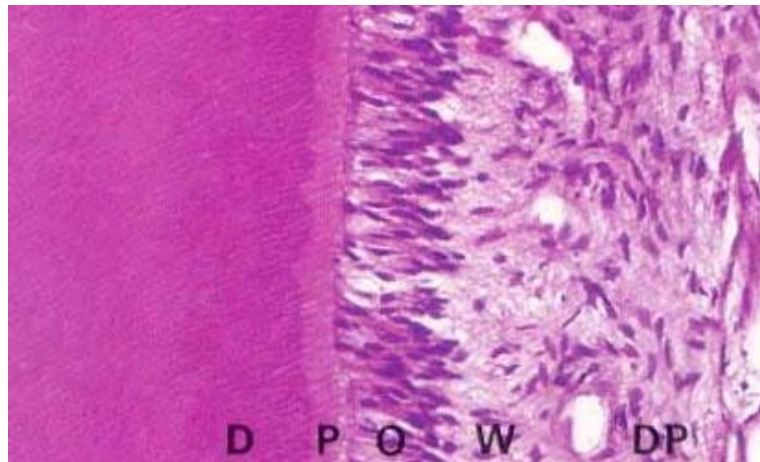
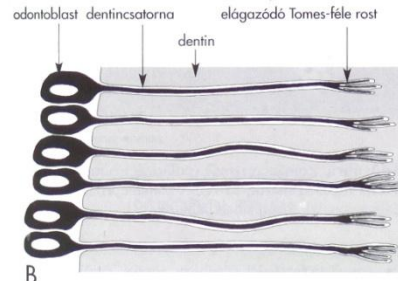
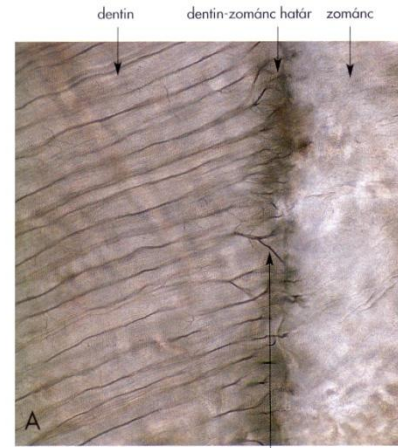
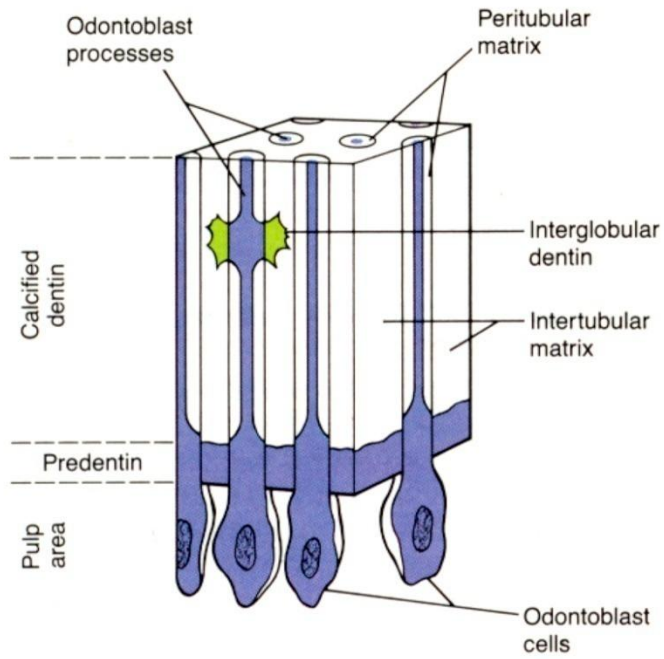
The Pulp is a soft mesenchymal connective tissue that occupies pulp cavity in the central part of the teeth.

It is a special organ because of the unique environment

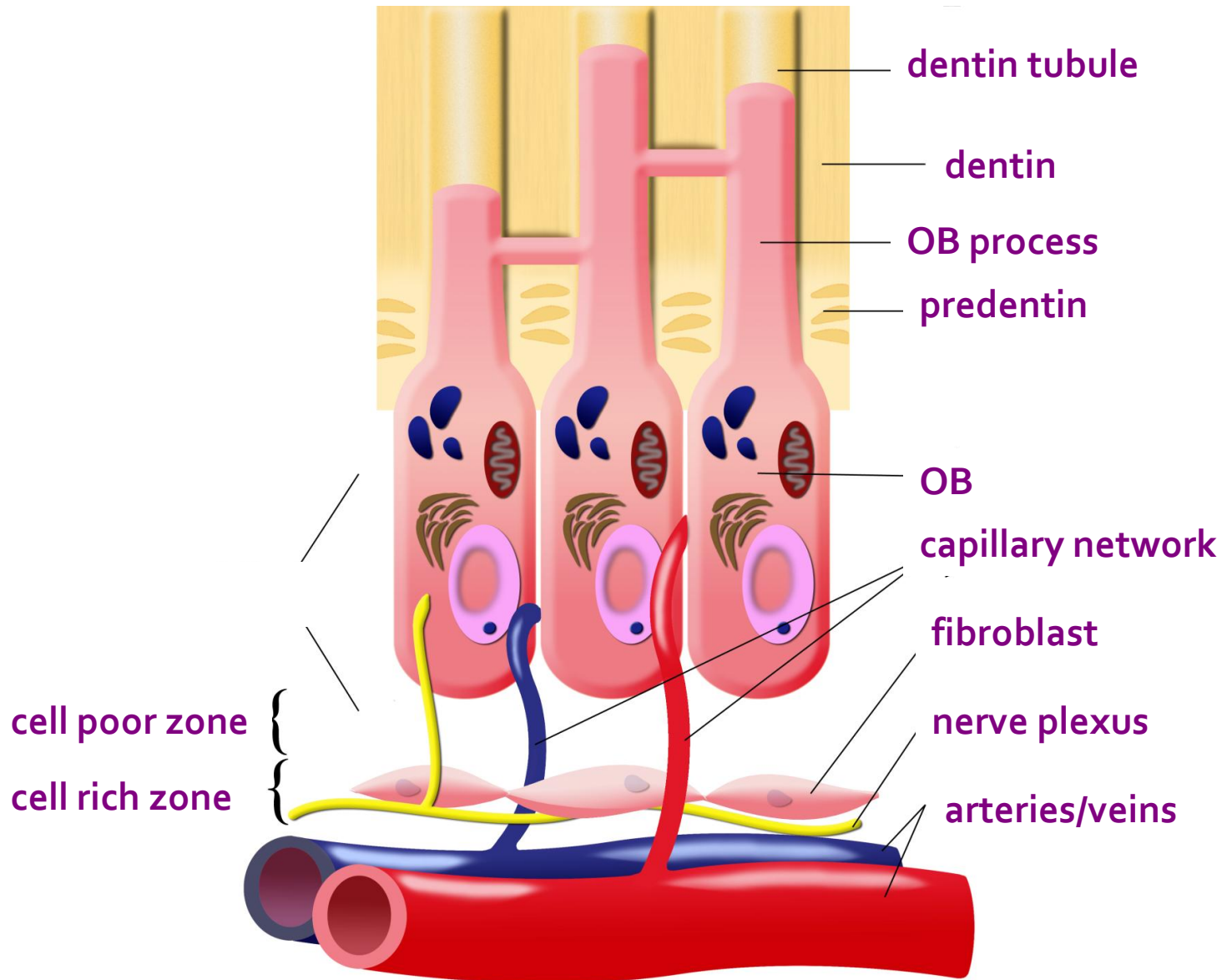
Each of these organs has a shape that conforms to that of the respective tooth.

Has ability to form dentin throughout life

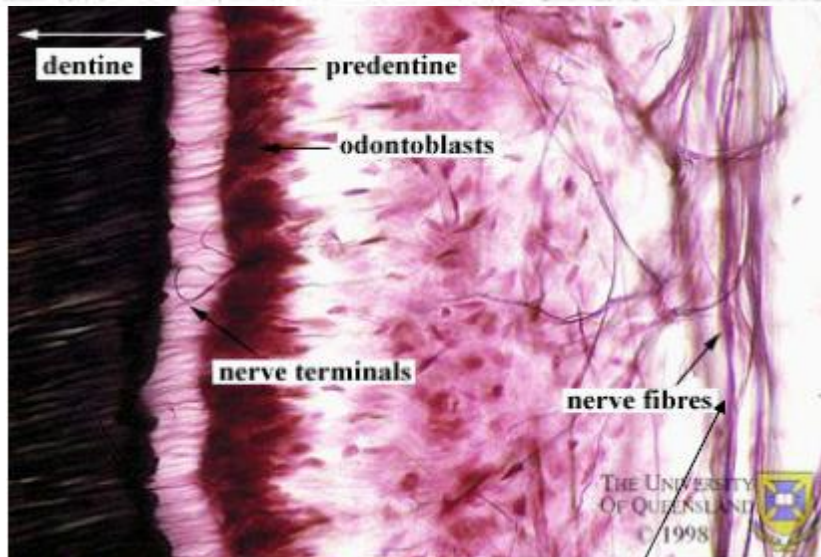
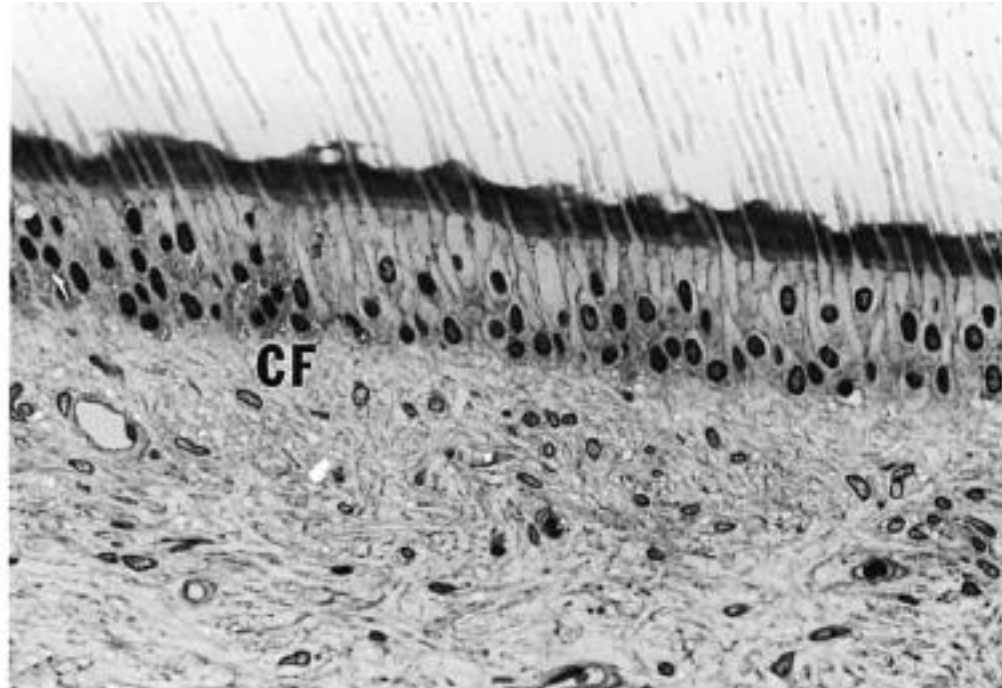
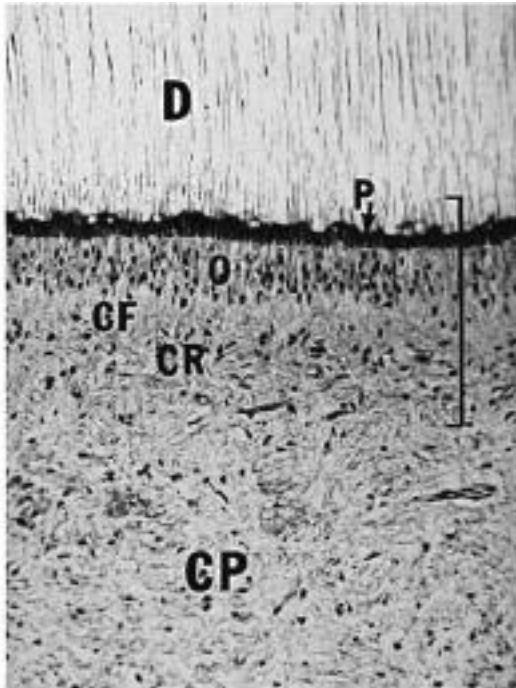
# DENTIN – PULP INTERFACE



# PULPAL DENTIN JUNCTION

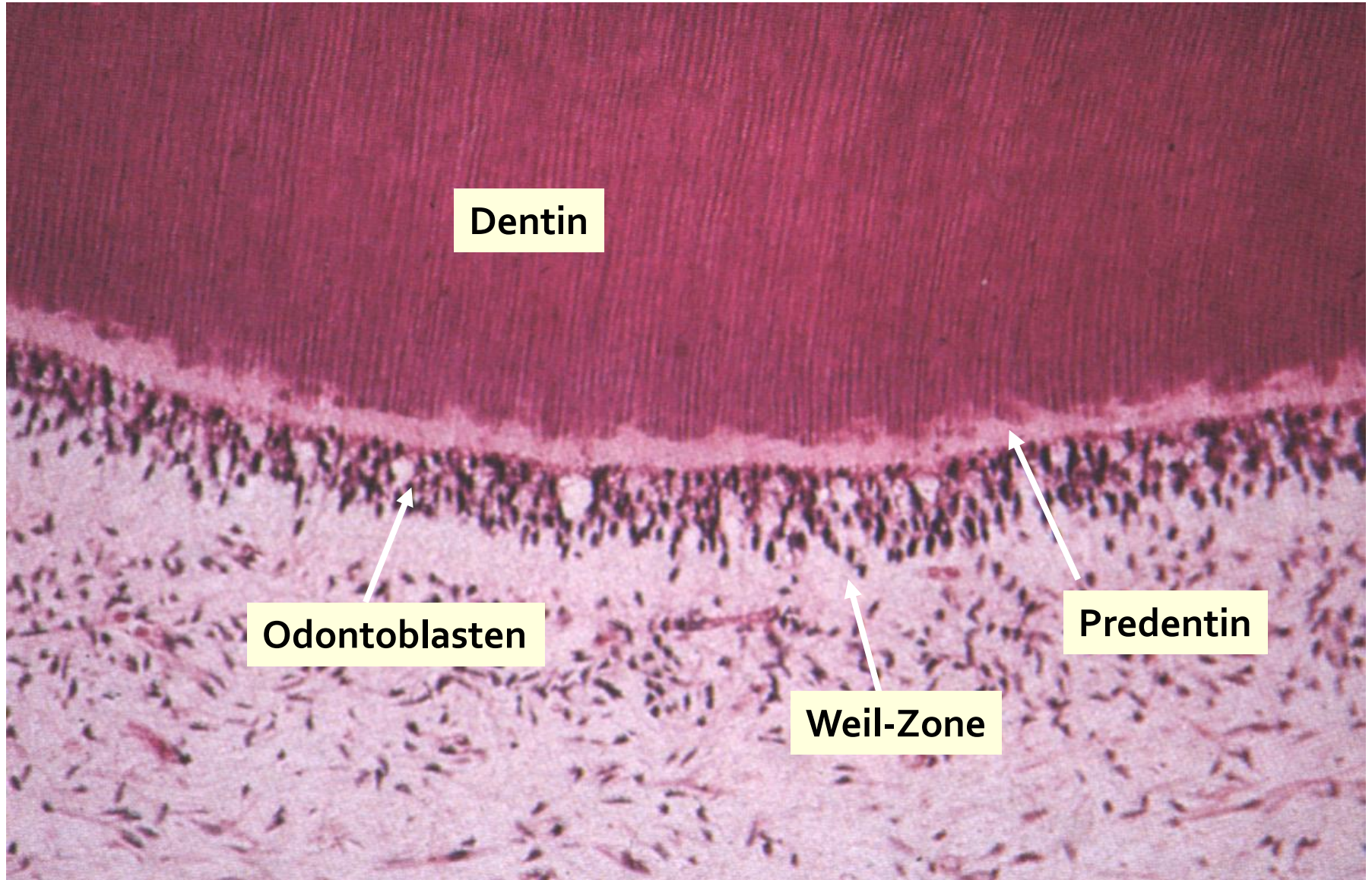


# ZAHNPULPA



CF: zellfreie Zone (Weil-Zone),  
Str. subodontoblasticum,  
Plexus subodontoblasticus aus  
nicht-myelinisierten  
Nervenfasern  
CR: zellreiche Zone  
CP: zentrale Pulpa (locker)

# ZAHNPULPENHISTOLOGIE



# ZAHNPULPA

## SCHICHTEN

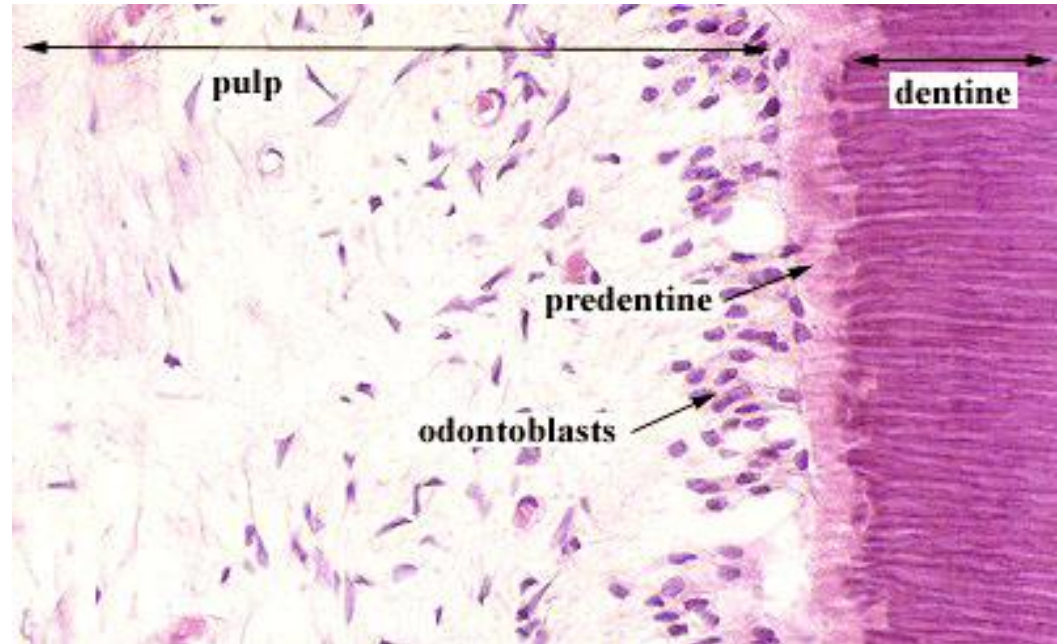
stratum odontoblasticum

acellular zone of Weil

stratum subodontoblasticum

cell rich zone

central pulp





# ZELLTYPEN

**Fibroblasten/fibrozyten**

*(alte vs junge Pulpa)*

**Odontoblasten**

**Stammzellen**

**Schutzzellen**

*macrophagen*

*dendritische AG presentierende zellen*

*mastzellen*

*plasmazellen*

*lymphozyten*

*eosinophilen*

*basophilen*

*neutrophilen*

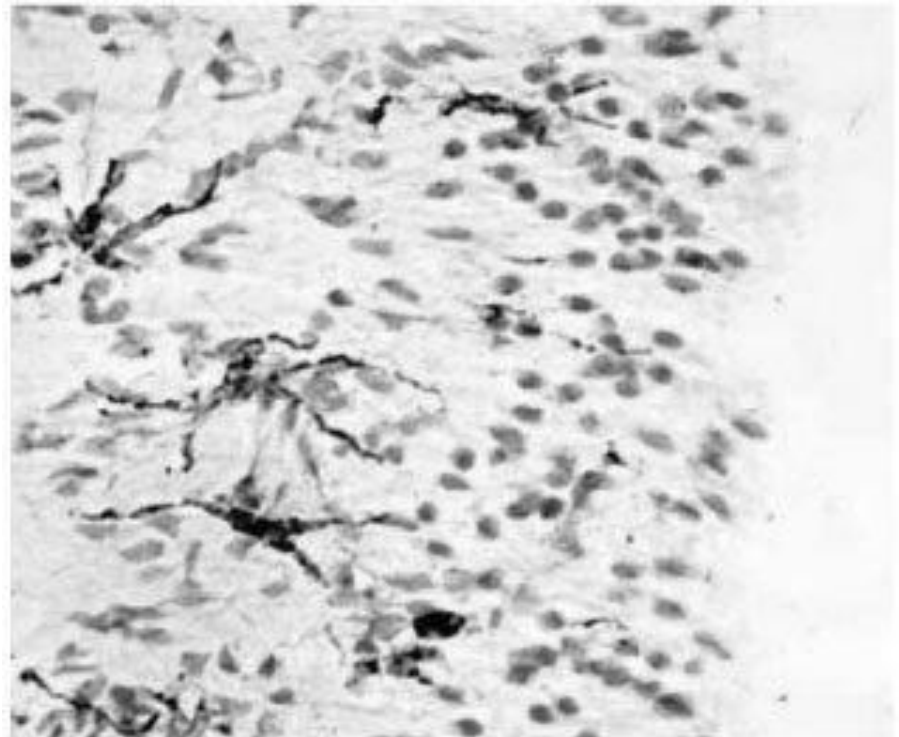
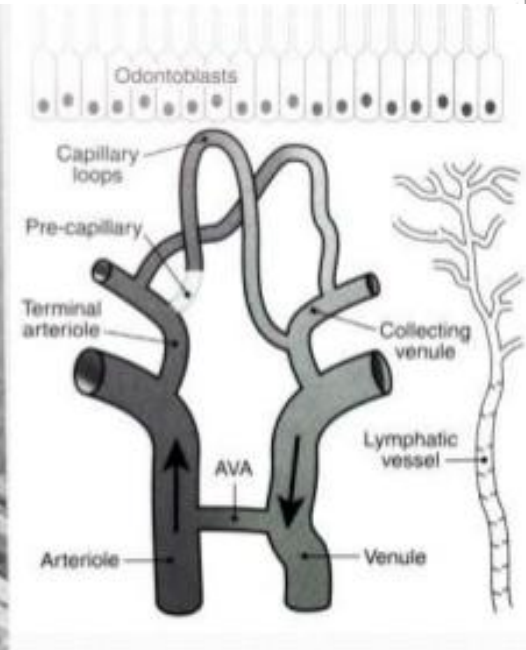
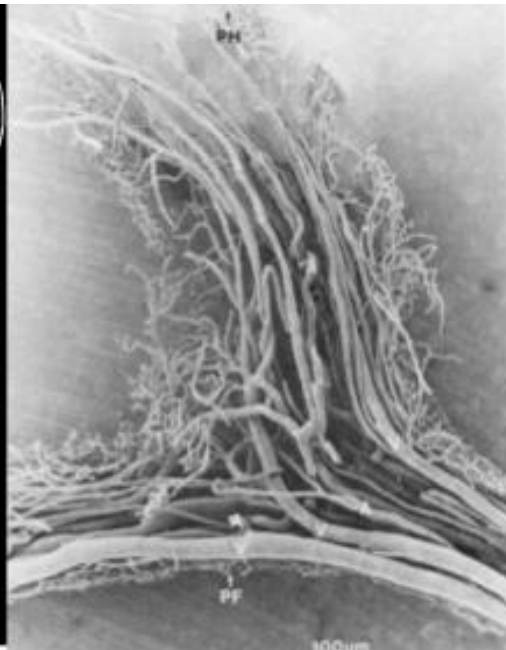
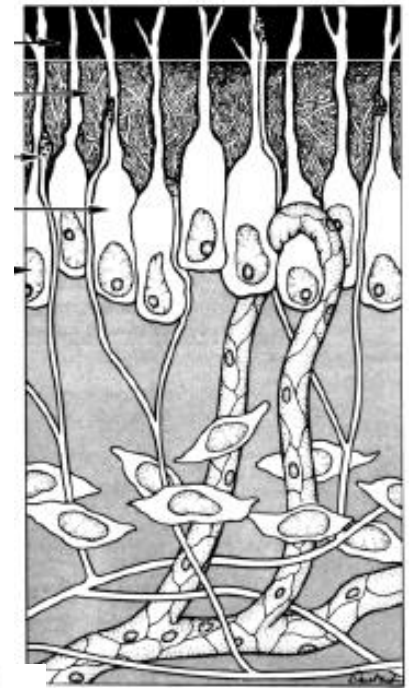


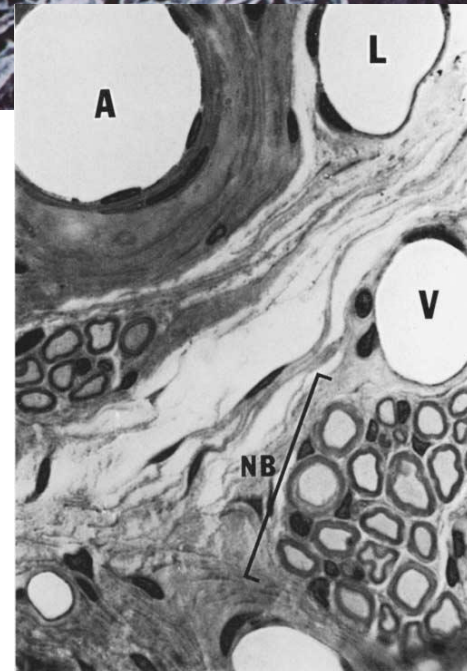
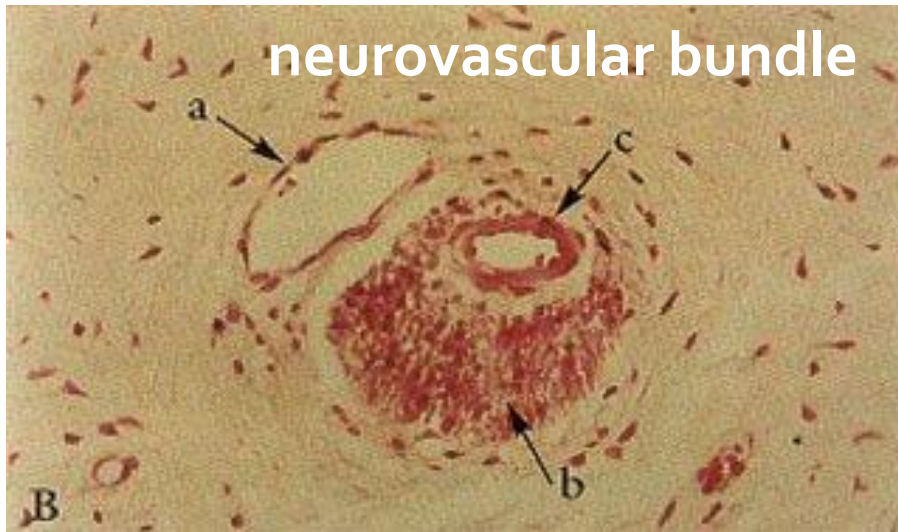
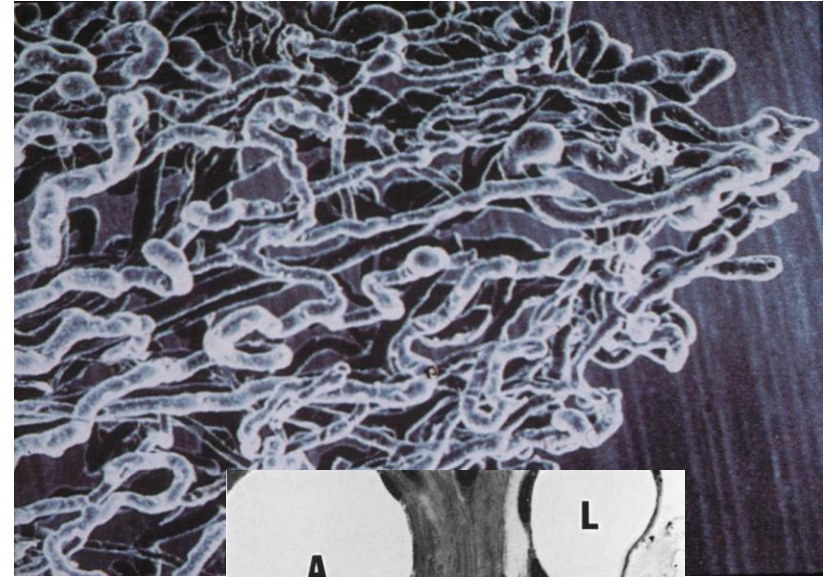
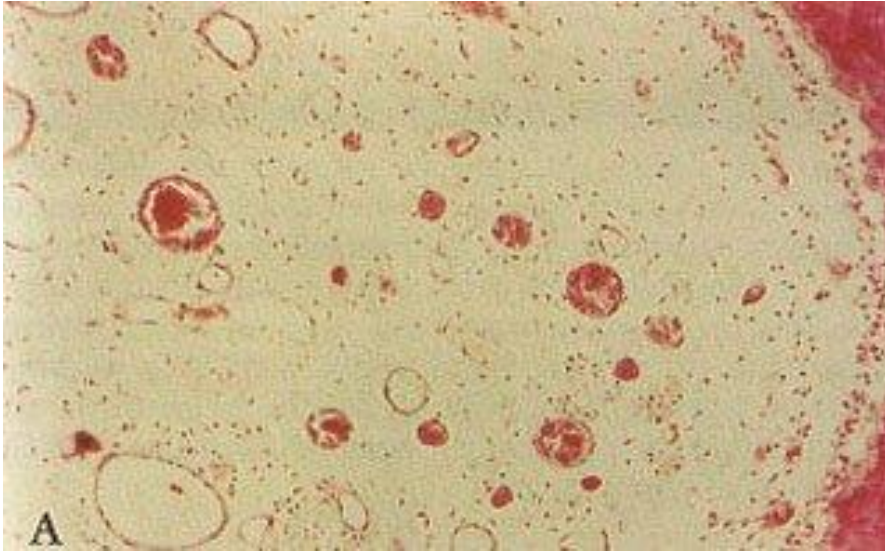
Fig. 2.13 Tissue section showing dendritic cells (stained brown) within the odontoblastic and subodontoblastic layer. Immunohistochemical staining was carried out with OX6-antibody, which is a marker for class II MHC molecules.

# PULPA GEFÄßE

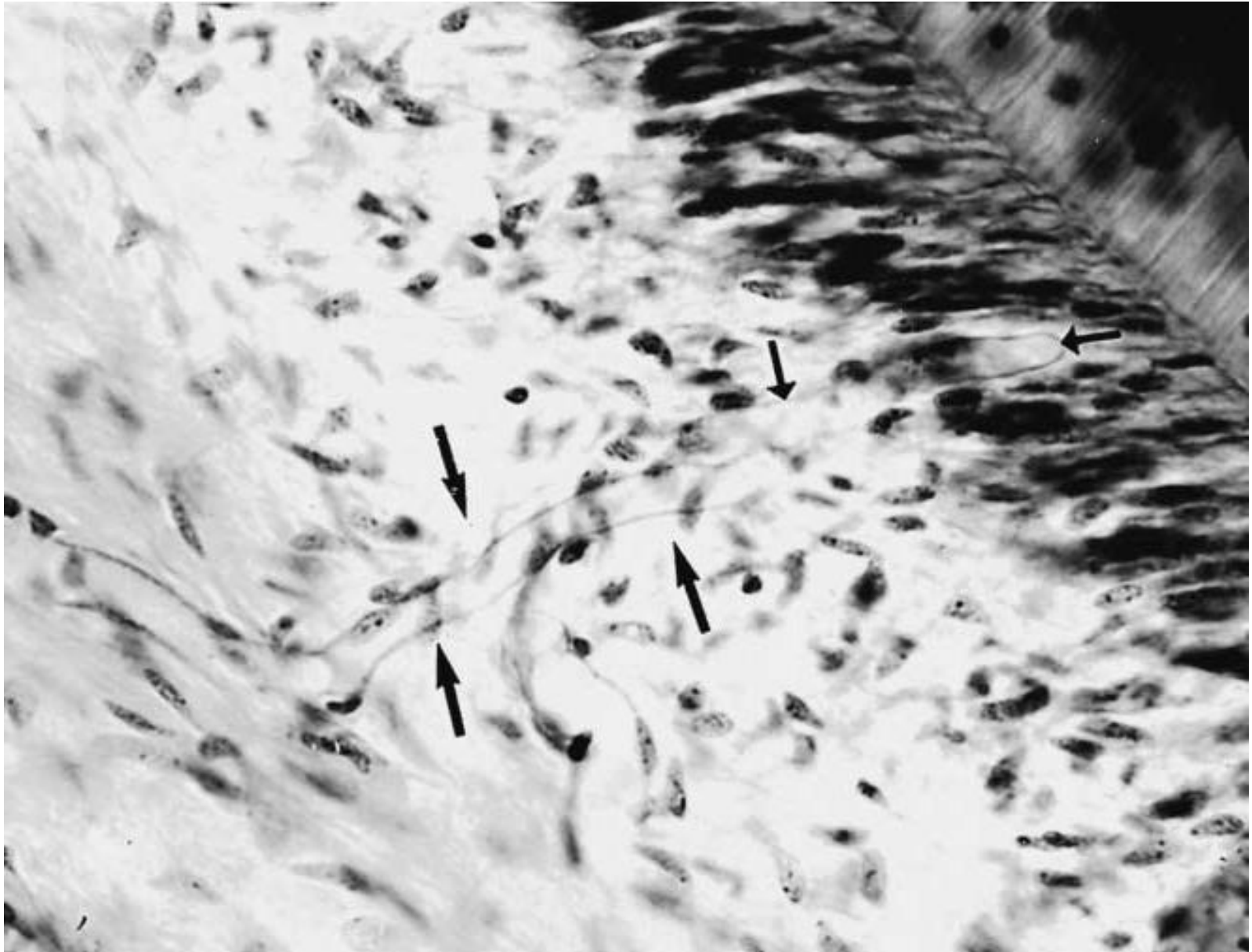
Rr. dentales → Foramen apicale  
Dichtes Plexus subodontoblasticus  
Mit fenestriertem und kontinuierlichem  
Endothel



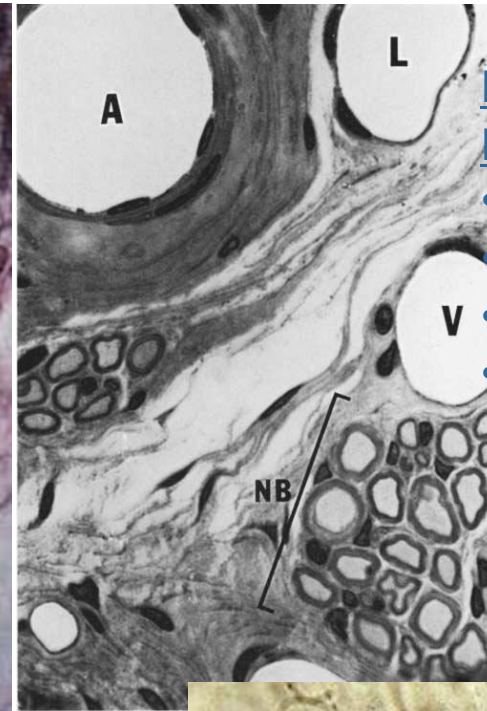
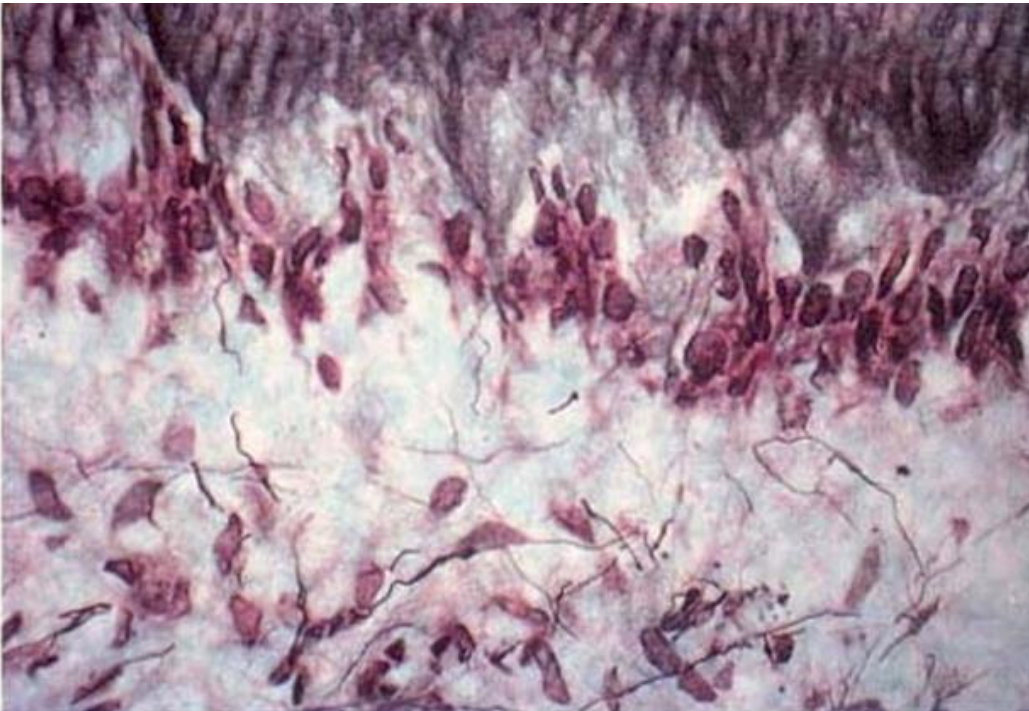
# PULPA GEFÄSSE



# LYMPH GEFÄSSE



# PULPA - LEITUNGSBAHNEN



## Neurovaskuläres Bündel:

- Arterie
- Vene
- Lymphkapillare
- Bündel von Nervenfasern

Rr. alveolares → Wurzelkanal

## Premolar:

300 myelinisierte Nervenfasern (90%: A $\delta$ , C), sensorisch, auch in den Dentinkanälchen (hier ohne Myelinscheide)

2000 nichtmyelinisierte Nervenfasern: sensorisch, postggl. sympathisch, SGRP, SP

Regeneration: NGF aus Odontoblasten, Fibroblasten



# NERVEN DER PULPA

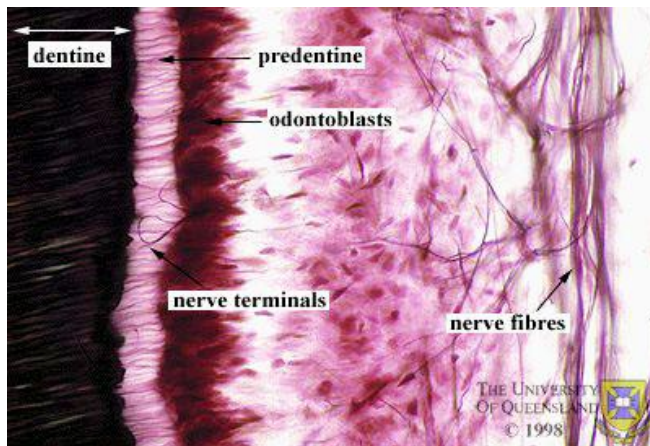
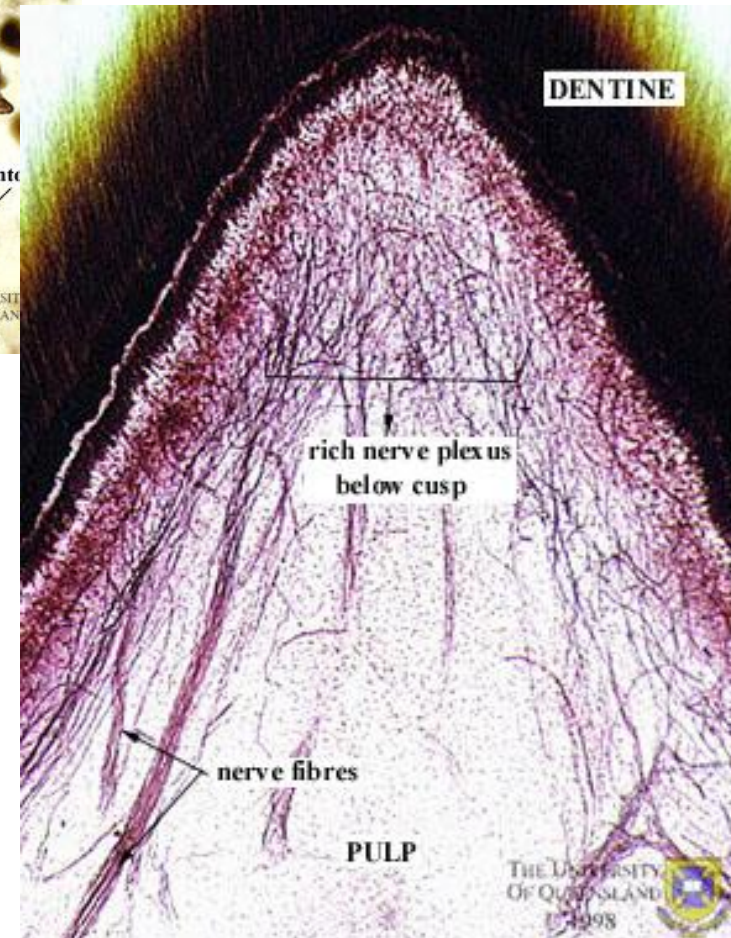
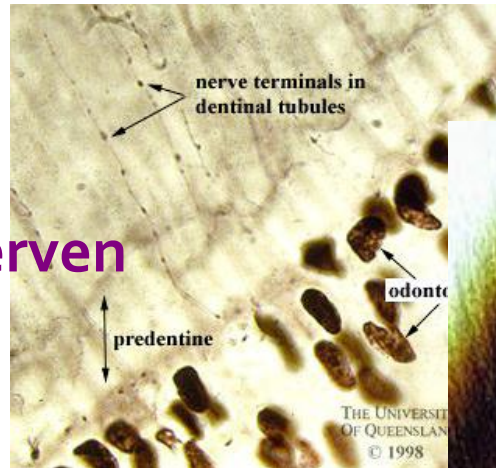
## Myelinisierte Nerven

*n. trigeminalis*  
(A beta Fasern)

## Non-myelinisierten Nerven

*C Fasern*

*Meistens gehören auch zum Trigeminalsystem, Einige Fasern gehören zum Sympatisches system Versorgen die arteriolen*



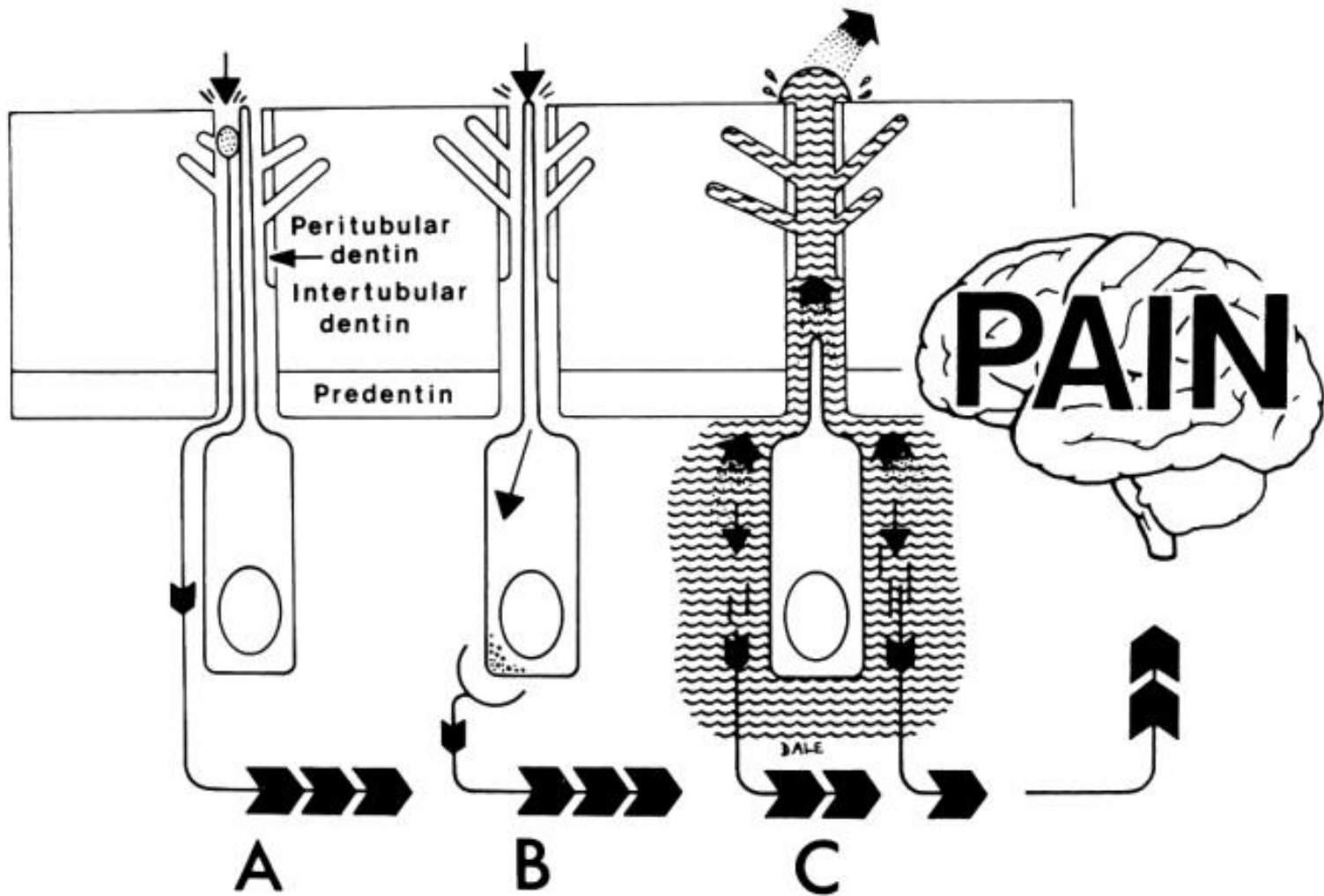
# NERVEN DER PULPA



*Raschkow plexus*

**Figure 9.14**

Nerve fibers in the subodontoblastic area. Fibers can be traced to the odontoblastic cell layer.



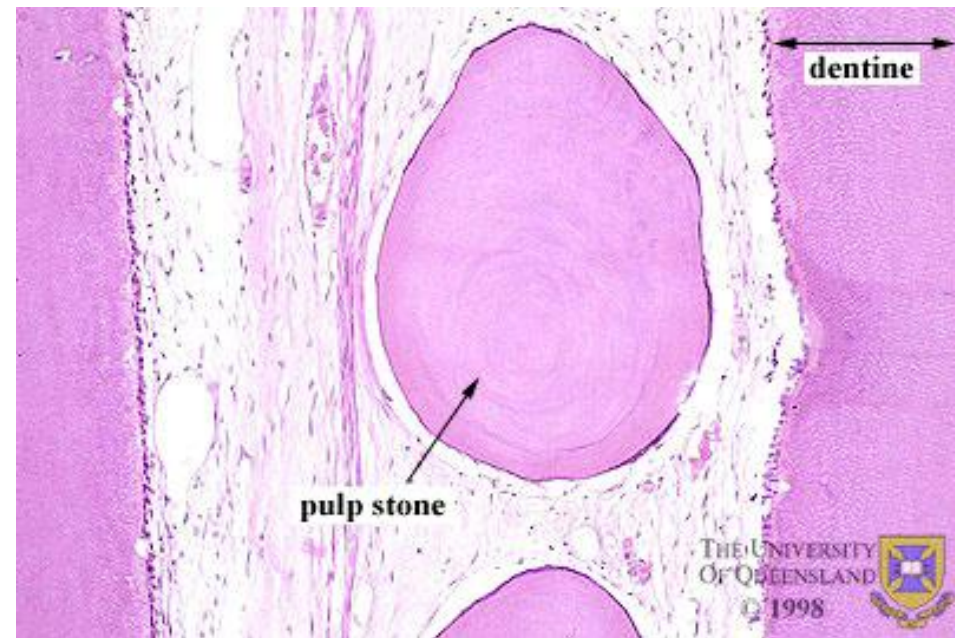
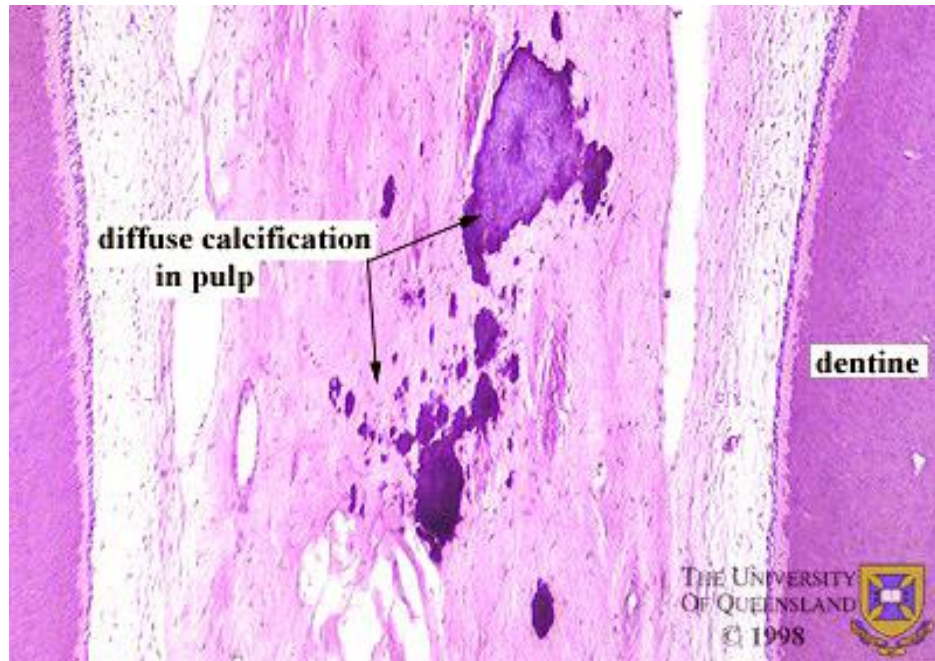
(from ART Cate: Oral Histology - Development, Structure, and Function; Mosby Year Book)



# KLINISCHE RELEVANZEN



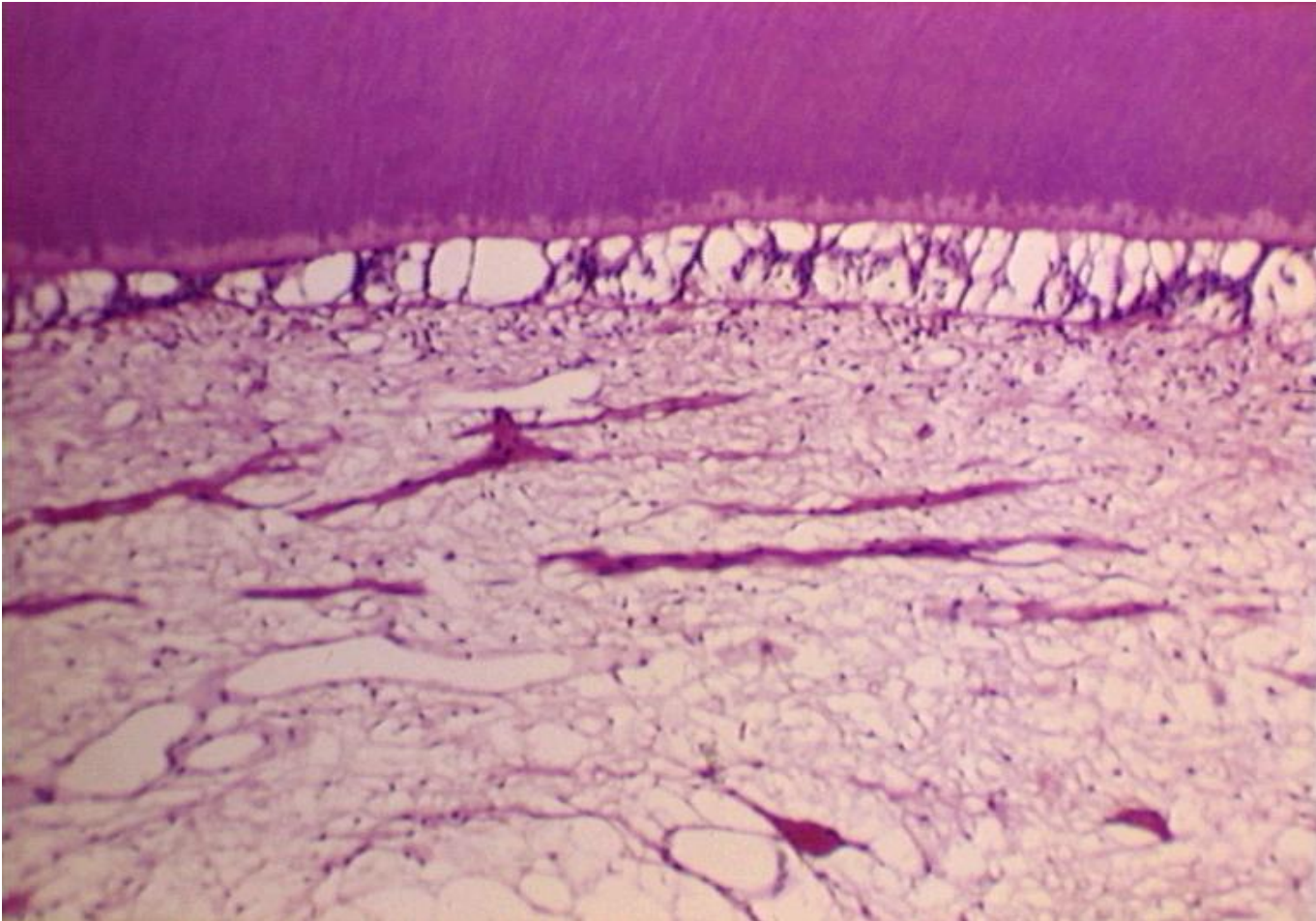
# PULP STONES



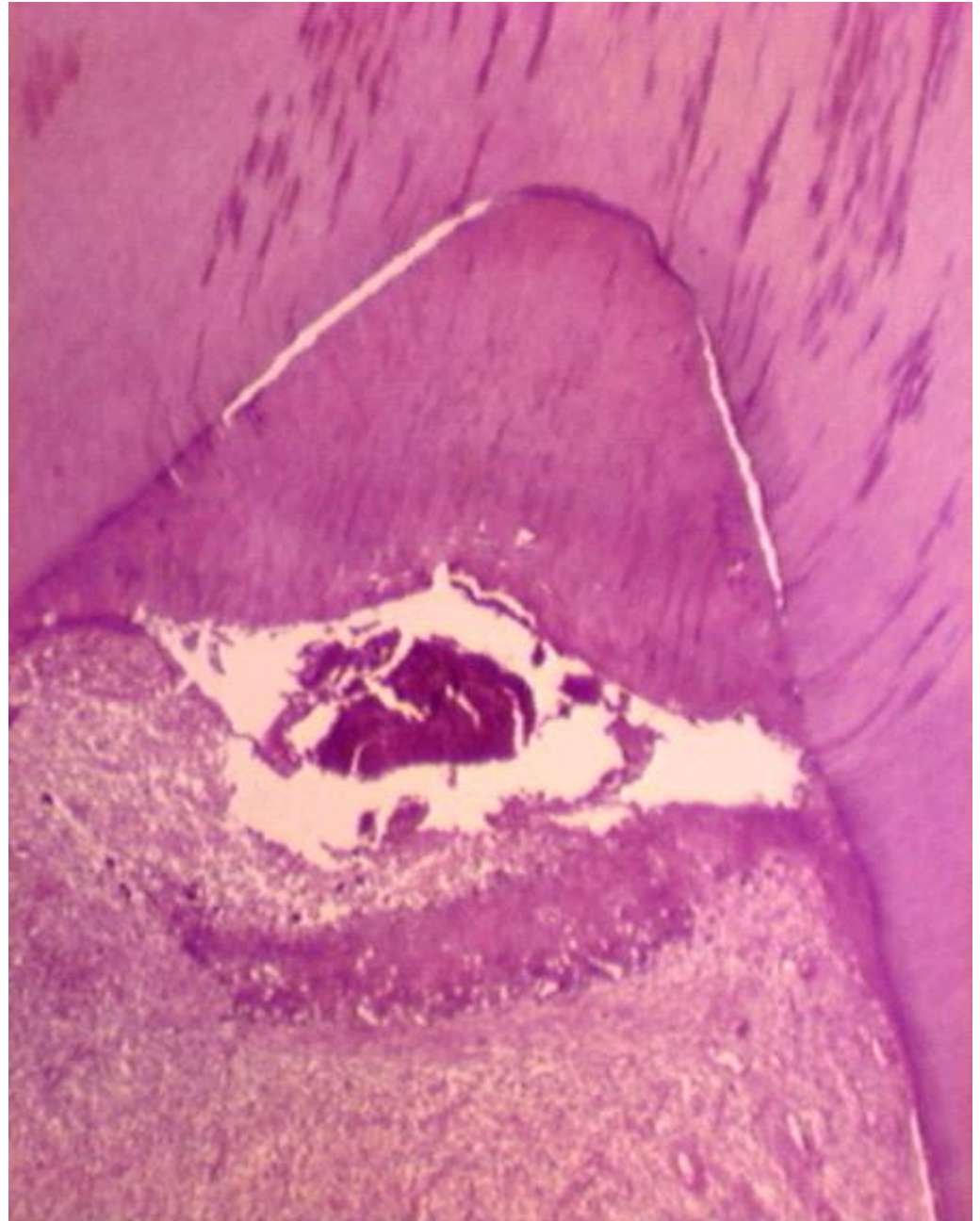
# PULPAL INFECTION



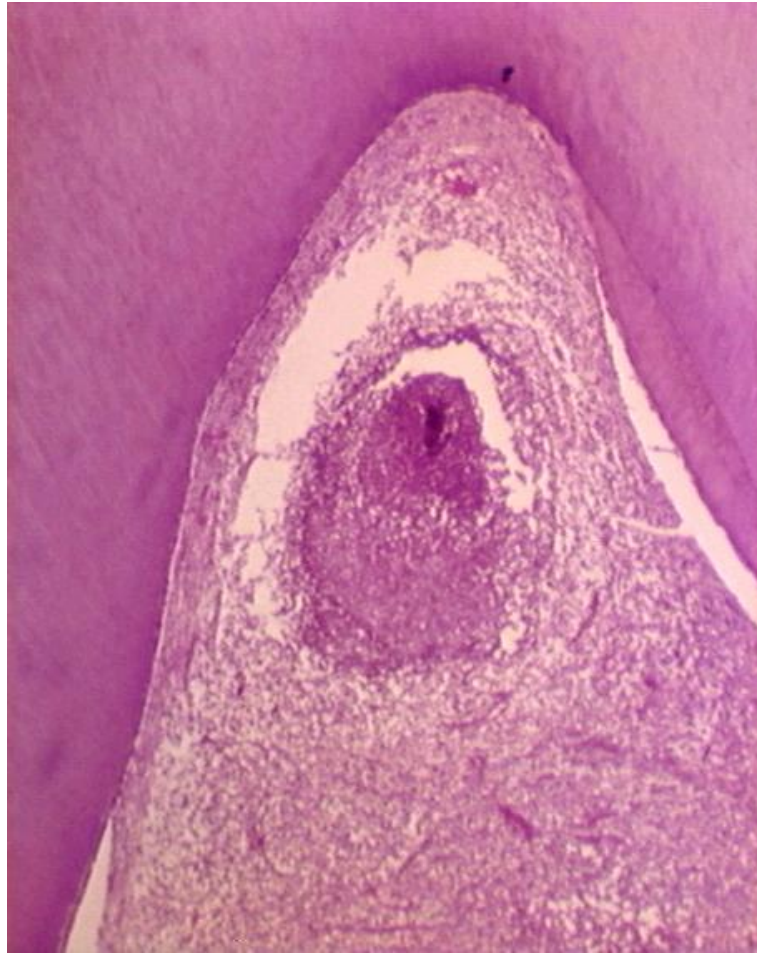
# PULPAL EDEMA



# PULPAL ABSCESS AND REPARATIVE DENTIN



# DECAY AND PULPITIS



# OPEN PULPITIS



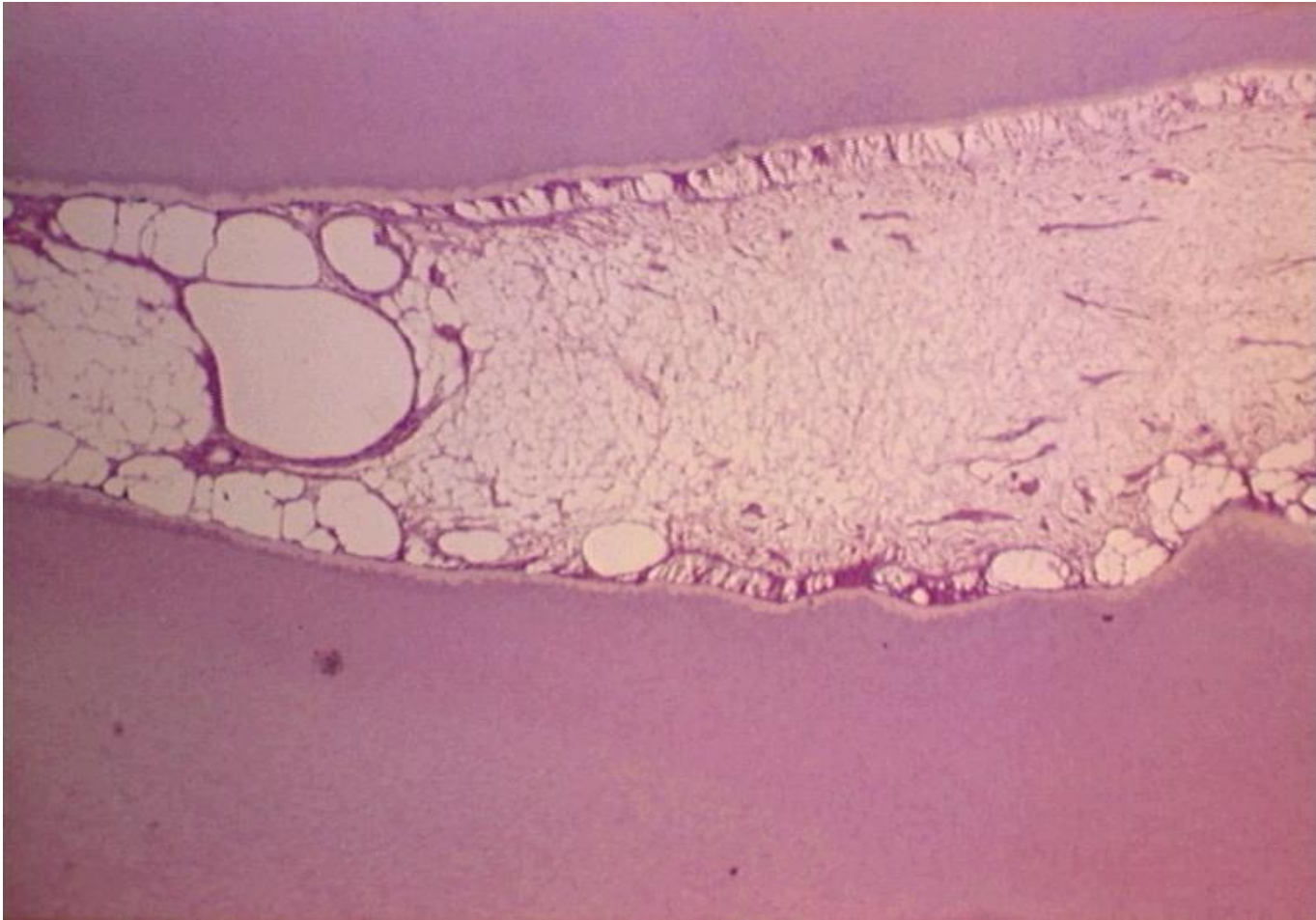
# PULPAL POLYPUS



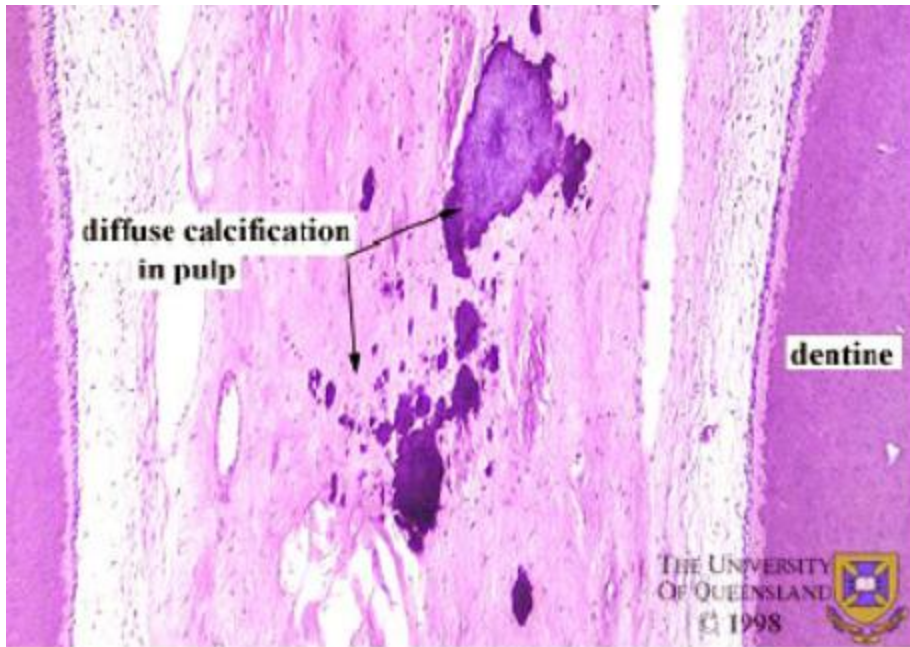




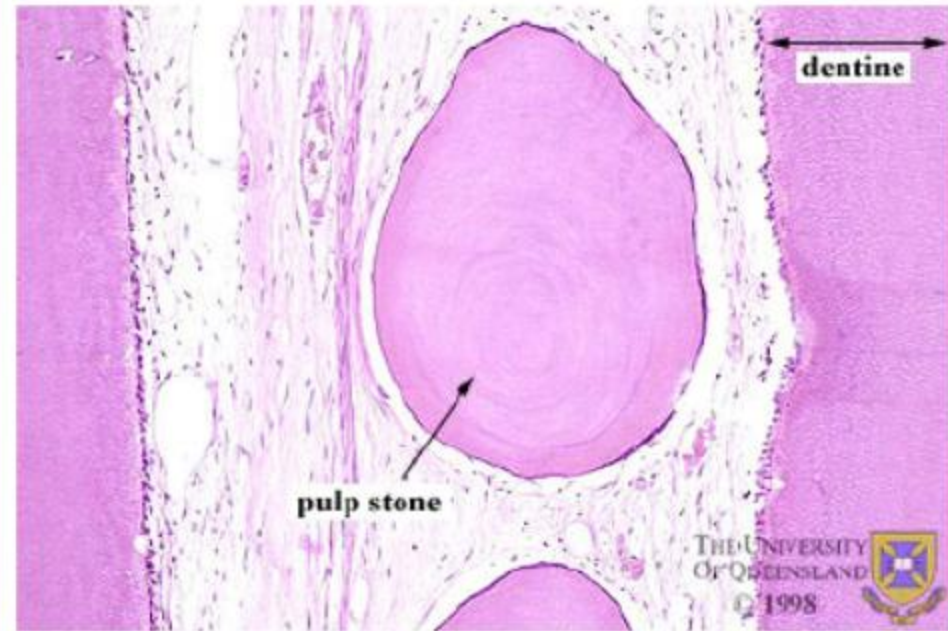
# RETICULAR PULPAL DEGENERATION



# Pulpa - Altersveränderungen

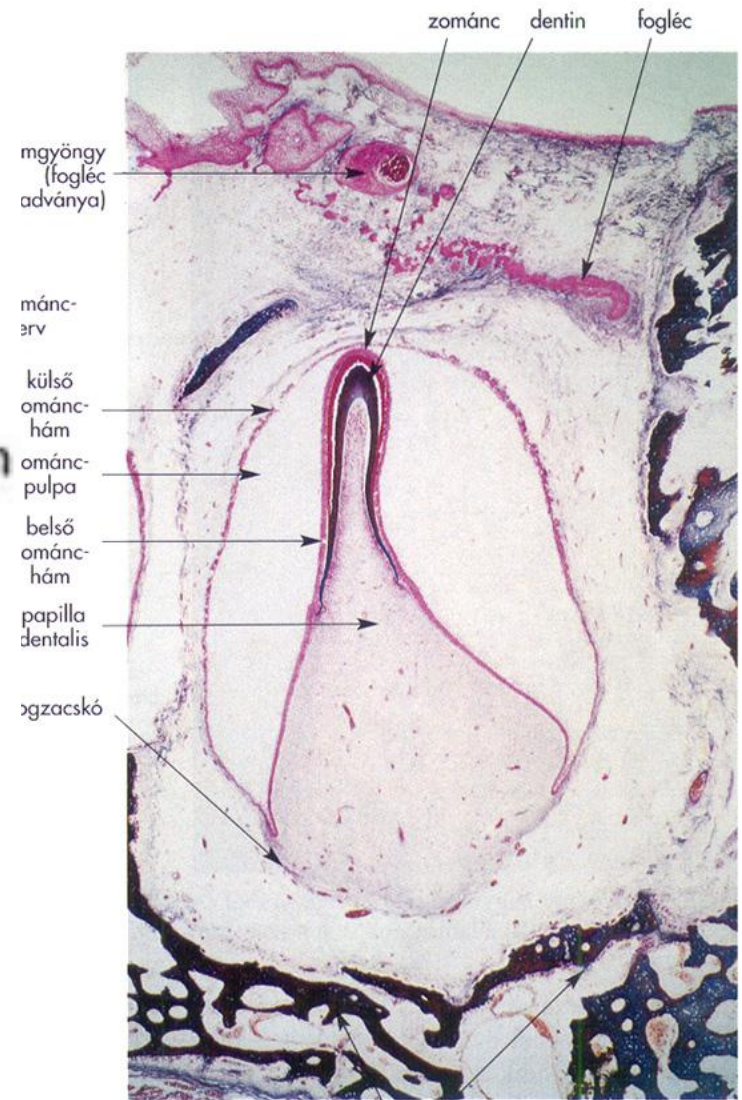


Diffuse oder umschriebene Verkalkungen



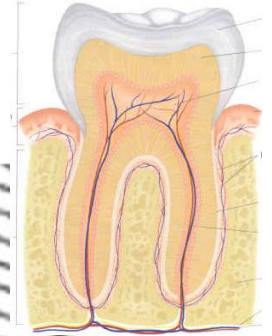
Denticulus: Pulpastein

# ZEMENTUM



fejlődő alveoluscsont (desmális csontosodás)

# SCHMELZ - ZEMENT GRENZE



**60%:**  
überlappend



**30%:**  
aufeinander  
treffend



**10%:**  
lückenhaft

# ZAHNHISTOLOGIE

# ZEMENTUM

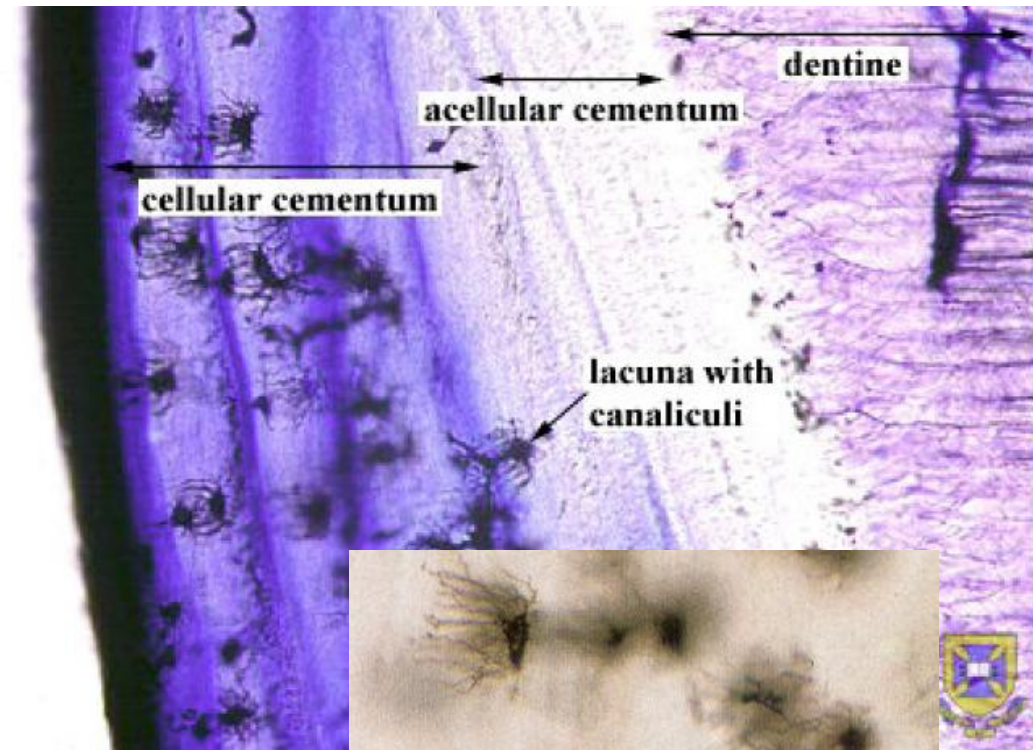
Bedeckt den Wurzel

Herkunft: Zahnsack

0,1-0,5 mm dick, kann in den Wurzelkanal reichen

Knochenähnlich, aber avaskulär

Gute Druckfestigkeit  
Zementozyten



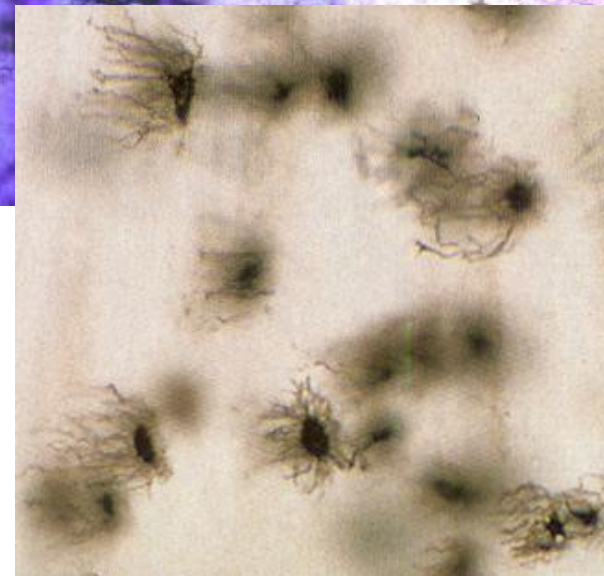
## TYPEN

### Azelluläres Zement

obere 2/3 der Wurzel, Zementozyten auf der Oberfläche; Verankerung der Sharpey-Fasern

### Zelluläres Zement

untere 1/3 der Wurzel



# ZAHNHISTOLOGIE

## ZEMENTUM

Zement ist eine dem Geflechtknochen ähnliche Substanz. Er umgibt als 0,1 - 0,5 mm dicke Schicht die Dentinoberfläche im Hals- und Wurzelbereich.

45-50% anorganische Substanz  
50-55% organische Substanz  
+ Wasser

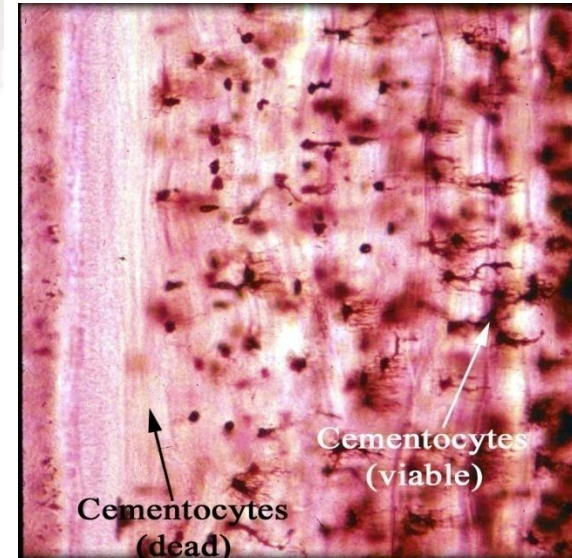
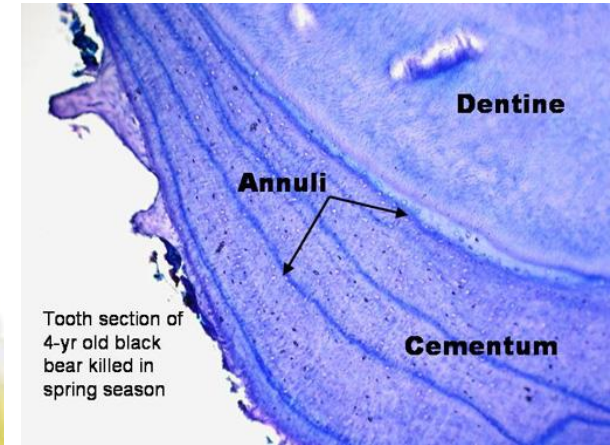
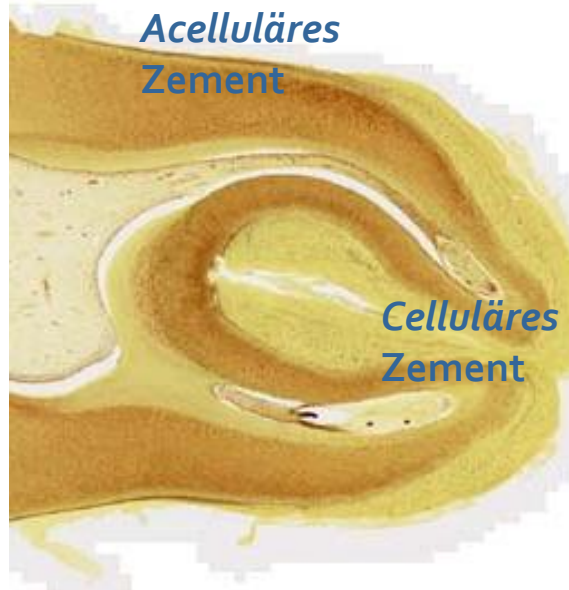
### ZELLEN:

Zementoblast, Zementocyt  
Nur im unteren 1/3! *zelluläres*  
Zement  
*Obere 2/3 Azelluläres Zement*

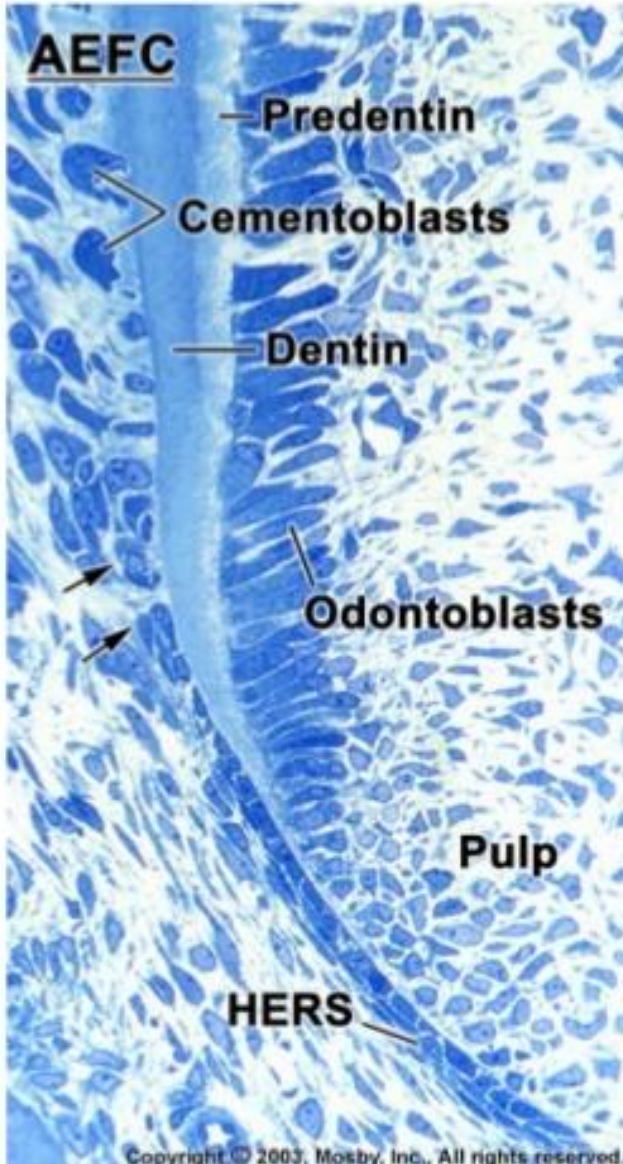
Fremdfaserzement (beim Periodont)  
Eigenfaserzement

Avaskuläres Gewebe

Hohe Widerstandsfähigkeit gegen  
Resorption (wichtig bei Orthodontie)



# ZEMENTBILDUNG



Cementum formation occurs along the entire tooth

Hertwig's epithelial root sheath (HERS) – Extension of the inner and outer dental epithelium

HERS sends inductive signal to ectomesenchymal pulp cells to secrete pre-dentin by differentiating into odontoblasts

HERS becomes interrupted

Ectomesenchymal cells from the inner portion of the dental follicle come in with pre-dentin by differentiating into cementoblasts

Cementoblasts lay down cementum



# STADIEN DER ZEMENTBILDUNG

- Phase I : Laying down of cementoid tissue  
(matrix formation)

- Phase II : Mineralization

Apatite crystals are deposited along the fibrils.

Cementum formation takes place rhythmically.

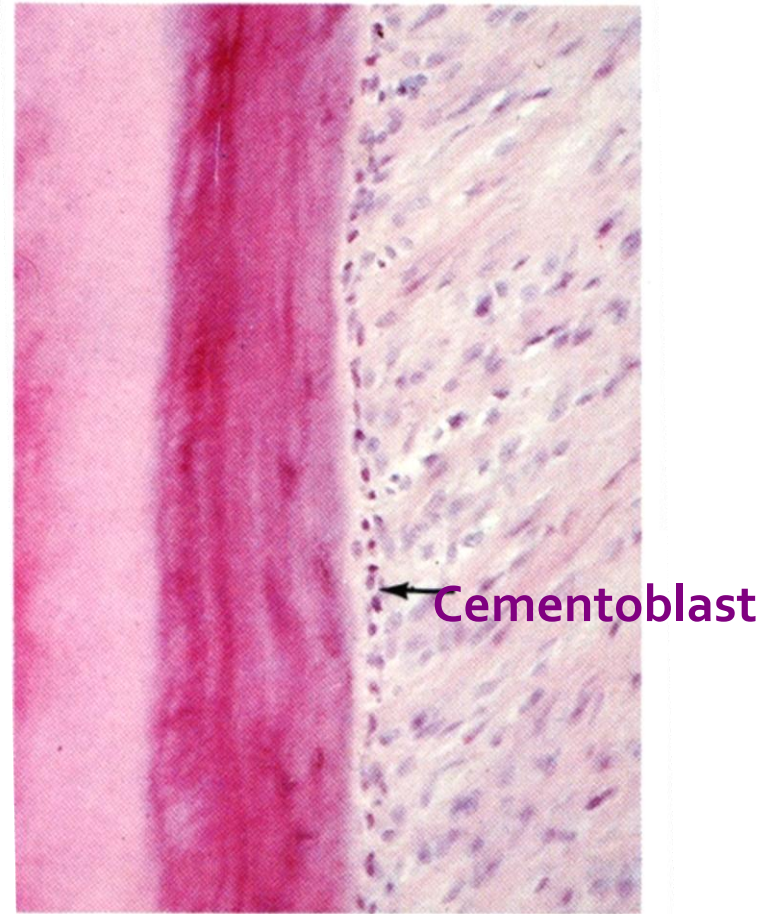
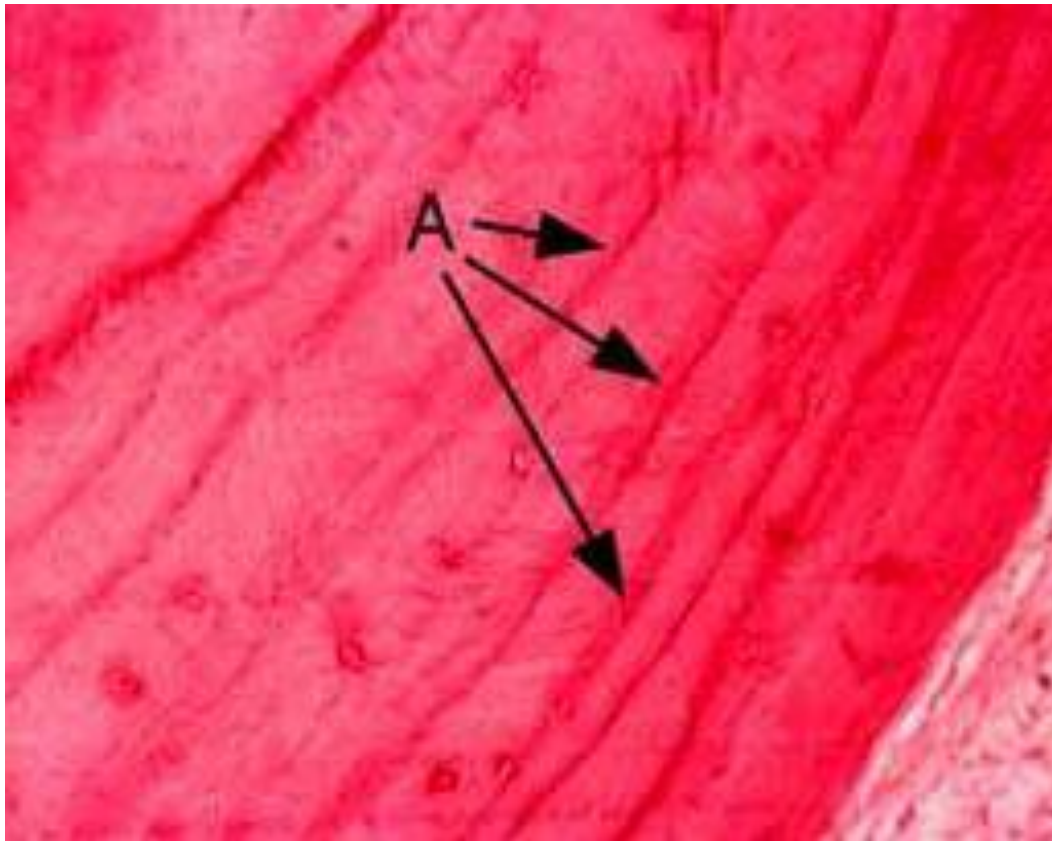
A thin layer of cementoid is seen on the surface of cementum lined by cementoblasts.

These fibers are embedded in the cementum and attaches tooth to the surrounding bone.

**Sharpey's Fibers.**

# ZEMENTUM

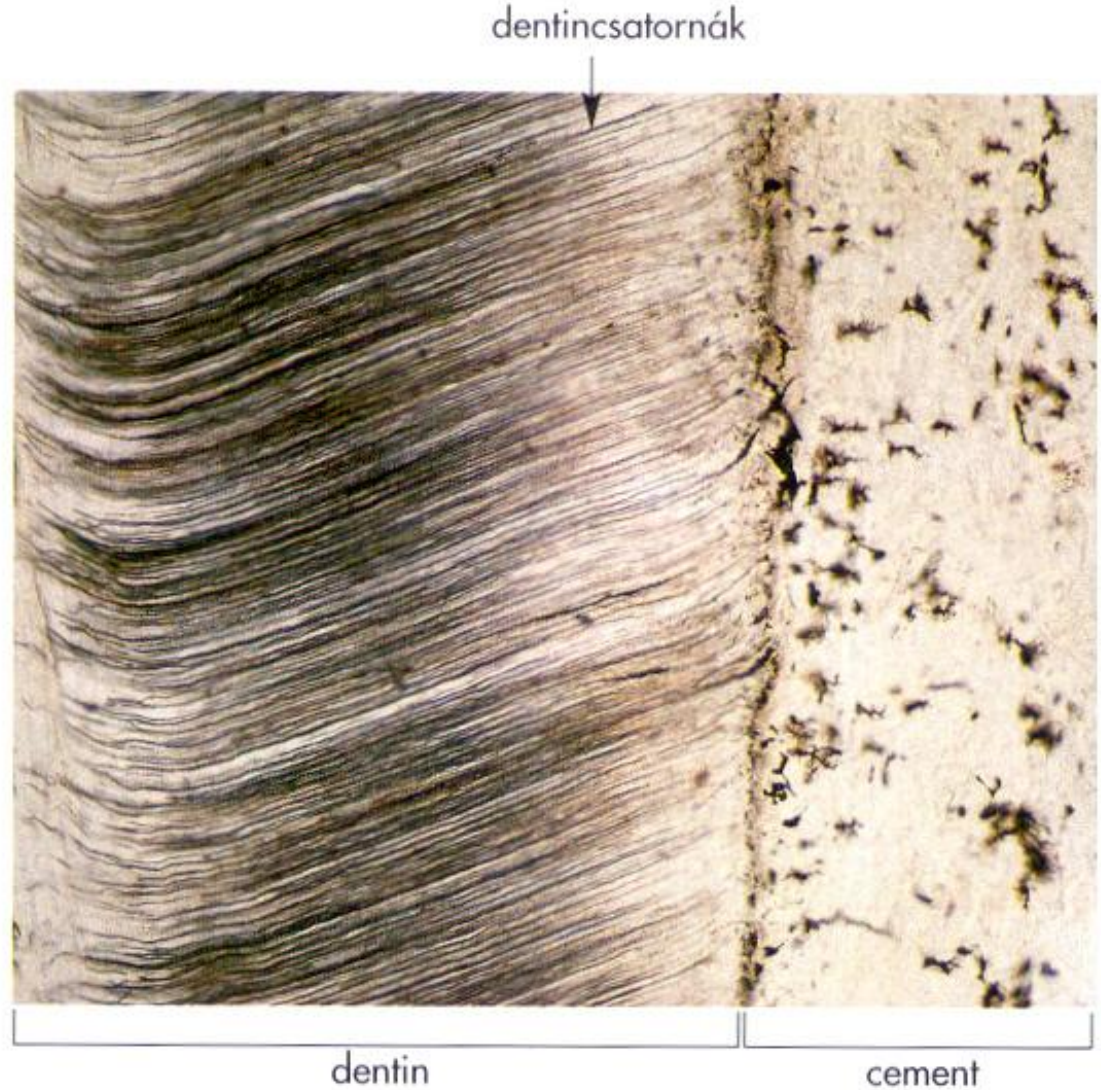
## *SALTERs*che WACHSTUMLINIEN



# ZEMENTUM

Verankert die  
periodontalen  
faserbündeln  
(collagen) -

Bildet einen Ersatz  
bei der  
Wurzelspitze



# ZEMENTUM

## TYPEN

### *Azelluläres fremdfaseriges Zement*

*Sharpeysche Fasern wachsen ein  
5-7 micrometer dick*

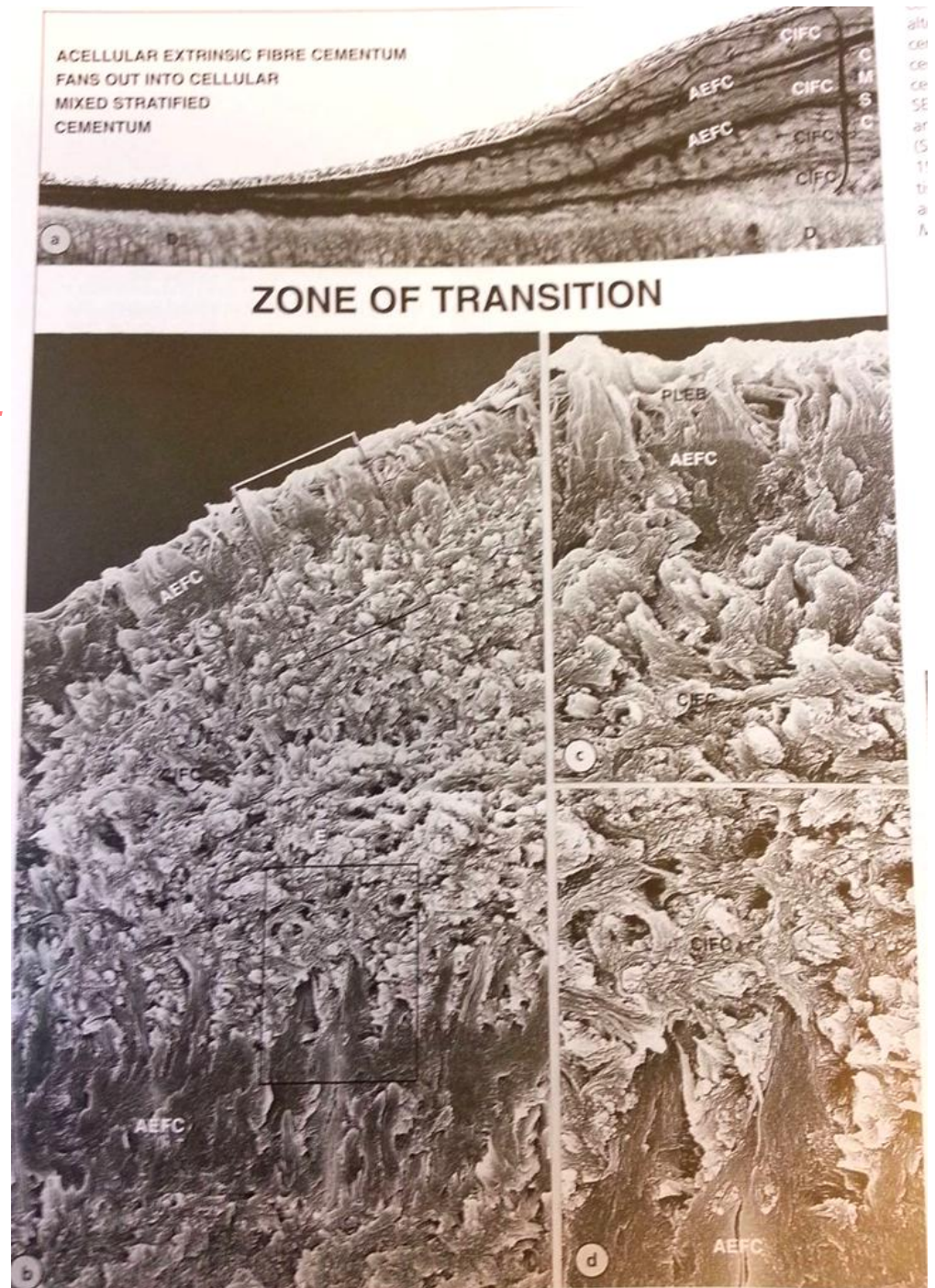
### *Zelluläres eigenfaseriges Zement*

*parallel laufenden Fasern  
1-2 micrometer dick*

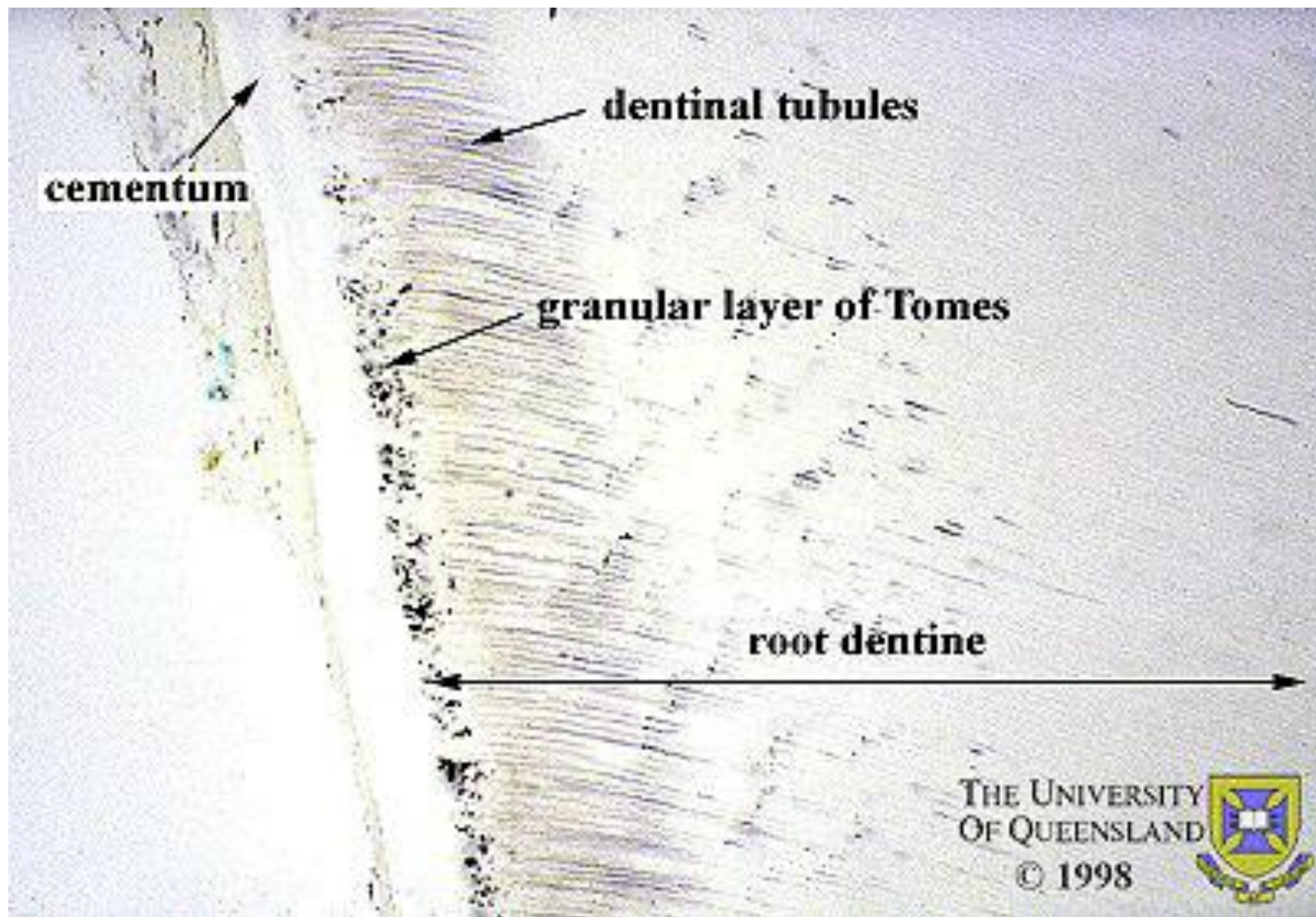
### *Gemischte faseriges Zement*

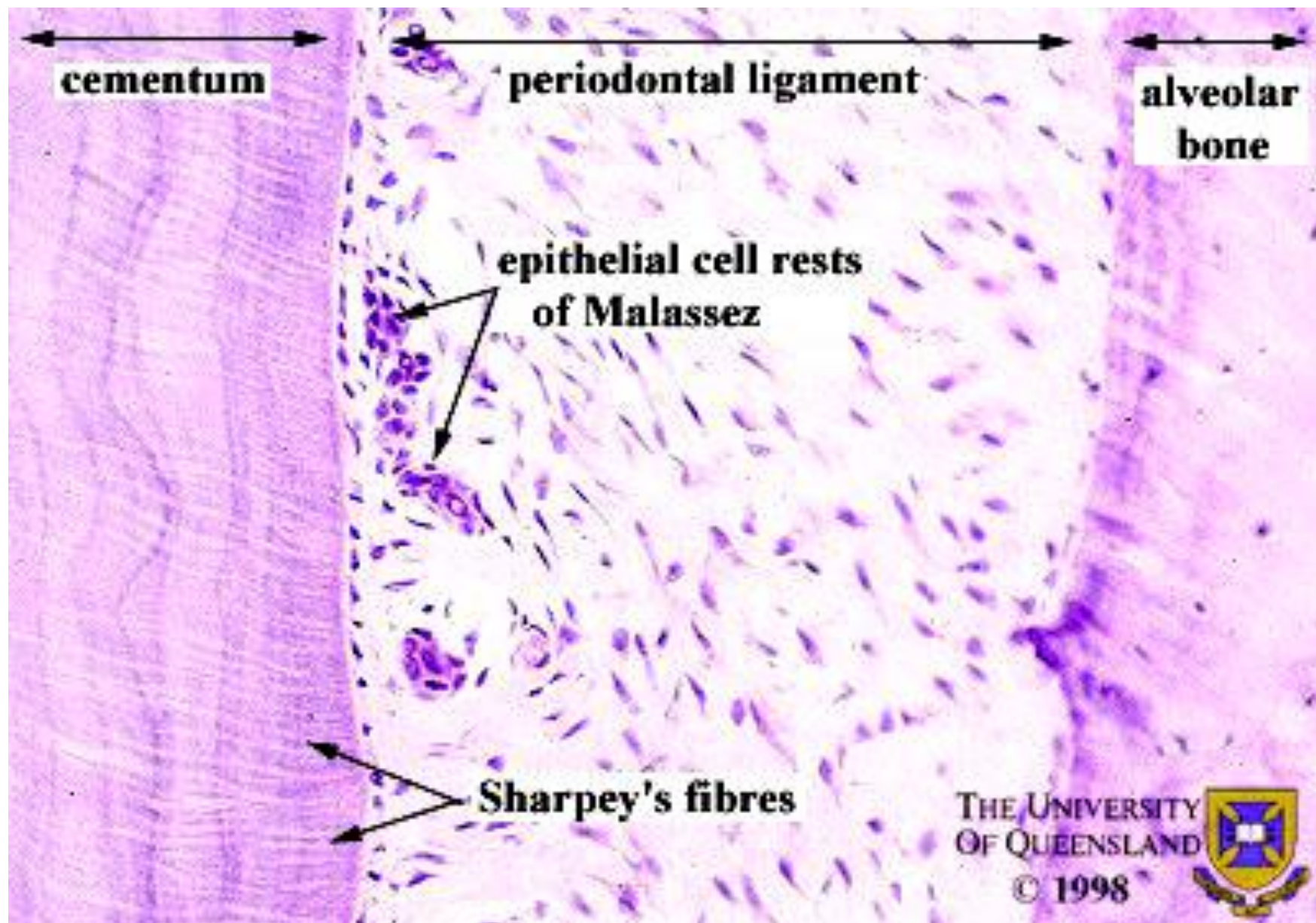
### *Afibrilläre Zement*

*Dünn azelluläre Schicht über z.B.  
Zervikale Schmelz  
(Kein Kollagenfibrillen)*



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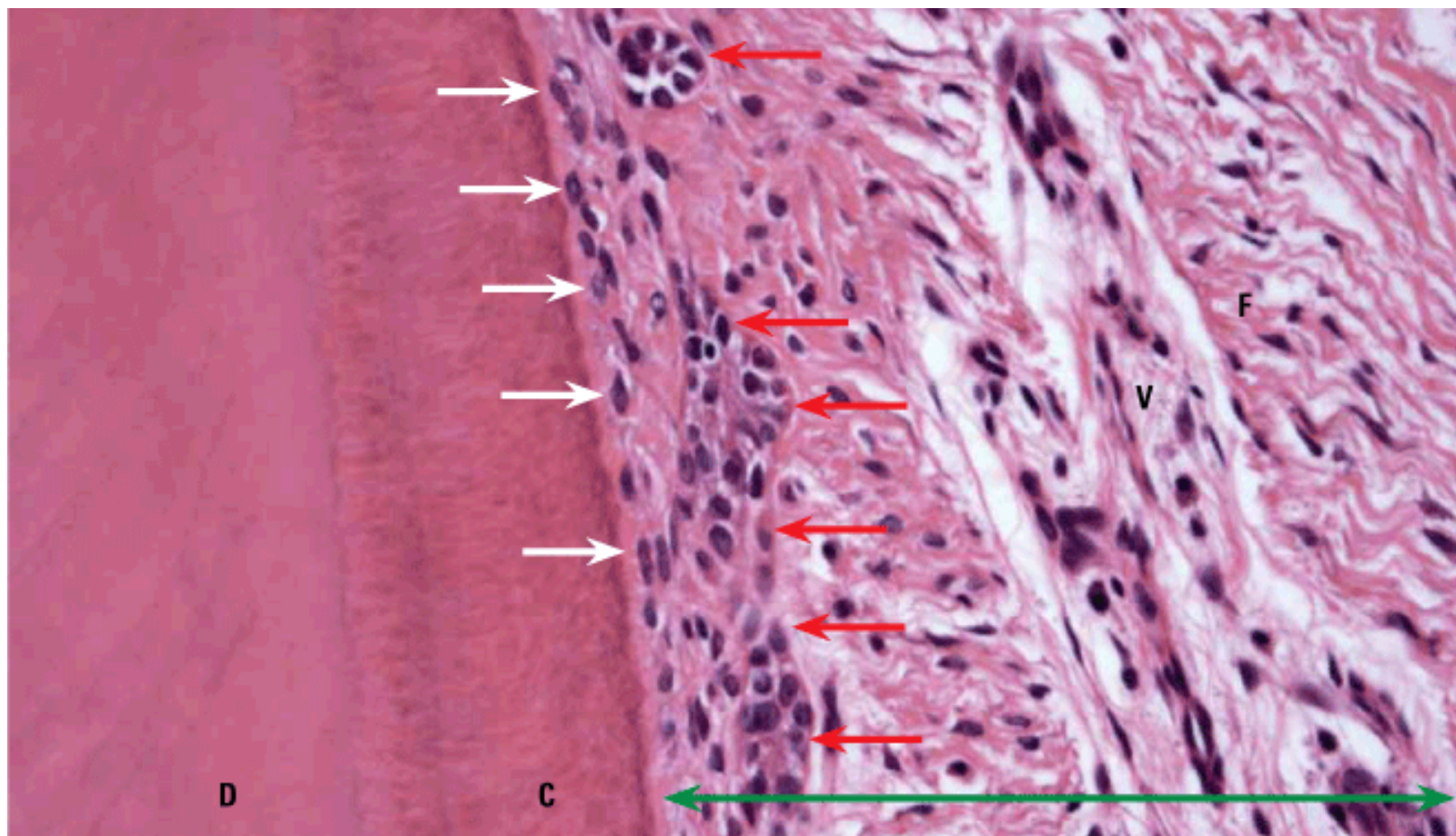
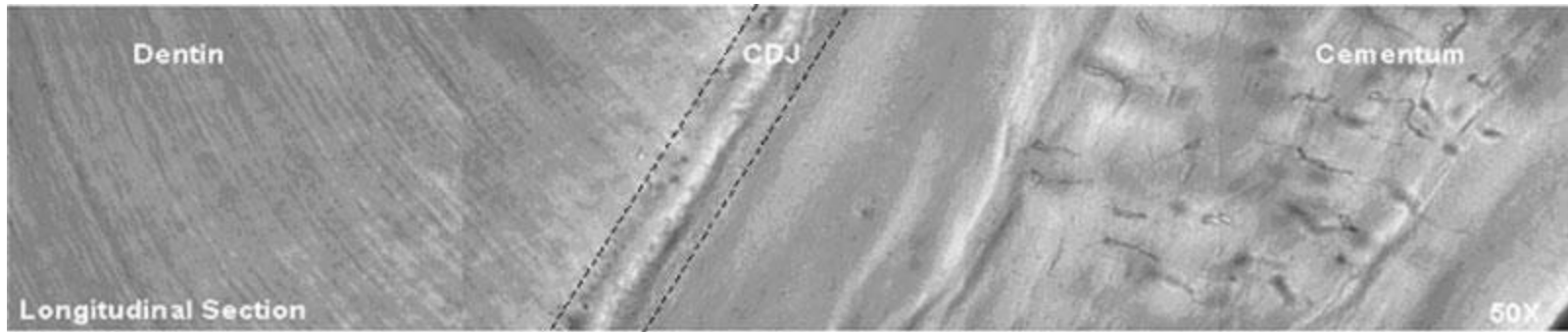


FIGURE 1 - On the root surface the cementum is covered by cementoblasts (**white arrows**). Collagen fibers—called Sharpey's fibers—penetrate amid these cells and attach themselves to the cementum (**C**). In the periodontal ligament (**green arrow**) epithelial cell islands and cords can be observed (**red arrows**) which form a three-dimensional network around the root, like a basketball hoop. This epithelial component of the periodontal ligament, called Epithelial Rests of Malassez (**red arrows**), constantly releases Epithelial (or Epidermal) Growth Factor (EGF), whose molecules diffuse through the cells in the extracellular matrix and stimulate osteoclasia on the periodontal bone surface, thereby promoting the maintenance of periodontal space (**D** = dentin; **F** = fibroblasts; **V** = blood vessels. HE; X25).

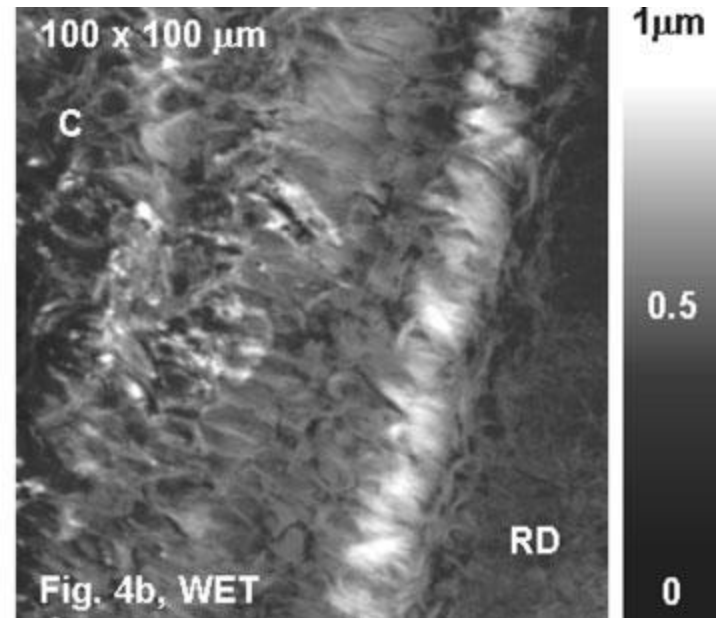
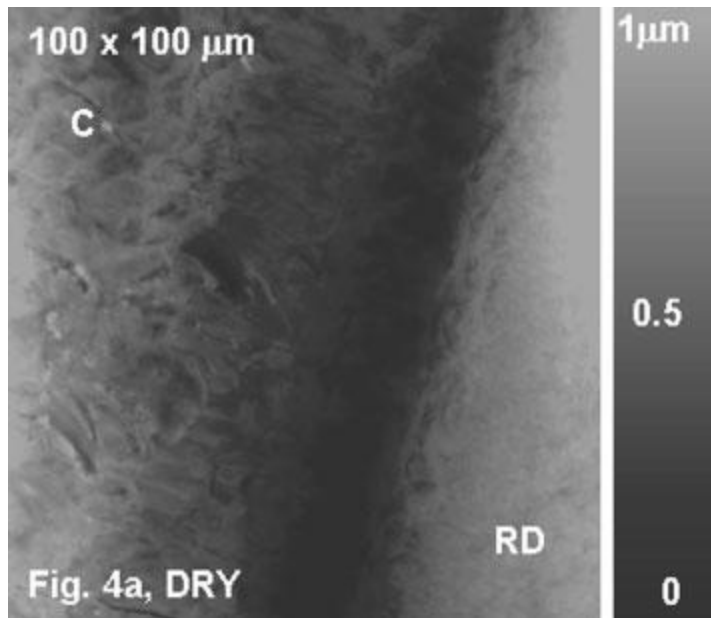
# ZEMENT-DENTIN-JUNCTIO (CDJ)

(HOPEWELL-SMITH HYALINE SCHICHT)

(1-3 MM)



(a)





Pig

Human

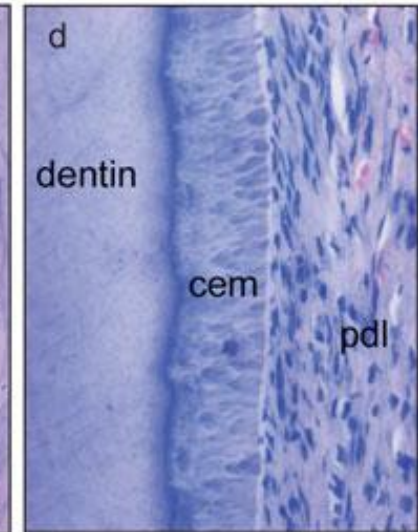
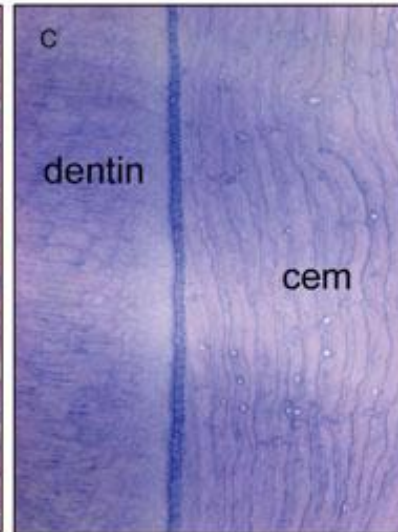
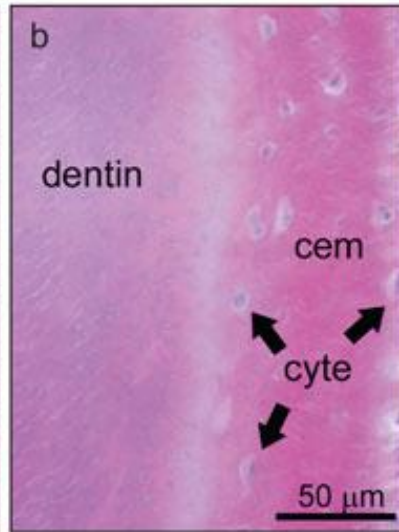
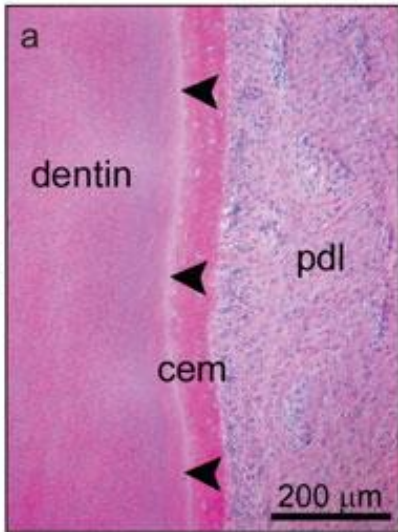
X100

X400

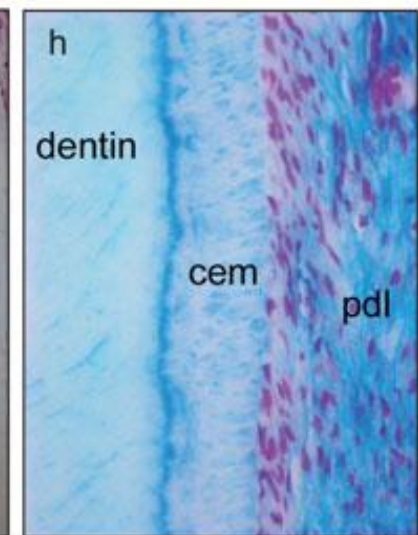
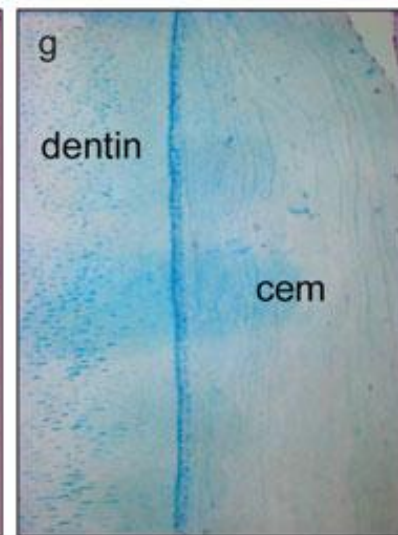
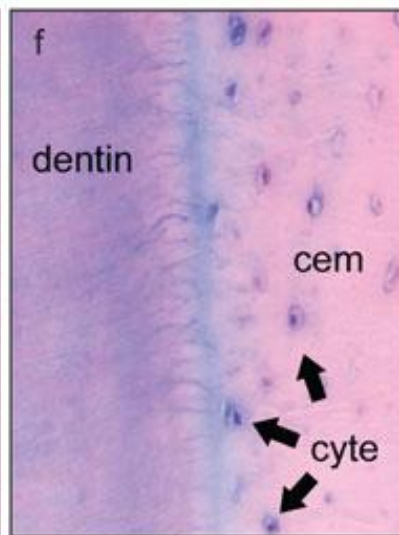
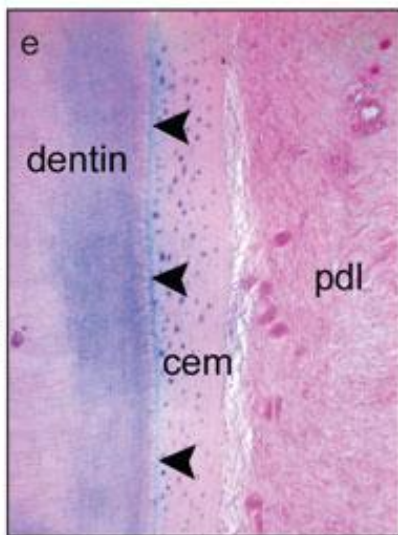
X100

X400

H&E



AB-NFR



Cervical root cellular cementum

Cellular / mixed stratified cementum

Acellular cementum