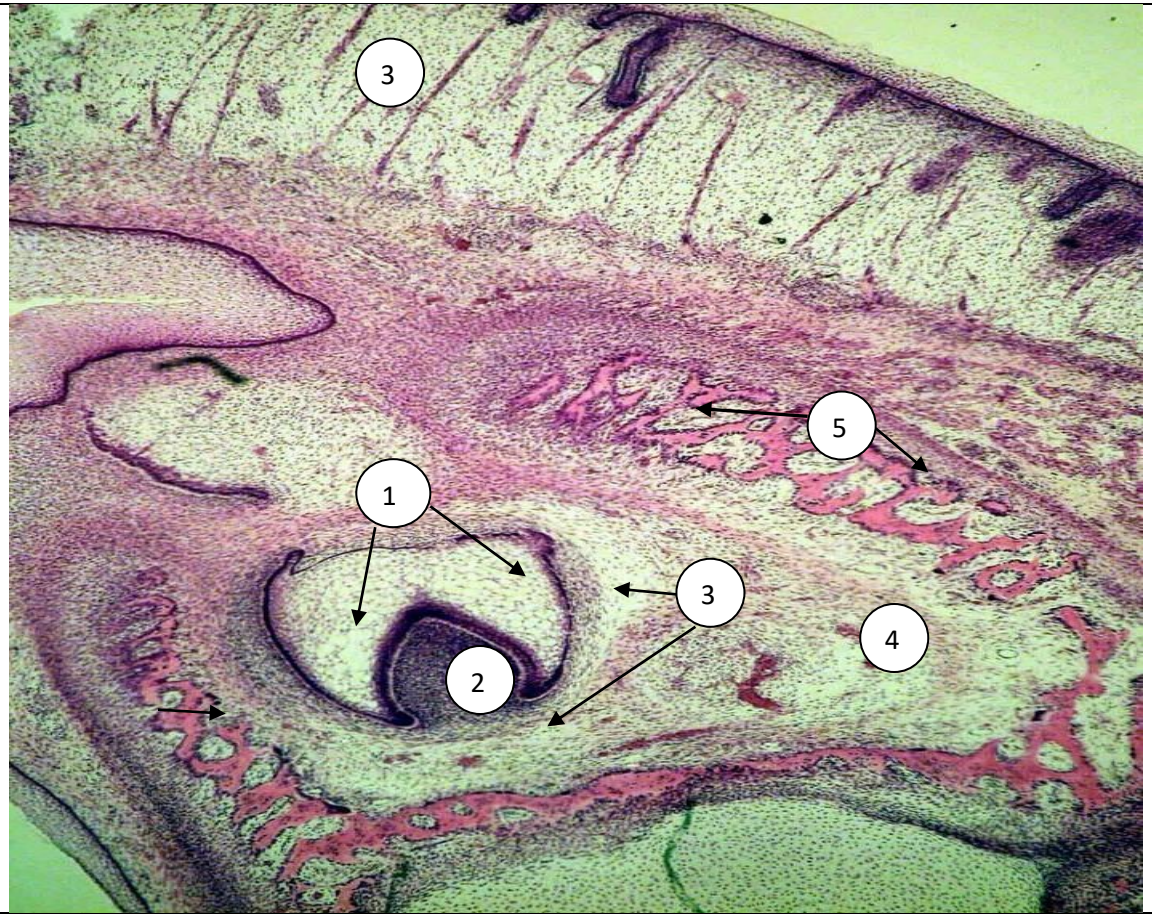
Topic 7. Development of baby and parmanent teeth.

Stages of tooth development			
Stage		**Period of development (week and month)**	**Features**
1.	**Initiation stage**	weeks 6–7 of **embryonic** period	Ectoderm gives rise to the primary epithelial band (oral epithelium).
2.	**Bud stage**	weeks 8–9 of **embryonic** period	Primary epithelial band gives rise to the dental lamina. The combination of the dental lamina and condensed mesenchymal tissues is called the tooth bud and develops into a primary tooth.
3.	**Cap stage**	weeks 10–11 of **embryonic** period	Dental lamina gives rise to the enamel organ and mesenchyme gives rise to the dental papilla. **Enamel organ** has concave shape and looks like a cap-shaped structure with mesenchymal cells beneath it. Other mesenchymal cell layers surrounding the enamel organ and **dental papilla** are called the **dental sac** (dental follicle). At this stage, the morphogenesis and formation of the tooth germs.
4.	**Bell stage**	weeks 12–14 of **embryonic** period	Differentiation of the **enamel organ**. It consists of **stellate reticulum**, **stratum intermedium**, **inner** and **outer enamel epithelium**. Differentiation of the **dental papilla** to **the outer cells of the dental papilla** and **the inner cells of the dental papilla**.
5.	**Differentiation of dental germs**	weeks 14–16 of **embryonic** period	1) The **inner enamel epithelium** is a row of columnar cells which differentiate and later become ameloblasts. 2) The **stratum intermedium** is composed of two to three layers of squamous or cuboidal cells and is located between the stellate reticulum and inner enamel epithelium. They are rich in alkaline phosphatase and to assist to production of enamel. 3) **Stellate reticulum** have star shaped and many cellular processes interconnected with one another to form a network within the enamel

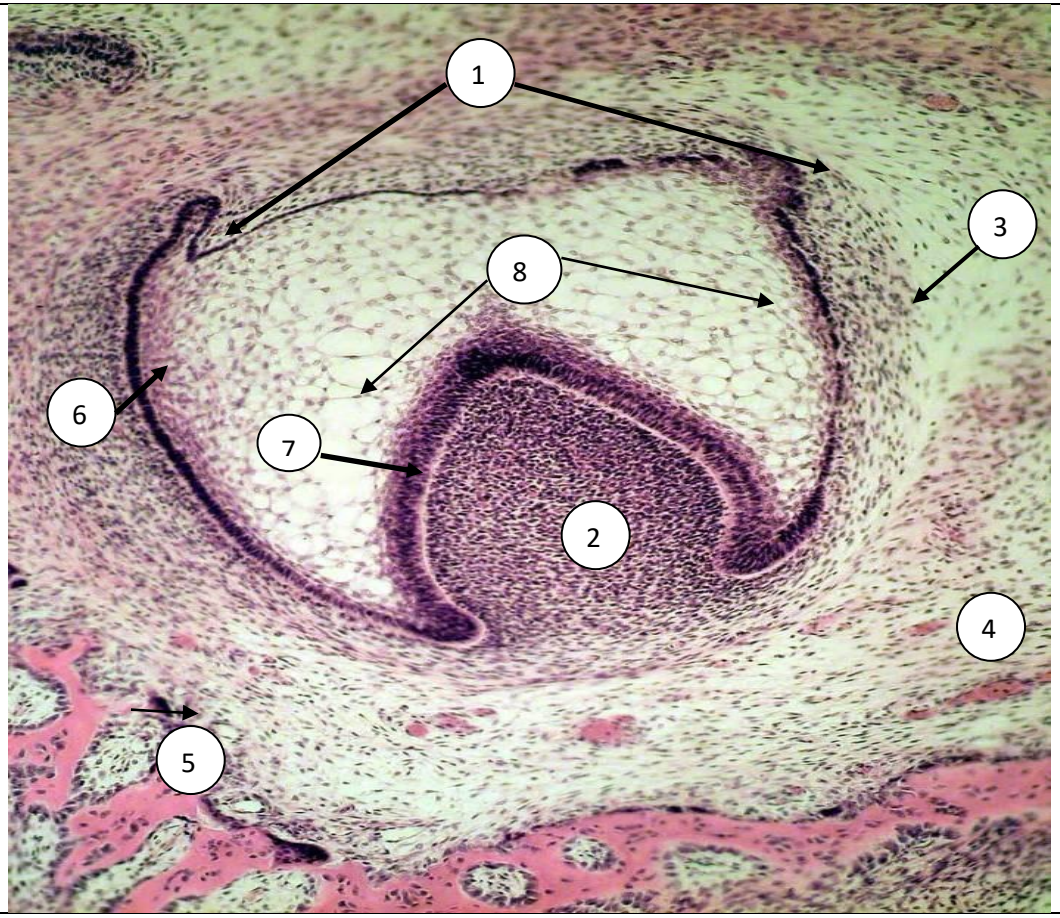
			organ. They contain **glycosaminoglycans** and **alkaline phosphatase.** There are desmosomes and gap junctions between the cells. 4) The **outer enamel epithelium** is composed of cuboidal cells and is the outermost layer of the enamel organ. This cell layer separates the enamel organ from the nearby mesenchymal tissues.
6.	**Root formation and eruption**	6-7 month of the **postnatal** period	The formation of the root begins at the **epithelial root sheath** (**Hertwig epithelial root sheath**), which develops from the cervical loop (distention between inner and outer enamel epithelia). The **epithelial root sheath** grows around the dental papilla. It induces the outer cell layer of the dental papilla to differentiate into odontoblasts, which produce the root dentin. When the root dentin has formed, the mesenchymal cells from the dental sac come in contact with the surface of the root dentin and induce these cells to differentiate into cementoblasts, which produce cementum.
7.	**Apposition stage (amelogenesis)**	from 4–5 month of **embryonic** period	The inner enamel epithelium gives rise to the **preameloblasts**. They gives rise to the **ameloblasts**. They actively secrete enamel matrix with assistance from the stratum intermedium. **Enamel** formation **moves outward (toward the enamel organ)**, and **dentin** formation **moves inward (toward the dental pulp)**. In the apposition stage, the two types of hard tissues (dentin and enamel) begin to form at the tooth crown.
8.	**Apposition stage (dentinogenesis)**	from 4–5 month of **embryonic** period	Outer cells of the dental papilla give rise to the **odontoblasts**. **Mature odontoblasts** are columnar shape and they produce dentinal matrix (**predentin**). The predentin soon becomes calcified and is called **dentin**. Dentin formation proceeds from the crown to the root.
Dongmei CuiJohn P. NaftelJonathan D. FratkinWilliam DaleyJames C. Lynch.: Atlas of Histology, With Functional and Clinical Correlations, Lippincott Williams and Wilkins, 2010			

Basic dental germs				
Name		**Embryonic tissue**	**Germ derivatives**	
1.	Enamel organ	Ectodermal epithelium	Outer enamel epithelium	Cuticle
			Inner enamel epithelium	Enamel
2.	Dental papilla	Mesenchyme	Dentin and pulp of tooth	
3.	Dental sac	Mesenchyme	Periodontal ligaments, cementum, alveolar processes of the maxilla and mandible.	



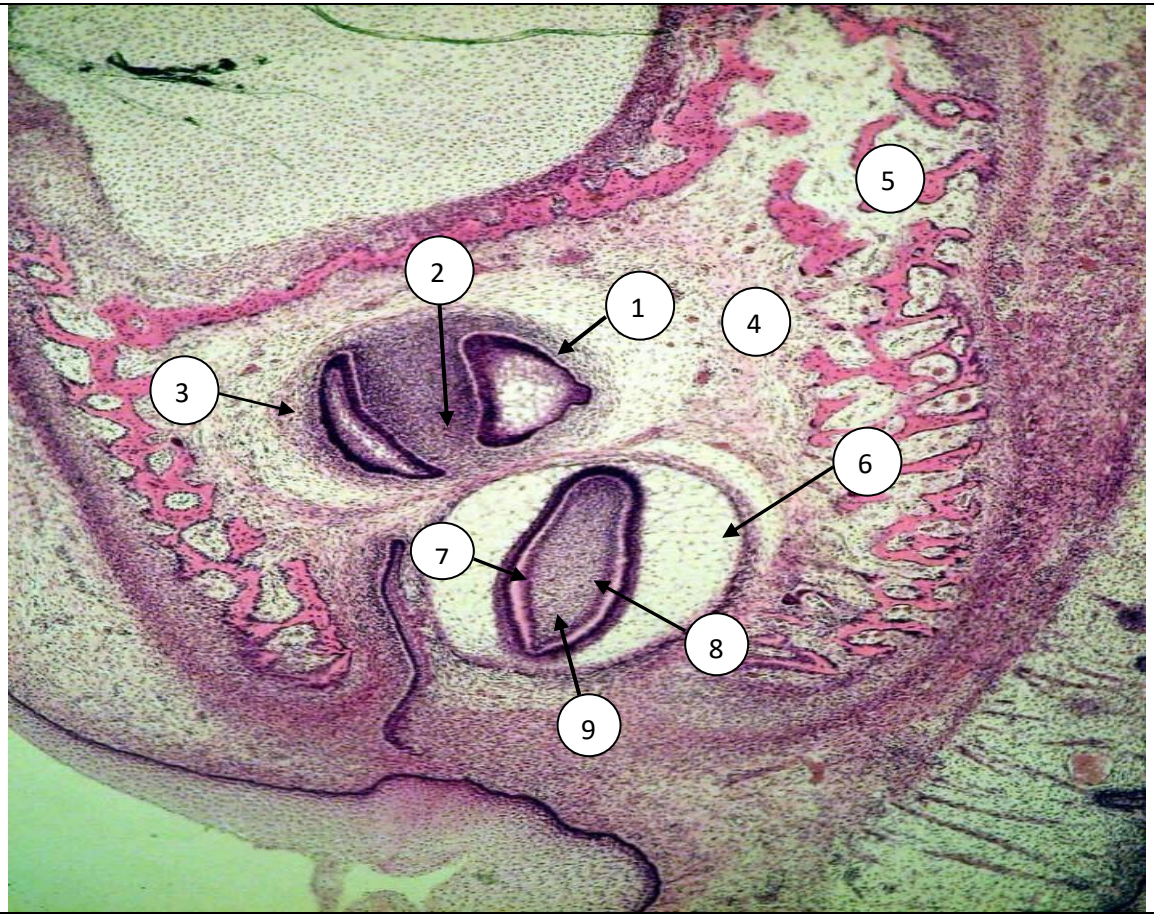
Tooth germ differentiation
Magnification X 40.

On the preparation of the tooth germ differentiation there are three main dental germs: enamel organ (1), dental papilla (2) and dental sac (3). They surrounded by mesenchymal cells (4) and regions of bone tissue (5).



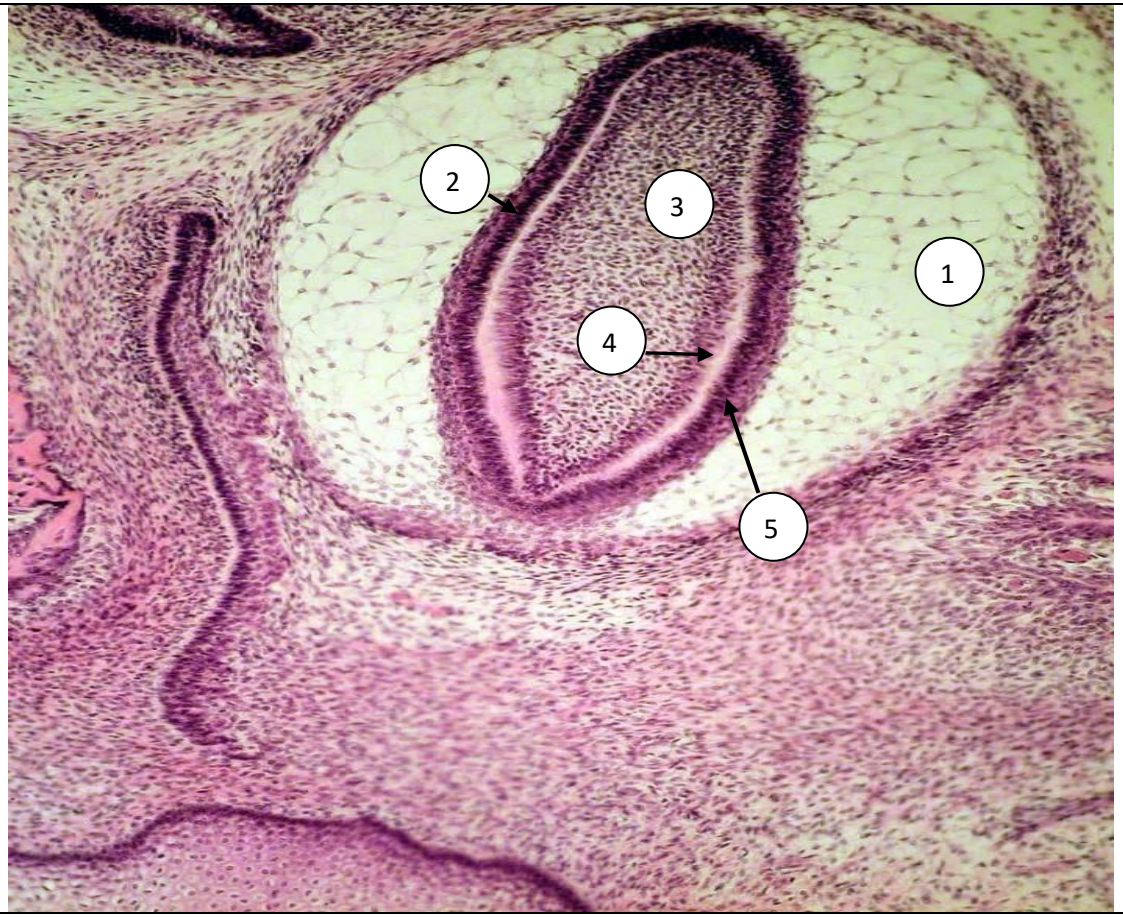
Tooth germ differentiation
Magnification X 100.

On the preparation of the tooth germ differentiation there are three main dental germs: enamel organ (1), dental papilla (2) and dental sac (3). They surrounded by mesenchymal cells (4) and regions of bone tissue (5). Enamel organ consists of external enamel epithelium (6), internal enamel epithelium (7) and stellate reticulum (8).



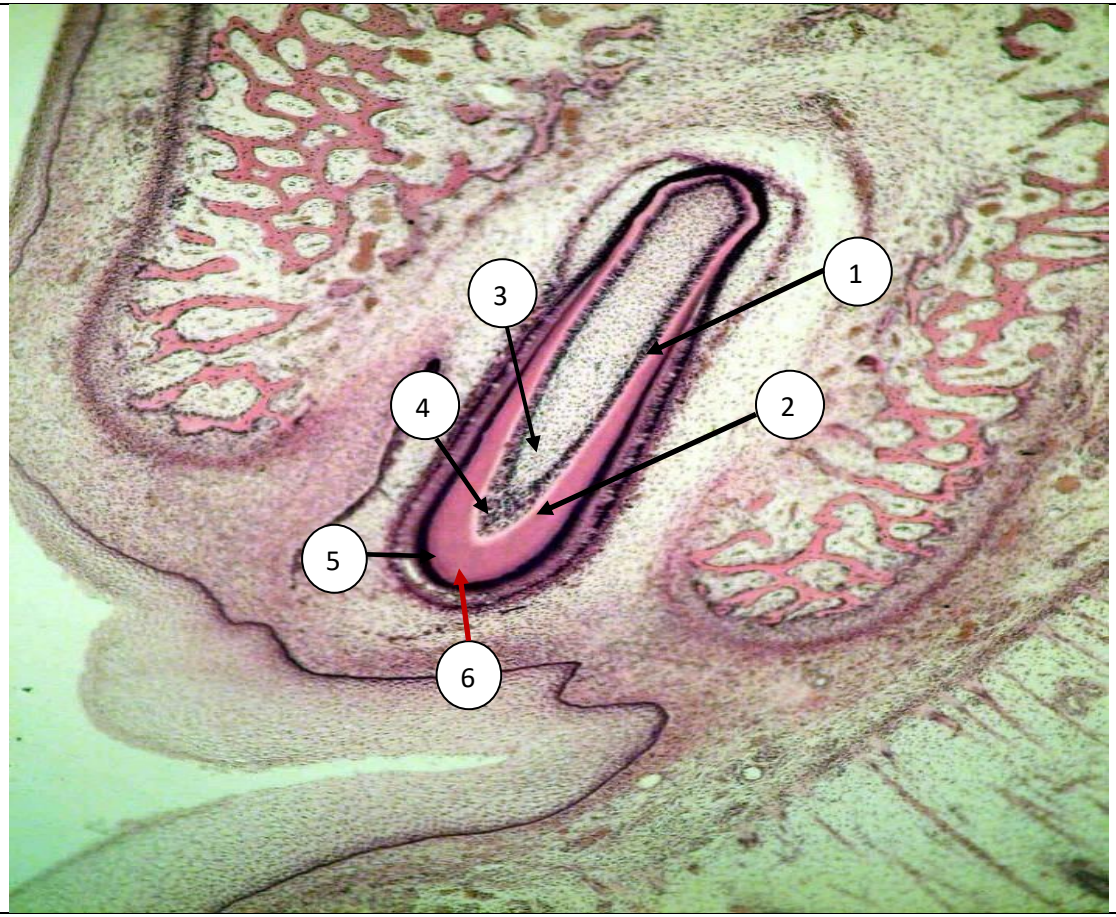
Dental tissue formation
Magnification X 100.

On the preparation of the dental tissue formation there are three main dental germs: enamel organ (1), dental papilla (2) and dental sac (3). They surrounded by mesenchymal cells (4) and regions of bone tissue (5). On this preparate there is region with formation of dental tissue. It includes stellate reticulum (6), internal enamel epithelium (7) and dental papilla (8) with odontoblast layer (9).



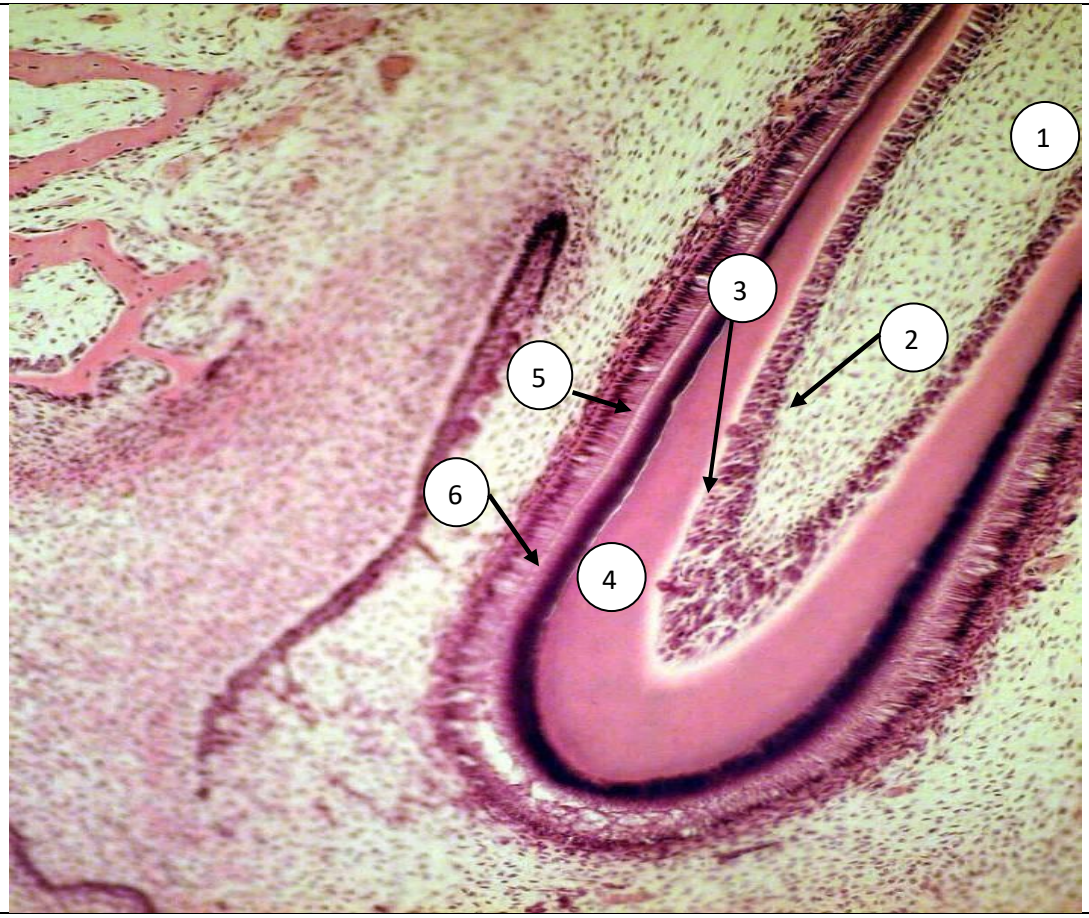
Dental tissue formation
Magnification X 100.

On the preparation there is region with formation of dental tissue. It includes stellate reticulum of enamel organ (1), internal enamel epithelium of enamel organ (2), dental papilla (3) with odontoblast layer (4) and process predentine formation (5).



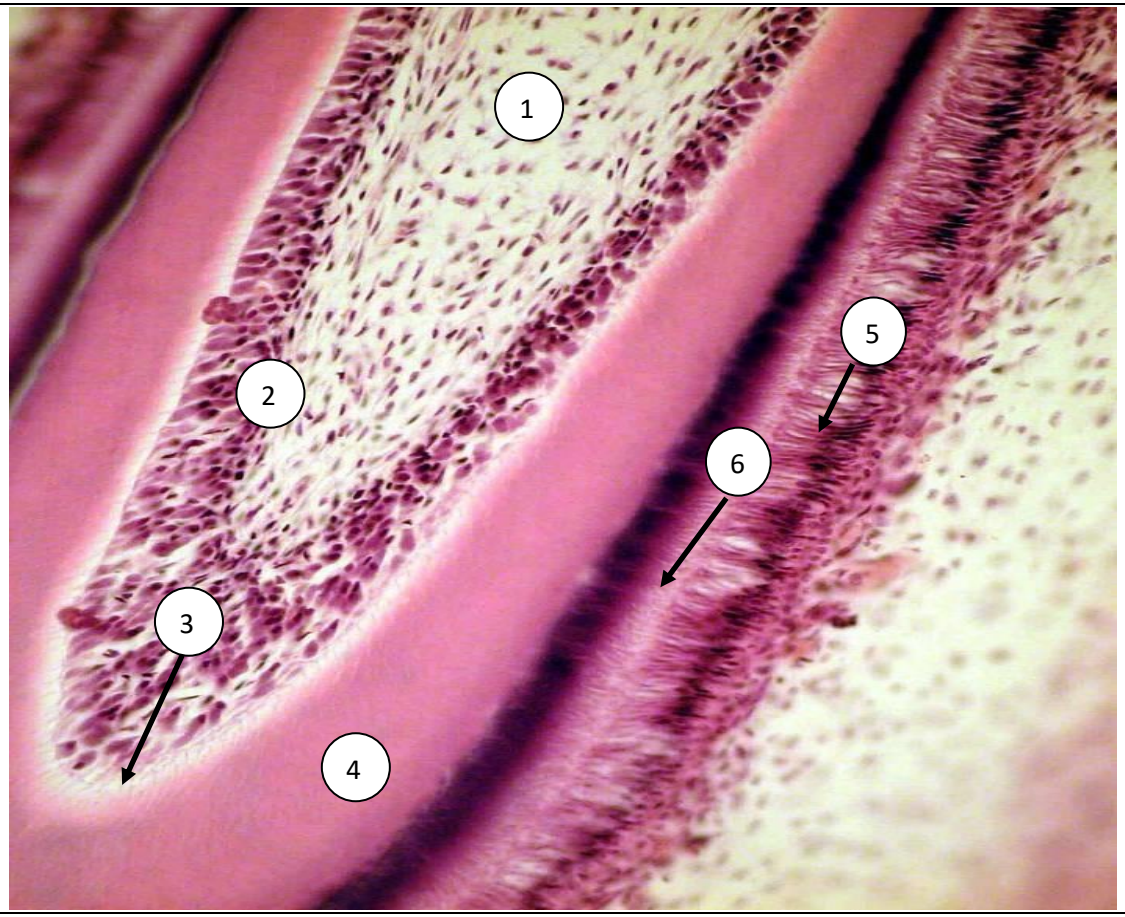
Histogenesis of enamel and dentine
Magnification X 40.

On the preparation there is region with formation of dental tissue. It includes dental papilla (1) with odontoblast layer (2). Odontoblast are responsible for the formation of dentine matrix (3) and dentine (4). Single-layered columnar ameloblasts (5) produce enamel (6).



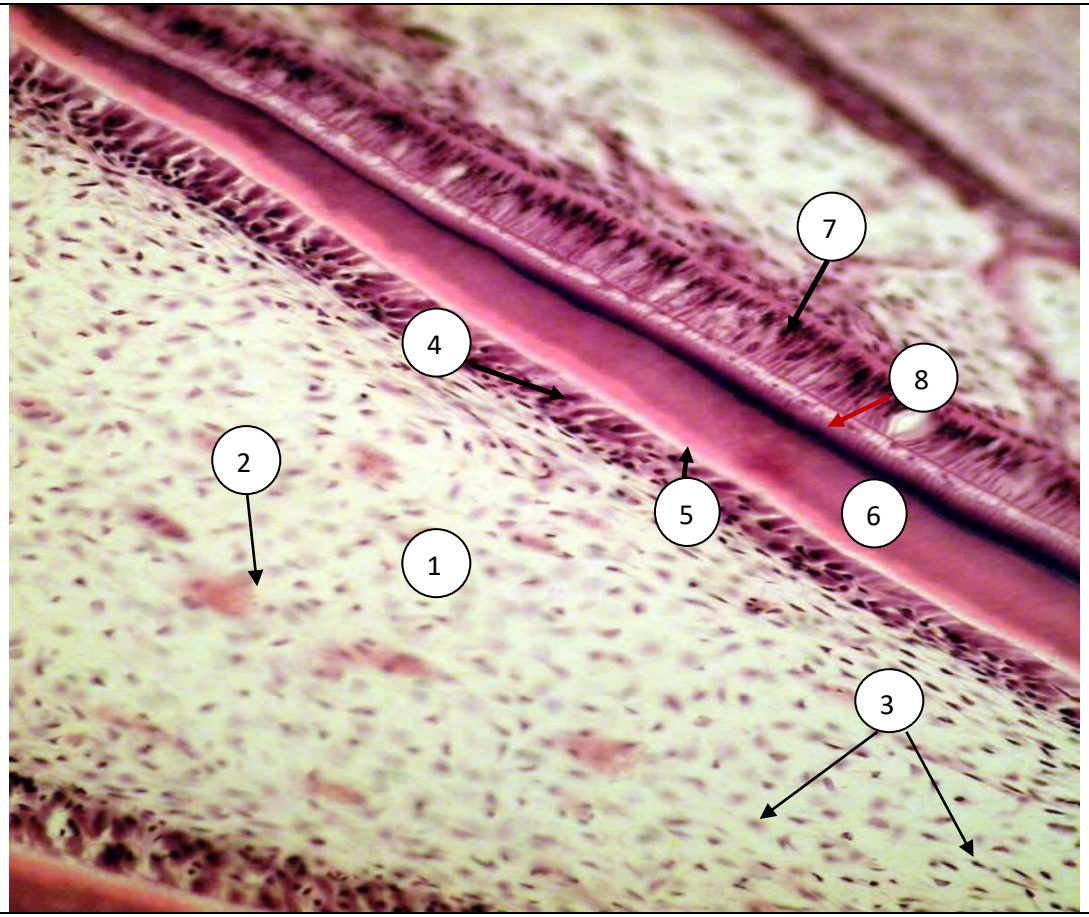
Histogenesis of enamel and dentine
Magnification X 100.

On the preparation there is region with formation of dental tissue. It includes dental papilla (1) with odontoblast layer (2). Odontoblast are responsible for the formation of dentine matrix (predentine) (3) and dentine (4). Ameloblasts (5) are highly elongated columnar cells that manufacture enamel (6).



Histogenesis of enamel and dentine
Magnification X 400.

On the preparation there is histogenesis of enamel and dentine. This process is characterized by cell apposition. On the preparation there is dental papilla (1) with odontoblast layer (2). Odontoblast are responsible for the formation of dentine matrix (predentine) (3) and dentine (4). Ameloblasts (5) are highly elongated columnar cells that manufacture enamel (6).



Histogenesis of enamel and dentine
Magnification X 400.

On the preparation there is histogenesis of enamel and dentine. This process is characterized by cell apposition. On the preparation there is dental papilla (1) which includes blood vessels (2) and fibroblasts (3). The central part of the dental papilla forms the pulp of the tooth. The peripheral part of the dental papilla contains odontoblast layer (4). Odontoblast are responsible for the formation of dentine matrix (predentine) (5) and dentine (6). Ameloblasts (7) are highly elongated columnar cells that manufacture enamel (8).

VOCABULARY

Dental lamina – is an area of epithelial tissue, which histologically is the first sign of tooth development and is formed (in humans) starting from the sixth week of development.

Enamel organ - a circumscribed mass of ectodermal cells budded off from the dental lamina; it becomes cup shaped and develops on its internal face the ameloblast layer of cells that produce the enamel cap of a developing tooth. It has three layers in the cap stage and four layers in the bell stage of tooth development.

Internal enamel epithelium – is a columnar epithelial cells that form the lower surface of the enamel organ and adjoining the tooth papilla.

Stellate reticulum cells – are star-shaped cells located in the middle of the enamel organ, which produce and secrete glycosaminoglycans into the intercellular space, attracting water into it. The intercellular fluid separates the cells, and the intercellular connections are maintained by desmosomes, making the cells of the stellate reticulum star-shaped.

Stratum intermedium is a stratified layer of cells located between the inner enamel epithelium and the stellate reticulum. The cells of the intermediate layer have a high activity of alkaline phosphatase and together with the cells of the inner enamel epithelium act as one functional unit in the process of enamel formation.

Outer enamel epithelium are cuboidal epithelial cells on the outer margin of the enamel organ. The outer enamel epithelium and the inner enamel epithelium are continual, and their connection forms a bell rim called the cervical loop. Cervical loop cells keep proliferating through the crown stage and play a key role in root development.

Ameloblasts – a group of cells derived from the ectoderm from which tooth enamel forms. The differentiation of ameloblasts is induced by more developed odontoblasts and stratum intermedium cells through molecular signals such as FGF and BMP. The main proteins of the enamel matrix are enamelins, amelogenins and ameloblastins, which are secreted by ameloblasts to the external environment.

Dental papilla is a protrusion of dense mesenchyme within the dental organ and a cap from which dentin and tooth

pulp are developed. It consists mainly of mesenchymal cells, some macrophages and fibroblasts. Mesenchymal cells together with fibroblasts exhibit a stellate morphology and become reduced in number as the dental papilla transforms into pulp.

Dental sac (follicle) - The human dental follicle is a tissue sac and as a part of the tooth germ it surrounds the whole enamel organ and limits the dental papilla at early stages of tooth development. It is accumulation of compacted mesenchyme around the dental organ and the dental papilla, from which cementum and periodontal ligament are being formed. The dental follicle surrounds the tooth germ during the early stages of tooth development, and plays a crucial role in tooth eruption and tooth development. During tooth development the dental follicle starts to disappear.

Links:

https://www.sciencedirect.com/topics/medicine-and-dentistry/stratum-intermedium
https://www.sciencedirect.com/book/9780323608268/pediatric-dentistry

TESTS

1. Electron microscopy of **periodontal fibers revealed that some of their ends are embedded in the cement** of the tooth root, and **others in the periosteum of the alveolar ridge**. What are these fibers?

Sharpey fibers
Korff fibers
Ebner fibers
Purkinje fibers
Argyrophilic fibers

2. The histologic preparation in the **periodontium shows thick bundles of collagen fibers that ensure the fixation of the tooth in the dental alveoli**. What fibers are located in the cervical region of the tooth?

Circular
Oblique
Apical
Elastic
Myelinated

3. A histological preparation of the **periodontium shows a dense connective tissue consisting of thick bundles of collagen fibers and providing the attachment of the tooth in the dental alveoli**. This structure has a special name:
Dental fiber connections
Breakthrough fiber
Myelinated fibers
Korff fibers
Ebner fibers

4. To fix the tooth in the alveolar sockets of the upper and lower jaws, there are **periodontal fibers located in different directions**. How periodontal fibers are oriented **on the sides of the root**?
Obliquely
Vertical
Horizontal
Perpendicular
Circularly

5. The histological specimen shows a developed tooth that has an **acid-resistant coating**, but **it can be found only on the lateral surfaces of the tooth**. What is meant by the coating?
Cuticle
Dentine
Enamel pellicle
Enamel
Cement

6. In a primary tooth, **during the formation of mantle dentin, the secretory activity of odontoblasts was impaired**. Which fibers will be affected?
Korff fibers
Reticular fibers

Elastic fibers
Ebner fibers
Nervous fibers

7. **Irregular dentinal tubules and collagen fibrils were identified in a decalcified adult tooth.** Name this type of dentin?
Secondary dentine
Primary dentine
irregular dentine
Sclerotic dentine
"Dead" tracts

8. During the extraction of a tooth**, dark areas of dentin are found on the cross-section.** Which process resulted in the formation of these areas?
Disorder of dentine
Proliferationof dentinoblasts
Hypertrophia of dentinoblasts
Atrophy of dentinoblasts
Proliferation of fibroblasts

9. In **thin areas** of dentin of an elderly person**, radial light borders can be found. These areas are called**?
Predentine
"Dead tracts"
Secondary dentine
All
Irregularly dentine

10. **The Gertwig's sheath** around the tooth is damaged**.** What layer of the tooth does this prevent from developing?
Cementum
Enamel papillae

Enamel saccule
Pulp
Dentine

11. The student made a mistake when answering the question about the **composition of periodontium**, naming Merkel's cartilage tissue and the gingival sac. What is the correct answer?
Periodontum, gingival, alveolar processus
Pulp, apex, periodontum
Periodontum, cementum, alveolar processus
Gingiva, papillae of gingiva, alveolar processus
-

12. The **crown is constantly being filed down** during its lifetime. What is the **mechanism that keeps the total length of the tooth constant during life?**
Growth of roots
Formation of dentine
Growth of periodontum
Reducing the pulp chamber
Growth of enamel

13. Examination of the histological specimen of the **child's milk tooth revealed hypoplasia** (**underdevelopment) of the enamel**. This anomaly is caused by **disorders in the activity of the following cells:**
Inner enamel epithelium
Pulp cells of the enamel organ
Outer enamel epitelium
Cells of the stratum intermedium of the enamel organ
Odontoblasts

14. On the histological preparation of the **enamel organ** of the tooth embryo, the **outer surface is rough, and the cells of the inner layer have reversed polarity (inversion of nuclei)**. Identify the beginning of the process that preceded these changes.

Enamelogenesis
Dentinogenesis
Pulpogenesis
Cementogenesis
Periodontal development

15. An examination of the patient revealed **enamel abnormalities**. What structural components of the tooth **germ are affected**?

Inner epithelium of enamel organ
Intermediate layer of the enamel organ
Pulp of enamel organ
Outer epithelium of enamel organ
Neck of enamel organ

16. In the process of **developing a baby tooth, dentin tissue is formed**. What is the source of its development?

Dental papilla
Dental pouch
Tooth plate
Inner cells of the enamel organ
Outer cells of the enamel organ

17. When examining a histological preparation of **tooth pulp**, it is observed that **collagen fiber bundles predominate in the connective tissue, the odontoblast layer is thin, and the intermediate layer is weakly expressed**. Which part of the tooth does the pulp have the following features?

Root pulp
Coronal pulp

Layer Weil
Peripheral layer of pulp
The central layer of pulp

18. The histological **preparation of the tooth shows an enamel organ in the form of a "bell", in which the outer cuboidal enamel cells, tall inner prismatic cells and centrally located cells with processes forming a network are visible**. What period of the tooth is represented on the picture?
During the formation and differentiation of dental germs.
Period bookmarks dental germs.
During the formation of the tissues of the tooth crown.
During the formation of the tissues of the tooth root.
Odontiasis period.

19. When the tooth develops, the **enamel organ has prismatic cells with a hexagonal cross-section, the nucleus of which is located in the central part of the cell**. What cells are we talking about?
Preenameloblasts
Exterior enameloblasts
Cambial cells
Enamel pulp cells
Preodontoblasts

20. In the course of embryogenesis of the oral cavity, the **development of tooth enamel was disturbed**. What fetal source of tooth development was damaged?
Epithelium
Mesenchyma
Mesoderma
Dental saccule
Dental papilla

21. A histological preparation of the lower jaw of an embryo shows a **tooth formation with a dental papilla consisting of small stellate basophilic cells**. What tissue forms this part of the tooth germ?
Mesenchyme
Epithelial
Reticular
Cartilaginous
Osseous

22. During experiments of dental germs **was destroyed the inner layer of the epithelium of the enamel organ**. Development of which tissue of tooth is broken?
Enamel
Dentine
Cementum
Pulp
Periodontal ligament

23. In embryonic development, the **surface of the mesenchymal cells of the dental epithelium of the dental papilla was damaged.** What tooth tissue formation disorders can result from this?
Dentine
Enamel
Cementum
Periodontum
Enamel cuticle

24. During tooth morphogenesis, the **cells of the internal dental sac were damaged**. What tooth tissue will be affected?
Cementum
Enamel
Dentine
Pulp

Periodontum

25. After a radiograph **an 11 year old child's lateral incisors are absent**. This is connected with?
Disorder the formation of enamel organs
Disorder the formation of enamel saccule
Disorder the formation of enamel papilla
Disorder the formation of dentine
Disorder the formation of cementum

26. In embryogenesis the oral tooth **enamel develops** from:
Epithelial
Mesenchyme
Ectoderma
Enamel saccule
Enamel papilla

27. Which cells during tooth **development are characterized by inversion** (organelles and nucleus move to opposite side), and change the polarity?
Enameloblasts
Odontoblasts
Preodontoblasts
Cementoblasts
Cementocytes

28. In embrogenesis the oral **periodontum develops** from:
Enamel saccule
Enamel papillae
Enamel lamilla
Paraenamelobasts

Enameloblasts

29. Harmful irritation of the tissue of the tooth resulted in the **formation of denticular structures across the peripheral zone of the pulp**. How does this phenomenon influence the existence of the tooth?
Loss of dentine regeneration ability
Loss of pulp regeneration ability
Loss of cementum regeneration ability
Loss of tooth innervation
Loss of enamel regeneration ability

30. During **enamel formation**, the process of its extraction from water and **protein was being damaged**. At what stage of enamel development does this happen?
Maturation (secondary mineralization)
Secretion (Primary mineralization)
Formation of secretory ameloblast
Formation of maturation ameloblast
Formation of dental germs

31. On an electron microphotography is **presented interprism enamel**. Which cells from it?
Secretory ameloblast
Enameloblasts II
Enameloblasts I
Preenameloblasts
Secretory active odontoblast

32. During the study of a histologcal specimen, a baby's tooth revealed a **strict dark line that seperates the enamel that formed after birth**. Name this structure?
Neonatal line
Enamel lamellae

Lines of Retzius
Enamel spindles
Enamel fascicles

33. On an electronic microphotography of **enamel organ reveals a prismatic cell with developed granular endoplasmic reticulum and Golgi complex**. At the apical part of the cell -Tom's process containing secretory granules and small vesicles. Identify this cell?
Ameloblast secretory active
Preenameloblast
Outer layer cells of enamel organ
Cells of pulp enamel
Cells of enamel organ

34. In the cement carrries were observed, destructive changes in the cement; its resorption. Specify the origin of the **cement's development**?
Inner cells of dentes sacculus
Outer cells of dentes sacculus
Intermediate cells of enamel organ
Inner cells of enamel organ
Outer cells of enamel organ

35. Histological specimen of the mandible reveals **10 tooth buds associated with dental plate**. Which element of the tooth's germ will **develop from them?**
Enamel organ
Enamel papillae
Enamel saccule
Enamel fascicles
Enamel pearls

Links:

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