Oral Histology

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Teeth Development: 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* .

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).

2-The 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 (OEE). The columnar cells of the enamel organ adjacent to the enamel papilla are known as inner enamel epithelium (IEE). The cells between the IEE and the stellate reticulum(SR) form a layer known as the stratum intermedium(SI).

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.

A- Early bell stage

High degree of histodifferentiation is achieved in the early bell stage .The enamel organ shows four distinct layer:

1- Inner enamel epithelium(IEE):

It consists of a single layer of cells that differentiate prior to amelogenesis into columnar cells, the ameloblasts. These elongated cells are attached together by junctional complex laterally and by desmosomes to stratum intermedium .The IEE cells rich in RNA. The IEE. is separated from the peripheral ells of dental papilla by a basement membrane and cell free zone about 1-2 µm wide.

The function of cells of this layer first is exert an organizing influence on the undelying ectomesenchymal cells of dental papilla to differentiate into odontoblasts, and then it differentiate into ameloblasts which form enamel. Also when the enamel formation of the crown completed, the IEE with OEE formed the structure from cervical loop which called Hertwig's epithelial root sheath which formed root.

2- Stratum intermedium (SI):

This first appears at the early bell stage and as layers of flattened cells lying between the IEE and stellate reticulum. The cells of this layer consists of several layer of squamous cells, closely attached by desmosomes and gab junction.

The function of cells of stratum intermedium is important in the mineralization of the enamel during amelogenesis because it characterized by high degree of alkaline phosphatase enzyme. Also the cells of this layer concern in the transport of materials to and from the IEE which later differentiate to ameloblasts.

3. The stellate reticulum(SR):

The intercellular spaces become fluid filled, presumably related to osmotic effects arising from the high concentration of glycos-aminoglycans. In addition ,

the cells also contain alkaline phosphatase. But have only small amounts of RNA and glycogen.

The cells are star-shaped with bodies containing prominent nuclei and many branching processes. The cells of this layer have numerous tonofilaments and few endoplasmic reticulum and mitochondria which present within the cytoplasm. The desmosomes and gap junctions are present between the cells.

The main function of stellate reticulum is a mechanical one. This relates to the protection of the underlying IEE against physical disturbance and to the maintenance of tooth shape. The hydrostatic pressure generated within the stellate reticulun is in equilibrium with that of the dental papilla, allowing the proliferative pattern of the IEE cells to determine crown morphogenesis, however, a change in either of these pressures might lead to change in the outline of the IEE and this could be important for crown morphogenesis.

4- The outer enamel epithelium (OEE)

As its name suggests, this forms the outer layer of cuboidal cells which limits the enamel organ. It is separated from the surrounding ectomesenchymal tissue of dental sac or follicle by a basement membrane 1-2μm thick, which , at the ultrastructural level(under electron microscope), corresponding to basal lamina and hemidesmosomes.

The OEE cells contain large, centrally placed nuclei. Ultrastructurally, they contain small amounts of the intracellular organelles associated with protein synthesis (e.g. endoplasmic reticulum, Golgi complex, mitochondria) and they contact each other via desmosomes and gap junctions.

The function of OEE is thought to be involved in the maintenance of the shape of the enamel organ and in the exchange of substances between the enamel organ and the environment. At the advance bell stage, when dentin lay down,the formerly smooth surface of the outer enamel epithelium is laid in folds. Between the folds,

adjacent mesenchyme of the dental sac forms papillae that contain capillary loops and thus provide nutritional supply for the intense metabolic activity of the *avascular enamel organ* during enamel formation.

Dental papilla:

The dental papilla is enclosed in the invaginated portion of the enamel organ. Before the inner enamel epithelium begins to produce enamel, the peripheral cells of the mesenchymal dental papilla differentiate into odontoblasts under the organizing influence of the epithelium. The dental papilla ultimately gives rise to dental pulp, once the dentin formation begins at the cuspal tip of the bell stage tooth germ.

The basement membrane that separates the enamel organ and the dental papilla just prior to dentin formation is called the *membrana preformativa*.

Dental sac (d.S.):

Before formation of dental hard tissue begins, the d.S. shows a circular arrangement of its fibers and it resemble a capsular structure. With the development of the root, the fibers of d.S. differentiate into periodontal ligament fibers that become embedded in the cementum and alveolar bone.

***B -Advance (late) bell stage or crown stage*:**

Hard tissues, including enamel and dentin, develop during advance bell stage. This stage is also called the crown, or apposition stage, by some researchers. Important cellular changes occur at this time. In prior stages, all of the IEE cells were dividing to increase the overall size of the tooth bud, but rapid dividing, called mitosis, stops during the crown stage at the location where the cusps of the teeth form. The first mineralized hard tissues form at this location is dentin. At the

same time, the IEE cells change in shape from cuboidal to columnar and become pre-ameloblasts. During this stage the boundary between inner E. epithelium and odontoblasts outlines the future D.E.J. (dentino enamel junction). In addition, the basal margin of the E. organ (cervical loop) gives rise to the epithelial root sheath.

Function of dental lamina:

First the functional activity of the dental lamina is concerned with the initiation of the entire deciduous dentition that begins at the *6 weeks* of intra-uterine life of embryo.

Second it deals with the initiation of the successors of the deciduous teeth.. It is preceded by the growth of the free end of the dental lamina (successional lamina), lingual to the enamel organ of each deciduous tooth, and occurs from about the *5th month* in embryo for the permanent central incisors to *10 months* of age for the second premolar.

Third is the extension of the dental lamina distal to the enamel organ of the second deciduous molar and the formation of permanent molar tooth germs.

Fate of dental lamina

1- Dental lamina is functional in developing *52* teeth from 6 prenatal weeks until 4 years after birth (development of third permanent tooth).

2- The dental lamina degenerates by mesenchymal invasions in late bell stage.

3- Developing tooth lose its connection with dental lamina.

4- Sometimes remnants of dental lamina remains in the jaws as *epithelial rests of Serres(Serres' pearls)* .

Nutrition and tooth development

Nutrition has an effect on the developing tooth. Essential nutrients for a healthy tooth include calcium, phosphorus, and vitamins A, C, and D. Calcium and phosphorus are needed to properly form the hydroxyapatite crystals(minerals), and their levels in the blood are maintained by Vitamin D.

Vitamin A is necessary for the formation of keratin, and Vitamin C is for collagen. Fluoride is incorporated into the hydroxyapatite crystal of a developing tooth and makes it more resistant to demineralization and subsequent decay.

Deficiencies of these nutrients can have a wide range of effects on tooth development:

- In situations where calcium, phosphorus, and vitamin D are deficient, the hard structures of a tooth may be less mineralized.
- A lack of vitamin A can cause a reduction in the amount of enamel formation.
- Fluoride deficiency causes increased demineralization when the tooth is exposed to an acidic environment, and also delays remineralization.
- Furthermore, an excess of fluoride while a tooth is in development can lead to a condition known as fluorosis.

Developmental disturbances of teeth:

1-Anodontia is a complete lack of tooth development. Anodontia is rare, most often occurring in a condition called ectodermal dysplasia.

2-Hypodontia (congenital missing tooth or teeth) . It is one of the most common developmental abnormalities, The absence of third molars is very common, followed in prevalence by the second premolar and lateral incisor.

Hypodontia is often associated with the absence of a dental lamina, which may be due to infection or chemotherapy medications, and is also associated with many syndromes, such as Down syndrome.

3-Hyperdontia is the development of supernumerary teeth. It is believed to be associated with an excess of dental lamina or epithelial rest of Serres.

4-Dilaceration is an abnormal bend found on a tooth, and is nearly always associated with trauma that moves the developing tooth bud. As a tooth is forming, a force can move the tooth from its original position, leaving the rest of the tooth to form at an abnormal angle.

5-Regional odontodysplasia is rare, but is most likely to occur in the maxilla and anterior teeth. The enamel, dentin, and pulp of teeth are affected. These teeth are very brittle. On radiographs the teeth appear more radiolucent than normal, so they are often described as "*ghost teeth"*.

6-Amelogenesis imperfect: is hereditary condition characterized by a defect in dental enamel formation. Teeth are often free of enamel, small, misshapen, and tinted brown. The cause of these deformities is due to a mutation in enamel in expression.

7-Natal and neonatal teeth : *Natal teeth* are present at the time of birth. *Neonatal teeth* will erupt during the first 30 days after birth. Although both conditions occur more frequently in females, natal teeth are three times more common than neonatal teeth. The most common location being the mandibular region of the central incisors.

DENTAL LAMINA

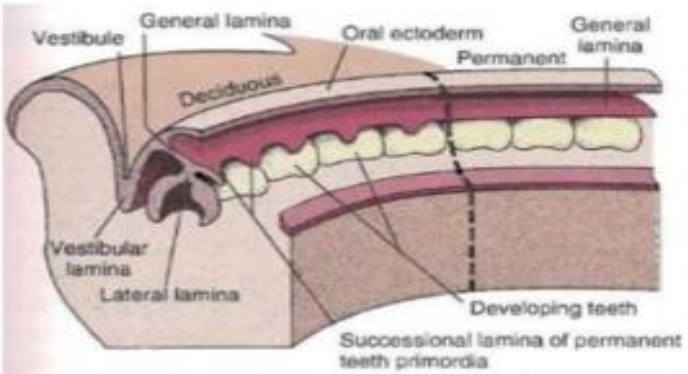

Fig. 5-3 **Dental lamina formation is shown in relation to the general lamina.** From the successional lamina come permanent teeth, which replace the primary teeth except for the permanent molars.