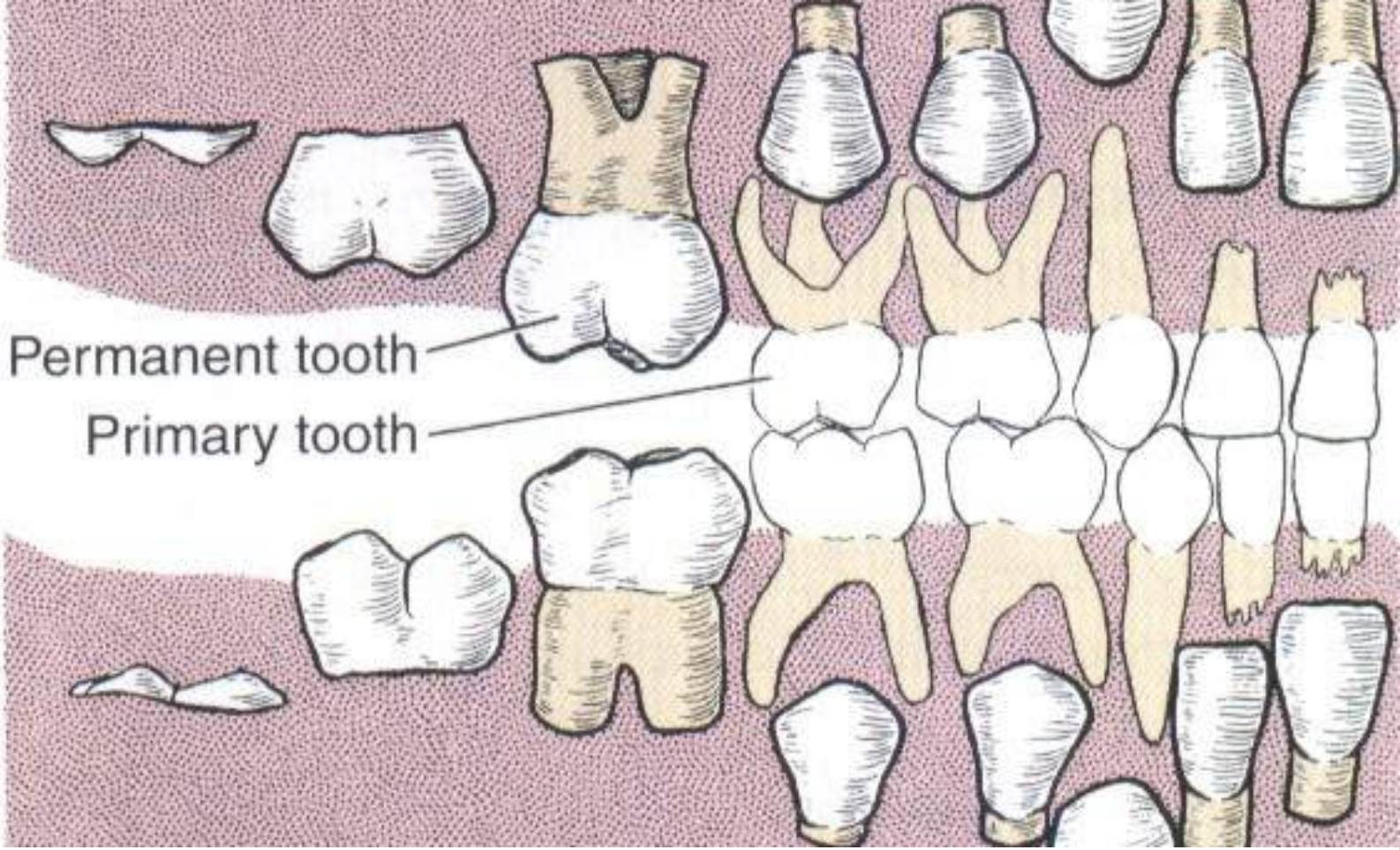
ERUPTION



Dynamics of the tooth development

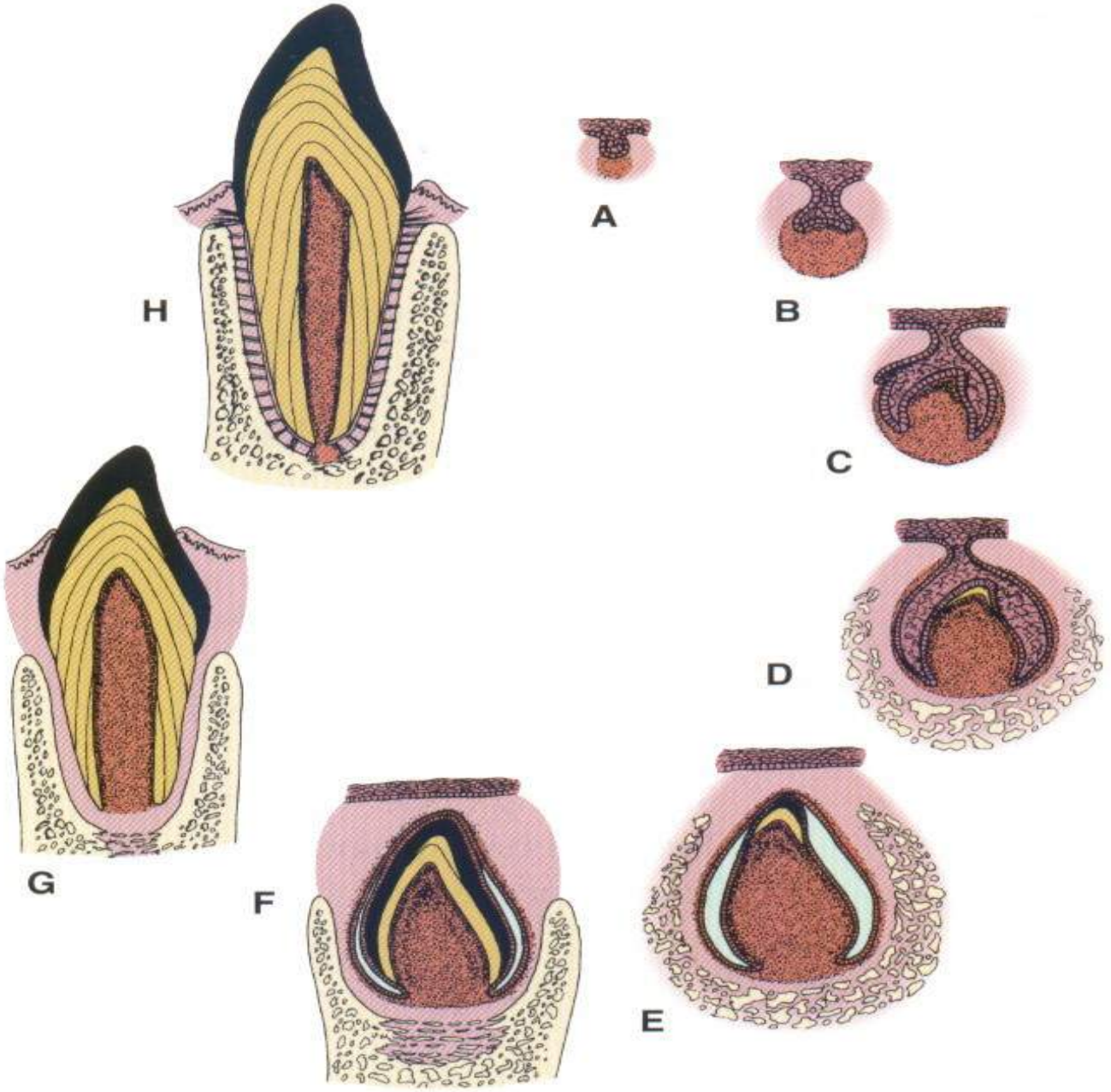
Development of teeth

- The dynamics of the tooth development is studying the chronological stages of the primary and permanent teeth development, characterized by quantitative and qualitative differences.

- Tooth formation is a continuous process, characterized by a series of easily distinguishable stages.

Stages of tooth development

- Initiation of tooth development – bud stage;
- The start of the mineralization;
- The completion of the crown;
- Eruption;
- Development of the tooth root;
- Shedding of the primary teeth.


A
B
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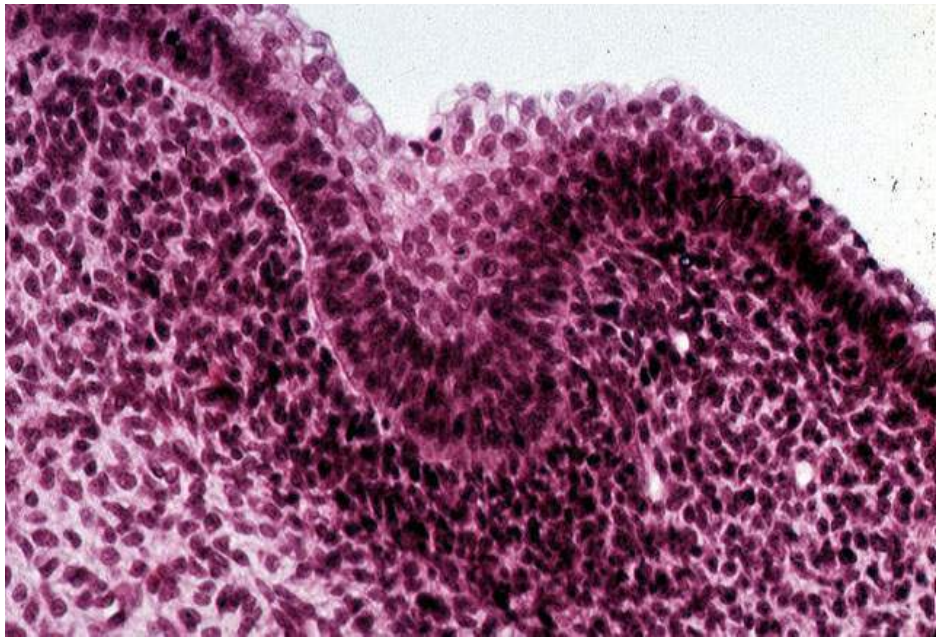
H

1. Initiation of tooth development – bud stage

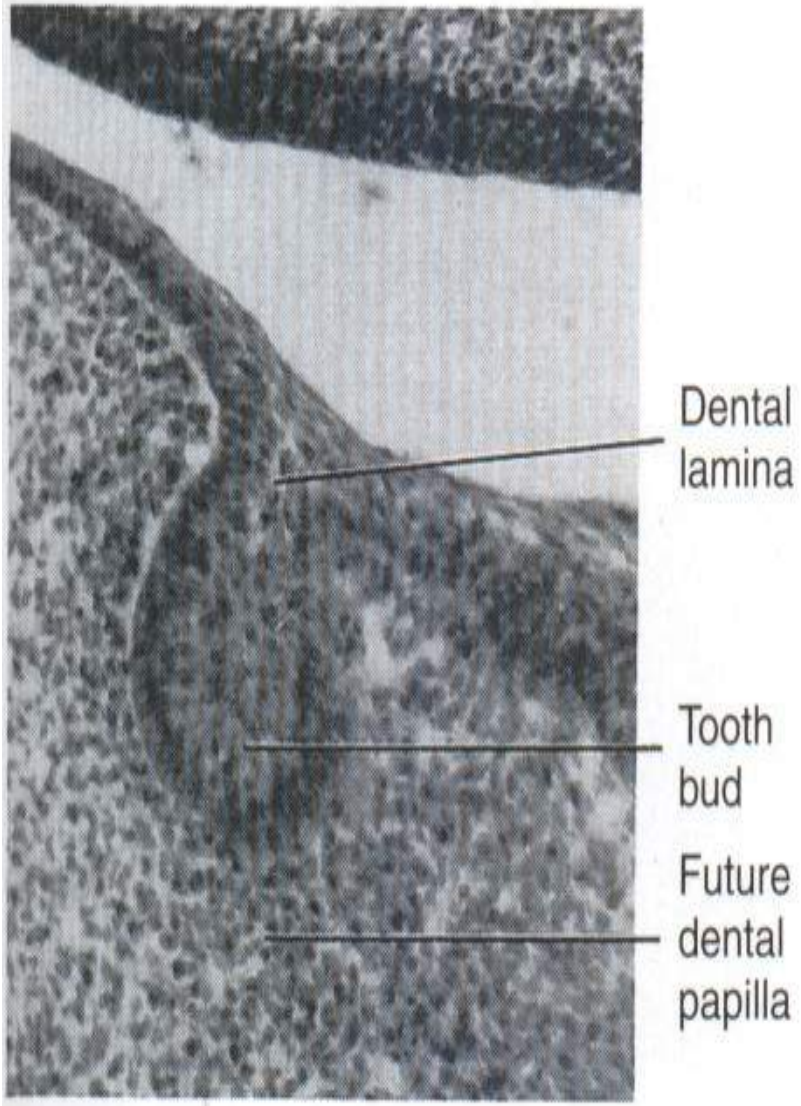
- Dental development starts with initiation and continues with proliferation;

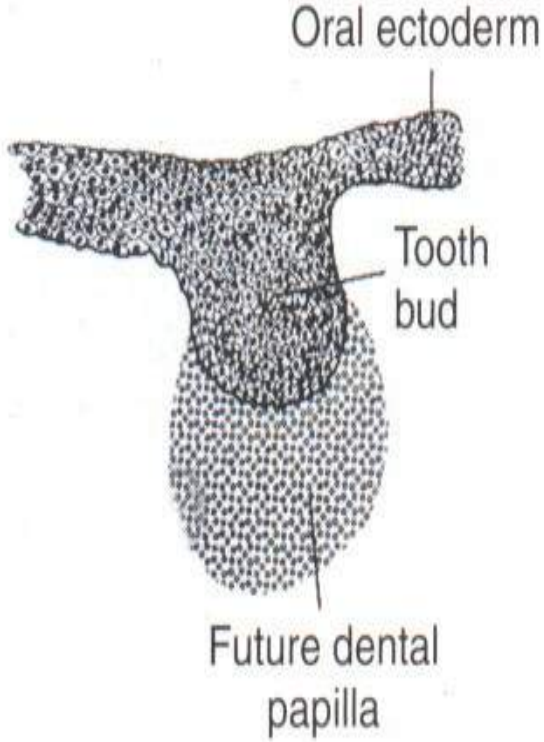
First sign of tooth formation



- The first sign of tooth formation is the development of dental lamina;

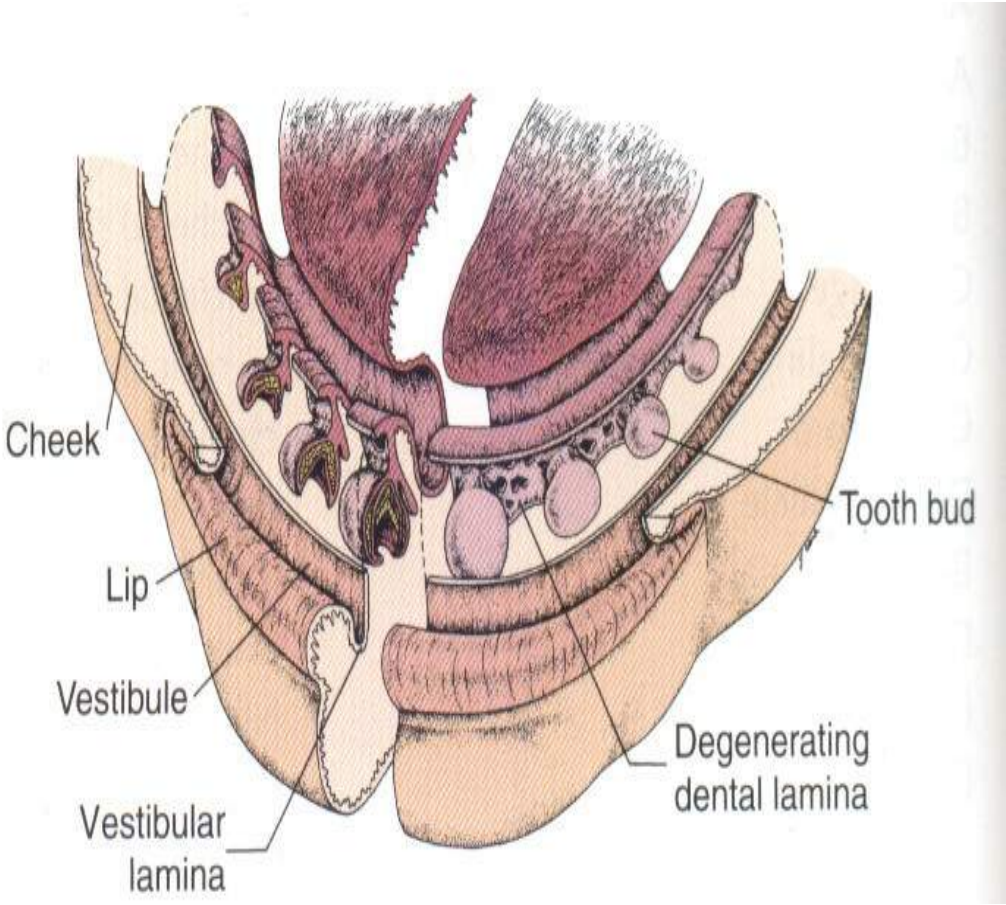
Dental bud stage





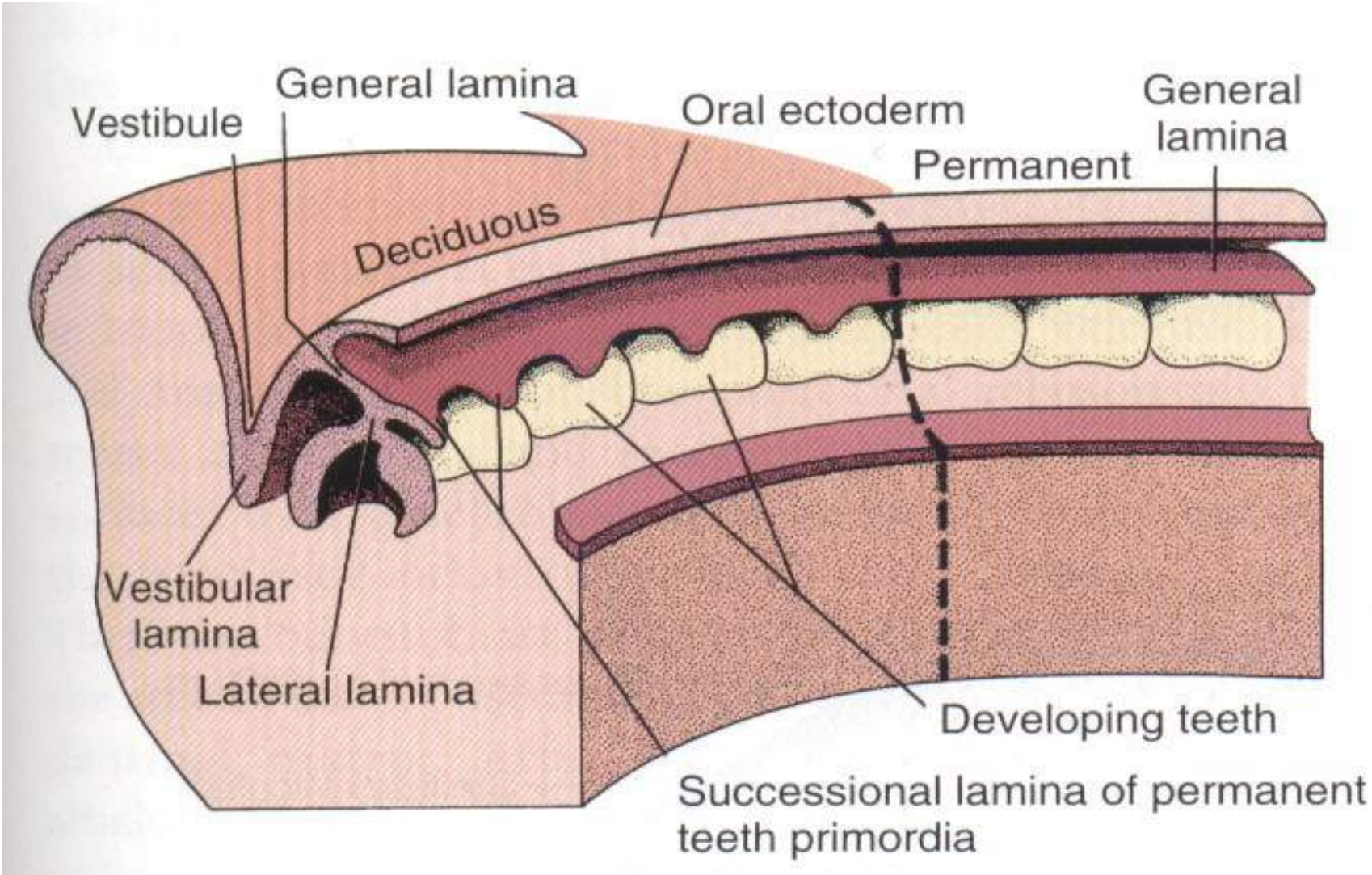
The initial stage of the dental tooth is **a bud stage.**

Tooth buds of the primary teeth



- At the leading edge of the lamina, 20 areas of enlargement appear, which form tooth buds for the 20 primary teeth;

Dental lamina formation is shown in relation to the general lamina

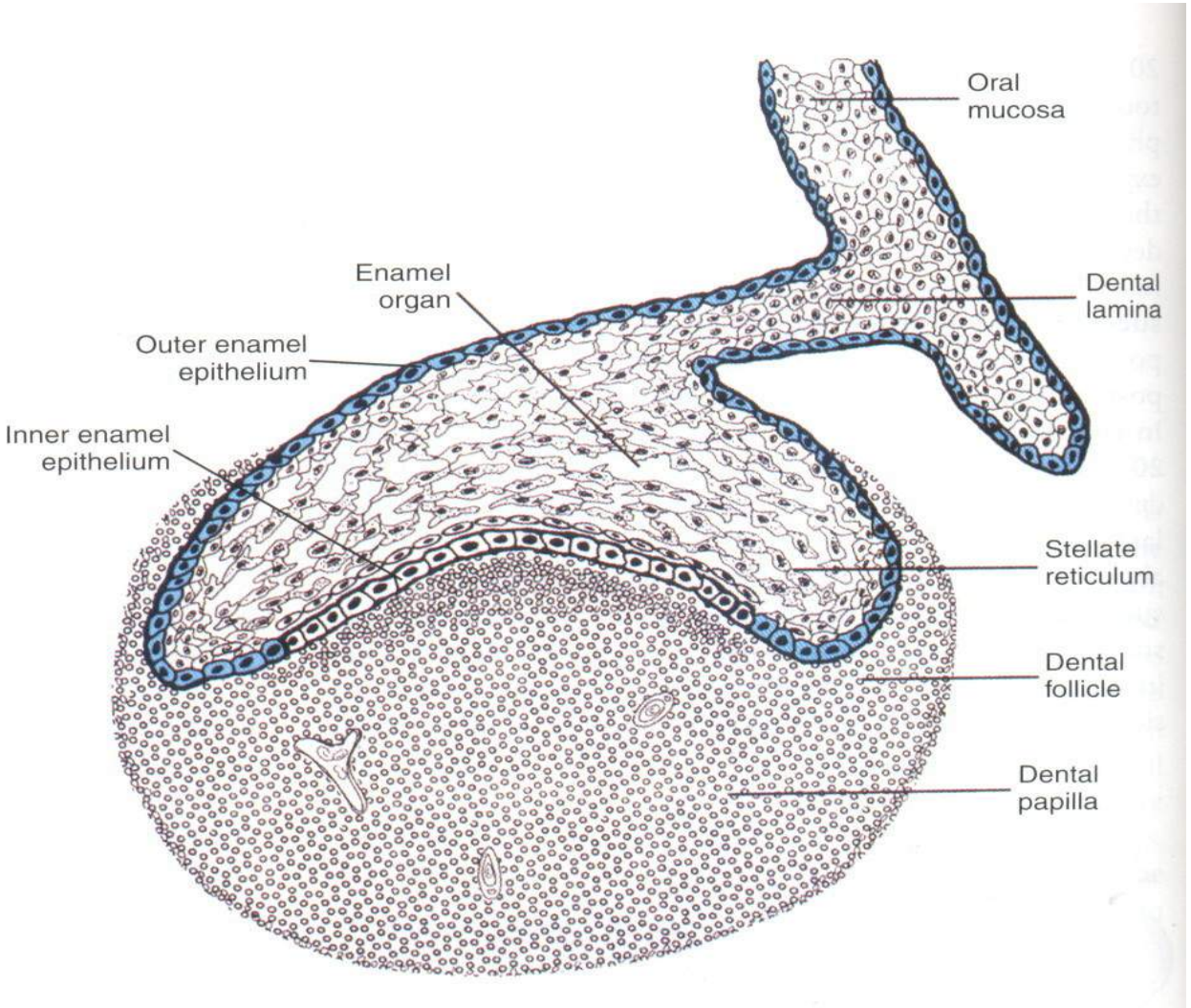


DENTAL BUD FORMATION IS THE BEGINNING OF THE TOOTH FORMATION

The processes involved in these stage are:

- The proliferation;
- The histodiferentiation;
- The stages of the tooth development are:
  - Bud stage;
  - Cap stage;
  - Bell stage.

Cup stage


Oral mucosa
Enamel organ
Dental lamina
Outer enamel epithelium
Inner enamel epithelium
Stellate reticulum
Dental follicle
Dental papilla

The absence of teeth means:

- Disturbance in the period of chronological time by formation of the tooth germ:
  - Lack of information from neural crests;
  - A defect in the system of cell signaling:
    - Effectors, modulators and receptors;
    - Changes in the basal lamina;
  - Defect in the ectoderm of Lamina dentis;
  - Defect in mesodermal field around the area of ectodermal proliferation.

Information about the practice

- At the bud stage starts prevention of the dental diseases:
  - This is the beginning of the nutritional prevention - providing the function of ectoderm and mesoderm;
- The absence of tooth bud means missing tooth;
- When fewer of six teeth are missing, it is termed hypodontia;
- When more then six teeth are missing – it is oligodontia;
- The absence of all teeth – it is anodontia.

2. Start of mineralization

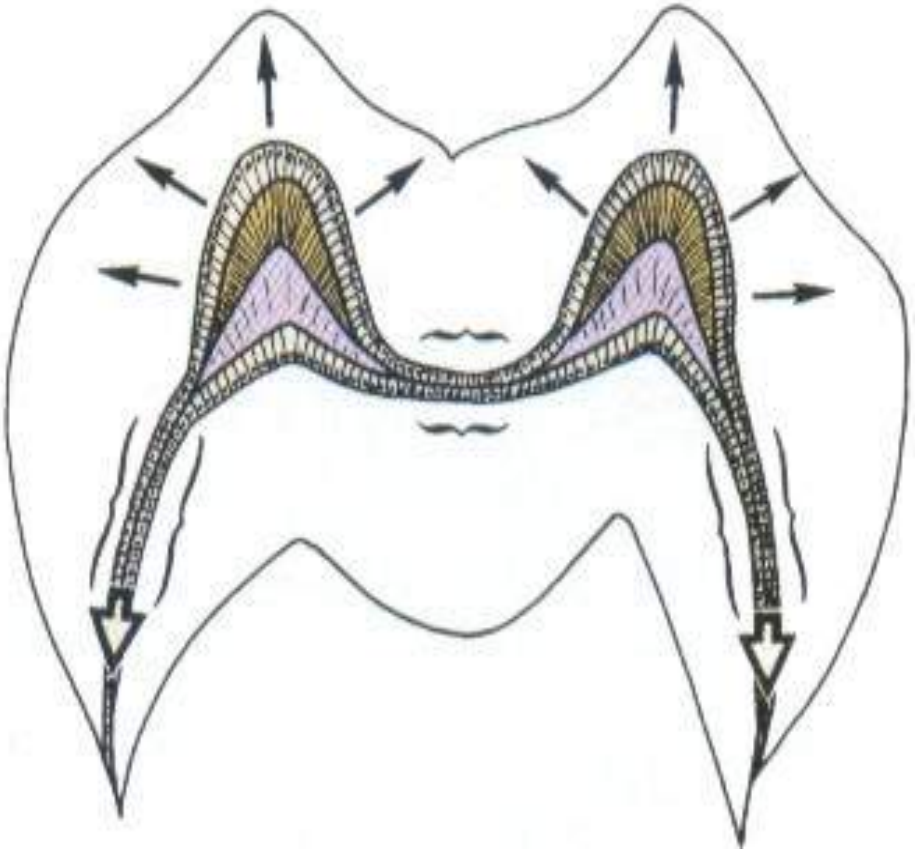
- Represents the starting point of the apposition and calcification;
- Starting with the first deposition and mineralization of dentin matrix;
- Then immediately postponed the first layer of enamel.

The beginning of the mineralization means:

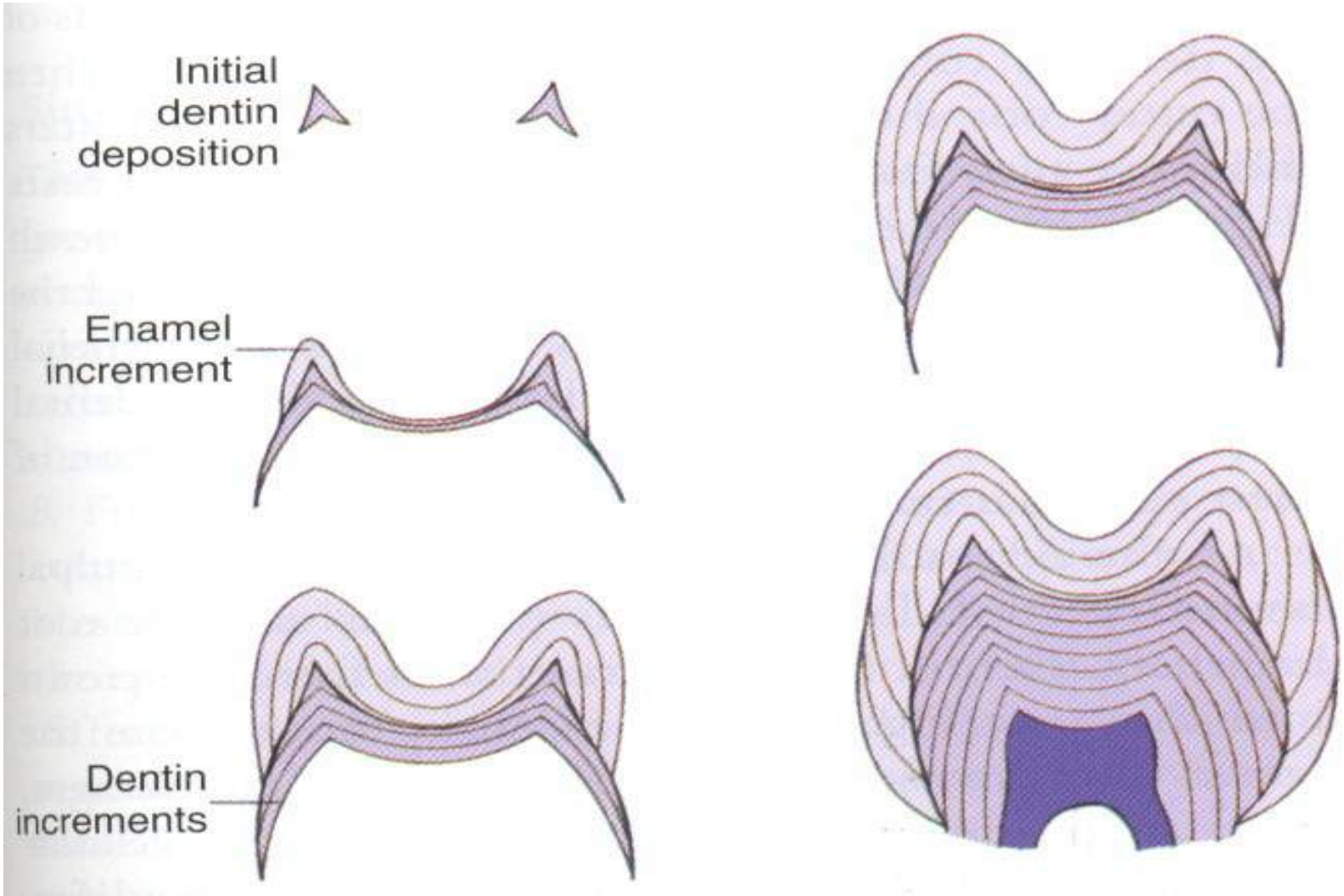
- The enamel organ is built;
- The differentiation of the ameloblasts and odontoblasts is completed;
- This is the beginning of their functional stage;
- This is the beginning of a qualitatively different process – the mineralization;
- This step is performed in parallel deposition of an organic matrix and mineralization.

The mineralization starts from the tips of cusps - directions of growth

Growth of cusps to predetermined point of completion



Incremental pattern of enamel and dentin formation from initiation to completion



Duration of the process

- Deposition of matrix and mineralization continue to complete construction of the enamel and complete consumption of the enamel organ.

Information about the practice

- Start time of the mineral prevention;
- Starting point for the occurrence of enamel hypoplasia;
- Starting point for disturbances in mineralization.

3. The completion of the crown

- This means the complete construction of the enamel;
- Complete consumption of the enamel organ - it remains only reduced enamel epithelium;
- Is formed a most of crown dentin.

At this stage, the following processes are carried out

- The enamel mineralization is 50%;
- Mineralization continues, but now at the expense of the overlying bone;
- Enamel maturation begins by reduced enamel epithelium;
- Cervical loop becomes Hertwig`s epithelial root sheath;
- This sets the beginning of the root completion.

Fate of the new crown

- When the crown is ready, starts the eruption of the tooth;
- It performs a number of complex movements and displacements:
- It begins a bone resorption in front of the crown and apposition - after the crown.

Information for the practice

- After complete construction of the crown is not possible occurrence of enamel hypoplasia;
- May be possible hypomineralization and hypomaturation;
- Should continue nutritional and endogenous mineral prevention.

4. Eruption

- Eruption is the first clinically detectable stage of tooth development;
- Tooth eruption is the process by which developing teeth emerge through the soft tissue of the jaws and overlying mucosa to enter the oral cavity.

Stages of tooth eruption

- Preeruptive phase;
- Prefunctional eruptive phase;
- Functional eruptive phase.

Preeruptive phase

- In this phase – the movements related to tooth eruption begin during crown formation and require adjustments relative to the forming bony crypt;
- Includes all movements of the crowns of the primary and permanent teeth by the time of their early initiation until the formation of the tooth crown;
- This phase is finished with early initiation of root formation.

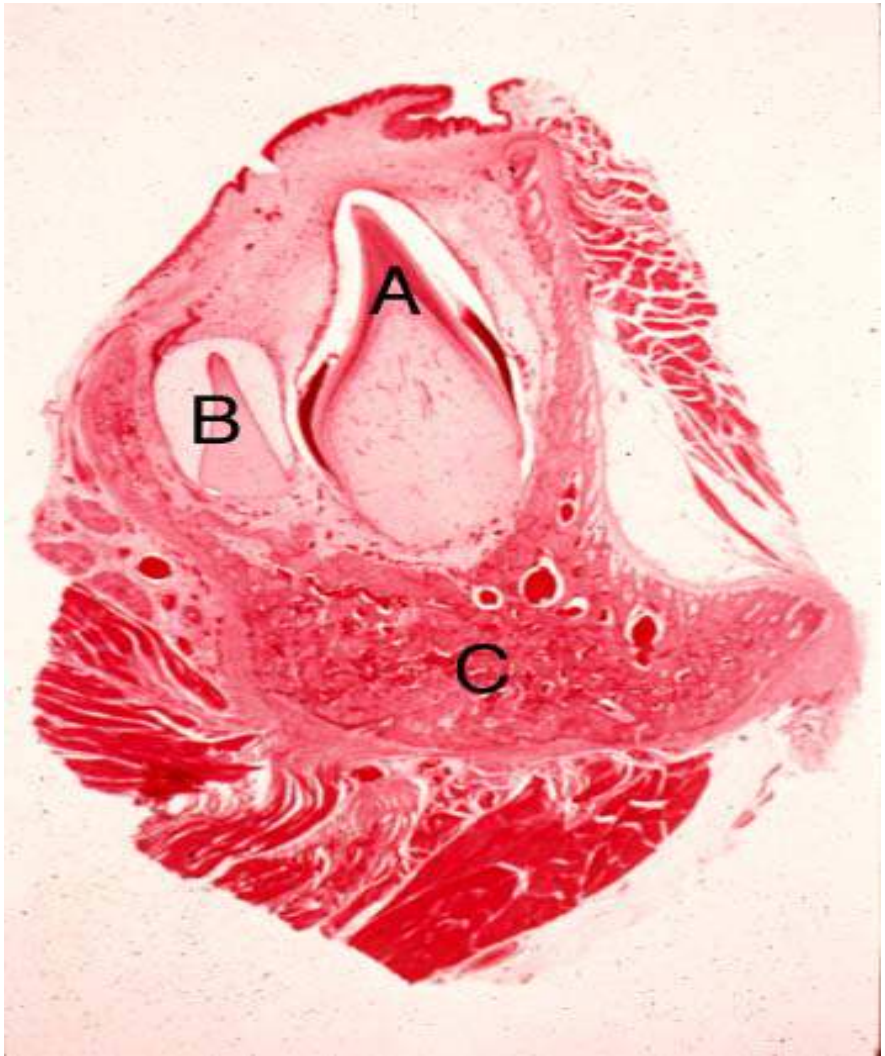
The developing crowns move constantly in the jaws during the preeruptive phase

- Positional changes:
  - They respond to positional changes of the neighboring crowns;
  - Towards developing jaws;
  - Towards to the facial changes;
- Direction of the movement:
  - During the lengthening of the jaws, primary and permanent teeth make mesial and distal movements;
  - The crowns of the permanent teeth move within the jaws, adjusting their position to the resorptive roots of the primary dentition and the remodeling alveolar processes.

Position of the permanent crowns in preeruptive phase

- Early in the preeruptive period, the permanent anterior teeth begin developing lingual to the incisal level of the primary teeth;
- Later, as the primary teeth erupt, the permanent successors are positioned lingual to the apical third of their roots;
- The permanent premolars shift from a location near the occlusal area of the primary molars to a location enclosed within the roots of the primary molars.

Position of the permanent incisor germ

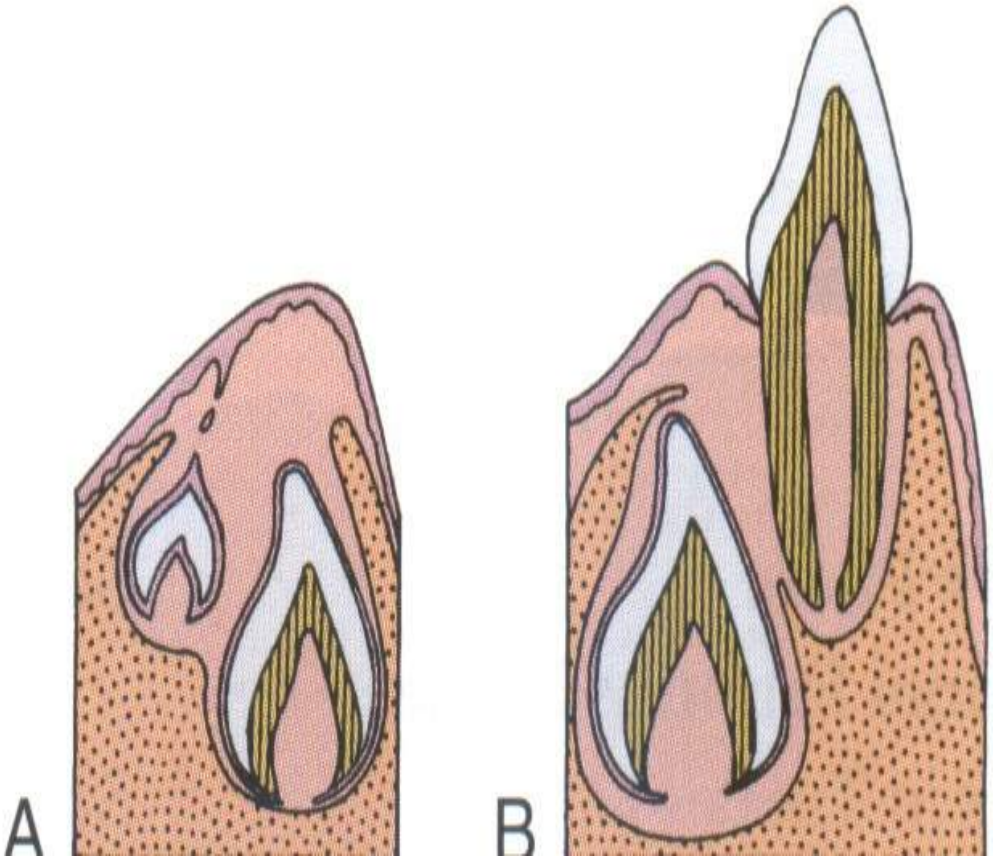


- Orally of the incisal area of the temporary germ.

Position of the permanent crowns

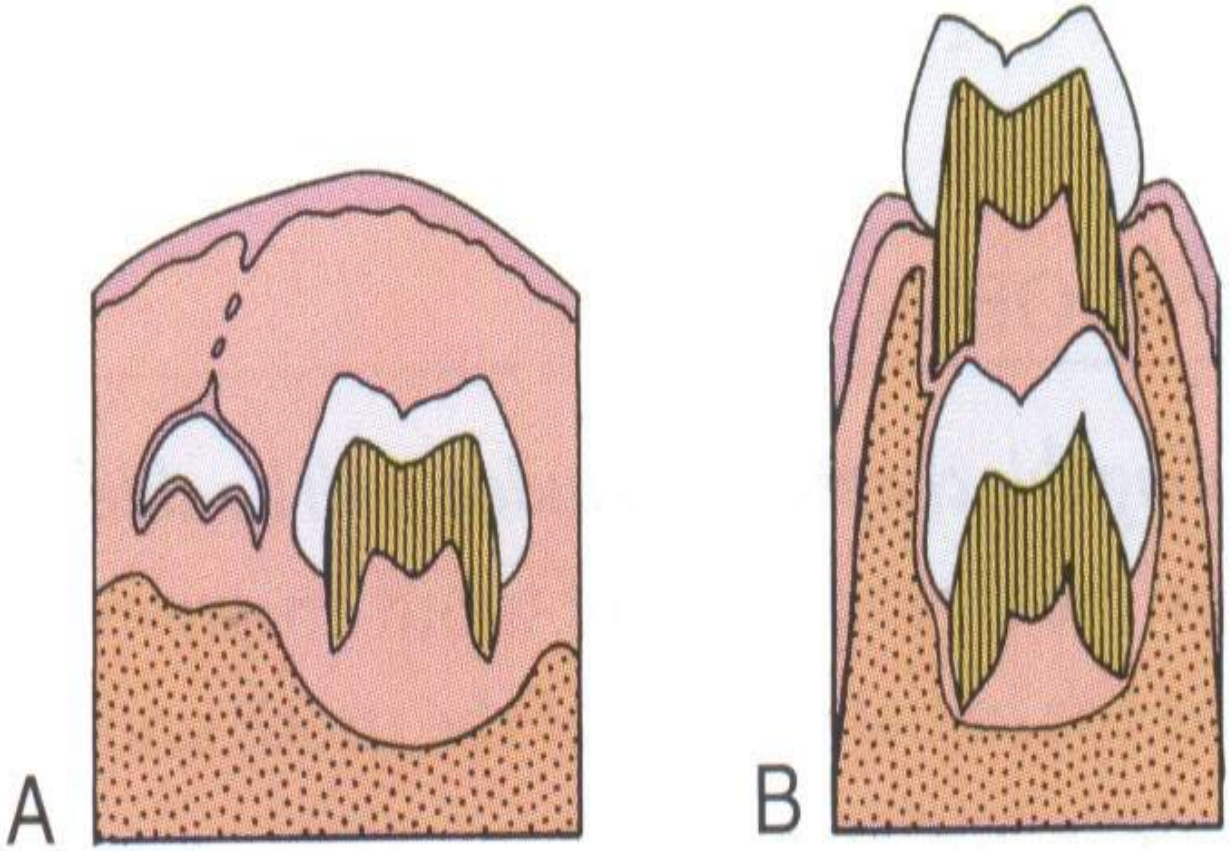
- Maxillary molars develop within the tuberosities of the maxilla with their occlusal surfaces slanted distally;
- Mandibular molars develop in the mandibular rami with their occlusal surfaces slenting mesially;
- All movements in the preeruptive phase occur within the crypts of the developing and growing crown before root formation begins.

Relative position of primary and permanent incisor teeth

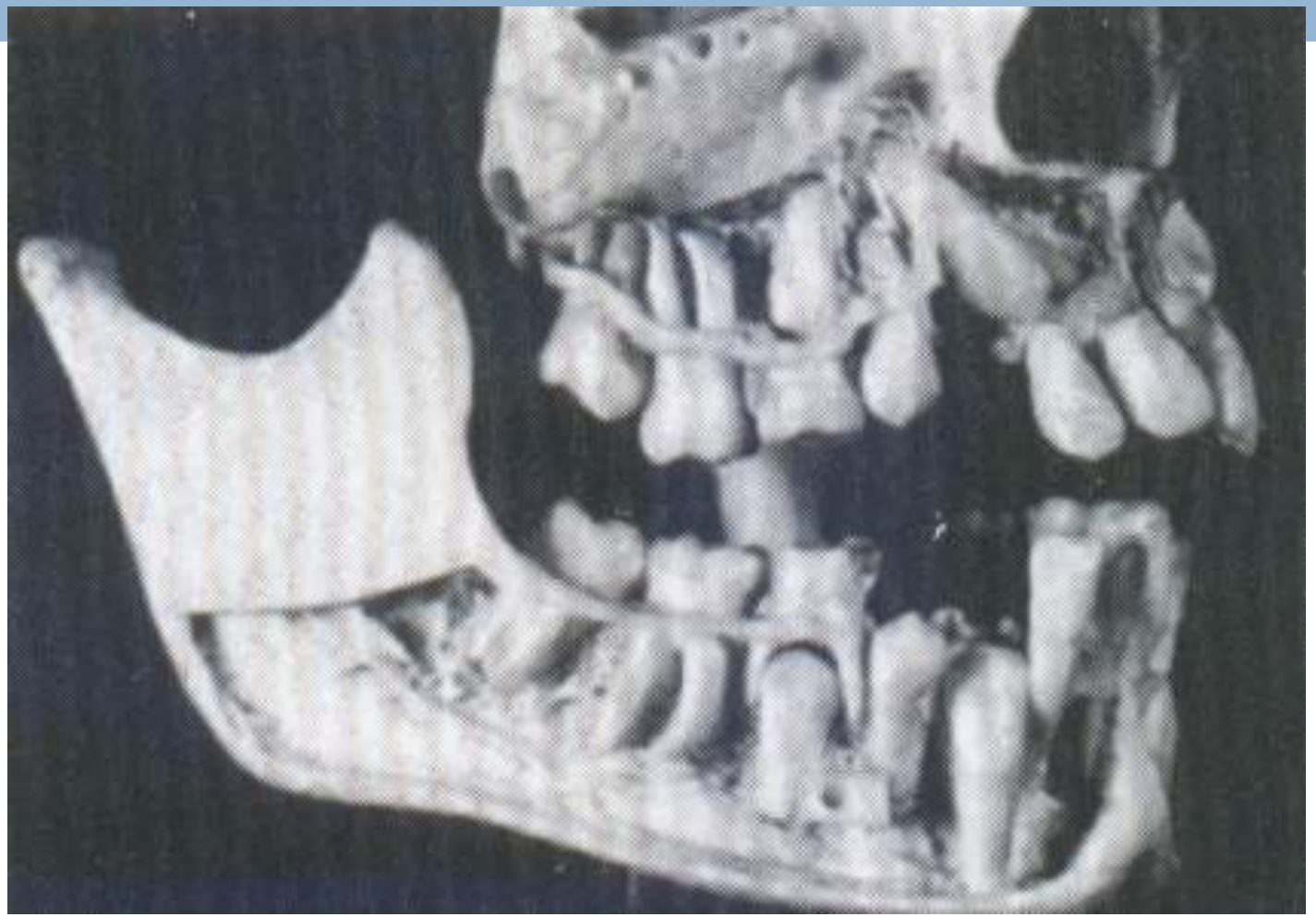


- A. Preeruptive period;
- B. Prefunctional eruptive period.

Relative position of primary and permanent molars



Human jaws at 8 to 9 years of age, during the mixed dentition period



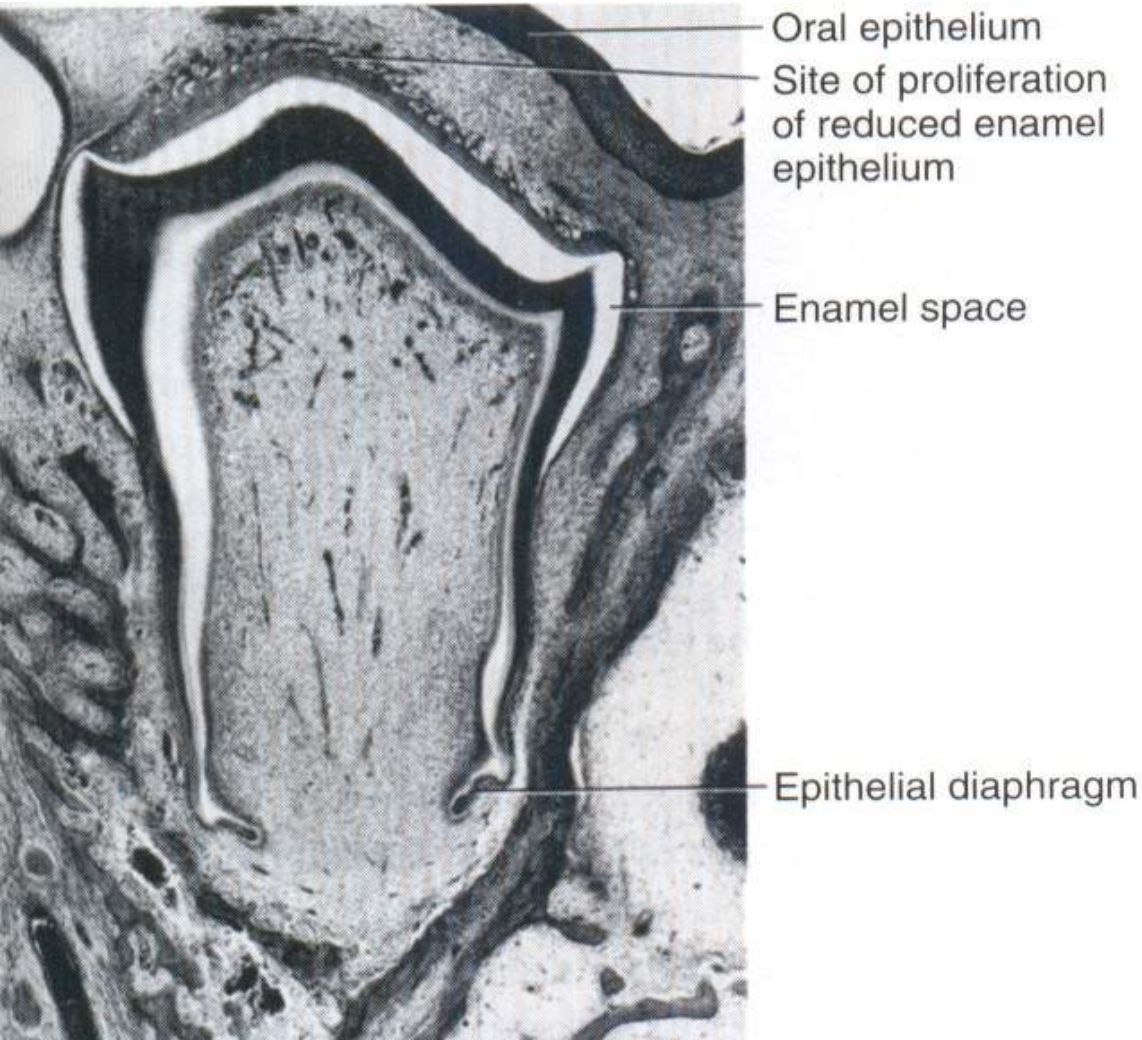
2. Prefunctional eruptive phase

- The prefunctional eruptive phase starts with the initiation of root formation and ends when the teeth reach occlusal contact;
- Four major events occur during this phase:
  - Root formation;
  - Movement;
  - Penetration;
  - Intraoral occlusal or incisal movement.

1. Root formation

- Requires space for the elongation of the root;
- The first step is proliferation of the epithelial root sheath, which in time causes initiation of root dentin and formation of the pulp tissues of the forming root;
- Root formation also causes an increase in the fibrous tissue of the surrounding dental follicle.

Histology of the prefunctional eruptive phase



The root develops;

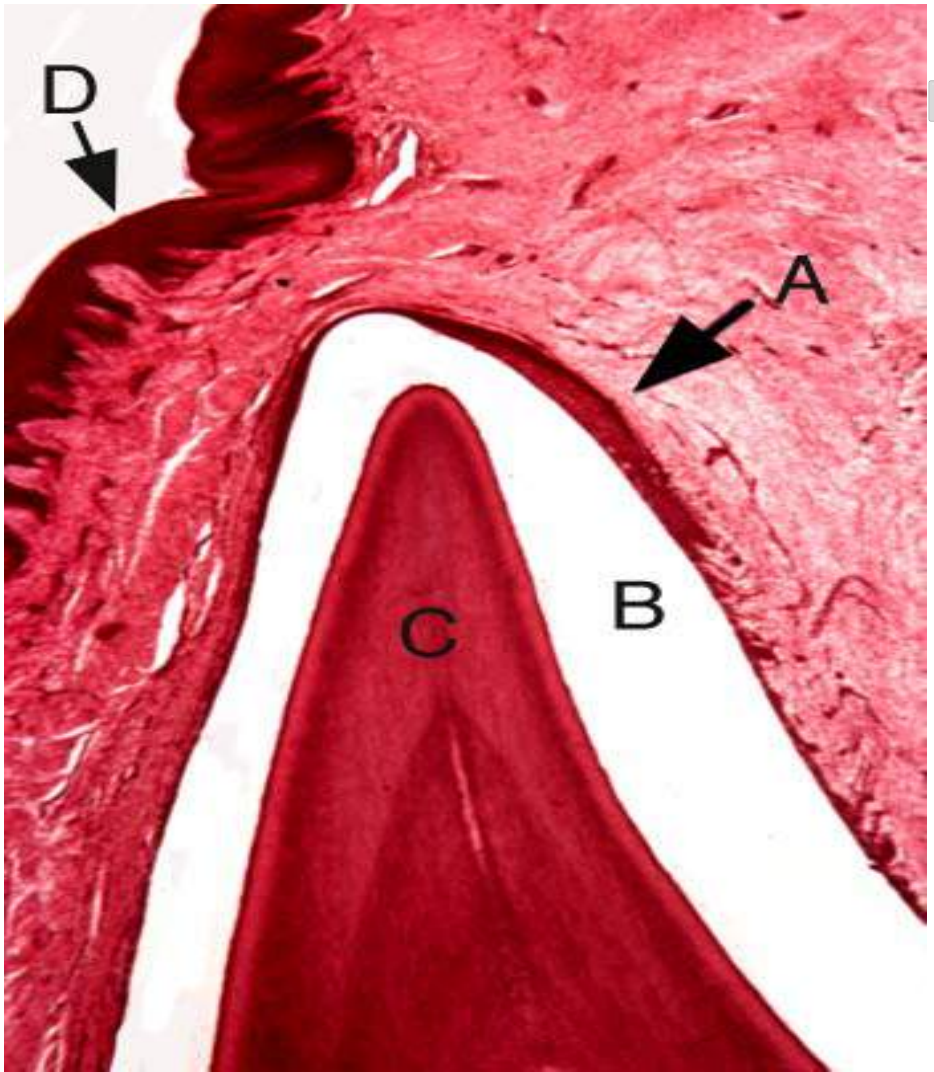
Reduced epithelium overlying crown approaches oral mucosa;

Reduced enamel epithelium proliferates, anticipating fusion.

2. Movement

- They occurs incisally or occlusally through the bony crypt of the jaws to reach the oral mucosa;
- The movement is the result of a need for space in which the enlarging roots can form;
- The reduced enamel epithelium next contacts and fuses with the oral epithelium;
- Both these epithelial layers proliferate toward each other, their cells intermingle and fusion occurs;
- A reduced epithelial layer overlying the erupting crown arises from the reduced enamel epithelium.

Prefunctional eruptive phase of the incisor

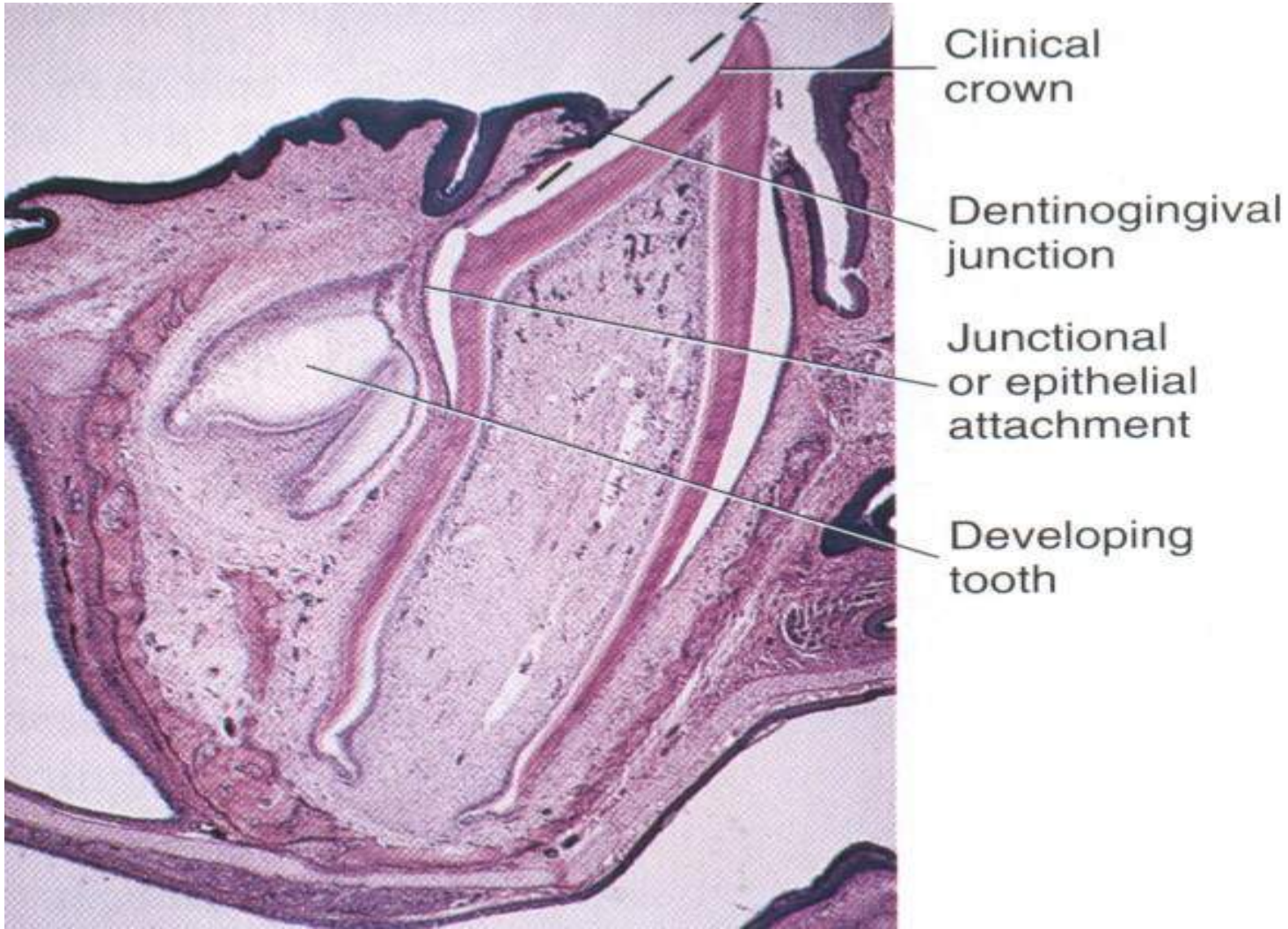


- The start of epithelial proliferation of the two epithelial layers.

3. Penetration

- Penetration of the tooth`s crown tip through the fused epithelial layers allows entrance of the crown enamel into the oral cavity;
- Only the organic developmental cuticle, secreted earlier by the ameloblasts, covers the enamel.

An erupting primary tooth appears in the oral cavity



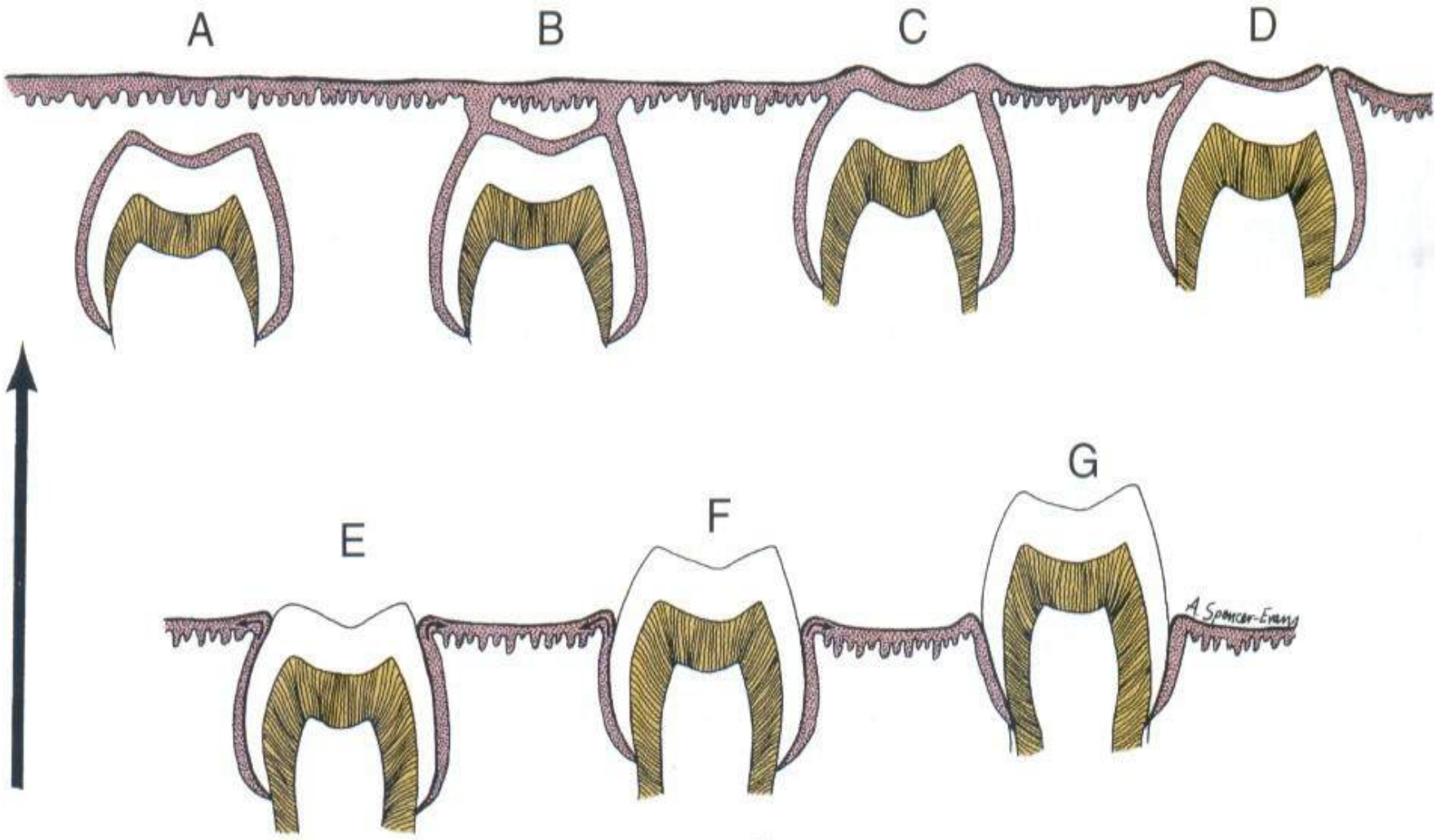
The fate of the developmental cuticle

- The organic developmental cuticle, secreated earlier by the ameloblasts, covering the enamel, is cleaved by masticatory forces and replaced by pelicula dentis (mucopolysaccharides film of saliva).

4. Intraoral occlusal or incisal movement

- It continues until clinical contact with the opposing crown occurs;
- The crown continues to move through the mucosa, causing gradual exposure of the crown surface, with increasingly apical shift of the gingival attachment;
- The exposed crown is the clinical crown, extending from the cusp tip to the area of the gingival attachment;
- Anatomic crown is the entire crown, extending from the cusp tip to the cementoenamel junction.

Stages of tooth eruption



Hypereruption

- Hypereruption occurs with loss of an opposing tooth;
- This condition allows the tooth to erupt farther than normal into space provided.

Changes in the tissue in the prefunctional phase

- Changes in the overlying tissues of the tooth;
- Changes in the surrounding tissues of the tooth;
- Changes in the underlying tissues of the tooth.

Changes in the overlying tissues of the tooth

- The dental follicle changes and forms a pathway for the erupting teeth;
- A zone of degenerating connective tissue fibers and cells immediately overlying the teeth appears first;

During this process:

- The blood vessels decrease in number;
- Nerve fibers break up into pieces and degenerate;
- The altered tissue area overlying the teeth becomes visible as an inverted triangular area known as the erupting pathway.

Developing eruption pathway

- In the periphery of this zone, the folicular fibers, regarded as the gubernaculum dentis or gubernacular cord, are directed toward the mucosa;
- Some scientists believe that these fibers guide the teeth in their movements to ensure complete tooth eruption.

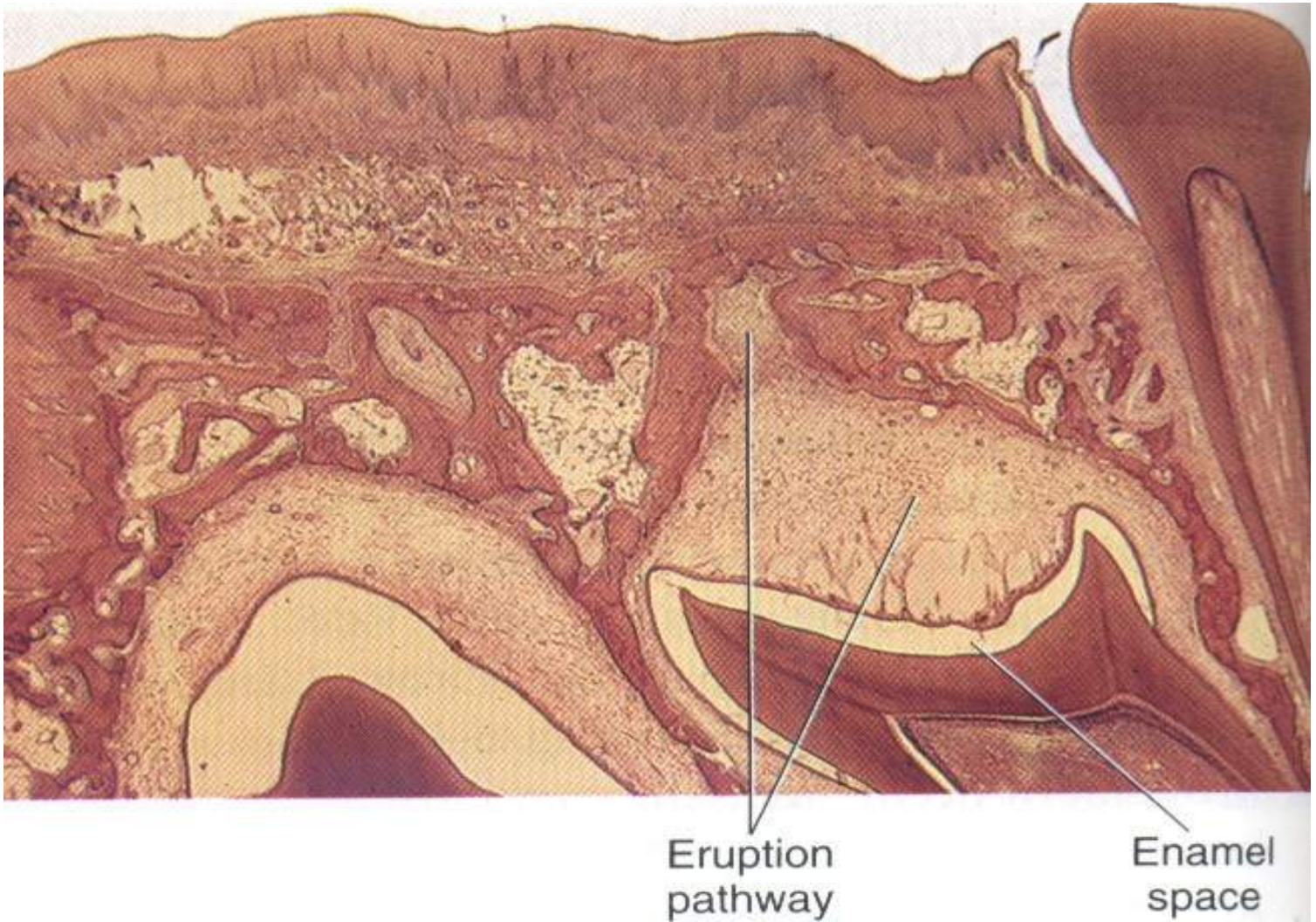
Other changes

- Macrophages appear in the eruption pathway tissue;
- These cells cause the release of hydrolytic enzymes that aid in destruction of the cells and fibers in this area with the loss of blood vessels and nerves;
- Osteoclasts are found along the borders of the resorptive bone overlying the teeth;
- This bone loss adjacent to the teeth keeps pace with the eruptive movements of the teeth.

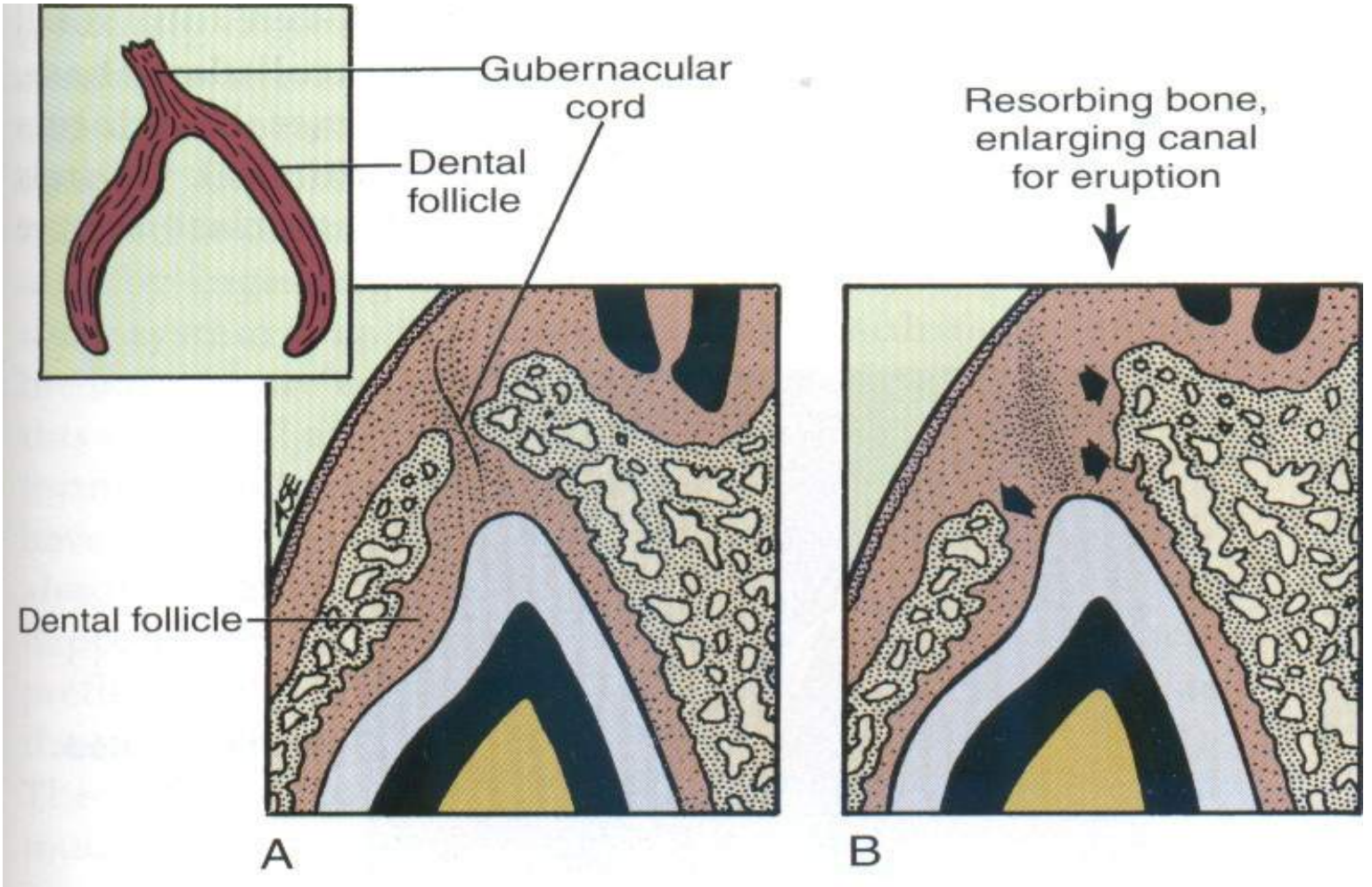
Osteoclasts and osteoblasts:

- Constantly remodel the alveolar bone as the teeth enlarge and move forward in the direction of the growing face.

The appearance of the eruption pathway



Developing eruption pathway, Gubernaculum dentis and resorption of the bone in eruption pathway



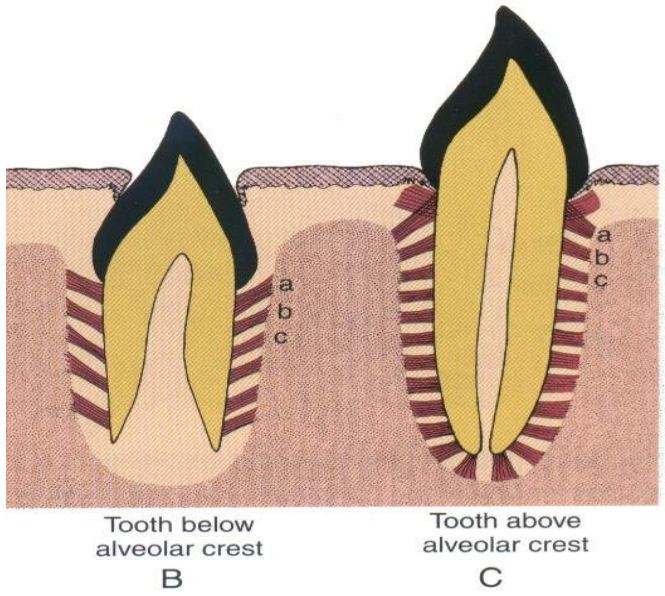
The changes in the surrounding tissues of the teeth

- There are fine fibers lying parallel to the surface of the tooth to bundles of fibers attached to the tooth surface and extending toward the periodontium;
- The first fibers to appear are those in the cervical area as root formation begins;

A

As the root elongated, bundles of fibers appear on root surface

- Fibroblasts are active cells in both the formation and the degradation of the colagen fibers;
- With tooth eruption, the alveolar bone crypt increases ir height to accommodate the forming root;
- After the teeth attain functional occlusion, the fibers gain their natural orientation (C).



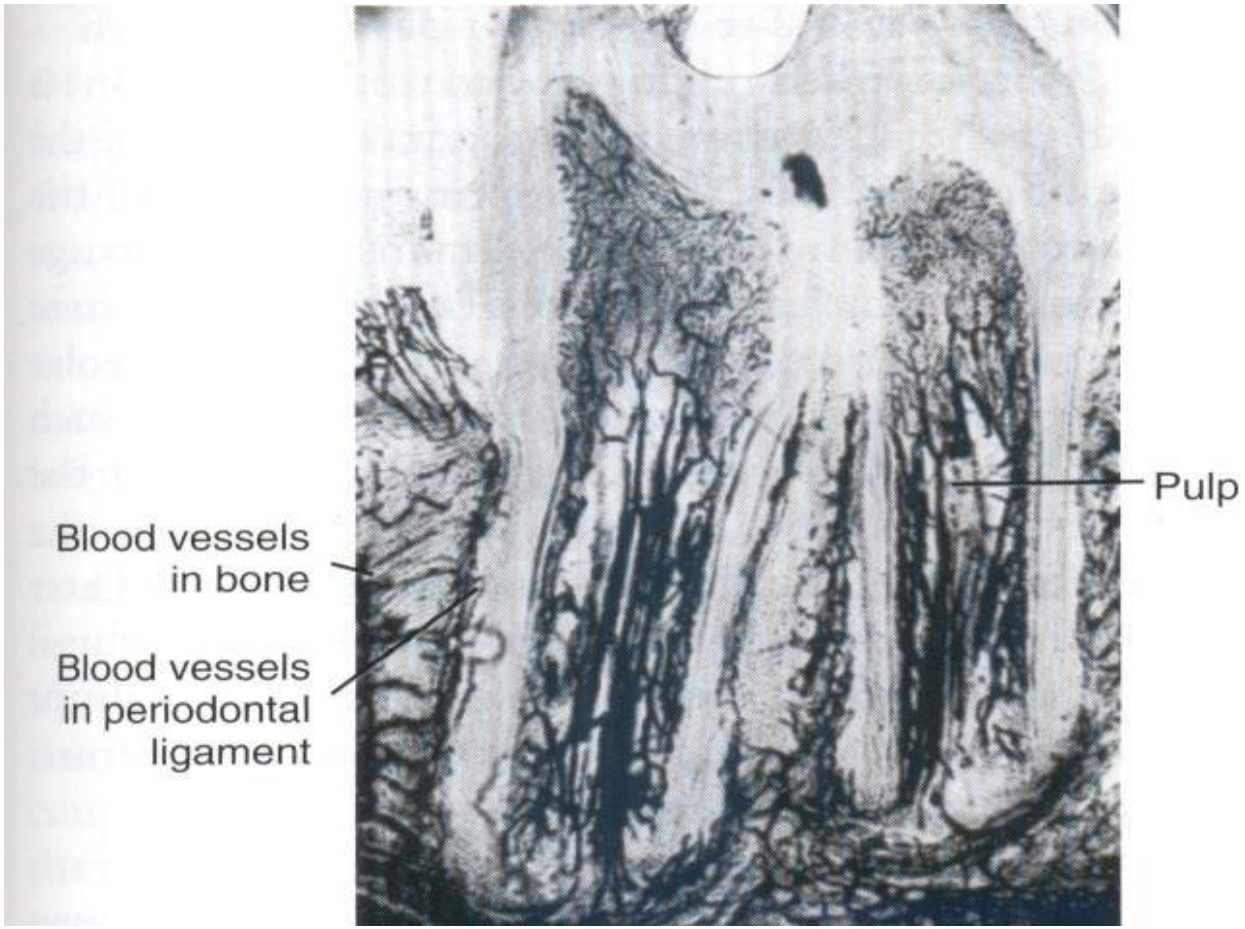
Special fibroblasts have been found in the periodontium around the erupting teeth

- These fibroblasts have contractile properties;
- During eruption, collagen fiber formation and fiber turnover are rapid, occurring within 24 hours;
- This mechanism enable fibers to attach and release and attach in rapid succession;
- Some fibers may detach and reattach later while the tooth moves occlusally as new bone forms around it;

Other events

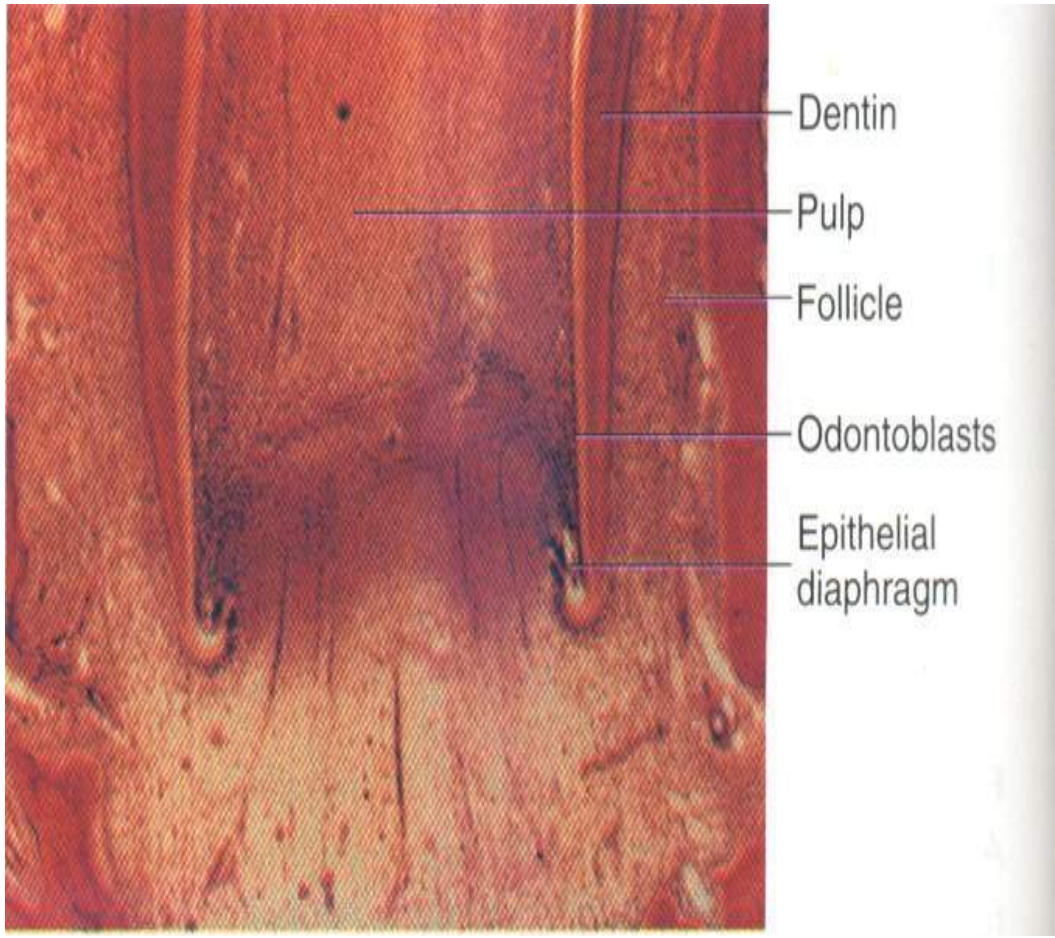
- Gradually the fibers organize and increase in number and density as the tooth erupts into the oral cavity;
- Blood vessels then become more dominant in the developing ligament and exert additional pressure on the erupting tooth.

Histology of erupting tooth with vascular injection



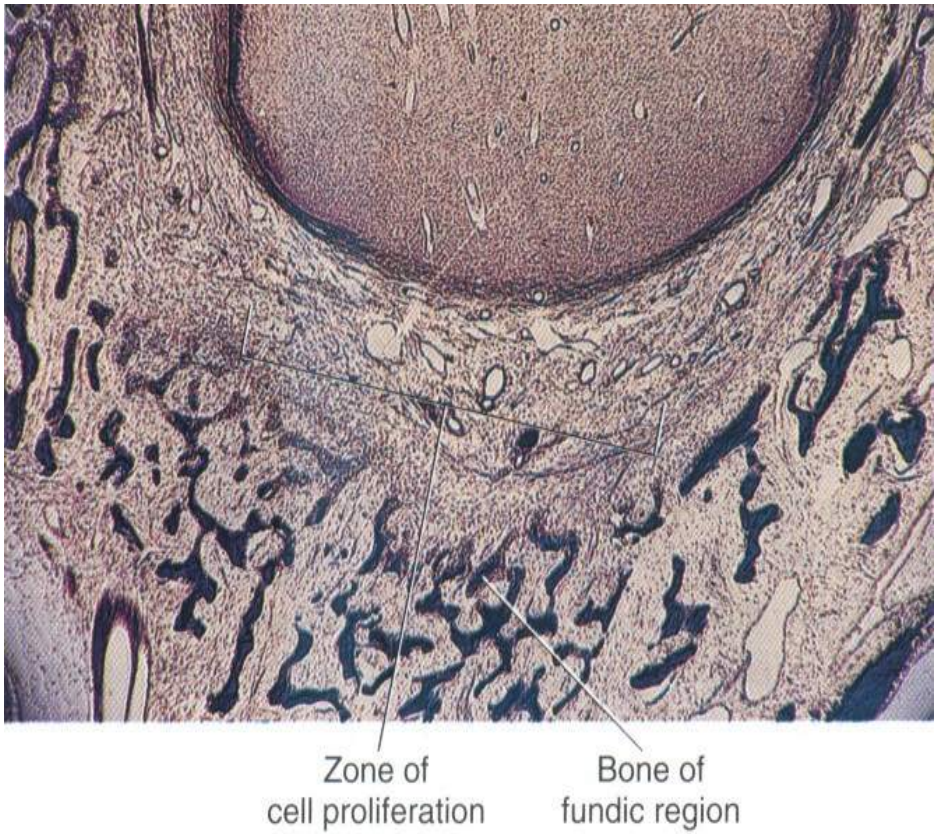
The changes in the underlying tissues of the tooth

- As the crown of a tooth begins to erupt, it gradually moves occlusally, providing space underlying the tooth for root to lengthen;



Histology of changes in fundic region during tooth eruption

- In the fundic region these changes in the soft tissue and the bone surrounding the root apex are belived to be largely compensatory for the lengthening of the root;
- During root formation, the dentin of the root apex tapers to a fine edge that terminates in the epithelial diaphragm.

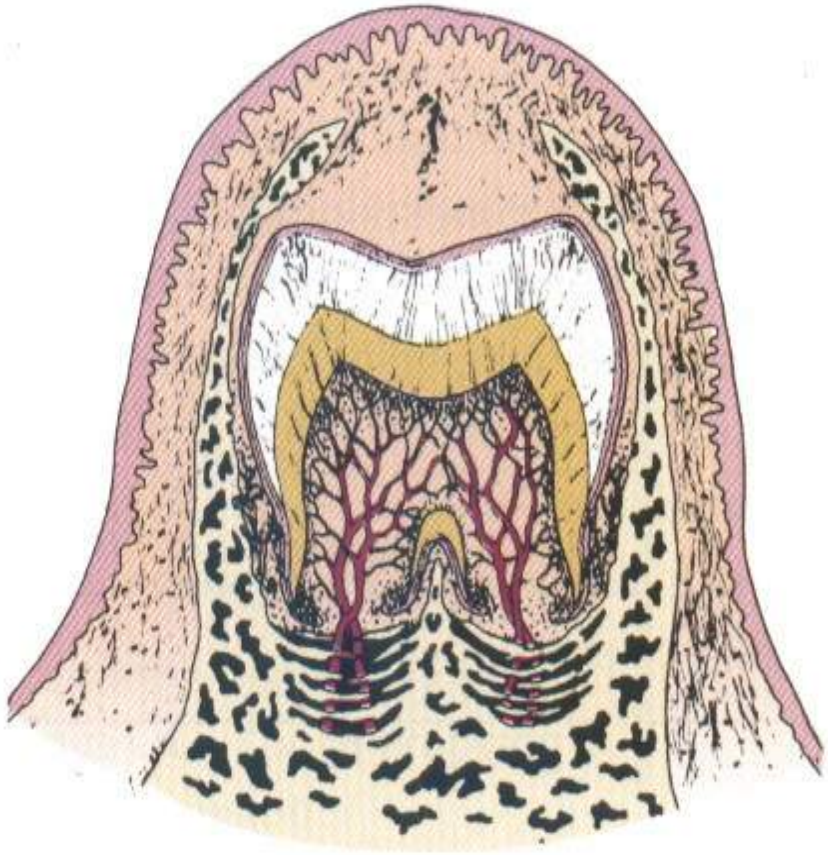


Fibroblasts and fiber bundles

- Fibroblasts from collagen around the root apex, and these fiber bundles become attached to the cementum as it begins to form in the apical dentin;
- Fibroblasts appear in great numbers in the fundic area, and some of these fibers from strands that mature into calcified trabeculae;
- They form a network, or bony ladder, at the tooth apex;
- This is believed to fill the space left behind as the tooth begins eruptive movement.

The fundic region further develops a bony ladder

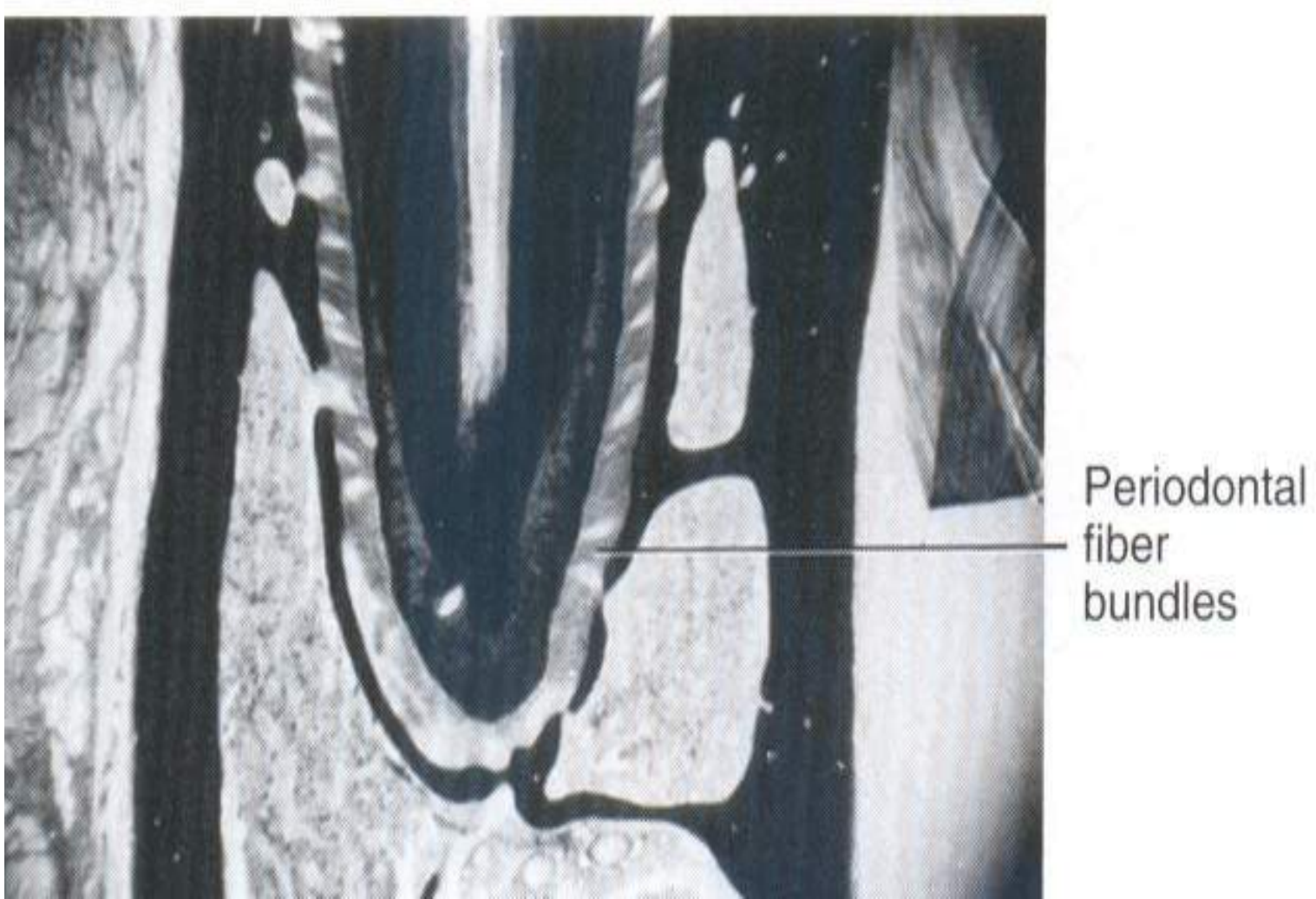
- The bony plates remain until the teeth are in functional occlusion at the end of this phase;
- Dense bone then forms around the tooth`s apex, and bundles of fibers attach to the apical cementum and extend to the adjacent alveolar bone to provide more support.



Functional eruptive phase

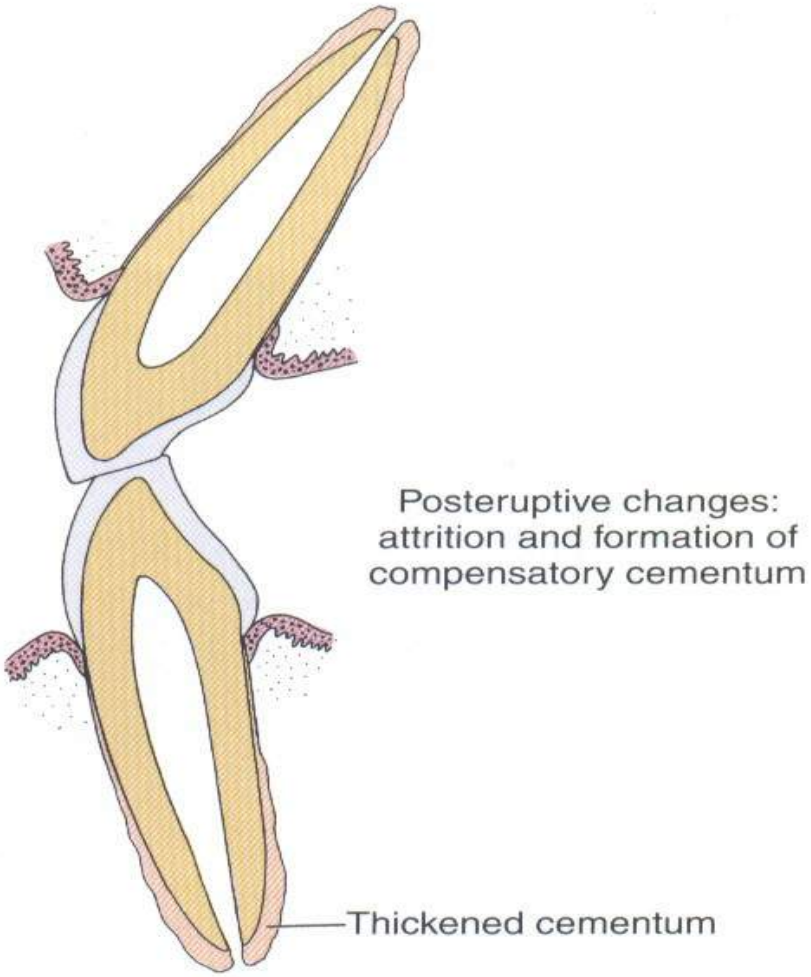
- The final eruptive phase takes place after the teeth are functioning and continues as long as the teeth are present in the mouth;
- During this period of root completion, the height of the alveolar process undergoes a compensating increase;
- The fundic alveolar plates resorbe to adjust for formation of the root tip apex;
- The root canal narrows as a result of root tip maturation;
- This process takes about 1 to 1,5 years for primary teeth and 2 to 3 years for permanent teeth.

Histology of tooth in functional occlusion to show density of functioning periodontal fibers.



Functional eruptive changes illustrating attrition of the incisal surface of enamel

Observe the compensatory deposition of cementum on the apical region of the root



Clinical comment

- Lack of eruption resulting from failure of root formation may be caused by:
  - Errors in root development;
  - Crowding of teeth;
  - Crown-to-root fusion;
  - Lack of development of the pulp proliferative zone.

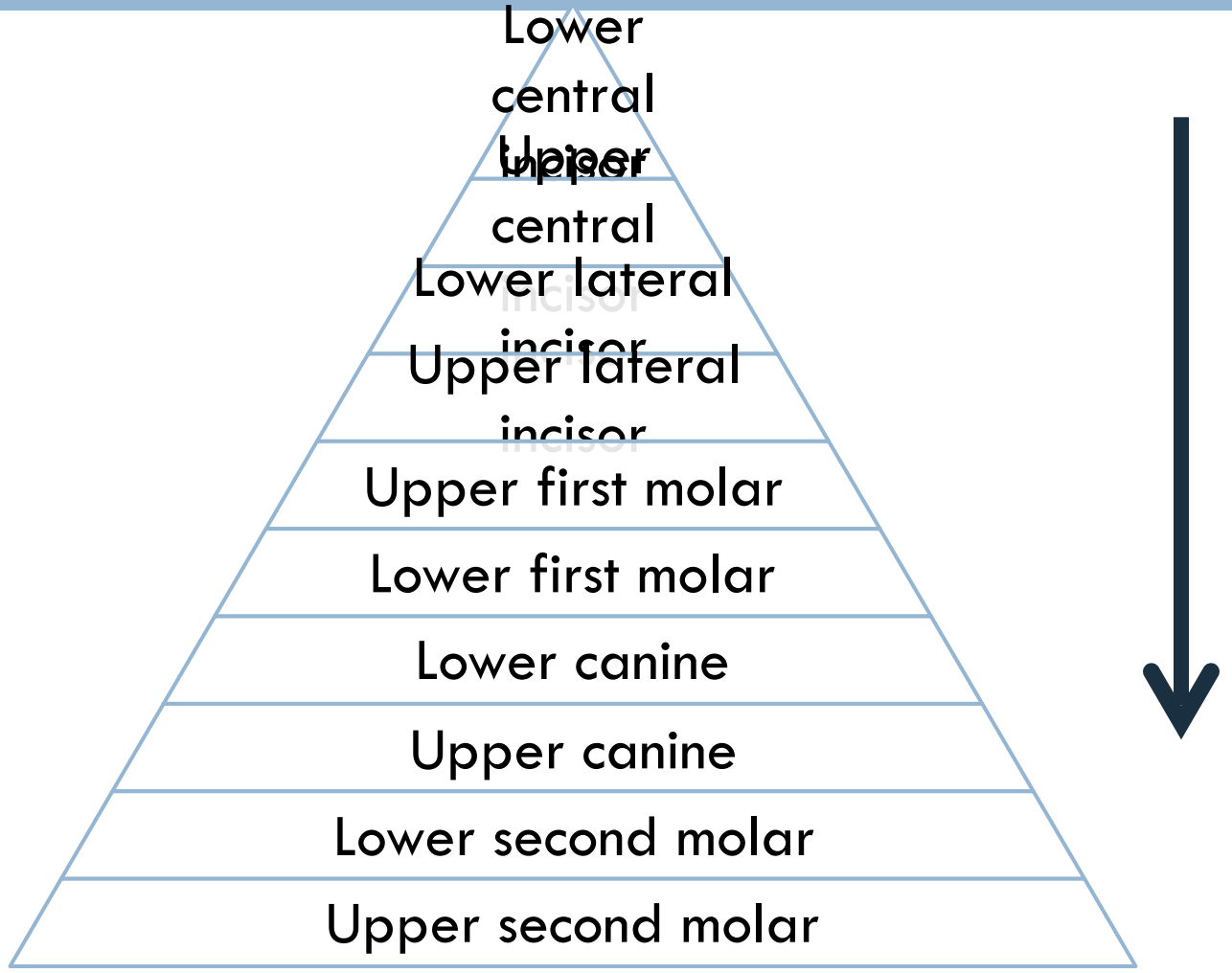
Possible causes of tooth eruption

- Root growth;
- Pulpal pressure;
- Cell proliferation;
- Increased vascularity;
- Increased bone formation around the teeth;
- Endocrine influence;
- Vascular changes;
- Enzymatic degradation.

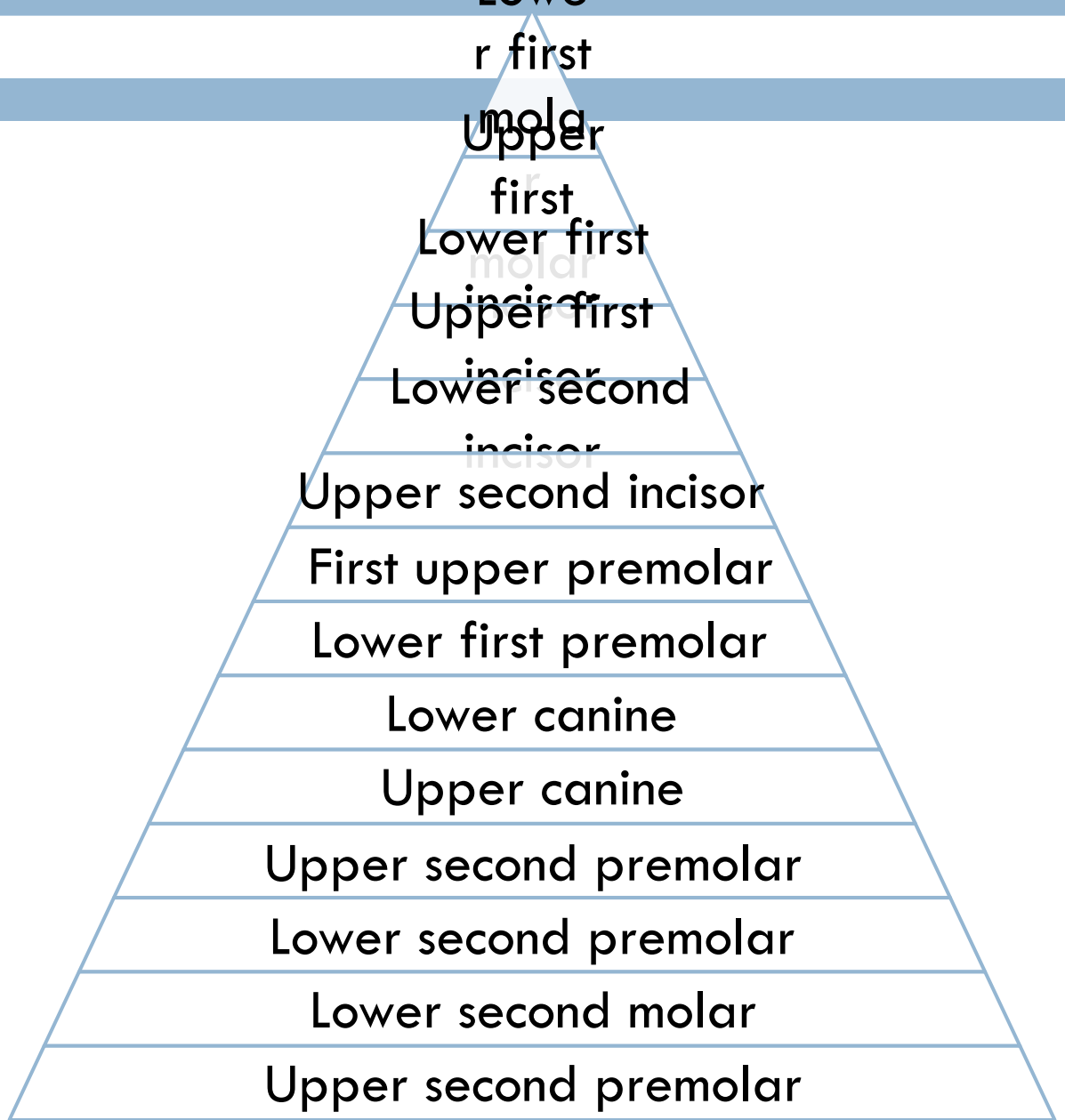
In summary

- All factors that influence the tooth eruption act simultaneously;
- The erupting tooth moves from area of increased pressure to an area of decreased pressure.

Sequence and chronology of primary tooth eruption



Sequence and chronology of permanent teeth eruption



4.Development of the tooth root

Begins after the formation of the crown;

Phases of development:

- Preeruptive;
- Eruptive;
- Functional eruptive.

Phases of the tooth root formation

1. Start of tooth root development;

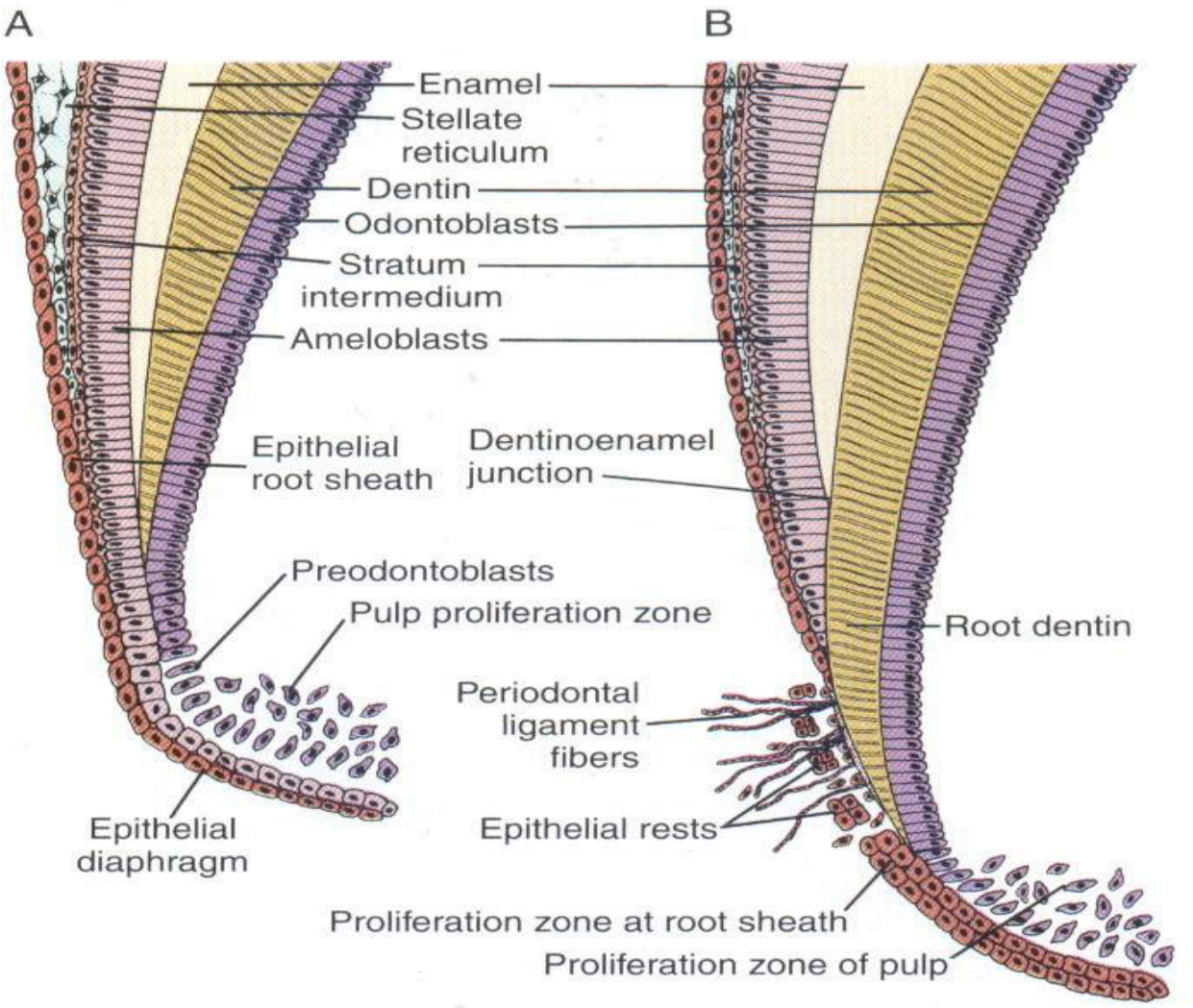
2. Short root walls;

3. Root walls, close to the final length;

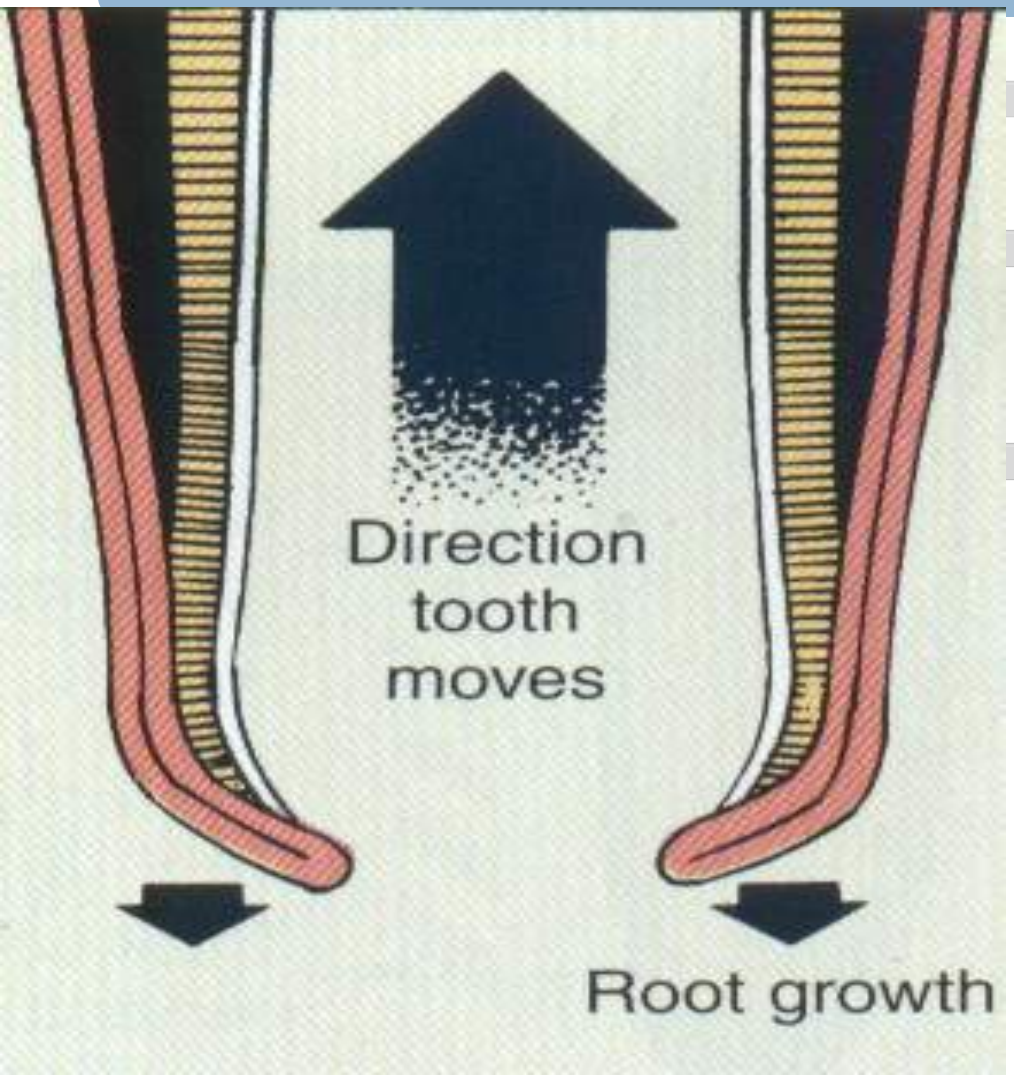
4. Constructed root walls but undeveloped apex;

5. Constructed apex.

The start of tooth root development

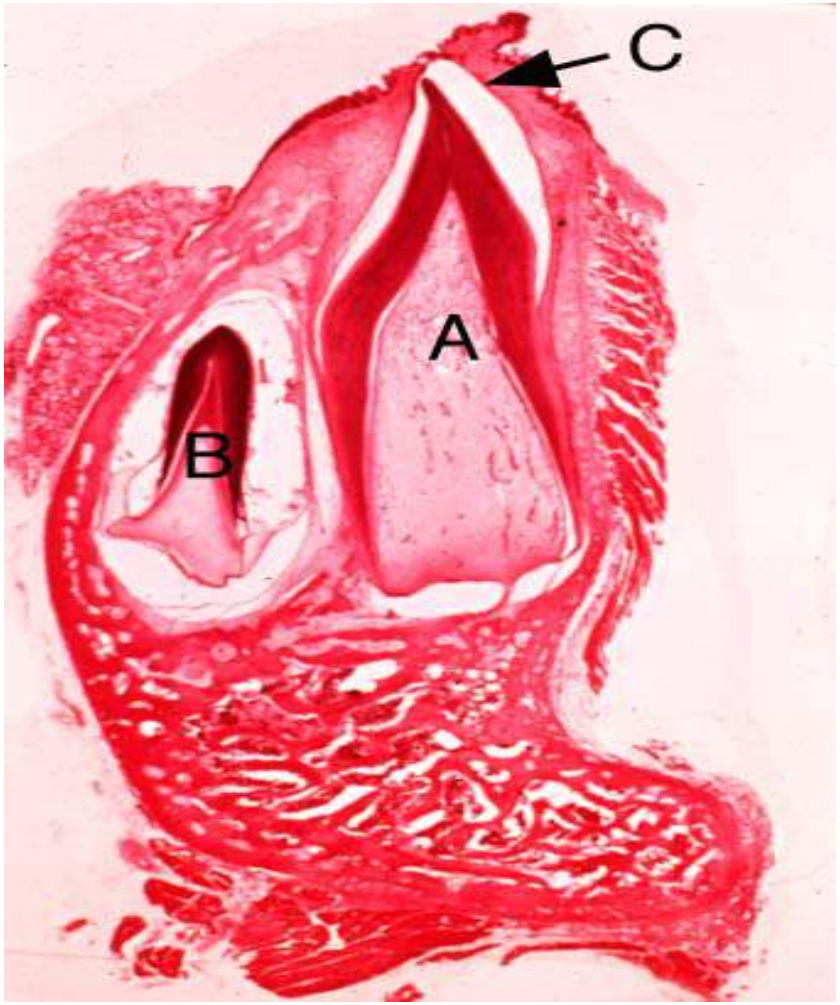


Short root walls



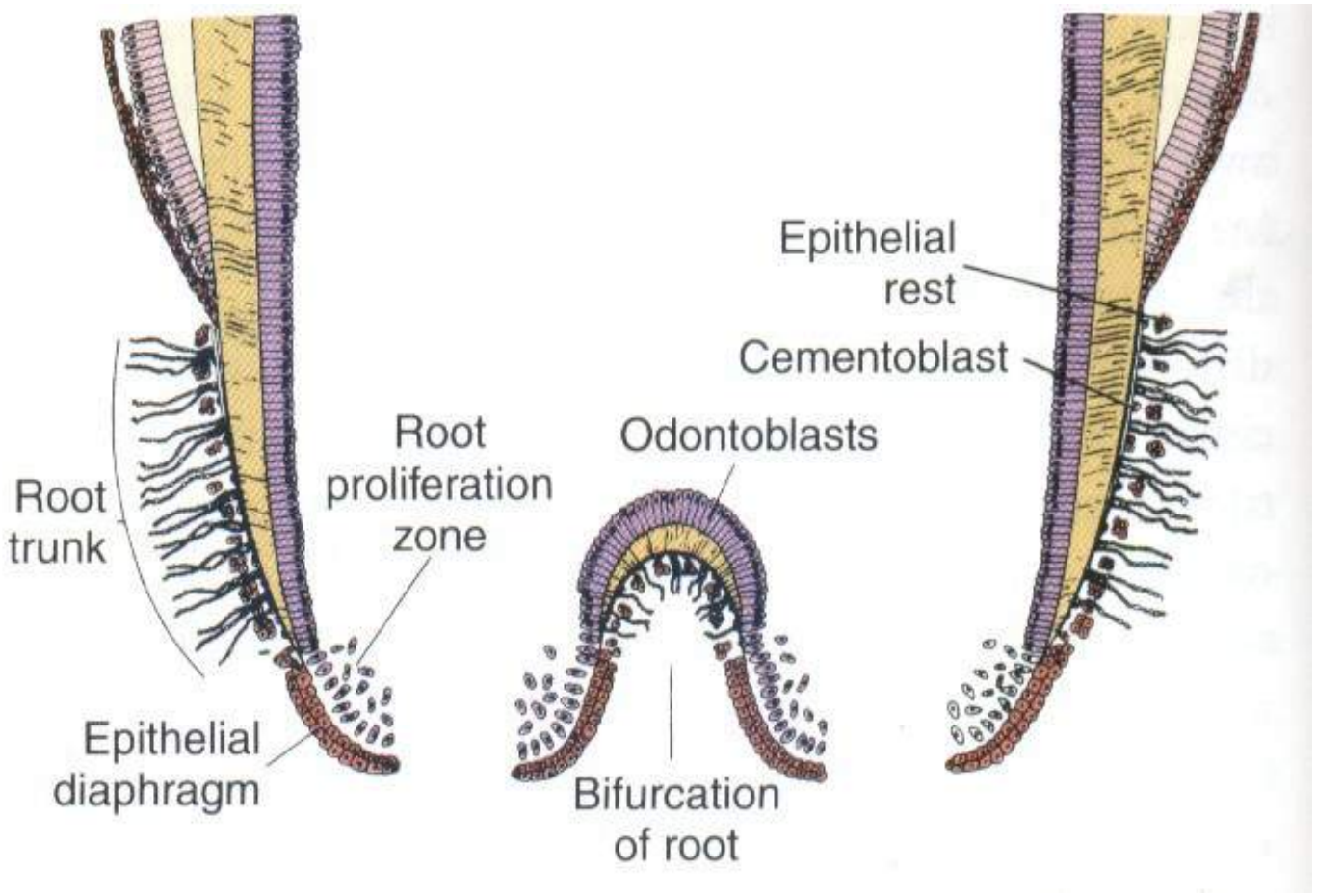
- Short, thin, tapered and parallel walls root;
- Their end finishes with epithelial root sheath and pulp proliferative zone;
- The dental pulp is wider apically than cervical.

Short root walls

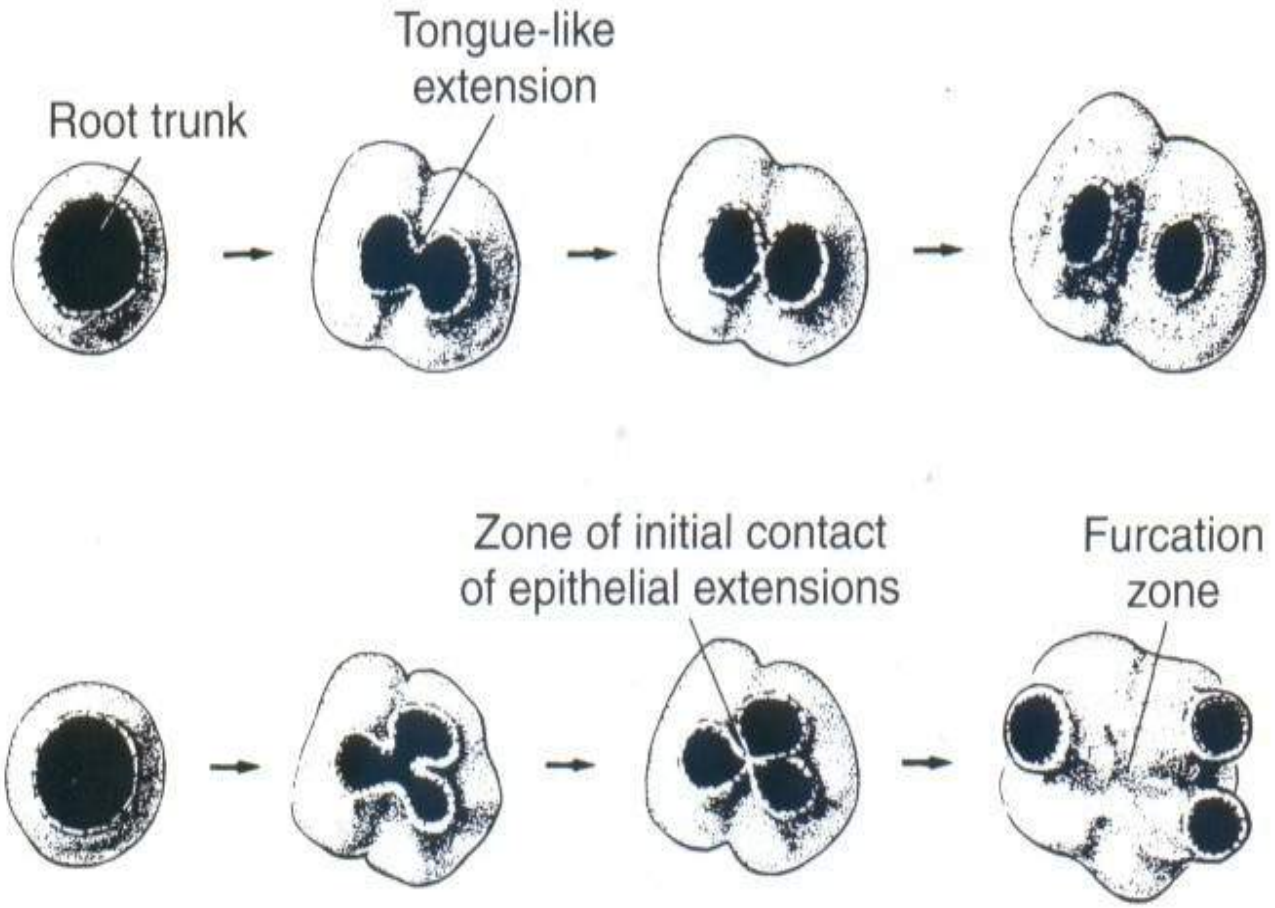


- This is happens prior to and during the tooth eruption;
- The periodontium is wide;
- Periodontal ligaments are not connected.

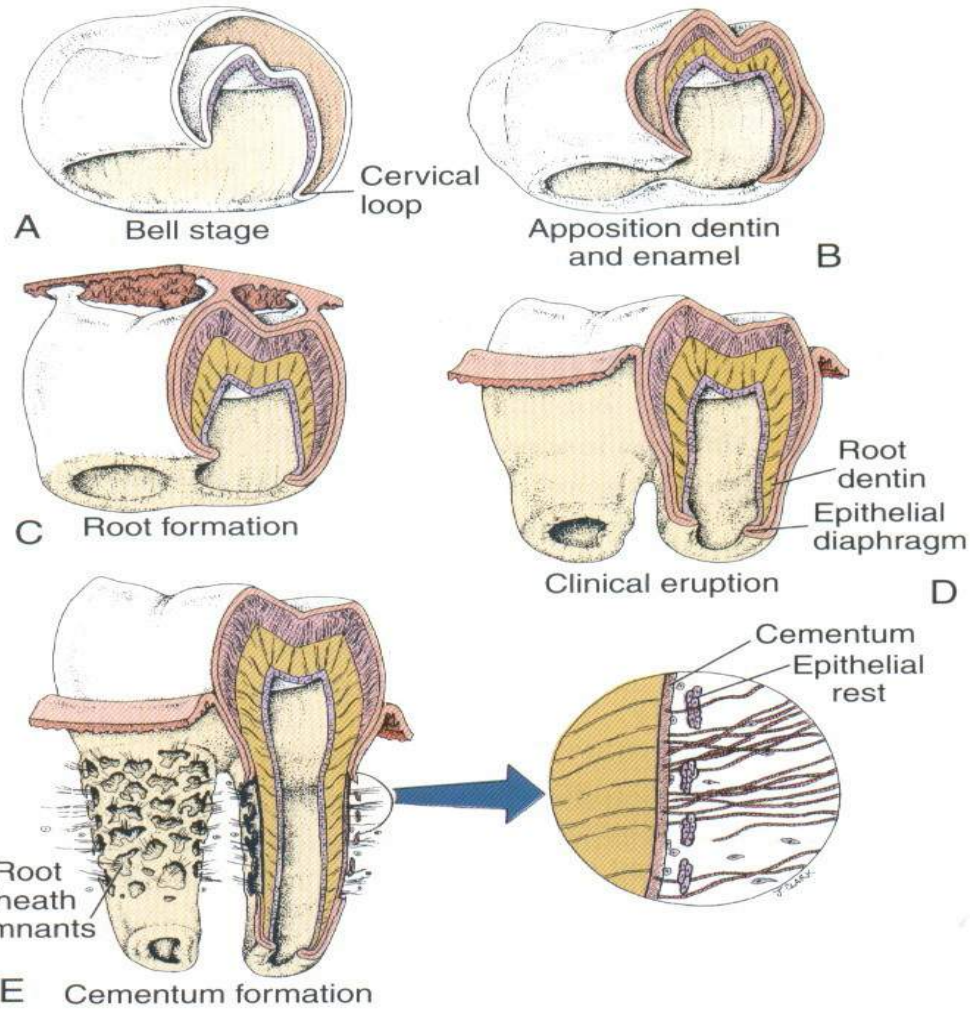
Bifurcation root zone in multiple root formation



Development of multirooted teeth

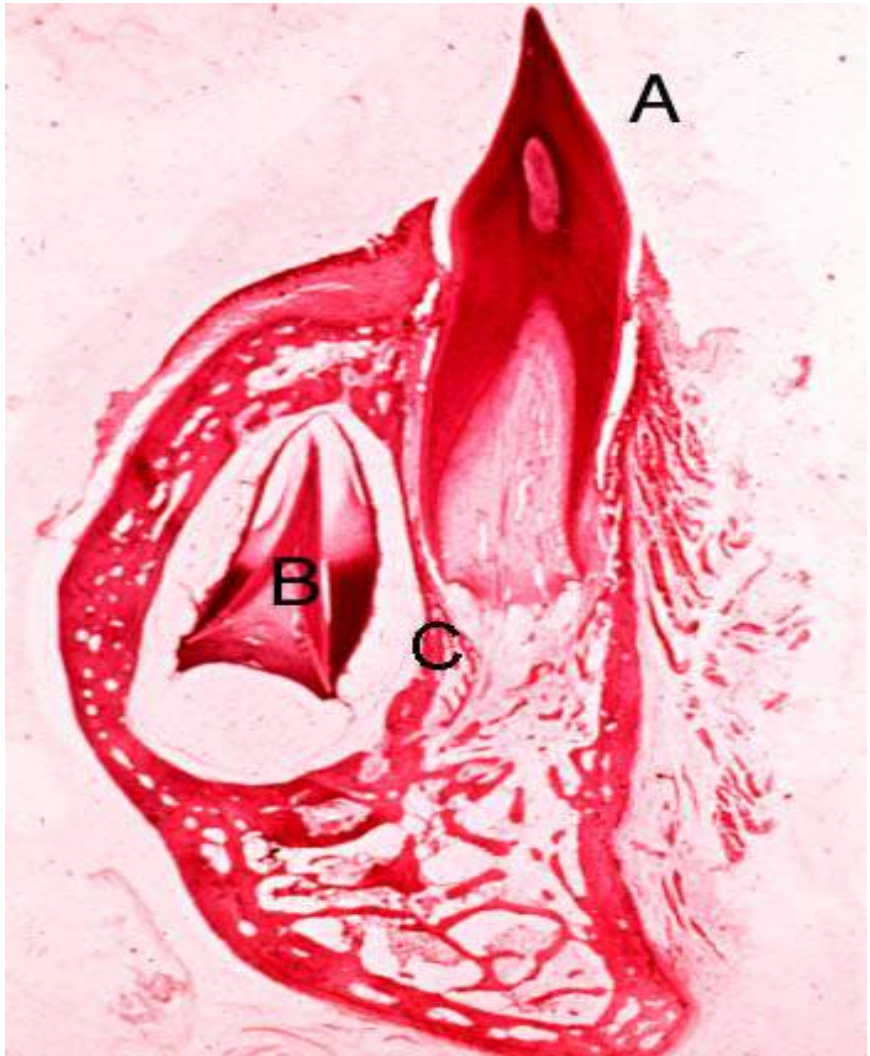


Stages of root development



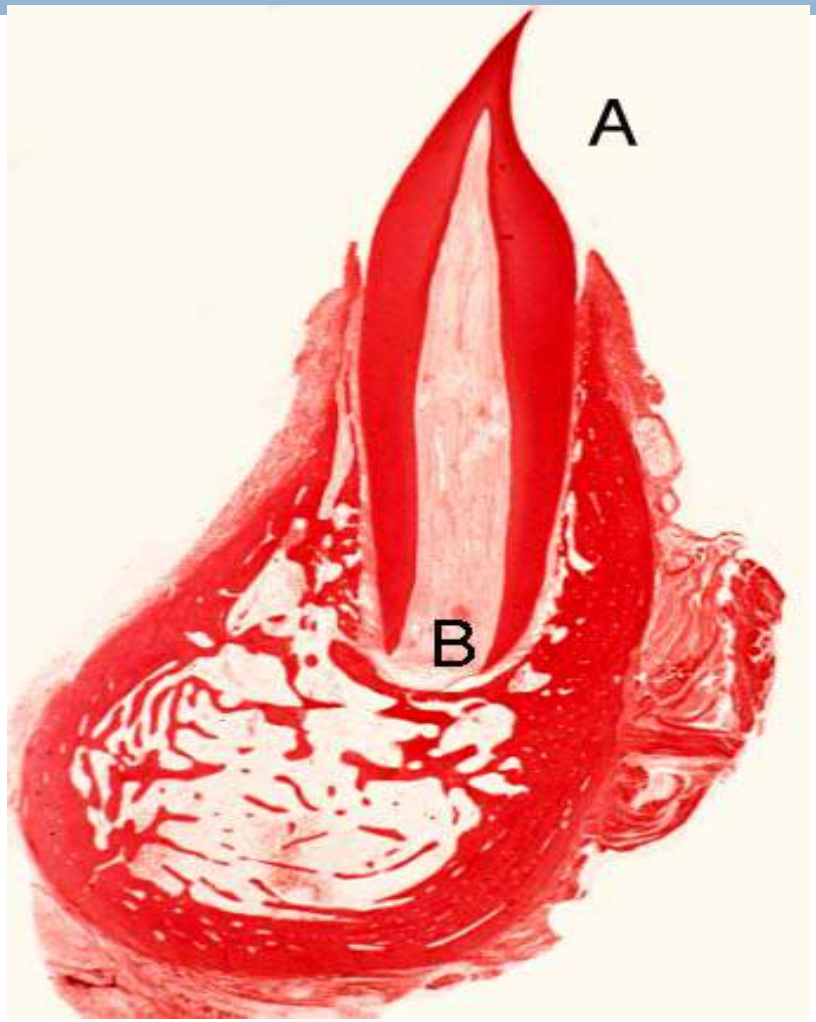
1. C. First stage of root development;
2. D. Second stage of short root walls;
3. E.Third stage - the root walls, close to the final length.

Third stage - the root walls, close to the final length.



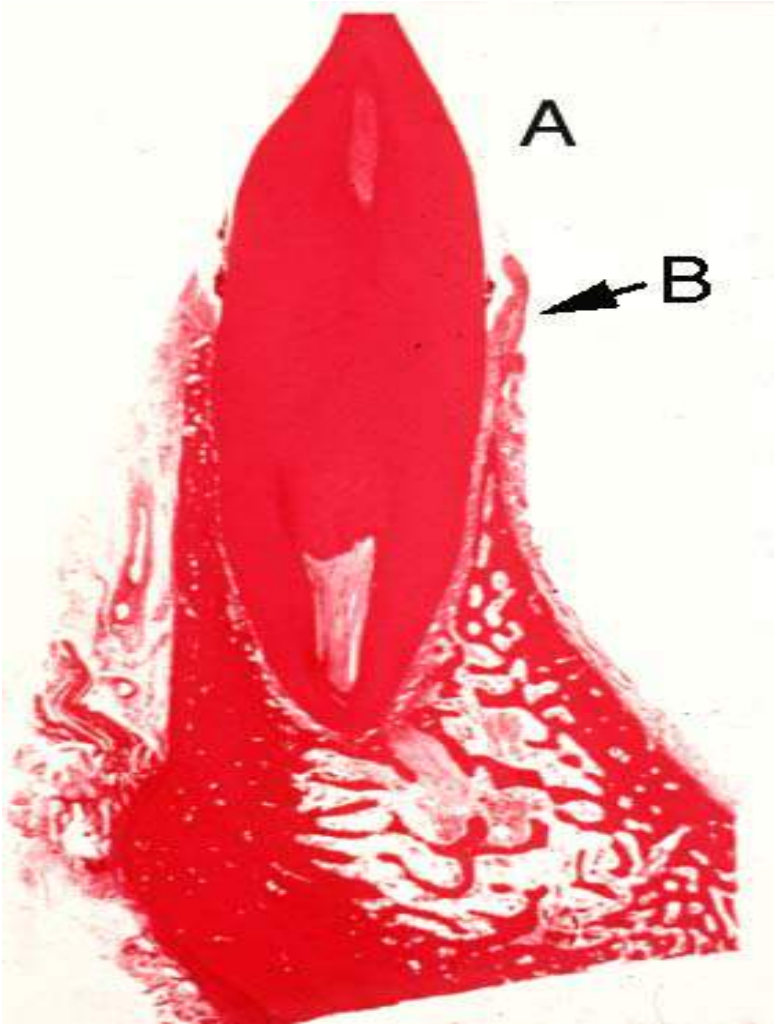
- Root walls are elongated, thickened, but still parallel, like tapered spear;
- Clearly visible proliferative zone.

Fourth stage - The root walls are build, but the apex is not.

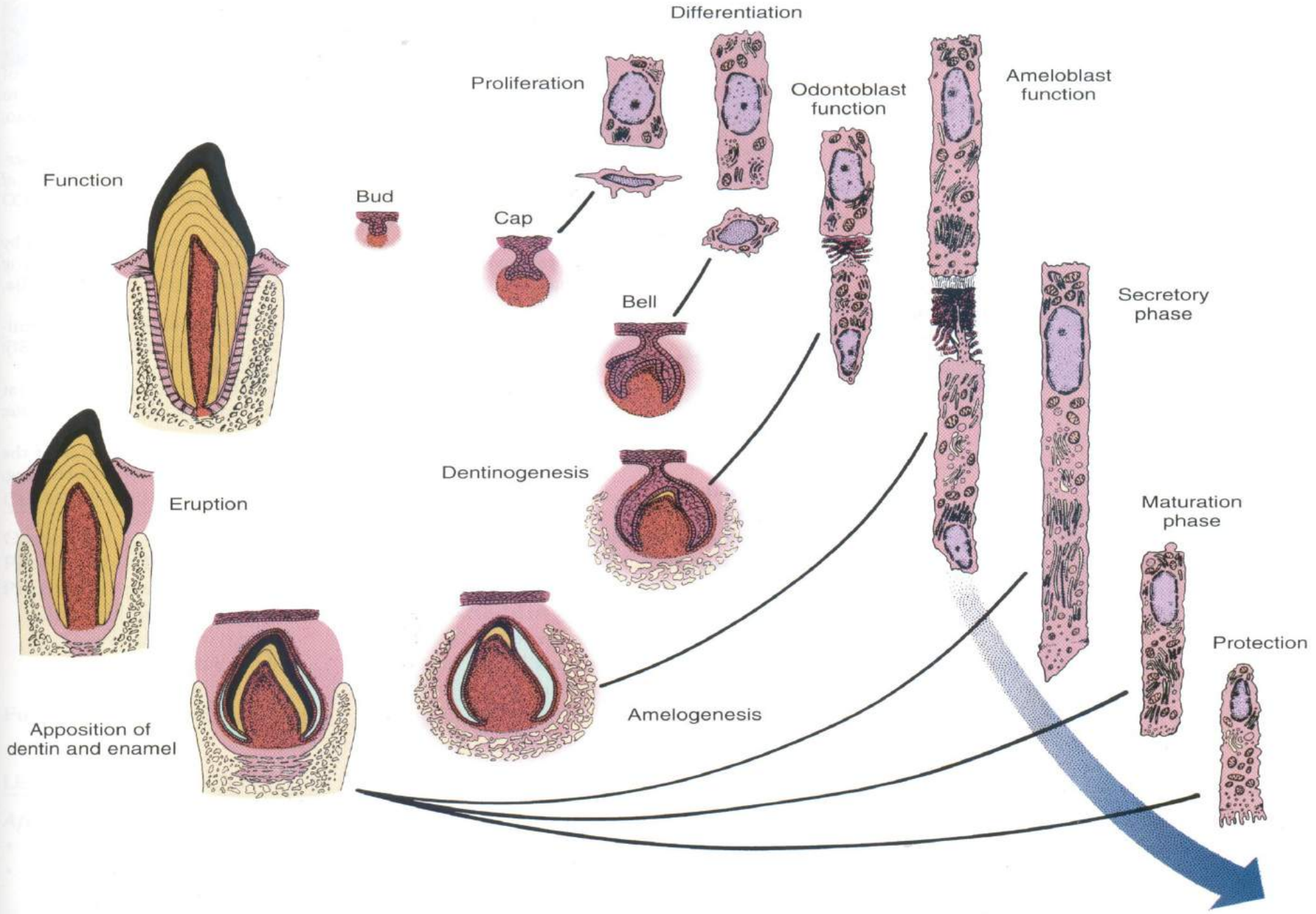


- The eruption is completed and the tooth is in the function;
- Root walls have reached a length;
- Root walls are thickened and slightly convergent;
- Apex has not yet was built and is widely open;
- The proliferative zone decreases.

Fifth stage - Apex is closed



- The apex is built;
- The periodontium is built, not only along the walls of the root, but in the area of the apex;
- Proliferative zone is lacking.


Differentiation
Proliferation
Odontoblast function
Ameloblast function
Function
Bud
Cap
Bell
Secretory phase
Dentinogenesis
Eruption
Maturation phase
Protection
Apposition of dentin and enamel
Amelogenesis

Shedding of primary teeth

- Humans are considered diphyodont;
- They possess two dentitions – primary and permanent;
- The teeth in the primary dentition are smaller and fewer in number than permanent dentition to conform to the smaller jaws of the yang person;

Functioning of the dentitions

- Primary dentition – from about 2 to 6 years of age;
- Mixed dentition – from about 6 to10 - 11 years;
- Permanent dentition – after this period.

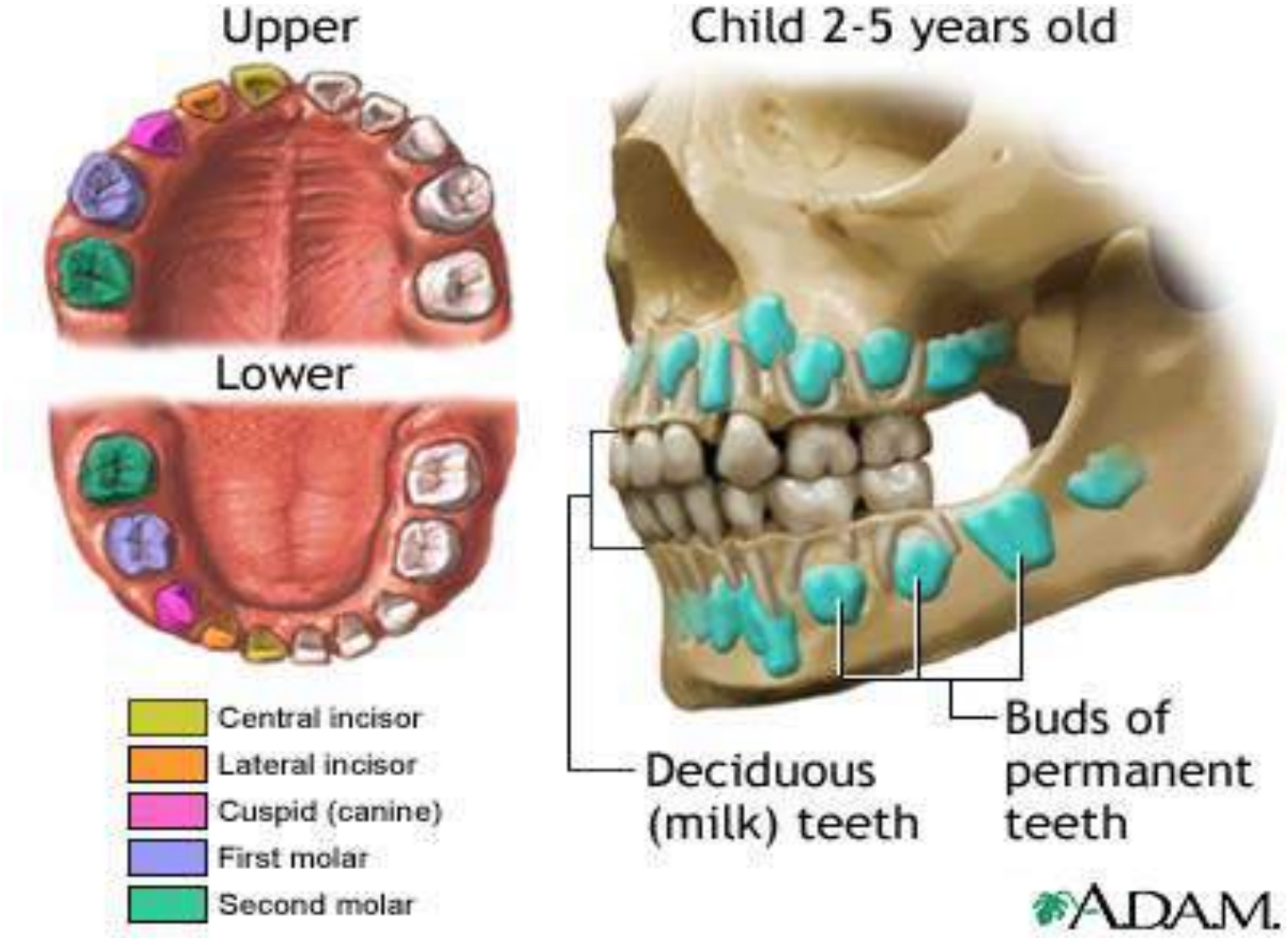
Shedding

- The period of tooth shedding follows the mixed dentition period;
- Shedding is the loss of the primary dentition caused by physiologic resorption of the roots, the loss of bony supporting structure, and therefore the inability of these teeth to withstand the masticatory forces.

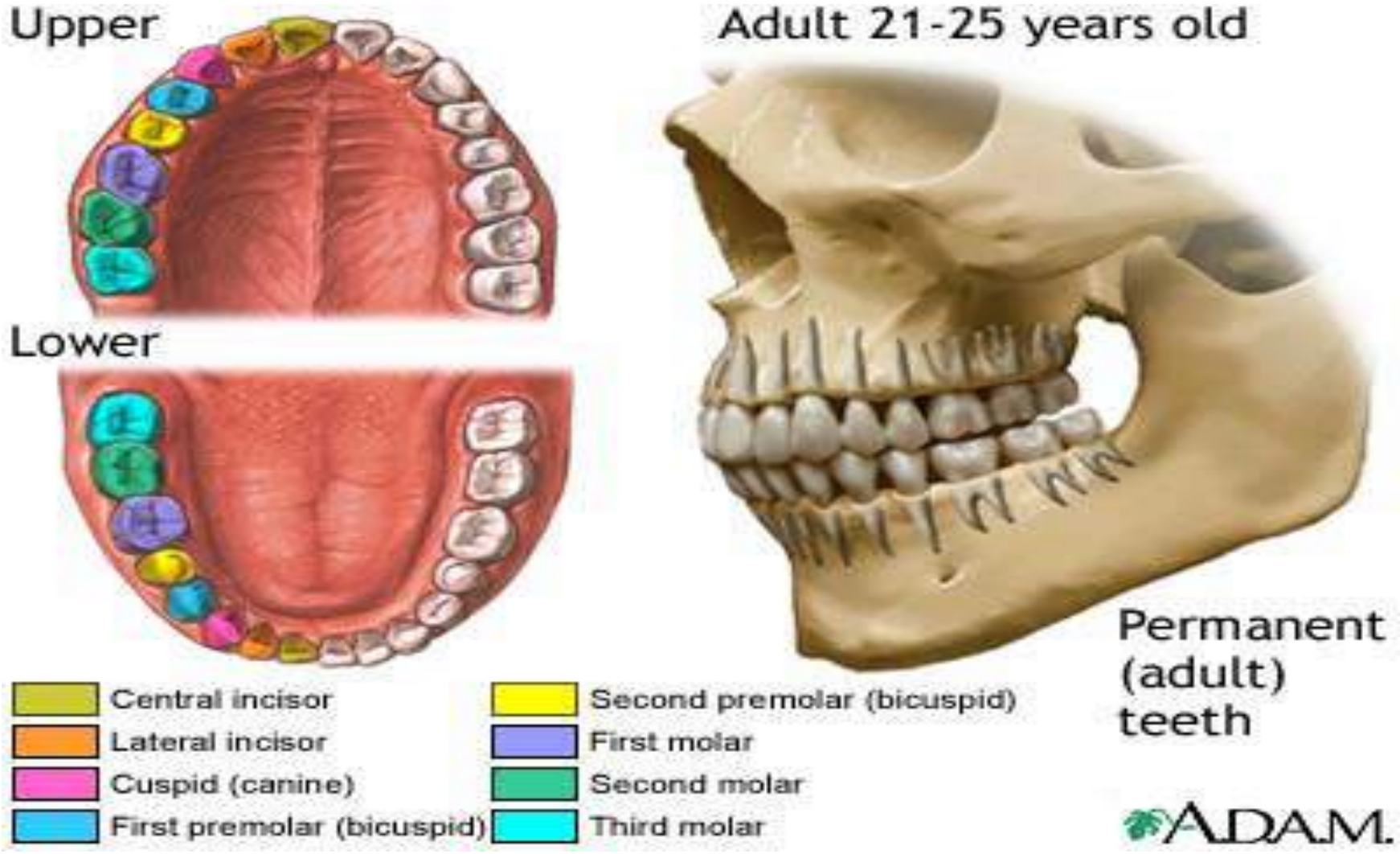
Mixed dentition

- Only part of the primary teeth roots are present while they undergo resorption;
- Only part of the permanent roots are present while they are in the formative stage;
- Nearly 50 teeth can be accommodated in the jaws during this 4-year span.

Primary and buds of permanent dentition



Permanent dention



Root resorption of the primary dentition

- Physiological resorption of deciduous teeth is implemented by the resorptive organ;
- It is attached to the resorbing root;
- The resorption occurs under the action of eruptive forces of the permanent tooth.

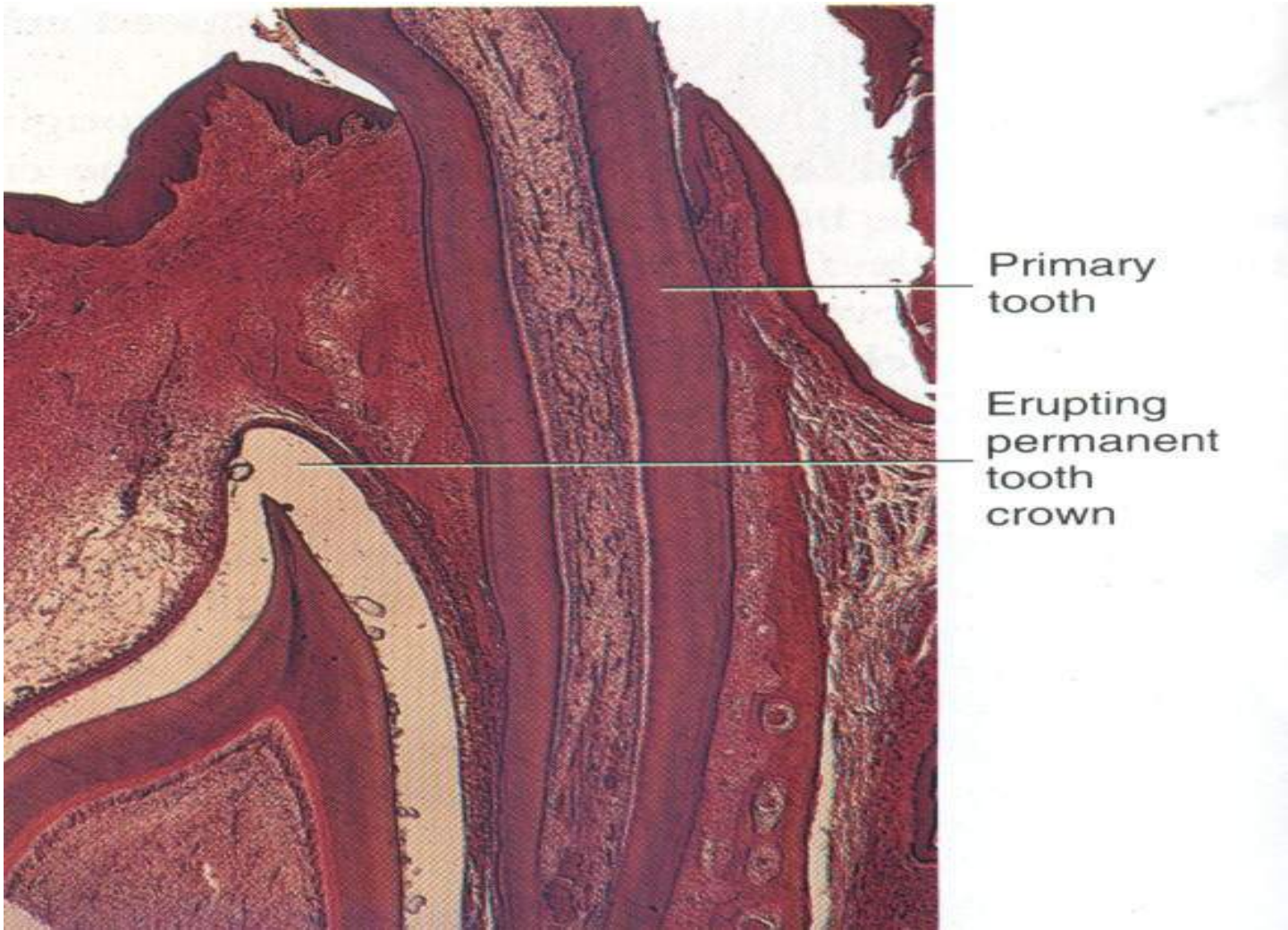
Root resorption and pulp degeneration

- The primary tooth root have a higher susceptibility to resorption than permanent teeth;
- The process of resorption is accompanied by gradual changes in the pulp;
- The first sign is a reduction in the number of cells in the pulp:
  - Nerve trunks degenerate and some fibrosis occurs;
  - Blood vessels remain until the root is exfoliated.

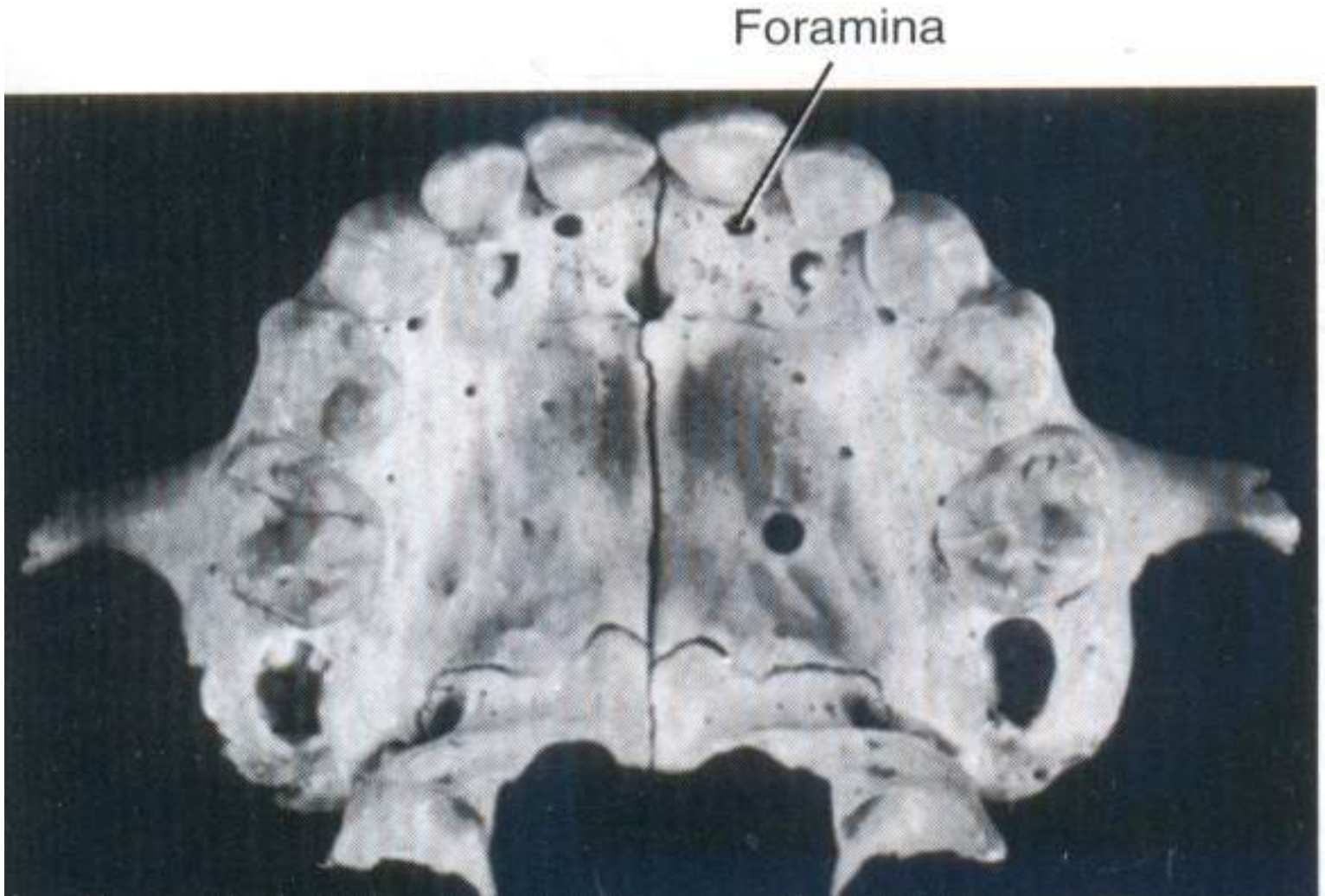
Resorption of incisors and canines

- Permanent dental germs of the incisors and canines are orally to the root of the primary teeth;
- Absorption is bevelled - more advanced orally and with longer preserved vestibular part of the root.

Position of the permanent tooth to the primary root



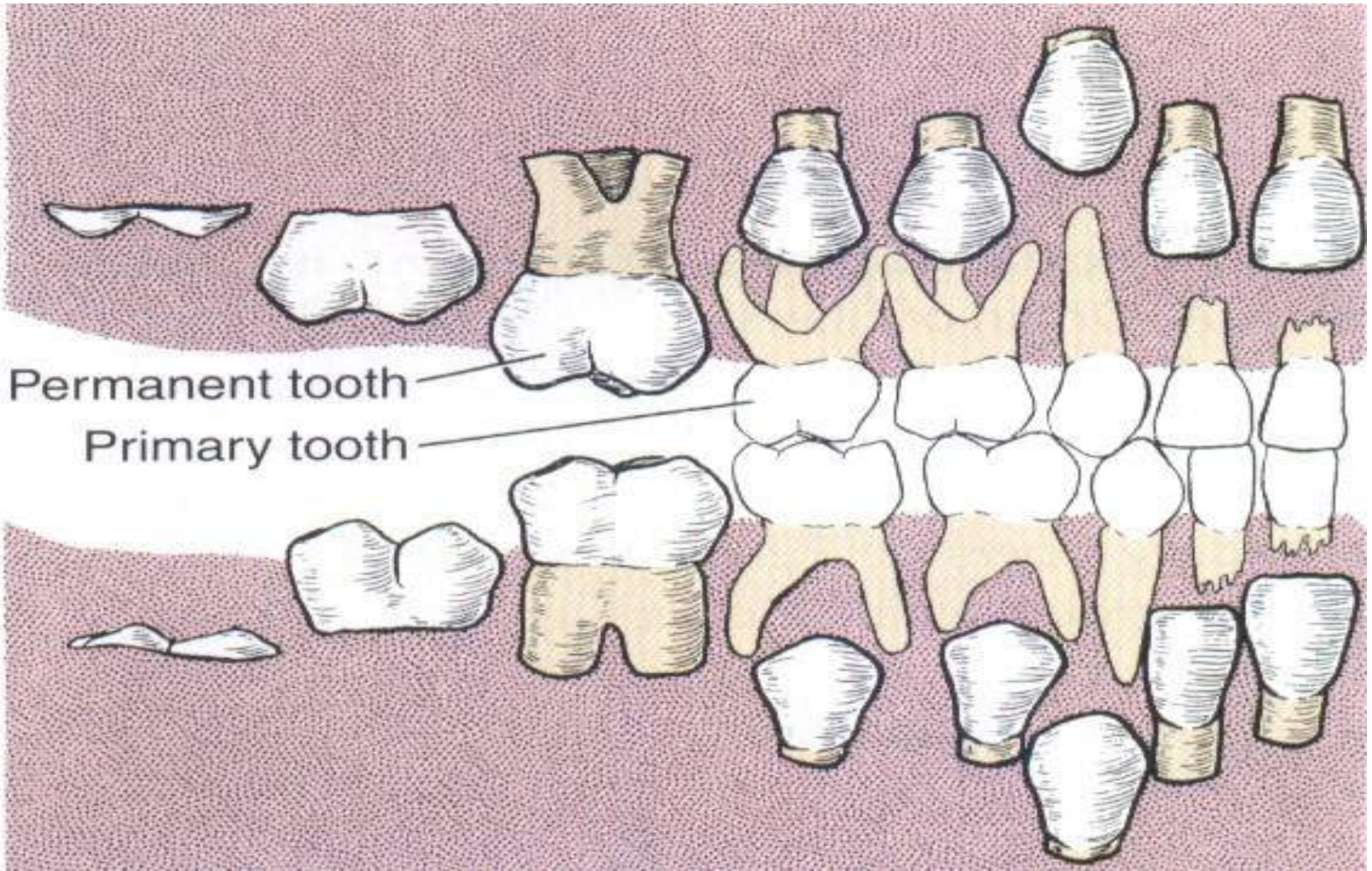
FORAMINA PALATAL to maxillary primary incisors



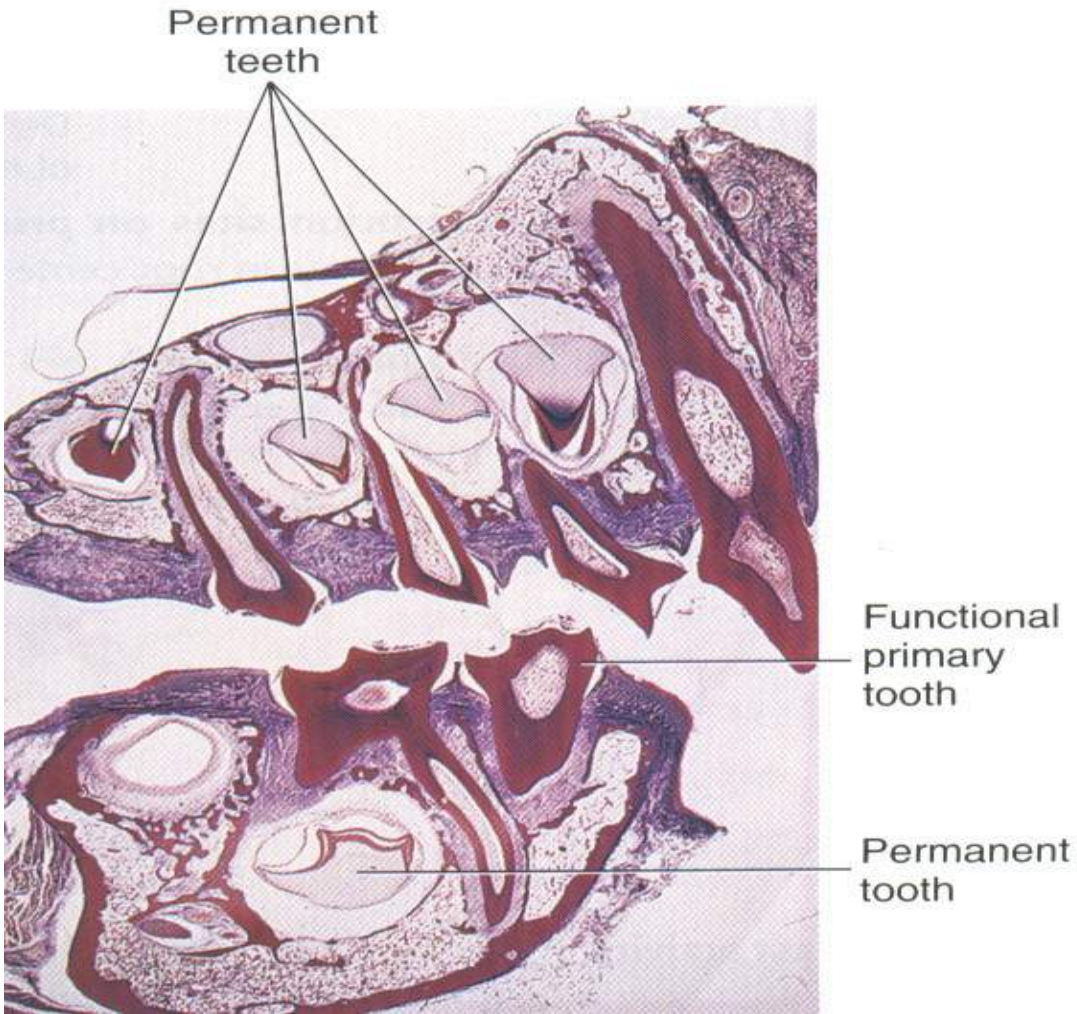
Resorption of the primary molars

- And here the resorption is beveled;
- Resorption takes place between the roots of the primary molars;
- Resorption is more advanced in the distal part of the root;
- Last is absorbed vestibulomedial root.

Shedding



Mixed dentition – the direction of the resorption



The reason for resorption

Eruptional pressure of the permanent tooth;

The cells of the overlying tissues are squeezed by the dental germ;

Metabolism in these cells is changing;

This cells are changing their enzymatic activity;

Constructive cells are transformed into degradative cells.

Basic cells of the resorption

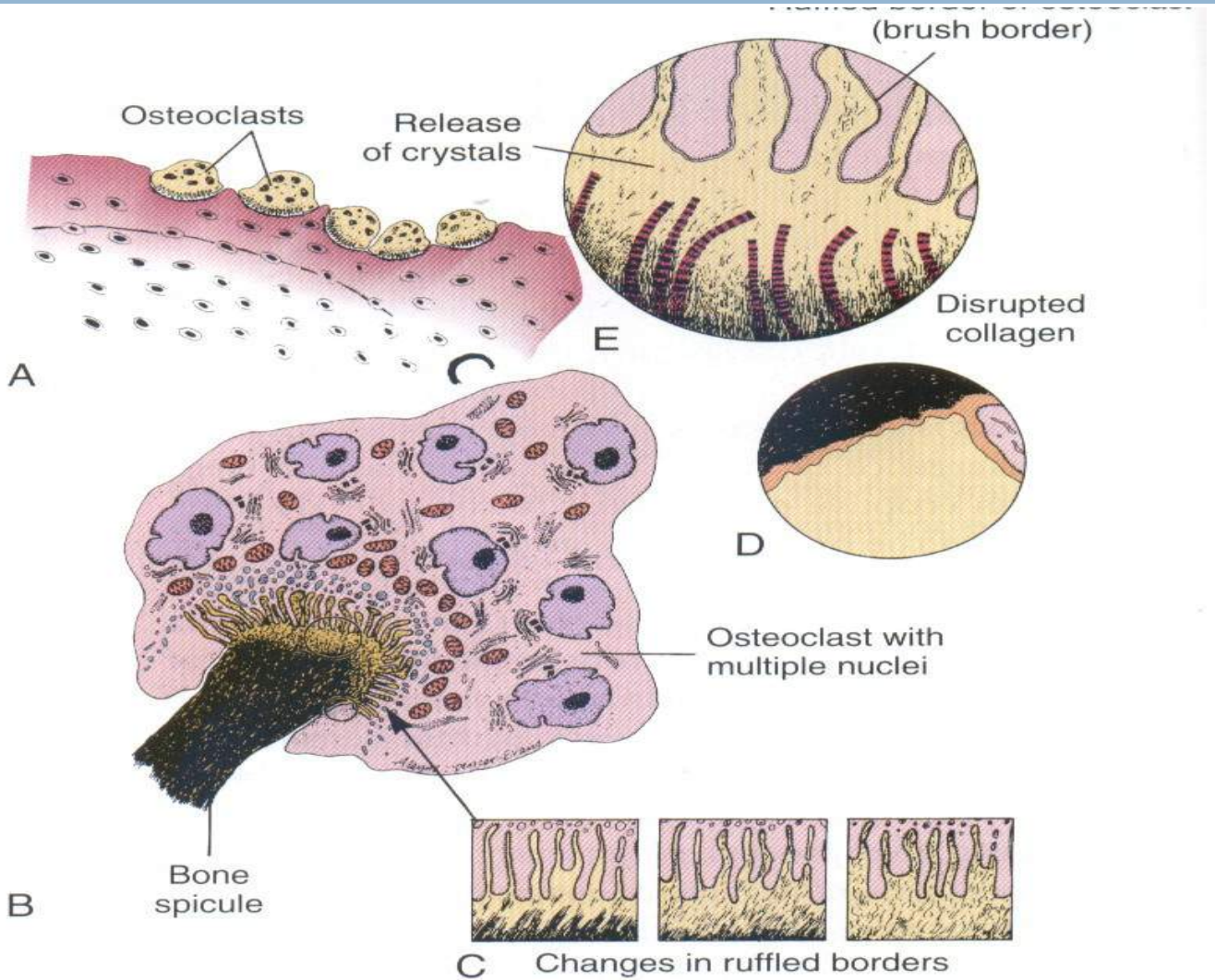
Osteoclasts

- Derived from monocytes
- Derived from osteoblasts
  - They become multinucleated cells
  - First bone separating primary from
    - Then the root of the primary tooth
  - Their function is to resorb hard tissue

Action of osteoclasts

- They secrete hydrolytic enzymes;
- They are separated minerals from the collagen matrix;
- The effect of enzymes is realized within lacunae, which are developed by the osteoclasts;
- The osteoclast`s cell membrane is in contact with the bone and becomes modified by an enfolding process termed the ruffled border;
- This border greatly increases the surface area of the osteoclast and allow the cell to function maximally in bone resorption.

The function of the osteoclasts

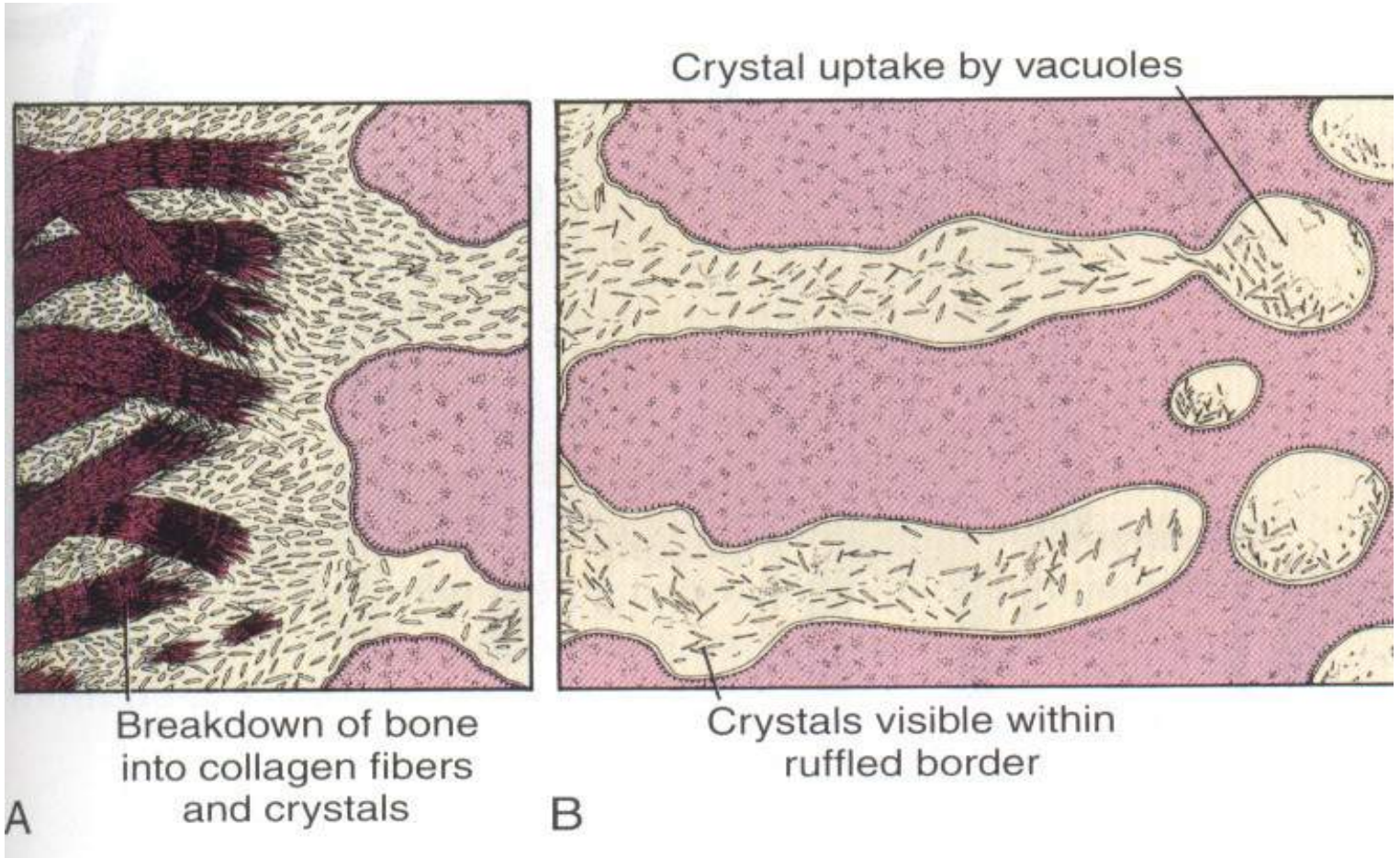


The phases of the resorption

Extracellular phase – in which mineral is separated from collagen and is broken into small fragments;

Intracellular phase – in which the osteoclasts ingests these mineral fragments and continues the dissolution of this mineral.

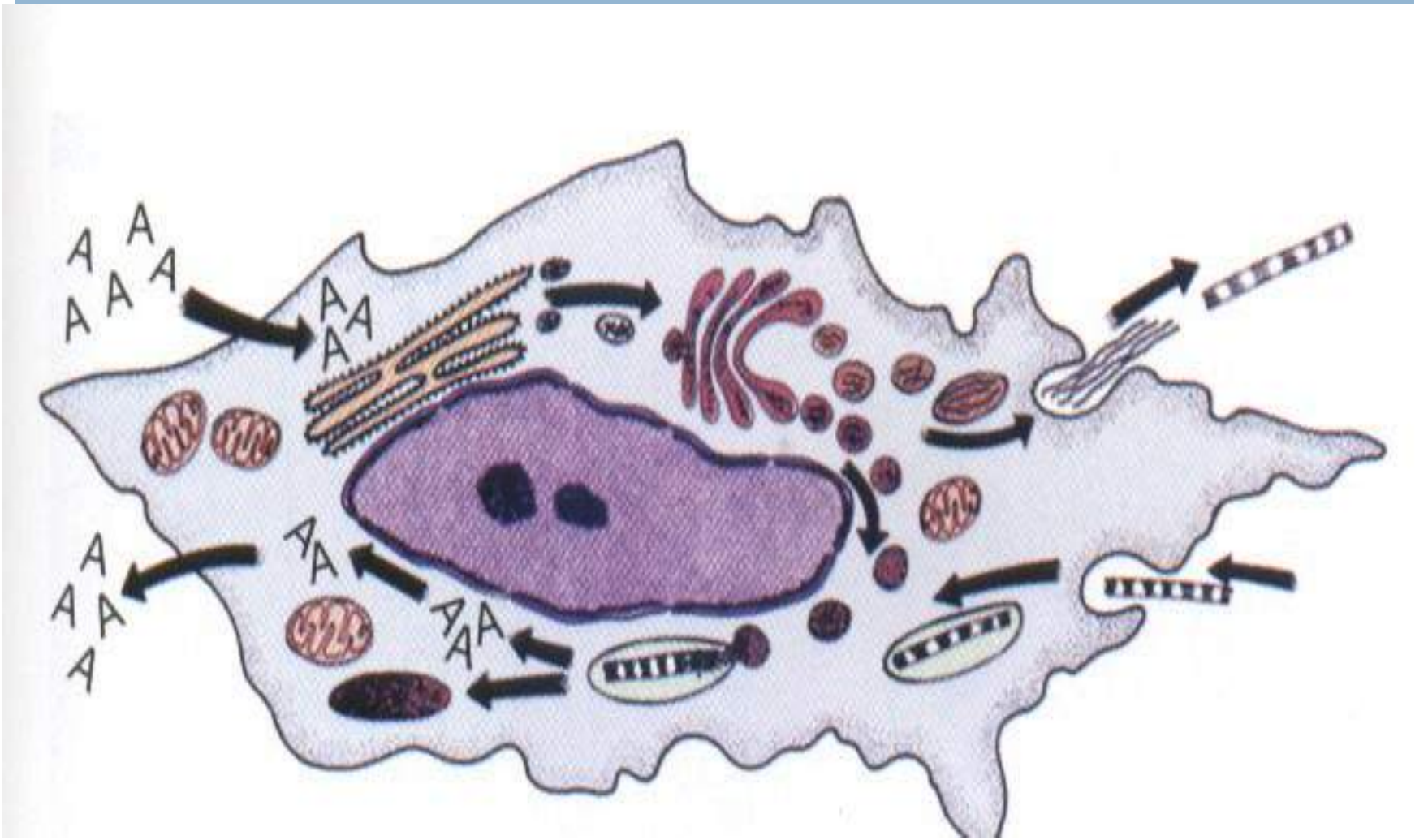
A. Mineral crystals are near the osteoclasts surface;
B. Crystals into osteoclast vacuoles.



Fibroblast-fibroclast

- These special cells are believed to destroy the remaining collagen fibers secondarily by ingesting them in an intracellular phagolysosome system;
- Amino acids resulting from this breakdown are used in the formation of collagen within this same cell and can be used in this same area for bone formation.

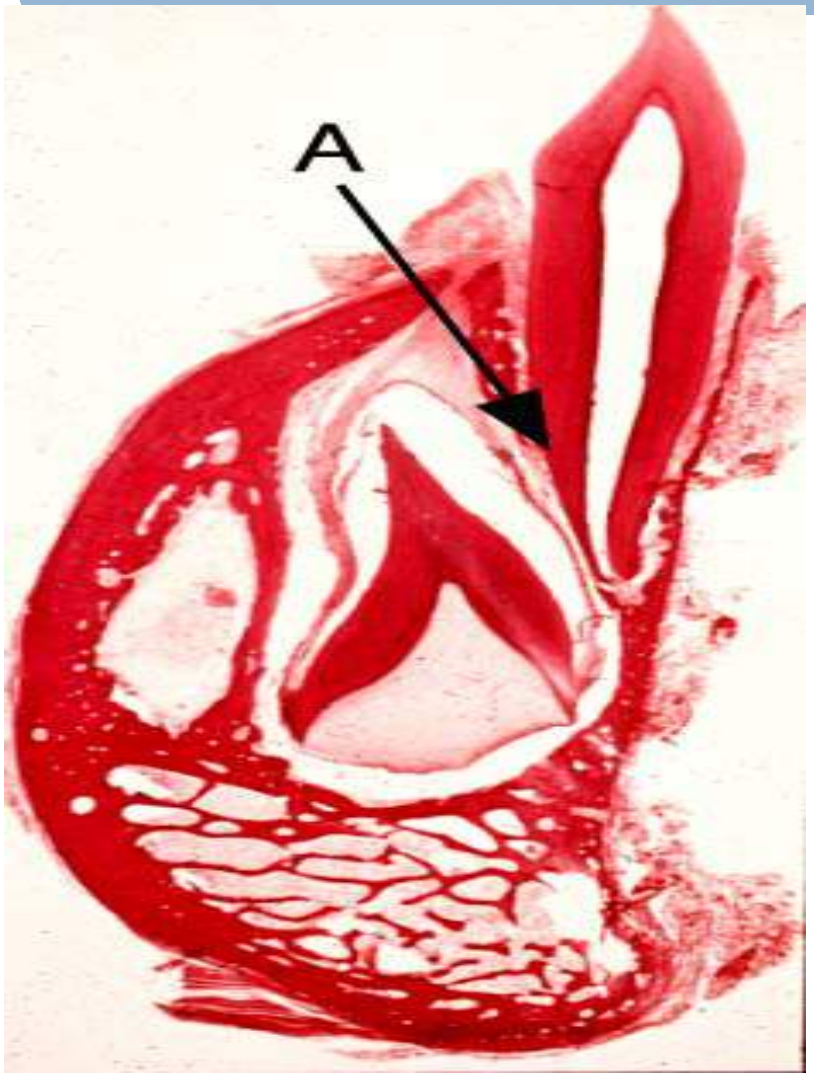
Fibroblast-fibroclast



First stage of resorption

- Resorbing bone plate between the root of the primary tooth and the permanent tooth follicle germ.

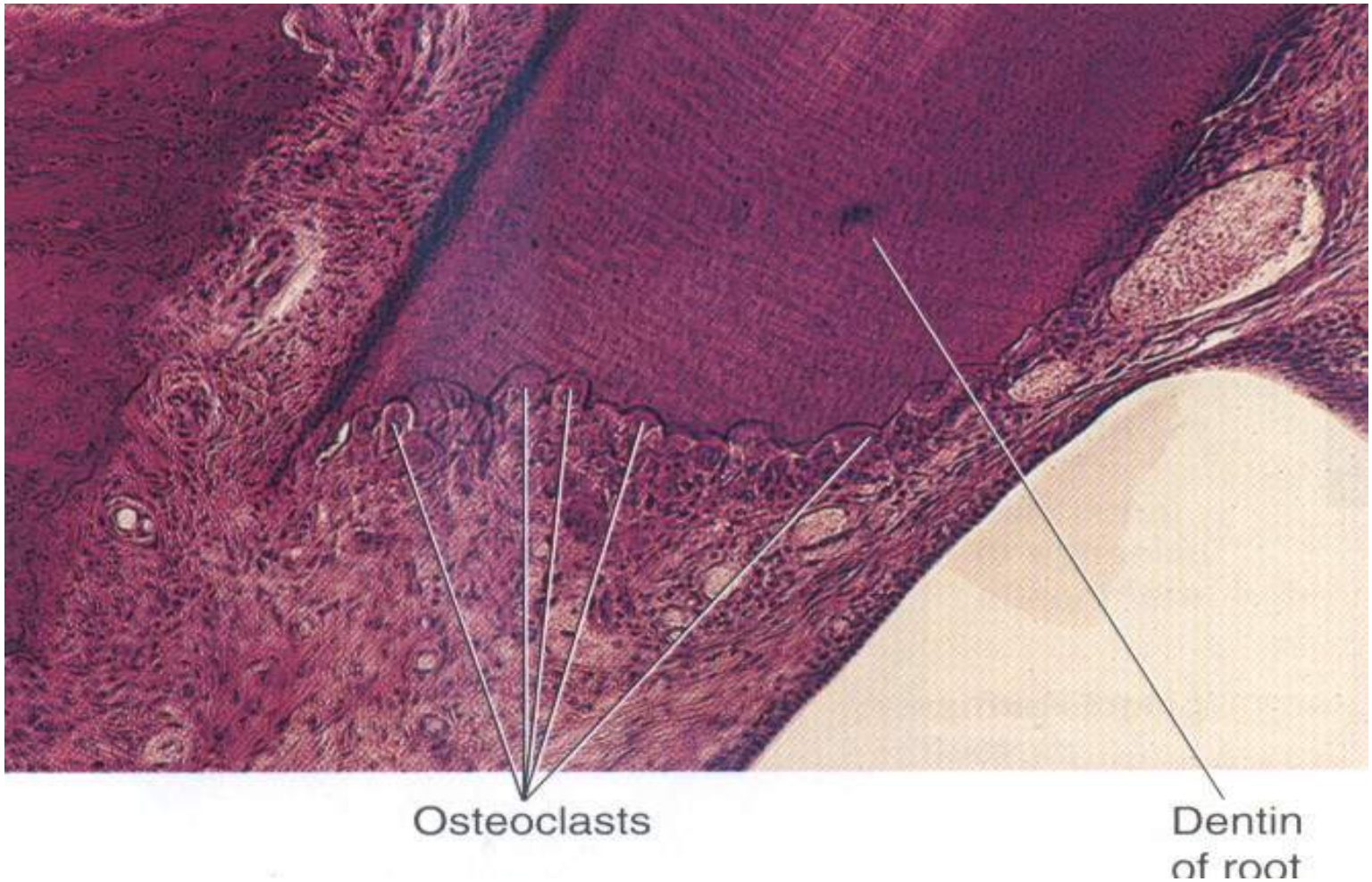
Second stage of the resorption



- Begin resorption of cement and dentin of the root of the primary molars.

Third stage of dentine resorption in its inner part by the pulp

Active resorption sites on primary tooth roots



Resorptive organ

An inner layer - made up of osteoclasts located at the root of the primary tooth;

Intermediate layer with infiltration of small cells;

Outer layer - granulation:

Contains blood capillaries and thin fibers.

Resorptive organ - laeyers

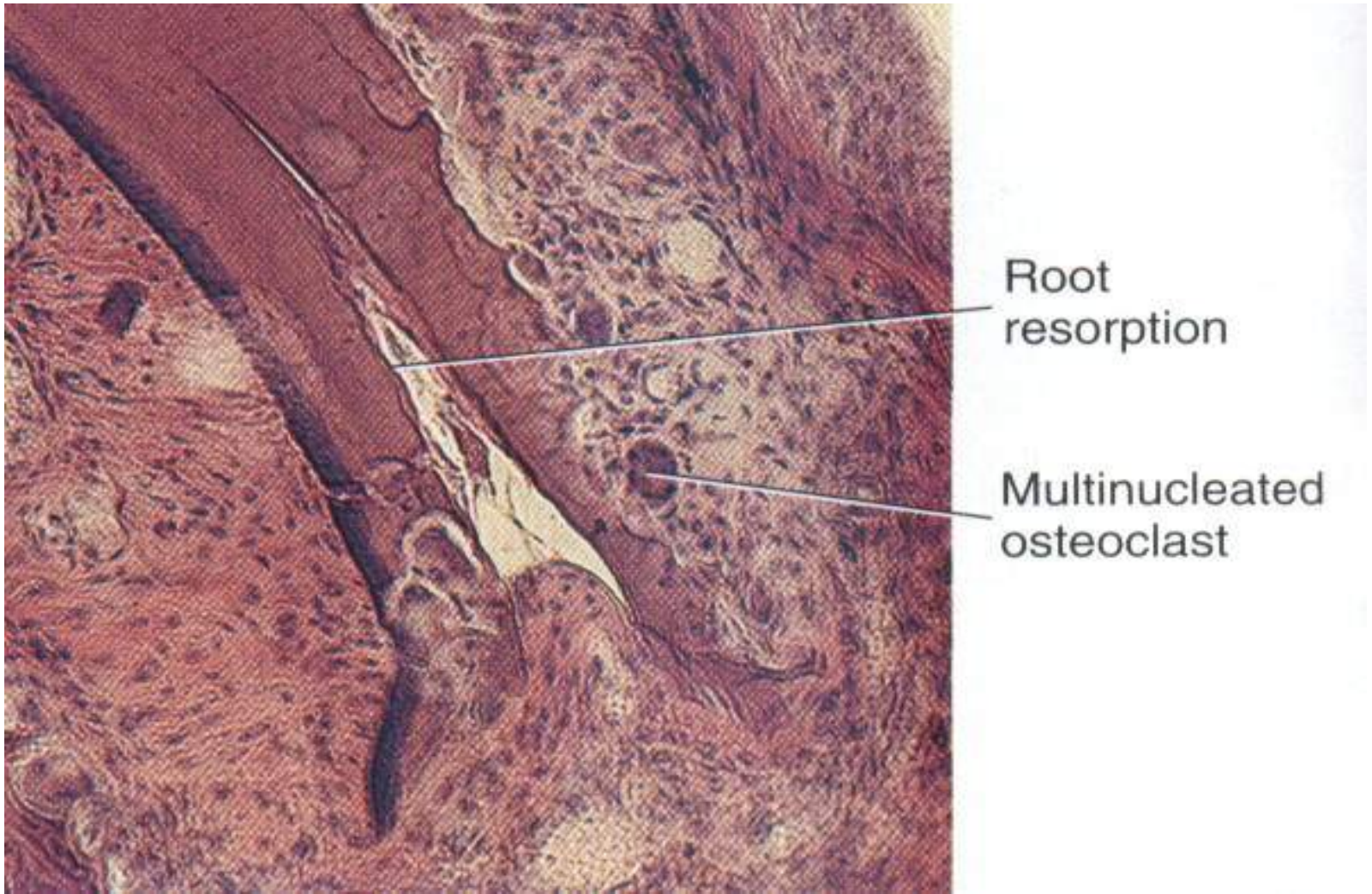


TABLE 6-1 CHRONOLOGY OF DEVELOPMENT OF THE PRIMARY DENTITION*

Primary teeth listed in order of eruption (sequence)	Beginning calcification (Mo in utero)	Crown completed postnatally (Mo)	Appearance in the oral cavity (eruption time) (Mo)	Root completed (Yr)
Lower central incisor	3-4	2-3	6-8	1-2
Upper central incisor	3-4	2	7-10	1-2
Upper lateral incisor	4	2-3	8-11	2
Lower lateral incisor	4	3	8-13	1-2
Upper first molar	4	6	12-15	2-3
Lower first molar	4	6	12-16	2-3
Upper canine	4-5	9	16-19	3
Lower canine	4-5	9	17-20	3
Lower second molar	5	10	20-26	3
Upper second molar	5	11	25-28	3

TABLE 6-2 CHRONOLOGY OF DEVELOPMENT OF THE PERMANENT DENTITION

Permanent teeth listed in order of eruption (sequence)	Beginning calcification	Crown completed (Yr)	Appearance in the oral cavity (eruption time) (Yr)	Root completed (Yr)
Lower first molar	Birth	3–4	6–7	9–10
Upper first molar	Birth	4–5	6–7	9–10
Lower central incisor	3–4 mo	4	6–7	9
Upper central incisor	3–4 mo	4–5	7–8	10
Lower lateral incisor	3–4 mo	4–5	7–8	9–10
Upper lateral incisor	10–12 mo	4–5	8–9	10–11
Lower canine	4–5 mo	5–6	9–10	12–13
Upper first premolar	1–2 yr	6–7	10–11	12–14
Lower first premolar	1–2 yr	6–7	10–11	12–14
Upper second premolar	2–3 yr	7–8	10–12	13–14
Lower second premolar	2–3 yr	7	11–12	14–15
Upper canine	4–5 mo	6–7	11–12	14–15
Lower second molar	2–3 yr	7–8	11–12	14–15
Upper second molar	2–3 yr	7–8	12–13	15–16
Lower third molar	8–10 yr	12–16	17–20	18–25
Upper third molar	7–9 yr	12–16	18–20	18–25

tooth	Dental bud (weeks in utero)	Beginning Of calcification (Mo in utero)	Crown comple-ted (Mo)	Erup-tion (Mo)	Root completed (Years)	Resorption (years)
i1	7	4	2	6-8	within two years after eruption	1-2 years After crown compl.
i2	7	4,5	4	8-12		
m1	8	5	6	12-16		
c	7,5	5	9	16-20		
m2	10	6	12	20-30		

tooth	Dental bud	Beginning Of calcification	Crown completed (years)	Eruption (years	Root completed (Years)
M_1	4 Mo in ut	9 Mo in ut	3	6	3 -4 years After erup-tion
I_1	5 Mo in ut	4 Mo	4	6	
I_2	5 Mo in ut	6 Mo	4	7	
Pm_1	birth	2,5 years	6	8	
C	4 Mo in ut	6 Mo	7	9	
Pm_2	8 Mo	2,5 years	7	10	
M_2	9 Mo	5 years	8	11	