

## 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. <b>Duodenum</b>	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 ( <b>Brunner glands</b> ). 6). Areas which are attached to other organs are covered by adventitia. 7) ) <b>Functions:</b> allow bile and pancreatic juice to enter small intestine; release mucus; regulate rate of emptying of stomach; absorption.
2. <b>Jejunum</b>	1). It makes up about two fifths of the rest of the small intestine.

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

### Structure and functions of the SMALL INTESTINE GLANDS

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

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

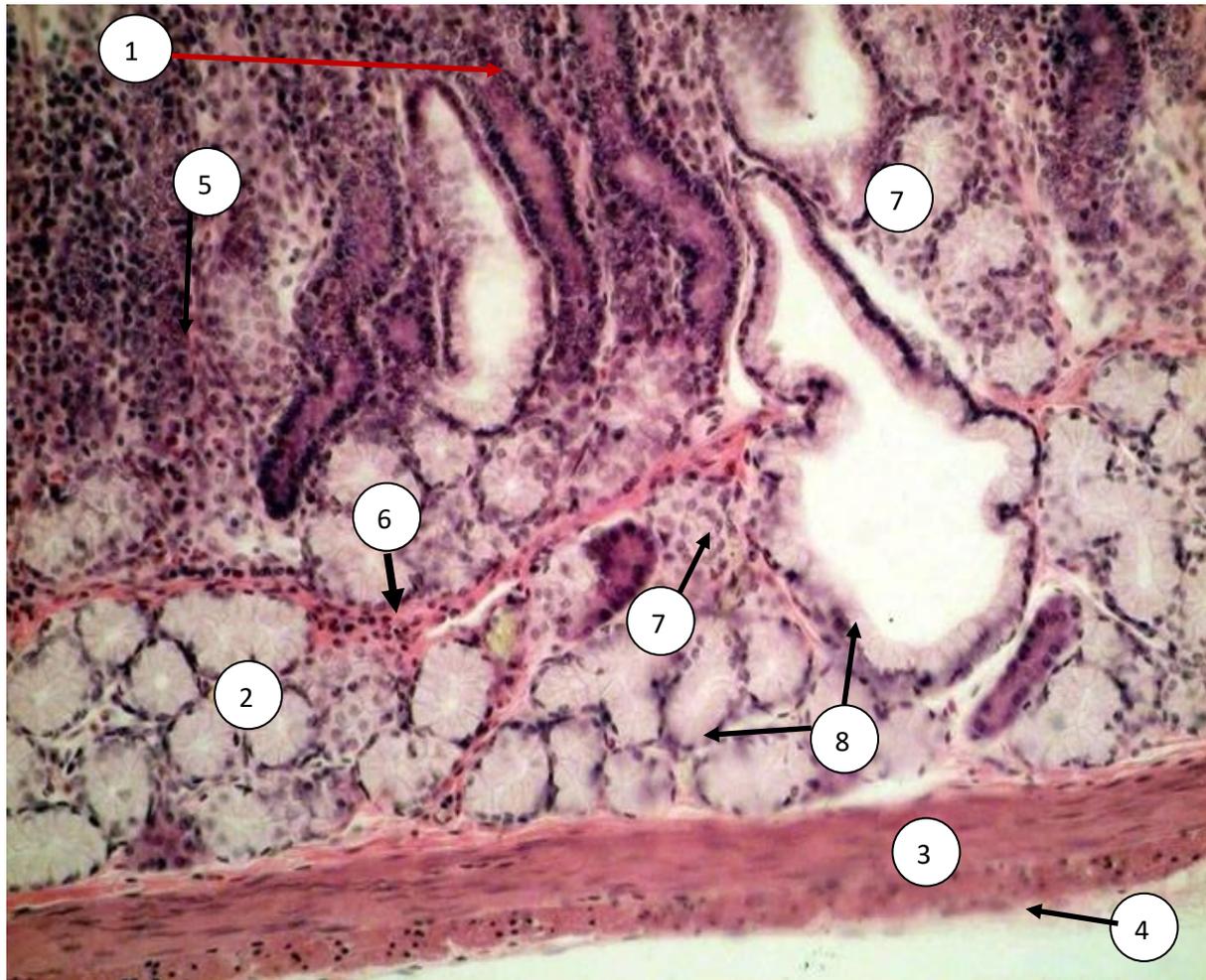
				mitochondria. 3) secretory granules are located at the base of cell. 4) <b>Function</b> – secret <b>somatostatin</b> wich inhibits gastrin releasing
			Others cells	<b>Function</b> - secret <b>cholecystokinin (CCK)</b> , <b>secretin</b> , <b>gastric inhibitory polypeptide (GIP)</b> and <b>motilin</b>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

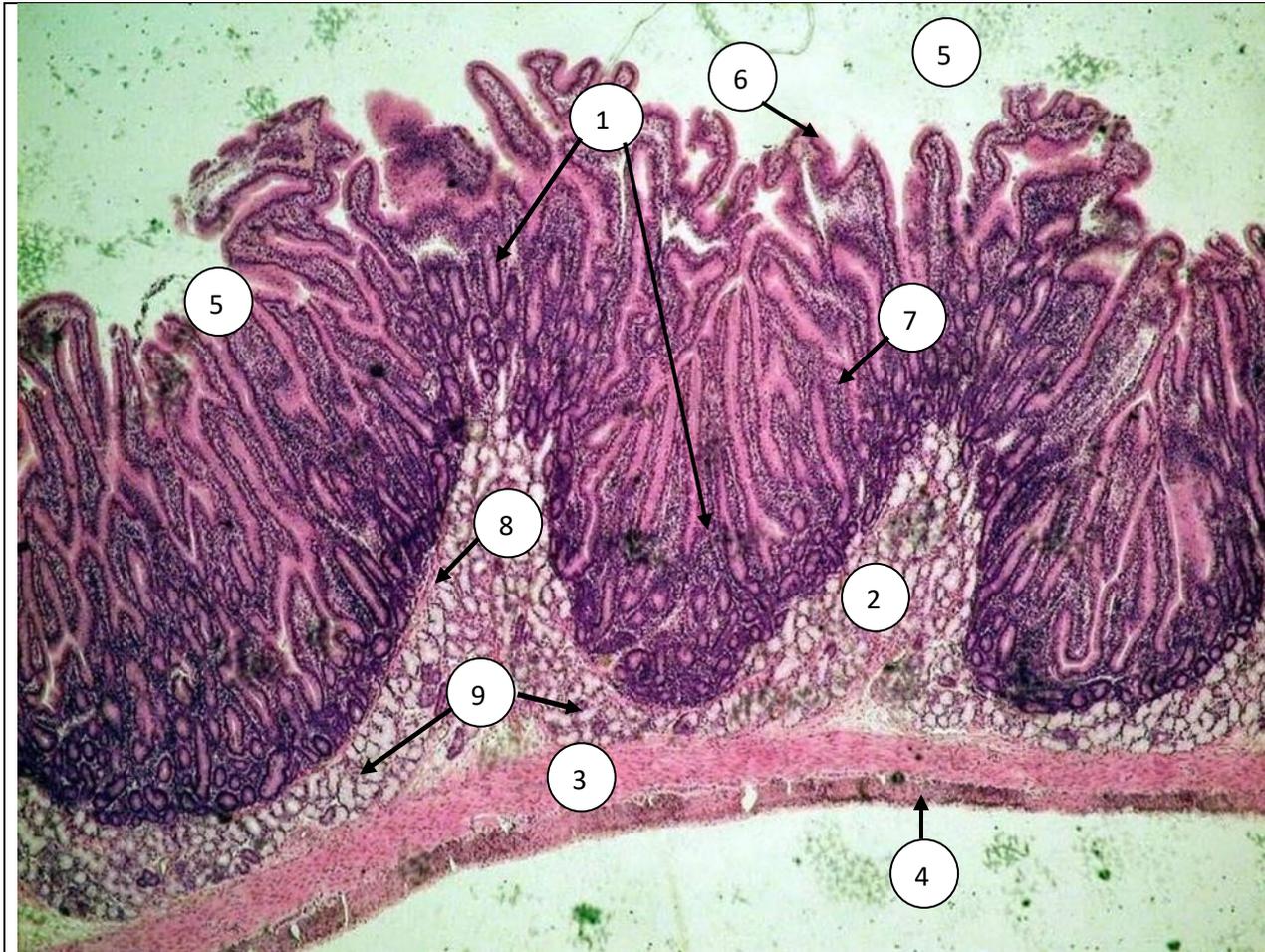
Parts		Structural features		
1.	<b>Cecum with its vermiform appendix</b>	1) There is ileocecal valve between ileum and cecum. 2) <b>Appendix</b> is very short, small-diameter blind end tube, 10 cm in length. It includes of lymphatic nodules in the lamina propria that extend into the submucosa. 3) <b>Functions: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

		<b>Transverse colon</b> <b>Descending colon</b> <b>Sigmoid colon</b>	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) <b>Functions:</b> absorption of water and salts, formation, storage and elimination of feces.
3.	<b>Rectum</b>	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) <b>Functions:</b> store feces; sensory receptors signal brain of the need to evacuate.		
4.	<b>Anal canal</b>	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 <b>anorectal junction</b> (dentate line – place of change from simple columnar epithelium to stratified squamous epithelium). 4) It is divided into <b>three zones</b> (according to the the epithelium): <b>1. colorectal zone</b> (upper third lined by simple columnar epithelium), <b>2. anal transitional zone</b> (middle third lined by stratified columnar epithelium), <b>3. squamous zone</b> (lower third lined by stratified squamous). 5) It includes mucus branched, straight tubular glands ( <b>anal glands</b> ) and in the skin surrounding the <b>anal canal (large apocrine glands - circumanal glands)</b> . 6) <b>Functions:</b> internal sphincter and external sphincter (skeletal muscle); relax to release feces.		



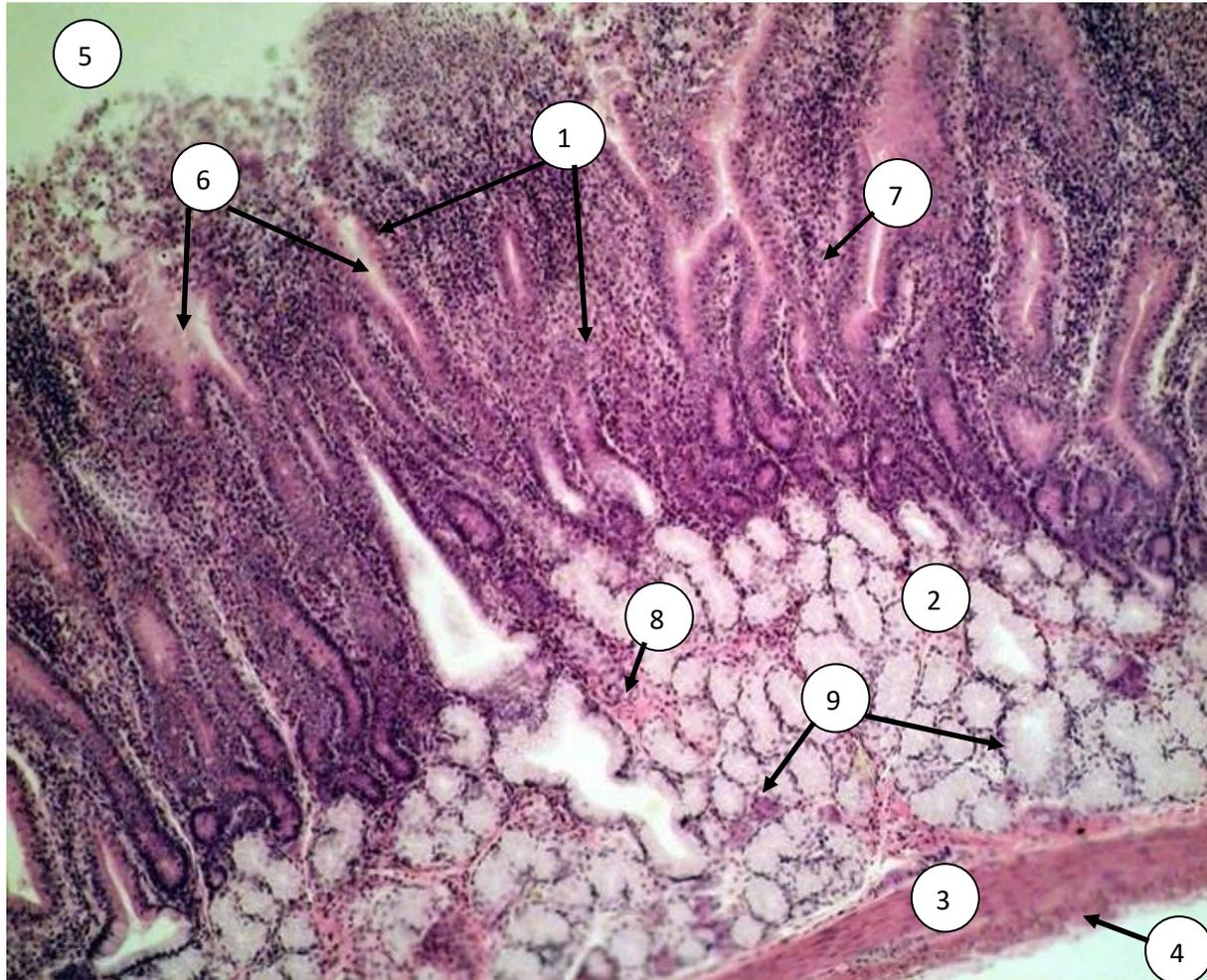
**Duodenum**  
**Magnification X 100.**

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).



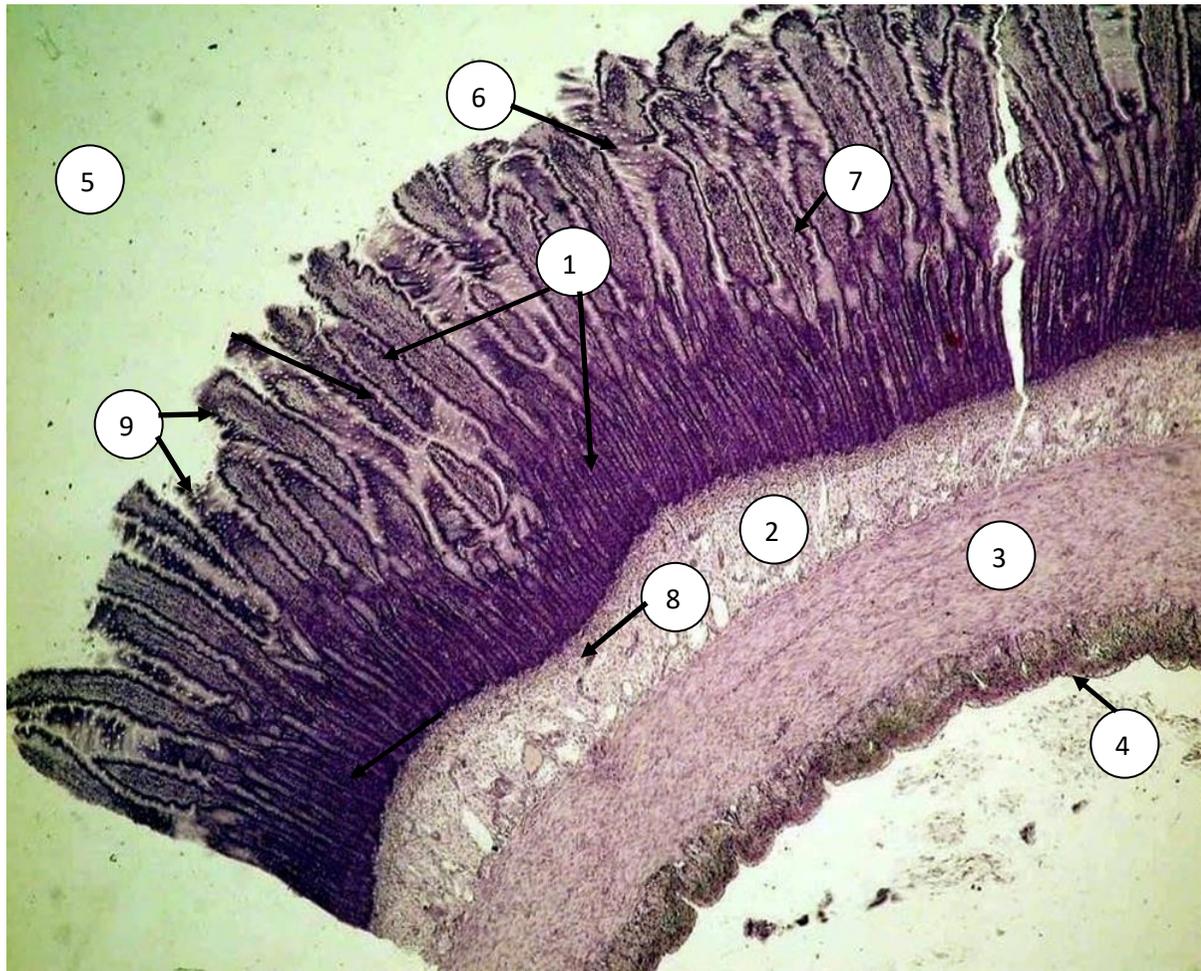
**Duodenum**  
**Magnification X 40.**

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).



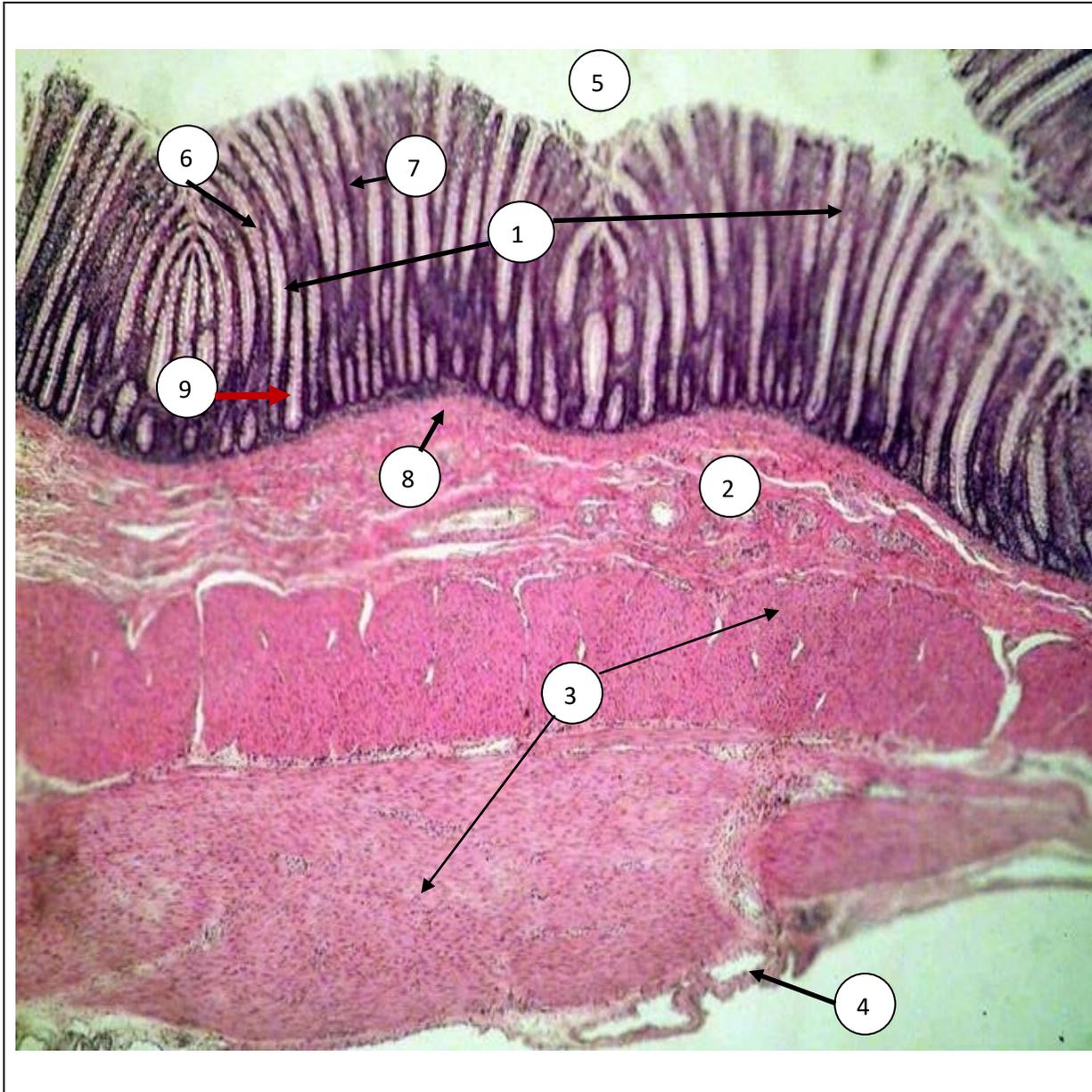
**Duodenum**  
**Magnification X 100.**

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).



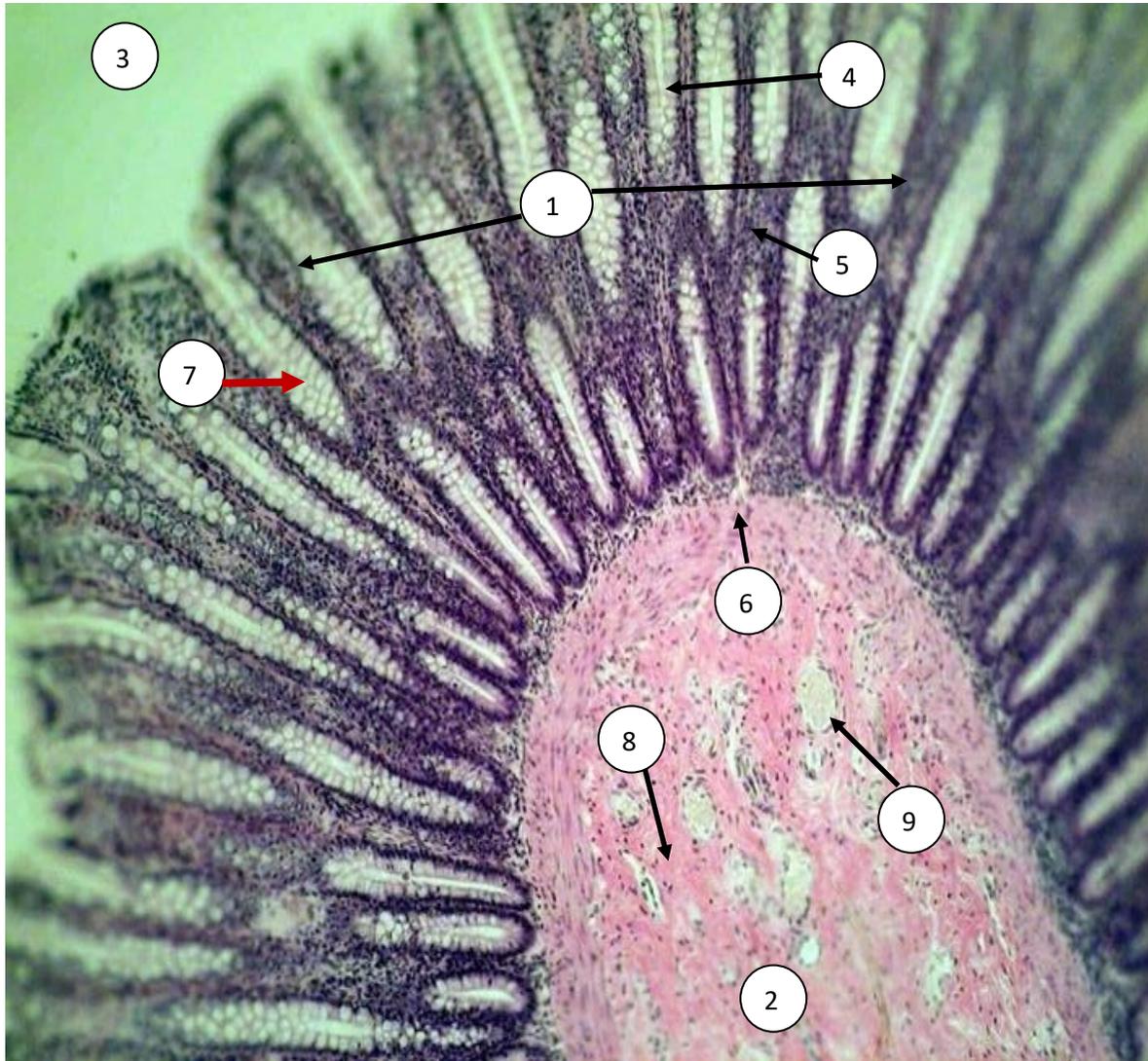
**Jejunum**  
**Magnification X 100.**

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), except 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** – eosinophilic, 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

Dipeptidase

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

Columnar 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 exocryocytes 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**

Folds, 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 keratinized**

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**

Jejunum

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 topography**. 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

Stratified 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>