Oral Histology

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Early tooth development

The primitive oral cavity, or *stomodeum*, is lined by stratified squamous epithelium called the oral ectoderm or primitive oral epithelium. The oral ectoderm contacts the endoderm of the foregut to form the buccopharyngeal membrane. At about the twenty-seventh day of gestation this membrane ruptures and the primitive oral cavity establishes a connection with the foregut. Most of the connective tissue cells underlying the oral ectoderm are of neural crest or ectomesenchyme in origin. These cells are thought to anterior portion of what will be instruct or induce the overlying ectoderm to start tooth development, which begins in the future maxilla and mandible and proceeds posteriorly.

Teeth development results from an interaction of the oral epithelial cells and the underlying ectomesenchymal cells. From this interaction, 20 deciduous and 32 permanent teeth developed. Each developing tooth grows as an anatomically distinct unit. The fundamental developmental process is similar for all teeth.

Dental organ or *tooth germ*: is a term used to constitute the structure that has enamel organ, dental papilla and dental follicle.

Primary epithelial band:

Two or three weeks after the rupture of the buccopharyngeal membrane, when the embryo is about 6 weeks old, certain areas of basal cells of the oral ectoderm proliferate more rapidly than do the cells of the adjacent areas. This leads to the formation of the *Primary epithelial band* which is a band of epithelium that has invaded the underlying ectomesenchyme along each of the horseshoe-shaped future dental

arches .At about 7th week the primary epithelial band divides into an inner (lingual) process called *Dental lamina* and an outer (buccal) process called *Vestibular lamina*.

Dental lamina:

The dental laminae serve as the primordium for the ectodermal portion of the deciduous teeth. Later, during the development of the jaws, the permanent molars arise directly from a distal extension of the dental lamina.

In the jaws, the neural crest cells induce the oral epith. to proliferate and form the dental lamina, which is the first sign of tooth development. This lamina then invaginates as a sheet of epith. cells into the underlying mesenchyme around the perimeter of both maxillary and mandibular jaws.

Along the leading edges of the lamina 20 areas of enlargement next appear, which are the forming buds of the 20 primary teeth, and the leading edge of the lamina continues to develop the 32permanent tooth buds.

Successional tooth buds form the permanent dentition lingual to the buds of the primary predecessors. Permanent molars develop posterior to the primary molars, and the general dental lamina grows posteriorly to form the permanent molar buds. The last teeth to arise from dental lamina are the third molars, which developed in about 4 years after birth.

The dental lamina is thus functional in developing the 52 teeth from the sixth prenatal week until 4 years after birth. So the activity of dental lamina extends over a period of about five years and disintegrates completely or remains as remnants in the gingiva and the jaw and they are called *epithelial rests of Serres(Serres' pearls)*.

Vestibular lamina:

Labial and buccal to the dental lamina in each dental arch, another epithelial thickening develops independently and somewhat later. It is the vestibular lamina, also termed the *lip furrow band*. It subsequently hollows and forms the oral vestibule between the alveolar portion of the jaws and the lips and cheeks.

Physiological phases in tooth development

Tooth development can be divided into the following overlapping phases, which are:

1-Initiation : During this phase, the sites of the future teeth are established with the appearance of tooth germs along an invagination of the oral epithelium called dental lamina.

2-Prolifertion: During this phase, Proliferative growth causes regular changes in the size and proportions of the growing tooth germ

3-Histodifferentiation: During this phase, differentiation of cell (begun during morphogenesis) proceed to give rise to the fully formed dental tissues, both mineralized (such as enamel, dentin and cementum) and unminaralized (such as pulp and periodontal ligament).

4- **Morphodifferentiation** : During this phase, the shape of the teeth are determined by a combination of cell proliferation and cell movement.

5-Apposition: During this phase, the deposition of dental hard tissue occur in the tooth like dentin and enamel.

Morphological stages of tooth development

For descriptive purposes, tooth germs are classified into bud, cap and bell stages according to the degree of morphodifferentiation and histodifferentiation of their epith. components (enamel organs). Leading up to the late bell stage, the tooth germ changes rapidly both in its size

and shape, the cells are dividing and morphogenetic processes are taking place.

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* (the tooth buds), 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. The cells of the tooth bud have a higher RNA content than those of the overlying oral epith., a lower glycogen content and an increased oxidative enzyme activity.

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. 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

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 distinction

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..

In the late cap stage of tooth development, the central cells of the enlarging enamel organ have become separated (through maintaining contact by desmosomes), the intercellular spaces containing significant quantities of glycosaminoglycans. 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 e. epith. become more columnar and show an increase in RNA content, and hydrolytic and oxidative enzyme activity.

The adjacent ectomesenchymal cells are continue to prolipherat and surround the E. organ. The part of the ectomesenchyme lying beneath the inner E. epith.. is called *dental papilla*. The ectomesenchymal tissue surrounding both enamel organ and dental papilla is called *dental sac or dental follicle.*

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.

However, the E. knote soon disappears and seems to contribute cells to the E. cord. Although its transitory, recent studies of E. knot suggest it may represent an important signaling center during tooth development. Unlike adjacent cells, those within the E. knot are non proliferative and produce molecules associated with signaling in other sites. These molecules include bone morphogenic proteins and fibroblast growth factor.

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. Its termed *E. septum* when E. cord extend from E. knot to the outer E. epith.

3- **Enamel niche**: Its an apparent structure in the histologic section, created because the dental lamina is a sheet rather than a single strand and often contains a concavity filled with C.T. A section through this arrangement creates the impression that the tooth germ has a double attachment to the oral epithelium by two separate strands.