Development of Dentition

Prenatal Development of Dentition

The embryonic oral cavity is lined by stratified squamous epithelium called the *oral ectoderm*, which is visible around 28-30 days of intrauterine life.

The first sign of tooth development appears late in the 3rd embryonic week when the epithelial lining begins to thicken on the inferior border of the maxillary process and the superior border of the mandibular process which join to form the lateral margins of the oral cavity.

At 6 weeks, four maxillary odontogenic zones coalesce to form the dental lamina and the two mandibular zones fuse at the midline. The dental lamina is the foundation for the future dental arches. Tooth formation begins with invagination of the dental lamina epithelium into the underlying mesenchyme at specific locations. The dental lamina gets demarcated into ten knoblike structures namely the tooth bud/germ.

A tooth bud (Fig. 1) consists of an enamel organ, which is derived from the oral ectoderm, a dental papilla and a dental sac, both of which are derived from the mesenchyme. Each of these swellings of the lamina proliferates and differentiate, passing through various histological and morphological differentiation stages namely bud, cap and bell stages.

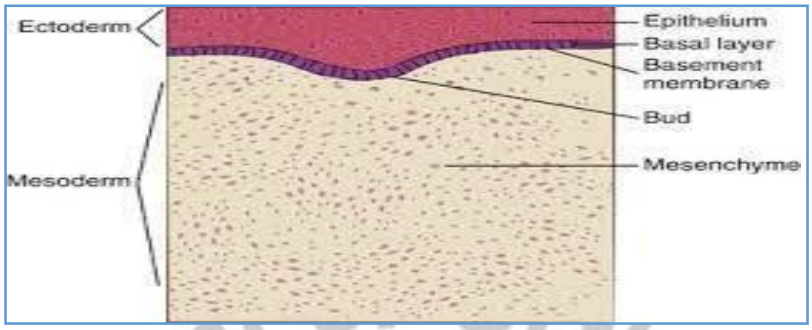


Figure no.1 tooth bud

Stages of Tooth Bud Development

1. ***Initiation***: This is the first epithelial incursion into the ectomesenchyme of the jaw. The tooth bud is the primordium of the enamel organ. Histologically it consists of peripheral low columnar cells and centrally located polygonal cells. Thearea of ectomesenchymal condensation subjacent to the bud is the dental papilla. The dental sac surrounds the tooth bud and the dental papilla. The dental papilla later on forms the dentin and pulp whereas the dental sac forms cementum and the periodontal ligament. Initiation takes place as follows:

• Deciduous dentition: 2nd month *in utero*.

• Permanent dentition: Growth of the free distal end of dental lamina gives rise to the successional lamina, which initiates the permanent dentition; starts from 5th month *in utero*.

• Dental lamina elongates distal to the second deciduous molar and gives rise to the permanent molar tooth germs.

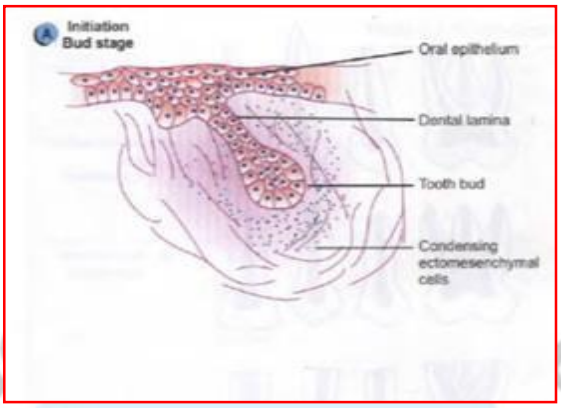


Figure no.2 Initiation stage

2. ***Proliferation***: Unequal growth in different parts of the bud produces a shallow invagination on the deep surface of the bud to produce a cap shaped structure. Histologically it is made up of the outer enamel epithelium (cuboidal cells) at the convexity of the cap and the inner enamel epithelium (tall, columnar cells) at the concavity of the cap. Between the above 2 layers polygonal cells are located whichis known as the stellate reticulum. These cells assume a branched reticular networkas more intercellular fluid is produced.

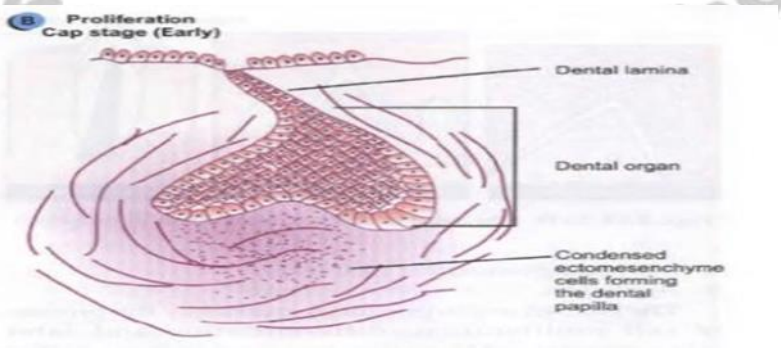


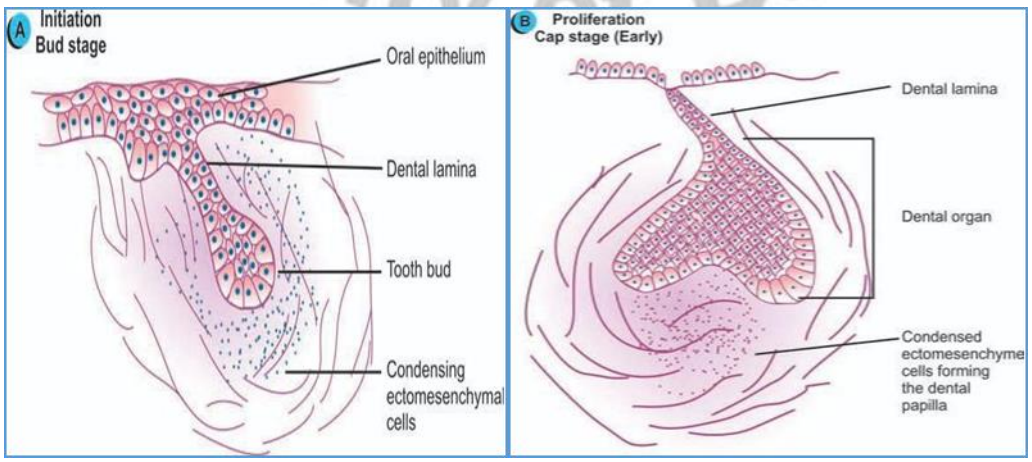
Figure 3: Proliferation stage

3. ***Histo-differentiation***: The enamel organ now assumes a bell shape as the invagination of the cap continues and the margins grow longer. Four different layers are seen. The inner enamel epithelium (IEE) cells remain tall columnar cells.The outer enamel epithelium flatten to low cuboidal cells. The stellate reticulum expands further and the cells become star shaped. A new layer of cells known as Stratum Inter medium whose function is to provide nutrition to IEE cells appears between inner enamel epithelium and stellate reticulum.

4. Morpho-differentiation (bell stage)

5. *Apposition*

The enamel organ produces enamel by the process of cell proliferation, differentiation and later mineralization. Mineralization commences in the deciduous dentition around the 14th week of intrauterine life and occurs first in thecentral incisors. The permanent tooth buds appear around the fourth to fifth monthof intrauterine life and their mineralization is initiated at birth, beginning with the first permanent molar



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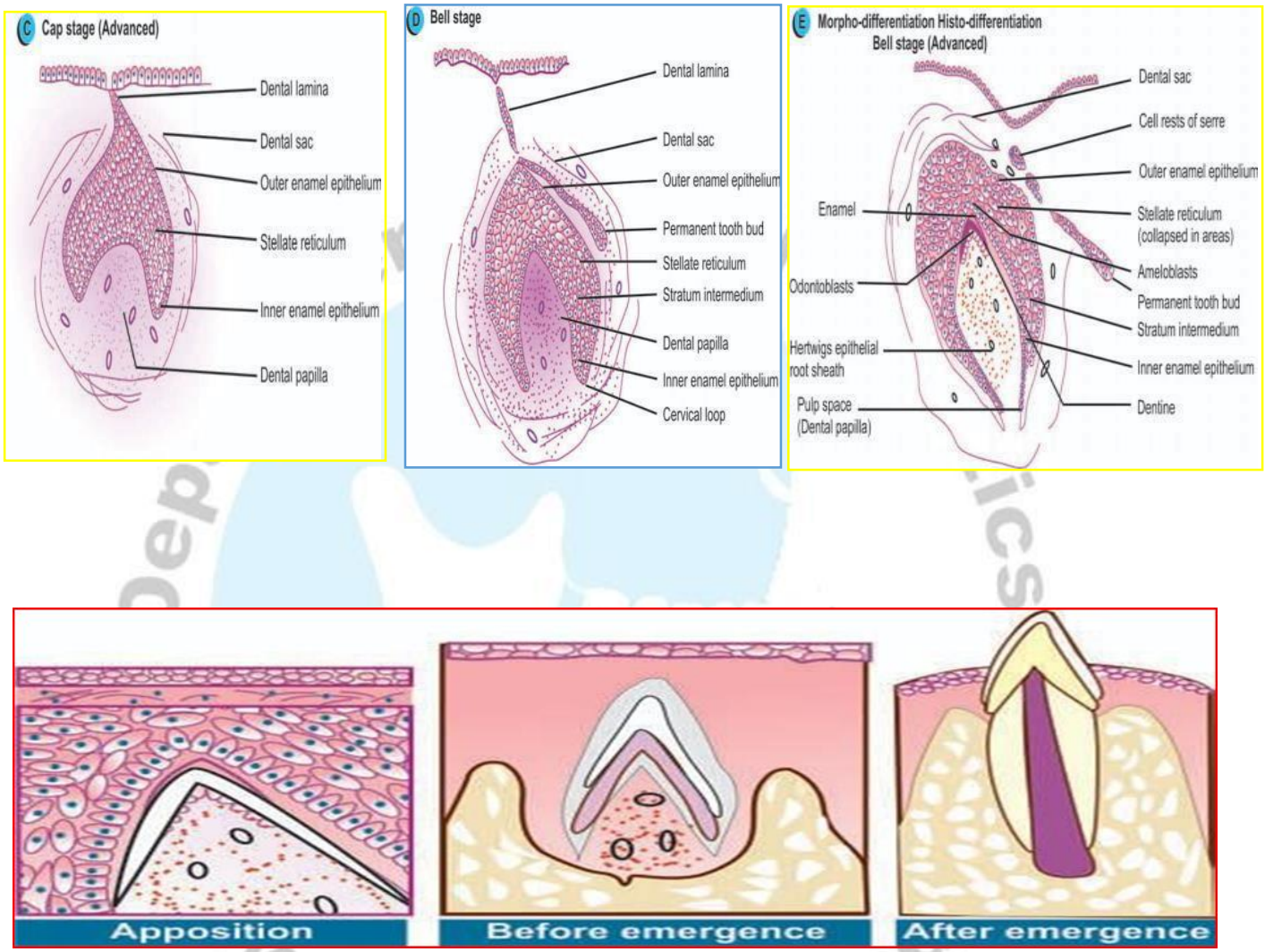

Figure no.4 A to H: Life cycle of tooth

Eruption

Eruption is the developmental process that moves a tooth from its crypt position through the alveolar process into the oral cavity and to occlusion with its antagonist. During eruption of succedaneous teeth:

• Primary tooth resorbs

• Roots of the permanent teeth lengthen

• Increase in the alveolar process height

• Permanent teeth move through the bone.

Teeth do not begin to move occlusally until crown formation is complete. It takes 2-5 years for posterior teeth to reach the alveolar crest following crown completion and 12-20 months to reach occlusion after reaching alveolar margin.

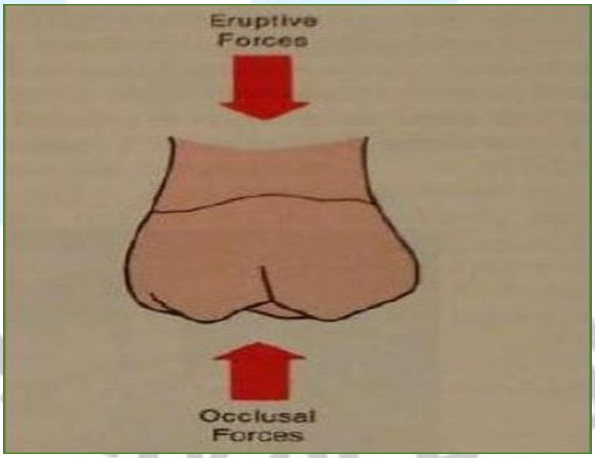

Figure 5: Eruption

THEORIES OF ORIGIN OF MAMMALIAN TEETH

THEORY OF CONCRESCENCE

Mammalian dentition was produced by the fusion of two or more primitive conical teeth and each tubercle with its root originated as simple reptilian tooth.

THEORY OF TRITUBERCULY

Each of the mammalian tooth was derived from a single reptilian tooth by secondary differentiation of tubercles and roots.

THEORY OF MULTI-TUBERCULY

Mammalian dentition is a result of reduction and condensation of primitive multi-tuberculate teeth.

In terms of evolution, teeth are said to have developed from lobes or primary centrals. Incisors, premolars and maxillary molars developed from 4 lobes whereas mandibular molars developed from 5 lobes

Factors Determining Tooth Position During Eruption

Tooth passes through four distinct stages of development:

1. *Pre-eruptive* initially position of tooth germ is dependent on heredity

2. *Intra-alveolar* Tooth position is affected by:-

• Presence or absence of adjacent teeth

• Rate of resorption of primary teeth

• Early loss of primary teeth

• Localized pathologic conditions.

3. *Intraoral stage* Tooth can be moved by lip, cheek, tongue muscles or externalobjects and drift into spaces.

4. *Occlusal stage* Muscles of mastication exert influence through interdigitation of cusps. The periodontal ligament disseminates the strong forces of chewing to the alveolar bone.

Develomental Disturbances Affecting The Teeth

Disturbances During Initiation Of Tooth Germs

1. *Ectodermal dysplasia* Complete or partial anodontia of both the dentitions along with the presence of malformed teeth.

2. *Anodontia* Absence of 1 or more teeth due to failure of tooth bud initiation. Most commonly missing teeth are third molars followed by mandibular second premolars, maxillary lateral incisor and maxillary second premolars.

Figure no,6 Anodontia

Supernumerary and supplemental teeth: teeth in excess of the normal complement of teeth. The difference between the two is that supplemental teeth resemble normal teeth whereas supernumerary teeth do not, e.g. of supernumeraryteeth.

Mesiodens : between maxillary central incisors.

Figure no.7 Mesioden

• *Peridens :* located buccal to the arch

• *Distomolar :* distal to the third molar.

• *Paramolar:* located buccal or lingual to molars.

3. *Natal and neonatal teeth:* These may be either supernumerary or deciduous teeth.

4. *Pre deciduous dentition:* Aborted structures with caps of enamel and dentine.

5. *Post permanent dentition:* Teeth erupt after the loss of the permanent dentition, usually impacted accessory teeth.

Disturbances During Morpho differentiation of Tooth Germs

1. Hutchinson's incisors: Screwdriver shaped notched incisors, e.g. in congenital syphilis.

Figure no.8 Hutchinson's incisor

2. Mulberry molars : Occlusal surface is narrower than the cervical margin and is made up of agglomerate mass of globules; seen in congenital syphilis.

Figure no.9 Mulberry molars.

3- Peg shaped laterals: Proximal surfaces of the crown converge giving the tootha conical shape.

Figure no.10 Peg shaped laterals

3. MacrodontiaTeeth: larger than normal. It may be true or relative generalized.

Figure no.11 MacrodontiaTeeth

4. MicrodontiaTeeth: smaller than normal. It may be true or relative generalized; most commonly the lateral incisor and third molars.

Figure no.12 *Microdontia* Teeth

5. Dens in dente: Tooth invaginates before calcification, e.g. permanent maxillarylateral incisor.

Figure no. 13 Dens in dente.

6. *Dens evaginatus:* A tubercle or protruberance from the involved surface of the affected tooth; occursdue to proliferation or evagination of part of the inner enamelepithelium into the stellate reticulum. Seen in premolars.

Figure no. 14 Dens evaginatus

7. *Gemination :* Single tooth germ splits into partially or fully separated crowns butwith a common root and root canal.
8. *Fusion* Two tooth germs unite to form a single large crown with two root canals;seen in incisors.

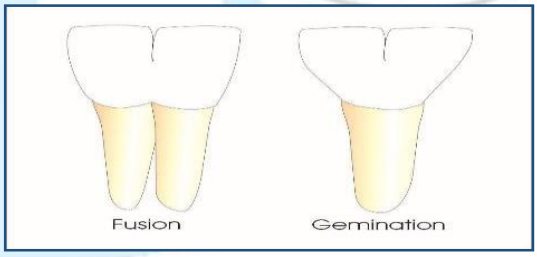

Figure no.15 Gemination and Fusion

9. Dilaceration: Twisting, bending or distortion of a root.

Figure 16: Dilaceration

10.Taurodontism: Enlargement of the body and pulp chamber of a multi-rootedtooth with apical displacement of the pulpal floor and bifurcation of the root.

Figure 17: Taurodontism.

Disturbances During Apposition of Hard Tissues

1. Enamel hypoplasia: Reduction in the amount of enamel formed.

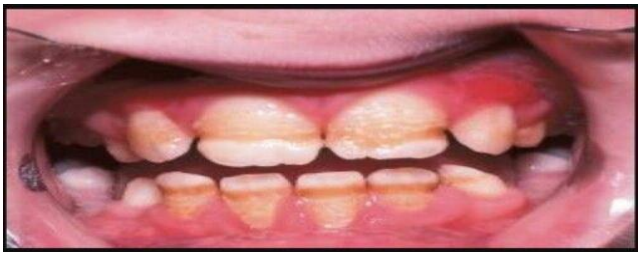

Figure no.18 Enamel hypoplasia

• Local enamel hypoplasia Periapical infection or trauma (Turner's tooth)

• Systemic enamel hypoplasia Rickets, German measles, fluoride ingestion.

• Hereditary enamel hypoplasia Tooth appears yellow due to reduced enamel thickness.

3. Amelogenesisimperfect: Hereditary disorder wherein the quality and quantity of enamel formed is altered. Three types:

Figure no.19 Amelogenesis imperfect

• Hypoplastic Defective matrix formation
• Hypocalcification Defective mineralization of matrix.
• Hypomaturation Immature enamel crystals.

4. Dentinogenesis imperfect: Hereditary developmental disorder of the dentine.

The dentine appears grey to brownish violet, enamel frequently separates from the defective dentine, roots become short, canals get obliterated, rapid attrition is seen.

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Figure 20: Dentinogenesis imperfect

4. *Dentinal dysplasia* Premature loss of teeth, short roots.

5. *Shell teeth* Roots fail to form, pulp chambers are wide.

6. *Odontodysplasia (Ghost teeth)* Enamel and dentine is defective and very thin.

7. Pigmentation of enamel and dentine

• Erythroblastosis fetalis: enamel is green/blue.

• Porphyria: red to brownish

• Tetracyclines: brownish

8.*Cementalhypoplasia* Reduced rate of cementum formation, e.g. hypophosphatasia.

9. *Enamel pearls* Attached to the furcation area of maxillary molars.

Disturbances During Calcification Of Hard Tissue

1. *Enamel hypocalcification* Calcification is subnormal. It may be local, systemic or hereditary.

2. *Interglobular dentine* Areas of partially calcified dentine.

Disturbances During Eruption of Teeth

1. *Concrescence:* Cemental union of two teeth.

2. *Retarded eruption:* Due to endocrine disturbances, vitamin deficiencies, local causes.

3. *Ankylosed teeth:* Teeth fail to erupt to the occlusal level as they are fused to the bone.

Figure no.21Ankylosed teeth

Development of dentition in humans is complex and depends on many variables. Development of dentition deviates markedly from that of other parts and structures of the body. Crowns of teeth are formed directly to adult size and housed within the jaws years Before theyemerge.To determine an abnormal course of development, it is the responsibility of an orthodontist to have adequate knowledge on the subject to differentiate abnormal from normal before initiating therapy.