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Department of Histology, Cytology and Embryology

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Textbook for students of higher education of English speaking

SPECIAL HISTOLOGY OF THE DIGESTIVE SYSTEM IN FIGURES AND DIAGRAMS

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Textbook for students of higher education of English speaking, EPP «Dentistry», EPP «Medicine», 22 «Healthcare», specialty 221 Dentistry, specialty 222 Medicine. The material of the textbook includes vocabulary, tables, diagrams and microphotographs. Provides systematization of knowledge of students, facilitates preparation for employment, gives the chance to make the analysis of structural features of organs of digestive system, promotes development of knowledge, abilities and skills.

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Topic 1. General structure of digestive system organs. Face development and organs of oral cavity.

<table>
<tr><th colspan="5">General structure of digestive system</th></tr>
<tr><th colspan="2">Oral cavity and associated structures</th><th colspan="2">Alimentary canal</th><th>Accessory glands and gallbladder</th></tr>
<tr><td rowspan="5">Organs of oral cavity</td><td>Lips</td><td colspan="2">Esophagus</td><td rowspan="2">Liver</td></tr>
<tr><td>Tongue</td><td colspan="2">Stomach</td></tr>
<tr><td>Cheeks</td><td rowspan="4">Small intestine</td><td>Duodenum</td><td rowspan="4">Pancreas</td></tr>
<tr><td>Teeth and suppoting tissues</td><td rowspan="2">Jejunum</td></tr>
<tr><td>Gums</td></tr>
<tr><td>Hard and soft palate</td><td>Ileum</td></tr>
<tr><td rowspan="3">Salivary glands</td><td>Submandibular gland</td><td rowspan="3">Large intestine</td><td>Colon Colon</td><td rowspan="3">Gallbladder</td></tr>
<tr><td>Parotid gland</td><td>Appendix</td></tr>
<tr><td>Sublingual gland</td><td>Anal canal</td></tr>
</table>

General structure of the digestive tract wall			
1.	**Mucosa**	Epithelium	Stratified squamous or simple columnar
		Lamina propria	Loose connective tissue
		Muscularis mucosae (lamina muscularis mucosae)	Smooth muscles tissue
2.	**Submucosa**	In the esophagus and duodenum the submucosa includes glands.	Loose connective tissue
3.	**Muscularis externa**	Can has one, two or three layers.	Smooth muscles tissue or striated muscles tissue
4.	**Adventitia or serosa**	Adventitia and serosa have one difference.	Adventitia includes loose connective tissue. Serosa consists loose connective tissue and mesothelium.

Development of face	
Inside view	**Outside view**
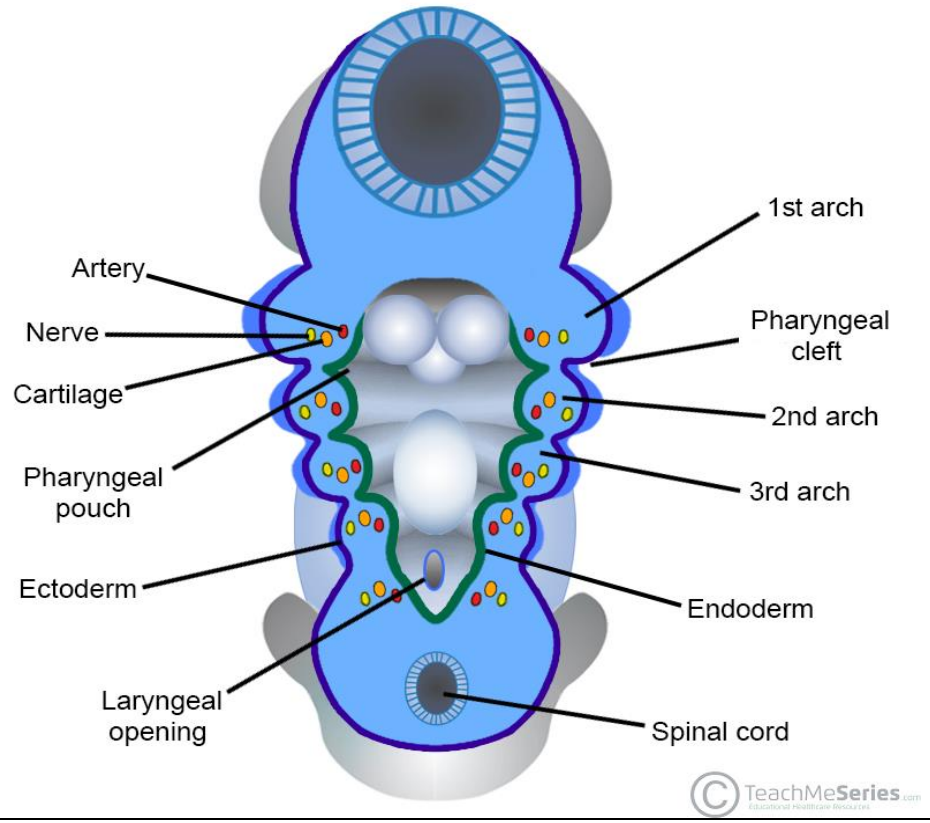	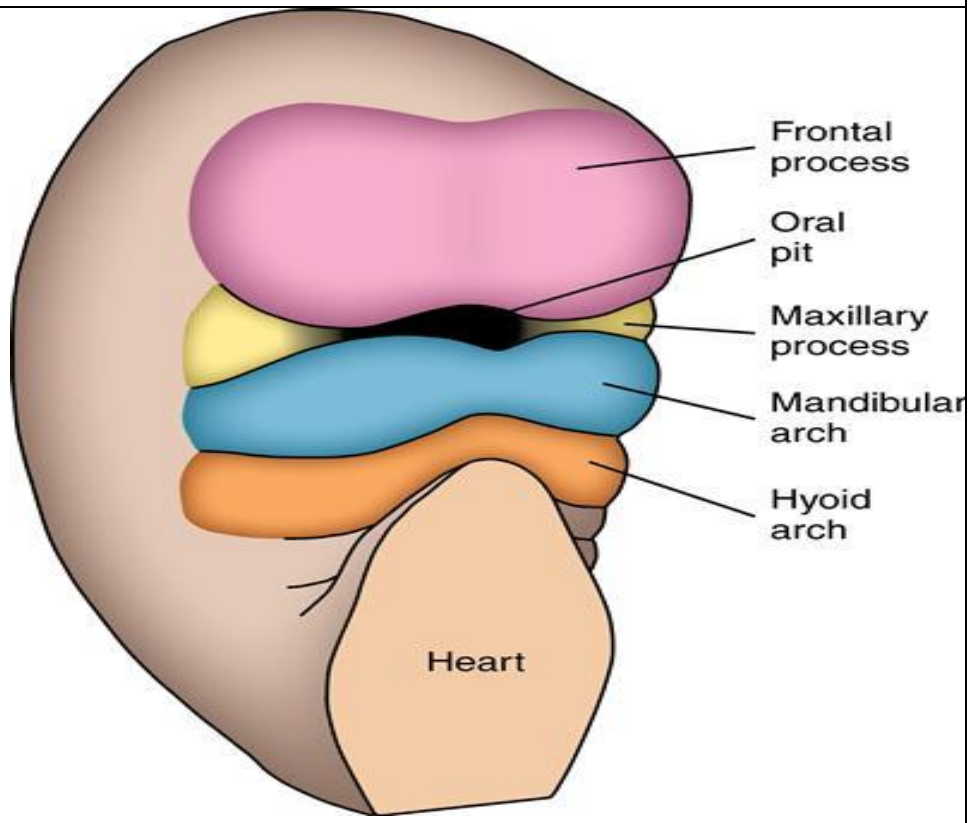
Fig. 1 https://teachmeanatomy.info/the-basics/embryology/head-neck/face-palate/	Fig. 2 https://pocketdentistry.com/4-development-of-the-face-and-palate/

Germinal layers and their derivatives		
1.	**Ectoderm**	Pharyngeal clefts
2.	Mesenchyme (thickening between the ectoderm and endoderm)	Pharyngeal arches
3.	Endoderm	Pharyngeal pouches

Pharyngeal arches and their derivatives		
Arches		**Derivatives**
1.	First arch (1st arch)	Maxillary, mandibular processes and frontonasal (prominence), malleus, incus (auditory ossicles).
2.	Second arch (2nd arch)	Stapes (auditory ossicle), styloid process of the temporal bone, lesser cornu of the hyoid bone, stylohyoid ligament.
3.	Third arch (3rd arch)	Greater horns of the hyoid bone, the body of the hyoid bone.
4.	Fourth arch (4th arch)	Thyroid cartilage of the larynx

Rudiments of facial skull bones			
Rudiments (Prominence or process)		**Derivatives**	**Developmental pathology**
1.	Frontal (frontonasal) process	Medial nasal, lateral nasal processes and frontal prominence proper, forehead, bridge of nose.	
2.	Maxillary processes	Cheeks, lateral upper lip, secondary palate, lateral upper jaw (maxilla).	Upper micrognathia
3.	Mandibular processes	Mandible (Meckel's cartilage gives rise mandibular bone), lower lip.	Middle cleft of the lower lip and lower jaw, microgeny or lower micrognathia.
4.	Upper part of the maxillary processes merge (connect) with the lateral nasal processes	Form the upper lip	Eye -nasal slit or oblique cleft of the face
5.	Lower part of the maxillary processes merge (connect) with	Form the upper lip	Lateral cleft of the upper lip (unilateral or bilateral).

	the medial nasal processes		
6.	Medial nasal processes	Medial part of the nose and medial part of the upper lip, philtrum, primary palate, upper 4 incisors.	Congenital middle cleft of the upper lip
7.	Lateral nasal processes	Lateral parts of the nose	
8.	Upper part of the maxillary processes merge (connect) with the lateral nasal processes	Nasolacrimal furrow (gives rise to the nasolacrimal duct)	Eye -nasal slit or oblique cleft of the face
9.	Lower part (medial part) of the maxillary processes merge (connect) with the medial nasal processes	Form the upper jaw (maxilla).	Lateral cleft of the upper lip (unilateral or bilateral).
10.	Concrescence of lateral departments of maxillary and mandibular processes	Intermediate area of the cheeks and rudimentary embryonic suture	Macrostomy and transverse cleft of face, microstomy.
Tab. 1 https://youtu.be/p8eeITuhFQg , https://pocketdentistry.com/4-development-of-the-face-and-palate/.			

Development of face from 5 to 10 weeks of embryonic development

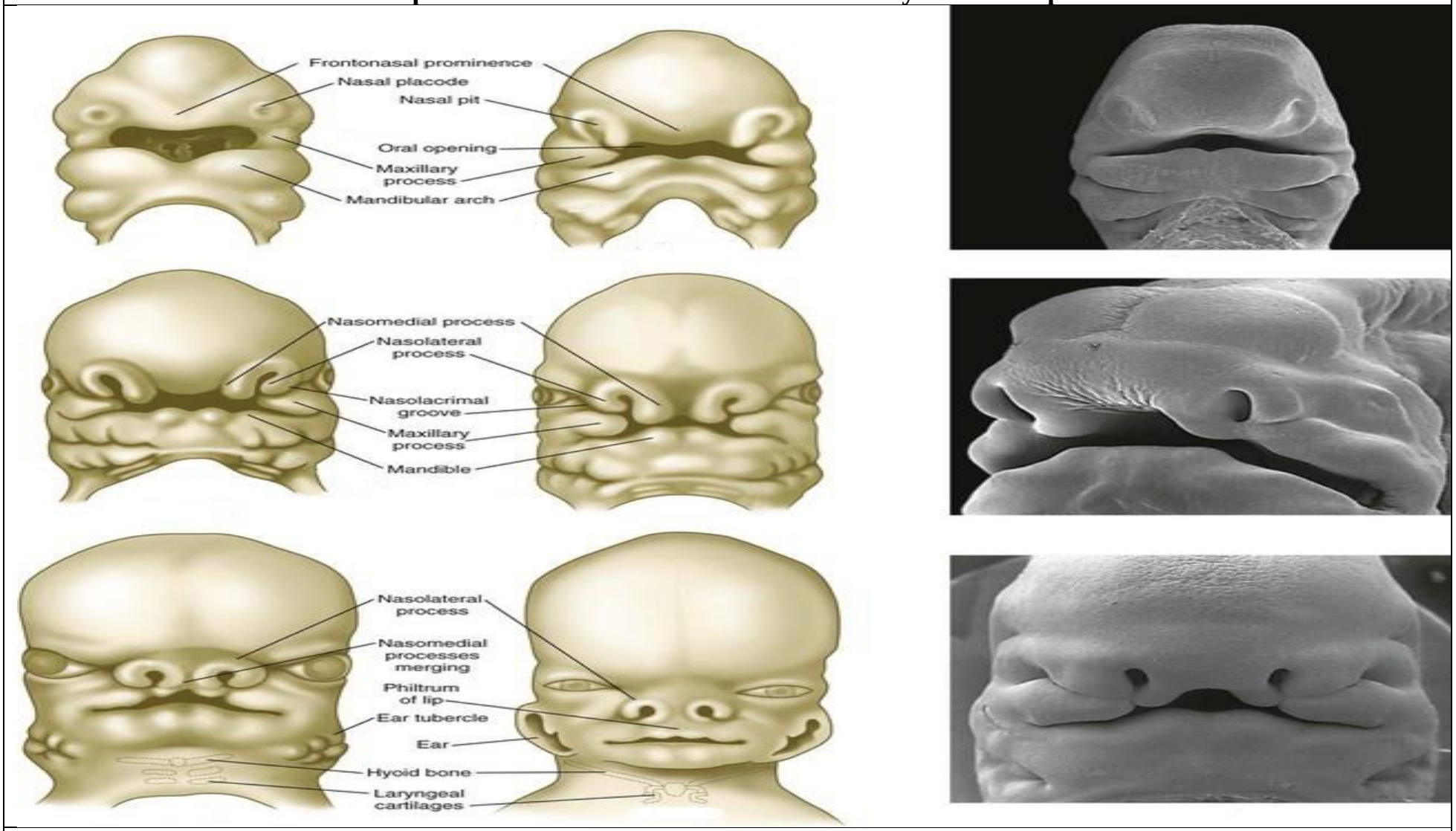

Fig. 3 https://teachmeanatomy.info/the-basics/embryology/head-neck/face-palate/

VOCABULARY

Stomatodeum (also called stomodeum or stomatodaeum) – is the embryonic anterior ectodermal part of the digestive tract. The recesses is located between the pericardium and the brain of the embryo, which acts as the predictor of the mouth and adenohypophysis.

Branchial (pharyngeal) arches – formation in the pharyngeal wall in the form of mesoderm overgrowth infiltrated with neural crest cells. As a result, six cylindrical thickenings are formed. Starting from the lateral wall of the pharynx, they expand and approach similar formations on the opposite side.

Branchial (pharyngeal) pouches. On the inside, the pharyngeal apparatus is lined with endoderm, which forms pouches or folds between the arches;

Branchial (pharyngeal) grooves. Externally, the pharyngeal structures are covered with ectoderm, which forms pharyngeal clefts (or grooves); initially, 4 pharyngeal clefts are formed, corresponding to the number of pharyngeal pouches.

Mucous membrane. A lining epithelium, including glandular tissue, an underlying layer of loose connective tissue called the lamina propria, which provides vascular support for the epithelium, and sometime contains mucosal glands. Finally, a thin double layer of smooth muscle is often present - the muscularis mucosa for local movement of the mucosa.

Submucosa - a layer of tissue under the mucous membrane. In the gastrointestinal tract submucosa is a layer of loose connective tissue or dense irregular connective tissue with blood and lymphatic vessels of large diameter and nerve trunks, the main function of which is support of the mucous membrane, as well as the connection of the mucous membrane with the layer of smooth muscles underlying it.

Muscularis externa ("muscularis"for short) is a muscular wall of the gastrointestinal tract located under the submucosa. The muscles of the tongue and upper esophagus belong to striated muscles. In the rest of the digestive tract, the muscularis externa consists of two layers of smooth muscles. The inner circular layer consists of smooth muscle fibers arranged in a circular pattern. The outer longitudinal layer is made of smooth muscle fibers that are extended along the digestive tube.

Serosa consists of a secretory epithelial layer and a thin connective tissue layer. The epithelial layer, known as mesothelium, consists of a single layer of avascular flat nucleated cells (simple squamous epithelium) that produce the lubricating serous fluid. Serous membranes line and enclose several body cavities, known as serous cavities, where they secrete a lubricating fluid to reduce friction from muscle movements.

Adventitia a connective tissue layer that binds together structures rather than reduces friction between them.

Links:
https://histology.siu.edu/erg/GI014b.htm

TESTS

1. A **newborn child** has a **middle cleft lip and maxilla**. Anomalies in the development of which processes are responsible for this defect?

Nonunion of the medial nasal processes
Cleft of the medial nasal processes of the upper jaw
Cleft of the lateral nasal processes of the upper jaw
Cleft of the palatine processes.
Cleft of the maxillary processes.

2. A histological preparation of the head end of a 5-week-old embryo shows **gill arches**. Indicate what develops from the **first pair** of these structures?

Mandibular and maxillary processes.
Mandibular processes.
Maxillary processes.
External auditory canal.
Cricoid cartilage.

3. An **enlargement** of which **parts of the facial skull in the embryonic period** leads to **abnormalities such as «cleft palate»**?

Palatine processes
Frontal processes
Frontal and maxillary processes
Mandibular processes
Mandibular and palatine processes

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
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https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 2. Characteristic of masticatory oral mucosa. Gums. Hard palate.

Structure of oral cavity		
Oral cavity	**Vestibule**	It is the space between the lips, cheeks, and teeth.
	Oral cavity proper	It lies behind the teeth and is bounded by the hard and soft palates superiorly, the tongue and the floor of the mouth inferiorly, and the entrance to the oropharynx posteriorly.

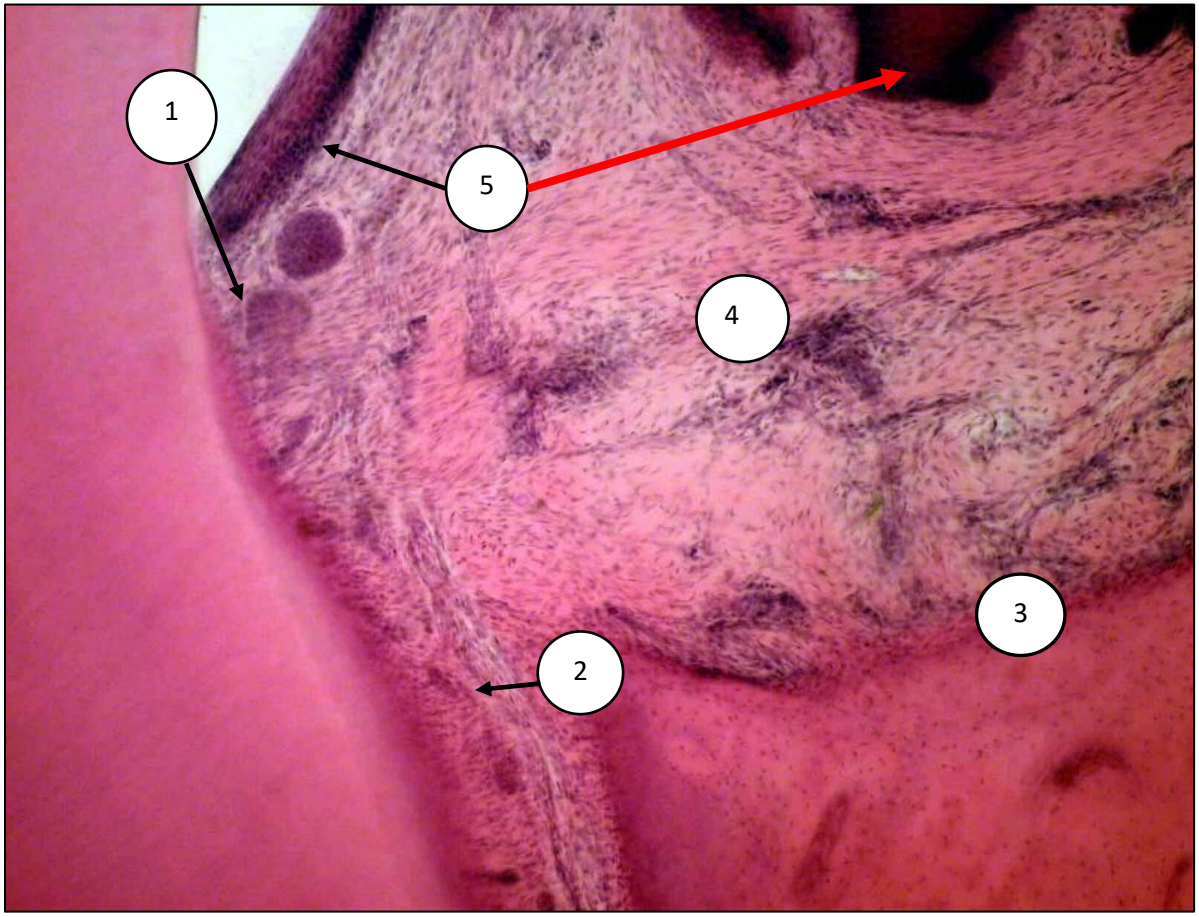
Types of oral mucosa			
Types		**Localization**	**Type of epithelium**
1.	**Mastigatory mucosa**	Hard palate, gums, medial area of the cheek (white line).	Stratified squamous keratinized
2.	**Lining mucosa**	Bottom of the oral cavity, the ventral surface of the tongue, maxillary and mandibular areas of the cheek, soft palate, lips.	Stratified squamous nonkeratinized
3.	**Specialized mucosa**	Dorsal surface of the tongue.	Stratified squamous keratinized

Hard palate consists of a bone base covered by mastigatory oral mucosa			
Hard palate		**Structural features**	
1.	**Mucosa**	Most developed in the posterior parts of hard palate	Consists of stratified squamous keratinized epithelium and lamina propria. Lamina propria includes connective tissue and forms finger-shaped papillae.
2.	**Submucosa**	In the **fatty zone** there is **adipose connective tissue.** In the **glandular zone** there are small salivary glands. In the **marginal zone** and **palatine raphe zone** submucosa is absent and lamina propria fused with periosteum.	
3.	**Bone base**	Formed from the palatine processes.	

Hard palate		
Parts		**Structural features**
1.	**Fatty zone**	forms the anterior one third of hard palate
2.	**Glandular zone**	forms the posterior two thirds of hard palate
3.	**Marginal zone**	the area which adjacents to the gums
4.	**Palatine raphe zone**	forms the middle line of hard palate

Gums (gingiva)		
1.	**Mucosa**	Consists of stratified squamous nonkeratinized (mostly keratinized) epithelium and lamina propria. Lamina propria includes dense connective tissue and connects with alveolar processes of the upper and lower jaws.
2.	**Submucosa**	is absent.
Gingiva is connected with bone base. **Bone base** is formed by the alveolar processes of the upper and lower jaws.		

Parts of gums (gingiva)		
1.	**Free gingiva**	Superior free part of the gingiva which does not attach to the cervix of the tooth. It is separated from the tooth surface by gingival sulcus.
2.	**Attached gingiva**	It is part of the gingiva which firmly attaches to the underlying hard tissues (alveolar bone, cementum, and edge of the enamel).
3.	**Interdental gum**	It is triangular region of gums is located between adjacent teeth



Dento-gingival junction
Magnification X 40, hematoxylin-eosin staining.

On the preparation of dento-gingival junction (1) there are periodontium (2), interradicular bone (3), lamina propria of gums (4) and epithelium of gum (5) The gums consist of epithelium and lamina propria.

VOCABULARY

Oral vestibule. The vestibule of the oral cavity is a slit-shaped space bordered on the outside by the cheeks and lips; from the inside - by teeth and gums. Above and below it is enclosed by the mucous membrane of the lips, cheeks and gums, belonging respectively to the upper and lower alveolar arch.

Oral cavity proper (*cavum oris proprium*) is bounded laterally and in front by the alveolar arches with their contained teeth; in the back, it connects to the pharynx by means of a narrowed opening called the isthmus faucium. It is covered by hard and soft palate, whereby most of the floor is formed by the tongue, the rest - by the mucous membrane protruding from the sides and under the lingual surface to the gums lining the inside of the lower jaw.

Oral mucosa. The lining of the oral cavity is mucous membrane, which is composed of two layers: an epithelium (stratified squamous epithelium) and subjacent connective tissue (lamina propria). Oral mucosa can be divided into three main types: masticatory, lining, and specialized.

Lining mucosa is found in most regions of the oral cavity, and is not involved significantly with mastication. These are regions more important for speech and swallowing. They are therefore mostly non-keratinized. They may have higher levels of elastic fibers within the lamina propria. It has small or no visible dermal papillae and rete pegs between the epithelium and connective tissue layers.

Masticatory mucosa is found in regions of high abrasion caused by mastication, such as the attached gingiva. The epithelium is either be ortho-keratinized or para-keratinized, which are both partially keratinized. Because this mucosa is generally under higher levels of stress, it has more pronounced dermal papillae and rete pegs than lining mucosa.

Specialized mucosa is found on the dorsal surface of the tongue. More important than its level of keratinization is the precense of specialized structures, such as lingual papillae and taste buds.

Filiform papillae are the majority of the tongue’s dorsal surface, giving it avelvety appearance. They contain an ortho-keratinized or para-keratinized stratified squamous epithelium. These papillae function to provide friction only, their mucosa contain no taste buds.

Fungiform papillae are shaped like a mushroom and are dotted throughouot the dorsal surface of the tongue. They contain an ortho-keratinized or para-keratinized stratified squamous epithelium over a highly vascular sub-mucosa, giving these structures a more reddish-appearance than neighboring filiform papillae. The epithelial layer contains taste buds.

Circumvallate papillae are found in a V-formation on the bordering between the anterior and posterior part of the tongue, the sulcus terminalis. They contain an ortho-keratinized or para-keratinized stratified squamous epithelium with minor salivary glands and taste buds.

Foliate papillae are found on the outer margins of the tongue. They are made up of ortho-keratinized or para-keratinized stratified squamous epithelium with taste buds.

Ortho-keratinized epithelium has visible nuclei and partly keratinized epithelial cells.

Para-keratinized epithelium does not display visible nuclei, with partly keratinized epithelial cells.

TESTS

1. The histologic specimen shows an **organ of the oral cavity**, the **basis of which is bone tissue**. It is covered with a mucous membrane, which shows a **multilayered squamous epithelium**. The **formation includes fatty, glandular and marginal zones**. In all areas of the **mucosa's own lamina propria, collagen fibers form a powerful bundle that intertwines with the periosteum**. What structure is represented in the sample?

Hard palate
Gums
Lips
Cheek
Tongue

2. During the biopsy **of the oral mucosa**, morphological signs of **gingival** lesions were found. What are the **normal features of the gums** structure?
Quiescent adherent to the periosteum, lamina propria forming high papillae, absent of muscular plate
Loose adhesion to periosteum, well defined muscle plate
Muscle plate is absent, submucosa is well developed
Muscular plate and the lamina propria are absent
Contains many small salivary glands

3. The histological preparations showed the **structure of the oral cavity**, **composed of a mucous membrane, which is loosely attached and strongly fused to the periosteum**. The **epithelium is a stratified squamous keratinized epithelium**. The **lamina propria forms long papillae deeply immersed in the epithelium**. What is this structure?
Gums
Hard palate
Lip
Cheek
Tongue

4. The dentist has found an enlarged space in the **gingival pocket caused by the separation of the epithelium from the tooth surface**. What type of epithelium was damaged?
Stratified squamous non keratinized
Stratified flat keratinized
Stratified cuboidal nonkeratinized
Stratified columnar nonkeratinized
Pseudostratified columnar epithelium

5. Examining the mucous membrane of the **hard palate**, the dentist found a rounded formation located in the mucous membrane's **lamina propria** in the suture. What kind of cells have formed?
Epithelial cells
Lymphocytes

Adipocytes
Pigment cells
Mucous cells

6. When performing a first-class cavity filling without a pre-fixed matrix, the filling material got into the **interdental space** and injured the **interdental papillae**. What structures were damaged?
Epithelial cells and lamina propria
Epithelial cells and submucosa
Epithelial cells and bone
Epithelial cells and glands
Epithelial cells and muscles

7. During the preparation of the chewing surface of an untreated tooth crown, the boron slipped and **injured the soft gingival tissue**. What tissue was broken?
Epithelial cells and lamina propria
Epithelial cells and submucosa
Epithelial cells and pulp
Epithelial cells and glands
Epithelial cells and muscles

Links:
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https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 3. Characteristic of lining oral mucosa. Cheek. Lip. Soft palate.

Cheek		
Surfaces (parts)		**Structural features**
1.	**Skin surface**	The outer part covered by skin.
2.	**Basic part**	Base containing striated muscle tissue.
3.	**Mucous surface (buccal mucosa)**	The inner surface covered by lining mucosa. It includes a **stratified squamous nonkeratinized epithelium (1 layer)** with three definite layers (stratum basale, spinosum and granulosum), many elastic fibers in the **lamina propria (2 layer)** and minor salivary glands (buccal glands) in the **submucosa layer (3 layer)**.

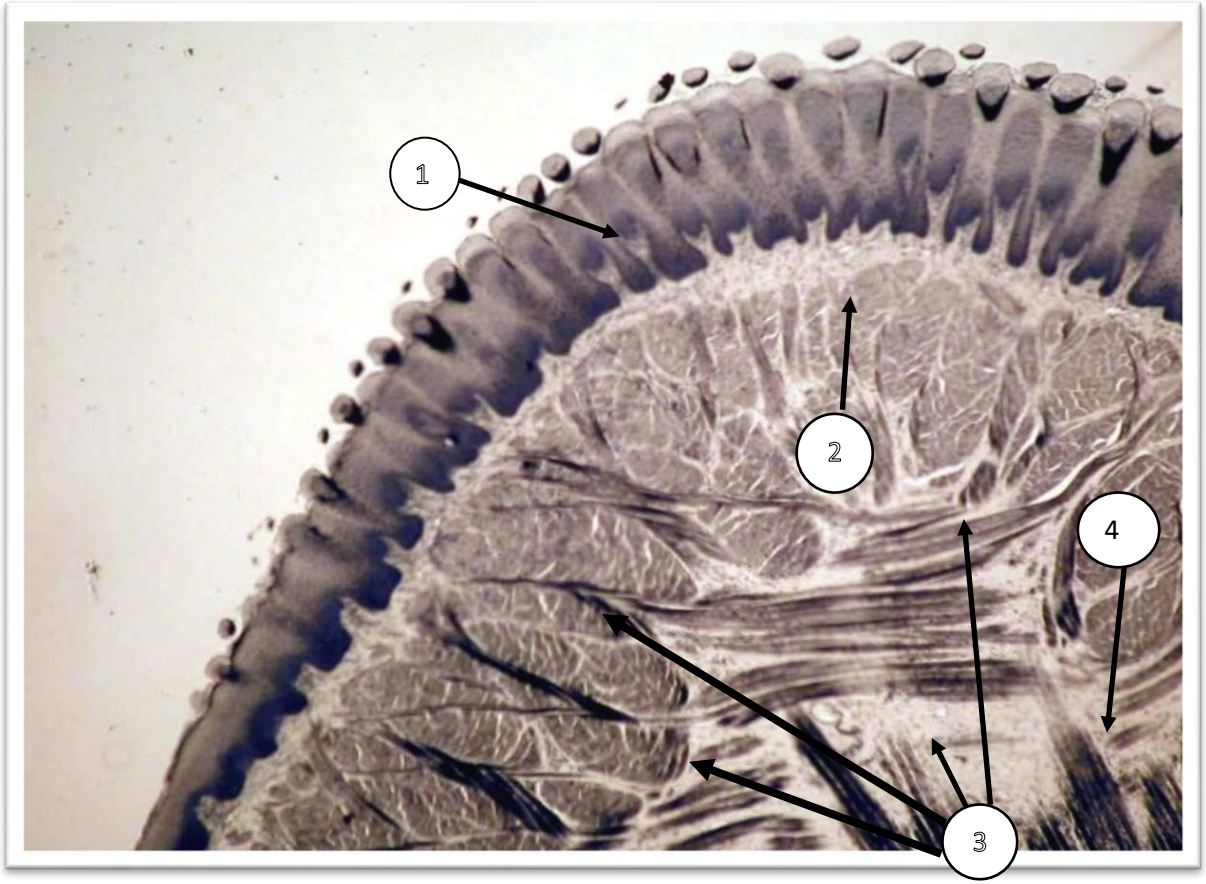
The structure of the mucous surface of the cheek (buccal mucosa)		
Zones		**Structural features**
1.	**Maxillary zone**	1) **stratified squamous nonkeratinized epithelium**, 2) **lamina propria** forms low papillae that go deep into the epithelium and has many collagen fibers, 3) **submucosa** with minor salivary glands and adipose tissue.
2.	**Intermediate zone**	1) **stratified squamous keratinized epithelium** 2) **lamina propria** forms high papillae that go deep into the epithelium and has many collagen fibers, 3) **submucosa without** salivary glands **but** there may be **sebaceous glands**.
3.	**Mandibular zone**	1) **stratified squamous nonkeratinized epithelium**, 2) **lamina propria** forms low papillae that go deep into the epithelium and has many collagen fibers, 3) **submucosa** with minor salivary glands and adipose tissue.

<table>
<tr><th colspan="4">Lip</th></tr>
<tr><th colspan="2">Parts</th><th colspan="2">Structural features</th></tr>
<tr><td>1.</td><td>Pars cutanea</td><td colspan="2">1) stratified squamous keratinized epithelium,
2) lamina propria forms high papillae that go deep into the epithelium,
3) hair, sebaceous and sweat glands.</td></tr>
<tr><td rowspan="3">2.</td><td rowspan="3">Pars intermedia (vermilion border)</td><td colspan="2">Connective tissue and striated muscle fibers. Includes two zones (external and internal).</td></tr>
<tr><td>External (without salivary glands, hair, sweat glands but there may be sebaceous glands)</td><td>1) stratified squamous keratinized epithelium (has thin stratum corneum)
2) lamina propria consists of loose connective tissue and forms papillae that go deep into the epithelium
3) there are nerve endings</td></tr>
<tr><td>Internal</td><td>1) thick stratified squamous epithelium (without stratum corneum) and turns from keratinized to nonkeratinized
2) epithelium forms villi (in newborns)
3) lamina propria does not have glands</td></tr>
<tr><td>3.</td><td>Pars mucosa</td><td colspan="2">1) thick stratified squamous nonkeratinized epithelium
2) lamina propria forms low papillae that go deep into the epithelium
3) submucosa includes collagen fibers in contact with muscle fibers, adipose tissue. seromucous salivary glands and blood vessels</td></tr>
</table>

Soft palate includes lining mucosa, fibrous aponeurosis and muscle fibers		
Parts		**Structural features**
1.	**Velum**	Striated muscle fibers
2.	**Uvula**	Both surfaces are covered by **stratified** nonkeratinized epithelium. Base consists of striated muscle fibers, mucous glands, small tonsil-like structures, connective tissue.

Tab. 1.
https://www.osmosis.org/learn/Anatomy_of_the_oral_cavity_(dentistry)

Surfaces of soft palate		
Surface		**Structural features**
1.	**Side of the oral cavity**	1) **stratified squamous nonkeratinized epithelium** 2) **lamina propria** forms high papillae that go deep into the epithelium and has blood vessels 3) layer of elastic fibers 4) muscular plate is absent in the mucosa 5) **submucosa** includes adipose tissue and mucous salivary glands 6) striated muscle fibers form anastomoses
2.	**Side of the nasal cavity**	1) pseudostratified columnar ciliated epithelium 2) **lamina propria** includes lymph nodes, seromucous and mucous glands 3) **submucosa is absent**



Ventral surface of the tongue. Magnification X 40, iron hematoxylin staining.

Preparation of cross-section of the tongue ventral surface shows a multilayered squamous non-keratinized epithelium (1), which is the first layer of the lining mucousa. Under the epithelium there is lamina propria (2), which is represented by loose connective tissue. The bulk of the thickness of the tongue is formed by striated muscle (3), the fibers of which are located in three mutually perpendicular directions. Between the fibers is the intermuscular connective tissue (4).

VOCABULARY

Outer surface of lip mucosa - is covered by skin with a thin, stratified squamous keratinized epithelium and hair follicles. The orbicularis oris muscle (skeletal) occupies the central core of the lip.

Vermilion border mucosa – is a transitional area between the skin keratinized epithelium and the mucous membrane nonkeratinized epithelium. Long connective tissue papillae deepen into the epithelium. In these papillae capillaries pass close to the surface. Since the epithelium in this area is very thin, the lips look red. There are no salivary glands in the vermilion zone, so the lips need to be constantly moistened (with the tongue) to prevent them from drying out.

Intermediate zone of lip mucosa - thin parakeratinized, stratified squamous epithelium with long irregular papillae, elastic and collagen fibers in connective tissue.

Labial mucosa - the inner surface of the lip is lined by the mucosal epithelium, a thick, moist stratified squamous epithelium; a stratum granulosum is absent. Minor salivary glands (labial glands) are located in the submucosa beneath the lamina propria and produce both serous and mucous secretions. **T**heir ducts empty into the vestibule of the oral cavity.

Buccal mucosa - The buccal mucosa is defined by the epithelium lining the inner surface of the cheeks and lips from the line of contact of the opposing lips to the line of attachment between the alveolar ridge (upper and lower) and the pterygomandibular raphe. There are approximately 800–1000 minor salivary glands located throughout the buccal mucosa. Very thick (500 nm) nonkeratinized, stratified squamous epithelium. Lamina propria with long, slender papillae, dense fibrous connective tissue containing collagen and some elastic fibers, rich vascular supply giving off anastomosing capillary loops into papillae.

Basal layer or stratum basale, is the most profound of the three layers of the mucous membrane. The basal layer consists of a single layer of cuboidal epithelial cells covering the basement membrane, lying over the lamina propria of the mucosa. The basal layer is also called the germinative layer because it shows mitosis of epithelial cells, but this cell division can be seen only under high magnification of the tissue.

Intermediate layer or stratum intermedium. The intermediate layer consists of larger, crowded cells with a

polyhedral shape. These cells seem larger or heavier than the basal layer cells due to the fact that they have a bigger volume of cytoplasm. This layer cells have lost the ability to mitose during migration. The intermediate layer forms the vast majority of nonkeratinized epithelium.

Superficial layer or stratum superficiale. In the mucous membrane it is difficult to recognize the precise division among the superficial layer and intermediate layers. In this layer, even larger analogically composed multilayered epithelial cells are visible, the outer cells of which have a flattened appearance in the form of plates. Cells in these layers show exfoliation or loss as they become mature and die during tissue growth and development. Thus, in this tissue maturation is manifested only in an increase in cell size with their surface migration.

Links:
https://histology.medicine.umich.edu/resources/oral-cavity
https://digitalhistology.org/organs-systems/digestive/oral-cavity/lip
https://www.sciencedirect.com/topics/medicine-and-dentistry/buccal-mucosa
https://openoregon.pressbooks.pub/histologyandembryology/chapter/chapter-3-histology-of-the-oral-mucosa/

TESTS

1. A histologic specimen of **an oral organ** shows that the **anterior surface** of the **organ is covered with stratified squamous epithelium**, and the **posterior surface is covered with ciliated epithelium**. What is this organ?
Soft palate
Gingiva
Hard palate
Lip
Cheek

2. There is a specimen of the **soft palate**, which shows both the **oral and nasal surfaces**. It is found that the **epithelium in the oral cavity is damaged**. Which epithelium is damaged?
Multistratal squamous nonkeratinizing

Multistratal cubical nonkeratinizing
Multistratal prismatic nonkeratinizing
Multistratal squamous keratinizing
Multirowed ciliated epithelium

3. A histological specimen of an oral cavity organ demonstrates that the organ's **anterior surface is lined with multilayer squamous nonkeratinous epithelium,** and its **posterior surface - with multiserial ciliated epithelium**. What organ is it?
Soft palate
Gingiva
Hard palate
Lip
Cheek

4. During the trauma, one of the regions of the mouth was damaged, **it has maxillary, intermediate and mandibular area**. Which organ was damaged?
Cheek
Tongue
Lips
Hard palate
Soft palate

5. Examination of histological preparations of the **oral cavity organ** shows that it has **three parts**: **skin, mucosa and intermediate**. The basis of the structure is formed by striated muscles. What is the structure of the oral cavity?
Lips
Hard palate
Soft palate
Tongue
Gums

6. The **child is feeding on breast milk**. What histological structure of the oral cavity **is adapted to stimulation of the nipple**, which causes the milk production reflex?
Epithelial villi of the lips
Keratinizing stratified squamous epithelium of the lips
Connective tissue papillae of the lips
Mushroom-shaped papillae of the tongue
Foliate papillae of the tongue

7. A newborn has a **defect along the sagittal line of the soft palate**. The physiology of which process will be disturbed?
Swallowing
Chewing
Digestion
Breathing
Articulation

8. A 40-year-old patient suffers from **heart attacks**. The doctor prescribed him to take **nitroglycerin** in a **sublingual** way. What features of the structure of the **oral mucosa primarily determine the possibility of taking the medications**?
Permeability of the stratified squamous nonkeratinized epithelium
Permeability of the stratified squamous keratinized epithelium
Permeability of the stratified squamous epithelium
The presence of papillae of the tongue
The presence of salivary glands

9. **Mucous membrane** preparation is made from the child's **cheek**, in which we identify the **maxillary, mandibular and intermediate zones**. What are the main features that can characterize the **intermediate zone**?
Absence of salivary glands
Absence of sweat glands
Absence of epithelium tissue

Absence of lamina propria
Absence of microvilli

10. Incorrect removal of the **enamel margins** from the second small molar tooth led to its breakage and the formation of **sharp edges that damage the cheek mucosa**. What structures of **cheek were injured**?
Epithelial cells and the lamina propria
Epithelial cells and aponeurosis
Epithelial cells and bone
Epithelial cells and glands
Epithelial cells and muscles

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

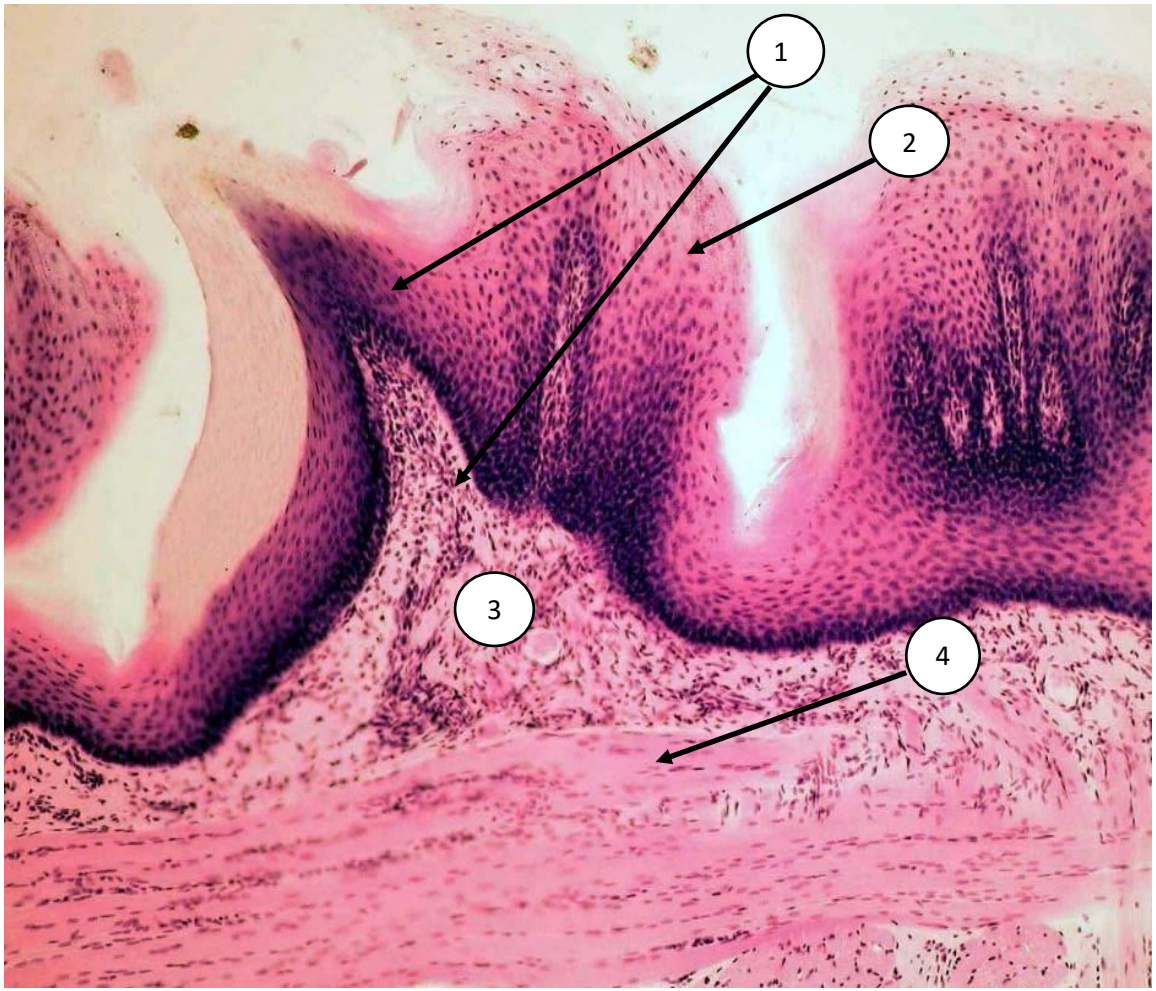
Topic 4. Characteristic of specialized oral mucosa. Development and structure of tongue.

Tongue		
Surfaces (parts)		**Structural features**
1.	**Superior surface**	is covered by specialized mucosa with numerous papillae. It includes a **stratified squamous keratinized epithelium (1 layer)** and **lamina propria (2 layer).** Mucosa is attached to the underlying skeletal muscle.
2.	**Inferior surface**	is covered by lining mucosa. It includes a **stratified squamous nonkeratinized epithelium (1 layer)**, **lamina propria (2 layer)** and **submucosa layer (3 layer)**.
3.	**Base of tongue**	Base containing striated muscle tissue. It is attached to the floor of the mouth.

The structure of the specialized mucosa of the tongue		
Types of papillae		**Structural features**
1.	**Filiform papillae**	1) **stratified squamous keratinized epithelium**, 2) **lamina propria** forms slender, cone-shaped papillae that go deep into the epithelium, 3) are the most numerous but smallest in size of the four types of papillae, 4) are often packed in rows and cover the entire superior surface of the **anterior two thirds** of the tongue (anterior to the sulcus terminalis), 5) have a central connective tissue core with several branches of small papillae, 6) are the only papillae that do not have taste buds, 7) their main functions are to help with chewing and mixing food.
2.	**Fungiform papillae**	1) **stratified squamous keratinized epithelium,** 2) **lamina propria** forms mushroom shaped papillae that go deep into the epithelium, 3) are much less numerous than the filiform papillae, 4) are taller than the filiform papillae, 5) each fungiform papilla has one to five taste buds on its superior surface. 6) **Types of taste:** sweet, sour, salty
3.	**Circumvallate**	1) **stratified squamous keratinized epithelium**,

	papillae (are arranged in a single row, which contains about 10 to 14 papillae that are located immediately anterior to the sulcus terminalis)	2) **lamina propria** forms cylindrical papillae in shape with groove, 3) each papillae is surrounded by a groove (moat), 4) ducts of the minor serous salivary glands (glands of von Ebner) open and drain serous products into the groove, 5) taste buds are located on the lateral walls of the groove. 6) **Types of taste:** bitter.
4.	**Foliate papillae**	1) **stratified squamous keratinized epithelium**, 2) **lamina propria** forms parallel ridges and furrows, 3) are located on the posterior lateral surface of the tongue and are poorly developed in adults, 4) taste buds are located at the lateral surface of papillae, 6) **Types of taste:** . sour and salty

The structure of the tongue		
Root of the tongue	Body of the tongue	Apex of the tongue



Filiform papillae of the tongue. Magnification X 40, hematoxylin-eosin staining.

On the preparation specialized oral mucosa of the tongue's dorsal surface there are filiform papillae (1). The papilla consists of a stratified squamous lightly keratinized epithelium (2). Under the epithelium there is lamina propria (3), which is loose connective tissue and forms the basis of the papilla. Under its lamina propria there are the skeletal muscle fibers (4). Filiform papillae do not contain taste buds.

VOCABULARY

The dorsal surface of the tongue and the lateral edges of the tongue are lined with mucous membrane, which contains nerve endings that perform the functions of general sensory perception and taste sense. The dorsal tongue surface is covered with tiny growths - papillae, which are not found on the ventral surface.

Filiform papillae - have the appearance of conical formations with a base of lamina propria coated with keratinized epithelium. They form a tough abrasive surface that is involved in compressing and breaking food when the tongue is opposed to the hard palate. In this way, the dorsal mucosa of the tongue functions as a masticatory mucosa.

Fungiform papillae - interspersed among the filiform papillae. They have wide smooth round apices and narrower bottoms. In young infants, the fungiform papillae can be seen with the bare eye as red dots on the back of the tongue (because the non-keratinized epithelium is relatively easy to see through). These papillae are less expressed in adults due to weak keratinization of the epithelium.

Foliate papillae - "leaf-shaped" papillae sometimes found on the lateral parts of the back of the tongue, although they are more frequently seen in mammals other than humans. These papillae consist of 4 to 11 parallel ridges that alternate with deep grooves in the mucosa, and a few taste buds are present in the epithelium of the lateral walls of the ridges.

Vallate (or circumvallate) papillae - adjacent and anterior to the sulcus terminalis are 8 to 12 circumvallate papillae, which are large papillae, each surrounded by a deep circular groove into which open the ducts of minor salivary glands, known as the glands of von Ebner. These papillae have a connective tissue core which is covered on the superior surface with a keratinized epithelium. The epithelium covering the lateral walls is nonkeratinized and contains taste buds.

Taste buds – are the chemoreceptors for the sense of taste. The taste buds are located in conjunction with the circumvallate papillae, fungiform papillae and leaf-like folds of the mucous membrane (folia linguae), which are located on the posterolateral part of the tongue. There are also taste buds on the posterior wall of the oropharynx, soft palate, epiglottis, and palatoglossal arches. Each taste bud consists of about 50 spindle-shaped cells, which according to the classification are divided into "light" (receptor), "dark" (supporting) and "basal" (stem) cells, based on their appearance. The unmyelinated nerves from cranial nerves VII, IX or X (depends on the location of the taste bud) form synapses with the receptor and, to certain extent, supporting cells of the taste bud.

Links:

https://histology.medicine.umich.edu/resources/oral-cavity

TESTS

1. A 53-year-old patient complained of **worsening of taste sensitivity**. During the examination, the doctor **observed atrophy of the mucous membrane** of certain areas of the oral cavity. Where are morphological changes most probably observed?

On the upper surface of the tongue
On the lower surface of the tongue
At the root of the tongue
On the hard palate
On the gums

2. During the examination of the patient's oral cavity, the dentist found that his **tongue was covered with whitish coatings**. What histological structures **are responsible for its formation**?

Epithelium of filiform papillae
Epithelium of foliate papillae
Epithelium of circumvallate papillae
Epithelium of fungiform papillae
Lingual tonsils

3. A 30-year-old patient visited a doctor with symptoms of fever up to thirty-eight degrees, weakness, and sore throat. On examination, it was found that the **patient's tongue is covered with a white bloom**. **What histological structures of the tongue are involved in the formation of the coating**?

Filiform papillae
Foliate papillae
Fungiform papillae
Circumvalate papillae
Connective tissue papillae of the tongue

4. In the preparation of the **tongue**, we see a **multilayered squamous nonkeratinized epithelium**, a well-developed basement mucosa and a **submucosal base through which the salivary gland excretory ducts pass**. What part of the tongue do we examine?

Inferior

Superior

Lateralis

Taste

Tonsillaris

5. On the tongue slide, we see a simple **alveolar-tubular gland, which** is **rich in mucus and has features of irregular secretion.** Which part of the tongue with these ducts is damaged?

Radix of tongue

Corpus of the tongue

Superior surface around circumvallate papillae

Apex of tongue

Inferior surface

6. **Basal cell damage** has occurred **in the taste buds** of the mushroom-shaped papillae of the tongue. What changes will be observed after this?

Physiological preparation of the receptor and supporting cells stops

Close taste pores of the buds

Receptor cells taste buds lost

Disorder of the buds innervation

-

7. The **taste buds of the tongue** are elongated and located in the thickness of the epithelium. They **consist of several types of cells**. **What type of cell regenerates** the supporting and sensitive cells of taste receptors?

Basal cells

Myoepithelial cells

Receptor cells

Taste cells

Secretory cells

8. **Which papillae of the baby's tongue irritate the mother's nipples**, facilitating breastfeeding?
Conical shape of tongue
Foliate papillae
Circumvallate
Fungiform
Filiform
9. A patient with **glossitis has a partial absence of papillae**. What **papillae are located on the sides of the tongue** in adults?
Foliate
Filiform
Conical shape
Fungiform
Circumvallate

10. A 3-year-old child has **lost the sense of taste due to a thermal burn of the lateral surface of the tongue**. What **cells** will be the source of functional **regeneration** of these taste buds?
Basal cells
Supporting cells
Sensory cells
Ito cells
Epithelial cells

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 5. Large and small salivary glands.

<table>
<tr><th colspan="4">General plan of the structure of the large salivary glands</th></tr>
<tr><th>Capsule and septa</th><th>Secretory portion special cells</th><th colspan="2">Duct system</th></tr>
<tr><td rowspan="5">Capsule consists of dense irregular connective tissue.
Septa consist of loose connective tissue.
They penetrate the gland and subdivide it into lobes and lobules.</td><td>Serous acinus</td><td rowspan="2">Intralobular duct</td><td>Intercalated ducts</td></tr>
<tr><td>Mixed acinus</td><td>Striated ducts</td></tr>
<tr><td>Mucous acinus</td><td rowspan="3">Interlobular duct</td><td>Lobar ducts</td></tr>
<tr><td rowspan="2">Myoepitheliocytes</td><td rowspan="2">Excretory duct</td></tr>
</table>

Histological structure of secretory portions			
Types		**Features**	**Morphological structure of cells**
1.	**Serous acinus**	1) It is consists of **serous secretory cells** and **myoepitheliocytes**. 2) Secretory portion has a rounded shape. 3) Myoepithelial cells are situated inside the basal lamina of the secretory units and the initial part of the duct system.	1) **Serous cells** produce proteins 2) **Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. 3) **Myoepitheliocytes** are well developed and branched (basket cells). 4) **Myoepitheliocytes** prevent distention of the secretory portion when the lumen is filled with a secret and their contraction accelerates movement of the product.
2.	**Mucous acinus**	1) It is consists of **mucous cells**. 2) Secretory portion has a rounded shape or tubular	1) The nuclei of **mucous cells** are flattened with condensed chromatin.

		shape.	2) The nuclei are located near the bases of the cells. 3) Cytoplasm includes hydrophilic glycoprotein mucins.
3.	**Mixed acinus**	1) It is consists of **mucous cells** and **serous secretory cells.** 2) Secretory portion are mucous tubules capped with serous cells. Such caps are called **serous demilunes.**	1) **Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. 2) **Mucous cells** have flattened nuclei which are located near the bases of the cells and cytoplasm with hydrophilic glycoprotein mucins.

Histological structure of duct system		
Part		**Features**
1.	**Intercalated duct**	1) It is lined by **simple cuboidal epithelium** 2) They are short ducts which connect with each other and form striated duct.
2.	**Striated duct**	1) It is lined by **simple columnar epithelium** 2) **Columnar cells have** striations which consist of folds of the basal plasma membrane. 3) The folds contain many **mitochondria** that provide adenosine triphosphate for active transport.
3.	**Lobar duct**	It is lined by pseudostratified or stratified cuboidal epithelium.
4.	**Excretory duct**	It is lined by stratified columnar epithelium.
5.	**Main duct**	It is lined by nonkeratinized stratified squamous epithelium.

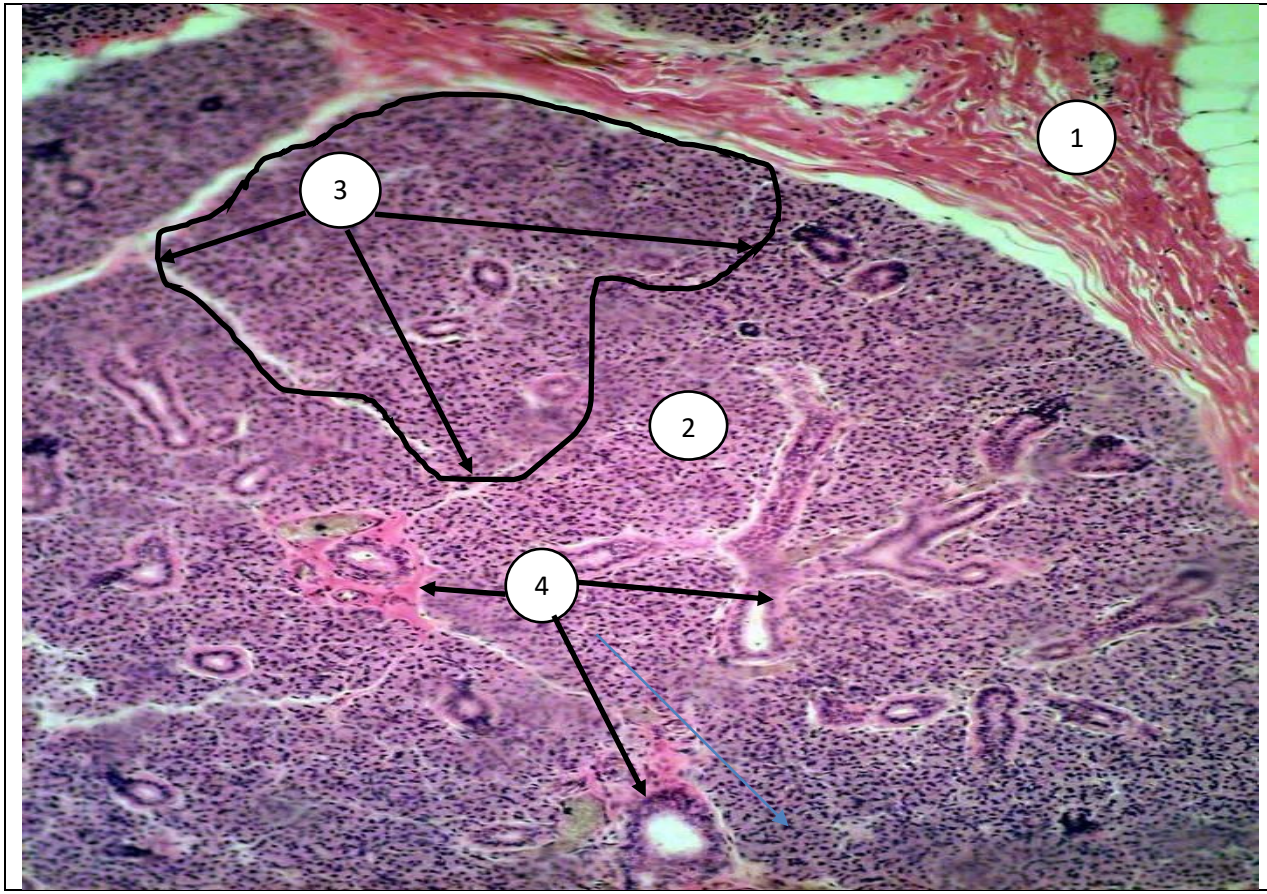
Parotid glands (have one type of secretory portions)			
Parts		**Features**	**Functions**
1.	**Serous acinus**	It includes **only serous acinuses.** They consist of **serous cells** and **myoepitheliocytes.** **1) Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. **2) Myoepitheliocytes** are well developed and branched (basket cells).	1) **Serous cells** produce proteins: -amylase and proline-rich proteins. 2) **Myoepitheliocytes** have contractile properties.
2.	**Intercalated ducts**	They are lined by simple cuboidal epithelium	They are short ducts which connect with each other and form striated duct.
3.	**Striated ducts**	1) They are lined by **simple columnar epithelium** 2) **Columnar cells have** striations which consist of folds of the basal plasma membrane. 3) The folds contain many **mitochondria** that provide adenosine triphosphate for active transport.	Such folds greatly increase the cell surface area, facilitating ion absorption, and are characteristic of cells specialized for ion transport.
4.	**Lobar ducts**	They are lined by pseudostratified or stratified cuboidal epithelium.	They collect the secret from the striated ducts and carry it to the excretory duct.
5.	**Excretory duct**	It is lined by stratified columnar epithelium.	It collects the secret from the lobar ducts to the main duct.
6.	**Main duct**	It is lined by nonkeratinized stratified squamous epithelium.	It carries the secret from the excretory duct to the oral cavity. It opens opposite the secondary upper molars
7.	**Capsule** consists of dense irregular connective tissue. **Septa** consist of loose connective tissue. They penetrate the gland and subdivide it into lobes and lobules.		

Submandibular glands (have two types of secretory portions)			
Parts		**Features**	**Functions**
1.	**Serous acinus**	They consist of **serous cells** and **myoepitheliocytes.** **1) Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. **2) Myoepitheliocytes** are well developed and branched (basket cells).	1) **Serous cells** produce proteins: -amylase and proline-rich proteins. 2) **Myoepitheliocytes** have contractile properties.
2.	**Mixed acinus**	1) It is consists of **mucous cells** and **serous secretory cells.** 2) Secretory portion are mucous tubules capped with serous cells. Such caps are called **serous demilunes.**	1) **Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. 2) **Mucous cells** have flattened nuclei which are located near the bases of the cells and cytoplasm with hydrophilic glycoprotein mucins.
3.	**Intercalated ducts**	They are lined by simple cuboidal epithelium	They are short ducts which connect with each other and form striated duct.
4.	**Striated ducts**	1) They are lined by **simple columnar epithelium** 2) **Columnar cells have** striations which consist of folds of the basal plasma membrane. 3) The folds contain many **mitochondria** that provide adenosine triphosphate for active transport.	Such folds greatly increase the cell surface area, facilitating ion absorption, and are characteristic of cells specialized for ion transport.
5.	**Lobar ducts**	They are lined by pseudostratified or stratified cuboidal epithelium.	They collect the secret from the striated ducts and carry it to the excretory duct.
6.	**Excretory duct**	It is lined by stratified columnar epithelium.	It collects the secret from the lobar ducts to the main duct.

7.	**Main duct**	It is lined by nonkeratinized stratified squamous epithelium.	It carries the secret from the excretory duct to the oral cavity. It opens into the oral cavity at the sublingual caruncles on both sides of the frenulum linguae.
8.	**Capsule** consists of dense irregular connective tissue. **Septa** consist of loose connective tissue. They penetrate the gland and subdivide it into lobes and lobules.		

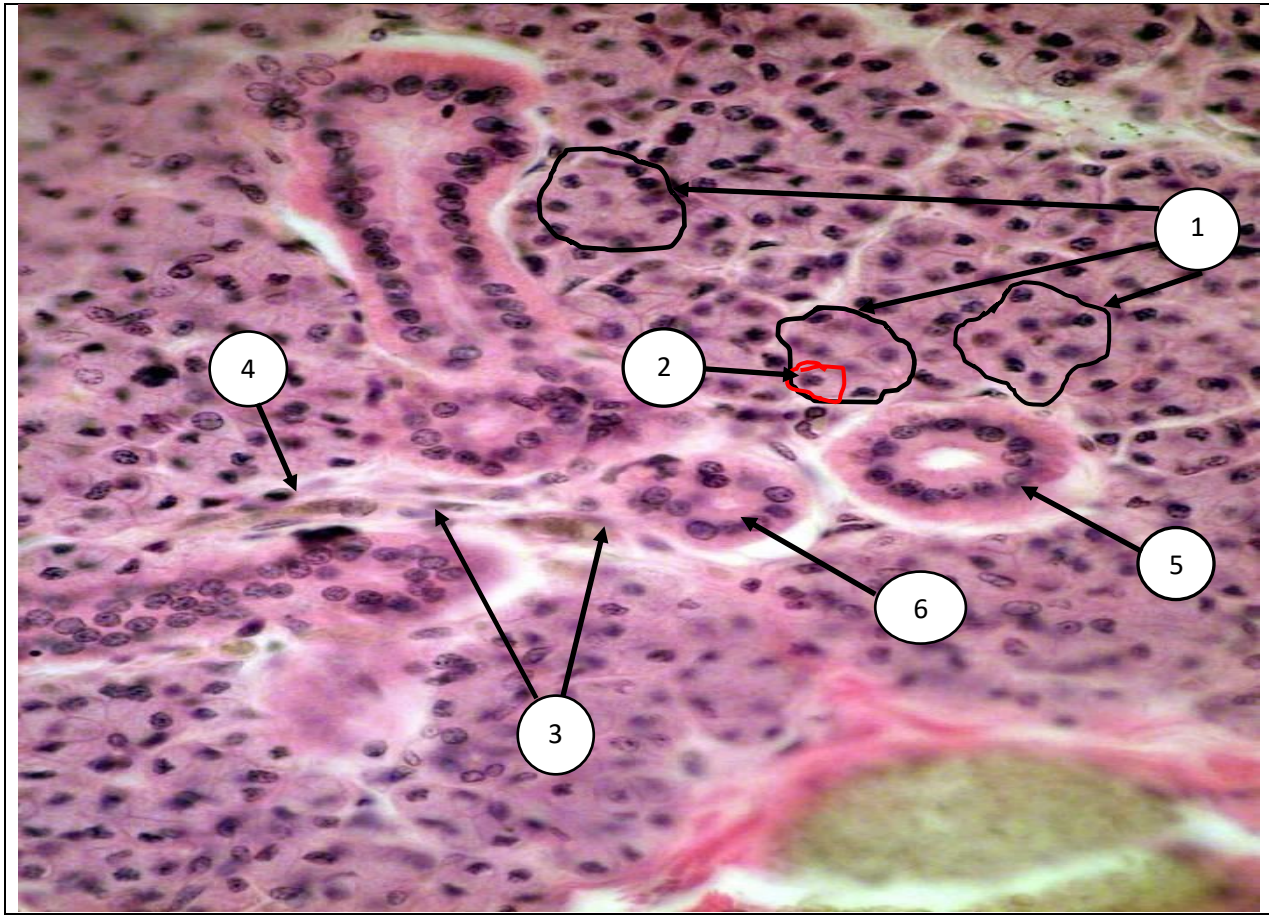
Sublingual glands (have three types of secretory portions)			
Parts		**Features**	**Functions**
1.	**Mucous acinus**	1) It is consists of **mucous cells**. 2) Secretory portion has a rounded shape or tubular shape. 3) They are prevail over others types of secretory portions.	1) The nuclei of **mucous cells** are flattened with condensed chromatin. 2) The nuclei are located near the bases of the cells. 3) Cytoplasm includes hydrophilic glycoprotein mucins.
2.	**Mixed acinus**	1) It is consists of **mucous cells** and **serous secretory cells.** 2) Secretory portion are mucous tubules capped with serous cells. Such caps are called **serous demilunes.**	1) **Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the basal part. 2) **Mucous cells** have flattened nuclei which are located near the bases of the cells and cytoplasm with hydrophilic glycoprotein mucins.
3.	**Serous acinus**	They consist of **serous cells** and **myoepitheliocytes.** **1) Serous cells** have rounded nuclei, rough ER in the basal third and protein-rich secretory basophilic granules in the	1) **Serous cells** produce proteins: -amylase and proline-rich proteins.

		basal part. **2) Myoepitheliocytes** are well developed and branched (basket cells).	2) **Myoepitheliocytes** have contractile properties.
4.	**Intercalated ducts**	They are lined by simple cuboidal epithelium	They are short ducts which connect with each other and form striated duct.
5.	**Striated ducts**	1) They are lined by **simple columnar epithelium** 2) **Columnar cells have** striations which consist of folds of the basal plasma membrane. 3) The folds contain many **mitochondria** that provide adenosine triphosphate for active transport.	Such folds greatly increase the cell surface area, facilitating ion absorption, and are characteristic of cells specialized for ion transport.
6.	**Lobar ducts**	They are lined by pseudostratified or stratified cuboidal epithelium.	They collect the secret from the striated ducts and carry it to the excretory duct.
7.	**Excretory duct**	It is lined by stratified columnar epithelium.	It collects the secret from the lobar ducts to the main duct.
8.	**Main duct**	It is lined by nonkeratinized stratified squamous epithelium.	It carries the secret from the excretory duct to the oral cavity. This glands have about 8 to 20 small ducts, which open into the crest of the sublingual fold on the floor of the oral cavity.
9.	**Capsule** consists of dense irregular connective tissue. **Septa** consist of loose connective tissue. They penetrate the gland and subdivide it into lobes and lobules.		



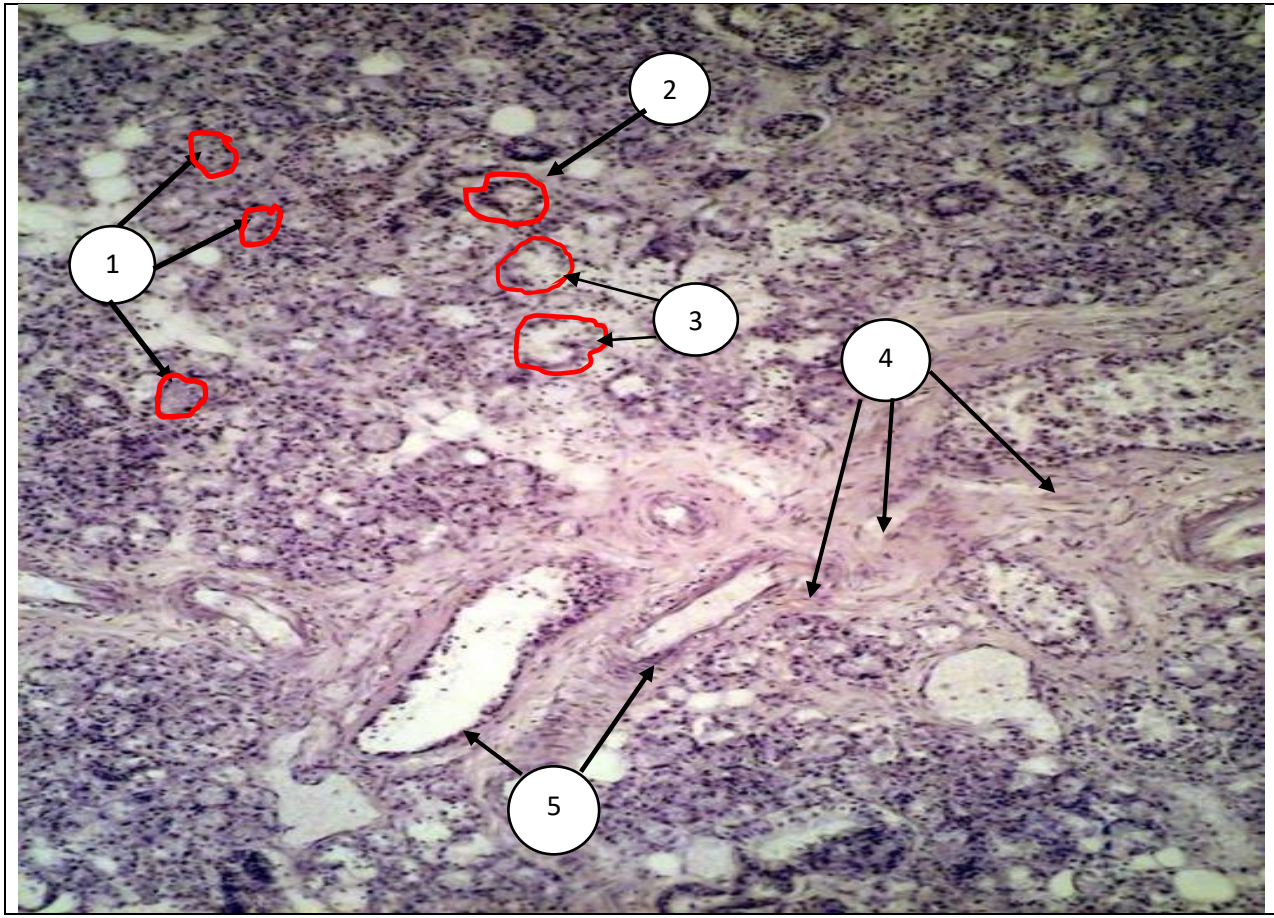
Parotid salivary gland
Magnification X 40, hematoxylin-eosin staining.

On preparations of a cross section of a parotid gland there are capsule (1) which is consist of dense connective tissue. Under the capsule there is the parenchyma of the gland (2). The parenchyma consist of lobules (3). Between the lobes there are layers of interlobular connective tissue (4), containing blood vessels and ducts.



Lobule of parotid salivary gland
Magnification X 100, hematoxylin-eosin staining

On the preparation of the cross section of the parotid gland there are alveolar secretory portions (1), consisting of serous secretory epitheliocytes (2). Between the secretory portions there are layers of loose connective tissue (3) which include blood vessels (4), striated (5) and intercalated ducts (6).



Sublingual gland
Magnification X 40, hematoxylin-eosin staining.

On a preparation of a cross section of Sublingual gland's lobe there are alveolar secretory portions: serous (1), mixed (2), mucous (3). Between the lobes of the gland there is loose connective tissue (4) which contains blood vessels (5).

VOCABULARY

Large salivary glands are paired symmetrical glands with long excretory ducts. They consist of submandibular, sublingual and parotid glands. These glands are composed of two general types of secretory cells - serous and mucous one and a duct system. Mucous cells are usually cuboidal to columnar in the shape. They are mucus-secreting cells. Each salivary gland originates from the oral cavity epithelium, in the process of its development.

Small salivary glands - are situated in the submucosa of various parts of the oral cavity. They include palatal, lingual, labial, buccal and molar glands. Small glands release highly glycosylated mucins containing blood group factors and are possibly active in the process of tissue lubrication. They also produce some antimicrobial proteins and immunoglobulins, and the tongue serous (von Ebner) glands secrete food enzymes and proteins that are likely to contribute to taste sensation.

Serous cells are generally of pyramidal shape, with a wide base that is resting on the basal lamina and a narrow apical surface with short, irregular microvilli facing the lumen. Serous acinar cells contain discrete secretory granules, which can be seen more clearly electronmicroscopically. The secretory granules contain protein and glycoprotein. The serous acinar cells contain rough endoplasmic reticulum, where protein is produced by the ribosomes.

Mucous cells - are seen light microscopically to contain a diffuse mass of secretory material that is weakly stained. They are seen electronmicroscopically to be packed with secretory granules. Electronmicroscopic histochemistry shows that mucous secretory granules are bipartite with little protein and extensive mucin in separate compartments. Rough endoplasmic reticulum, Golgi apparatus, and mitochondria are difficult to discern, and the nucleus is irregular in outline and usually at the base of the cell.

Myoepithelial cells - contractile cells associated with the secretory end-pieces. They are branching or stellate-shaped cells with processes containing actin and myosin that embrace the secretory cells. Although their structural and functional characteristics are similar to those of smooth muscle cells, myoepithelial cells are derived from epithelium are found on the epithelial surface of the basal lamina and reside on the epithelial side of the basal lamina. The myoepithelial cells provide support for the secretory cells and their contraction helps to expel saliva from the end-pieces into the ductal system.

Terminal secretory unit – is a functional subunit of the salivary gland which is called an acinus. Despite its size and

location, the terminal secretory compartment is composed of epithelial secretory cells, namely serous and mucous acini. The serous and mucosal cells, together with myoepithelial cells, are organised in acinuses, which are mostly spherical or tubular in shape and have a central drain.

Intercalated ducts - small ducts in salivary glands connecting the secretory cells to larger striated ducts.

Striated ducts - intralobular salivary ducts with a striated appearance due to membrane infoldings and aligned mitochondria; active in electrolyte secretion and absorption.

Terminal excretory ducts – these ducts are arranged within the connective tissue between gland lobules and are wider in diameter than the striated duct. These ducts are covered with pseudostratified epithelium with columnar cells extended from the basal lamina into the luminal space of the duct and small basal cells placed on the basal lamina. In the process of fusion of small ducts into large excretory ducts, the number of basal cells grows, and dispersed mucous (goblet) cells are also observed. The main excretory duct may become stratified near the oral opening. Brush cells with long microvilli and apical vesicles are visible, which are assumed to be receptor cells because they show nerve endings close to the basal part of the cell. Dendritic cells are also prominent and play an important role in immune defence.

Hand AR, Pathmanathan D, Field RB. Morphological features of the minor salivary glands. *Arch Oral Biol*. 1999;44 Suppl 1:S3-S10. doi:10.1016/s0003-9969(99)90002-x

Links:

https://entokey.com/salivary-gland-histology/
https://www.sciencedirect.com/science/article/pii/B0123868602006286
https://www.intechopen.com/chapters/63843

TESTS

1. The micropreparation of the **submandibular salivary** gland indicates a number of **basket-shaped cells** focused **around the acini and the excretory ducts.** These **cells surround the bases of serous cells and are called myoepithelial cells**. What tissue do these cells belong to?

Muscular tissue

Epithelial tissue
Neural tissue
Special connective tissue
Loose fibrous connective tissue

2. What **substance** is responsible for **making saliva viscous and mucous** and **provides a protective function**, in particular, **protection against mechanical damage to the oral mucosa**?
Mucin
Glucose
Kallikrein
Amylase
Lysozyme

3. A histological preparation made from the **gland** revealed **acini containing 10-15 conical cells with basophilic cytoplasm**, a **round nucleus** and a well-developed **granular endoplasmic reticulum**. The acini are surrounded by the **basement membrane, which contains myoepithelial cells** in the extensions. The section from which organ is shown on the specimen?
Parotid salivary glands
Pancreas
Lungs
Sublingual
Liver

4. An **abnormality in the development of a newborn** in the form of a **disorder of the structure of the major salivary glands** has been detected. As a result of damage to which **embryonic germ**, this pathology was created?
Ectoderm
Splanchnotom
Somites
Entoderm

Mesenchyme

5. The histologic specimen of the **submandibular gland** demonstrates the **excretory duct**. The mucous membrane of the **duct is lined with cuboidal epithelium**, the cells of which **have poorly developed organelles**. What is the excretory duct?
Intercalated
Striated
Interlobular
Common excretory
-
6. The micropreparation of the **parotid gland shows secretory acini** with **serous cells that synthesize mainly enzymes**. Based on the **chemical composition classification, the parotid gland belongs to** the following glands:
Serous
Mucous
Seromucous
Enzymatic
-

7. The examination of a microsection from an unidentified **organ** revealed several **acini containing 10-15 cone-shaped cells with basophilic cytoplasm, a round nucleus, and a well-developed rough endoplasmic reticulum**. The acinar is surrounded by the basement membrane, in the branches of which **myoepithelial cells** are localized. What organ is the section made of?
Parotid gland
Pancreas
Lungs
Sublingual gland
Liver

8. **Submandibular salivary gland** is known to have **mucous end sections consisting of mucocytes**. What are the characteristics of these cells?

Flattened nucleus and light cytoplasm
Basophilic cytoplasm
Rounded nucleus in the center of the cell
Microvilli
Basal striation

9. Certain **diseases** of the salivary glands are associated with **dysfunction of their excretory ducts**. **What types of salivary gland ducts** are distinguished?

Intra-, interlobular duct and common duct
Intralobular ducts, striated and common duct
Glistering, striated and common duct
Intra-, interlobular ducts
Intralobular ducts and outside the gland ducts

10. The examination of the histologic specimen of the **gland** reveals only **serous terminal portions**. The interlobular connective tissue shows ducts lined with bilayer or multilayer epithelium. Identify this structure.

Parotid gland
Submandibular salivary gland
Pancreas
Sublingual salivary gland
Liver

11. It has been proven that the secret of the **parotid gland** is excreted in the oral cavity through the ducts. Some **ducts are lined by epitheliocytes with basal striations and microvilli**. Which duct is characterized by the following features?

Striated ducts
Excretory ducts
Intralobular ducts
Intercalated ducts
Interlobular

12. Many small **salivary gland ducts open to the surface of the tongue**, which is an atypical topographic location for the glands. Indicate the **position of the salivary gland of the tongue**?

Muscularis mucosae
Mucous membrane
Submucosa
Epithelium of the tongue superior surface
Epithelium of the tongue inferior surface

13. For medical reasons, a 47-year-old patient had one of his **salivary glands removed**, after which the content of **amylase in his saliva decreased rapidly**. Which gland was deleted?

Parotid
Buccal
Submucosa
Gingival
Sublingual

14. In the **parotid salivary glands**, a viral process causes rapid **sclerosis of the parenchyma** and a **decrease in the production of biologically active hormones**. This **disrupts the regeneration** of the oral mucosa. What is absent in saliva?

Growth factors of epithelium
Interstitial cell-stimulation factors
Colony-stimulating factors(CSF)
Lysozyme
Parotin

15. The **epithelium of the interlobular excretory ducts is affected** as a result of chronic inflammation of the parotid gland. What epithelium is damaged?

Slightly stratified epithelium
Stratified columnar
Simple squamous

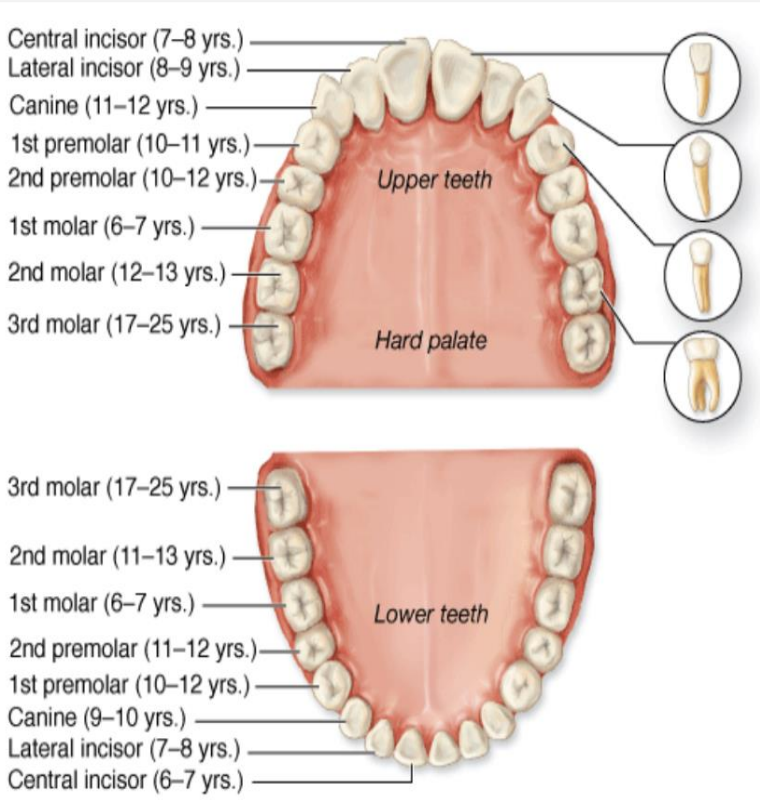
Stratified ciliated
-

16. The **secretory compartments of the parotid glands** have been damaged as a result of acute inflammation. Which cells will be affected as a result?
Serous and myoepithelial cells
Serous and mucosus
Myoepithelial
Serous and mucosus
Mucosus and myoepithelial cells

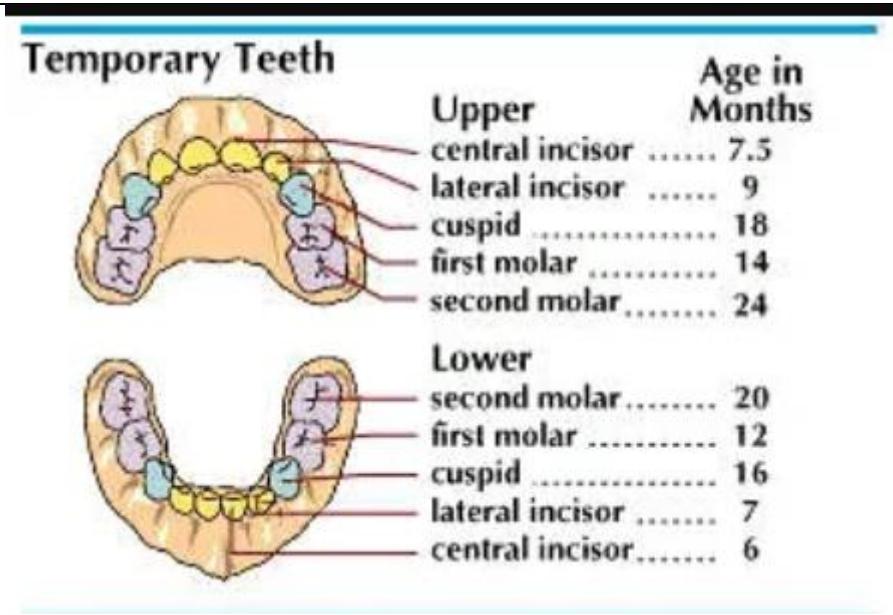
17. In the preparation of the extracted salivary gland, we detect a small stone in the **duct**, the wall of which **is lined with stratified squamous epithelium**. In which duct was the stone found?
Excretory ducts
Interlobular
Striated
Intercalated
Intercellular

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 6. Structure of baby and permanent teeth.

<table>
<tr><th colspan="4">Permanent (secondary, adult) teeth</th></tr>
<tr><th colspan="2">Type</th><th>Number and location</th><th>Picture</th></tr>
<tr><td>1.</td><td>Incisors</td><td>1) Central and lateral of maxilla and mandibula (upper and lower jaw).
2) 2 central incisors and 2 lateral incisors of maxilla
3) 2 central incisors and 2 lateral incisors of mandibula</td><td rowspan="4"> 

Mescher.: Junqueira's Basic Histology, Text and Atlas, Fourteenth Edition, McGraw-Hill Education – Europe, 2015</td></tr>
<tr><td>2.</td><td>Canine</td><td>2 canine of maxilla and mandibula</td></tr>
<tr><td>3.</td><td>Premolars</td><td>1) two 1st premolars and two 2nd premolars of maxilla
2) two 1st premolars and two 2nd premolars of mandibula</td></tr>
<tr><td>4.</td><td>Permanent molars</td><td>1) two 1st molars, two 2nd molars and 3rd molars of maxilla
2) two 1st molars, two 2nd molars and 3rd molars of mandibula</td></tr>
</table>

Primary (baby) teeth			Picture
Type		**Number and location**	
1.	**Incisors**	1) Central and lateral of maxilla and mandibula (upper and lower jaw). 2) 2 central **incisors** and 2 lateral **incisors** of maxilla 3) 2 central **incisors** and 2 lateral **incisors** of mandibula	
2.	**Canine (cuspid)**	2 **canine** of maxilla and mandibula	
3.	**Molars**	1) two 1st **molars and** two 2nd **molars** of maxilla 2) two 1st **molars and** two 2nd **molars** of mandibula	https://kids.britannica.com/students/assembly/view/54068

Anatomical structure of the tooth		
Parts		**Features**
1.	**Crown**	Part of tooth which is exposed above the gingiva.
2.	**Neck (cervix)**	Part of tooth which is situated between the root and crown and is constricted at the gum. It is the junction between the crown and root.
3.	**Roots**	Part of tooth which is situated below the gingiva and that hold the teeth in bony sockets called alveoli. It has apical foramen (small opening where nerves and blood vessels enter and exit the dental pulp).

Histological structure of the tooth			
Parts		**Features**	**Content of mineral and organic substances**
1.	**Enamel**	1) It is situated in the **crown** of the tooth. 2) The region where the enamel and cementum meet is called the cementoenamel junction (CEJ). 3) Structural unit **- enamel rod (prism)**	1) **Minerals** – 96-98% calcium hydroxyapatite, fluoride. 2) **Organic substances** – 1% proteins, amelogenin and enamelin, but no collagen 3) 3% water
2.	**Dentin**	1) It is situated in the **crown and root** of the tooth. 2) Structural unit - **dentinal tubule** which includes odontoblastic processes. 3) It includes **dentinal tubule**, **odontoblastic processes** and **dentinal matrix**. 4) Each dentinal tubule contains an odontoblastic process about halfway toward the dentinoenamel junction; the rest of the space is filled with fluid.	1) **Minerals** – 70% calcium hydroxyapatite 2) **Organic substances** – 20% type I collagen fibers and glycosaminoglycans 3) 10% water
3.	**Pulp**	1) It is situated in the **the central core and root canals of the tooth**. 2) Loose connective tissue. 3) It is a highly innervated and vascularized tissue (venules and capillaries). 4) Some nerve fibers lose their myelin sheaths and extend into the dentinal tubules.	1) **Organic substances** – **bodies of odontoblasts** there are in the peripheral zone of the pulp, fibroblasts, macrophages, lymphocytes, ground substance, reticular fibers and other fine I, III collagen fibers, fibronectin and elastin.
4.	**Cementum**	1) It covers **root** of the tooth from the **cervix to the apex of root**. 2) **Cellular cementum** includes cementocytes. It is often found at the apical third of the tooth	1) **Minerals** – 65% calcium hydroxyapatite 2) **Organic substances** – 23% collagen fibers, Sharpey fibers and ground

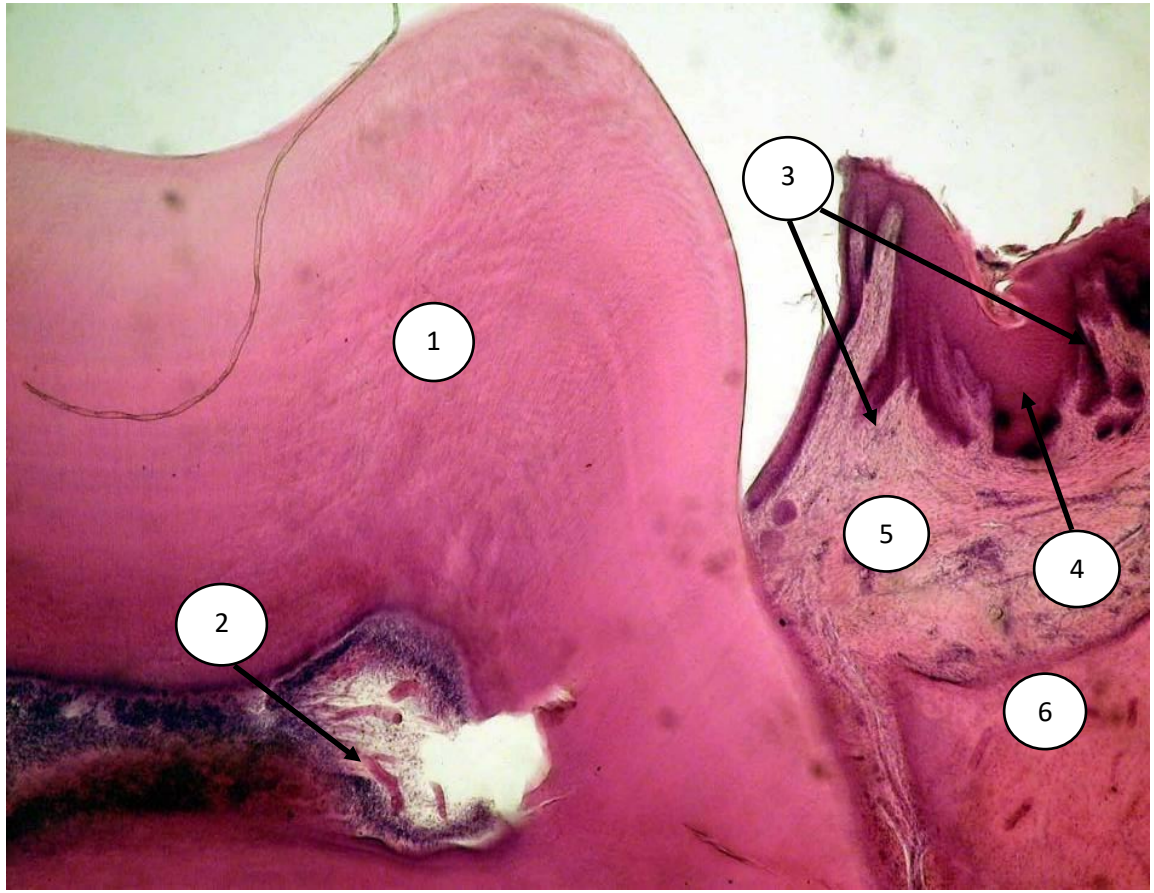
		root and is similar to bone with a calcified intercellular matrix. 3) **Acellular cementum** includes collagen fibers and does not cells. It is often found at the cervical two thirds of the root.	substance, cementocytes. 3) 12% water

Lines and defects of enamel		
Types		**Features**
1.	**Striae of Retzius (incremental growth lines)**	Bands or longitudinal sections (arcs) of the mature enamel. These patterns reflect the changes in enamel secretory rhythm.
2.	**Enamel tufts**	are hypomineralized areas filled with organic material from the dentinoenamel junction to the surface.
3.	**Enamel lamellae**	are hypomineralized, thin, sheetlike defects that can run through the entire enamel and are commonly caused by cracks.
4.	**Enamel spindles**	are thin, needlelike lines extending from the dentinoenamel junction to the enamel and includes odontoblast processes which trapped in the enamel during early amelogenesis.

Classification of dentin for localizatin		
Types		**Features**
1.	**Peritubular dentin**	It is situated inside of dentinal tubule and is highly calcified.
2.	**Intertubular dentin**	It is dentinal matrix which is situated between the dentinal tubules and is less mineralized than the peritubular dentin.

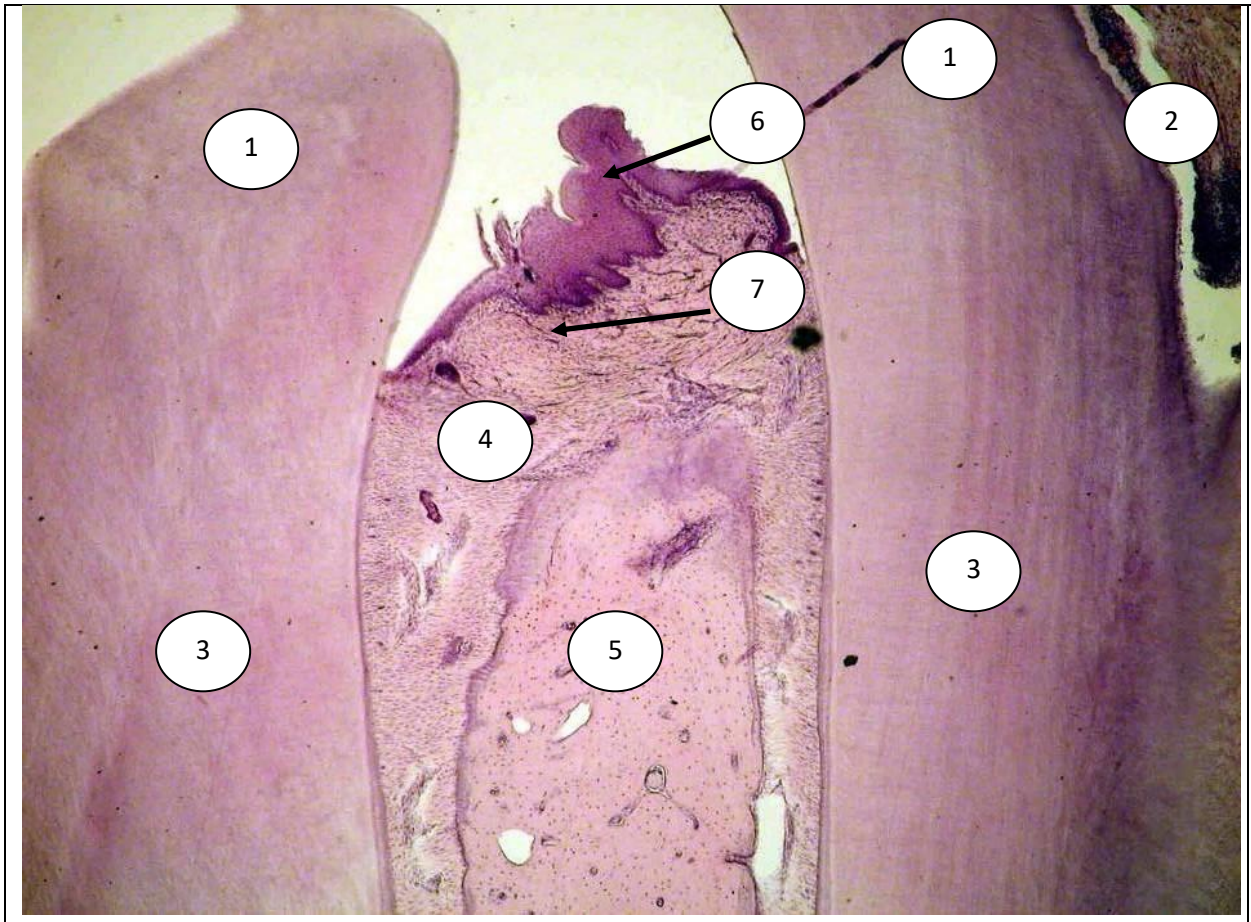
Classification of dentin for histogenesis		
Types		**Features**
1.	**Primary dentin**	It is deposited before the formation of the tooth root and tooth eruption have been completed, includes mantle dentin (at the dentinoenamel junction) and circumpulpal dentin.
2.	**Secondary dentin**	It is produced after tooth eruption and root formation have been completed, is deposited very slowly and is located beneath the primary dentin.
3.	**Tertiary (reparative) dentin**	It is produced in response to injures (caries, drilling, or attrition). It is produced only by the odontoblasts that are directly stimulated when the tooth is injured. It has few, mostly irregular, dentin tubules.

Parts of palp		
Parts		**Features**
1.	**Odontoblast layer**	It is peripheral layer of the pulp which includes bodies of **odontoblasts.**
2.	**Cell-free zone (zone of Weil)**	It is directly under the odontoblast layer. It has fibers, cellular processes, axons, and capillaries running through it but contains no cell nuclei.
3.	**Cell-rich zone**	It is beneath the cell-free zone, and has many cells and nuclei of cells densely packed in rows. It has fibroblasts, undifferentiated mesenchymal cells, neural plexuses, and capillaries. Mesenchymal cells in this layer can differentiate into new odontoblasts.
4.	**Pulp proper (pulp core)**	It contains blood vessels and nerves within the loose connective tissue



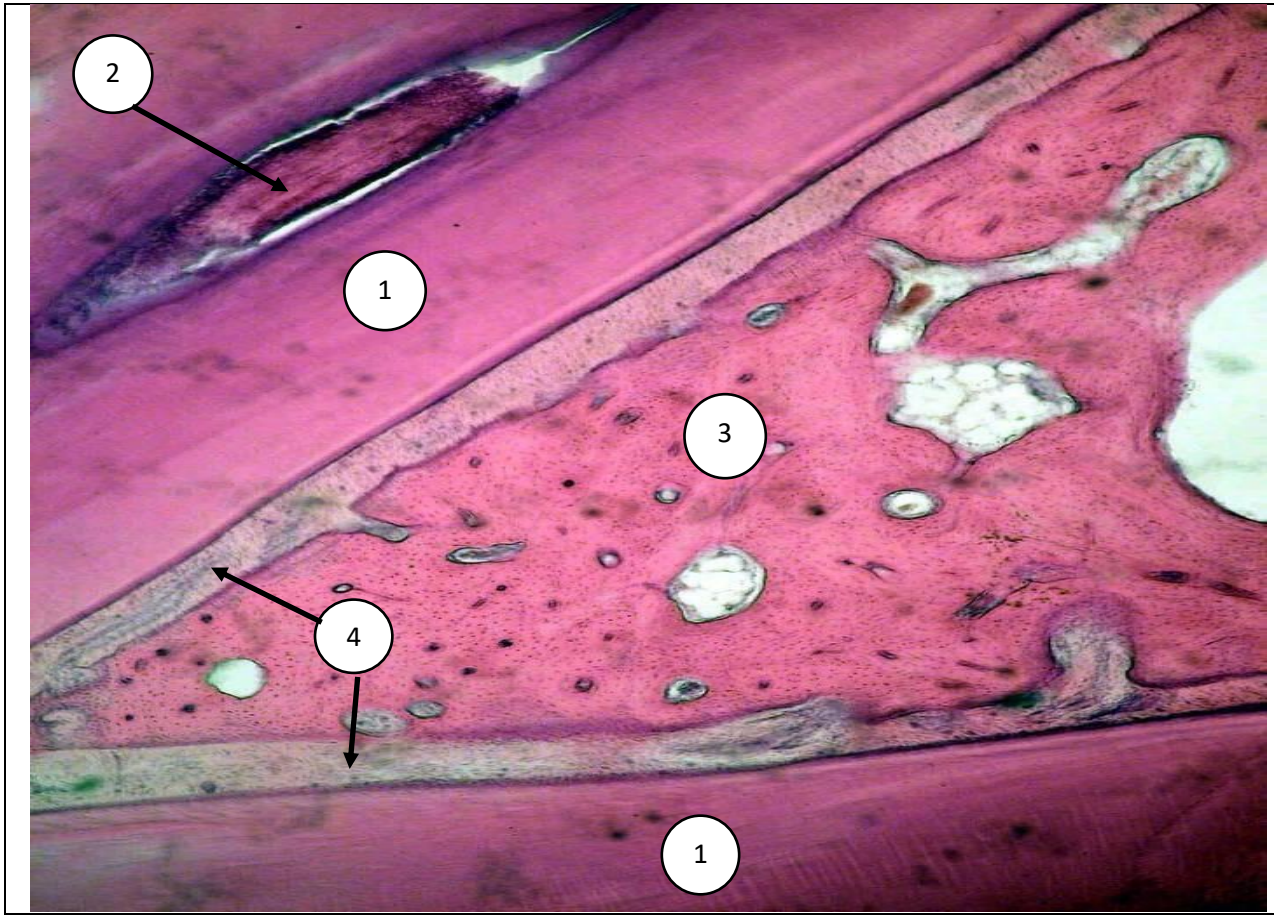
Section of the tooth
Magnification X 40, hematoxylin-eosin staining.

On the preparation of the tooth cross section you can see the crown of the tooth (1), the pulp cavity (2). Laterally from the crown there are gums (3) and alveolar process (6). The gums consist of epithelium (4) and lamina propria (5).



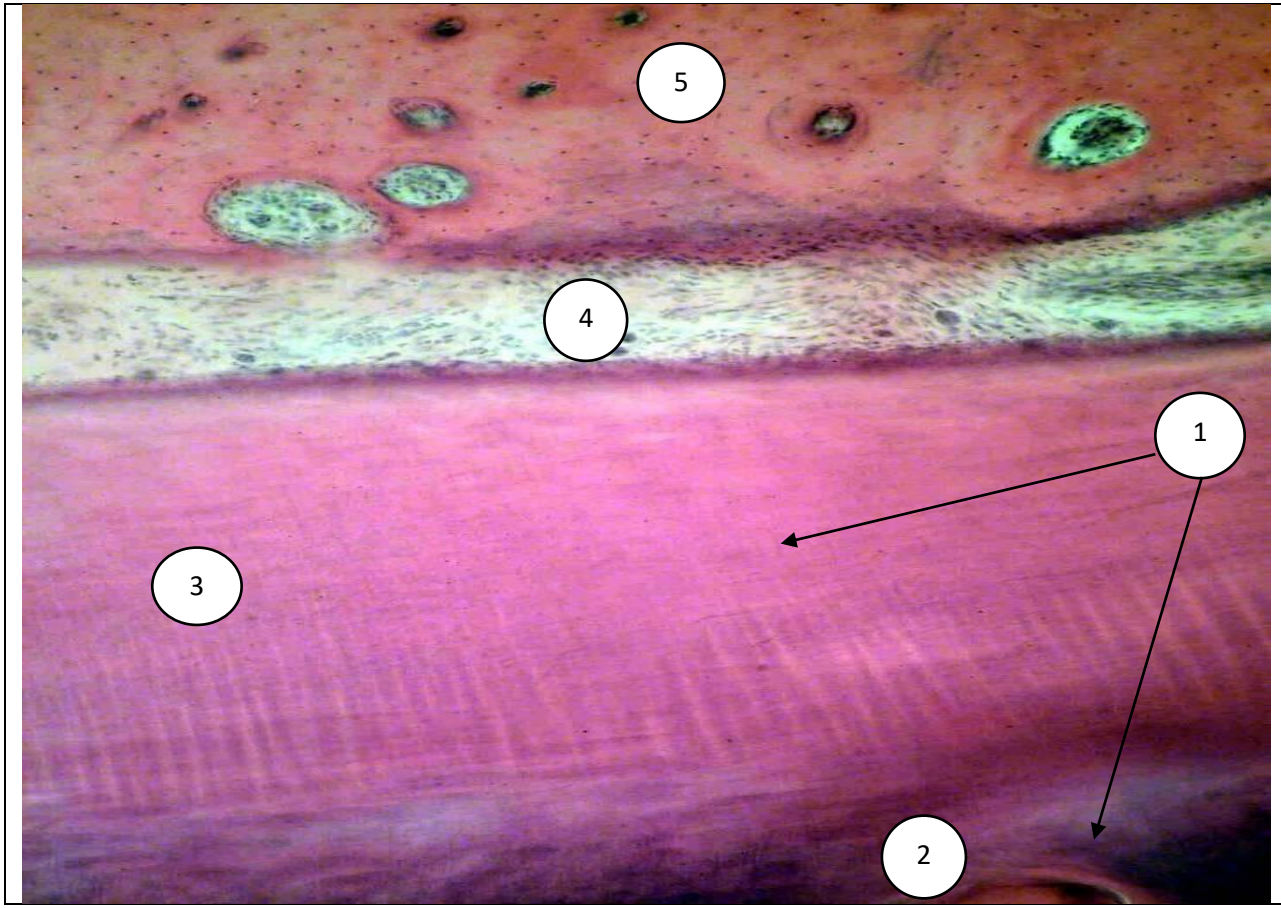
Section of the teeth
Magnification X 40, hematoxylin-eosin staining.

On the preparation of the teeth cross section you can see the crowns of the teeth (1), the pulp cavity (2) and roots of the teeth (3). Laterally from the crowns and roots there are gums (4) and alveolar process (5). The gums consist of epithelium (6) and lamina propria (7).



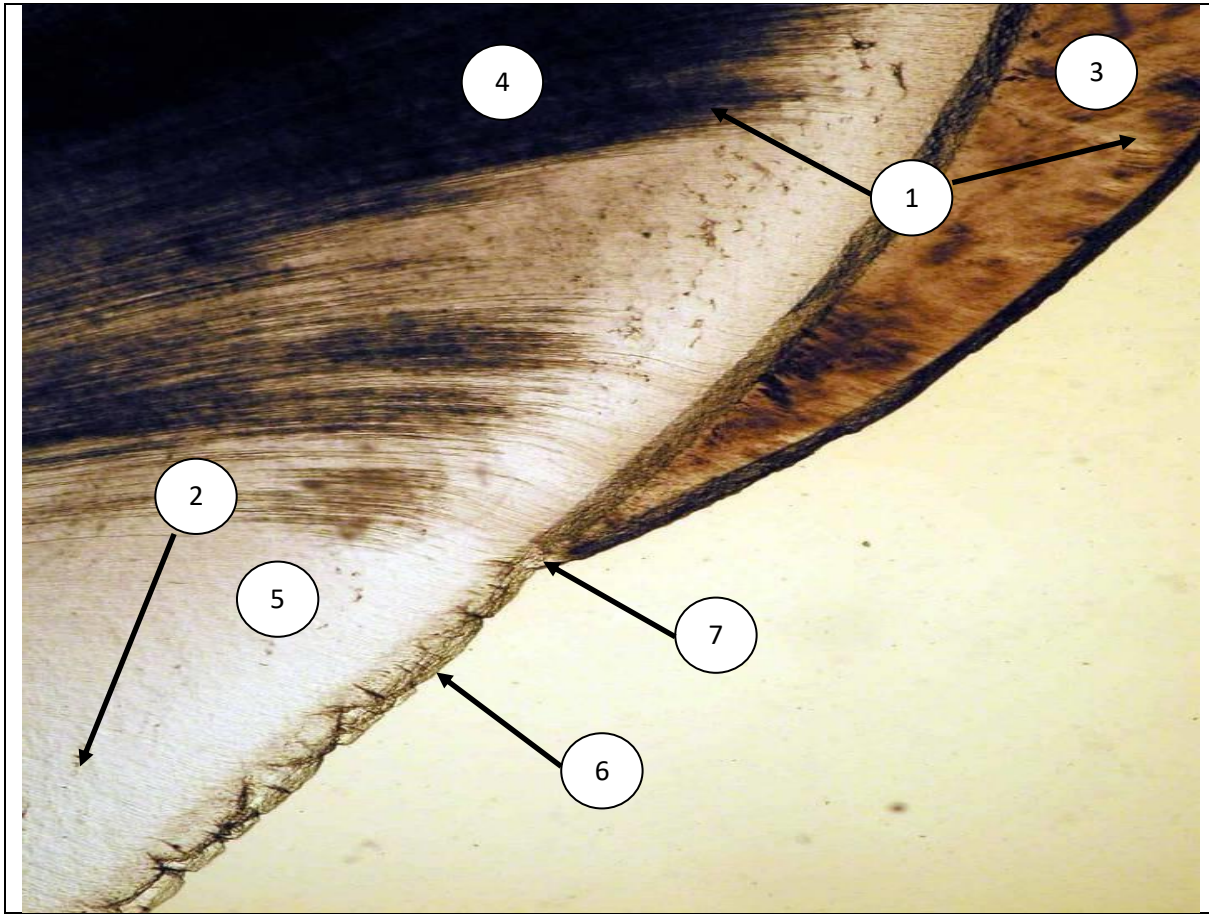
Interradicular bone
Magnification X 40, hematoxylin-eosin staining.

On the preparation of cross section interradicular bone there are roots of teeth (1), the pulp cavity (2). Laterally from roots there is interradicular bone (3). Periodontium is a ligament that supports the root of the tooth in the bone alveoli (4).



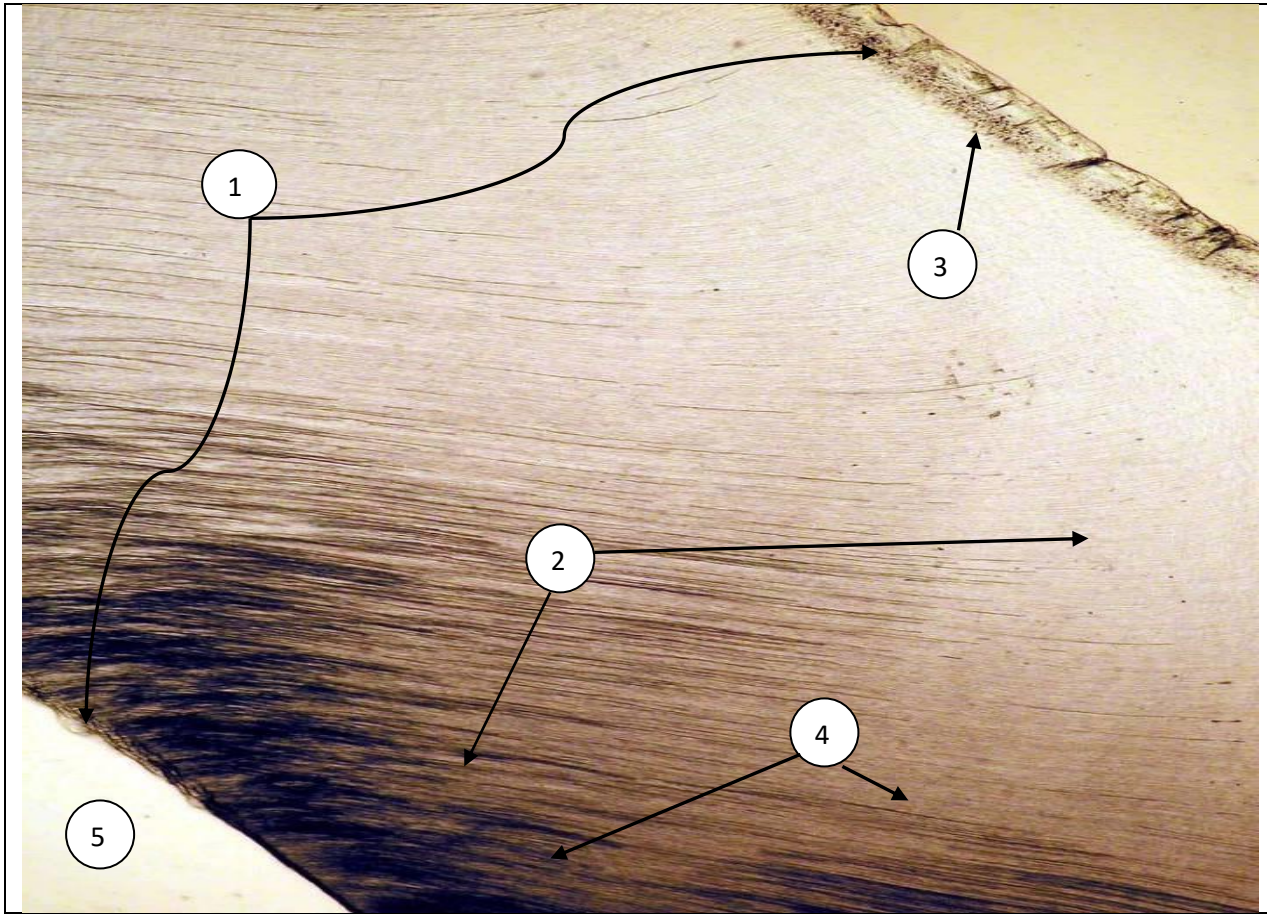
Root of the tooth
Magnification X 100, hematoxylin-eosin staining.

On the preparation of cross section root of the tooth (1) there are pulp (2), dentine (3). Laterally from the root there are periodontium (4) and interradicular bone (5).



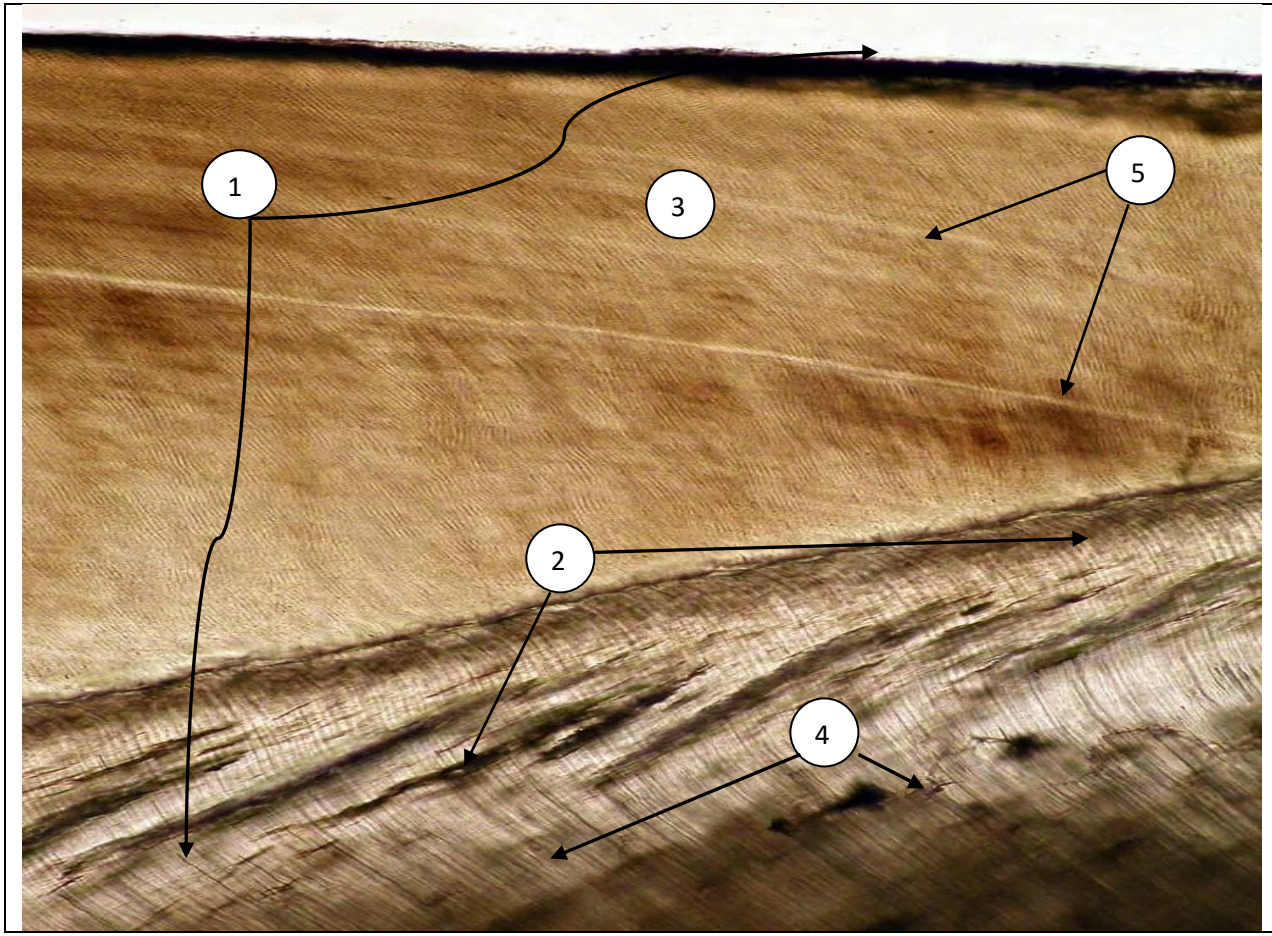
Cervix of tooth
Magnification X 100. Ground specimen.

On the preparation of the tooth there are crown (1) and root (2). Crown consists of enamel (3) and dentine (4), Root consists of dentine (5) and cementum (6). Between the crown and root there is cervix (7).



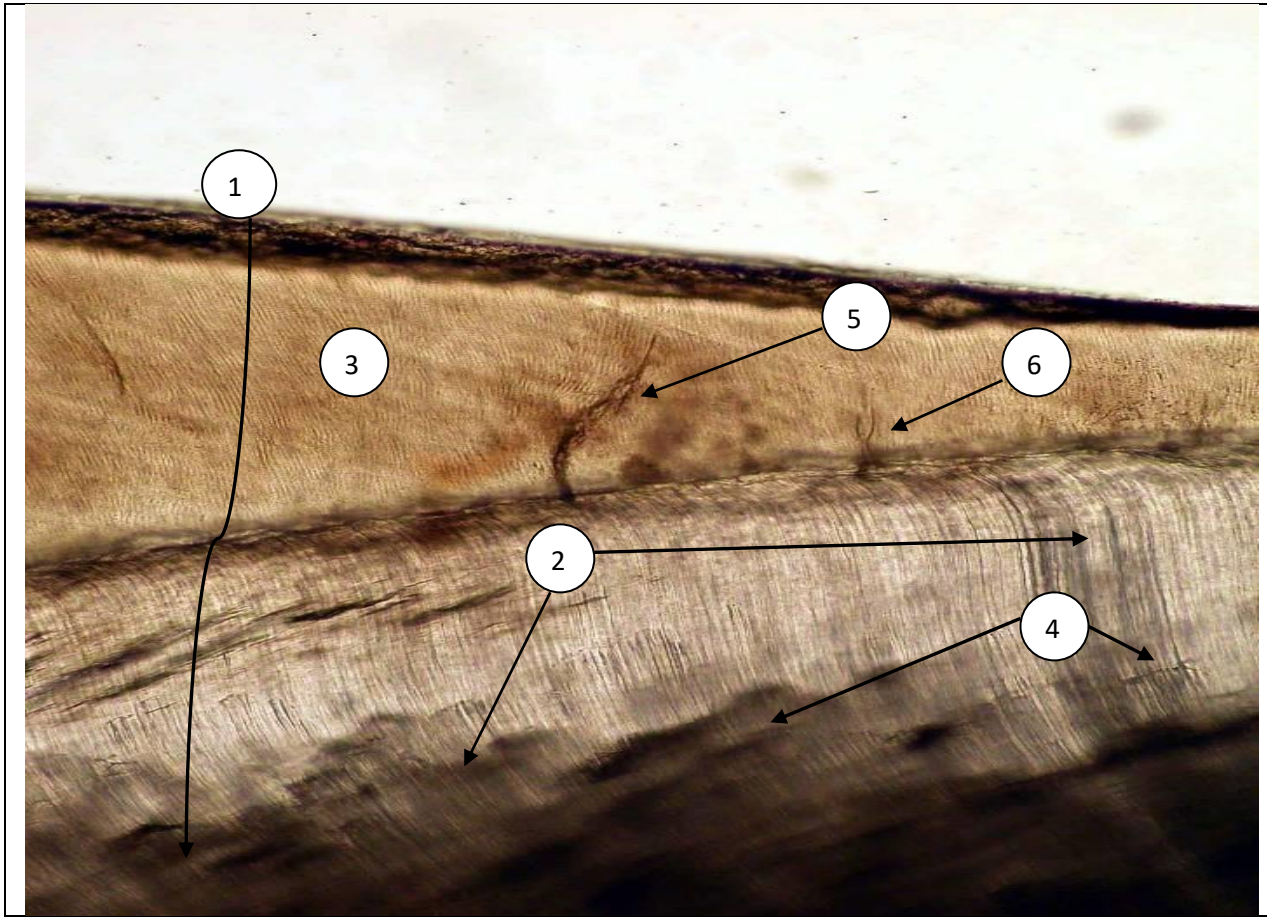
Dentinal tubules
Magnification X 100. Ground specimen.

On the preparation of the tooth there is root (1). Root consists of dentine (2) and cementum (3). Dentine consists of dentinal tubules (4). In the left corner of the preparation there is pulp cavity (5).



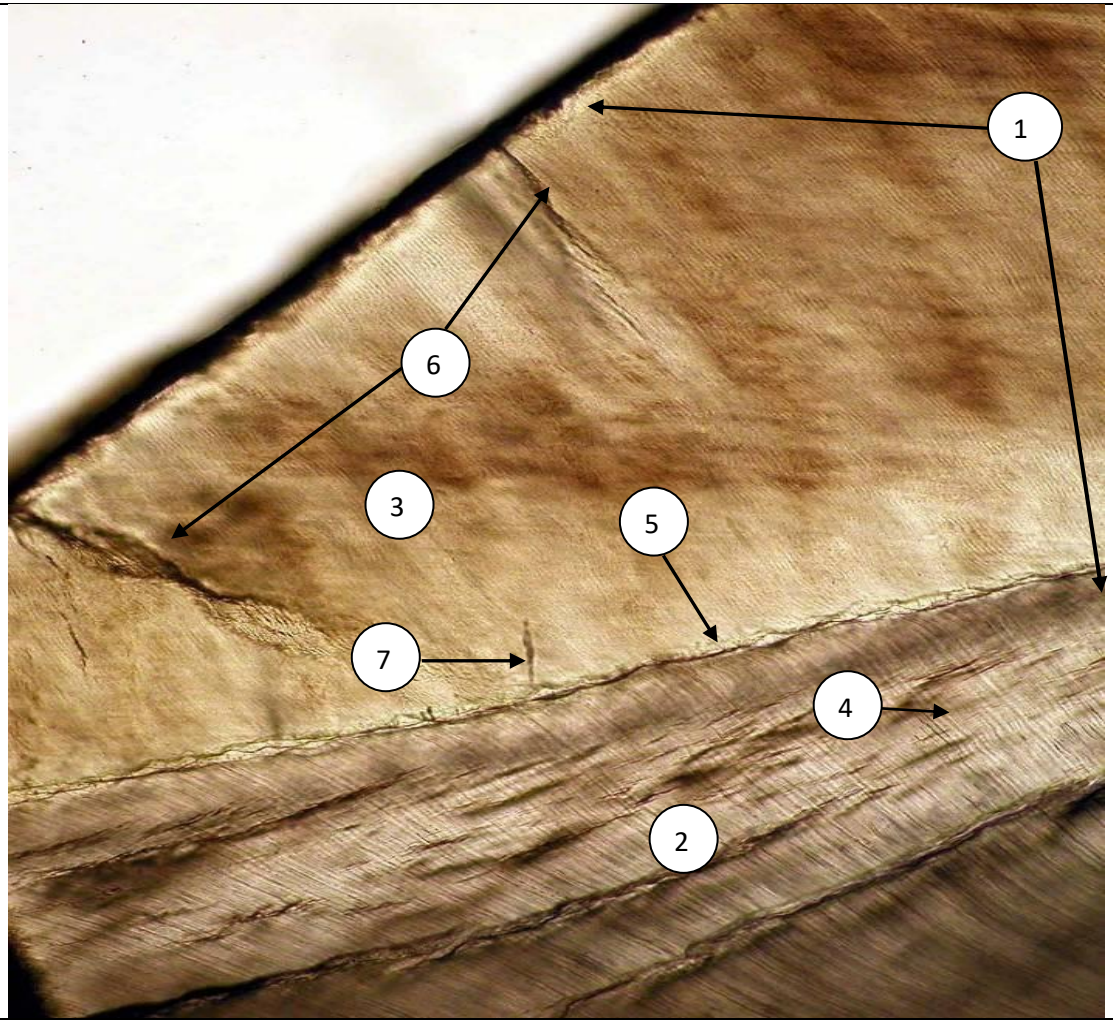
Retzius lines in enamel Magnification X 100. Ground specimen.

On the preparation of the tooth there is crown (1). Crown consists of dentine (2) and enamel (3). Dentine consists of dentinal tubules (4). In the enamel there are Retzius lines (5).



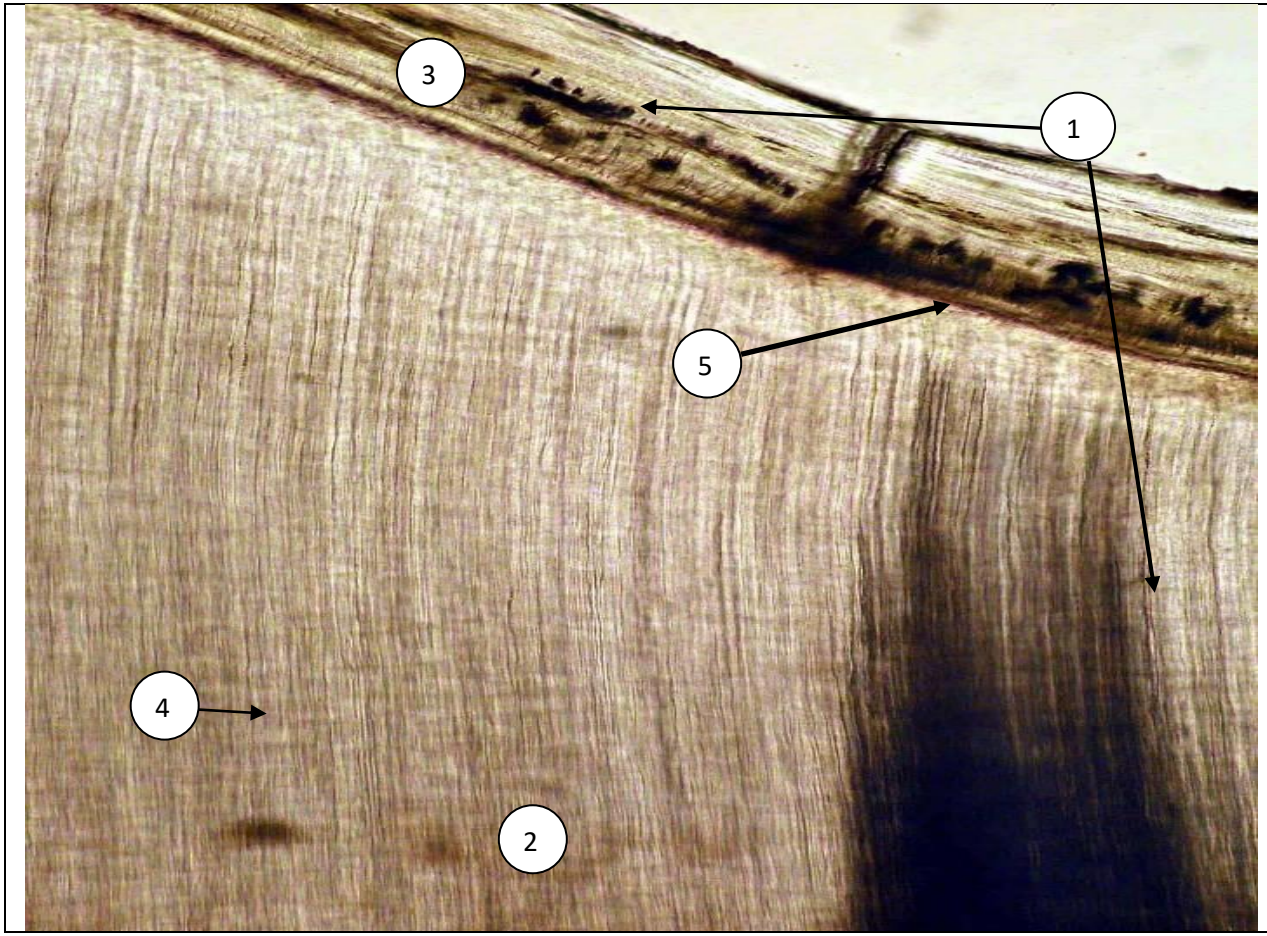
Dentinoenamel junction Magnification X 100. Ground specimen.

On the preparation of the tooth there is crown (1). Crown consists of dentine (2) and enamel (3). Dentine consists of dentinal tubules (4). In the enamel there are enamel tufts (5), which extend from the dentinoenamel junction and enamel spindles (6).



Enamel plates

Magnification X 100. Ground specimen. On the preparation of the tooth there is crown (1). Crown consists of dentine (2) and enamel (3). Dentine consists of dentinal tubules (4). Between enamel and dentin there is dentinoenamel junction (5). In the enamel there are enamel plates (6) and enamel spindles (7).



Dentinocemental border Magnification X 100. Ground specimen.

On the preparation of the tooth there is root (1). Root consists of dentine (2) and cementum (3). Dentine consists of dentinal tubules (4). Between cementum and dentin there is dentinocemental border (5).

VOCABULARY

Enamel shares some mineral characteristics with bone tissue, but it is acellular and avascular. Enamel matrix is deposited in columns called enamel rods by cells called ameloblasts. Enamel is the strongest substance in the human body, due to its high mineral content. Extra-Cellular Matrix is mostly calcium hydroxyapatite, instead of collagen fibers, enamel contains proteins including amelogenins and enamelins.

Enamel rods (**prisms**) – the main structural unit of tooth enamel, 4 microns wide, consisting of a densely formed and organized set of hydroxyapatite crystals, hexagonal in shape.

Striae of Retzius –are lines of growth visible in the enamel. As a result of the acceleration and deceleration of the enamel deposition process, bands of lighter and darker enamel (less dense and more dense) can be seen on the cross section.

Bands of Hunter-Schreger – are enamel that is produced by a set of ameloblasts, and are lines that extend perpendicular to the junction of dentin and enamel. The curvature of Hunter-Schrager bands makes sure that there is no single layer on which the tooth can easily become chipped.

Enamel tufts look like to enamel spindles, but shorter, have a bushy shape and do not possess odontoblastic processes.

Dentin - the yellowish tissue that constitutes the basic mass of all teeth. It is harder than bone but softer than enamel and consists mainly of apatite crystals of calcium and phosphate.

Odontoblasts - a cell of neural crest origination, which constitutes part of the tooth pulp outer surface, and whose function is the dentin formation.

Dentinal tubules –are very tiny channels that pass through dentin, starting from the pulp cavity and ending at the dentin-enamel or cemento-dentin junction.

Interglobular dentin – imperfectly calcified matrix of dentin situated between the calcified globules near the dentinal periphery; also called interglobular space of Owen.

Pulp - is an unmineralized oral tissue composed of soft connective tissue, vascular, lymphatic and nervous elements that occupies the central pulp cavity of each tooth.

Cementum - a layer of bonelike, mineralized tissue covering the dentin of the root and neck of a tooth that anchors the fibers of the periodontal ligament**.**

Cellular cementum - consists of cells and collagen fibers that attach the tooth to the alveolar bone. It is located at the root apex.

TESTS

1. A 42-year-old patient suffering from **periodontitis** has **rounded structural formations in the crown part of the pulp**. Name these structures?

Denticles
interglobular dentine
Sclerotic dentine
Dead dentine
Dental stones

2. During the examination of a tooth section of a 42-year-old man, **hard linear carinated structures up to 1/3 of the enamel depth** were **found at the dentin-enamel junction**. What structures were found?

Enamel spindles
Denticles
Enamel fascicles
"Dead" tracts
Carious damage

3. In the histological preparation of a **multi-rooted tooth, polygonal cells with processes are found in the area of root bifurcation.** What cells and what tissues of the tooth are characterized by this morphological feature?
Cementocytes, cementum
Odontoblasts, enamel
Enameloblasts, enamel
Fibroblasts, pulp
Cementocytes, dentine

4. A 42-year-old patient visited a dentist with **symptoms of severe toothache**. After examination, the doctor found **inflammation of the tooth pulp**. What tissue forms the tooth pulp?
Loose connective tissue
Amorphous dense fibrous connective tissue
Dense fibrous connective tissue framed
Reticular connective tissue
Mesenchyme

5. The main part of the crown, the neck and the root of the tooth contains **dentin,** the length of which can increase with age, potentially as part of its **regeneration** after an injury. What structures ensure these processes?
Odontoblasts
Dentinal tubules
Perytubular dentin
Ameloblasts
Cementoblasts

6. In the molars, the tissue located **at the apex** and at their branching points is visible. This **tissue contains cells that lie in the gaps and numerous collagen fibers that run radially or longitudinally**. Name this tissue.
Cell cement
Reticular fibrous bone tissue
Dentin

Enamel
Dense connective tissue

7. **Non-calcified areas are found in the enamel at the border with dentin**, which are often the site of infection in the tooth. What are the names of such structures?
Enamel bundles
Enamel prisms
Enameloblasts
Dentynoblasts
Toms Fibers

8. The **child complained of a toothache**. The dentist diagnosed carious lesions of the enamel. What minerals are reduced in this pathology:
Phosphorous, fluorine and calcium;
Sodium, calcium, potassium,
Potassium, phosphorus, fluorine;
Magnesium fluoride, calcium
Phosphorus, magnesium, potassium

9. On a histological preparation of a **tooth slice**, light and **dark stripes 100 mm wide, directed radially, are determined in the enamel.** Give the correct name to these enamel formations.
Bands of Gunther Shreher
Lines of Retius
Perykimatiy
Enamel prisms
Enamel tufts

10. A histologic specimen shows **cell-free cement**. In which part of the tooth **is this type of cement localized**?
On the lateral surface of the tooth root

On the surface of the crown
Forms a layer of coronal pulp
At the top of the tooth root
In the pulp canal

11. The study of the chemical composition of **dentin revealed some areas with an increased mineral content**. When a tooth is damaged by caries, **this dentin is destroyed much faster, which leads to the expansion of dentin tubes and an increase in dentin permeability**. What type of dentin is it?
Peritubular dentin
Interglodular dentin
Predentine
Mantle dentin
Circumpulpal dentin

12. A histological section of **crown dentin reveals a small number of collagen fibers (Korf fibers)** running radially in the intercellular substance. Name this layer of dentin
Mantle dentine
Circumpulpal dentin.
Granular layer.
Interglobular dentin.
Predentine.

13. In a histological specimen of **tooth slice**, **cell-free tissue consisting of tubes containing cell processes is identified**. What tooth tissue is represented in the section?
Dentine.
Enamel.
Pulp.
Cement.
Dense connective tissue.

14. **Electron micrographs** of transverse ultrathin sections of tooth **enamel** reveal **oval, polygonal or arcuate formations consisting of compacted and organized hydroxyapatite crystals**. What are these formations?
Enamel prisms
Lines of Retius
Bands of Gunther - Shreher
Perykimatium.
Collagen fibers.

15. On the histological preparation of a **tooth in one of the tissues in the intercellular substance, collagen fibers are visible in radial and tangential directions.** Identify the tissue histogenesis for which this is a typical pattern?
Dentin
Enamel
Cementum
Pulp.
Dense connective tissue.

16. **Dentin tubules** can be seen on the longitudinal section of the tooth. What **is inside the tubules**?
Processes of dentynoblasts.
Processes of enameloblasts.
Body of dentynoblasts.
Fbroblasts.
Elastic fibers

17. Before the teeth erupt, a hard tissue, **similar to membranous reticular bone, appears on their roots**. What is this tissue?
Cement
Dentin
Enamel

Loose fibrous connective tissue
Dense fibrous connective tissue

18. A histologic specimen representing a tooth section shows that the intercellular substance of **dentin contains collagen fibers located tangentially to the dentin-enamel junction and perpendicular to the dentinal tubules (Ebner's fibers).** This layer of dentin is called:
Parapulpar dentin
Mantle dentin
Granular layer
Interglobular dentin
Secondary dentin

19. During the histological examination of a **transverse section of enamel, linear bands in the form of concentric circles were found, which are directed at an angle to the dentin-enamel junction**. Name these structures:
Retsius' lines
Hunter-Schreger's lines
Enamel plates
Enamel fascicles
Enamel spindles

20. During the histological examination of the **extirpated pulp, cylindrical cells were found in its peripheral layer**. What are the names of these cells?
Odontoblasts
Fibroblasts
Monocytes
Ameloblasts
Myofibroblasts

21. Histological examination revealed linear streaks in the form of **concentric circles on the transverse section of the enamel**, which are directed at an angle to the enamel-dentin junction. What are these structures?
Lines of Retzius
Bundles of Gunter-Shreher
Enamel lamellae
Enamel spindle
Enamel bundles

22. For some reason, the effectiveness of certain cells in the **peripheral zone of the pulp is temporarily inhibited**. What tooth structure is at risk of disruption of its physiological regeneration?
Dentine
Enamel
Pulp
Cellular cement formation
Acellular cement formation

23. Two tooth samples were histologically examined and found to have **cell-free cement in one** and **cellular cement in the other**. From which part of the tooth was the **second sample taken**?
Root apex
Cervix of tooth
The upper region of the tooth below the gumline
Crown of tooth
The bound between crown and root

24. During microscopic examination of the tooth's crown, **enamel pellicle** is diagnosed. Which structural components are part of the enamel's pellicle?
Thin layer of glycoprotein
Rete of collagen fibers
Accumulation of calcium salts

Residual of enaml organ cells
Gingiva

25. A medical research was conducted to study the source of **tissues that feed the tooth**. Which structural component of the tooth provides dentin **trophism**?
Pulp
Enamel
Cementum
Periodontum
Bone of processus maxillae

26. In the **thin regions of the crown**, we can see structures **called enamel tufts**. How they are formed?
Processus of cuticle enamel
Enamel prisms
Fibers with inorganic substances
Fibers with organic substances
-

27. On a histological preparation **are tooth structures that form cement**. Which cell are part of the formation of tooth cement?
Cementoblasts
Odontoblasts
Enameloblasts
Cementocytes
Osteoblasts

28. The many processes of **dentinoblasts are communicating** with each other through intercellular contacts. The **processes are responsible for contraction**, allowing for circulation of tissue fluid and saturation of dentin and enamel with minerals. Due to which organelles of dentinoblasts, contraction occurs?

Microfilaments
Golgi apparatus
Mitochondria
Lysosomes
Ribosomes

29. During the histological examination, **cylindrical cells** are found in the **peripheral layer of the pulp**. What are these cells called?
Odontoblasts
Fibroblasts
Monocytes
Ameloblasts
Myofibroblasts

30. A study was performed to investigate the **characteristics of the tooth structure**. In which **component of the tooth are blood vessels**?
Pulp
Enamel cuticle
Acellular cement formation
Dentinal tubules
Cellular cement formation

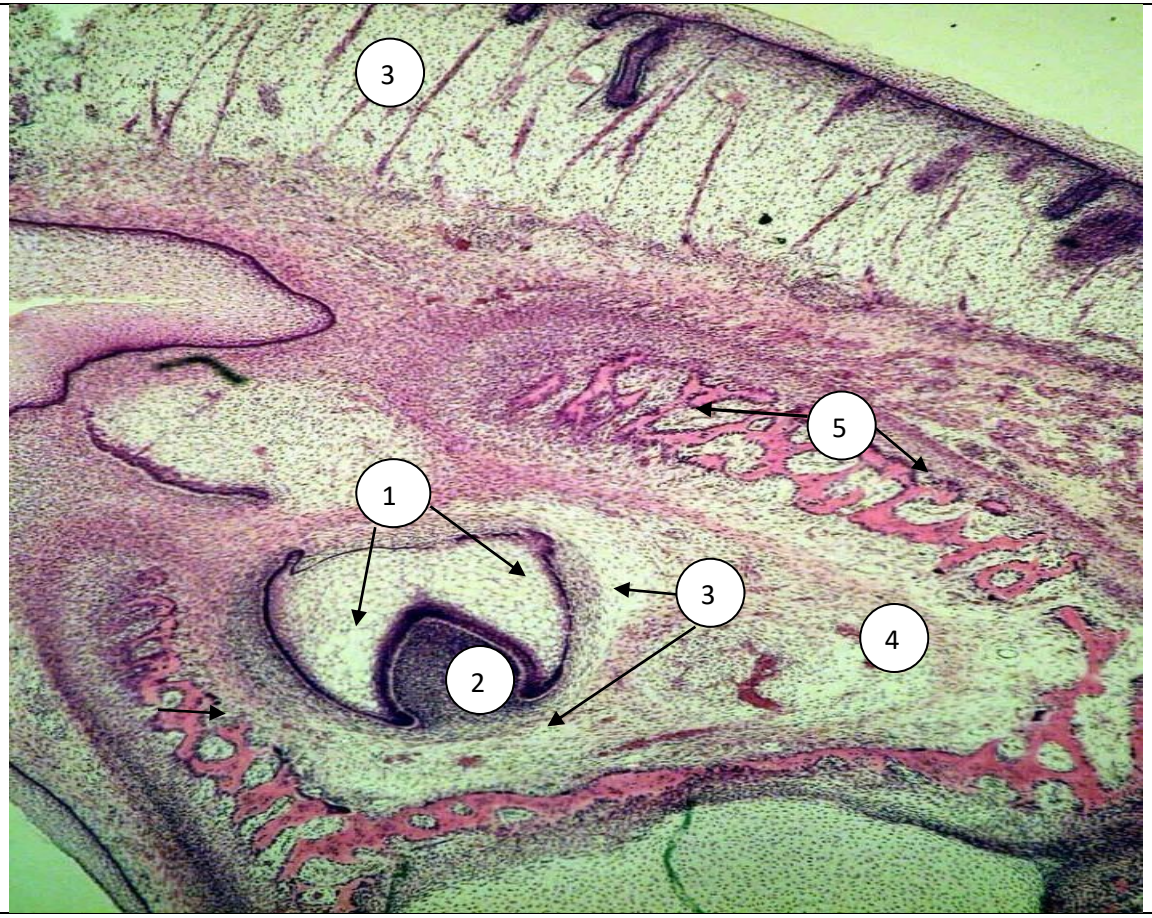
Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

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

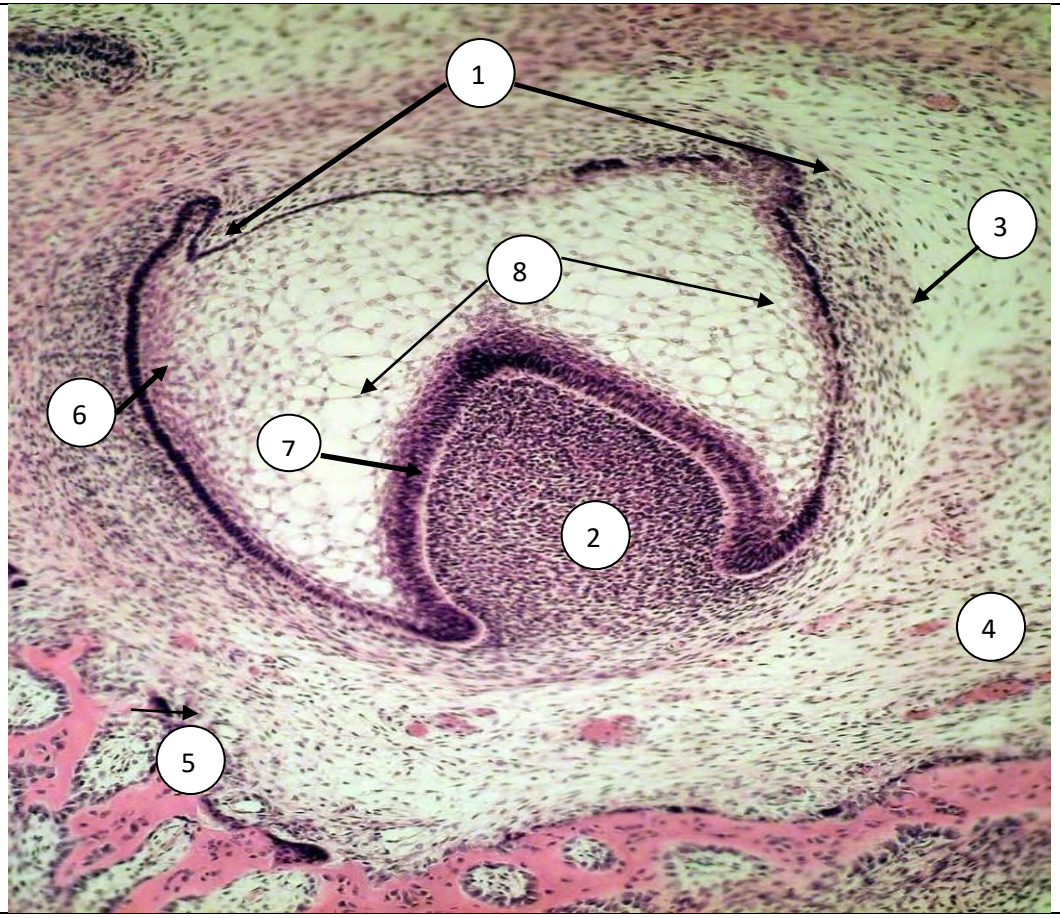
			organ. They contain **glycosaminoglycans** and **alkaline phosphatase.** There are desmosomes and gap junctions between the cells. 4) The **outer enamel epithelium** is composed of cuboidal cells and is the outermost layer of the enamel organ. This cell layer separates the enamel organ from the nearby 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.	



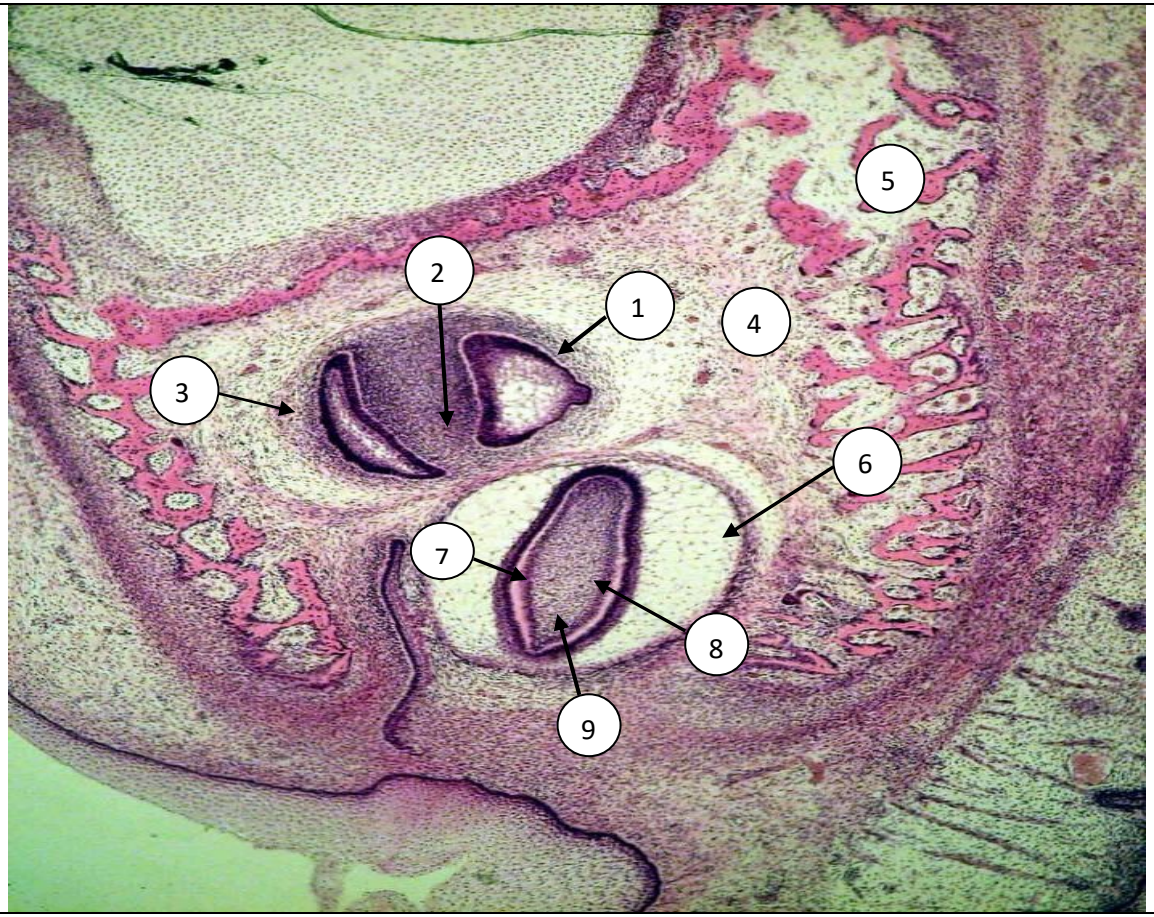
Tooth germ differentiation
Magnification X 40.

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).



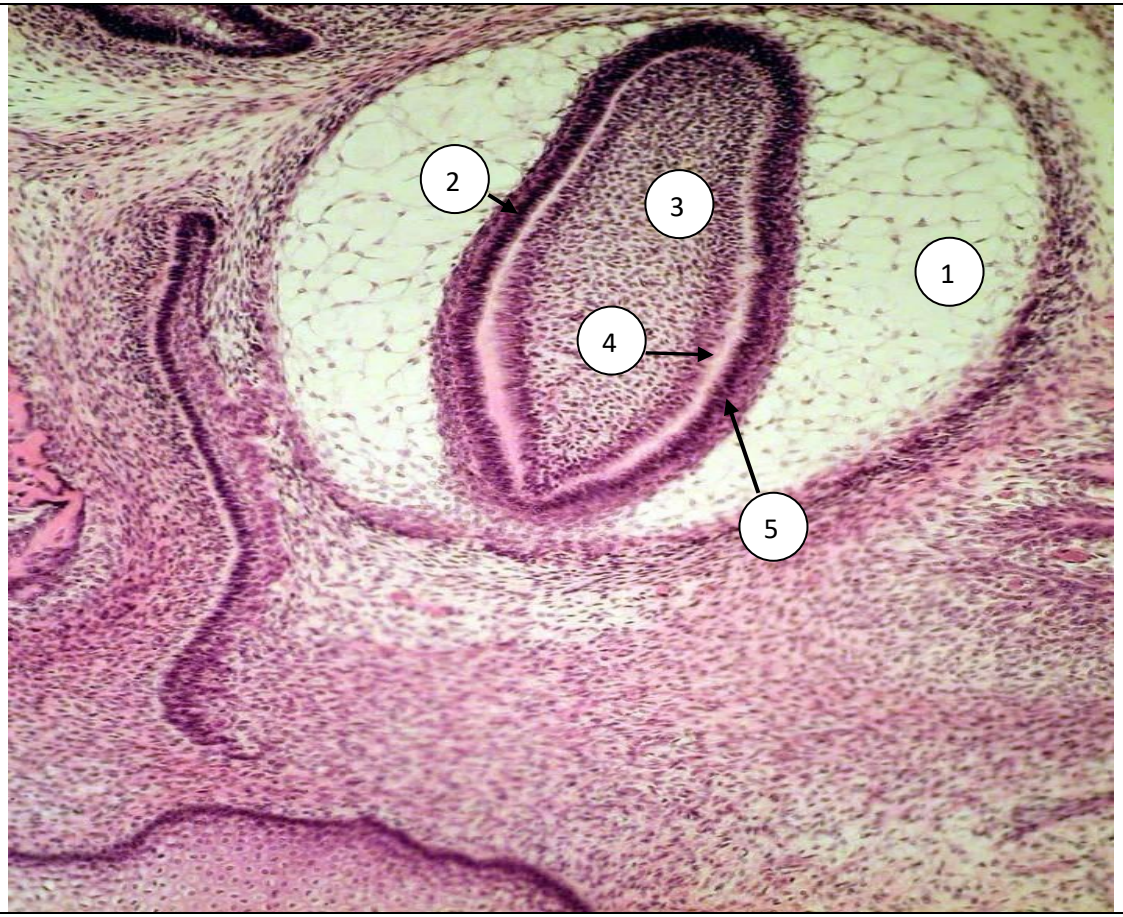
Tooth germ differentiation
Magnification X 100.

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).



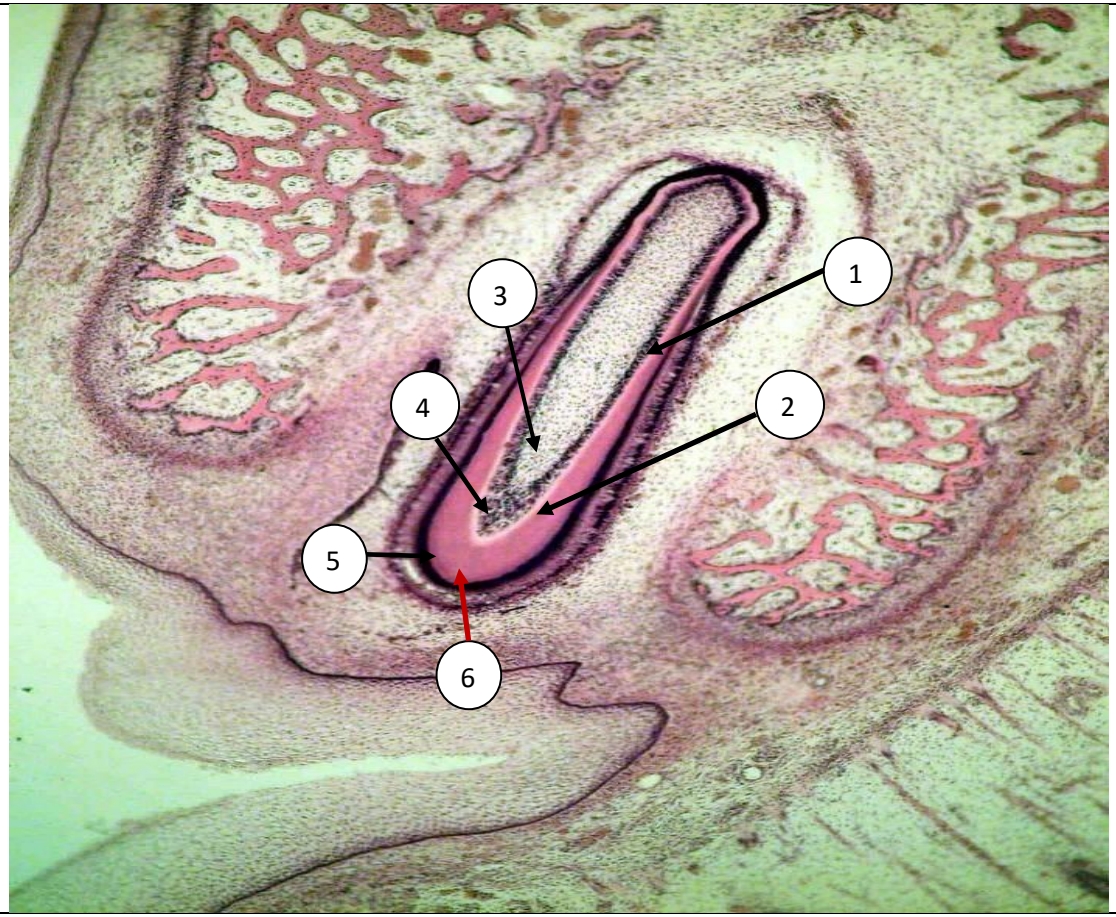
Dental tissue formation
Magnification X 100.

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).



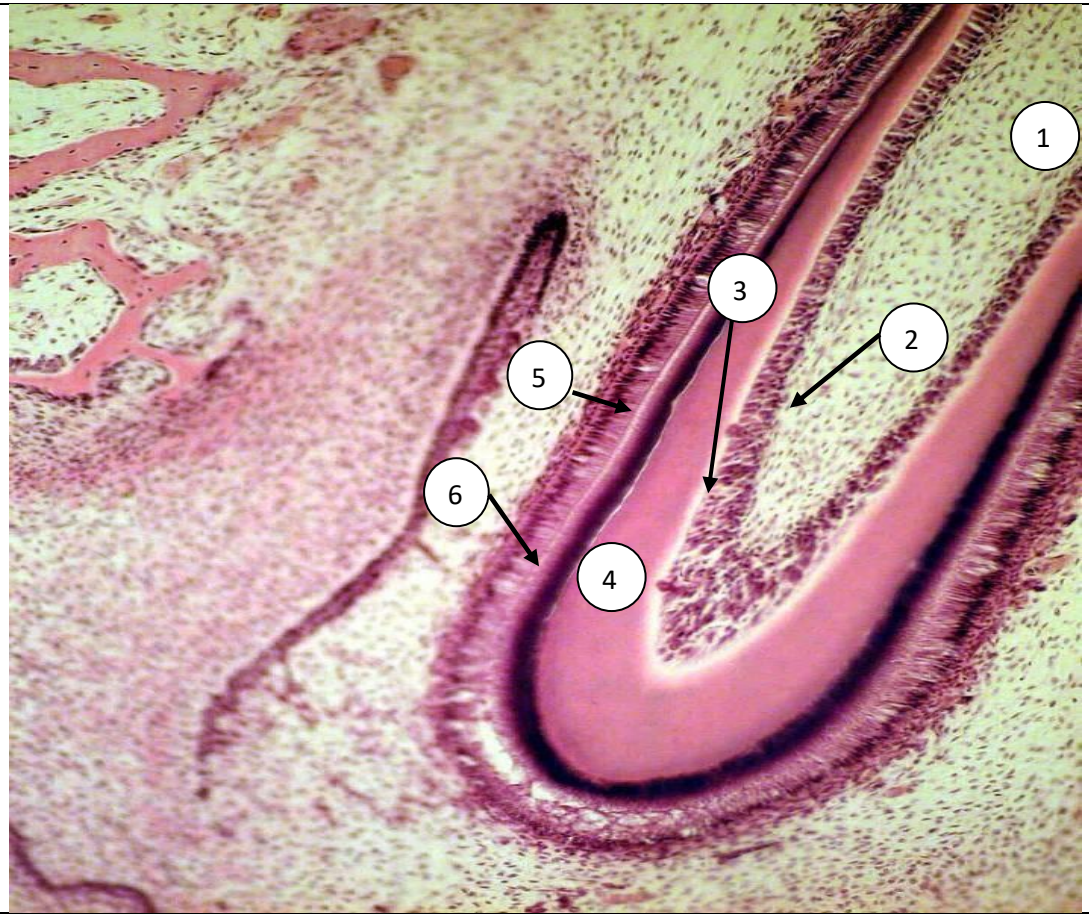
Dental tissue formation
Magnification X 100.

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).



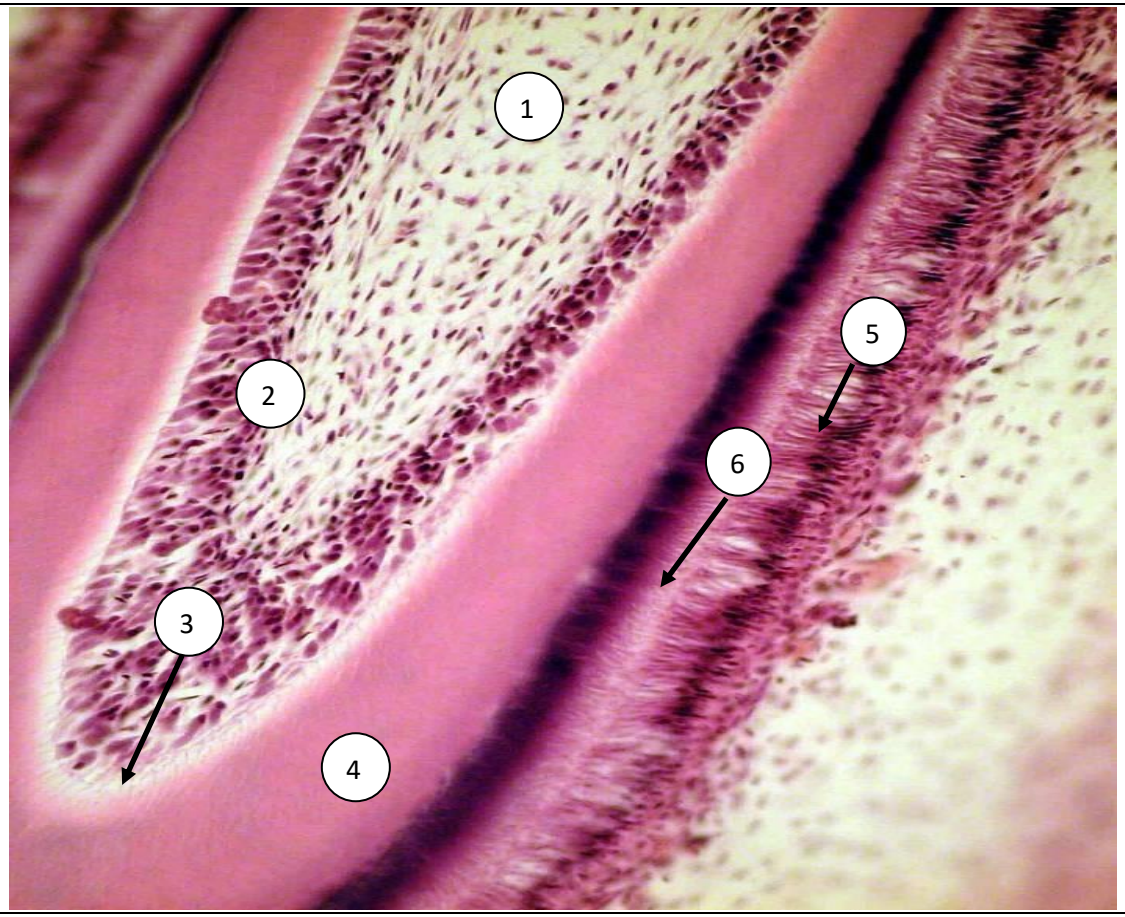
Histogenesis of enamel and dentine
Magnification X 40.

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).



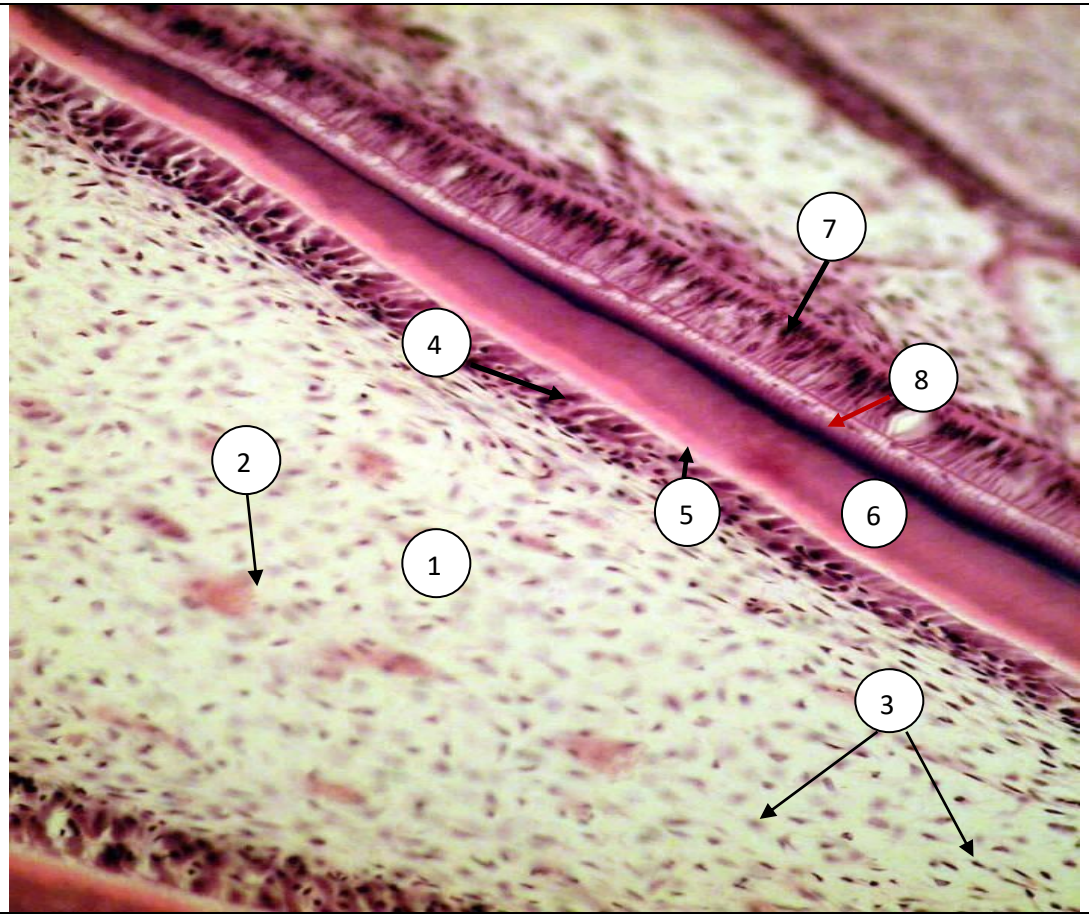
Histogenesis of enamel and dentine
Magnification X 100.

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:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 8. Periodontium. Eruption and changing of teeth.

Supporting tissues of tooth (periodontium)		
1.	Cementum	Cementum is a thin layer of hard tissue (calcified matrix) that does not have a direct blood supply. The slower growing acellular cementum allows fibers (Sharpey fi bers) from the periodontal ligaments (PDL) to become trapped in the matrix of the cementum to form the tooth attachment. Cementum is much more resistant to reabsorption than bones.
2.	Alveolar bone (alveolar process)	It includes the **alveolar crest**, the **alveolar bone proper**, and **supporting bone**.
3.	Periodontal ligaments (PDL)	They consist of dense fibrous connective tissue with a direct nerve and blood supply. They are located between the cementum and the alveolar bone, which surrounds the tooth root. Fibroblasts are the main cells responsible for the formation of the PDL. The PDL supports the tooth root by forming a strong attachment between the cementum and alveolar bone by Sharpey fbers.
Dongmei CuiJohn P. NaftelJonathan D. FratkinWilliam DaleyJames C. Lynch.: Atlas of Histology, With Functional and Clinical Correlations, Lippincott Williams and Wilkins, 2010		

Periodontal ligaments			
Name of ligament		**Features**	**Functions**
1.	**Alveolar crest group of fibers**	The fibers have a horizontal direction. They are located on the crest of the alveoli and connect adjacent teeth.	1. Supportive 2. Protective 3. Sensory 4. Nutritive
2.	**Horizontal group of fibers**	The fibers have a horizontal direction. They connect tooth root cementum (upper portion of tooth) with alveolar processes of the upper and lower jaws.	

3.	**Oblique group of fibers**	The fibers have a oblique direction. They connect tooth root cementum (middle and lower portions of tooth) with alveolar processes of the upper and lower jaws.	
4.	**Apical group of fibers**	The fibers have a vertical direction. They connect tooth root cementum (apex of root) with lacunas of the upper and lower jaws.	
5.	**Interradicular group of fibers**	They connect parts of tooth roots together. They are only present between multirooted teeth.	
6.	**Ggingival group of fibers**	They attach the gingiva to the hard tissue of the tooth.	

Alveolar bone (alveolar process)		
Structure		**Features and functions**
1.	**Alveolar bone**	It provides support and protection for the tooth root.
2.	**Alveolar bone proper**	It is a thin layer of compact bone which lines the tooth socket and has Sharpey fibers embedded in it. It is remodeled constantly to adapt to stresses and tensions.
3.	**Supporting bone**	It is composed of **compact bone (1)** and **cancellous bone (2)**. The **compact bone** forms the cortical plate, which provides surface strength. The **cancellous bone** makes up the central core of the alveolar bone and contains bone marrow.

Eruption and shed of teeth

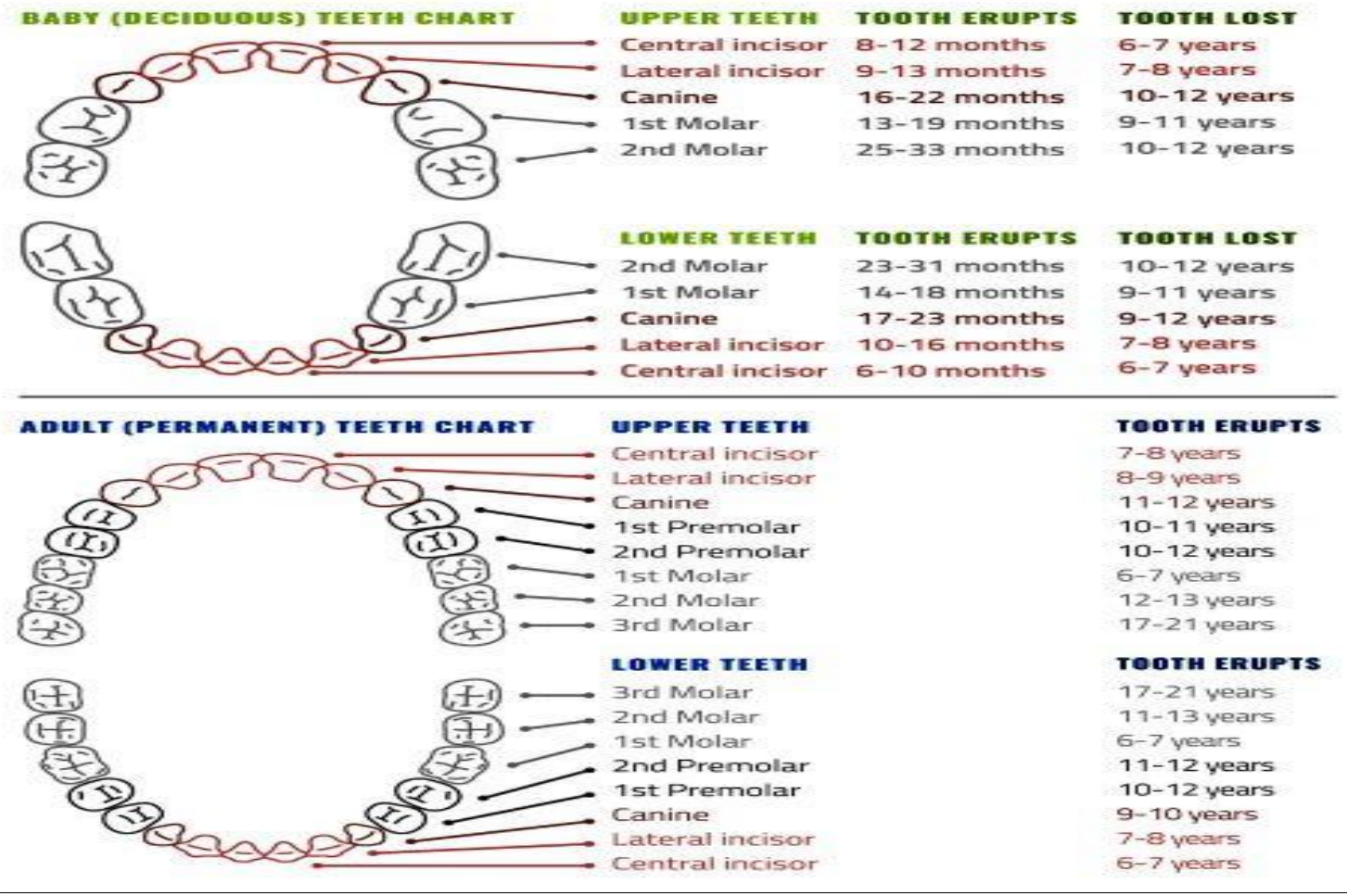
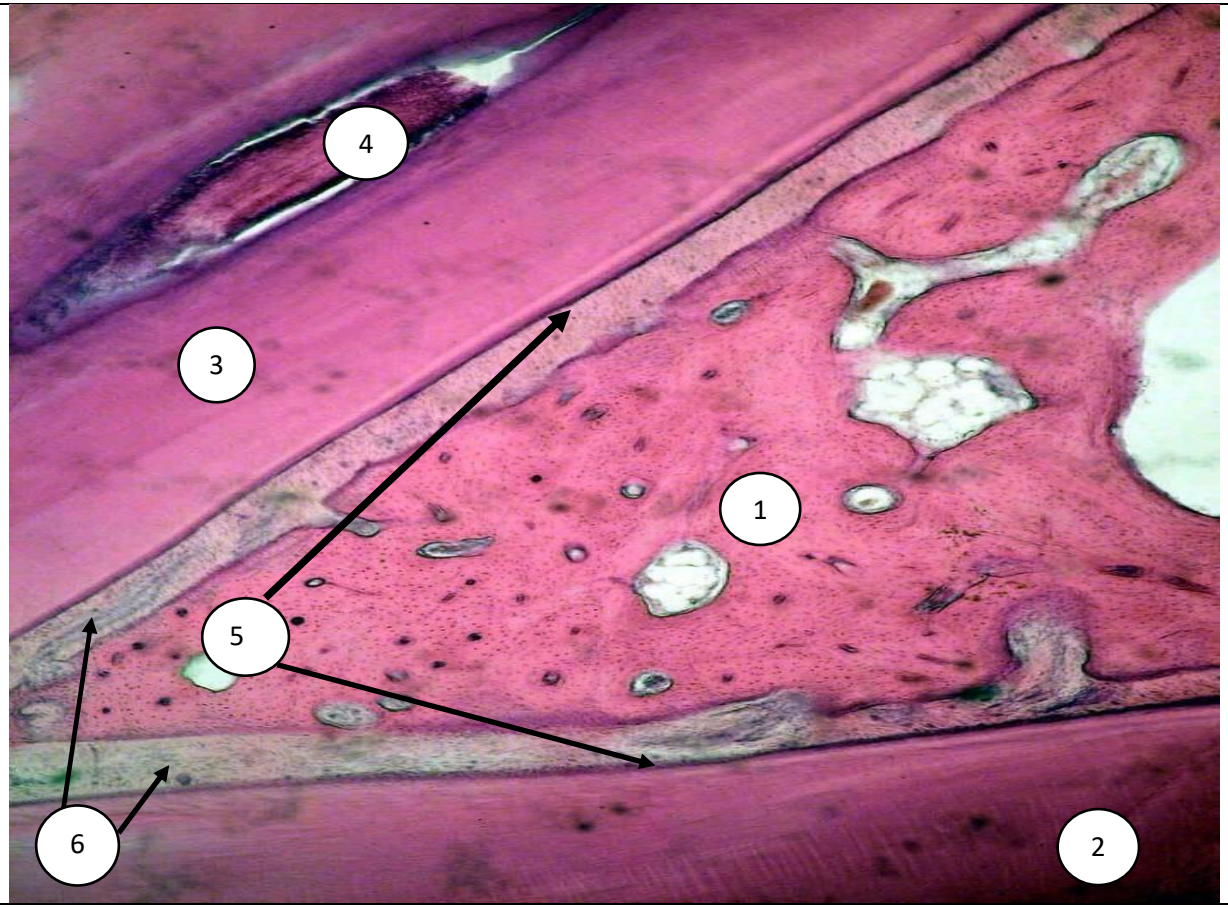


Fig. 1
https://dentistryfortheentirefamily.com/difference-between-baby-adult-teeth/

Blood supply of periodontal ligaments		
Name of blood vessels		**Features**
1.	**Alveolar arteries**	They are branches of the **infraorbital artery** and **maxillary artery**.
2.	**Dental arteries**	They are branches of **alveolar arteries**.
3.	**Supraperiosteal artery**	They are branches of **dental arteries.** They are located above alveolar crest.
4.	**Interdental artery**	They are located between the roots parts of multirooted teeth.



Interradicular bone
Magnification X 40, hematoxylin-eosin staining.

On the preparation there are roots of two adjacent teeth. Between the roots there is interradicular bone (1).
You can see the dentin of both teeth (2), (3)**,** the pulp cavity of the first tooth (4). Laterally from the dentin there is cement (5). There is a periodontium (6) between the interradicular bone and the roots.

VOCABULARY

Periodontium – is a connective tissue composed of four parts: cementum, periodontal ligament, alveolar bone and gingival tissue. The functions of the periodontium include retention of the tooth, prevention of exposure to oral microflora, as well as ensuring the attachment of the tooth to the bone.

Cementum - is a mineralized tissue covering the entire root surface. Cementum has historically been classified into cellular and acellular cementum by inclusion or non-inclusion of cementocytes. Generally, acellular cementum is thin and covers the cervical root, whereas thick cellular cementum covers the apical root.

Periodontal ligament - is a component of the periodontium that allows for the teeth to be attached to the surrounding alveolar bone via the cementum. PDL fibers also transmit and absorb forces between the teeth and alveolar bone. Heavily anastomosed, the PDL ensures the vitality of the surrounding cells. Nutrients are transmitted through three blood vessel types: gingival vessels, perforating vessels, and apical vessels. Well innervated, the PDL involves nociception, mechanoreception, and reflexes. The PDL contains progenitor cells which can differentiate into osteoblasts. These cells are believed to be for physiological maintenance and repair of the alveolar bone.

Alveolar bone - the alveolar process is that bone of the jaws that contains the sockets (alveoli) for the teeth and consists of outer cortical plates, a central spongiosa, and bone lining the alveolus. The cortical laminae and the bone covering the alveolus are joined at the alveolar crest, most often 1.5-2.0 mm lower than the cemento-enamel junction of the tooth it encircles. The bone lining the socket is specifically referred to as bundle bone, because it is this bone that provides attachment for the ligament fiber bundles and has its likely origin from the dental follicle. It is perforated by many foramina, which transmit nerves and vessels, and is therefore sometimes referred to as the cribriform plate.

Dentogingival junction – the epithelium of the junction is divided into sulcular (cervicular) epithelium, a continuation of oral epithelium, and junctional epithelium, derived from dental epithelium. Junctional epithelium forms the epithelial attachment of gingiva to tooth structure using hemidesmosomes.

Gingival sulcus - is the natural space located between the surface of the tooth and the surrounding gum or gingival tissue. The gingival sulcus is lined by the sulcular epithelium. The depth of the sulcus is surrounded by two different entities

which include: apically by the gingival fibers of the connective tissue attachment and coronally by the free gingival margin. A healthy depth is three millimeters or less.

Links:
https://www.ncbi.nlm.nih.gov/books/NBK570604/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5390338/
http://www.uky.edu/~brmacp/oralhist/module8/lab/imgshtml/image15.htm

TESTS

1. Sensitive nerve endings in the form of **glomeruli are found in the periodontal bundles along their fibers**. What role do these receptors play?
Touch receptors
Thermoreceptors
Pain receptors
Chemical receptors
Mechanical receptors

2. The excess filling in a cavity led to an overestimation of occlusion. This caused **pain during bite due to periodontal injury. What kind of nerve endings in the periodontum are involved in feeling pain**?
Free nerve endings
Absence of capsule
Presence of capsule
Axo-muscle
Synapses

3. A study was conducted t determine the tissue structures belonging to the tooth. What tissue belongs to the **periodontum**?
Dense regular connective tissue
Loose connective tissue
Bone tissue

Reticular tissue
Adipose tissue

4. A 43 year old patient for **a long time has not had enough vitamin C in his diet**. What is the pathology of the supporting apparatus of the tooth to be expected in the first place?
Periodontum disorder
Keratinization of gingival epithelium
Gingival pockets formatia
Alveolar bone transformation
Disorder of sulcus epithelium

5. During examination of a **child's oral cavity a pediatrician found 8 incisors**. The child's development corresponds to his age. How old is the child?
10-12 month
6-7 month
7-8 month
12-15 month
16-20 month

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 9. Esophagus. Stomach.

General structure of ESOPHAGUS wall			
1.	**Mucosa**	Epithelium	Nonkeratinized stratified squamous and can be keratinized.
		Lamina propria (includes glands in the **lower third**)	Loose connective tissue with many fibers, fibroblasts, macrophages, mast cells, plasma cells, leukocytes and **esophageal cardiac glands**.
		Muscularis mucosae (lamina muscularis mucosae)	Smooth muscles tissue.
2.	**Submucosa**	It includes glands.	Loose connective tissue (or dense irregular connective tissue) with mucous esophageal glands (**esophageal glands proper**).
3.	**Muscularis externa**	It has two layers of muscle: inner circular and outer longitudinal layers.	Smooth muscles tissue and striated muscles tissue
4.	**Adventitia or serosa**	Adventitia (upper and middle thirds) and serosa (lower third) have one difference.	Adventitia includes only loose connective tissue. Serosa consists of loose connective tissue and mesothelium.

Special structures of different thirds of the ESOPHAGUS		
Parts (thirds)		**Structural features**
1.	**The upper third**	1) Connects the **oropharynx** to the **middle third of esophagus.** 2) **Esophageal glands proper** secrete mucus which lubricate the wall of esophagus **(location - submucosa)**. 3) Muscularis externa contains **only skeletal muscle fibers**. 4) These are voluntary muscle fibers and are innervated by the glossopharyngeal nerve (CN IX).
2.	**The middle third**	1) The **esophageal glands proper in the submucosa** are less numerous than in the upper esophagus. 2) The muscularis externa contains both **skeletal and smooth muscles**.
3.	**The lower third**	1) Connects the esophagus to the cardia of the stomach. 2) This region contains large numbers of mucous glands in the **lamina propria** and **submucosa**. 3) Mucous glands are called **esophageal cardiac glands (location - lamina propria)** and produce mucous secretions to protect the lower esophagus from being damaged by reflux of acidic gastric juices from the stomach. 4) Contains **only smooth muscle fibers** in the muscularis externa. 5) It controls by the enteric branches of the **vagus nerve** (CN X).

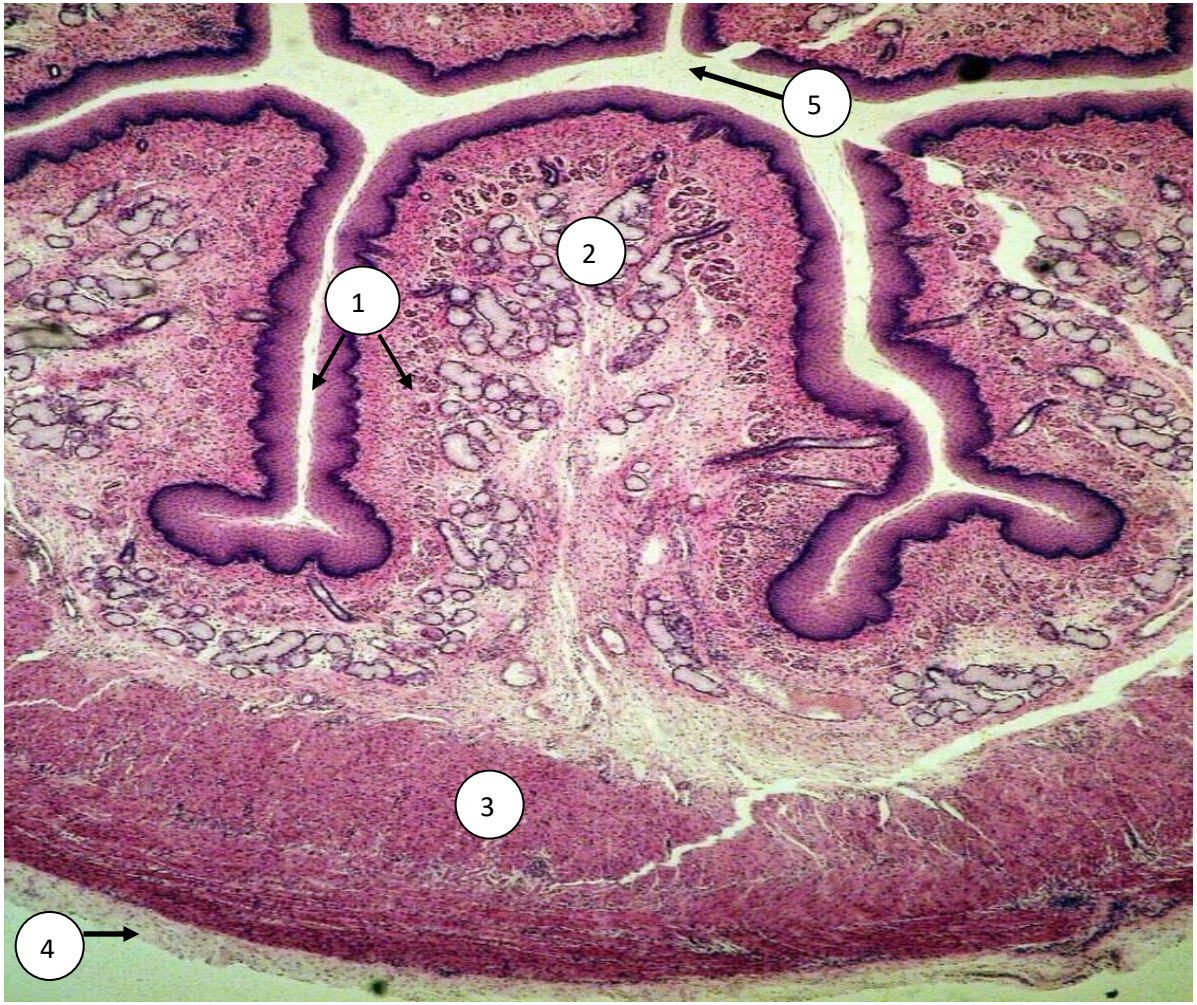
General structure of STOMACH wall			
1.	**Mucosa**	Epithelium	Simple columnar
		Lamina propria	Loose connective tissue with **stomach glands**.
		Muscularis mucosae (lamina muscularis mucosae)	Smooth muscles tissue.
2.	**Submucosa**	It does not contain glands.	Loose connective tissue (or dense irregular connective tissue).
3.	**Muscularis externa**	It has three layers of muscle: inner oblique layer, middle circular layer, and outer longitudinal layers.	Smooth muscles tissue.
4.	**Serosa**	It consists of loose connective tissue and mesothelium.	Serosa consists of loose connective tissue and mesothelium.

Special structures of different parts of the STOMACH		
Parts		**Structural features**
1.	**Cardia**	1) It is connects **to the lower esophagus.** 2) **It is at the esophagogastric junction,** which is characterized by a change from the nonkeratinized stratified squamous epithelium (esophagus) to the simple columnar epithelium (stomach). 3) There is **gastroesophageal sphincter** (lower esophageal sphincter) or **cardiac sphincter**. 4) Branched tubular glands **(cardiac glands)** which situated in the lamina propria. They include **mucus-secreting cells**, **stem cells**, **enteroendocrine cells** and **parietal cells**. 5) Secret of **cardiac glands - mucus and lysozymes.**
2.	**Fundus**	1) It is the largest portion of the stomach and has short gastric pits. 2) There are branched tubular glands **(fundic glands)** in the lamina propria.

		3) They include **parietal cells**, **chief cells**, **stem cells**, **mucous neck cells** and **enteroendocrine cells**.
3.	**Body**	1) It is the largest portion of the stomach and has short gastric pits. 2) There are branched tubular glands **(gastric glands)** in the lamina propria. 3) They include **parietal cells**, **chief cells**, **stem cells**, **mucous neck cells** and **enteroendocrine cells**.
4.	**Pylorus**	1) It is the lower end of the stomach, which connects with the duodenum. 2) There is **pylorus sphincter (pyloric valve) surrounds** the end of the pylorus region. 3) There are **pyloric glands** in the lamina propria. 4) **Pyloric glands** include mucus-secreting cells and two special types of enteroendocrine cells: gastrin-secreting cells (G cells) and somatostatin-secreting cells (D cells).

Structure and functions of the STOMACH glands		
Types of cell		**Structural features and functions**
1.	**Chief cells**	1) In the cytoplasm there are large amount of rER in the basal portion of the cell (it has basophilic staining). 2) In the apical region of the cell there are secretory vesicles (**zymogen granules**) which include pepsinogen and lipase. 3) They produce pepsinogen which is the precursor enzyme of the gastric secretion. 4) **Pepsinogen** is converted to the **pepsin** by HCl. 5) Pepsin hydrolyzes proteins into small peptides by splitting interior peptide bonds.
2.	**Parietal cells**	1) They are localized in the neck of the fundic glands and in the deeper part of the gland, in the upper and middle portions of the neck. 2) In the cytoplasm there are extensive amount of membrane comprising the intracellular canaliculus, tubulovesicular system, mitochondria, and the relatively small number of ribosomes. 3) The cytoplasm stains with eosin largely, nucleus are spherical.

		4) They produce HCl and intrinsic factor. 5) **HCl** is converted **pepsinogen** to the **pepsin.** 5) **Intrinsic factor** is a glycoprotein that complexes with vitamin B12 in the stomach and duodenum, a step necessary for subsequent absorption of the vitamin in the ileum.	
3.	**Mucous neck cells**	1) Cells are located in the neck region of the fundic gland. 2) Cells secrete less alkaline soluble mucus. 3) Cells are present in clusters or as single cells between parietal cells in the necks of gastric glands. 4) They are irregular in shape, with the nucleus at the base of the cell and the secretory granules near the apical surface.	
4.	**Enteroendocrine cells**	G cells	1) They are found at the base of the pyloric glands. 2) Nuclei is basally positioned and clear cytoplasm containing secretory granule 3) They are gastrin-secreting cells. 4) **Gastrin** stimulates parietal cells to secrete HCl
		D cells	1) Nuclei is basally positioned and clear cytoplasm containing secretory granule 2) They are somatostatin-secreting cells. 3) **Somatostatin** inhibits the release of gastrin by G cells.
5.	**Stem cells**	1) They are few in number and found in the neck region of the glands. 2) They are low columnar cells with basal nuclei and divide symmetrically. 3) Some of the daughter cells move upward to replace the pit and surface mucous cells, which have a turnover time of 4–7 days.	

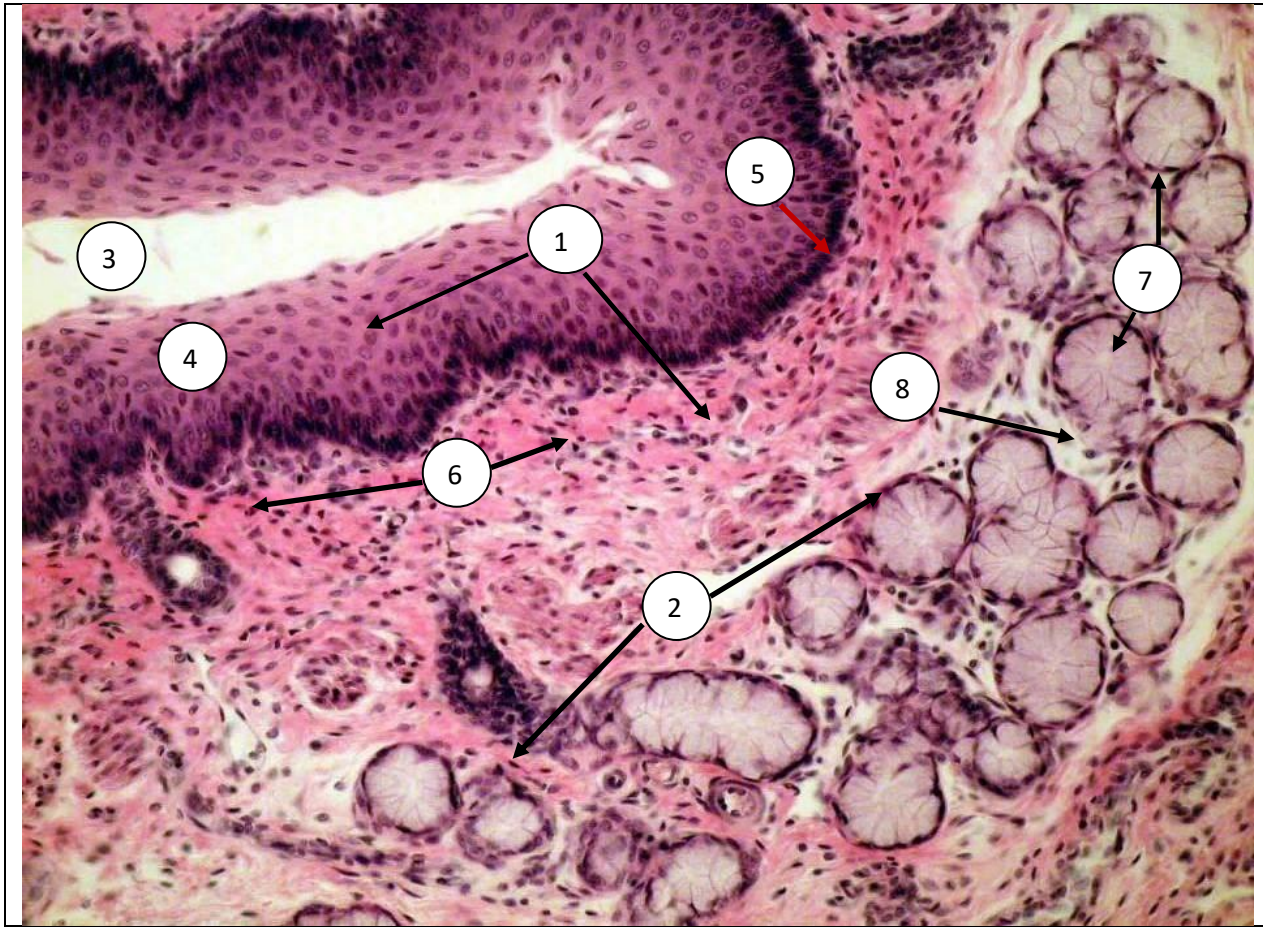


Esophagus
Magnification X 100.

On the preparation of the esophagus there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and adventitia (4). The space in the center of the organ is called the lumen (5).

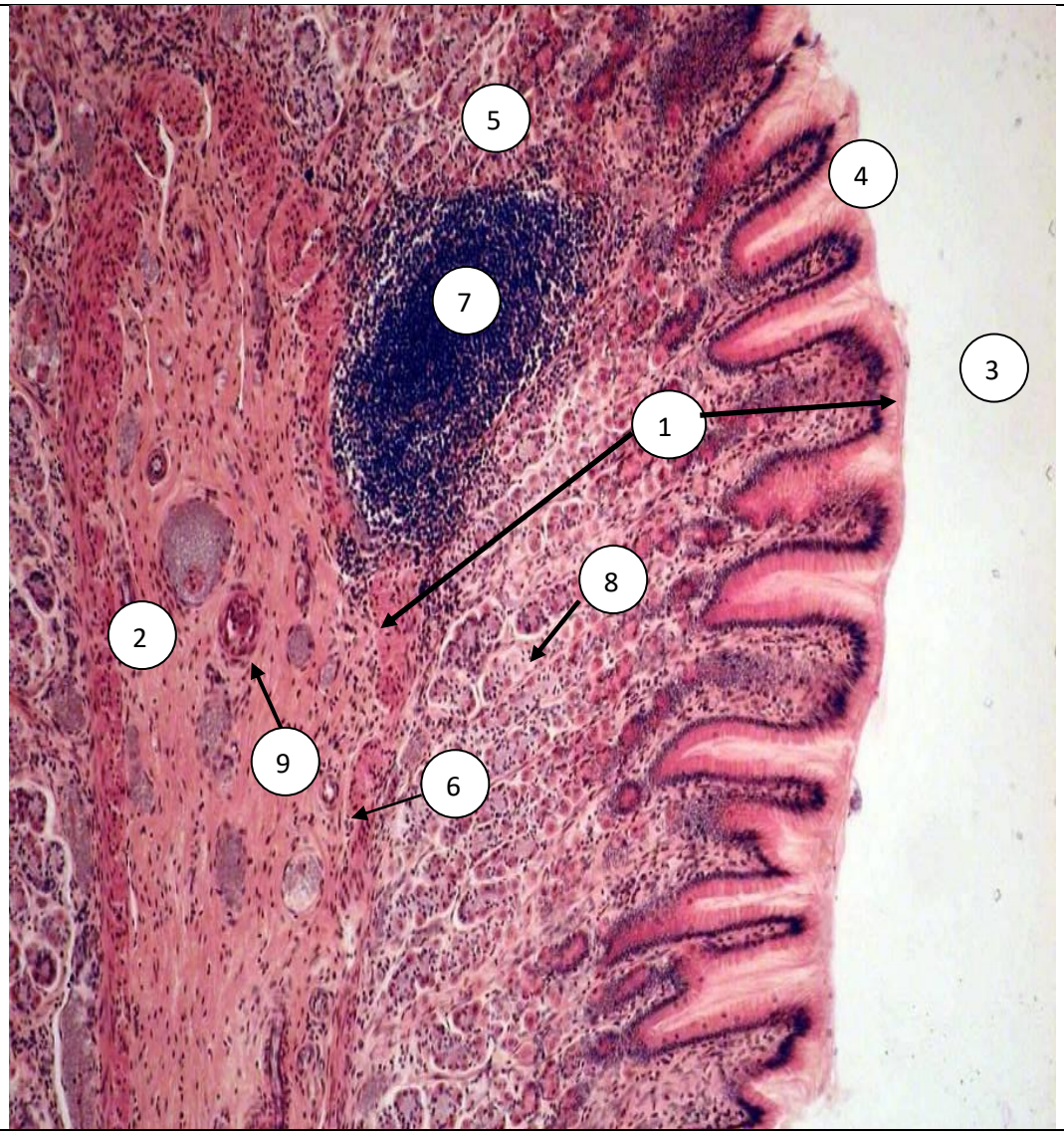
Esophagus
Magnification X 100.

On the preparation of the esophagus there are three layers of wall: mucosa (1), submucosa (2), muscularis externa (3) except adventitia. The space in the center of the organ is called the lumen (4). Muscularis externa consists of inner circular layer and outer longitudinal layer of muscle cells.



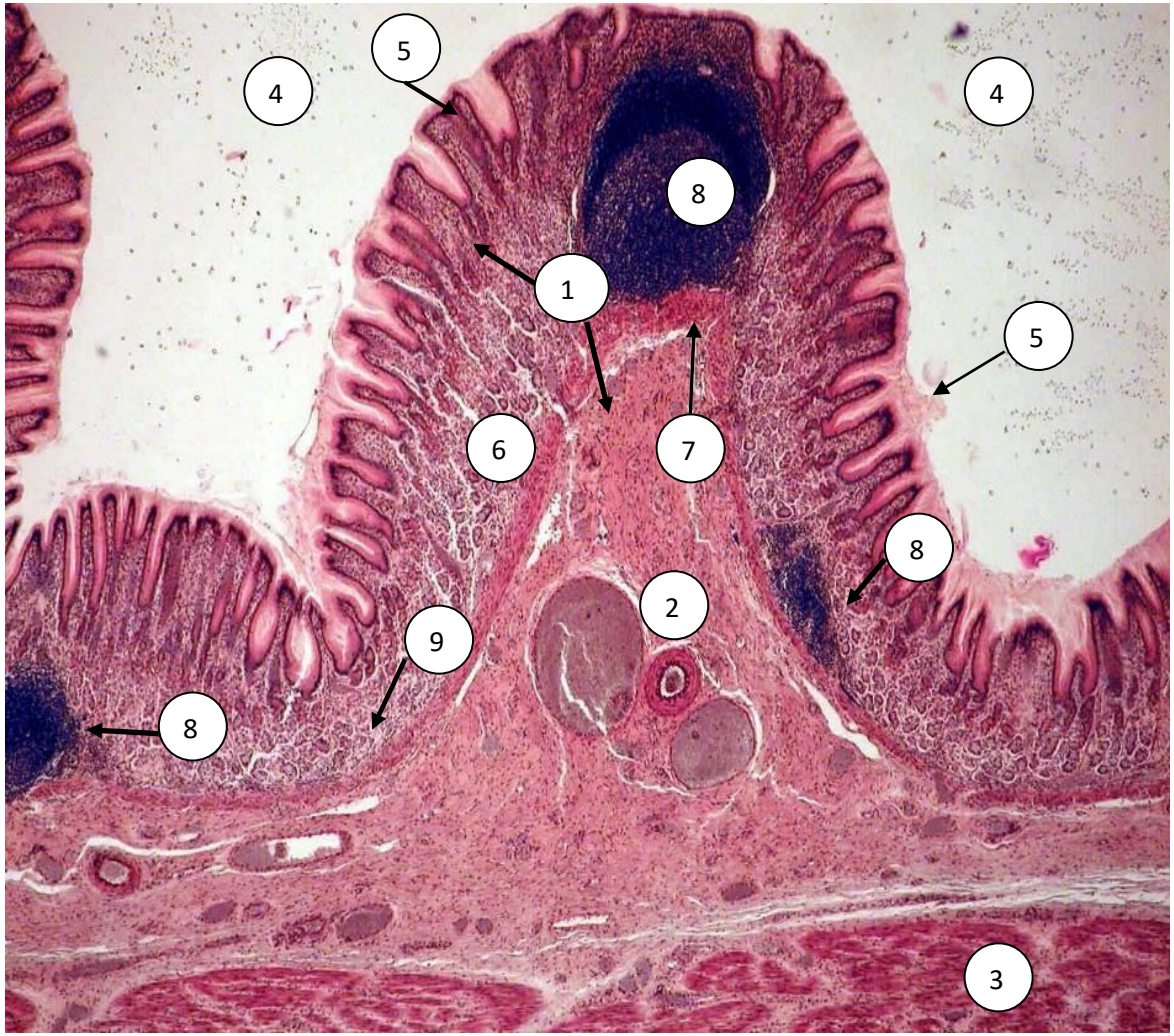
Esophagus
Magnification X 100.

On the preparation of the esophagus there are two layers of wall: mucosa (1), submucosa (2) except muscularis externa and adventitia. The space in the center of the organ is called the lumen (3). Mucosa consists of stratified squamous epithelium (4), lamina propria (5) and muscularis mucosae (6). In the submucosa there are esophageal glands proper (7) and dense irregular connective tissue (8) with elastic fibers.



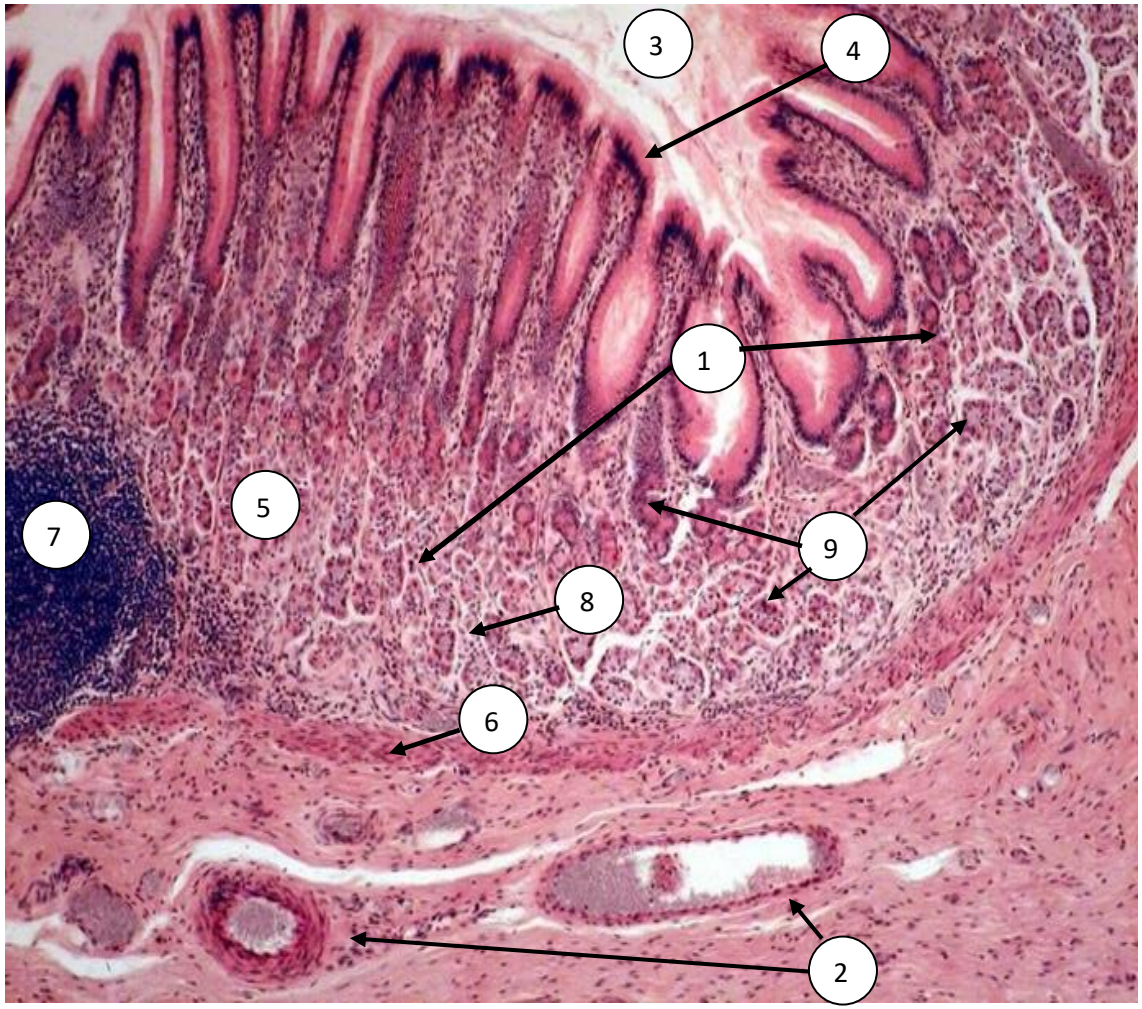
Stomach
Magnification X 100.

On the preparation of the stomach there are two layers of wall: mucosa (1), submucosa (2), except muscularis externa and serosa. The space on the right is called the lumen (3). Mucosa consists of simple columnar epithelium (4), lamina propria (5) and lamina muscularis mucosae (6). In the lamina propria there are lymph follicles (7) and loose connective tissue (8). Submucosa (2) consists of dense irregular connective tissue and blood vessels (9).



Stomach
Magnification X 40.

On the preparation of the stomach there are three layers of wall: mucosa (1), submucosa (2), muscularis externa (3) except serosa. The space in the upper right and left corners is called the lumen (4). Mucosa consists of simple columnar epithelium (5), lamina propria (6) and lamina muscularis mucosae (7). In the lamina propria there are lymph follicles (8) and loose connective tissue (9). Submucosa (2) consists of dense irregular connective tissue and blood vessels.



Stomach
Magnification X 100.

On the preparation of the stomach there are two layers of wall: mucosa (1), submucosa (2), except muscularis externa and serosa. The space on the right is called the lumen (3). Mucosa consists of simple columnar epithelium (4), lamina propria (5) and lamina muscularis mucosae (6). In the lamina propria there are lymph follicles (7), loose connective tissue (8) and gastric glands (9). Submucosa (2) consists of dense irregular connective tissue and blood vessels (marked with arrows).

Stomach
Magnification X 100.

On the preparation of the stomach there are two layers of wall: mucosa (1), submucosa (2), except muscularis externa and serosa. The space on the right is called the lumen (3). Mucosa consists of simple columnar epithelium (4), lamina propria (5) and lamina muscularis mucosae (6). In the lamina propria there are loose connective tissue (7) and gastric glands (8). Submucosa (2) consists of dense irregular connective tissue and blood vessels.

VOCABULARY

Esophageal cardiac glands (so called due to their similarity in structure to the cardiac glands in the stomach) are located in the lamina propria of the esophageal mucosa. They are found in the distal part of the esophagus. By structure, they are simple tubular glands.

Esophageal glands – are acinar, with cubic-shaped cells, located in the submucosa, which secrete mucus, bicarbonates and epidermal growth factor into the esophageal lumen through the collection system. Mucus performs mainly the function of lubrication, because, compared to the stomach, it does not create a noticeable viscous protective layer over the multilayer squamous epithelium. The released bicarbonate protects the mucosa by neutralizing the acid released during reflux, thereby increasing the pH to normal.

Gastric glands. There are 3 kinds of glands in the stomach: cardiac, gastric and pyloric glands, which are named based on the area in which they are located. These glands secrete digestive ferments and the mucous contents of the stomach. The gastric glands of the fundus/body play an important role in the production of gastric digestive juice, whereas the cardiac and pyloric glands mainly produce a mucous secretion that protects the stomach from the aggressive effects of hydrochloric acid and prevents self-digestion of the stomach.

Gastric pit made of superficial epithelium invaginations. They are connected to the gastric glands and therefore provide the flow of glandular secretions into the stomach lumen. The pits are are covered by the same type of mucus-secreting surface epithelium that is present in the gastric mucosa. On histological section they are usually cut crosswise and not lengthwise, so they look like small round holes instead of tubular invaginations. Gastric pits and gastric glands are composed of the same 5 types of cells: stem cells, mucous neck cells, parietal cells, chief cells and enteroendocrine cells.

Gastric rugae. The interior wall (mucous membrane and submucosal layer) is folded into ridges known as rugae, or gastric folds, which enable the stomach to stretch during meals.

Cardiac glands and pyloric glands in general are characterized by the absence of parietal and chief cells, but have a large number of mucous neck cells. These departments are the transition zones between the stomach and other parts of the

gastrointestinal tract. Hence, the mucous secretion they release protects the esophagus and duodenum from the aggressive influence of gastric juice.

Links:

https://www.sciencedirect.com/topics/immunology-and-microbiology/esophageal-gland
https://www.kenhub.com/en/library/anatomy/stomach-histology

TESTS

1. The man of 35 years with a **stomach ulcer the resection** of antral department of stomach is made. Which secretion of **gastrointestinal hormone as a result** of operation will be broken most of all?

Gastrin
Secretin
Neurotenzin
Hystamine
Holecystokinin

2. At the patient at gastroscopy the insufficient quantity amount of **mucus on a surface of mucosa is revealed**. To what infringement of **function of stomach's cells** it is connected?

Columnar cells
Parietal cells
Endocrinocytes
Cervical cells
Chief cells

3. On histologic preparation the cross-section of **alimentary tubular organ's** wall which mucous shall **is covered by nonkeratinazed epithelia** is submitted. What is the organ?

Esophagus
Uterus
Duodenun
Small intestine

Appendix

4. On the fourth week of embryonic developments **occurs physiological atresia of esophagus**. Up to the end of the eighth week it again becomes passable. What biological **process provides recanalisation of esophagus** at human embryo?
Apoptosis
Descvamation
Meiosis
Necrosis
Mitosis

5. During histological examination of **the stomach** it was found out a significant reduction or complete **absence of parietal cells in the glands**. Mucose membrane of what part of the stomach was studied?
Pyloric part
Fundus of stomach
Cardia
Body of stomach
-

6. When the pH level of the stomach lumen decreases to less than 3, the **antrum of the stomach releases peptide that acts in paracrine fashion to inhibit gastrin release**. This peptide is:
GIF
Acetylcholine
Gastrin-releasing peptide (GRP)
Somatostatin
Vasoactive intestinal peptide (VIP)

7. Examination of a 43 y.o. patient revealed that his stomach has difficulties with digestion of protein food. **Gastric juice analysis revealed low acidity**. Function of which **gastric cells is disturbed** in this case?
Parietal exocrinocytes

Main exocrinocytes
Mucous cells (mucocytes)
Endocrinous cells
Cervical mucocytes

8. An electron microphotography of a fragment of **proper gastric gland shows a big irregular round-shaped cell**. There are **a lot of intracellular tubules and mitochondria in the cytoplasm**. Specify this cell:
Parietal cell
Principal cell
Undifferentiated cell
Mucous cell
Endocrine cell

9. A patient ill with chronic gastritis went for endogastric pH-metry that allowed revealing **decreased acidity of gastric juice**. It is indicative of diminished function of the following cells:
Parietal exocrinocytes
Chief exocrinocytes
Endocrinocytes
Cervical cells
Accessory cells

10. A patient underwent gastroscopy that revealed **insufficient amount of mucus covering the mucous membrane**. This phenomenon is caused by the dysfunction of the following cells of stomach wall:
Cells of prysmatic glandular epithelium
Parietal cells of gastric glands
Principal exocrinocytes of gastric glands
Cervical cells of gastric glands
Endocrinocytes

11. The 60 years old patient is suffering from chronic gastritis. At the endoscopy of the **stomach observed changes in the epithelium of the mucosa**. Which type of epithelium covers of the stomach mucosa?
Simple columnar mucous epithelium
Pseudostratified ciliated columnar epithelium
Simple squamous epithelium
Simple cuboidal epithelium
Simple columnar brush-border epithelium

12. The patients with burnings of the **esophagus was examined** by the doctor and found that lesions of the mucous membrane are not deep. Due to **which layer of cells will take place regeneration** of damaged epithelium.
Basal
Spinous
Grained
Intermediate
Surface

13. On histological slide represented a cross section of a **hollow organ wall**, which has a mucous membrane consist of **nonkeratinized stratified epithelium**. What kind of structure is it?
Esophagus
Duodenum
Colon
Uterus
Appendix

14. On microscopic examination **were presented striated muscle tissue of the digestive system**. In what kind of organ the biopsy was taken?
Esophagus
Stomach
Duodenum

Ileum
Appendix

15. A malignant **tumor** which developed from the transverse **striated muscle of a digestive system organ** was submitted for pathologic anatomic research. The biopsy was taken from which organ?
Upper portion of esophagus
Stomach
Duodenum
Ileum
Lower portion of esophagus

16. During microscopic research of the **digestive system organ** it was discovered that it has a mucous membrane that is covered with a **stratified squamous non-keratinized epithelium** and a **lamina propria that contains simple tubular glands**, definitive sections of which consist of mucous and a few parietal cells. What organs is it?
Esophagus
Stomach
Small intestine
Trachea
Urethra

17. A **digestive tract organ** was selected for histological research. The mucosal and submucosal membranes form longitudinal folds. The superficial surface of the mucous membrane is smooth and lined by a **stratified squamous non-keratinized epithelium.** Define this organ?
Esophagus
Stomach
Duodenum
Large intestine (colon)
Trachea

18. In a histological investigation of the **neck region of the stomach's proper gland** we identify **small cells with a high nuclear-cytoplasmic ratio and mitotic figures.** Define the function of these cells?
Regeneration of glandular epithelium
Protective
Endocrine
Ion Cl- decretion
Pepsinogen secretion

19. Under the action of harmful factors occurred focal damage of the **epithelium of the stomach**. What kind of **cell can provide regeneration** process?
Mucous neck cells
Parietal cells
Chief cells
Enteroendocrine cells
Mucocytes

20. On the electronic microphotographs of **fundic glands were determined a large, pale and round to pyramidal cells**. They **have one or 2 central nuclei and acidophilic cytoplasm**. The many **mitochondria indicate that their secretory activity** is energy-dependent. What kind of cell they are?
Parietal (oxyntic) cells
Mucous neck cells
Undifferentiated cells
Enteroendocrine cells
Chief cells

21. Insulin injection did for assess the completeness of vagotomy accompanied by a **significant increase of ph of gastric juice.** Which **cells of gastric glands controls this process**?
Parietal cells
Enteroendocrine cells

Chief cells
Mucous neck cells
Undifferentiated cells

22. On the histological sections of **fundic glands we can see as large cells with acidophilic cytoplasm**. What kind of component of **gastric juice is produced as a result of the activity of these cells**?
Hydrochloric acid
Pepsinogen
Mucus
Serotonin
Gastrin

23. The 20 years old patient suffers from rheumatism appointed of prolonged use of aspirin. What is the structural component of the **mucous membrane of the stomach is best suited to provide her protection** from damage?
Simple columnar mucous epithelium
Connective tissue
Muscle tissue
Multi-ciliated epithelium
Stratified squamous nonkeratinized epithelium

24. The patient biopsy from the **stomach** shows histologically revealed a significant reduction or complete **absence of parietal cells in the glands**. Which layer of mucous membrane they studied?
Pylorus
Fundus of stomach
Cardiac part
Body of stomach
–

25. In 42 years old patient after radiotherapy of cancer of the **stomach** developed **pernicious anemia due to damage cells by producing intrinsic factor**. Which cells of fundic glands were damaged?
Parietal cells
Mucous neck cells
Surface mucous cells
Enteroendocrine cells
Chief cells

26. In the embryonic material **was damaged endoderm**. What kind of changes of development may arise in this process?
Stomach
Heart
Kidneys
Aorta
Salivary glands

27. Damaged by exposure to **various factors of gastric mucosa can restore its integrity**. By which cells of gastric glands can occur their **regeneration**?
Mucous neck cells
Parietal cells
Paneth cells
Chief cells
Enteroendocrine cells

28. By ingestion of a foreign body in the **stomach was damaged epithelium** of the child. How the **cell regeneration process** possible?
Mucous neck cells
Chief cells
Parietal cells
Connective tissue cells

Fat cells

29. During the **fibrogastroscopy** of the patient revealed damage of the mucosa layer. By which cells will occur in the treatment **of epithelial regeneration**?
Poorly differentiated mucous neck cells
Chief cells
Parietal cells
Enteroendocrine cells
Paneth cells

30. During inflammatory diseases of the **stomach damaged surface epithelium of the gastric mucosa**. What kind of epithelium was damaged?
Simple columnar mucous epithelium
Stratified squamous nonkeratinized epithelium
Stratified squamous keratinized epithelium
Simple cuboidal epithelium
Stratified cuboidal epithelium

31. Analysis of biopsy material of human **gastric mucosa, gastritis patient showed a dramatic decrease in the number of parietal cells.** How will change the components of gastric juice?
Reduce acidity
Increased acidity
Increased gastric juice
Reduction of gastric juice
Reducing mucus production

32. Examination of a patient, suffering from **atrophic gastritis, revealed megaloblastic anemia**. The anemia is likely to be caused by the deficiency of the following substance:
Gastromucoproteid

Vitamin B6
Vitamin B1
Iron
Erythropoietins

33. A patient underwent **gastroscopy that revealed insufficient amount of mucus covering the mucous membrane**. This phenomenon is caused by the **dysfunction of the following cells of stomach wall**:
Cells of prysmatic glandular epithelium
Parietal cells of gastric glands
Principal exocrinocytes of gastric glands
Cervical cells of gastric glands
Endocrinocytes

34. During the examination of the patient's oral cavity dentist noticed that his tongue is rough hypertrophic nipples, deep furrows. The doctor advised the patient to consult a gastroenterologist. The examination revealed that he had considerably **increased acidity of gastric juice**. Hyperfunction of which cells in the glands of the mucous membrane of the stomach mainly caused this condition?
Parietal cells of fundic glands
Chief cells
Additional mucocytes
Goblet cells
Exocrine pancreatocytes

35. The 60 years old patient is suffering from **chronic gastritis.** During an endoscopy of the stomach observed changes in **the epithelium of the mucosa**. What epithelium has undergone a change?
Simple columnar mucous epithelium
Connective tissue
Muscle tissue
Multi-ciliated epithelium

Stratified squamous nonkeratinized epithelium

37. A patient with **hypersecretion of a gastric juice is advised to stay away from a diet rich in broth and vegetable** broth, because they **stimulate gastric secretion** due to the following mechanism:
Stimulate gastrin production by endocrine cells
Irritate taste buds
Irritate mechanic receptors of oral cavity
Irritate mechanic receptors of stomach
Stimulate stimulating production in duodenum

38. A resection of the **stomach with the removal of pyloric substance was performed**. What process of the **stomach** will be affected?
Chime transit into duodenum
Intestine peristaltic
Reabsorption
Juice secetion in duodenum
-

39. A 45 year old man has complaints about the dysfunction of his **stomach**. During a complex investigation a **tumor was found in the epithelial tissue**. What cells gave development to this tumor?
Mucous neck cells
Chief (zymogenic)
Enteroendocrine cells
Surface mucous cells
Parietal cells

40. The glands at the bottom of the **stomach contain cells**, which with their own secretions weaken or **strengthen the formation of gastric juice components, gastric motility and activity of the pancreas**. What are these cells?
Gastropancreatic endocrine

Chief zymogenic cells
Parietal cells
Simple columnar cells
Mucous neck cells

41. Due to the deficit synthesis of **intrinsic factor (gastromucoproteid)** we detect **pernicious anaemia of Adison-Beimer** in a patient, which **cells of the principal glands in a stomach** are damaged
Parietal
Chief (zymogenic) cells
Mucous neck cells
Endocrine cells
Surface mucous cells

42. During microscopic investigation we observe a **digestive tract organ, relief of which presents folds and fields**. What **epithelium is covering the mucous membrane of this organ**?
Simple columnar epithelium
Simple cuboidal
Simple squamous
Striated non keratinized squamous
EPseudostratified columnar epithelium

43. An **organ** is selected for morphological research. The **wall of which consists of a mucosal, submucosal, muscular and serous layers**. Name this organ?
Stomach
Esophagus
Small intestine
Large intestine(colon)
Urethra

44. After an **intragastric Ph measurement** a patient with chronic gastritis is diagnosed with the **reduced acidity of gastric juice.** What cell function is reduced?
Parietal
Chief
Enteroendocrine
Mucous neck cells
-

45. **Pepsinogen** is produced by the stomach's principal cells. However secretions of **other cells of the stomach are required in order to activate pepsinogen in the cavity of the stomach.** What is the name of these cells?
Parietal
Chief
Mucous neck cells
Enterendocrine cells
Mucous cells

Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 10. Small and large intestine.

General structure of the SMALL INTESTINE wall			
1.	Mucosa	Epithelium	Simple columnar is lining the surface of the villi.
		Lamina propria	Loose connective tissue which forms the base of villi.
		Muscularis mucosae (lamina muscularis mucosae)	Smooth muscles tissue.
2.	Submucosa	It includes glands only in the duodenum (this mucous glands are called Brunner glands).	Loose connective tissue (or dense irregular connective tissue).
3.	Muscularis externa	It has two layers of muscle: inner circular layer, and outer longitudinal layers.	Smooth muscles tissue
4.	Serosa and adventitia	Adventitia and serosa have one difference.	Areas of duodenum which are attached to other organs are covered by adventitia.

Special structures of parts of the SMALL INTESTINE Small intestine is a tubular organ, about 6 to 7 m long.		
Parts		**Structural features**
1.	**Duodenum**	1). Shape - C-shaped. 2). Length - about 20 to 25 cm. 3). It is proximal region of the small intestine. 4). Mucosa includes the glands of Lieberkühn which have absorptive cells, goblet cells, Paneth cells, enteroendocrine cells and stem cells. 5). In the submucosa there are mucous glands (**Brunner glands**). 6). Areas which are attached to other organs are covered by adventitia. 7)) **Functions:** allow bile and pancreatic juice to enter small intestine; release mucus; regulate rate of emptying of stomach; absorption.
2.	**Jejunum**	1). It makes up about two fifths of the rest of the small intestine.

		2). It has a larger diameter and thicker wall than the ileum. 3). It has long villi. 4). It does not have Brunner glands and Peyer patches. 5) **Functions:** absorption of carbohydrates, proteins, lipids, and vitamin K
3.	**Ileum**	1). Mucosa includes of Peyer patches which may extend into submucosa 2). Mucosa includes the glands of Lieberkühn which have many goblet cells, Paneth cells, enteroendocrine cells and stem cells. 3). Length - about 1,5 to 3,0 m. 4). The villi in the ileum are shorter and smaller than in other parts of the small intestine. 5). The numbers of goblet cells are greatly increased in the ileum. 6) **Functions:** absorption vitamins K and B12 and bile salts.

Structure and functions of the SMALL INTESTINE GLANDS				
Types of glands		**Structural features**	**Secrets of cells and their functions**	
1.	**Brunner glands**	1. Location – submucosa of **duodenum.** 2. Type- branched, tubular glands. 3. Structure: zymogen-secreting and mucus-secreting cells.	1. Cells produce **mucus** and **bicarbonate ions.**	
2.	**Lieberkühn glands (intestinal glands or crypts)**	1. Location – mucosa of **duodenum, jejunum, ileum.** 2. Structure: absorptive cells,	**Enterocytes** (absorptive cells)	1) **Shape** - columnar (tall) epitheliocytes, 2) oval nucleus there is in the basal half of the cell. 3) they have mitochondria and microvilli (**striated or brush border**) at the apical cytoplasm and apical surfaces. 4) **Function –** absorption.

		goblet cells, Paneth cells, enteroendocrine cells and stem cells.	**Goblet cells**	1) goblet shape. 2) nucleus is situated in the base of the cell. 3) they have mucus-secretory granules with **mucinogen** at the apical surfaces. 4) **Function** – secrete mucus that moisturizes and protects the mucosa.	
			Paneth cells	1) **Location** – at the base of the crypts. 2) nucleus is situated in the base of the cell. 3) acidophilic-secretory granules there are in the apical region of the cytoplasm and they include antibacterial enzymes **(lysozymes, tumor necrosis factor- α, defensins)**. 4) have well-developed rough endoplasmic reticulum and Golgi complexes. 5) **Function** – antibacterial enzymes help to regulate the normal bacterial flora of the intestine.	
			Enteroendocrine cells	G cells	1) **Location** – at the base of the crypts. 2) have well-developed rough endoplasmic reticulum, Golgi complexes and many mitochondria. 3) secretory granules are located at the base of cell. 4) **Function** – secret **gastrin** wich stimulates parietal cell to secretion of HCl.
				D cells	1) **Location** – at the base of the crypts. 2) have well-developed rough endoplasmic reticulum, Golgi complexes and many

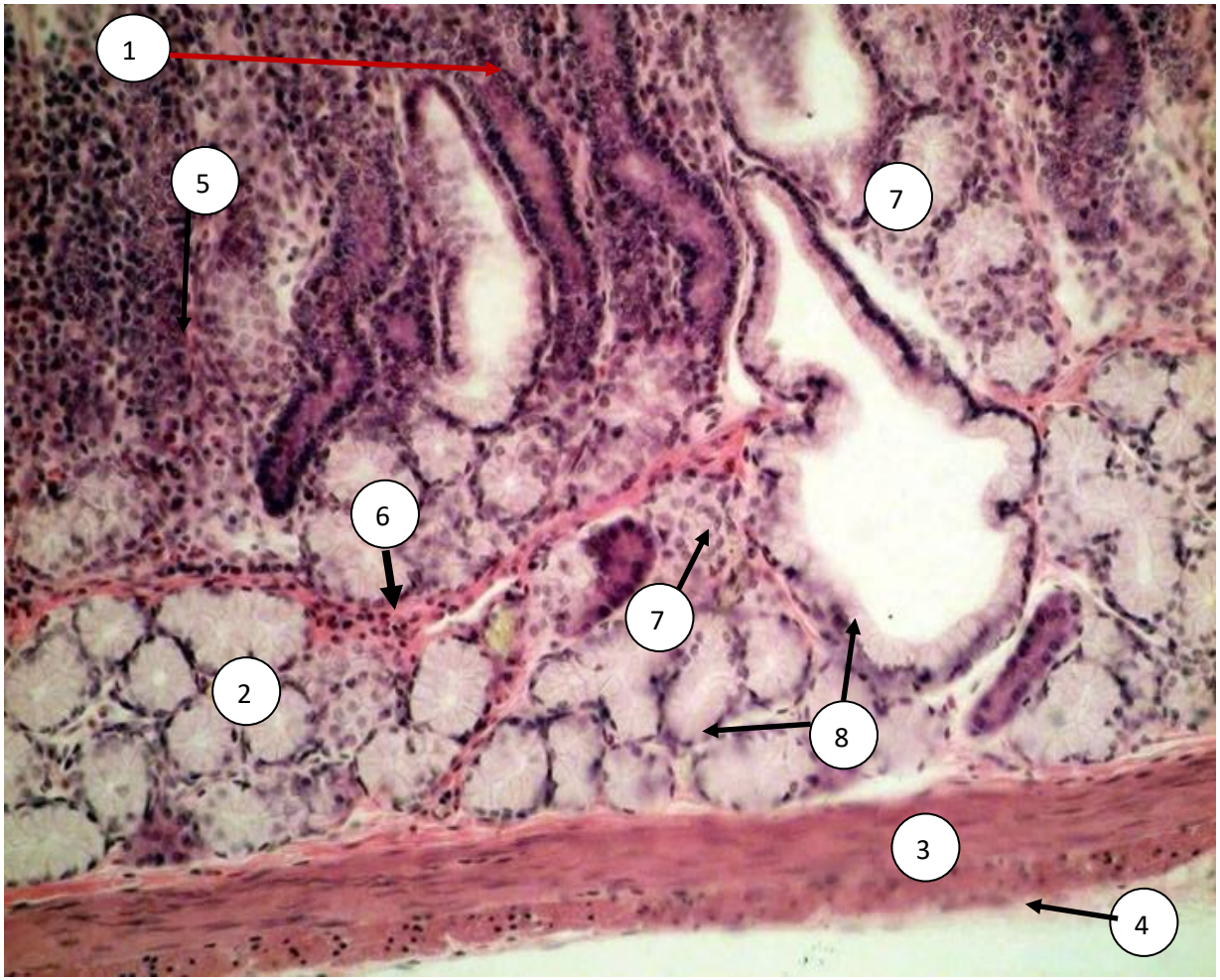
					mitochondria. 3) secretory granules are located at the base of cell. 4) **Function** – secret **somatostatin** wich inhibits gastrin releasing
				Others cells	**Function** - secret **cholecystokinin** (CCK), **secretin**, **gastric inhibitory polypeptide** (GIP) and **motilin**. **1) CCK and secretin** - increase pancreatic and gallbladder activity and inhibit gastric secretory function and motility. 2) **GIP** stimulates insulin release in the pancreas. 3) **Motilin** initiates gastric and intestinal motility.
			Stem cells	1) Location - lower one-half of the gland. 2) They have polymorphic shape. 3) **Function** - regeneration and recovery.	

Special structures of parts of the LARGE INTESTINE

1) **Length** is about 1,5 m.
2) **Walls** of portions have the same general structure of mucosa, submucosa, muscularis externa, and serosa/adventitia.
3) Parts have **large lumen** except the appendix.
4) **Mucosa** has large number of goblet cells and crypts but no villi.
5) Outer longitudinal muscle layer of the muscularis externa has become three narrow bands called **teniae coli.**

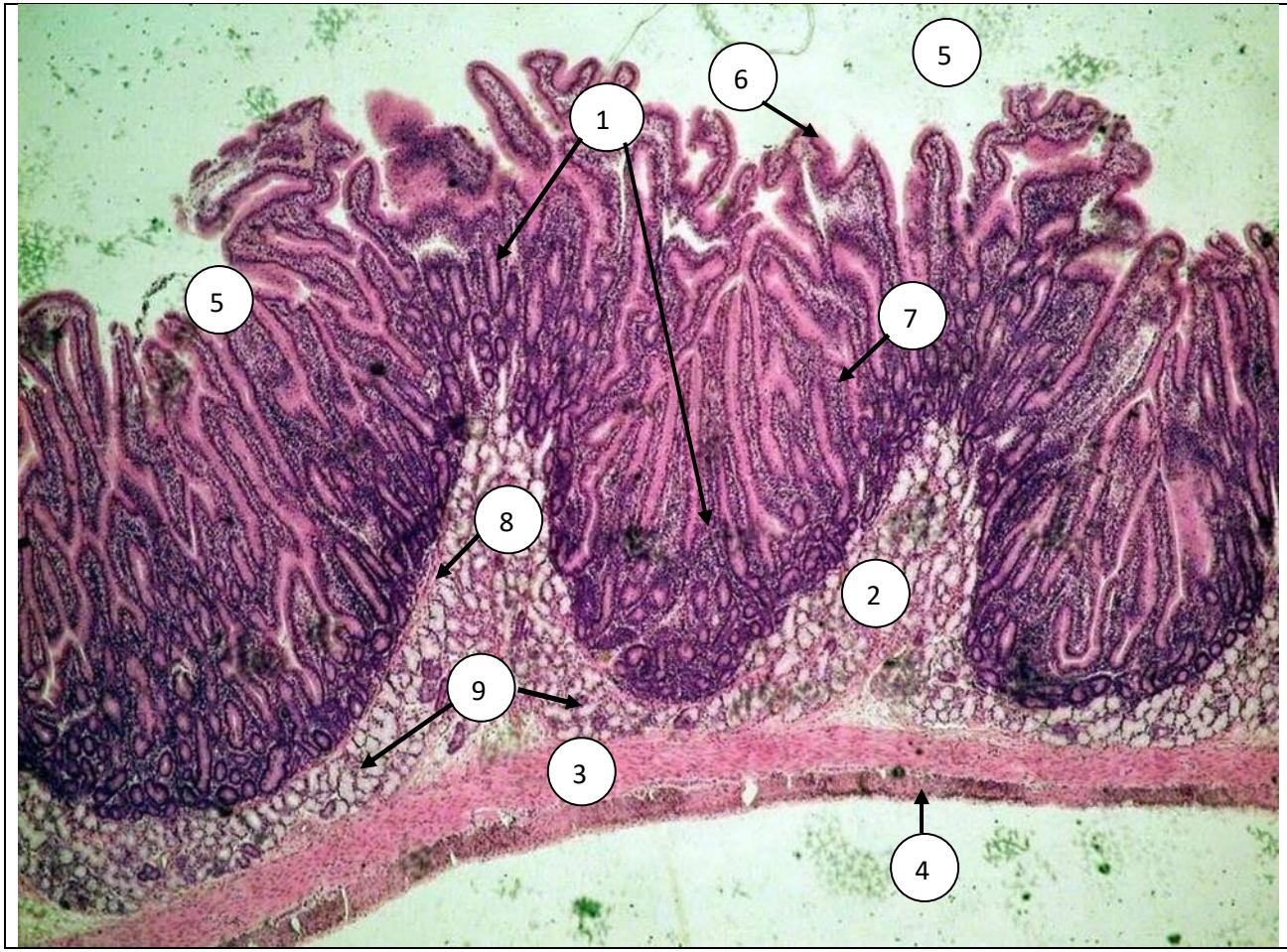
Parts		**Structural features**		
1.	**Cecum with its vermiform appendix**	1) There is ileocecal valve between ileum and cecum. 2) **Appendix** is very short, small-diameter blind end tube, 10 cm in length. It includes of lymphatic nodules in the lamina propria that extend into the submucosa. 3) **Functions:** absorption of water and salts, formation, storage and elimination of feces.		
2.	**Colon**	**Ascending colon**	Walls have the same general	1) Mucosa contains glands of

		Transverse colon **Descending colon** **Sigmoid colon**	structure of mucosa, submucosa, muscularis externa, and serosa/adventitia.	Lieberkühn which don't contain Paneth cells. 2) The stem cells are located at the base of the glands (crypts) of Lieberkühn. 3) **Functions:** absorption of water and salts, formation, storage and elimination of feces.
3.	**Rectum**	1) It connects the sigmoid colon to the anal canal. 2) It is distal part of the large intestine. 3) It has fewer intestinal glands of Lieberkühn. 4) It has longitudinal folds (anal columns) in the gross view. 5) Mucosa is covered by stratified squamous epithelium. 6) Lamina propria contains many large veins (venous plexus). 7) Muscularis externa contains inner circular and outer longitudinal smooth muscle layer. 8) The inner circular smooth muscle becomes thicker and forms the internal anal sphincter. 9) **Functions:** store feces; sensory receptors signal brain of the need to evacuate.		
4.	**Anal canal**	1) It is externally surrounded by a layer of skeletal muscle called the exterior sphincter. 2) It has an average length of 4 cm and extends from the upper aspect of the pelvic diaphragm to the anus. 3) There is **anorectal junction** (dentate line – place of change from simple columnar epithelium to stratified squamous epithelium). 4) It is divided into **three zones** (according to the the epithelium): **1. colorectal zone (**upper third lined by simple columnar epithelium)**. 2. anal transitional zone (**middle third lined by stratified columnar epithelium**), 3. squamous zone (**lower third lined by stratified squamous). 5) It includes mucus branched, straight tubular glands (**anal glands**) and in the skin surrounding the **anal canal (large apocrine glands - circumanal glands).** 6) **Functions:** internal sphincter and external sphincter (skeletal muscle); relax to release feces.		



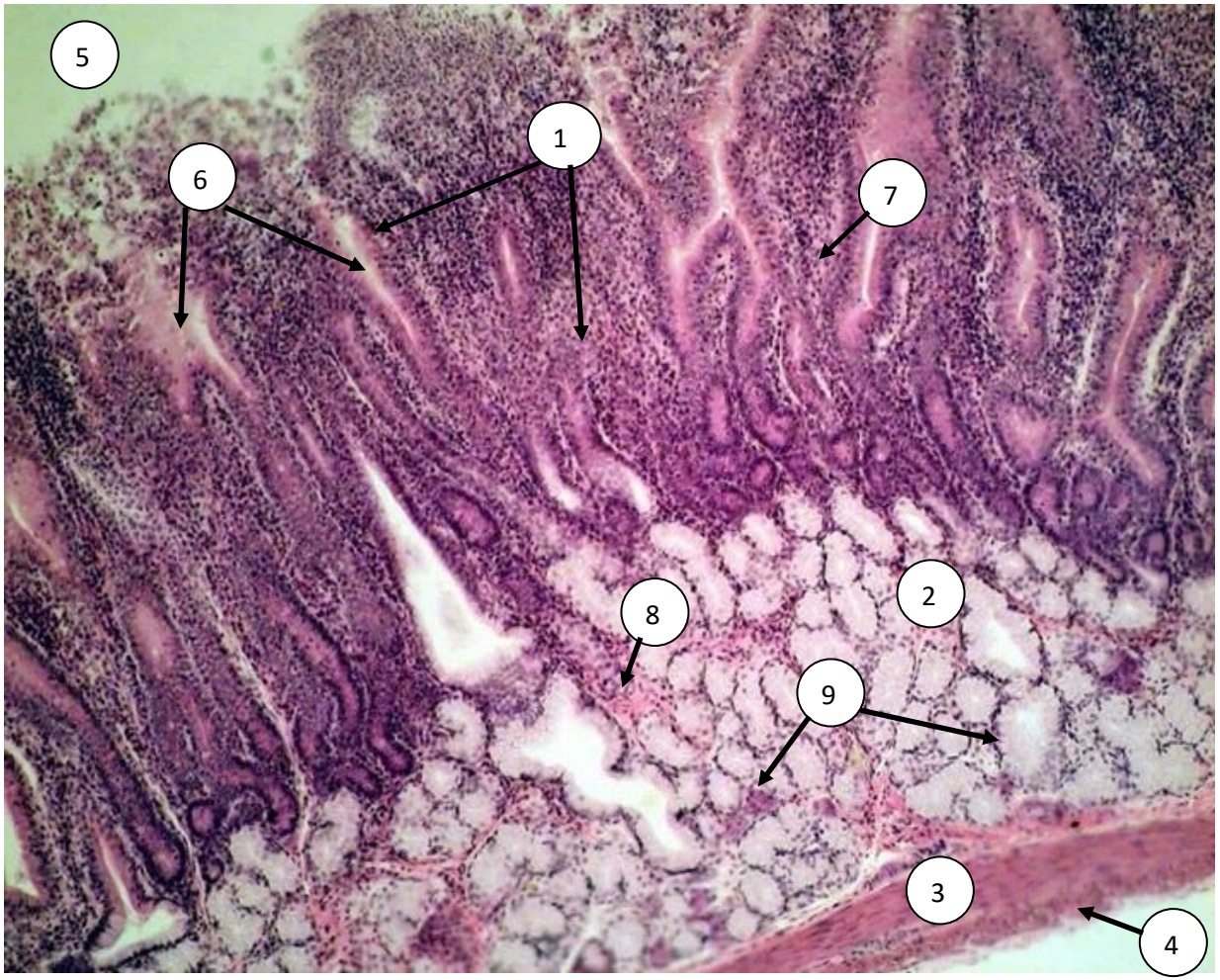
Duodenum
Magnification X 100.

On the preparation of the duodenum there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and serosa (4). Mucosa consists of simple columnar epithelium, lamina propria (5) and muscularis mucosae (6). In the submucosa (2) there are loose connective tissue (7) and Brunner's glands (or duodenal glands) (8).



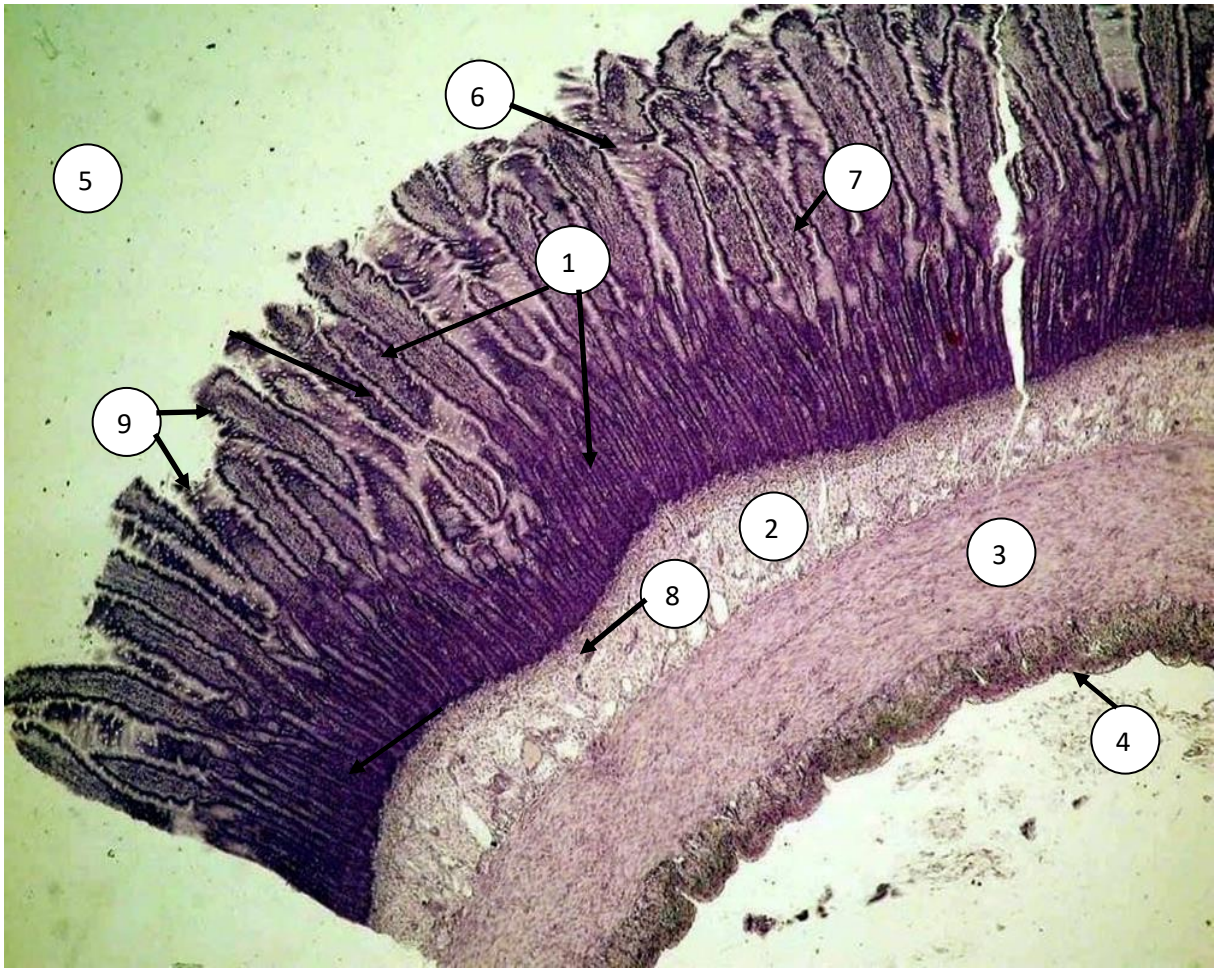
Duodenum
Magnification X 40.

On the preparation of the duodenum there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and serosa (4). The space above is called the lumen (5). Mucosa consists of simple columnar epithelium (6), lamina propria (7) and lamina muscularis mucosae (8). In the submucosa (2) there are loose connective tissue and Brunner's glands (or duodenal glands) (9).



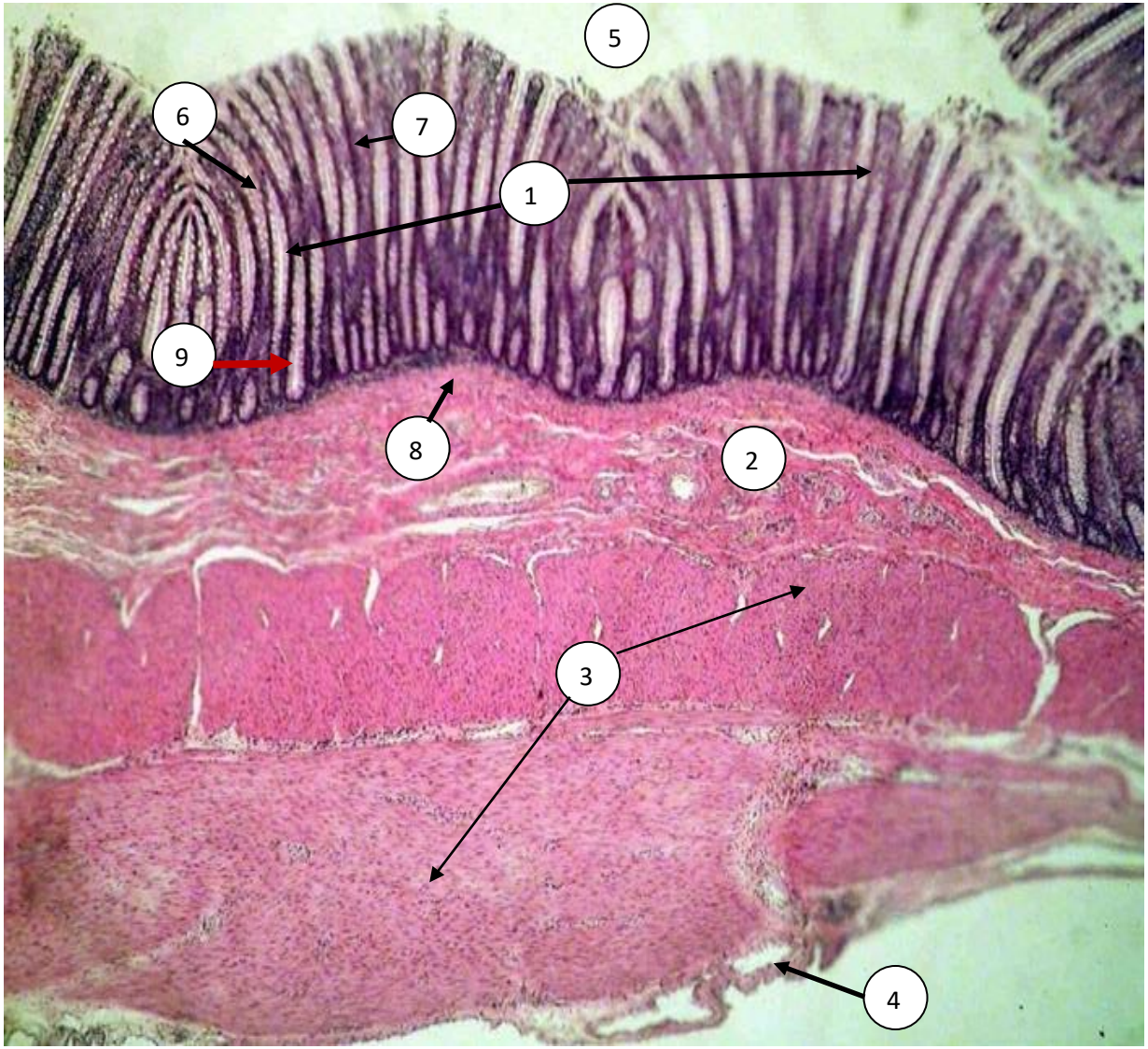
Duodenum
Magnification X 100.

On the preparation of the duodenum there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and serosa (4). The space above is called the lumen (5). Mucosa consists of simple columnar epithelium (6), lamina propria (7) and lamina muscularis mucosae (8). In the submucosa (2) there are loose connective tissue and Brunner's glands (or duodenal glands) (9).



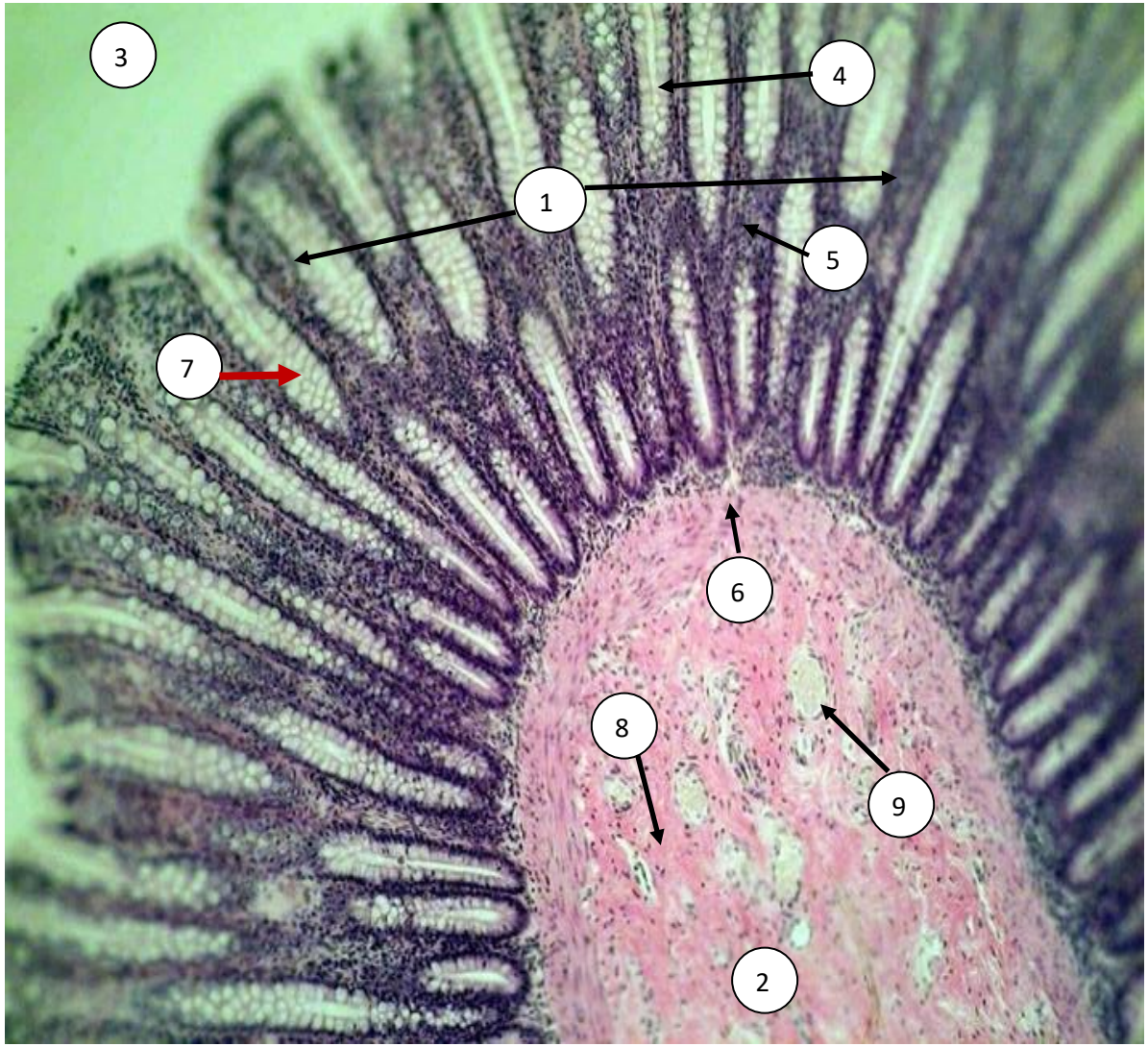
Jejunum
Magnification X 100.

On the preparation of the jejunum there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and serosa (4). The space above is called the lumen (5). Mucosa consists of simple columnar epithelium (6), lamina propria (7) and lamina muscularis mucosae (8). Mucosa forms villi (9). In the submucosa (2) there is loose connective tissue.



Large intestine
Magnification X 100.

On the preparation of the large intestine there are four layers of wall: mucosa (1), submucosa (2), muscularis externa (3) and serosa (4). The space above is called the lumen (5). Mucosa consists of simple columnar epithelium (6), lamina propria (7) and lamina muscularis mucosae (8). Mucosa forms crypts (9). In the submucosa (2) there is loose connective tissue.



Large intestine
Magnification X 100.

On the preparation of the large intestine there are two layers of wall: mucosa (1), submucosa (2), exept muscularis externa and serosa. The space above is called the lumen (3). Mucosa consists of simple columnar epithelium (4), lamina propria (5) and lamina muscularis mucosae (6). Mucosa forms crypts (7). In the submucosa (2) there is loose connective tissue (8) and blood vessels (9).

VOCABULARY

Villi (Villus, plural villi), in anatomy are small, thin, vascular protrusions that enlarge the membrane surface area. Villi of the small intestine protrude into the cavity of the intestine, significantly increasing the area of food absorption and additionally producing digestive secretions. Each villus has a central core composed of one artery and one vein, a strand of muscle, a centrally located lymphatic capillary (lacteal), and connective tissue that adds support to the structures.

Absorptive cells - tall, narrow, columnar cells that absorb the substances passed into the blood and lymphatic vessels. Each columnar cell has about 600 very thin outgrowths called microvilli, which additionally increase the absorption surface of each villus.

Goblet cells are specialized epithelial cells that are located on many mucosal surfaces and play an important role in providing barrier function by secreting mucus. In addition, they release antimicrobial proteins, chemokines and cytokines, thus demonstrating functions of innate immunity. Recently it was discovered that these cells can form goblet cell-associated antigen passages and provide substances to antigen-presenting cells of the lamina propria, thus they are able to activate an adaptive immune response.

Intestinal crypts, called the crypt of Lieberkühn, is a gland found in the epithelial lining of the small intestine and colon. The crypts and intestinal villi are covered by epithelium that contains two types of cells: goblet cells that secrete mucus and enterocytes that secrete water and electrolytes.

Paneth cells – eosinophillic, lysozyme secreting cells at the base of the crypts of Lieberkühn that provide antibacterial and phagocytic activity.

Enteroendocrine cells - hormone secreting cells that regulate the secretion of pancreatic, biliary and gastric juices and activates enteric motility.

Peyer's patches are one of the MALT components (mucosa-associated lymphoid tissue). They are commonly found in the ileum (though they are present in other segments of small intestine). The lymphoid tissue lies right beneath the mucosal layer. Peyer's patches mainly include T cells, but there may be germinal centres with B lymphocytes and also

macrophages. Peyer's patches have no afferent lymphatic pathways. Activated lymphocytes enter the efferent lymph and are sent to the lymph nodes.

M (microfold) cells - are specialized epithelial cells that reside above Peyer's patches. These cells capture a minimal amount of antigens that enter the intestinal lumen and further transfer them to antigen-presenting cells as well as MALT lymphocytes.

Taeniae coli – are three longitudinal smooth muscle strips in the wall of the colon about 8 mm wide. They are all parallel, evenly distributed and form three-helix structure from the appendix to the sigmoid colon. The cords are fairly constant in width throughout the entire length of the colon until they expand to occupy most of the sigmoid colon's circumference in its distal section and fuse to make a continuous longitudinal muscle covering the rectum.

Haustra. Haustral folds (Latin haustrum, plural: haustra) are folds of mucous membrane in the large intestine. Haustra are small segmented pouches of intestine separated by haustral folds. They are made up by circular contraction of the colon inner muscular layer.

Links:

https://www.britannica.com/science/villus
https://www.nature.com/articles/s41385-018-0039-y
https://www.kenhub.com/en/library/anatomy/histology-of-the-lower-digestive-tract
https://www.histology.leeds.ac.uk/lymphoid/MALT.php
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3281971/

TESTS

1. What deficiency of **enzyme is the reason of incomplete digestion of fats** in a gastroenteric path and increases in quantity amount of neutral fat in feces more often?

Lipase
Enterokinase
Lactase
Dipepttidase

Secretine

2. On histologic section of **small intestine's wall at the crypts' cells located by groups are found**, in **apical parts contain big acidophilic secretory granules; cytoplasm is basophilic**. What are these cells?
Paneth cells
Columnar cells
Endocrinocytes
Goblet cells
Enterocytes

3. At the patient with **chronic enterocolitis (the inflammation of intestines)** is revealed infringement of digestion and absorption digestive products in thin gut **as a result of insufficient quantity amount in intestinal juice dipeptidases**. In what **cells synthesis of these enzymes is broken**?
Paneth cells
Goblet cells
Columar cells without brush border
Stem cells
Enterocytes with a brush border

4. The patient with **thyreotoxicosis** complains of **diarrhea, heavy feeling in stomach**. At examination - **feces without pathological changes.** At radiological research definitely **acceleration of passage of baric masses along intestines**. The **hypertonus of what shall of alimentary tube is the reason of the given condition**?
Muscular
Serous
Mucous
Adventitial
Submucous

5. An electron microphotograph of **duodenal epithelium** clearly shows a **cell with electron-dense granules in the basal pole. What cell is it?**
Endocrine
Prismatic with a limbus
Poorly differentiated
Goblet
Parietal

6. The **intestinal submucosal membrane** is being investigated, complex **branched tubular glands resembling the pyloric stomach glands are found.** Which part of the intestine is found in the histological specimen?
Duodenum
Ileum
Rectum
Appendix
Sigmoid colon

7. In some diseases of the **colon change correlation of number between epithelial cells of the mucosa**. What types of **cells predominate in the epithelium of the crypts of the colon** normally?
Goblet cells
Columnar villous epithelial cells
Endocrinocytes
Cells with acidophilic granules
Undifferentiated cells

8. Some diseases of the **small intestine** associated with dysfunction of exocrynocytes with **acidophilic granules (Paneth cells)**. Where are these **cells located**?
At the bottom of intestinal crypts
On the apical side of intestinal villi
On the sides of the intestinal villi

In place of transition in villus crypt
In the upper part of the intestinal crypts

9. During endoscopic examination of the patients with **chronic enterocolitis (inflammation of the colon)**, there **IS NO specific structures reliefs of the small intestine**. What components determine the relief features of the mucous membrane of this organ?
Circular folds, villi and crypts
Felds, folds, holes
Haustry, villi, crypt
Oblique folds
Villi

10. During the examination of the patients with diseases of the **small intestine** revealed **disruption of the wall and membrane digestion.** With dysfunction of what kind of cells it is connecting?
Column with border
Column without border
Goblet
Paneth cells
Endocrinocytes

11. During the diseases of the mucosa layer of the **small intestine suffers absorption function**. What **kind of epithelium** is responsible for this function?
Simple columnar epithelium
Simple cuboidal
Simple columnar
Stratified squamous epithelium
Stratified cuboidal

12. The student had a histological slide of the **small intestine submucosa** in which the foundation has a **large number of glands.** Which part of the small intestine is it?
Duodenum
Jejunum
Ileum
Ascending colon
Descending colon

13. On the electronic microphotogram of **crypts** of the **small intestine can be identified some cells**. They lying in the bases of the crypts, have many large **acidofilic secretory granules**. What is the name of these cells?
Paneth cells
Enterocytes
Goblet cells
Undifferentiated cells
Enteroendocrine cells

14. On a histological specimen of the **small intestine in the lamina propria of mucosa revealed clumps of cells spherical shape with large basophilic nuclei surrounded by a narrow rim of cytoplasm.** In most of the central part of the light clusters and contains fewer cells than peripheral. Which is the morphological structure of such clusters?
Lymphatic nodule
Nerve bundle
Fat cells
Blood vessels
Lymphatic vessels

15. On a histological specimen of **submucosa of the small intestine is filled of endings of the protein secretory glands.** Where was the section of intestine done which is presented in the sample?
Duodenum
Jejunum

Cecum
Ileum
Appendix

16. In the cytoplasm of **epithelial cells of the colon's crypts were found dypeptydase and lysozyme**. What kind of cells can produce these enzymes?
Paneth cells
Columnar epithelial cells
Goblet cells
A-cells
S-cells

17. On a histological specimen of a wall of the **digestive system in the lamina propria of the mucosa and submucosa were found numerous lymphoid nodules.** Name the structure.
Appendix
Stomach
Duodenum
Ileum
Colon

18. During a biopsy investigation of the **wall of the small intestine has been taken out the part of mucosa layer**. What **epithelium covers the mucosal surface of the organ**?
Simple columnar epithelium with goblet cells
Stratified squamous nonkeratinized epithelium
Stratified squamous keratinized epithelium
Simple cuboidal epithelium
Stratified cuboidal epithelium

19. A specimen presented an organ of the **digestive system which has a thickened lamina propria of the mucous membrane, numerous lymphoid nodules and a submucosal membrane**. In what organ do the lymphoid nodules occupy the largest volume in relation to the thickness of the cell?

Appendix
Stomach
Duodenum
Ileum
Colon

20. A patient with **polypous columnar growths in the rectal area** was examined by a proctologist. Which epithelium became the source of **polyps**?

Stratified squamous non keratinzed
Simple cubic
Simple flat
Simple cubic
Simple polynuclear

21. During an endoscopic examination of active digestion we observe active **movement of villi of the small intestine, as a result of which their length changes.** Which of the following is the reason for this change?

Contraction of smooth muscle cells
Plicae
Peristaltic
Pre-innervation
Crypt enlongation

22. It is recommended to **take drugs that are in the form of alcohol tincture before a meal**. This applies especially to meals rich with fats. This is related to which functional features of the stomach?

Absorption function
Splitting of nutrients

Excretory function
Endocrine
All of the above

23. While describing a specimen of a **particular organ of the gastrointestinal tract**, a student noticed that within the **lamina propria of the mucosal and submucosal membranes there were clusters of lymph nodes which had almost no crypts and few microvilli.** Which organ has these features?
Ileum
Jejenum
Colon
Appendix
Stomach

24. The cells making up the mucous membrane of the **intestine have borders on their surfaces (microvilli).** In some **diseases these borders are destroyed**. Which function of the cell will be disturbed the most?
Absorption
Digestive
Excretion
Accumulation
Synthetic

25. An organ of the **digestive tract** is revealed in a histological specimen, **villi and crypts are present in it's topog**raphy. What epithelium is covering the mucous membrane of the organ?
Simple prismatic fringularis
Simple prismatic glandular
Simple polynucleus prismatic ciliated
Stratified squamous nonkeratinized
Stratified transitive

26. The duodenal contents of a 36 year old woman is being researched. Which type of **epithelium covering the gall bladder can be found** in the sediment of the examinations?
Simple prismatic with border
Simple cubic
Simple prismatic ciliated
Strtified flat
Stratified cubic

27. In the diseases of **small intestine** the mucous membranes **absorption function is damaged**. What epithelium is responsible for this function?
Simple prismatic with border
Simple cubic
Simple prismatic ciliated
Stratified flat
Stratified cubic

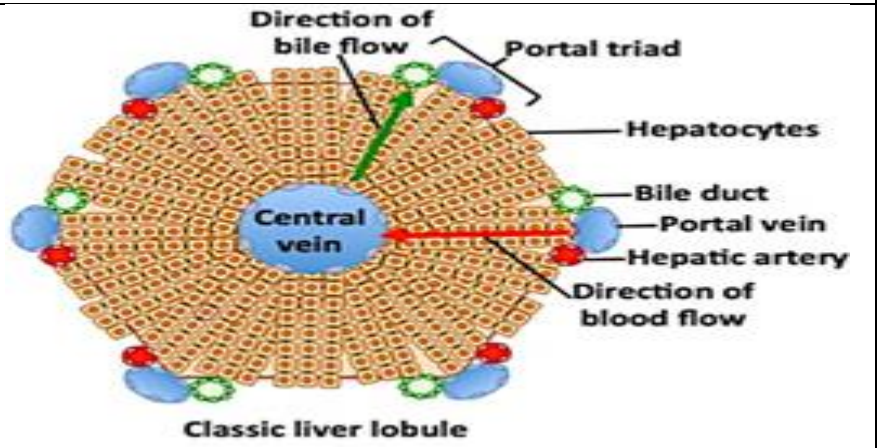
Links:
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

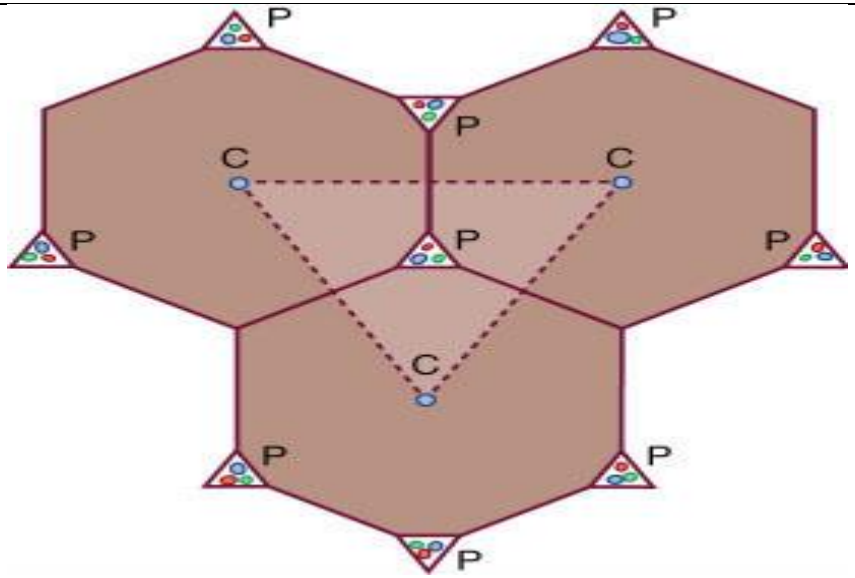
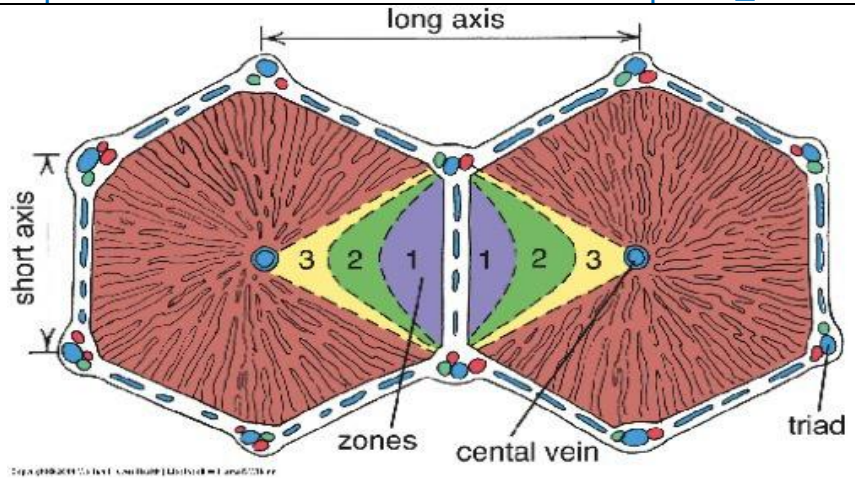
Topic 11. Liver and pancreas.

General structure of LIVER	
Basic structures	**Functions**
Classic lobules **Portal lobules** **Liver acinus**	1) synthesizing and releasing plasma proteins (**fibrinogen, prothrombin, lipoproteins, and albumins**) – **endocrine function.** 2) production of bile **(water, bile salts, bilirubin, cholesterol, fatty acids, lecithin, and electrolytes)** – **exocrine function.** 3) **detoxification**. 4) it is involved in **lipid, carbohydrate, and protein metabolism**. 5) transport wastes (such as **bilirubin**) into the bile.

Blood supply, ducts and spaces of liver		
Sources		**Functions**
1.	**Portal veins**	carry nutrient-rich blood from the small intestine to the hepatic sinusoids through their branches (portal venules)
2.	**Hepatic arteries**	carry oxygen-rich blood to the hepatic sinusoids through their branches (hepatic arterioles).
3.	**Hepatic sinusoids**	carry mixed blood from the hepatic arterioles and portal venules of portal triad to the central veins of classical hepatic lobules.
4.	**Sublobular vein**	collect venous blood from the central veins of the classic liver lobes.
5.	**Large hepatic veins**	collect venous blood from the sublobular veins into the inferior vena cava.
6.	**Perisinusoidal space (spaces of Disse)**	is situated between the sinusoidal endothelium and the hepatocytes. is also the main extracellular compartment from which liver lymph is derived.
7.	**Bile canaliculi**	carry bile to the bile ductules of portal triad of classical hepatic lobules. are enlarged intercellular spaces, located between two adjacent hepatocytes. Tight junctions seal each side of the bile canaliculus, preventing initial bile from leaking out of the canaliculus.

8.	**Hepatic ductules**	collect bile and carry it into the hepatic ducts, which then join the cystic duct from the gallbladder.
9.	**Right and left hepatic ducts**	carry bile into the **common hepatic duct**, which connects to the cystic duct.
10.	**Common hepatic duct**	formed by merging of **right and left hepatic ducts.**
11.	**Common bile duct**	carries bile from the **common hepatic duct and cystic duct, and** joins the pancreatic duct at the hepatopancreatic ampulla and bile enters the duodenum through the major duodenal papilla.
12.	**Lymphatic vessels**	carry lymph from the **liver drains** into the **hepatic lymph vessels** and passes through the **lymph nodes** (near the liver) to then drain into the **thoracic duct**.

General histological structure of LIVER		
Basic structures and features of classification	**Features**	
Classic lobule (is based on the direction of the blood flow)	1. **hexagon** shape. 2. contains **six portal triads** and **one central vein.** 3. blood flows from portal triads into a central vein.	 Classic liver lobule https://vmicro.iusm.iu.edu/hs_vm/docs/lab12_12b.htm

Portal lobule (is based on the direction of the bile flow)	1. **triangular** shape. 2. contains **one portal triad in the center** and three **central veins** in the angles**.** 3. Hepatocytes produce bile and bile enters the bile canaliculi to then drain into the bile ductule of portal triad.	 https://medicine.en-academic.com/137819/portal_lobule
Liver acinus (is on the blood oxygen level, nutrient supply, and metabolic activity)	1. **diamond** shape. 2. contains two **portal triad** and two **central veins** in the angles. 3. subdivides into three zones: zone 1, zone 2, and zone 4. cells of **zone 1** receives the most blood flow and blood toxins first are more likely to be damaged (are situated closer to the portal veins and hepatic arteries of portal triads). 5. cells of **zone 2** have an intermediate response to oxygen and toxins. 6. cells of **zone 3** have a poor oxygen and nutrient supply, but is also less exposed to blood toxins (are situated far from the portal triads and close to the central veins).	 https://quizlet.com/595782776/liver-and-biliary-tract-pathology-flash-cards/

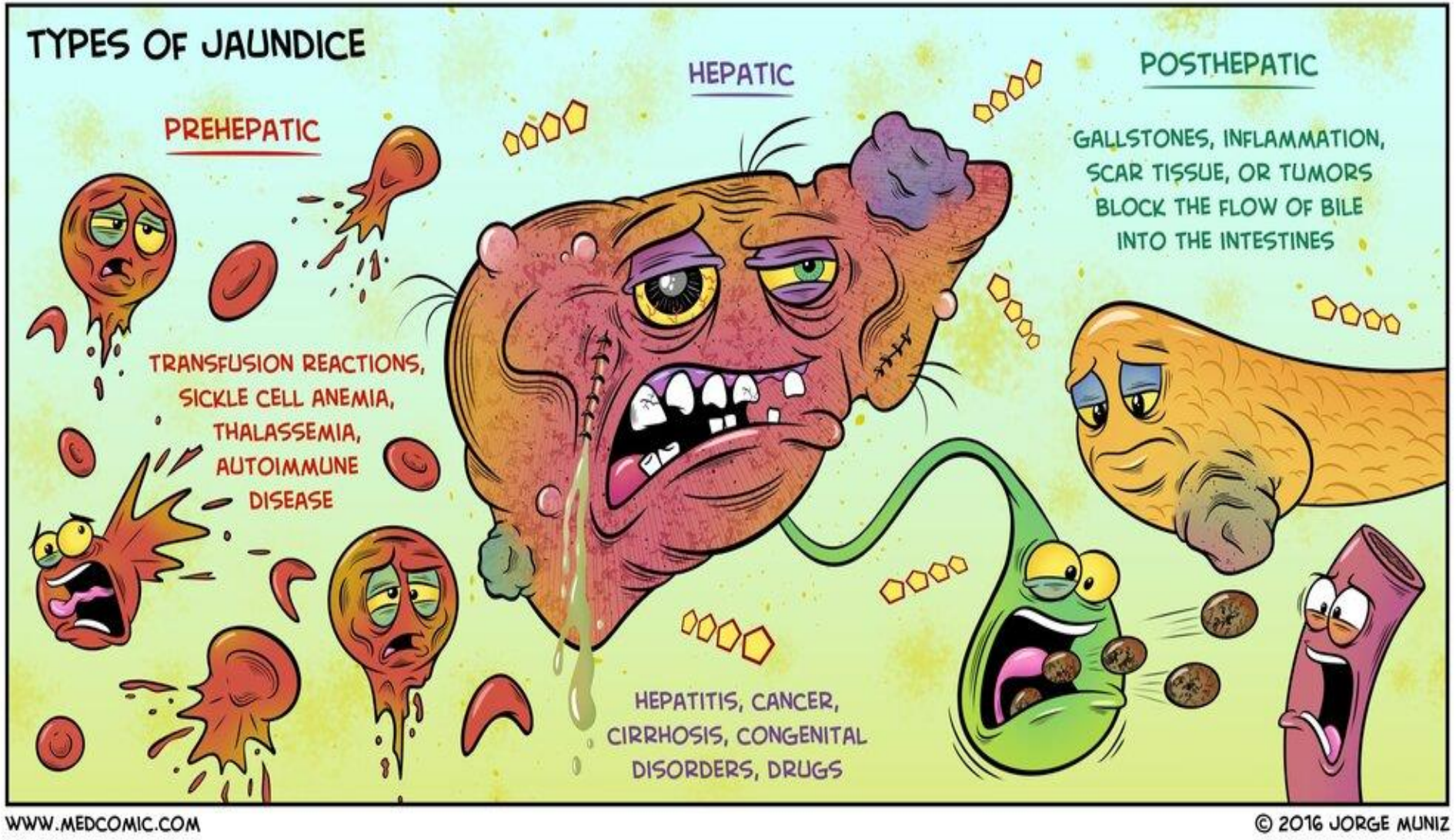
General structures and features of liver parenchyma and stroma	
Basic structures	**Functions**
Capsule	fibrous connective tissue that becomes thicker at the hilum.
Loose connective tissue	surrounds and supports the liver cells and the sinusoidal endothelial cells of the liver lobules, vessels and ducts all the way to their termination (or origin) in the portal spaces between the liver lobules.
Hepatocytes	1. large polygonal cells 2. have round two or more nuclei and about 50% of them are polyploid (4n, 8n or more times the normal diploid chromosome number) 3. they are arranged in plates that are one or two cells thick. 4. between the plates of hepatocytes there are hepatic sinusoids. 5. have many mitochondria, smooth endoplasmic reticulum, rough endoplasmic reticulum and inclusions. 6. Short microvilli of the hepatocytes extend into the space of Disse.
Hepatic sinusoids	1. are discontinuous capillaries 2. **Kupffer cells** (irregular shape cell with ovoid nuclei) are phagocytes that purify luminal surface of the hepatic sinusoids. 3. **Ito cells (fat-storing cells)** or hepatic stellate cells are located in the space of Disse and contain many lipid droplets (store vitamin A) or vacuoles in their cytoplasm.
Portal triad	1. is composed of a **portal vein**, a **hepatic artery**, and a **bile ductile.** 2. vessels and bile duct are surrounded by connective tissues, which usually contains a lymphatic vessel. 3. **portal vein** (large lumen, thin vessel wall) gives branches (**portal venules**) which feed the hepatic sinusoids. 4. **hepatic artery** (small lumen, wall with 2 to 3 cell layers thick of smooth muscle that) gives branches (**hepatic arterioles**), which feed hepatic sinusoids.

General structure of GALLBLADDER				
Structure			**Functions**	
It stores, concentrates, and releases bile.				
1.	**Mucosa** has many branching folds	Simple columnar epithelium	columnar epitheliocytes with many microvilli on the apical surfaces.	absorb water from bile in the lumen and transport it into the interstitial tissue
			some columnar epitheliocytes have interdigitating lateral membranes and many mitochondria in the cytoplasm	transport water
		Lamina propria	loose connective tissue	
2.	**Muscularis**		1) consists of interlacing longitudinal and obliquely oriented bundles of smooth muscle fibers. 2) forms at neck of the gallbladder **spiral valve of Heister**	1) helps empty bile through the cystic duct into the bile duct 2) controls the opening or closing of the gallbladder
3.	**Serosa/adventitia**		**serosa** consists of connective tissue and mesothelium	covers most of the gallbladder
			adventitia consists of only connective tissue	attaches the gallbladder to the liver
4.	**Cystic duct**		1) mucous membrane is lined by simple columnar epithelium (cholangiocytes). 2) lamina propria and submucosa are relatively thin, with mucous glands. 3) has thin muscularis layer.	carry bile to the gallbladder and from the gallbladder to the common bile duct

Jaundice

Symptom - skin and sclera become markedly yellow.
Reason - high level of common bilirubin (due to either direct or indirect bilirubinb type, or both at the same time) in the bloodstream.

	Type	**Pathology** in which this type of jaundice is observed
1.	Prehepatic	1) transfusion reaction 2) sickle cell anemia 3) thalassemia 4) autoimmune disease
2.	Hepatic	1) hepatitis 2) cancer 3) cirrhosis 4) congenital disorders 5) drugs
3.	Posthepatic	1) gallstones 2) inflammation 3) scar tissue or tumors which block the flow of bile to the intestines



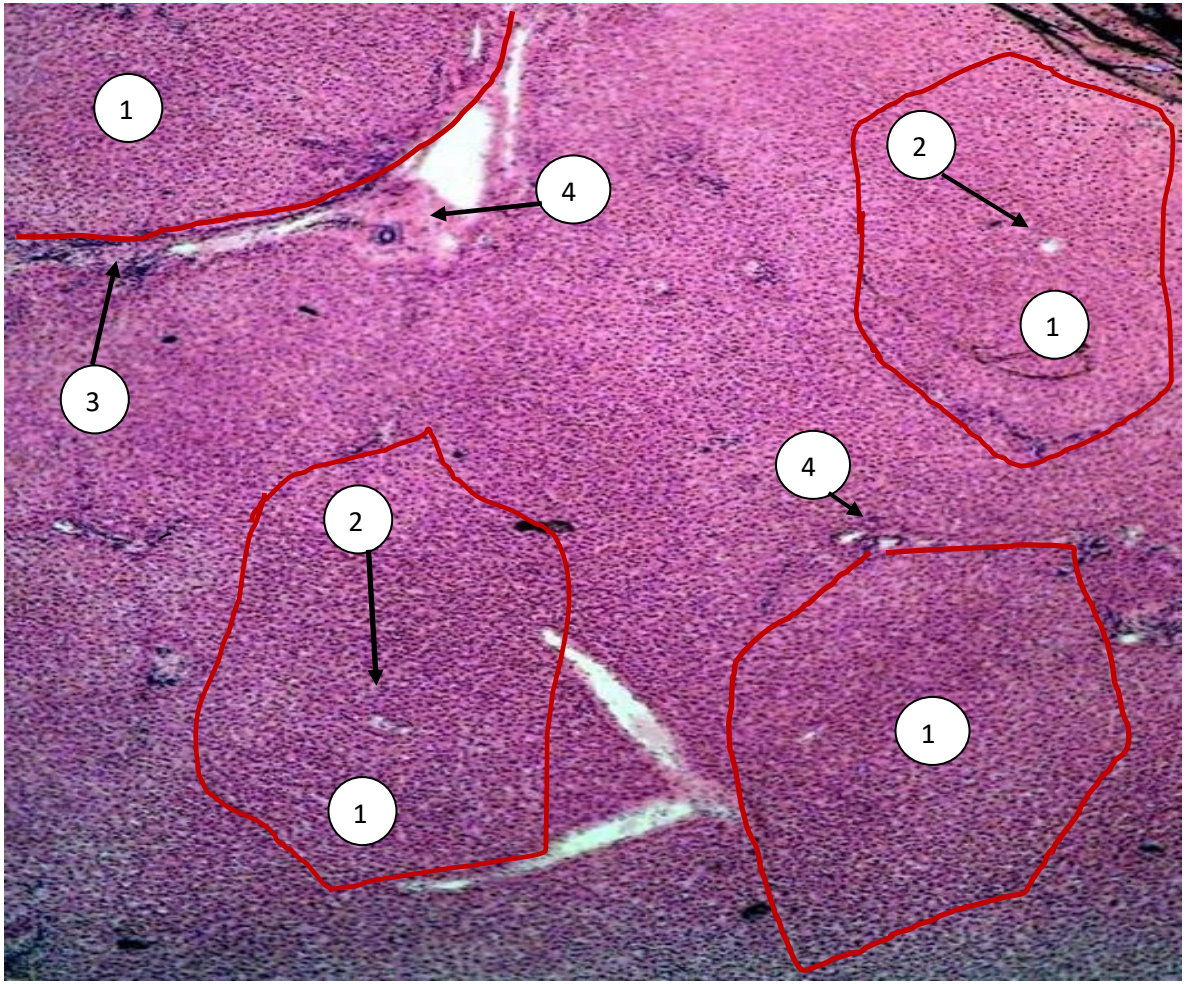
https://www.medcomic.com/medcomic/types-of-jaundice

General structure of PANCREAS				
1.	Anatomical structure	Has three parts (**head, body and tail**).		
2.	Histological structure	**Stroma**	**Parenchyma**	
		1) thin capsule (dense connective tissue) covers the pancreas sends septums into parenchyma. 2) septums separate the pancreatic lobules.	**Exocrine portions** Pancreatic acini	**Endocrine portions** islets of Langerhans
3.	System of ducts	1) begins from **intercalated ducts** (formed by centroacinar cells) and then drained into the **intralobular ducts**, the **interlobular ducts**, and finally into the **main duct**. 2) **Endocrine portions don't have system of ducts.**		

General structure of pancreas EXOCRINE PORTION			
Parts			**Features and functions**
1.	**Pancreatic acini**	Pancreatic acinar cells	1) have a round nucleus 2) cytoplasm contains many zymogen granules in the apical region, RER in the basal region, Golgi complex near the nucleus. 3) **Function:** secrete enzymes which help in the digestion of proteins, lipids, and carbohydrates. 4) **Enzymes**: a) proteases - **trypsinogens, chymotrypsinogen, proelastases, protease e, kallikreinogen, procarboxipeptidases** b) α -amylase c) lipases d) nucleaseS (**DNAase and RNAase**).

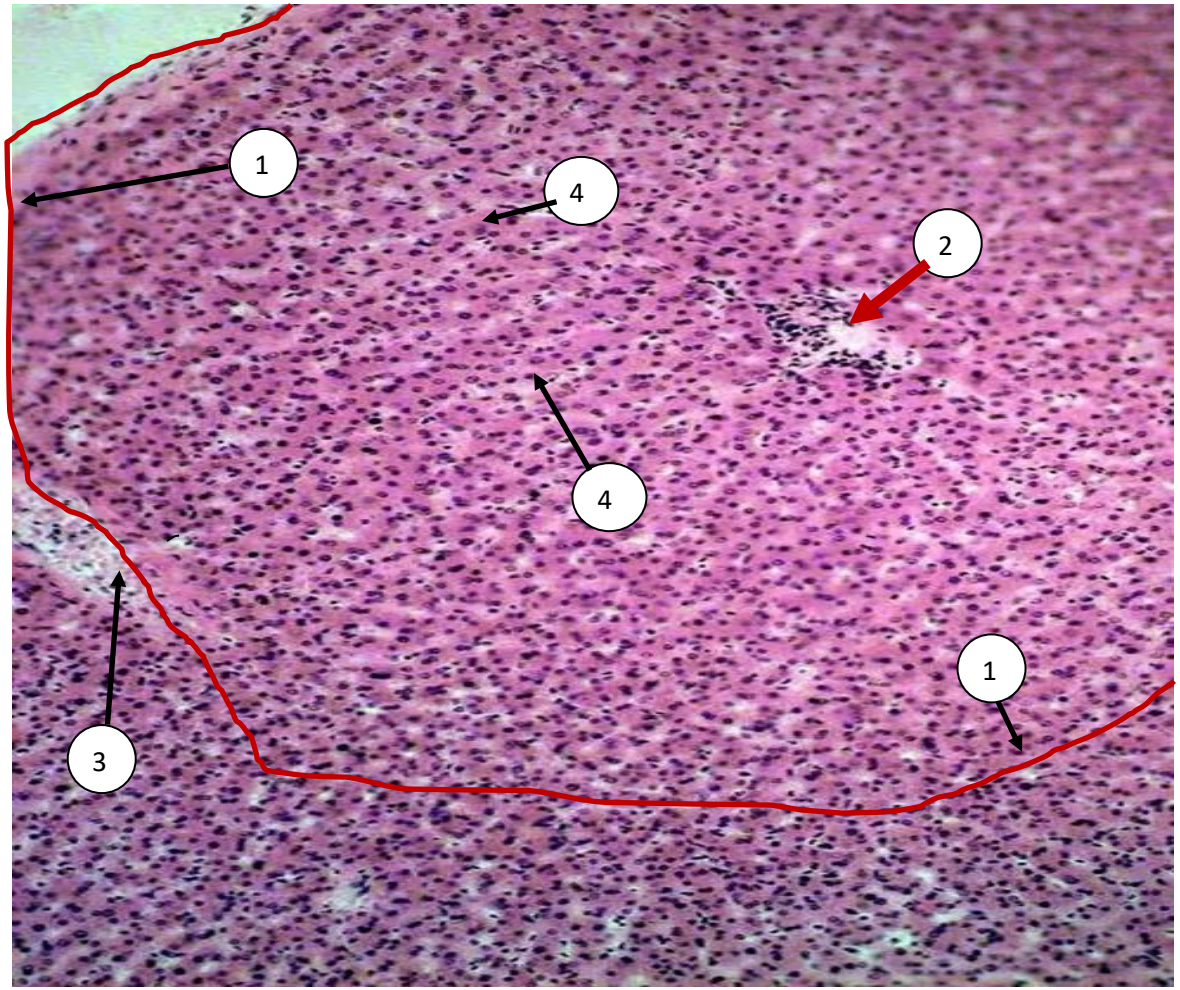
		Centroacinar cells	1) have many mitochondria but less RER. 2) are located at the center of each acinus and form initial parts of the intercalated ducts. 3) **Function:** secrete fluid (with **sodium** and **bicarbonate**) which helps neutralize acidic food contents entering the duodenum from the stomach.
2.	**Septum**	Loose connective tissue	1) includes blood vessels, nerves and ducts 2) separate lobules into secretory acinuses
3.	**System of ducts**	intercalated ducts	1) formed by centroacinar cells 2) transport primary pancreatic secretion 3) are lined by simple squamose or cuboidal epithelium
		intralobular ducts	1) formed by merging of intercalated ducts 2) are lined by simple cuboidal epithelium
		interlobular ducts	1) are lined by simple columnar epithelium with goblet and endocrine cells.
		main duct	1) opens at the hepatopancreatic ampulla of duodenum through the major duodenal papilla 2) are lined by simple columnar epithelium with goblet and endocrine cells. 3) smooth muscle cells form a sphincter at the exit of duct.

General structure of pancreas ENDOCRINE PORTION				
Strucure			**Hormone and functions**	
	islets of Langerhans	alpha cells	glucagon	1) cells include small and medium granules which have an electron-dense core with a very narrow electron-lucent surround. 2) stimulates the synthesis and release of glucose from the liver into the blood (increasing blood glucose levels).
		beta cells	insulin	1) cells include larger granules, a less dense core, and a wide lucent area surrounding the core. 2) stimulates glucose entry in many cells, in this way regulating carbohydrate metabolism and lowering blood glucose levels.
		delta cells	somatostatin	inhibit glucagon and insulin secretion
			gastrin	stimulate gastric gland secretion
		PP cells	pancreatic polypeptide	inhibit exocrine pancreatic secretion
		capillaries	fenestrated or sinusoidal capillaries	



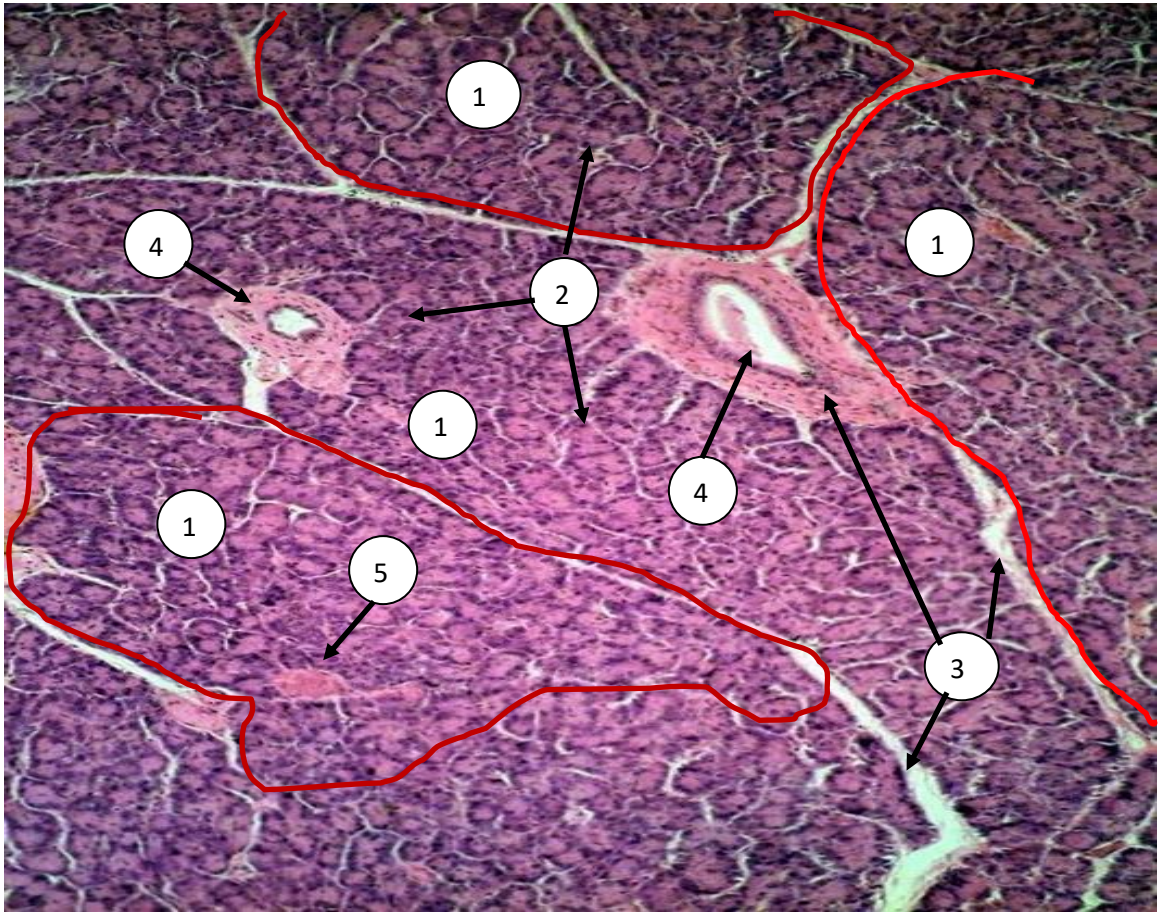
Liver
Magnification X 100.

On the preparation of the liver there are classic lobules (1). Inside the classic lobule there is the central vein (2). Between the classic lobules there is a loose connective tissue (3). In the corners of the classic lobule there are portal triads (4).



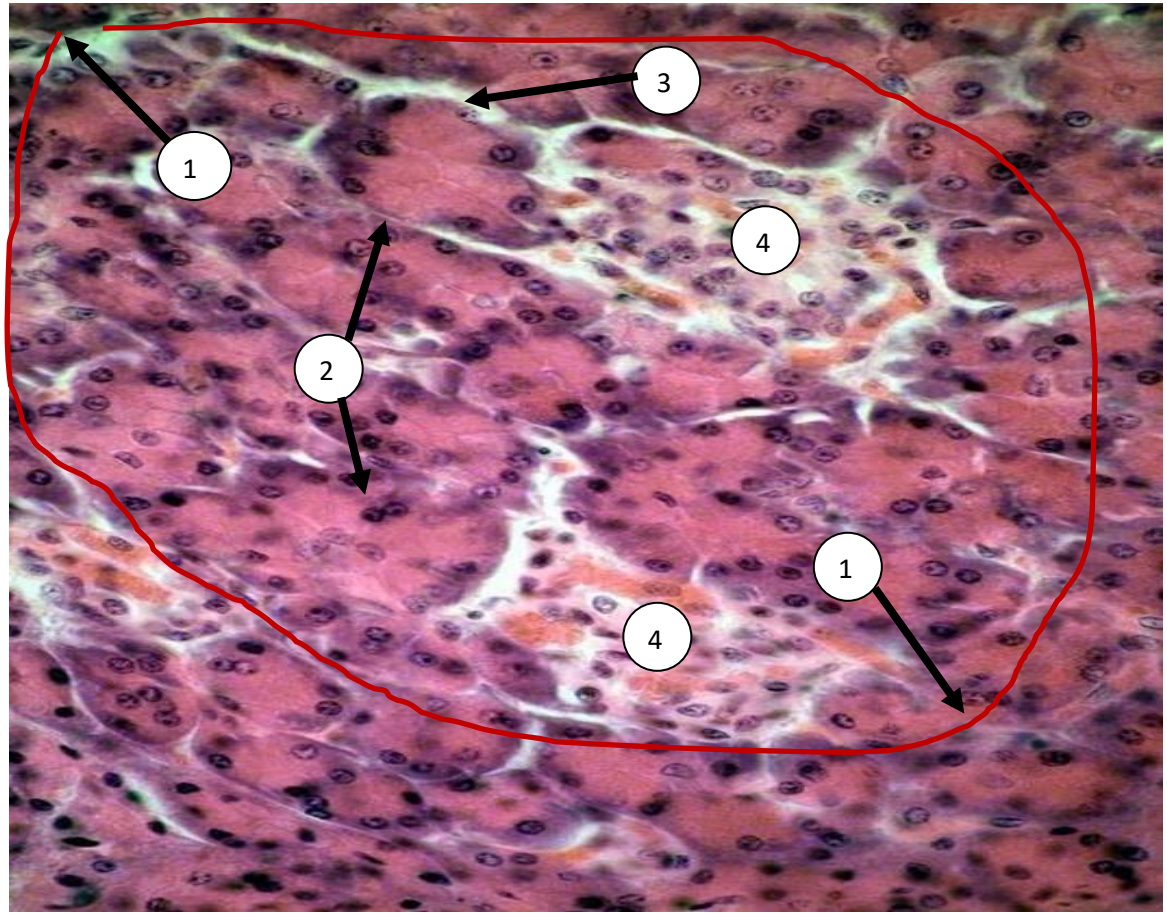
Liver
Magnification X 100.

On the preparation of the liver there is classic lobule (1). Inside the classic lobule there is the central vein (2). Between the classic lobules there is a loose connective tissue (3). Classic lobule consists of hepatocytes which form liner cords (4).



Pancreas
Magnification X 100.

On the preparation of the pancreas there are lobules (1). Parenchyma of pancreas (pancreatic lobules) consists of pancreatic acini (2). Between the lobules there is a loose connective tissue (3) with interlobular ducts (4). In the lobules there are islets of Langerhans (5).



Pancreas
Magnification X 100.

On the preparation of the pancreas there are lobules (1). Parenchyma of pancreas (pancreatic lobules) consists of pancreatic acini (2). Between the acini there is a loose connective tissue (3). In the lobules there are islets of Langerhans (4).

VOCABULARY

Hepatocytes are the main functional cells of the liver. They are large and polygonal epithelial cells that constitute roughly up to 80% of the liver mass. The hepatocytes have one (sometimes two) round central-placed nuclei surrounded by cytoplasm rich with organelles that facilitate protein and lipid synthesis and secretion (rough and smooth endoplasmic reticulum, Golgi apparatus and mitochondria).

Portal triad. The liver, as an organ, is supplied with blood from two separate systems. Mostly - through the portal hepatic vein (75%), which transports venous blood from the intestines, spleen and pancreas. In spite of the low oxygen content, this blood carries a large amount of nutrients, endocrine products, destroyed red blood cells and toxins that have entered the body. Another main source is the hepatic artery (25%), which delivers blood saturated with oxygen to the liver. The hepatic portal vein and hepatic artery together with the bile duct form the portal triad. These structures provide blood to the hepatocytes and sinusoids, after which it is drained into the central vein. The second way of outflow is through the hepatic veins, which flow into the inferior vena cava.

Kupffer cells. Sinusoids include a specific type of cells called Kupffer cells, which have ovoid nuclei. These monocytic derivatives of the mononuclear phagocytic system are located in the wall of the sinusoid, from which they project processes into its lumen. Hence, Kupffer cells constantly monitor the blood flowing through the sinusoids, thus phagocytising destroyed red blood cells, antigens and microorganisms.

Ito cells. In the perisinusoidal space is a certain type of cells called Ito cells, or stellate hepatic cells. Their role is to store hepatic vitamin A in lipid droplets, which is further released as retinol. Meanwhile, Ito cells are also considered to be responsible for liver fibrosis, as they produce large collagen amounts in case of liver damage.

Classic lobule is formed of hexagonal layers of hepatocytes overlapping each other. Inside each plate, hepatocytes diverge from the central vein outward. As they approach the periphery, the hepatocytes are organized in rows similar to the spokes of wheels. Between the bands of hepatocytes are hepatic sinusoids, which flow into the central vein.

Portal lobule. While the appearance of the classical lobule reflects the blood distribution and arrangement of the liver

tissue, the shape of the portal lobule reflects the exocrine liver function, i.e. biliary secretion. Each functional unit in this case is a triangle whose central axis passes through the portal field and the imaginary vertices pass through the three different but nearest portal channels enclosing it. The area occupied by the triangle displays the parts of the liver that excrete bile into the exact same bile duct.

Pancreatic islets (islets of Langerhans) are irregularly shaped clusters of endocrine tissue found in the pancreas of most vertebrates. They are named after the German physician Paul Langerhans, who first identified them in 1869. Human islets consist of circa 30% glucagon-producing α-cells, circa 60% insulin producing β-cells, with the remainder circa 10% made up of δ-cells (somatostatin-producing), γ- or PP cells (pancreatic polypeptide-producing), and ε-cells (ghrelin-producing), with these endocrine cells randomly distributed throughout the islet.

Acinar cell are in the shape of a pyramid, arranged in a radial pattern around a small central lumen and have intracellular, zymogen granules bound to the membrane in the apical region. A perinuclear region that is more basophilic, with a rough endoplasmic reticulum, provides the acinar cell a bicolor, apical-basal polarized view. Inactive precursor proteins (trypsinogen, procarboxypeptidase, chymotrypsinogen, proelastase and kallikreinogen) are synthesized and retained in zymogen granules, prepared for discharge by fusion of the granules with the apical membrane upon cell activation by acetylcholine and cholecystokinin.

Intercalated ducts. The thin ducts running from the acini to the wider excretory ducts lying outside the lobule are known as intercalated ducts and can be revealed by small aggregations of 3-5 mildly elongate nuclei that lie among the acini; the ductal cell cytoplasm is extremely pale. Similar to the salivary glands, intercalated pancreatic duct cells provide bicarbonate ions (sodium and water are passively taken up) to the secreted exocrine juice. But unlike the salivary glands, the pancreas does not have striated ducts for sodium reuptake, so the end product is saturated with both sodium and bicarbonate.

Centroacinar cells. The primary, intraacinar part of the intercalating duct is covered with simple squamous epithelial cells, the so-called centroacinar cells, which indicate the beginning of the ductal system of the pancreas exocrine part. Centroacinar cells are small, pale-staining cells with microvilli on their apical surfaces. The pale-staining character reflects the sparse cytoplasm, small amount of rER, small size of the Golgi apparatus, and the lack of zymogen granules within the cell. Unlike acinar cells, centroacinar cells contain carbonic anhydrase, which catalyzes the generation of HCO_3- from CO2.

Links:
https://www.kenhub.com/en/library/anatomy/hepatocytes
https://www.kenhub.com/en/library/anatomy/liver-histology
https://www.britannica.com/science/islets-of-Langerhans
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5867580/
https://www.sciencedirect.com/topics/medicine-and-dentistry/centroacinar-cell
https://histology.medicine.umich.edu/resources/pancreas

TESTS

1. On histological preparation **parenchyma of organ it is submitted by lobes which have the 6-angular prisms shape** and consist from trabeculas between sinusoidal capillaries which radiality converge to the central vein. What anatomic organ has the given morphological structure?
Liver
Thymus
Pancreas
Spleen
Lymph node

2. There is **large number of carbohydrates in the human diet**. What structures are detected while **in the cytoplasm of hepatocytes**?
Glycogen granules
Droplets of fat.
One big fat drop.
Increase the number of free ribosomes
The inclusion of lipofuscin.

3. A viral infection has damaged **cells that form walls of bile capillaries**. This stimulated conditions for inflow of **bile into the blood of sinusoidal capillaries**. What cells are damaged?
Hepatocytes

Kupffer's cells
Ito cells
Pit-cells
Endotheliocytes

4. During proliferation of connective tissue **in parenchyma of the liver** (fibrosis) due to chronic diseases there **is disruption of blood circulation in classic liver lobule.** What is the direction of blood flow in these structures?
From the periphery to the center
From the center to the periphery
Around lobule
From the top to the bottom
From the bottom to the top

5. Examination of 28-year-old patient with **hepatocerebral degeneration revealed an impairment of ceruloplasmin synthesis.** This defect is associated with the following organelles:
Granular endoplasmic reticulum
Smooth endoplasmic reticulum
Mitochondria
Lysosomes
Golgi complex

6. An electron micrograph of internally **lobed liver sinusoid represented cells, which can be seen in the cytoplasm granules with a seal like fruit pit.** We know that this is a natural killer cell. Which cell is represented.
Pit-cell
Hepatocytes
Endothelial cells of sinusoid
Kupfer cells
Fat-storing cell

7. In the patient from therapeutic department with severe **liver pathology revealed violations of coagulation. What is the function of the liver can be affected in this case**?
Protein synthesis
Detoxication
Endocrine
Protective
Bile formation

8. An examination of the patient revealed **abnormalities of the liver**. Which **embryonic germ layers have been damaged**?
Endoderm middle sections of primary colon
Endoderm posterior wall
Foregut endoderm
Mesonephritic duct
Hindgut endoderm

9. As a result of stab wounds in the **liver was damaged the hepatic artery, but the liver lobule blood continued to flow.** Which vessel provided blood flow in lobules?
Interlobular vein
Interlobular artery
Portal vein
Sublobular vein
Hepatic vein

10. In histological slide of **parenchyma of the organ slices is presented, the shape is hexagonal prisms** and consist of **anastomosing plates between which are sinusoidal capillaries that converge radially to the central vein**. What is the anatomical organ has given morphological structure?
Liver
Pancreas
Thymus

Spleen
Lymph node

11. During carbohydrate over-feeding of the animals **in the cells of the liver we can find histologically a large amount of glycogen granules.** What group of cell structures includes glycogen?
Trophic inclusion
Secretory inclusion
Excretory inclusion
Pigment inclusion
Organelles with special functions

12. As a result of **hepatotrophic poisons in hepatocytes was destroyed granular EPR**. Synthesis of which components will be change in the epithelium of the liver?
Albumin and fibrinogen
Phospholipids
Glycogen
Cholesterol
Vitamins

13. Damage of junctions between **liver hepatocytes which causes pathological processes as a result of it bile gets into bloodstream, causes jaundice.** Disorder of what type of intercellular junction may explain this appearance?
Tight (zonular occludentes)
Simple contact
Zonular adherents
Desmosomes
Gap junctions

14. A **large number of glycogen is detected in the cytoplasm of a hepatocyte in a specimen**. What process in the body causes this appearance?

Increased blood sugar
Reduced blood sugar
Increased absorption of lipids in the intestine
Reduced absorption of lipids in the intestine
Increased absorption of proteins in the intestine

15. A patient with signs of **jaundice** is admitted into the surgery department. **Bile from the bile capillary does not enter the bloodstream in normal circumstances.** What ultrastructural feature of hepatocyte structure contributes to this?
Presence of zonula occludentes between hepatocytes
Their polygonal shape
Presence of hepatocyte biliary surface
The absence of bile capillary wall
Presence of microvilli on the surface of the capillary

16. A **polygonal cell with a bright big nucleus and big nucleolus is found in microscopic research of a liver lobe**. It has many well developed organelles and inclusions in it's cytoplasm. What are these cells?
Hepatocytes
Endothelial cells
Stellate macrophage
Pit-cell
Ito-cell

17. In a specimen of parenchymal organ we can make out unclearly distinct **hexagonal shaped segments, in the centre of which lies a vein and in interlobular tissue are the triads (artery, vein, and excretory ducts).** What organ is this?
Liver
Pancreas
Thymus
Spleen
Thyroid gland

18. The walls of **bile capillaries are damaged as a result of a viral infection. This created conditions for flow of bile into the blood of the sinusoidal capillaries.** What cells were damaged?
Hepatocytes
Fat-storing cells
Ito-cells
Pit-cells
Endothelial cells of sinusoid

19. The patient since **14 years old has diabetes**. What endocrine cells of **pancreatic islands** don't function?
B – cells
D - cells
A - cells
D1-cells
PP - cells

20. In patients after **acute pancreatitis** is determined massive damage of **acinar cells**. By which **cells will go their recovery**?
Intercalated duct cells
Cells of islets of Langerhans
Cells of interlobular duct
Cells of gland's stroma
Endothelium of blood vessels

21. Endocrinologist diagnosed in patient disorders of the **endocrine function of the pancreas, resulting descending of the hormone glucagon in the blood.** The function of this gland cells broken in this case?
A-cells of the islets of Langerhans
B-cells in the islets of Langerhans
D-cells of islets of Langerhans

D1-cells of islets of Langerhans
PP-cells of islets Lanhenhans

22. A ptient has **disturbed digestion of proteins, fats and carbohydrates**. It is most licely to be caused by reduced secretion of the following digestive juice:
Pancreatic
Saliva
Gastric
Bile
Intestinal

23. A 50 years old patient complains with **increased appetite, thirst, decreased body weight, weakness and fatigue.** During laboratory examination revealed **increase the amount of sugar in the blood**. Which cells dysfunctions are associated with the development of this disease?
B cells
A -cell
Thyrocytes
Pankreatocytes
Lipotropocytes

24. In histological slide were studied **exocrine portion of the pancreas**. In the cells of **the exocrine parenchyma contained secretory granules with enzymes.** How do they come (these enzymes) to the digestive tract?
Through duct system
Through the bloodstream
Fall into the lymph
Axonic transport
Dendritic transport

25. During the study of **pancreatic cells plasmolemma** after exposure to drugs offenses were discovered in the structure of the **glycocalyx**. What are the chemical components of the glycocalyx is composed of cells of the pancreas?
Oligosaccharides
Proteins
Lipids
Mineral salts
Water

26. In the histological slide of the **pancreas** we can find a **group of cells**. Some of them are **centrally located and has basophilic secretory granules.** Their **secret regulates carbohydrate metabolism**. What kind of cells they are?
B cells
PP cells
A cells
Adipocytes
D cells

27. A high concentration of **insulin is revealed** in the blood of a 48-year old woman. The activity of which **pancreatic cells causes this?**
B-cells
A-cells
D
D1
PP

28. In a preparation of **a gland** we distinguish **acini, which consist of 8-12 secretory cells with a cranial shape, has a light nucleus and 1-2 nucleoli**.The basal part of the cell is stained basophysically and the apical part contains oxyphyllic granules, **myoepitheliocytes are absent**. What is this gland?
Pancreas
Parotid glands

Submandibular salivary gland
Breast
Oil bag

29. **Crypts of the small intestine** are composed of all the following **except**:
Kupfer's cells
Goblet cells
Panet's cells
Intestinal epithelial cells
Columnar epithelial cells

30. A 55-year old patient visits an endcrinologist about the violation of **endocrine pancreatic function**, manifested by a **decrease of glucagon hormone in the blood**. The function of which cells is damaged?
A-cells
B-cells
D-cells
D1-cells
PP

Links:
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https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

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ALL SPECIMENS HAVE BEEN TAKEN FROM THE OWN HISTOLOGY, CYTOLOGY AND EMBRYOLOGY DATABASE.

Links:

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http://www.slideshare.net

Topic 1. General structure of digestive system organs. Face development and organs of oral cavity.

Fig. 1 - https://teachmeanatomy.info/the-basics/embryology/head-neck/face-palate/

Fig. 2 - https://pocketdentistry.com/4-development-of-the-face-and-palate/
Fig. 3 - https://teachmeanatomy.info/the-basics/embryology/head-neck/face-palate/
Tab. 1 - https://youtu.be/p8eeITuhFQg , https://pocketdentistry.com/4-development-of-the-face-and-palate/
Vocabulary:
https://histology.siu.edu/erg/GI014b.htm
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
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Topic 2. Characteristic of masticatory oral mucosa. Gums. Hard palate.
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 3. Characteristic of lining oral mucosa. Cheek. Lip. Soft palate.
Tab. 1 - https://www.osmosis.org/learn/Anatomy_of_the_oral_cavity_(dentistry)
Vocabulary:
https://histology.medicine.umich.edu/resources/oral-cavity
https://digitalhistology.org/organs-systems/digestive/oral-cavity/lip
https://www.sciencedirect.com/topics/medicine-and-dentistry/buccal-mucosa
https://openoregon.pressbooks.pub/histologyandembryology/chapter/chapter-3-histology-of-the-oral-mucosa/
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf

https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 4. Characteristic of specialized oral mucosa. Development and structure of tongue.
Vocabulary:
https://histology.medicine.umich.edu/resources/oral-cavity
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 5. Large and small salivary glands.
Vocabulary:
https://entokey.com/salivary-gland-histology/
https://www.sciencedirect.com/science/article/pii/B0123868602006286
https://www.intechopen.com/chapters/63843
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https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 6. Structure of baby and permanent teeth.
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
https://www.testcentr.org.ua/banks/stomat/k1-stom-f-eng.pdf
https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 7. Development of baby and parmanent teeth.
Vocabulary:
https://www.sciencedirect.com/topics/medicine-and-dentistry/stratum-intermedium
https://www.sciencedirect.com/book/9780323608268/pediatric-dentistry
Tests
https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
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Topic 8. Periodontium. Eruption and changing of teeth.
Fig. 1 - https://dentistryfortheentirefamily.com/difference-between-baby-adult-teeth/
Vocabulary:
https://www.ncbi.nlm.nih.gov/books/NBK570604/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5390338/
http://www.uky.edu/~brmacp/oralhist/module8/lab/imgshtml/image15.htm
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https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
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https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
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Topic 9. Esophagus. Stomach.
Vocabulary:
https://www.sciencedirect.com/topics/immunology-and-microbiology/esophageal-gland
https://www.kenhub.com/en/library/anatomy/stomach-histology
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https://www.testcentr.org.ua/en/exams/all-about-the-exams/about-medical-licensing-exams
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https://histology.pdmu.edu.ua/resources/new/two/krok-krok

Topic 10. Small and large intestine.
Vocabulary:
https://www.britannica.com/science/villus
https://www.nature.com/articles/s41385-018-0039-y
https://www.kenhub.com/en/library/anatomy/histology-of-the-lower-digestive-tract
https://www.histology.leeds.ac.uk/lymphoid/MALT.php
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3281971/
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Topic 11. Liver and pancreas.
Vocabulary:
https://www.kenhub.com/en/library/anatomy/hepatocytes
https://www.kenhub.com/en/library/anatomy/liver-histology
https://www.britannica.com/science/islets-of-Langerhans
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5867580/
https://www.sciencedirect.com/topics/medicine-and-dentistry/centroacinar-cell
https://histology.medicine.umich.edu/resources/pancreas
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https://www.testcentr.org.ua/banks/med/k1-med-f-eng.pdf
https://histology.pdmu.edu.ua/resources/new/two/krok-krok