Development of teeth

5.DM - Pedo
Tooth development

- process of continuous changes in predetermined order
- starts from dental lamina

A band of ectodermal cells growing from the epithelium of the embryonic jaws into the underlying mesenchyme and giving rise to the primordia of the enamel organs of the teeth.

- epithelial thickening appearing at the site of future dental arches
- arises from the epithelium at the border of primary oral cavity
Primary teeth development

• dental lamina for deciduous teeth ➞ primary dental lamina

• originates in the 6th week of fetal life

• dental lamina than proliferates into underlying mesenchymal tissue and forms 10 buds

• epithelium induces condensation of the mesenchymal cells, which are determined for odontogenic lineage
Dental Lamina Cysts
(Bohn’s nodules/ Epstein pearls)

Whitish-yellow nodules which appear on the gums and hard palate in a large percentage of new-born babies.

**Causes**
Bohn’s nodules are odontogenic cysts that arise from the dental lamina. They are filled with keratin. Epstein pearls are epithelial inclusion cysts. The condition is harmless but worries new mothers who may mistake the nodules for emerging teeth.

**Symptoms**
Whitish-yellow nodules which appear on the gums or hard palate.

**diff.dg:**
natal teeth.

**Treatment**
No treatment is necessary. The cysts will disappear within 1-2 weeks of birth.
Primary teeth development

- during subsequent morphogenesis the epithelium at its anterior side proliferates to 10 buds in both jaws
- buds give rise to the enamel organs for primary teeth
- enamel organ of the decidual tooth is differentiated into 4 layers:
Primary teeth development

- By the time enamel organ comes into contact with the dental papilla, the cells of the inner enamel layer are differentiated into special cells - ameloblasts
Odontogenic mesenchyme

- 2 cell lineages –
  1. dental papilla
  2. dental follicle

DENTAL PAPILLA CELLS – give rise to pulpal tissue, its outer layer is differentiated to odontoblasts.

DENTAL FOLLICLE CELLS – surround the tooth germ, give rise to periodontal tissue.

At this stage of development the tooth germ consists of:

- the enamel organ
- the dental papilla
- the follicle (sack)
The following photographs show various stages of early tooth development:

This photo illustrates the earliest extension of the epithelium, called a tooth bud – **bud stage**. The epithelia will continue to proliferate and form a process.

Tooth bud forming process, extending in from dental lamina.

Continued lengthening of the process. Mesenchyme has begun to condense around the base.
The base has begun to expand by the proliferation of the cells along the inner edge. The process becomes flattened at its end and forms the ENAMEL ORGAN.

The expansion of the enamel organ. Note the condensed mesenchyme around the organ. Eventually, the enamel organ epithelia will invaginate and enclose this mesenchyme. This region will become the tooth pulp.

The enamel organ has continued to expand by the proliferation of its epithelium and the base continues to broaden. It has begun to invaginate at one end, enclosing the condensed mesenchyme. This is the beginning of the **cap stage**. The area of enclosed mesenchyme is called the DENTAL PAPILLA.
The cuboidal cells on the upper part of the bell or cap are called the OUTER or EXTERNAL dental epithelium (also called enamel epithelium).

The more columnar cells lining the concave surface of the bell or cap are called the INNER or INTERNAL dental or enamel epithelium. These will become the layer of AMELOBLASTS which deposit enamel.

In this photograph, the columnar cells to the right (forming the base of the enamel organ, are the Inner enamel epithelium (labeled inner). The cells lining the top of the bell (and continuous with the process) are called the outer enamel epithelium (outer). Cells in the center which have lots of spaces between them are called the STELLATE RETICULUM (stellate).

After the enamel organ is formed, the process extending from the oral epithelium will proliferate to form a second tooth bud. Eventually this will become the PERMANENT TOOTH.
View of the top of a tooth.

On top of enamel layer are the ameloblasts.

The dentin is laid down by odontoblasts. They can be seen lined along the inside of the dentin layer.

The innermost region is the dental papilla which is the future pulp cavity.
High magnification – notice dentinal tubules, which radiate from the pulp cavity.

PULP CAVITY - the loose connective tissue, blood vessels, nerves and the inner lining of ODONTOBLASTS.

NECK OF THE TOOTH - the CEMENTUM. Cementum is similar to bone, but there are no Haversian systems. The cells in the cementum are called cementocytes. These can best be seen at the bottom of the tooth.

In-between the tooth and the actual bone is dense connective tissue called the PERIODONTAL LIGAMENT. It actually looks like a tendon. Its collagenous fibers run from the bone into the cementum.
Different stages of tooth development

A. BUD STAGE.
B. CAP STAGE.
C. BELL STAGE.
D. CALCIFICATION OF ENAMEL MATRIX.
E. FORMATION OF THE ROOT.
F. RESORPTION OF ROOTS AT DECIUOUS TOOTH.
THE TIME FOR TOOTH GERM OF PRIMARY TEETH:
3th - 4th month of fetal life

THE MINERALISATION OF PRIMARY TEETH START AT
5th - 6th month of fetal life
The mineralisation the crowns of the primary teeth are end up
2, 4, 9 and 12 month of life

THE ORDER AND EROPTION OF PRIMARY TEETH

\[ i_1 \] - 5-7 month of life
\[ i_2 \] - 6-8 "
\[ m_1 \] - 12-15 "
\[ c \] - 16-20"
\[ m_2 \] - 20-30 "

• The differentiation of odontoblasts is induced by the establishment of the ameloblasts

• The process we call the formation of the dentino-enamel junction

• The inner enamel layer forms the shape of the crown

• When DE junction is formed – ameloblasts and odontoblasts produce enamel and dentin matrices

• Number/shape of teeth – subject to strong genetic regulation

• Epithelial dental lamina possesses all information needed for tooth formation

• Disturbances during early morphogenic events may lead to numeric or morphological aberations
Deposition and structure of dentin and enamel

- Deposition of dentin starts at the sites of the future dental cusps, then spreads down the cuspal slopes.
- Odontoblasts remain lining the dental pulp, their processes form tubular character of dentine.
- Each ameloblast produces one prism.
- Inherited defects of enamel structure may involve gene mutations in the genes coding enamel protein.
Mineralisation of enamel is completed after eruption.

Ions from the oral cavity invade porous enamel surface and completes the enamel formation.
Root formation

• Starts when dentin and enamel depositions reach the junction of inner and outer enamel epithelia

• These epithelia form Hertwig’s epithelial root sheath – located between dental papilla and dental follicle

• Differentiation of root odontoblasts, deposit root dentin

• Apical part of the sheath proliferates and determines the shape and length of the root
Root formation

• Dental follicle cells – cells and fibres of periodontal lig.

• those in contact with root surface – cementoblasts

• organic matrix of cementum

• Cementum covers the root, attaches fibres of the periodontal ligament to the root
Posteruptive maturation of teeth

- After eruption – “immature condition”
- **Process of maturation continues for several years (2-4y):**
  - secondary mineralisation of enamel
  - formation of dentin proceeds for the rest of life
  - after eruption – dentin thin, tubuli wide => maturation =>
    thickness, less penetrable => increased resistance to
caries progress
- production of cementum
- increasing amount of periodontal ligaments, reorganized,
  linking the tooth to the alveolar bone
- at eruption – apical part of root is incomplete, to obtain
  full root length and closure takes several years
ERUPTION: the movement of the developing tooth in axial direction from its original location in the jaw bone to its functional position in the oral cavity.

Eruption Cyst is a bluish, translucent, elevated, compressible, asymptomatic, dome-shaped lesion of the alveolar ridge associated with an erupting primary or permanent tooth. If left untreated, the cyst will spontaneously rupture. The cyst may be marsupialized or punctured to facilitate eruption.
**ERUPTION**

- bone resorption occlusal to the crown
- bone deposition apical to the root
- reduced enamel epithelium covering crown unite with oral epithelium
- tooth emerges through the formed epithelial canal
- eruption continues until reaching the occlusion
- growth of jaws => vertical and mesial drift of the teeth
teeth without root or with completed root can also erupt

pressure of fluids may contribute to the eruptive movements

**selective alveolar bone remodeling** – regulated by the dental follicle, pushes the tooth up...according to this theory...no real „eruptive force“ needed

**periodontal ligament** – real pulling forces, fibroblasts, fibres ... contract + direction of their arrangement during tooth development

**eruption is likely the combination of several factors**
Shedding of primary teeth

• prior to eruption of permanent teeth

• roots of the primary teeth are resorbed

• dentinoclasts appear on the apical surface of the roots of primary teeth

• when permanent tooth is missing the primary predecessor usually undergoes root resorption but in a later time
# Primary roots resorption

<table>
<thead>
<tr>
<th>teeth</th>
<th>start</th>
<th>time</th>
<th>end</th>
</tr>
</thead>
<tbody>
<tr>
<td>incisors</td>
<td>4.year</td>
<td>1,5 – 2 y</td>
<td>6.year</td>
</tr>
<tr>
<td>molars</td>
<td>7.year</td>
<td>2,5 – 3,5 y</td>
<td>10.year</td>
</tr>
<tr>
<td>canines</td>
<td>8.year</td>
<td>2,5 – 3 y</td>
<td>11.year</td>
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Permanent teeth development

- the inner side of dental lamina and both posterior to primary molars – secondary dental lamina
- 16 buds in both jaws
- normally the apex closes 3-4 years after eruption
- Mn teeth develop earlier than Mx
- girls cca half a year ahead of boys
SECONDARY DENTAL LAMINA
12 w. of life

DENTAL GERMS
from 17th w. to 4 year

Mineralisation of the permanent

<table>
<thead>
<tr>
<th>START:</th>
<th>END UP:</th>
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<tbody>
<tr>
<td>birth</td>
<td>3. year</td>
</tr>
<tr>
<td>3.5 month</td>
<td>4. - 6. year</td>
</tr>
<tr>
<td>1½ - 3. year</td>
<td>5. - 8. year</td>
</tr>
<tr>
<td>8. year</td>
<td>12. - 16. year</td>
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THE ORDER and ERUPTION
of the permanent teeth

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<thead>
<tr>
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<tbody>
<tr>
<td>M₁</td>
<td>6. - 7. year</td>
</tr>
<tr>
<td>I₁</td>
<td>6. - 8. year</td>
</tr>
<tr>
<td>I₂</td>
<td>8. - 9. year</td>
</tr>
<tr>
<td>C, P, P₂</td>
<td>10. - 12. year</td>
</tr>
<tr>
<td>M₂</td>
<td>13. - 15. year</td>
</tr>
<tr>
<td>M₃</td>
<td>17. - 21. year</td>
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DEVELOPING STAGES OF THE TOOTH

1. Stage of follicle
2. Stage of start of mineralisation
3. Stage of start mineralisation of crown
4. Stage of start of root development
5. Stage of 2/3 length of root
6. The root has defined length, but walls of canal are parallel
7. The apex is closed
various stages of tooth development – x-ray