

**Lec. 4  Dr. Ali H. Murad**

**Root formation**

The development of the roots begins after enamel & dentin formation has reached the future cementoenamel junction.

The enamel organ plays an important part in root development by forming Hertwig’s epithelial root sheath, which molds the shape of the roots & initiates radicular dentin formation.

Hertwig’s epithelial root sheath consists of the outer & inner enamel epithelia only.
Prior to the beginning of root formation, the root sheath forms the epithelial diaphragm. The outer & inner enamel epithelia bend at the future cementoenamel junction into a horizontal plane, narrowing the wide cervical opening of the tooth germ. The plane of the diaphragm remains relatively fixed during the development & growth of the root.

The proliferation of the cells of the epithelial diaphragm is accompanied by proliferation of the cells of the C.T. of the pulp, which occurs in the area adjacent to the diaphragm.

![Diagram of root sheath and epithelial diaphragm.](image)

The differentiation of odontoblasts & the formation of dentin follow the lengthening of the root sheath.

At the same time the C.T. of the dental follicle surrounding the root sheath proliferates & invades the continuous double epithelial layer (Hertwig’s epithelial root sheath) dividing it into a network of epithelial strands.

Then the epithelium is moved away from the surface of the dentin so that C.T. cells come into contact with the outer surface of the dentin of the root & differentiate into cementoblasts that deposit a layer of cementum onto the surface of the root dentin.

In the last stages of root development, the proliferation of the epithelium in the diaphragm lags behind that of the pulpal C.T. The wide apical foramen is reduced first to the width of the diaphragmatic opening itself & later is further narrowed by apposition of dentin & cementum to the apex of the root.
**Formation of multi-root**

When the Hertwig’s epithelial root sheath formed from a double layer of inner & outer enamel epithelium. This sheath grows around the dental papilla between the dental papilla & the dental follicle.

Differential growth of the epithelial diaphragm in multirooted teeth causes the division of the trunk into 2 or 3 roots.

To understand multiple root formation, imagine the root sheath as a collar or skirt hanging from the enamel organ.

Two tongues like extension of the horizontal diaphragm develop in teeth with 2 roots & 3 tongues like extension develop in teeth with 3 roots.

The free ends of these horizontal epithelial flaps grow toward each other & fuse.

On the pulpal surface of the dividing epithelial bridges, dentin formation starts, & on the periphery of each opening.

N.B.: the root sheath determines whether a tooth has single or multiple roots, is short or long, or is curved or straight.

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**Clinical consideration**

1-initiation induction requires ectomesenchymal interaction. The mechanism of such interaction is not understood. However, it has been demonstrated that dental papilla mesenchyme can induce tooth epithelium & even non tooth epithelium to form enamel. Teeth may develop in abnormal locations, for e.g., in the ovary.
(dermoid tumor). In such instances the tooth undergoes stages of development similar to those in the jaws.

2-a lack of initiation result in the absence of either a single tooth or multiple teeth (partial anodontia), or complete lack of teeth (anodontia). While abnormal initiation may result in the development of single or multiple supernumerary teeth.

3-during the histodifferentiation stage, the cells become restricted in their function, this phase reaches its highest development in the bell stage, just before the beginning of formation & apposition of dentin & enamel.

4-enamel does not form in the absence of dentin. Dentin formation therefore precedes & is essential to enamel formation. However, differentiation of the inner enamel epithelial cells precedes & is essential to the differentiation of the odontoblast & the initiation of dentin formation.

5- the morphologic pattern & relative size of the future tooth is established by morphodifferentiation stage. Morphodifferentiation is impossible without proliferation (cap stage).

6- endocrine disturbances affect the size or form of the crown of teeth, but is not produced unless the effects occur during morphodifferentiation, that is, in utero or in the first year of life. While size & shape of the root may be altered in later period.

7- disturbances in morphodifferentiation may affect the form & size of the tooth without impairing the function of the ameloblasts or odontoblast. New parts may be differentiated to supernumerary cusps or roots, twinning may occur, or loss of cusps or roots with enamel & dentin that may be normal in structure.