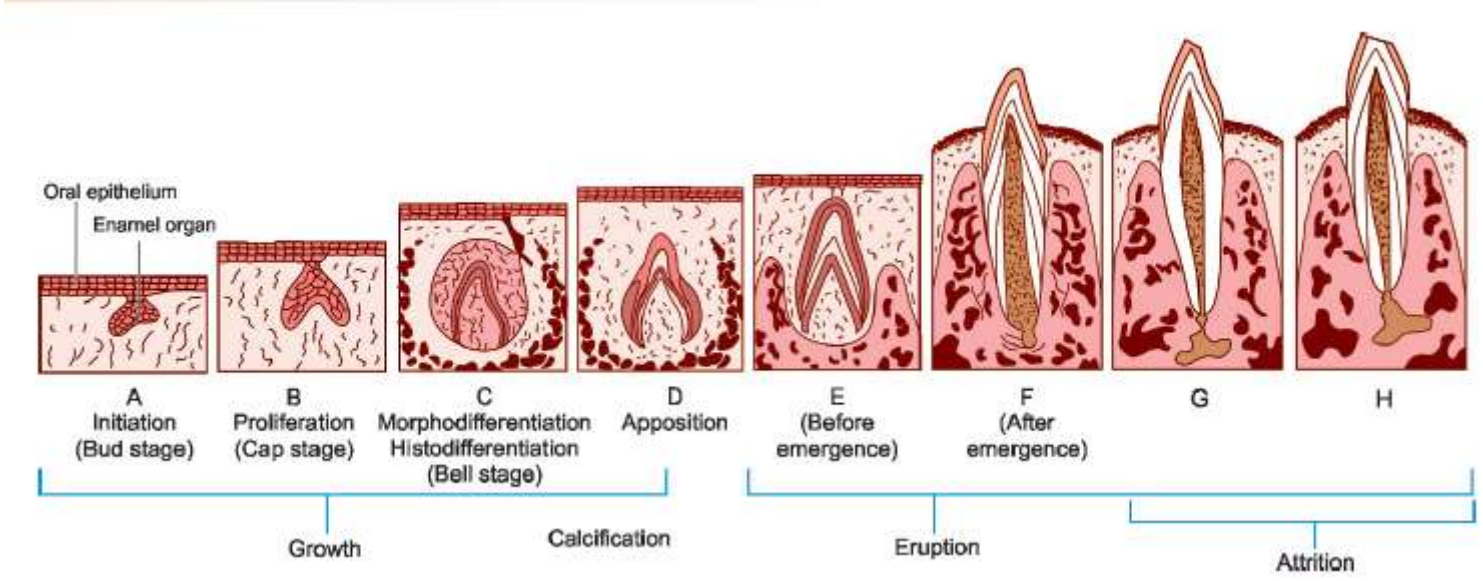
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Tooth development

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Lec 6

DEVELOPMENTAL or morphological STAGES

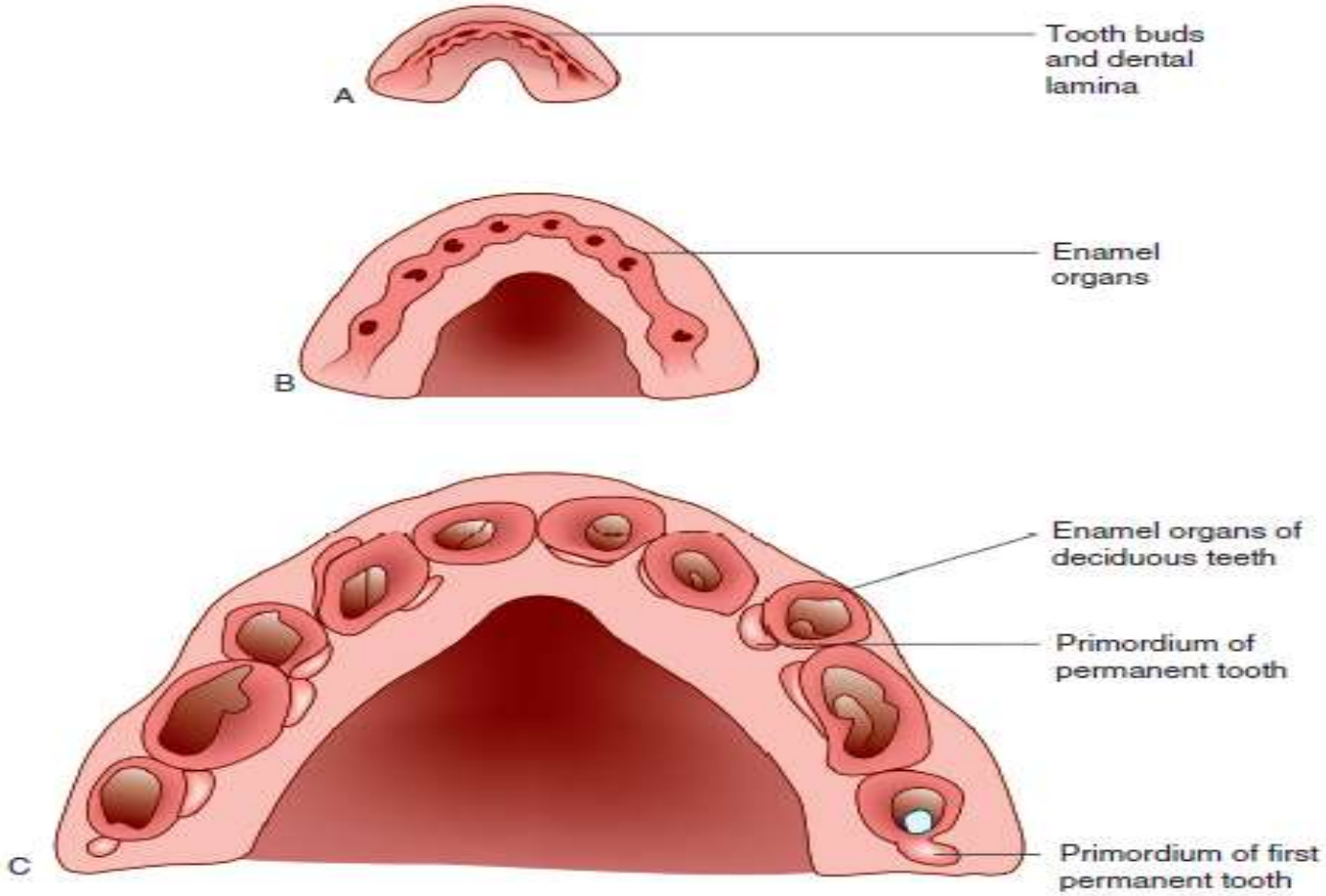
Although tooth development is a continuous process, the developmental history of a tooth is divided into several morphologic ‘stages’ for descriptive purposes. While the size and shape of individual teeth are different, they pass through similar stages of development. They are named according to the shape of the enamel organ and are called the bud, cap, and bell stages


Oral epithelium
Enamel organ
A
Initiation
(Bud stage)
B
Proliferation
(Cap stage)
C
Morphodifferentiation
Histodifferentiation
(Bell stage)
D
Apposition
E
(Before
emergence)
F
(After
emergence)
G
H
Growth
Calcification
Eruption
Attrition

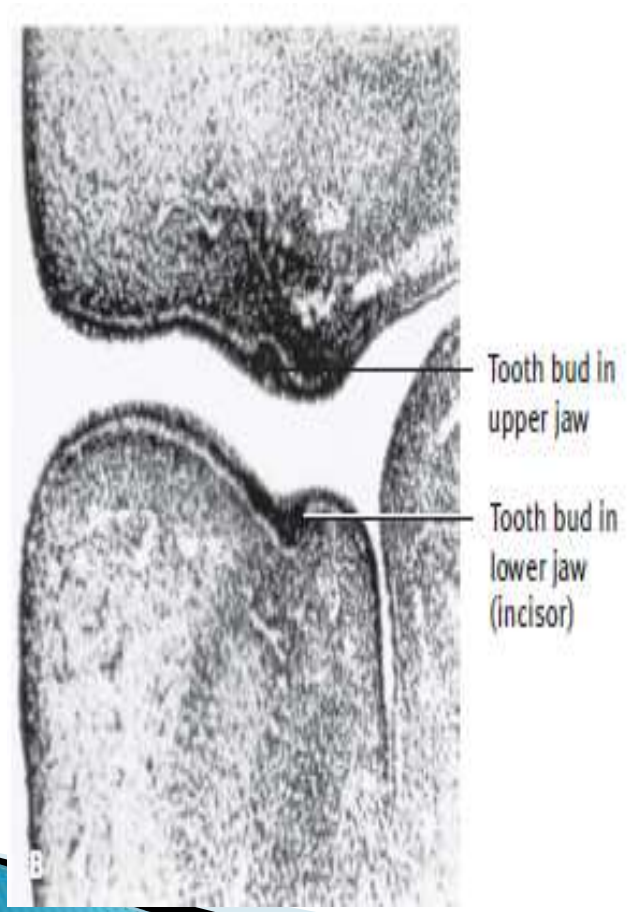
Bud stage

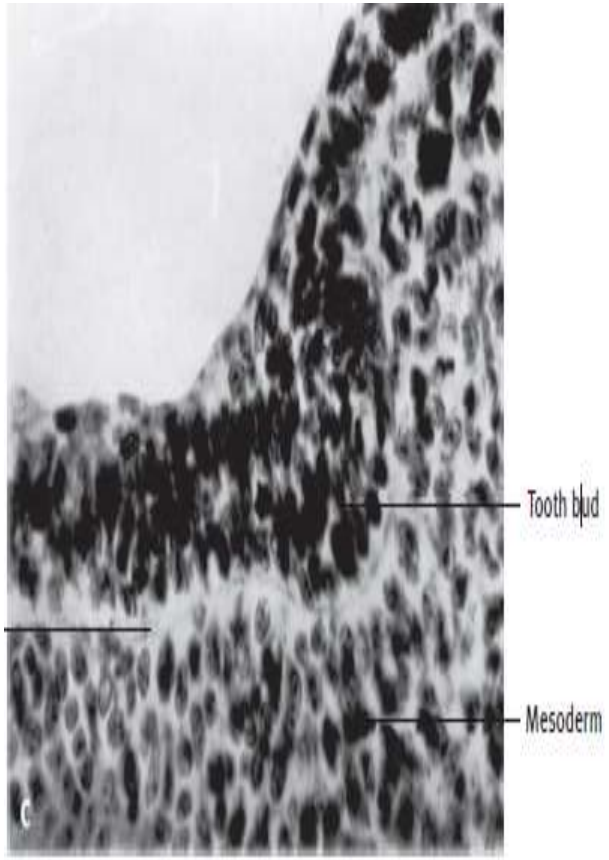
Round or ovoid swellings at ten different points arise from dental lamina in each jaw, corresponding to the future position of deciduous teeth.

They are the primordial of *enamel organs* , thus the development of the tooth germ is initiated, proliferation of cells is still faster than adjacent ectomesenchymal cells. These epith. condensation is poorly morphodifferentiated and histodifferentiated in development.


A
Tooth buds and dental lamina
B
Enamel organs
C
Enamel organs of deciduous teeth
Primordium of permanent tooth
Primordium of first permanent tooth

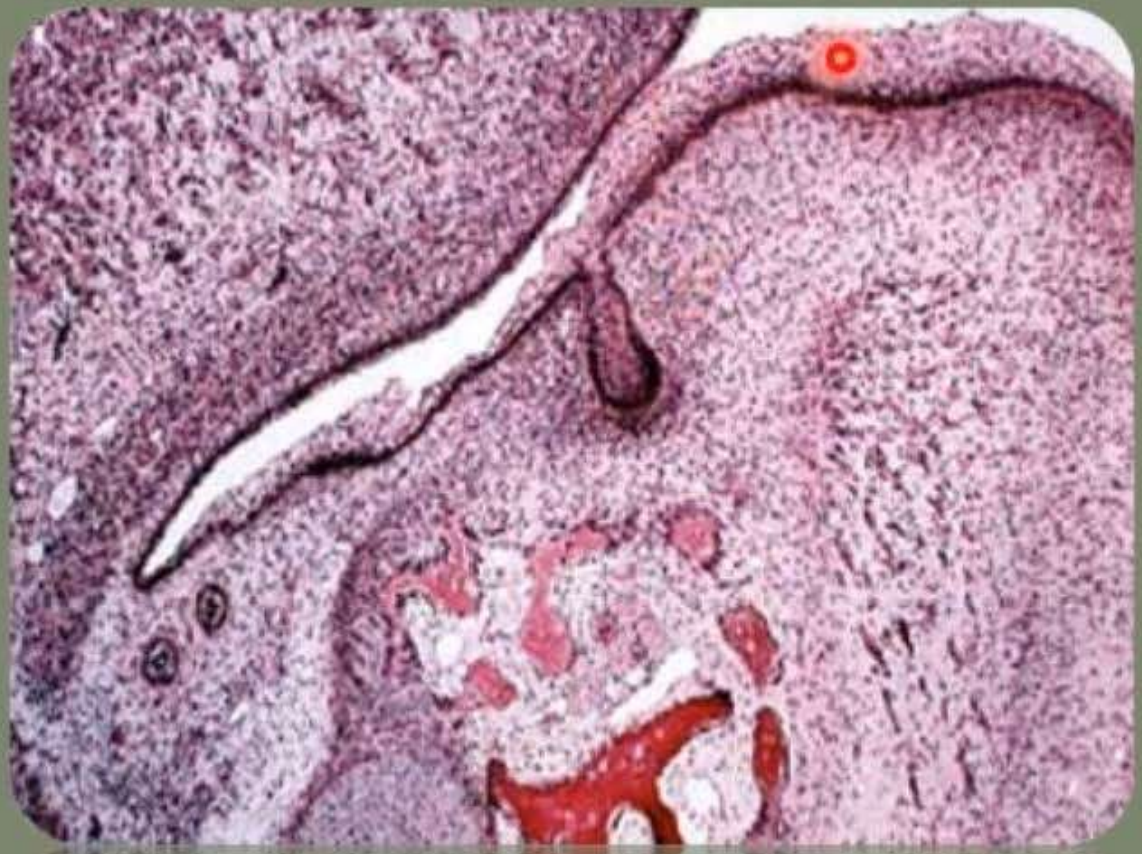
Bud stage


Tooth bud in upper jaw
Tooth bud in lower jaw (incisor)

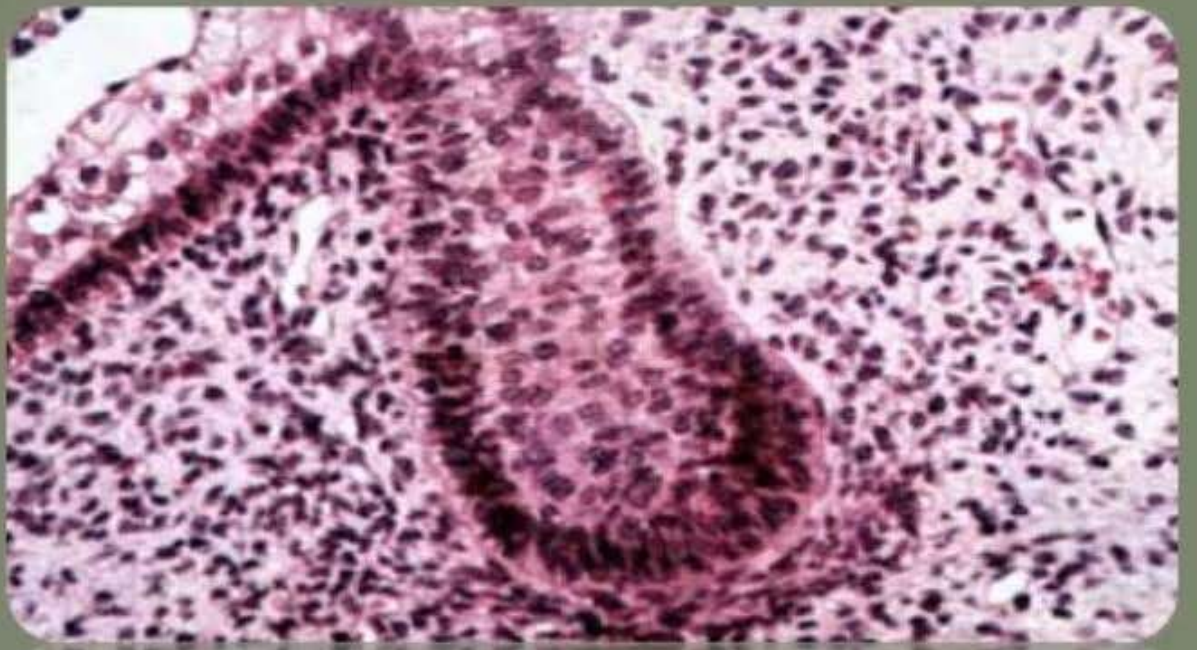

Tooth bud
Mesoderm

Enamel organ histology in this stage consist of peripherally located low columnar cells and centrally located polygonal cells.

The enamel organ is separated from the adjacent ectomesenchyme by *basement membrane*. Many cells of the tooth bud and the surrounding mesenchyme undergo mitosis. As a result of the increased mitotic activity and the migration of neural crest cells into the area the ectomesenchymal cells surrounding the tooth bud condense.

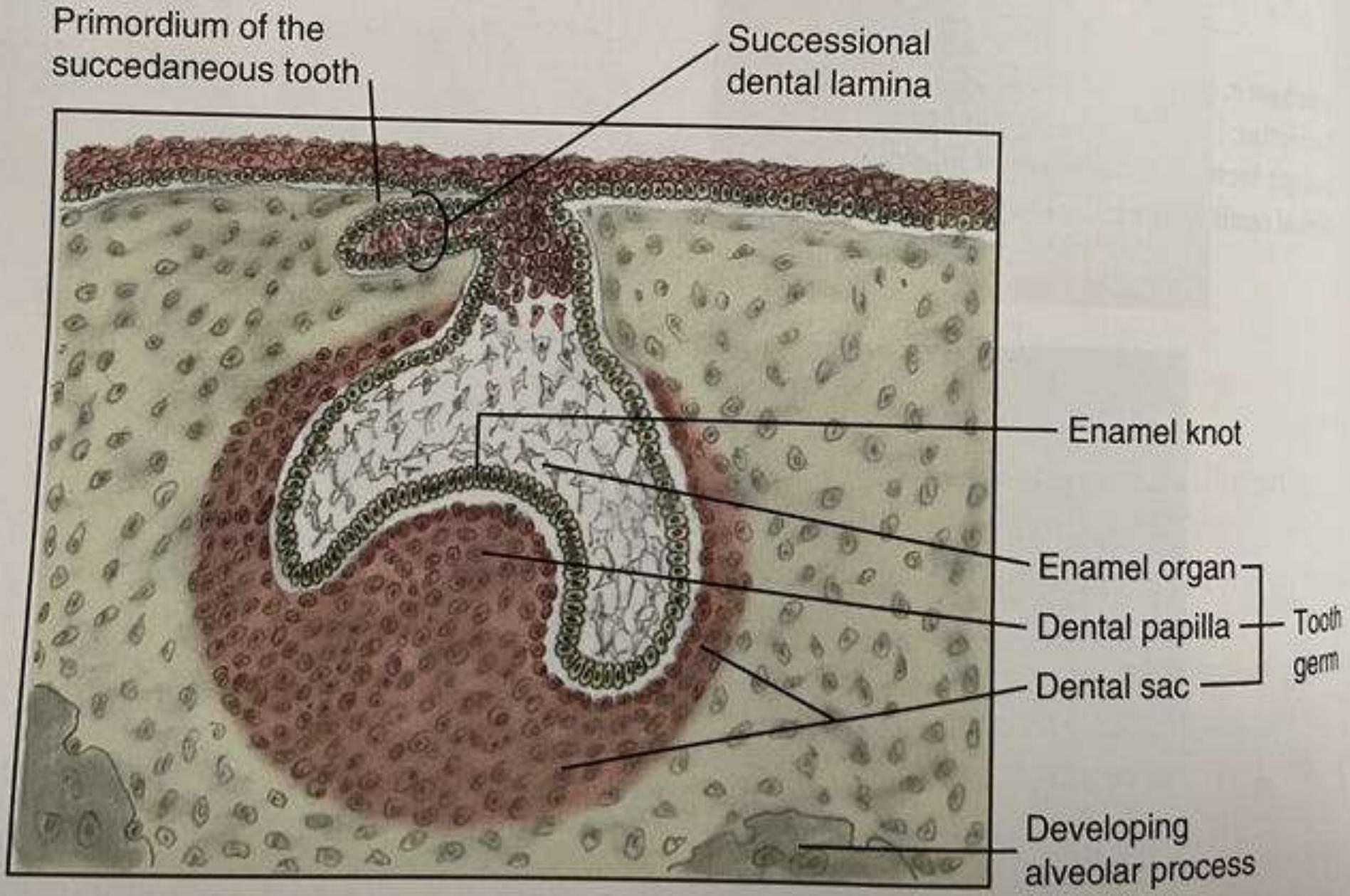


Bud stage: is characterized by rounded, localized growth of epithelium surrounded by proliferating mesenchymal cells, which are packed closely beneath and around the epithelial buds



In the bud stage, the enamel organ consists of peripherally located
low columnar cells and centrally located polygonal cells

- . The area of ectomesenchymal condensation immediately subjacent to the enamel organ is the dental papilla.
- The condensed ectomesenchyme that surrounds the tooth bud and the dental papilla is the dental sac. Both the dental papilla and the dental sac become more well defined as the enamel organ grows into the cap and bell shapes


Primordium of the succedaneous tooth
Successional dental lamina
Enamel knot
Enamel organ
Dental papilla
Dental sac
Tooth germ
Developing alveolar process

Dental papilla

Under the proliferating epithelium of the enamel organ, the ectomesenchyme (neural crest cells) that is partially enclosed by the invaginated portion of the inner enamel epithelium proliferates. It condenses to form the dental papilla, which is the formative organ of the dentin and the primordium of the pulp .

The peripheral cells of dental papilla adjacent to the inner enamel epithelium enlarge and later differentiate into the odontoblasts and undefferencieted fibroblasts .

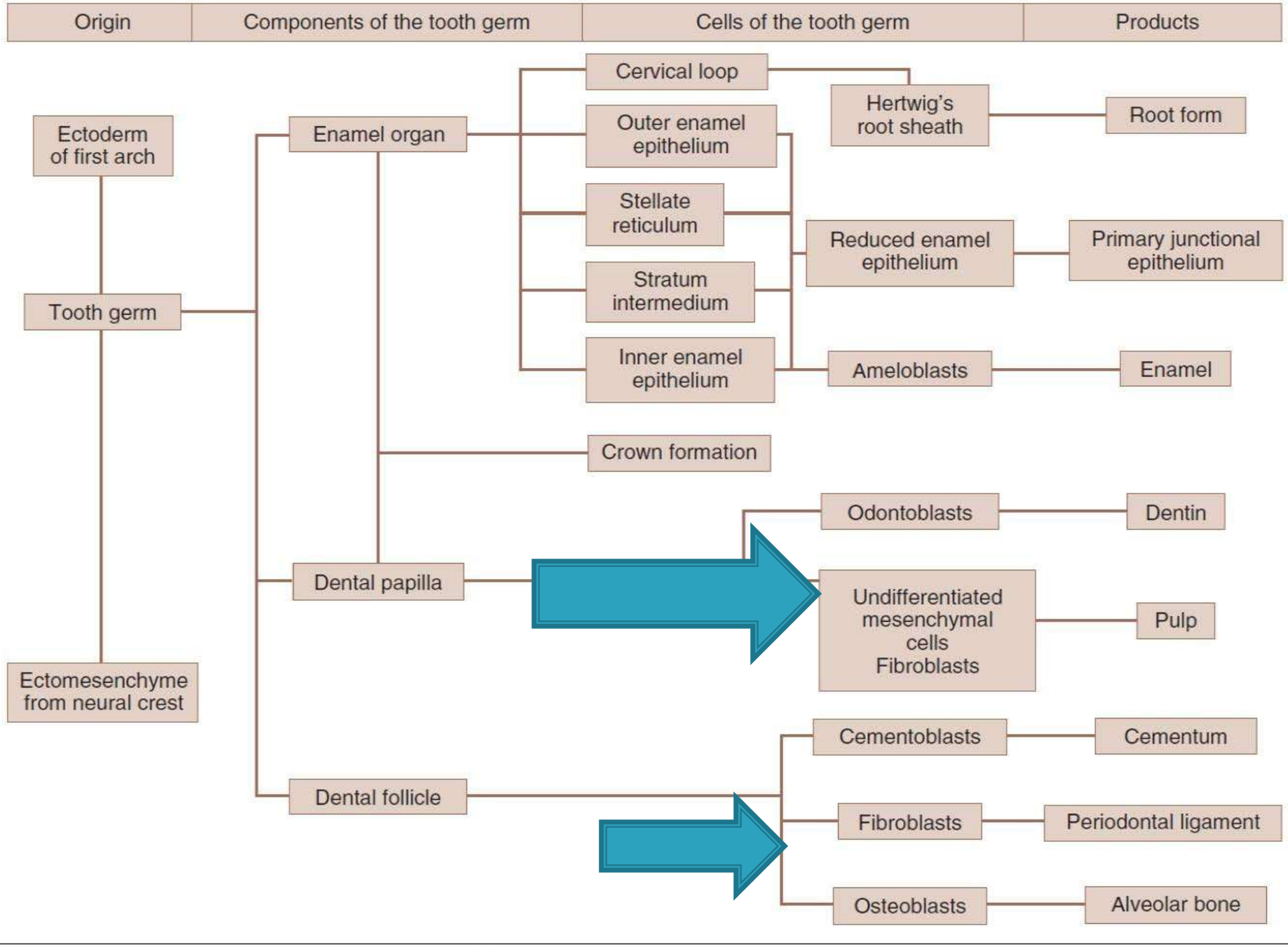
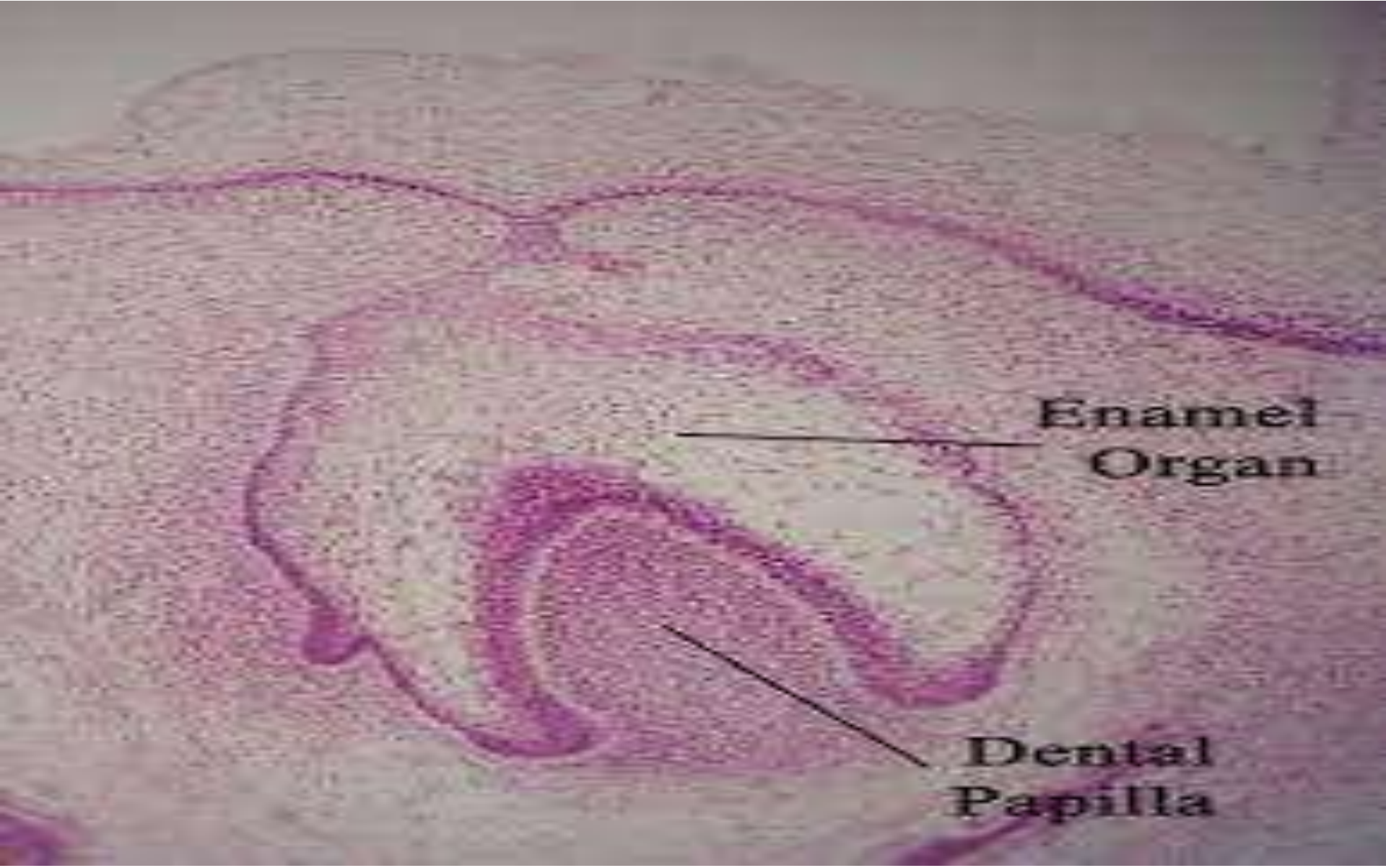
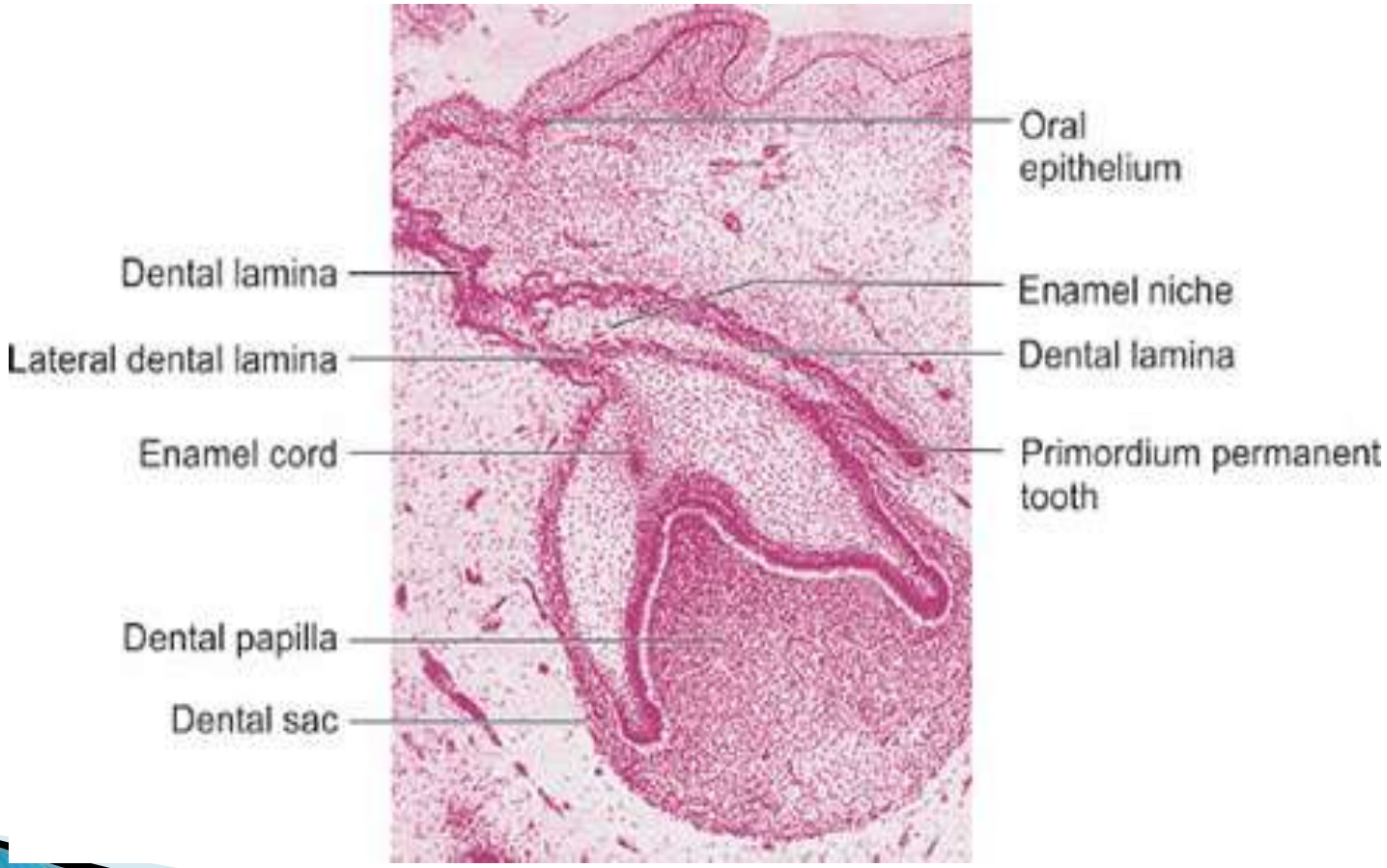


FIGURE 5-35 Summary of tooth formation.


Enamel
Organ
Dental
Papilla

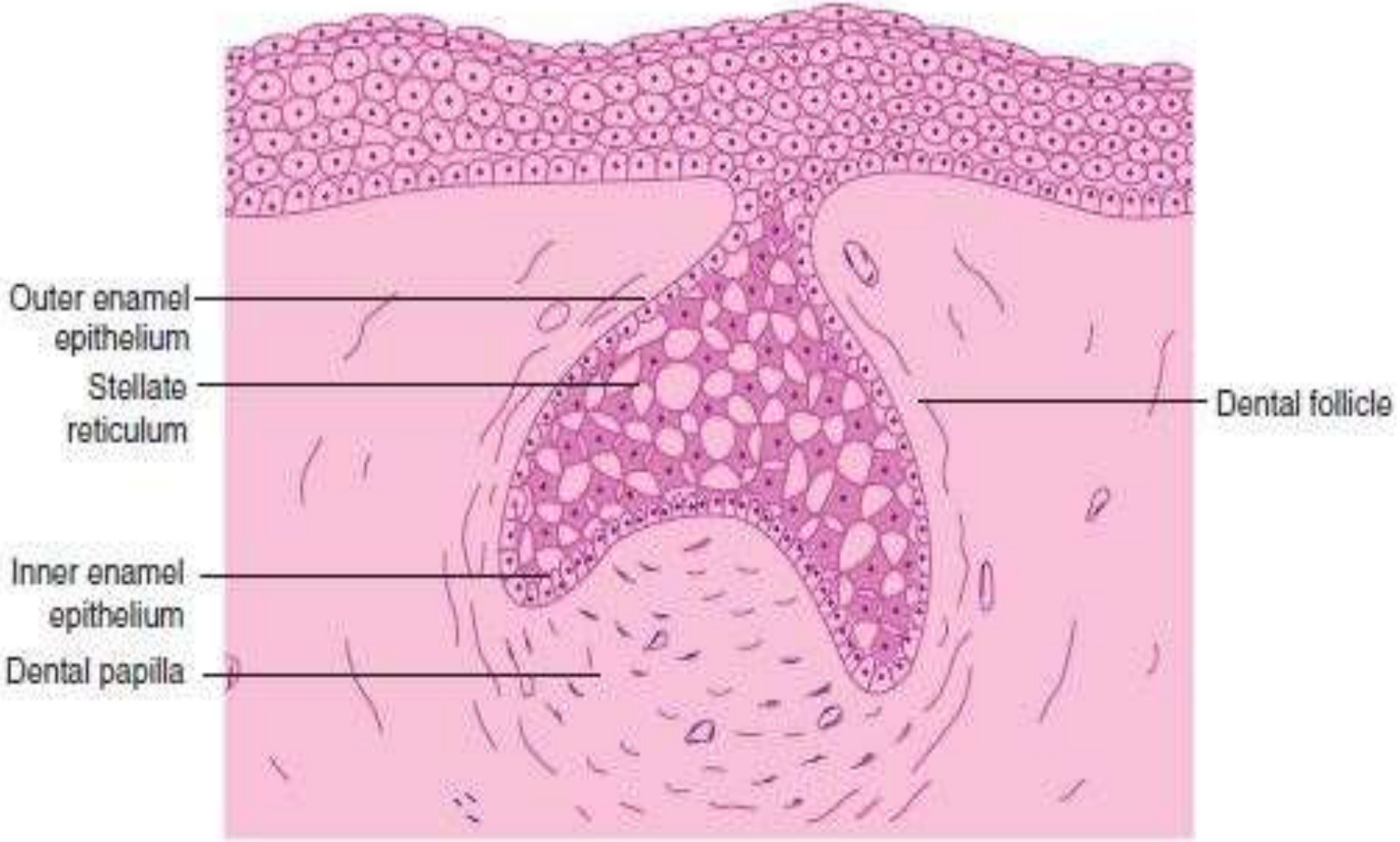
Dental sac (dental follicle)

Concomitant with the development of the enamel organ and the dental papilla, there is a marginal condensation in the ectomesenchyme surrounding the enamel organ and dental papilla. Gradually, in this zone, a denser and more fibrous layer develops, which is the primitive dental sac to form the cementoblasts , fibroblasts and osteoblasts.

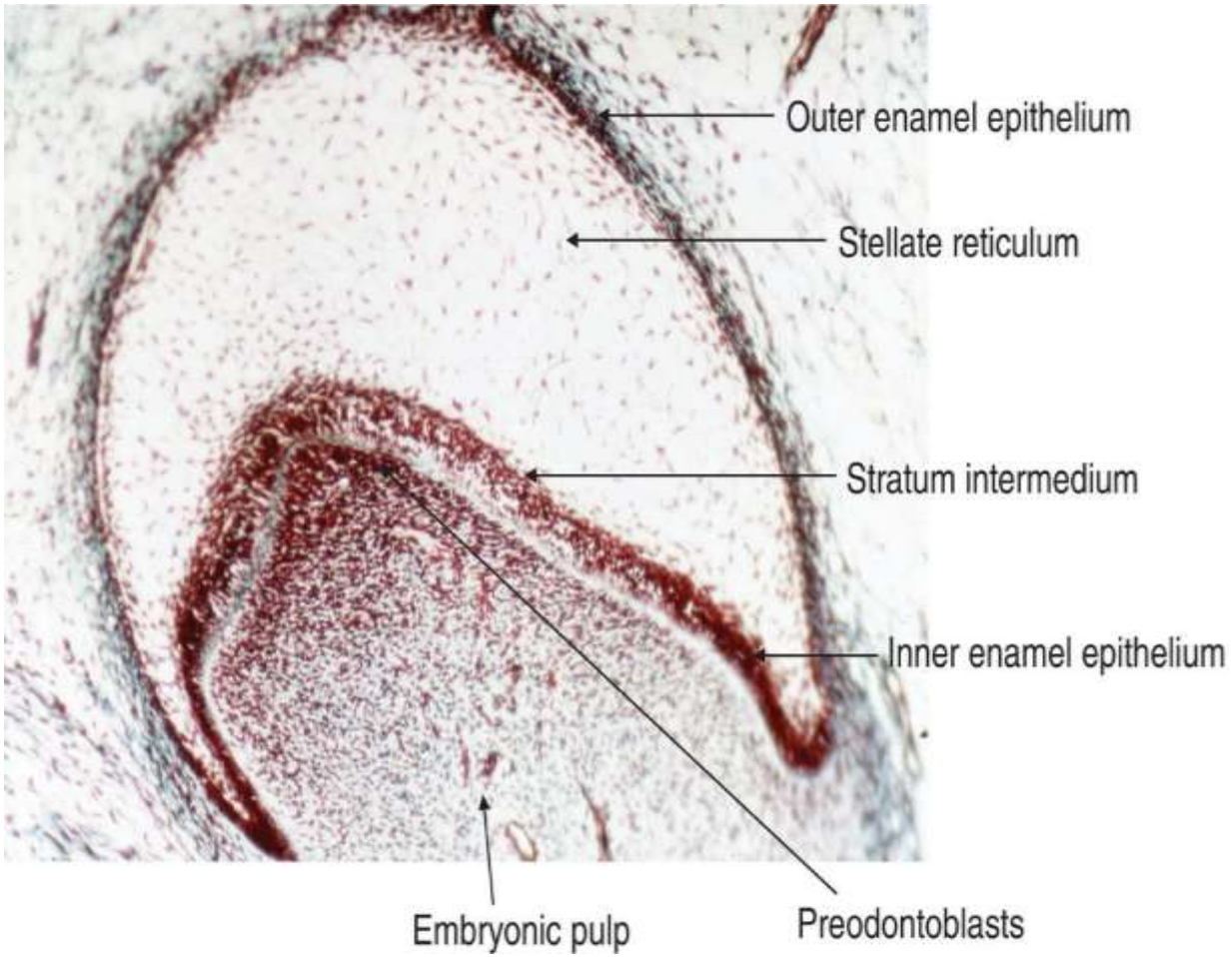

Oral epithelium
Dental lamina
Enamel niche
Lateral dental lamina
Dental lamina
Enamel cord
Primordium permanent tooth
Dental papilla
Dental sac

Cap stage

As the epith. bud continues to proliferate into the ectomesenchyme, morphogenesis has progressed, the deeper surface of the enamel organ invaginating to form a cap-shaped structure. Although, enamel organ appearing relatively poorly histodifferentiated, a greater part develops between the more rounded cells in the central portion of the enamel organ and the peripheral cells which are becoming arranged to form the outer and inner dental epith.


Outer enamel epithelium
Stellate reticulum
Inner enamel epithelium
Dental papilla
Dental follicle

In the late cap stage of tooth development, the central cells of the enlarging enamel organ have become separated , The resulting tissue is termed the stellate reticulum, although it is not fully developed until the late bell stage. The cells of the outer enamel epith. remain cuboidal, where as those of inner enemal epith. become more columnar and show an increase in RNA content, and hydrolytic and oxidative enzyme activity.


Outer enamel epithelium
Stellate reticulum
Stratum intermedium
Inner enamel epithelium
Embryonic pulp
Preodontoblasts

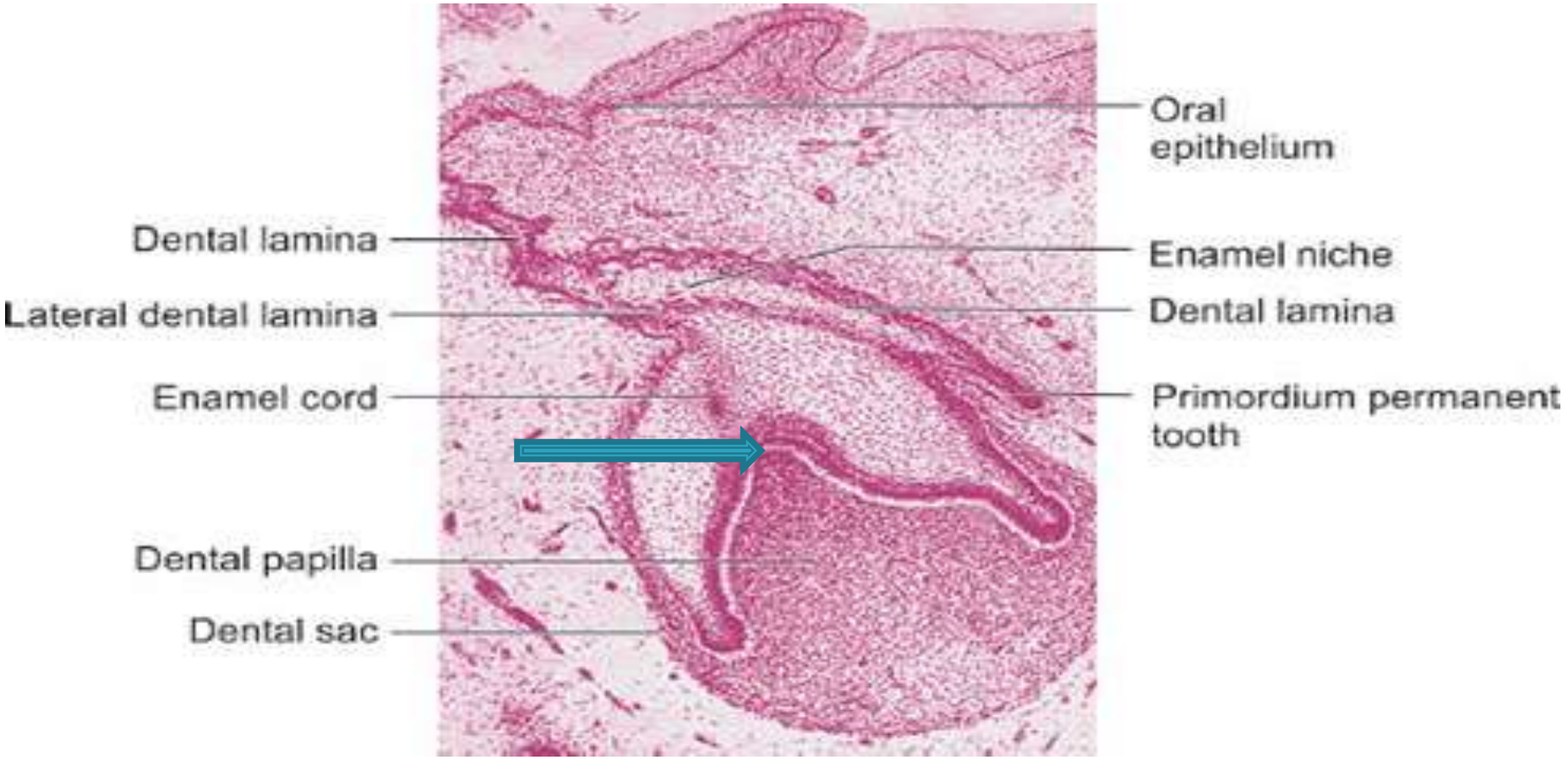
Transitory structures:

During the early stages of tooth development, three transitory structures may be seen, which are E. knot, E. cord and E.niche.

1- **Enamel knot**: It's a localized mass of cells in the center of the inner E. epith. Once thought that E. knote played a role in the formation of crown pattern by outlying the central fissure.

2- **Enamel cord**: It's a strand of early bell stage of development. It arises in the increasingly high enamel organ as a vertical extension of the E. knot.

3- **Enamel niche**: Its an apparent structure in the histologic section, created because the dental lamina is a sheet rather than a single strand


Oral epithelium
Dental lamina
Enamel niche
Lateral dental lamina
Dental lamina
Enamel cord
Primordium permanent tooth
Dental papilla
Dental sac

Bell stage

- The bell stage is known for the histodifferentiation and morphodifferentiation that takes place. The dental organ is bell-shaped during this stage, and the majority of its cells are called stellate reticulum because of their star-shaped appearance.
- The bell stage is divided into the *early bell stage* and the *late bell stage* .

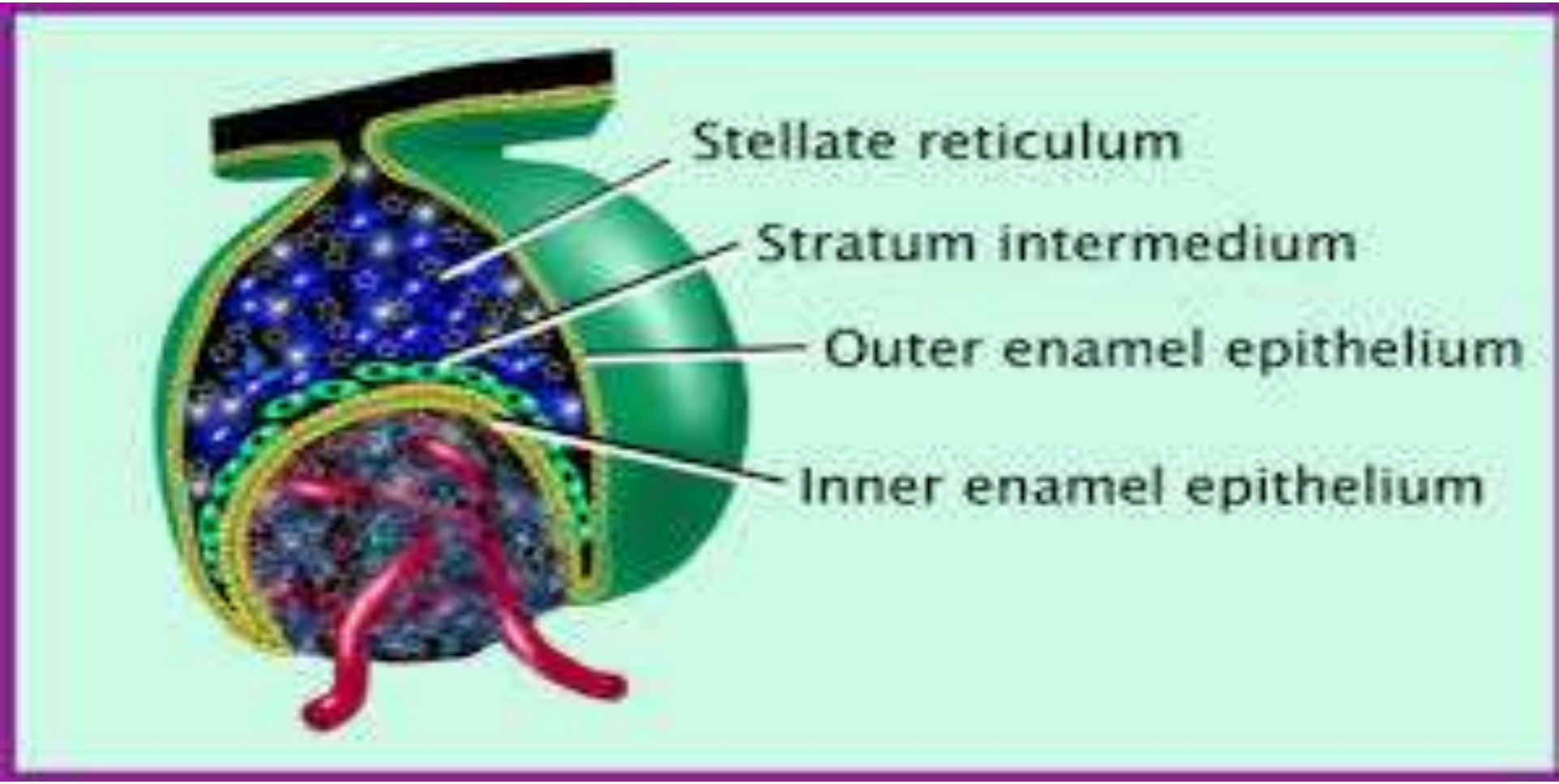
Characteristic features of bell stage:

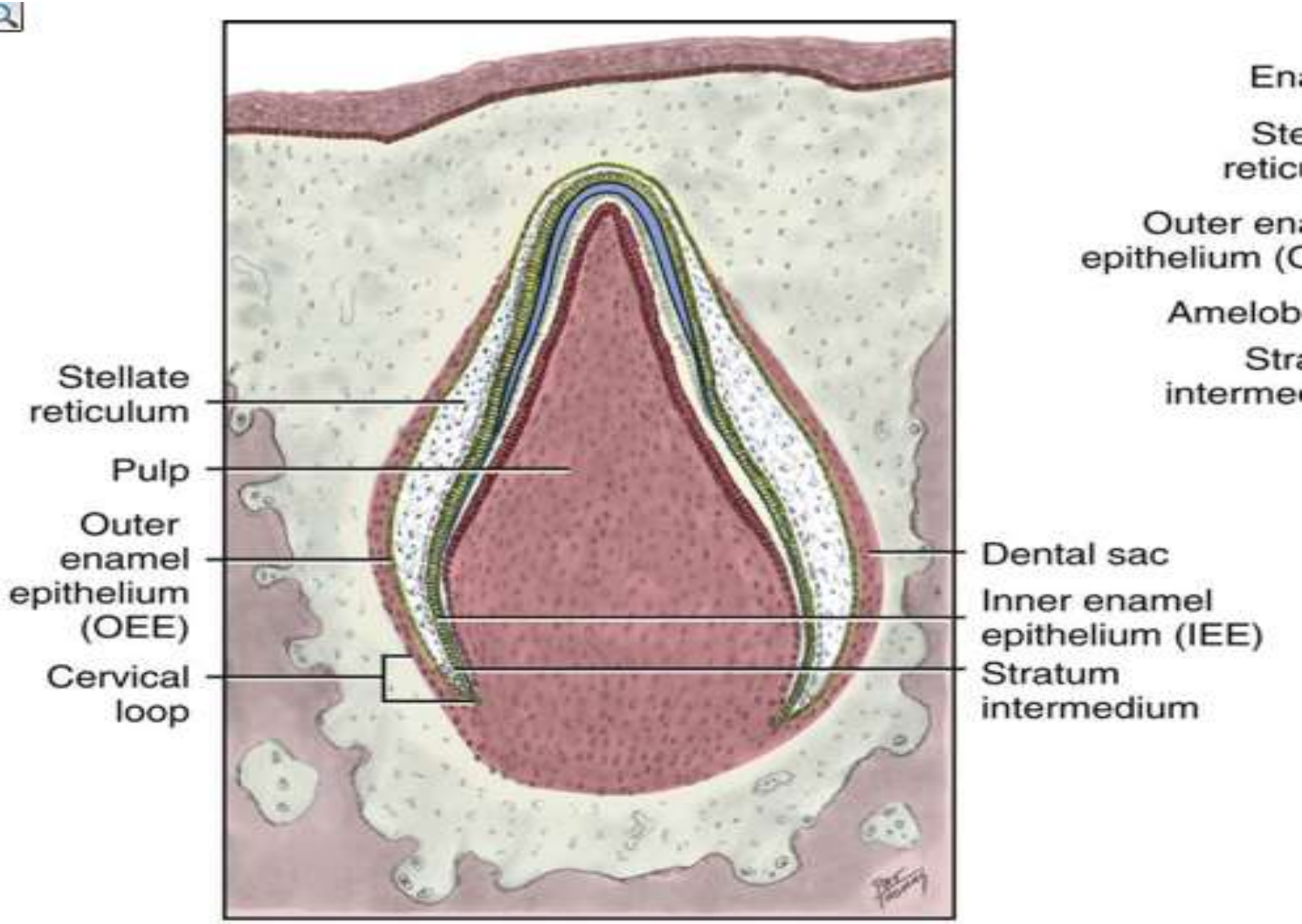
1 Tooth crown assumes its final shape (Morphodifferentiation), and the cells that will be making the hard tissues of crown (Ameloblasts and odontoblasts) acquire their distinctive phenotype (Histodifferentiation).

2The enamel organ is bell-shaped and it composed of 4 distinctive cell layers.

- Cuboidal cells on the periphery of the enamel organ are known as outer enamel epithelium , The columnar cells of the enamel organ adjacent to the enamel papilla are known as inner enamel epithelium,The cells between the IEE and the stellate reticulum form a layer known as the stratum intermedium.

3 The rim of the enamel organ where the outer and inner enamel epithelium join is called the cervical loop.
4 Other events occur during the bell stage, the dental lamina disintegrates, leaving the developing teeth completely separated from the epithelium of the oral cavity.
5 The crown shape of the tooth, which is influenced by the shape of the inner enamel epithelium, also occur during this stage.


Stellate reticulum
Stratum intermedium
Outer enamel epithelium
Inner enamel epithelium


Stellate reticulum
Pulp
Outer enamel epithelium (OEE)
Cervical loop
Dental sac
Inner enamel epithelium (IEE)
Stratum intermedium

- Thank you