“DEVELOPMENT & MORPHOLOGY OF PRIMARY TEETH”

Understanding the process of tooth development is of particular importance for the dentist; as developmental disturbances may occur at any stage of this process resulting in different types of tooth anomalies. Primary teeth consist of 20 teeth and start to develop in utero.

Development of teeth:

Odontogenesis is the process of tooth development. Although this process takes place in stages, there is no clear-cut beginning or end point between stages. These stages are:

- **Initiation stage:**

  Around the sixth week of embryonic life, the stomodeum of the embryo (primitive mouth) is lined by ectoderm. The outer part of ectoderm gives rise to oral epithelium. At the surface of stomodeum, two horseshoe-shaped bands of this oral epithelium forms that represent each future dental arch. Deep to each epithelial band, ectomesenchymal tissue is present, which is derived from neural crest cells (Fig. 4-1).

  A week later, an induction of the cells of the basal layer of oral epithelium begins. Proliferation of these cells results in thickening of the oral epithelium into the underlying ectomesenchyme and forming of dental lamina (Fig. 4-2). Between oral epithelium and ectomesenchyme present the basement membrane.

  At this stage, failure of initiation of epithelial cell proliferation will result in partial or complete absence of teeth (hypodontia or anodontia) (Fig. 4-3 and 4), whereas continued cell initiation from persistent clusters of dental lamina will produce a supernumerary tooth or teeth (Fig. 4-5).

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**Figure (4-1):** Developing stomodeum  
**Figure (4-2):** Initiation of dental lamina formation
Bud stage:

This stage starts at the beginning of the eighth week of prenatal development. It involves extensive proliferation of the dental lamina into buds. In each future jaw, ten oval buds start to penetrate into the surrounding ectomesenchyme (Fig. 4-6), that will later form the primary teeth.

Permanent molars, like primary teeth, arise from the dental lamina; while the permanent incisors, canines, and premolars develop from the buds of their primary predecessor.

Improper proliferation of tooth bud during this stage can cause abnormality in tooth size (macrodontia or microdontia) (Fig. 4-7 and 8).
Cap stage:

This stage starts between the ninth and tenth week of prenatal development. During this stage, proliferation of cells continues, but in unequal manner in different parts of the tooth bud, resulting in the formation of a three-dimensional cap shape overlying the ectomesenchyme. Not only proliferation of cells occurs during this stage, but also different levels of cell differentiation take place.

From the processes of proliferation and differentiation of the epithelial cells, a depression develops in the deepest part of each tooth bud of dental lamina forming the cap-shaped enamel organ, which will later produce enamel. Within the concavity of this cap, the inner ectomesenchymal cells condensed into a mass to form the dental papilla that will produce the future dentin and pulp. At the same time, the surrounding outer ectomesenchyme condenses to form the dental sac which will produce the periodontium (including cementum, periodontal ligament, and alveolar process) (Fig. 4-9).

At the end of this stage, the three embryological structures (the enamel organ, dental papilla, and dental sac) are considered together as the tooth germ. At the same time, extension of the dental lamina will occur lingual to the developing primary tooth germ to form the primordium of the permanent tooth germ (anteriors and premolars). These teeth are considered succedaneous as they develop from the primary predecessor. On the other hand, the permanent molars are non-succedaneous as they develop from the posterior extension of the dental lamina distal to the dental lamina of the primary second molar (Fig. 4-10).

Figure (4-9): Cap stage

Figure (4-10): Development of permanent teeth

During this stage, different forms of dental anomalies may develop. Dense invaginatus (dense in dente) will result from invagination (infolding) of enamel organ into the dental papilla. This invagination results in an enamel-lined pocket extending from the lingual surface and leaves the tooth with a deep
lingual pit. It may appear as a “tooth within a tooth” on radiographic examination. Early detection of this anomaly is important as it may result in pulpal exposure and pathology with subsequent endodontic therapy. The most commonly affected teeth are the permanent maxillary incisors and especially the lateral incisors (Fig. 4-11).

**Tubercles** can also develop during this stage as a result of trauma, pressure, or metabolic disease that affects the enamel organ as it forms the crown. Tubercles are small rounded enamel extensions forming extra cusps on the occlusal surface of posterior teeth or on the cingulum of maxillary anterior teeth (Fig. 4-12).

Another anomaly that may develop during this stage is **gemination**. It occurs when a single tooth germ tries unsuccessfully to divide into two tooth germs resulting in a large single-rooted tooth with an enlarged pulp cavity. **Fusion** is another disturbance that may also occur during this stage. It results from the union of two adjacent tooth germs leading to a broader, falsely macrodontic tooth similar to germination. However, it could be differentiated from gemination by counting the teeth or radiographic examination, as two distinct pulp cavities with united enamel, dentin and pulp can be detected (Fig. 4-13).

![Figure 4-11: Dense in dente](image1)

![Figure 4-12: Dental tubercle](image2)

![Figure 4-13: Gemination of the lower right central incisor & Fusion of the lower left central and lateral incisor](image3)
Bell stage:

Between the eleventh and twelfth weeks of prenatal development, the processes of cell proliferation, differentiation, and morphogenesis continue. At this stage, differentiation of the epithelial cells of enamel organ results in four distinct types of cells; the outer enamel epithelium, stellate reticulum, stratum intermedium, and inner enamel epithelium. This produces a three-dimensional bell shape of the enamel organ (Fig. 4-14).

The outer cuboidal cells of outer enamel epithelium (OEE) acts as a protective barrier for the enamel organ during enamel production. On the other hand, the innermost tall columnar cells of inner enamel epithelium (IEE) will differentiate into enamel-secreting cells (ameloblasts). Between these two cell layers, the stellate reticulum and stratum intermedium support the future production of enamel.

At the same time, histodifferentiation of dental papilla takes place to form outer cells of dental papilla and inner cells of dental papilla. The outer cells of dental papilla will give rise to dentin-secreting cells (odontoblasts), while the central cells of dental papilla will produce the pulp. At this stage, the dental sac only increases its amount of collagen fibres (Fig. 4-15).

Apposition:

During this stage, deposition of tissue matrix takes place. Ameloblasts and odontoblasts start to deposit enamel matrix and dentin matrix respectively in successive layers (Fig. 4-16).
Any disturbances (local or systemic) to the ameloblasts during this stage that causes interruption or arrest of enamel matrix apposition will result in **enamel hypoplasia** which results from reduction in the quantity of enamel matrix (Fig. 4-17). On the other hand, severe systemic disturbance is usually required to develop the less common hypoplasia of dentin.

**Calcification:**

Following matrix deposition, matrix calcification (or mineralisation) begins. It involves the precipitation of inorganic calcium slats within the deposited matrix. Any disturbance to the ameloblasts during this stage will result in localised or generalized **enamel hypomineralisation** or **hypocalcification**, which is reduction in the quality of the mineralized enamel (Fig. 4-18).
**Importance of primary teeth:**

Although primary teeth may present in the mouth for relatively short time (5 to 12 years), they have important functions in:

1. Giving the face its normal appearance (aesthetic).
2. Aiding in mastication.
3. Aiding in the development of clear speech (phonetic).
4. Helping get good nutrition, as missing or carious teeth will make it difficult to chew causing children to reject food. Also, the pus discharged from a grossly decayed teeth will be swallowed and cause GIT disturbances.
5. Maintaining the arch length for the succedaneous permanent teeth.
6. Helping give a healthy start to the permanent teeth, as decay and infection of primary teeth can cause enamel defects on the underlying permanent teeth.

**Morphology of the individual primary teeth:**

Good knowledge of primary teeth parts, forms, and configurations is of particular importance in the clinical practice of various dental procedures.

- **Maxillary central incisor:** *(Fig. 4-19)*

The characteristic features of this tooth are:

- The crown has greater mesio-distal dimension than cervico-incisally.
- Incisal edge is almost straight even before abrasion.
- Labial surface is smooth with no evidence of developmental lines.
- Lingual surface has well-developed marginal ridges and distinctly developed cingulum.
- The root is conical with tapered sides.

- **Maxillary lateral incisor:** *(Fig. 4-20)*

The morphological features of this tooth are:

- The outline of this tooth mimics that of maxillary central incisor, but the crown is smaller in all dimensions.
- The crown is greater in the cervico-incisal dimension than mesiodistally.
- The root outline is identical to that of maxillary central incisor, but is longer in proportion to the crown.

Figure (4-19): Primary maxillary central incisor  Figure (4-20): Primary maxillary lateral incisor

- Maxillary canine: (Fig. 4-21)

The form features of this tooth are:

- The crown is more constricted at the cervical region than that of the incisors.
- The incisal and distal surfaces are more convex.
- Rather than having a straight incisal edge, there is a well-developed sharp cusp.
- The root is tapered, slender, and long (more than twice the length of the crown). It is also inclined distally, apical to the middle third.
**Mandibular central incisor:** (Fig. 4-22)

This tooth has the following characteristics:

- The crown is smaller than that of the maxillary central incisor, but the labio-lingual measurement is usually only 1 mm less.
- Incisal edge is straight and bisects the crown labio-lingually.
- Labial surface is flat without developmental grooves.
- Lingual surface has marginal ridges and cingulum. The middle and incisal thirds of this surface may have flattened level with the marginal ridges, or there may be a slight concavity.
- The root is almost twice the length of the crown.

**Mandibular lateral incisor:** (Fig. 4-23)

The characteristic features of this tooth are:

- The outline of this tooth resembles that of mandibular central incisor, but is somewhat larger in all dimensions except labio-lingually.
- The incisal edge inclines toward the distal aspect of the tooth.
- The lingual surface may have greater concavity between the marginal ridges.
**Mandibular canine: (Fig. 4-24)**

The morphology of this tooth is similar to that of maxillary canine with few exceptions:

- The crown is slightly shorter.
- The tooth itself is not as large labiolingually as its maxillary counterpart.
- The root may be as much as 2 mm shorter than that of maxillary canine.
Maxillary first molar: (Fig. 4-25)

The characteristic features of this tooth are:

- The crown has its greatest dimension at the mesiodistal contact areas. From these areas, it converges toward the cervical region.
- The buccal surface is smooth, with little evidence of developmental grooves.
- The largest and sharpest cusp is the mesiolingual cusp.
- The distolingual cusp is poorly defined, small, and rounded.
- The three roots are long, slender, and widely spread.

Figure (4-25): Primary maxillary first molar

Maxillary second molar: (Fig. 4-26)

This tooth looks like maxillary first permanent molar:

- There are two well-defined buccal cusps, with a developmental groove between them.
- There are three cusps on the lingual surface; a mesiolingual cusp is large and well-developed, a distolingual cusp, and a third and smaller supplemental cusp (the cusp of carabelli). There is also a well-defined groove that separates the mesiolingual cusp from the distolingual cusp.
- Occulsally, there is a prominent oblique ridge connects the mesiolingual cusp with the distobuccal cusp.

- The crown is considerably larger than that of the maxillary first primary molar.

- The roots are longer and heavier than those of the maxillary first primary molar. The bifurcation between the buccal roots is close to the cervical region, whereas the palatal root is large and thick compared to the other roots.

![Figure (4-26): Primary maxillary second molar](image)

- **Mandibular first molar: (Fig. 4-27)**

Dissimilar to other primary teeth, this tooth does not look like any of the permanent teeth:

- When viewed from the buccal aspect, the mesial outline is almost straight from the contact area to the cervical region; the distal area is shorter than the mesial area; and there are two distinct buccal cusps (the mesial cusp is the larger) with no evidence of a distinct developmental groove between them.

- Lingually, the mesiolingual cusp is long and sharp at the tip; a
developmental groove separates it from the distolingual cusp, which is rounded and well developed.

- The mesial marginal ridge is well-developed, to the extent that it appears as another small cusp lingually.

- On the mesial aspect, the crown has a pronounced lingual convergence, with a rhomboid outline present on the distal aspect.

- When viewed from the mesial aspect, there is an extreme curvature buccally at the cervical third.

- The crown length is greater in the mesiobuccal area than in the mesiolingual area; thus the cervical line inclines upward from the buccal to the lingual surface.

- The roots are slender and long. They spread considerably at the apical third, extending beyond the outline of the crown. When the mesial root is being viewed from the mesial aspect, it does not mimic any other primary root. The buccal and lingual outlines of the root drop straight down from the crown, being essentially parallel for more than half their length. The end of the root is flat and almost square.

Figure (4-27): Primary mandibular first molar
Mandibular second molar: (Fig. 4-28)

This tooth resembles mandibular first permanent molar, except that the primary tooth is smaller in all its dimensions:

- The buccal surface is divided into three cusps that are separated by mesiobuccal and distobuccal developmental grooves. The cusps are almost equal in size.

- There are two cusps (almost equal in size) on the lingual surface. They are divided by a short lingual groove.

- When viewed occlusally, the tooth appears rectangular with a slight distal convergence of the crown. The mesial marginal ridge is developed to a greater extent than the distal marginal ridge.

- One difference between the crown of the primary molar and that of the first permanent molar is that the distal cusp of the permanent molar is smaller than the other two buccal cusps, while the three buccal cusps of primary mandibular second molar are nearly equal in size.

- The roots are long and slender, with a characteristic flare mesiodistally in the middle and apical thirds.

Figure (4-28): Primary mandibular second molar
Morphology of the root canal system of primary teeth:

Anterior primary teeth have a relatively simple root canal system that follows the outline of the tooth with few irregularities, thus, these teeth can be easily treated endodontically. In contrast, the root canal system of posterior primary teeth shows multiple ramifications and deltas between the canals.

When root formation of primary molars have completed, there is usually only one canal present in each root. However, resorption of the roots starts as soon as the root length is completed. This will cause continuous change in the position of the apical foramen. Additionally, under the influence of function and abrasion of the primary teeth, secondary dentin is usually deposited within the root canal system. Subsequently, variations and alterations in the number and size of roots canals will result, which may sometimes lead to division of a single root canal into two separate canals.

Morphological differences between primary and permanent teeth:

- **Crowns:** (Fig. 4-29)
  - The crown colour of primary teeth is whiter and lighter in shade.
  - The crowns of primary teeth are shorter relative to the root length (smaller crown: root ratio).
  - Crowns of primary teeth are characterised by significant cervical constriction in both the mesiodistal and buccolingual dimensions.
  - Enamel and dentin are thinner (about half that of permanent teeth).
  - The enamel rod direction in the cervical area is angled occlusally compared with the apical direction in permanent teeth.
  - The primary molars have a pronounced buccal cervical bulge.
  - The occlusal tables of primary molars are more constricted buccolingually and much narrower mesiodistally when compared with the permanent molars.
  - The contact areas of primary molars are flat and very broad buccolingually compared with the permanent molars.

- **Roots:** (Fig. 4-29)
  - The roots of anterior primary teeth have a much narrower mesiodistal width
than the crown when compared with those of the permanent ones.
- Primary molars have roots with greater flare to accommodate the developing crowns of the succedaneous permanent premolars. These roots are relatively longer and more slender in relation to crown size than are those of the permanent molars.

➢ **Pulp and root canal system: (Fig. 4-30)**
- The pulp size relative to the crown is larger in the primary teeth.
- The pulp horns are higher in proportion and are located closer to the dentino-enamel junction and to the outer surface of the crown.
- Pulp horns are present under each cusp of the primary molars.
- The mesial pulp horns are higher than the distal pulp horns.
- From an occlusal view, the pulp chambers are shaped comparably with the shape of the outline of the crown.
- The pulp chambers of primary mandibular molar teeth are normally larger than the pulp chamber of primary maxillary molars.
- The root canal system of fully developed primary molars is extremely tortuous and complex.

![Figure (4-29): Crown & root difference between Primary and permanent teeth](image1)

![Figure (4-30): Pulp difference between primary and permanent teeth](image2)

➢ **References:**