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ИНСТИТУТ ФУНДАМЕНТАЛЬНОЙ МЕДИЦИНЫ И БИОЛОГИИ
Кафедра морфологии и общей патологии

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SPLANCHNOLOGY
Part I. Digestive system
(Пищеварительная система)

Учебно-методическое пособие на английском языке

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Учебно-методическое пособие адресовано студентам первого курса медицинских специальностей, проходящим обучение на английском языке, для самостоятельного изучения нормальной анатомии человека. Пособие посвящено Спланхнологии (науке о внутренних органах). В данной первой части пособия рассматривается анатомическое строение и функции системы в целом и отдельных органов, таких как полость рта, пищевод, желудок, тонкий и толстый кишечник, железы пищеварительной системы, а также расположение органов в брюшной полости и их взаимоотношения с брюшиной. Учебно-методическое пособие содержит в себе необходимые термины и объём информации, достаточный для сдачи модуля по данному разделу.

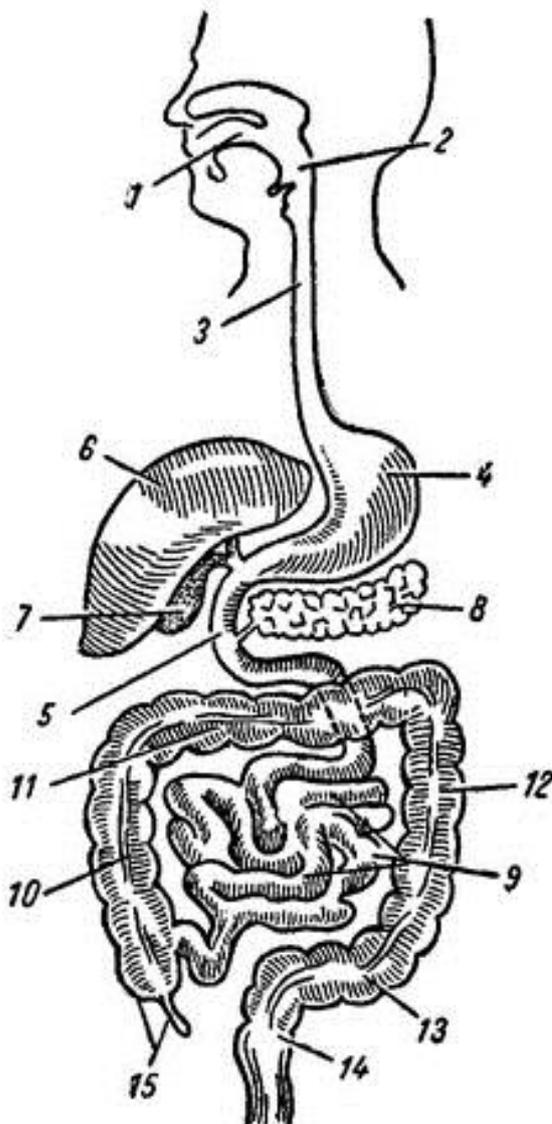
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THE ALIMENTARY SYSTEM (*systema alimentarium/digestorium*)

The **alimentary system** is a complex of organs with the function of mechanical and chemical treatment of food, absorption of the treated nutrients, and excretion of undigested remnants.

- Organs of digestive system form a long muscular tube which continuous lumen opens at both ends to the exterior. The organs include (Fig. 1) the oral cavity, oral pharynx, esophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine (cecum, appendix, ascending, transverse, descending and sigmoid colon, rectum, anal canal).



**Fig. 1. General structure of
digestive system**

1. Oral cavity
2. Pharynx
3. Esophagus
4. Stomach
5. Duodenum
6. Liver
7. Gall bladder
8. Pancreas
9. Small intestine
10. Ascending colon
11. Transverse colon
12. Descending colon
13. Sigmoid colon
14. Rectum
15. Cecum and appendix

- Each organs wall has the same structure and consists of four layers: mucosa, submucosa, muscular layer and serosa or adventitia (Fig. 2).

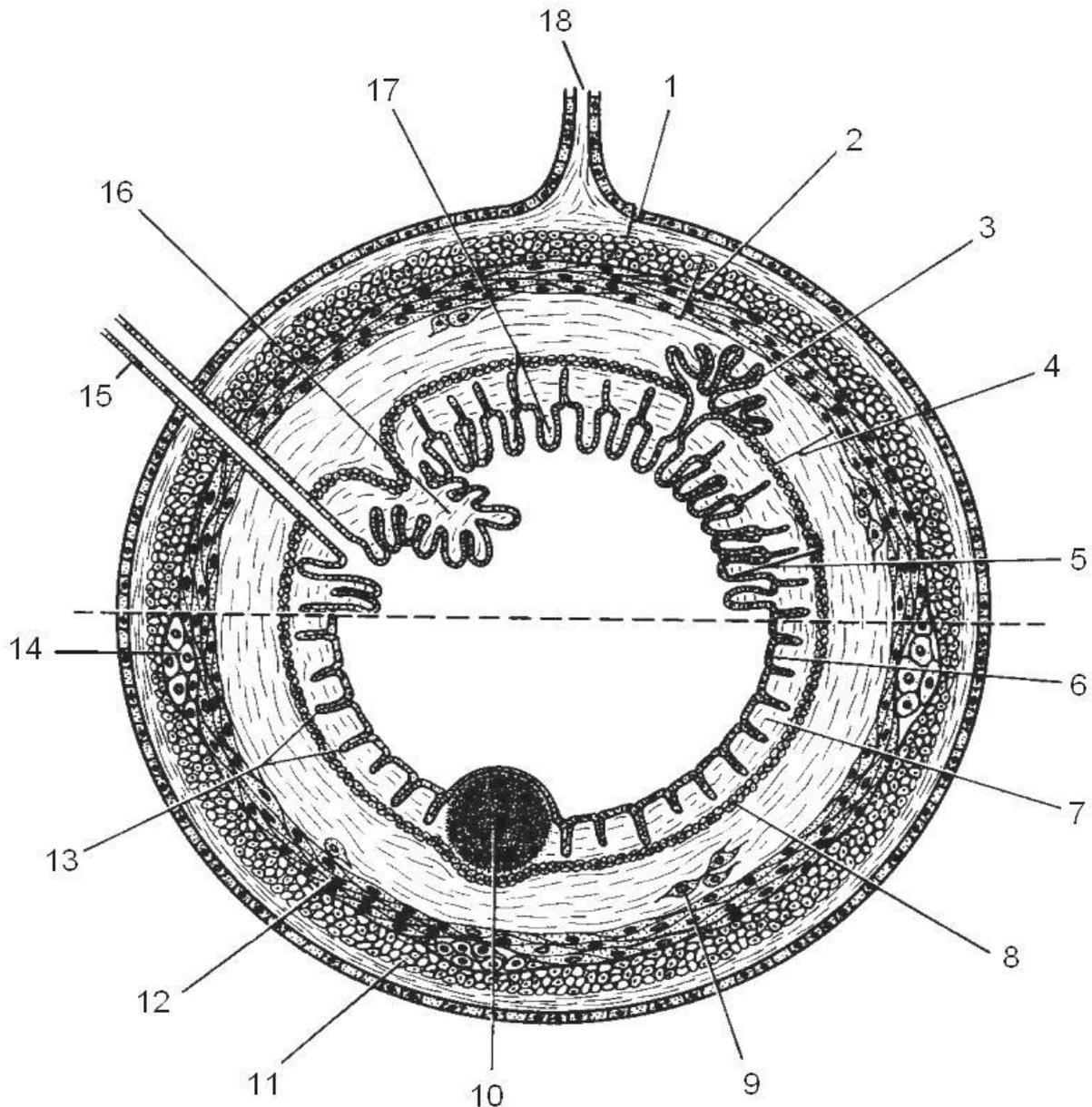


Fig. 2. The structure of the intestines wall (Bloom W., Fawcett D.W. A Textbook of Histology, 10th ed. Philadelphia, WB Saunders, 1975, p. 599)

1. Subserosa.
2. Muscularis externa.
3. Glands in subserosae.
4. Submucosa.
5. Mucosa.
6. Epithelium.
7. Lamina propria.
8. Muscularis submucosae.
9. Submucosal plexus (Meissner).
10. Lymphoid nodule.
11. Longitudinal layer of muscular layer.
12. Circular layer of muscular layer.
13. Glands in the mucosa.
14. Intermuscular plexus (Auerbach).
15. The duct of digestive gland.
16. Fold.
17. Villi.
18. Mesentery.

- **Mucosa**
 - Is inside of the tube
 - Is lined by epithelium
 - Has glands and villi
 - Has lamina propria with vessels, nerves, and lymphoid follicles
 - Has muscularis mucosae
- **Submucosa**
 - Is under the mucous
 - Has vessels and nerves
 - Attaches the mucous
 - Has glands
 - Forms folds
- **Muscular layer**
 - Consists of smooth muscle cells
 - Usually has 2 layers:
 - internal – circular (makes sphincters),
 - external – longitudinal
 - Has vessels and nerves are in between these layers
 - Provides muscle tone and peristalsis.
- **Serosa** is thin external layer of connective tissue covered by simple squamous epithelium.
- **Adventitia** is external layer of connective tissue without epithelial cells.

THE ORAL CAVITY

(cavitas oris)

The oral cavity is divided into an outer portion (the oral vestibule), and an inner part (the oral cavity proper).

Oral vestibule (**vestibulum oris**)

The oral vestibule is the space bounded by the lips and cheeks externally and by the teeth and gums internally. The vestibule communicates with the exterior through *the oral fissure (rima oris)*, that is bounded by the lips.

- *The lips (labia oris)* are fibers of the orbicularis oris muscle covered on the outside by the skin and lined inside with mucous membrane.
 - At the angles of the oral fissure the lips come together by *the labial commissure (commissura labiorum)*.
 - *The frenulum of upper (lower) lip (frenulum labii superioris (inferioris))* is the fold of mucous membrane extending from the lips to the gums on the midline.
- *The cheeks (buccae)* are the fibers of the buccinator muscle covered on the outside by the skin and lined inside with mucous membrane.
 - *The buccal fat pad (corpus adiposum buccae)* lies between the skin of the cheek and the buccinator muscle. It is developed much better in infants because it helps to decrease the pressure during sucking.
 - *The papilla of parotid duct (papilla ductus parotidei)* opens on the inner surface of the cheek opposite the crown of the upper second molar tooth.

Oral cavity proper (**cavitas oris propria**)

- The oral cavity proper is bounded anterolaterally by the teeth, superiorly by the hard palate and the anterior part of the soft palate, inferiorly by the mylohyoid muscles, which form the floor of the oral cavity.
- Posteriorly the cavity communicates with the pharynx through *the isthmus of fauces (isthmus faucium)*. The isthmus is bounded on the sides by the palatoglossal arches, above by the soft palate, and below by the back of the tongue.
- The oral cavity is occupied by the tongue.

THE PALATE (**palatum**)

The palate consists of two parts – the hard palate and the soft palate.

- **The hard palate (palatum durum)** occupies anterior two thirds of the palate and it has a bony foundation (bony palate).
 - **The palatine raphe (raphe palati)** is seen on the midline of the palate. At the anterior end of the raphe is a row of **the transverse palatine folds (plicae palatinae transversae)**.
- **The soft palate (palatum molle or velum palatinum)** occupies posterior third of the palate and has a muscular structure with a fibrous plate – **the palatine aponeurosis (aponeurosis palatina)**. It is covered by the mucous membrane.
 - The anterior border of the soft palate is attached to the posterior border of the hard palate, while its posterior part extends freely downwards and has a tongue-like projection in the midline – **the uvula (uvula palatine)**.
 - Laterally the soft palate is continuous with two arches.
 - **The palatoglossal arch (arcus palatoglossus)** passes anteriorly on the sides of the tongue.
 - **The palatopharyngeal arch (arcus palatopharyngeus)** passes posteriorly to the lateral wall of the pharynx.
 - **The tonsillar fossa (fossa tonsillaris)** is a depression between the anterior and posterior arches which lodges **the palatine tonsil (tonsilla palatina)**. Each palatine tonsil is an oval-shaped mass of lymphoid tissue. The medial surface of the tonsil has an irregular tonsillar crypts and pits. The internal carotid artery passes at a distance about 1 cm from the tonsil.
- The soft palate is composed of the following **muscles** (Fig. 3):
 - **Palatoglossus muscle (m. palatoglossus)** passes from the inferior surface of the soft palate within the palatoglossal arch to the lateral side of the

tongue, where it continuous with the transverse muscle of the tongue. It lowers the soft palate.

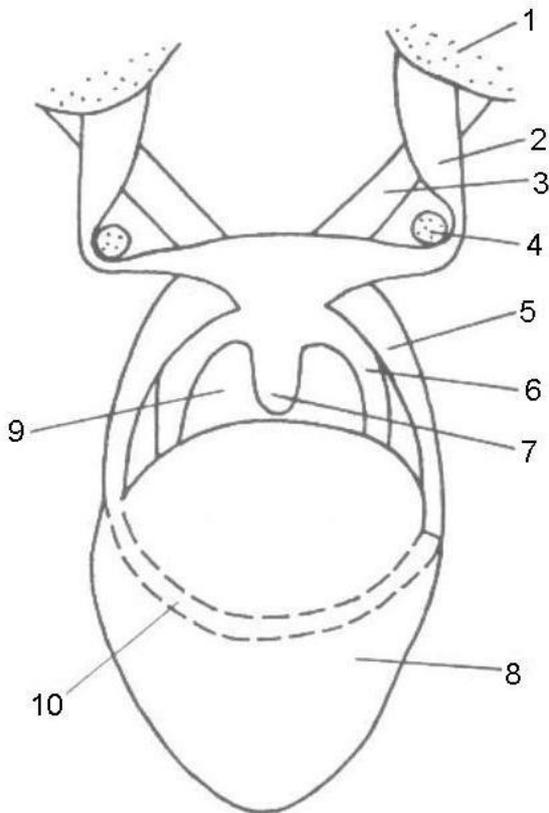


Fig. 3. Soft palate

1. Inferior surface of the petrous part of the temporal bone
2. Tensor veli palatini
3. Levator veli palatini
4. Pterygoid hamulus
5. Palatoglossal arch (muscle)
6. Palatopharyngeal arch (muscle)
7. Uvula
8. Tongue
9. Fauces
10. Transverse muscle

- ***Palatopharyngeus muscle (m. palatopharyngeus)*** passes from the palatine aponeurosis and from pterygoid hamulus within the palatopharyngeal arch to the lateral side of the pharyngeal wall. It pulls the soft palate downwards and the pharynx upwards; the pharynx becomes shorter and presses the soft palate to the posterior pharyngeal wall.
- ***Levator veli palatini muscle (m. levator veli palatini)*** passes from the inferior surface of the petrous part of the temporal bone and the cartilaginous part of the auditory tube to the palatine aponeurosis. It raises the soft palate.
- ***Tensor veli palatine muscle (m. tensor veli palatini)*** passes from the spine of the sphenoid bone and the membranous part of the auditory tube, its tendon curves around the pterygoid hamulus, turns medially almost at a

right angle, and is inserted into the palatine aponeurosis. It tenses the soft palate in the transverse direction.

- *Muscle of the uvulae* (**m. uvulae**) passes from the posterior nasal spine and the palatine aponeurosis to the uvula. It shortens the uvula.

THE GUM (gingiva)

The gums are the soft tissues which envelop the alveolar processes of the upper and lower jaws and surround the necks of the teeth. The gums are composed of dense fibrous tissue covered by stratified squamous epithelium.

THE TEETH (dentes)

- The teeth form a part of masticatory apparatus and are fixed to the jaws.
- Each tooth has three parts (Fig. 4).
 - *The crown* (**corona dentis**) is projecting above the gum. Five surfaces are distinguished in each tooth crown:
 - *The occlusal surface* (**facies occlusalis**) for occlusion with the teeth of the opposite row.
 - *The vestibular surface* (**facies vestibularis**) facing the oral vestibule.
 - *The lingual surface* (**facies lingualis**) facing the oral cavity and the tongue.
 - *Two contact surfaces* (**facies contacta**) coming in contact with the surfaces of the adjacent teeth.
 - *The root* (**radix dentis**) is embedded in the jaw beneath the gum. It terminates as *the root apex* (**apex radialis dentis**). A small opening – *the apical foramen* (**foramen apicis dentis**) is seen on the root apex. Vessels and nerves enter the tooth through this opening.
 - *The neck* (**cervix dentis**) is between the crown and the root, surrounded by the gum.

- Structurally, each tooth is composed of:
 - **The dental pulp (pulpa dentis)** in the center of the tooth, within **the pulp cavity (cavitas dentis)**. **The pulp cavity of crown (cavitas coronae)** is the widest part of the cavity. **The root canal (canalis radialis dentis)** is the narrowed part of the cavity; it opens at the root apex by the apical foramen. The pulp cavity contains vessels, nerves and lymphatics.
 - **The dentine (dentinum)** is surrounding the pulp;
 - **The enamel (enamelum)** is covering the crown;
 - **The cement (cementum)** is covering the root.
- **The periodontium (periodontium)** is connective tissue, which holds the root in its socket.
- **The paradontum** consists of cementum, periodontum, wall of dental alveoles and the gum.

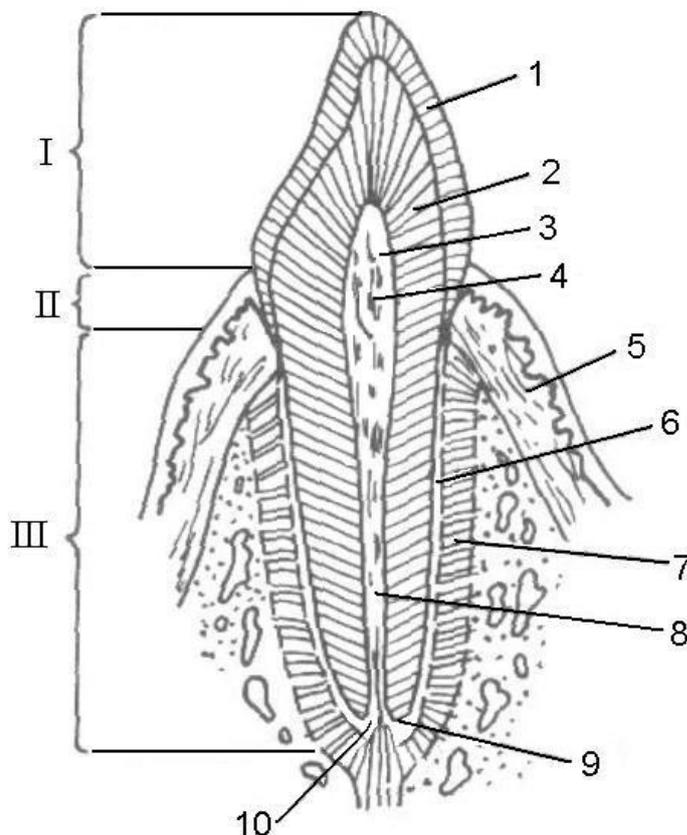


Fig. 4. Tooth

I – Crown
 II – Neck
 III – Root

1. Enamel
2. Dentine
3. Pulp cavity
4. Dental pulp
5. Gum
6. Cement
7. Periodontum
8. Root canal
9. Root apex
10. Apical foramen

- The types of the teeth:
 - **The incisor tooth (dens incisivus)** is cutting one, with chisel-like crown;

- *The canine tooth* (**dens caninus**) is holding and tearing tooth, with conical and rugged crown;
- *The premolar tooth* (**dens premolarus**) is crushing one with two cusps;
- *The molar tooth* (**dens molarus**) is grinding tooth, with square crown, bearing 4-5 cusps on its crown.
- The incisors, canines and premolars have single roots (exception – first upper premolar which has a bifid root).
- The upper molars have 3 roots: two lateral and one medial.
- The lower molars have only two roots: anterior and posterior.
- The teeth are replaced only once. The teeth of the first set are known as milk, or *deciduous teeth* (**dentes decidui**), and the second set – *permanent teeth* (**dentes permanentes**).
- The deciduous teeth are 20 in number. In each half of each jaw there are two incisors, one canine, and two molars. These teeth begin to erupt at the age of six months. By the end of the second year of life or soon after all deciduous teeth are erupted.
- The permanent teeth are 32 in number. In each half of each jaw there are two incisors, one canine, two premolars and three molars. These teeth begin to erupt at about six years. All of them are usually present by the end of the 12th year. The third molars (wisdom teeth) can erupt at 17-25 years or even later.

THE TONGUE (lingua)

The tongue is a muscular organ. It is associated with the functions of taste, speech, mastication and deglutition. Three parts are distinguished in the tongue – the root, the body and the apex.

- *The apex of tongue* (**apex linguae**) forms its anterior free end.
- *The root of tongue* (**radix linguae**) is attached to the mandible above, and to the hyoid bone below.

- **The body of tongue (corpus linguae)** has a curved upper surface called **the dorsum of tongue (dorsum linguae)** and **the inferior surface (facies inferior linquae)**.
- **The margins of tongue (margo linguae)** are between the dorsum and inferior surface of the tongue.
- The dorsum has **the median groove of tongue (sulcus medianus linguae)**, which passes from the apex to the foramen caecum. Within the tongue the groove corresponds to a fibrous **lingual septum (septum linguae)**.

The dorsum of tongue is divided into **anterior** (oral) and **posterior** (pharyngeal) **parts (pars anterior et posterior)** by V-shaped **terminal sulcus of tongue (sulcus terminalis linguae)**. The two limbs of the “V” meet at a median pit, called **the foramen caecum (foramen caecum linguae)**. The foramen is the site from which the thyroid diverticulum grows in the embryo. The oral and pharyngeal parts of the tongue differ in their development.

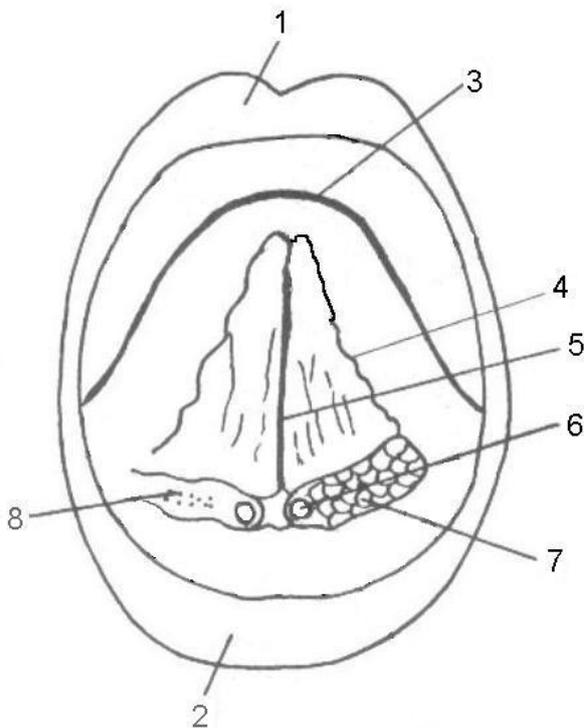


Fig. 5. The inferior surface of the tongue

1. Upper lip
2. Lower lip
3. Apex of tongue
4. Fimbriated fold
5. Frenulum of tongue
6. Sublingual caruncle
7. Sublingual gland (mucous removed)
8. Openings of the sublingual ducts on the sublingual fold

- The anterior part of the dorsum is covered with taste papillae:
 - *The filiform papillae (papillae filiformes)* cover the dorsum in front of the terminal sulcus. They don't contain taste buds.
 - *The fungiform papillae (papillae fungiformes)* are numerous near the tip and margins of the tongue, but some of them are also scattered over the dorsum.
 - *The vallate papillae (papillae vallatae)*, 8-12 of them are situated immediately in front of the terminal sulcus.
 - *The foliate papillae (papillae foliatae)* are located on the margins of the tongue.
- The posterior part has no papillae, but has many *lymphoid nodules (noduli limphoidei)* that constitute *the lingual tonsil (tonsilla lingualis)*.
- *The inferior surface of tongue* (Fig. 5) is covered with *the mucous membrane of tongue (tunica mucosa linguae)*, which forms a median fold called *the frenulum of tongue (frenulum linguae)*. On either side of the frenulum there is a fold called *the fimbriated fold (plica fimbriata)* that is directed forwards and medially towards the tip of the tongue.
- On each side of the frenulum there is a noticeable eminence, *the sublingual caruncle (caruncula sublingualis)*, with the opening of the ducts of the submandibular and sublingual salivary glands.
- *The sublingual fold (plica sublingualis)* stretches on each side of the sublingual caruncle; it is formed by the sublingual salivary gland situated here.
- **The muscles of tongue**
 - Extrinsic muscles connect the tongue to the bones and the palate (Fig. 6):
 - *Genioglossus (m. genioglossus)* passes from the mental spine to the body of the hyoid bone (lower fibres), the root of the tongue (middle fibres) and the apex of the tongue (upper fibres). It moves the tongue forwards and flattens it.

- **Hyoglossus (m. hyoglossus)** passes from the greater horn of the hyoid bone to the margins of the tongue. It pulls the tongue backwards and downwards.
- **Styloglossus (m. styloglossus)** passes from the styloid process to the inferior surface of the tongue. It pulls the tongue upwards and to the back.
- **Palatoglossus (m. palatoglossus)** – see muscles of the soft palate.

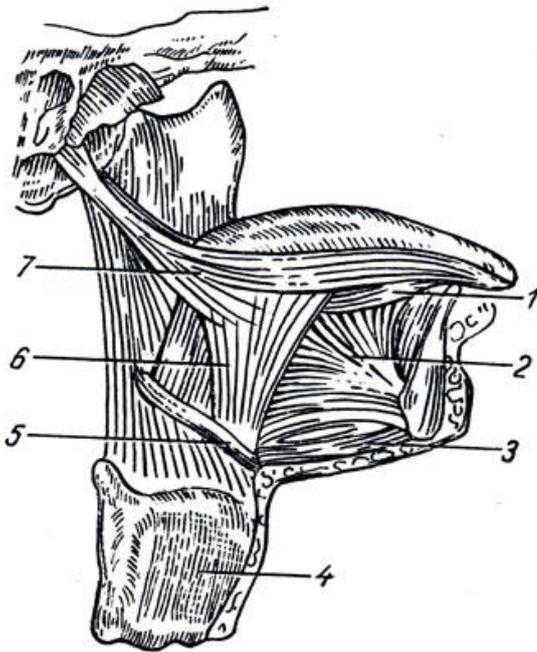


Fig. 6. Extrinsic muscles of the tongue

1. Inferior longitudinal muscle
2. Genioglossus muscle
3. Mylohyoid muscle
4. Thyroid cartilage
5. Hyoid bone
6. Hyoglossus muscle
7. Styloglossus muscle

○ Intrinsic muscles (Fig. 7):

- **Superior longitudinal muscle (m. longitudinalis superior)** lies beneath the mucous membrane. It shortens the tongue and makes its dorsum concave.
- **Inferior longitudinal muscle (m. longitudinalis inferior)** is a narrow band lying close to the inferior surface of the tongue between the genioglossus and the hyoglossus. It shortens the tongue and makes its dorsum convex.
- **Transverse muscle (m. transversus linguae)** extends from the lingual septum to the margins. It makes the tongue narrow and elongated.

- **Vertical muscle (m. verticalis linguae)** is found at the borders of the anterior part of the tongue. It makes the tongue broad and flattened.

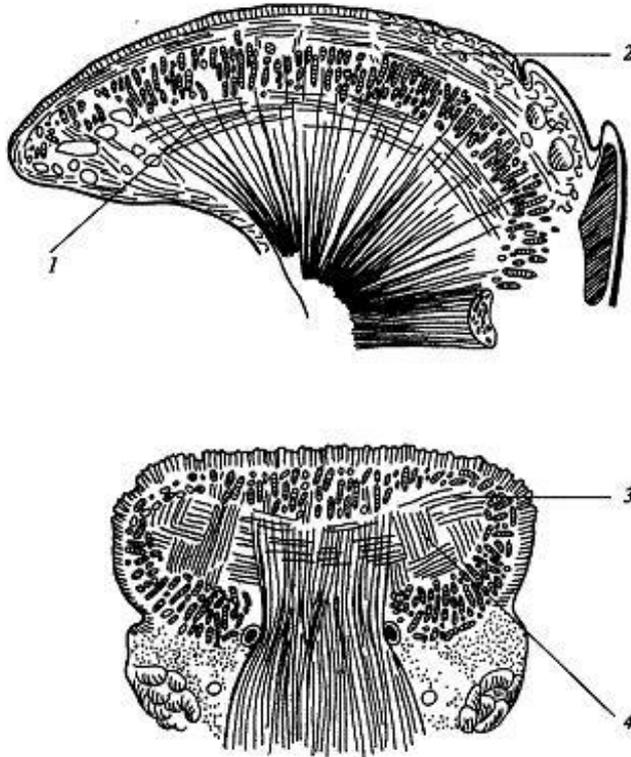


Fig. 7. Intrinsic muscles of the tongue

1. Superior longitudinal muscle
2. Inferior longitudinal muscle
3. Transverse muscle
4. Vertical muscle

GLANDS OF THE MOUTH (glandulae oris)

The ducts of three pairs of major salivary glands open into the oral cavity: the parotid, submandibular and sublingual glands (Fig. 8). Besides these, there are numerous minor glands in the mucous membrane of the mouth. According to the character of the secretion, the glands may be serous, mucous or mixed.

Major salivary glands (glandulae salivariae majores)

- **The parotid gland (glandula parotidea)**
 - It is the largest of the glands.
 - It has a serous secret, which contains amylase.
 - Positioned on the lateral side of the face in front of and a little below the ear it penetrates into the retromandibular fossa. The gland extends upwards almost to the zygomatic arch and downwards to the mandibular angle. The

masseter muscle lies in front of it; at the back it reaches the external acoustic meatus and the anterior border of the sternocleidomastoid muscle.

- The gland is invested in a fascia parotidea.
- ***The parotid duct (ductus parotideus)*** is 5-6 cm long and arises from the anterior border of the gland, passes along the surface of the masseter muscle, curves around its anterior border, and penetrating through the fatty tissue of the cheek pierces the buccinator muscle. It opens by the papilla of parotid duct on the inner surface of the cheek opposite to the crown of the upper second molar tooth.
- ***The submandibular gland (glandula submandibularis)***
 - It has a mixed character.
 - It is situated in the submandibular fossa, emerges under the border of the mandible and is covered here by the skin, the platysma and the fascia. The fascia forms a capsule for this gland.
 - ***The submandibular duct (ductus submandibularis)*** opens on sublingual caruncle together with the so named gland.
- ***The sublingual gland (glandula sublingualis)***
 - It is the mucous gland.
 - It is situated over the mylohyoid muscle on the floor of the oral cavity, and, covered only by the mucous membrane, forms the sublingual fold.
 - ***The major sublingual duct (ductus sublingualis major)*** opens by means of a single opening common to the submandibular and sublingual glands or by its own opening.
 - ***The minor sublingual ducts (ductus sublinguales minores)*** open into oral cavity along the sublingual fold.

Minor salivary glands (glandulae salivariae minores)

According to their location, they are called as follows:

- ***the labial glands (glandulae labiales)***;
- ***the buccal glands (glandulae buccales)***;
- ***the molar glands (glandulae molares)***;

- *the palatine glands (glandulae palatinae);*
- *the lingual glands (glandulae linguales).*

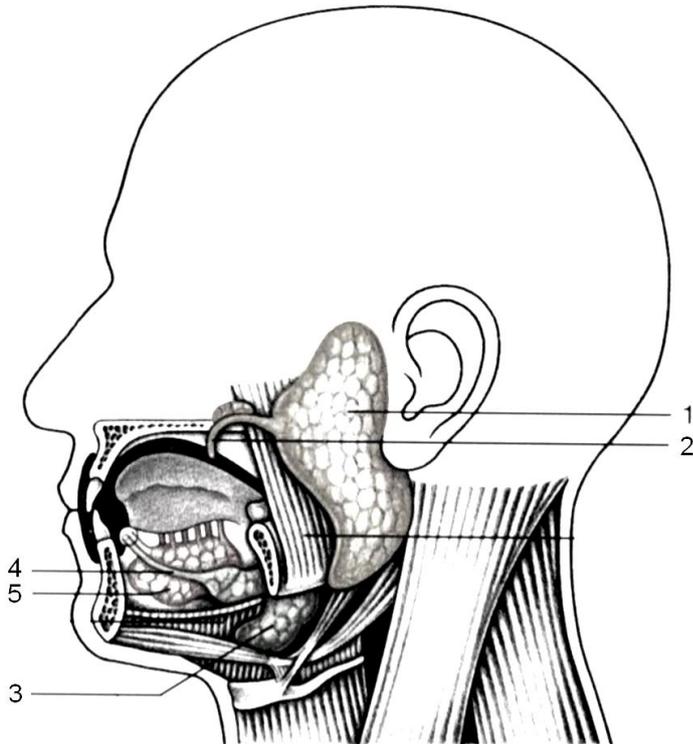


Fig. 8. The salivary glands

1. Parotid gland
2. Parotid duct
3. Submandibular gland
4. Submandibular duct
5. Sublingual gland

THE PHARYNX (pharynx)

The pharynx is a wide muscular tube, situated behind the nose, the mouth and the larynx. The pharynx has three parts – nasopharynx, oropharynx and laryngopharynx (Fig. 9).

Boundaries of the pharynx

- Superiorly – base of the skull, including the posterior part of the body of the sphenoid bone and the basilar part of the occipital bone, in front of the pharyngeal tubercle. The superior wall of the pharynx, which adjoins the base of the skull, is called *the vault of pharynx (fornix pharyngis)*.
- Inferiorly – the pharynx continuous with the esophagus at the level of the 6-7th cervical vertebra.
- Posteriorly – the pharynx glides freely on the prevertebral fascia.

- Anteriorly – it communicates with the nasal cavity, the oral cavity and the larynx. Thus the anterior wall of the pharynx is incomplete.
- Laterally – the pharynx is attached to:
 - the medial pterygoid plate,
 - the pterygomandibular raphe,
 - the mandible,
 - the tongue,
 - the hyoid bone,
 - the thyroid and cricoid cartilages.
- **The peripharyngeal space (spatium peripharyngeum)** is behind and on the sides of the pharynx. It is divided into:
 - **The retropharyngeal space (spatium retropharyngeum);**
 - **The parapharyngeum space (sparium lateropharyngeum).**
- The pharynx is related on each side with the common, internal and external carotid arteries and the cranial nerves related to them.

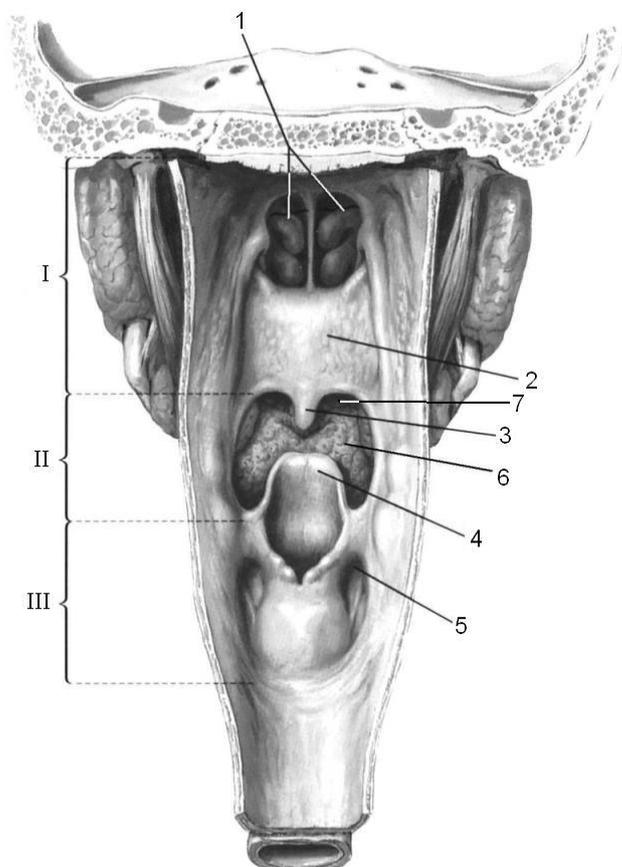


Fig. 9. The pharynx
(anterior wall,
view from the back)

I – Nasopharynx
II – Oropharynx
III – Laryngopharynx

1. Choanae and nasal conchae
2. Soft palate
3. Uvula
4. Epiglottis
5. Piriform fossa
6. Lingual tonsil
7. Fauces

The nasopharynx (pars nasalis pharyngis)

- This is the upper part of the pharynx situated behind the nasal cavity, and above the lower border of the soft palate.
- The wall of the nasopharynx is formed by the pharyngobasilar fascia (see the wall of the pharynx). It does not collapse.
- Anteriorly the nasopharynx communicates with the nasal cavity through the choanae. It resembles the nose structurally and functionally.
- On each lateral wall of nasopharynx there is a funnel-shaped *pharyngeal opening of auditory tube (ostium pharyngeum tubae auditivae)*. Thus pharynx communicates with the middle ear cavity through the auditory tube. Superiorly and posteriorly the opening is bounded by *the torus tubarius (torus tubarius)* formed due to the projection of the cartilage of the auditory tube here. *The tubal tonsil (tonsilla tubaria)* is between the pharyngeal opening of auditory tube and the soft palate.
- At the junction of the superior and posterior pharyngeal walls on the midline is an accumulation of lymphoid tissue, *the pharyngeal tonsil (tonsilla pharyngealis)*.
- Inferiorly the nasopharynx communicates with the oropharynx at the isthmus of fauces.

The oropharynx (pars oralis pharyngis)

- The oropharynx is the middle part of the pharynx communicating with the oral cavity in front through the isthmus of fauces.
- The oropharynx is mixed in function because the alimentary and respiratory tracts are crossing here.

The laryngopharynx (pars laryngea pharyngis)

- This is the lower part of the pharynx situated behind the larynx.
- It extends from the upper border of epiglottis to the lower border of the cricoid cartilage.
- On the anterior wall there is the entrance into the larynx bounded in front by the epiglottis and on the sides by the ary-epiglottic folds (see the larynx).

- *The piriform fossa (recessus piriformis)* lies laterally to each ary-epiglottic fold.

The wall of the pharynx

The wall of the pharynx is composed of the following layers from within outwards:

- *The mucosa (tunica mucosa)*. The mucosa of the nasopharynx is covered with ciliated epithelium, whereas in the inferior part it is covered with stratified squamous epithelium. The mucosa has *the pharyngeal glands (glandulae pharyngeales)*.
- *The submucosa (tela submucosa)* is a fibrous sheet, which thick upper part forms *the pharyngobasilar fascia (fascia pharyngobasilaris)*.
- *The pharyngeal muscles (musculi pharynges)*. They are arranged longitudinally (dilators) and circular (constrictors), Fig. 10.
 - The circular layer is much stronger and consists of three constrictors – *the superior, middle, inferior constrictors (m. constrictor pharynges superior, medius, inferior)*. They arise on different points (the bones of the base of the skull, the mandible, the root of the tongue, the hyoid bone, the laryngeal cartilages), the fibers of the muscles on each side pass backwards and join each other to form on the midline of the pharynx *the pharyngeal raphe (raphe pharyngis)*.
 - The longitudinal muscles :
 - *Stylopharyngeus (m. stylopharyngeus)* passes from styloid process to the pharyngeal wall. It pulls the pharynx upwards and backwards.
 - *Palatopharyngeus* (see the soft palate).
- *The buccopharyngeal fascia* covers the outer surface of the constrictors of the pharynx and extends forwards across the pterygomandibular raphe to cover the buccinator. It is best developed in the upper part of the pharynx.

The Pirogov's-Waldeyr's lymphatic ring

In relation to the isthmus of fauces, there are several aggregations of lymphoid tissue that constitute the Pirogov's-Waldeyr's lymphatic ring. The most important aggregations are:

- The right and left palatine tonsil;
- The right and left tubal tonsil;
- The pharyngeal tonsil;
- The lingual tonsil.

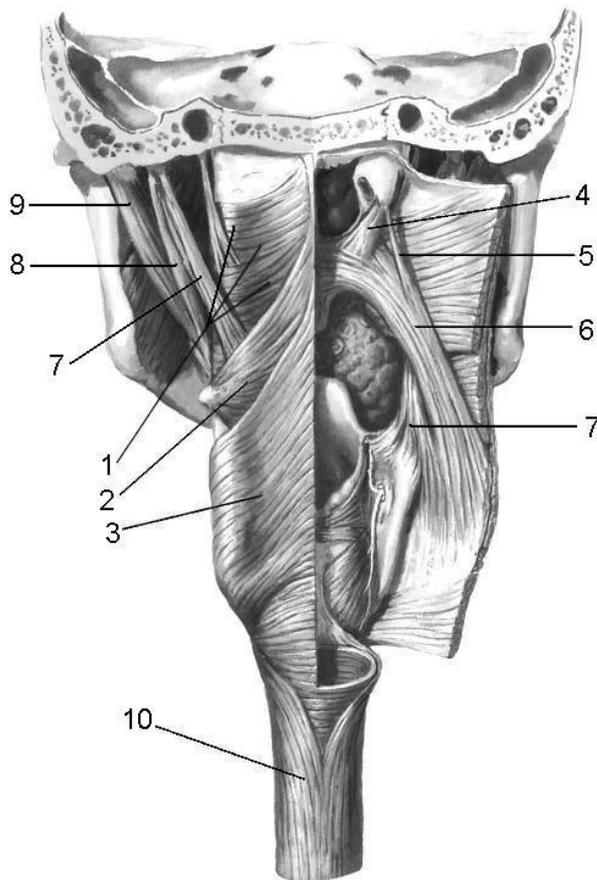


Fig. 10. The pharyngeal muscles

1. Superior constrictor muscle
2. Middle constrictor muscle
3. Inferior constrictor muscle
4. Levator veli palatini muscle
5. Tubopharyngeal muscle
6. Palatopharyngeal muscle
7. Stylopharyngeal muscle
8. Stylohyoid muscle
9. Posterior belly of digastricus
10. Oesofagus

The act of swallowing

Since the respiratory and alimentary tracts intersect in the pharynx, special devices exist, which separate these two tracts during swallowing.

- By contraction of the tongue muscles the bolus is pressed against the hard palate and then pushed through the fauces. During this process, the soft palate is pulled upwards (contraction of the levator veli palatini and the tensor veli palatini) and brought nearer to the posterior pharyngeal wall (contraction of the palatopharyngeus muscles). In this manner, the nasopharynx is completely separated from the oropharynx.

- At the same time, the suprahyoid muscles of the neck pull the pharynx upwards, while the root of the tongue is pulled downwards (contraction of the hyoglossus muscle). The root of the tongue presses against the epiglottis, depresses it and closes the opening into larynx in this way.
- Then the pharyngeal constrictors contract in succession as a result of which the bolus is pushed towards the oesophagus. The longitudinal muscles act as elevators, they pull the pharynx to meet the bolus.

OESOPHAGUS (oesophagus)

- This is a narrow muscular tube, forming the food passage between the pharynx and stomach.
- It extends from the lower part of the neck to the upper part of the abdomen and has about 25 cm long.
- The oesophagus is flattened anteroposteriorly, and the lumen dilates only during the passage of the food bolus.
- It begins at the lower border of the cricoid cartilage (level of vertebrae C6-7). It descends in front of the vertebral column through the thoracic cavity and pierces the diaphragm at the level of vertebra T10. Esophagus is opening into the stomach at the level of vertebra T11.
- The esophagus has three parts: *the cervical part (pars cervicalis)*, *the thoracic part (pars thoracica)* and *the abdominal part (pars abdominalis)*.
- The esophagus is vertical, but it has two side to side curvatures, both towards the left:
 - One at the root of the neck;
 - The other one near the lower end.
- It also has anteroposterior curvatures that correspond to the curvatures of the spine.

Topography

- The trachea is in front of the cervical part of the esophagus, the prevertebral fascia is behind, vessels and nerves pass on both sides of it.
- The spinal column is behind the upper third of the cervical part of the esophagus. The trachea and mediastinal pleura are to the right.
- In the middle third of the thoracic part of the oesophagus the aortic arch is in front (T4). A little lower (T5) are the bifurcation of the trachea and the left main bronchus. The descending aorta is to the left.
- In the lower third of the thoracic part of the oesophagus the aorta is to the back and to the right, the pericardium is in front. The left pleura and the left vagus nerve are to the left (then the latter is displaced to the anterior surface), the right vagus nerve is to the right (then it is displaced to the posterior surface).
- The abdominal part of the oesophagus is covered by the peritoneum in front and on the sides. The liver is in front and to the right, the spleen is to the left.

Constrictions

The oesophagus has 3 constrictions at the following levels:

- At its beginning (the paryngo-oesophageal junction is the narrowest part of the alimentary canal except for the vermiform appendix)
- ***The broncho-aortic constriction (constrictio bronchoaortica)*** where it is crossed by the aortic arch and the left bronchus.
- ***The diaphragmatic constriction (constrictio diaphragmatica)*** where it pierces the diaphragm.

The wall of the oesophagus

- Mucosa with ***the oesophageal glands (glandulae oesophageae)***.
- Submucosa.
- ***Muscular layer (tunica muscularis)*** has two layers:
 - The outer longitudinal layer dilating the oesophagus;
 - The inner circular layer constricting the oesophagus.

In the upper third of the oesophagus both layers consist of striated muscles but distally they are gradually replaced by smooth muscle.

- *Adventitia* (**tunica adventitis**) in cervical and thoracic parts.
- *Subserosa* (**tela subserosa**) and *serosa* (**tunica serosa**) in abdominal part.

THE STOMACH (**gaster**)

The stomach is a sac-like expansion of the alimentary canals. After passing through the oesophagus food accumulates in the stomach and undergoes the first stages of digestion here (Fig. 11).

The stomach has two walls, two curvatures and two openings.

- *The anterior wall* (**paries anterior**) faces forwards and upwards.
- *The posterior wall* (**paries posterior**) faces backwards and downwards.
- *The greater curvature* (**curvatura major**) is the convex border of the stomach facing downwards and to the left.
- *The lesser curvature* (**curvatura minor**) is the concave border of the stomach facing upwards and to the right.
- *The cardial orifice* (**ostium cardiacum**) is the opening of the oesophagus into the stomach (T10-11). The adjoining portion of the stomach is *the cardia* (**cardia**).
- The dome-shaped part of the stomach to the left of the cardial orifice is called *the fundus of stomach* (**fundus gastricus**).
- The distal opening of the stomach is called *the pyloric orifice* (**ostium pyloricum**) (T12-L1). The adjoining portion of the stomach is *the pyloric part* (**pars pylorica**).
- The lesser curvature has *the angular incisure* (**incisura angularis**), which separates the body of the stomach from the pyloric part of the stomach.
- The pyloric part is divided into *the pyloric antrum* (**antrum pyloricum**) and *the pyloric canal* (**canalis pyloricus**). The pyloric canal is about 2,5 cm long. It is narrow and tubular. At its right end it terminates at *the pylorus* (**pylorus**).

- **The body of stomach (corpus gastricus)** stretches from the fundus to the pyloric antrum.

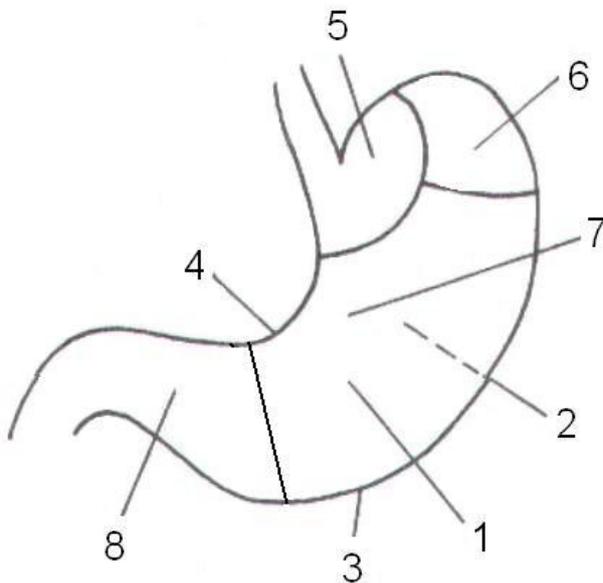


Fig. 11. The stomach

1. Anterior wall
2. Posterior wall
3. Greater curvature
4. Lesser curvature
5. Cardia
6. Fundus of stomach
7. Body of stomach
8. Pyloric part

Topography

- The stomach is situated in the epigastrium.
- Its greater portion is to the left of the median plane.
- When full, stomach comes in contact with the inferior surface of the left lobe of the liver and with the left dome of diaphragm superiorly, with the upper pole of the left kidney and the adrenal gland, with the spleen and the anterior surface of the pancreas posteriorly, with the mesocolon and the transverse colon further downwards, and with the abdominal wall between the liver on the right and the ribs on the left anteriorly.

The wall of the stomach

- **Mucosa:**
 - The mucosa of an empty stomach is thrown into **the gastric folds (plicae gastricae)**. The folds are longitudinal along the lesser curvature and are irregular elsewhere. The part of the lumen of the stomach that lies along the lesser curvature is called **the gastric canal (canalis gastricus)**. This canal allows rapid passage of liquids to the lower part of the stomach.

- On the mucosal surface there are numerous small depressions that can be seen with a hand lens. They are *the gastric pits (foveolae gastricae)*.
- *The gastric glands (glandulae gastricae)* open into the gastric pits.
- In the region of the pyloric orifice there is the circular mucosal fold, separating the stomach from the intestine. It is called the *valvula pylorica*.
- *Submucosa*.
- *Muscular coat* has three layers: external *longitudinal layer (stratum longitudinale)*, middle *circular layer (stratum circulare)* and internal *oblique fibres (fibrae obliquae)*. The circular layer forms *the pyloric sphincter (m. sphincter pyloricus)* at the junction of the pylorus and duodenum. *The valvula pylorica*, which corresponds to the pyloric sphincter, on contraction of the sphincter isolates completely the cavity of the stomach from the cavity of the duodenum.
- *Subserosa*.
- *Serosa*.

THE SMALL INTESTINE (intestinum tenue)

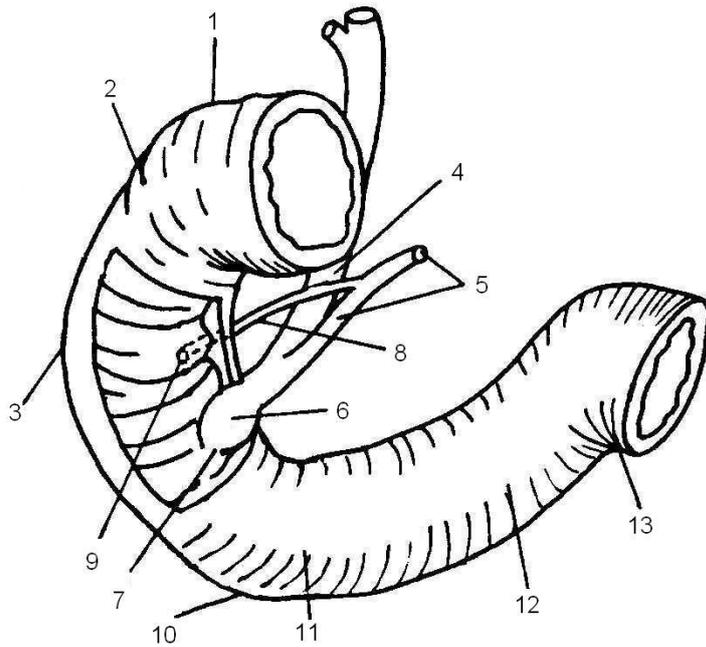
The small intestine extends from the pylorus to the ileocaecal junction. It is about 5-6 m long. The structure of the small intestine is adapted for digestion and absorption.

- The small intestine is divided into:
 - an upper, fixed part, called the duodenum,
 - a lower, mobile part, forming a very long convoluted tube:
 - The upper 2/5 of the mobile intestine are called the jejunum,
 - The lower 3/5 of the mobile intestine are called the ilium.

The duodenum (duodenum)

- The duodenum is the shortest (25 cm), widest and most fixed part of the small intestine from the pylorus to the duodeno-jejunal flexure (Fig. 12).
- It is curved round the head of the pancreas in the form of the letter “C”.

- The duodenum lies above the level of the umbilicus, opposite vertebrae L1-3.
- The duodenum is mostly retroperitoneal; it is only partly covered by peritoneum anteriorly.
- The duodenum is divided into four parts – superior, descending, horizontal and ascending.



Pic. 12. The duodenum

1. Superior part
2. Superior duodenal flexure
3. Descending part
4. Bile duct
5. Pancreatic duct
6. Hepatopancreatic ampulla
7. Major duodenal papilla
8. Accessory pancreatic duct
9. Minor duodenal papilla
10. Inferior duodenal flexure
11. Horizontal part
12. Ascending part
13. Duodenojejunal flexure

The superior part (pars superior)

It begins at the pylorus, and passes backwards, upwards and to the right to meet the descending part at ***the superior duodenal flexure (flexura duodeni superior)***. The initial part of it is distinguished as ***the ampulla (ampulla)***.

- ***Visceral relations:***
 - Anteriorly – quadrate lobe of the liver and gall bladder.
 - Posteriorly – gastroduodenal artery, bile duct and portal vein.
 - Inferiorly – head and neck of the pancreas.

The descending part (pars descendens)

It begins at the superior duodenal flexure, passes downwards to reach the lower border of the third lumbar vertebra, where it curves towards the left at ***the inferior duodenal flexure (flexura duodeni inferior)*** to become continuous with the third part.

- ***Visceral relations:***

- Anteriorly – right lobe of the liver, transverse colon, root of the transverse mesocolon, small intestine.
- Posteriorly – right kidney, inferior vena cava, right psoas major muscle.
- Medially – head of the pancreas and bile duct.
- Laterally – right colic flexure.

The horizontal part (pars horizontalis)

It begins at the inferior duodenal flexure. It passes almost horizontally and slightly upwards in front of the inferior vena cava, and ends by joining the fourth part in front of the abdominal aorta.

- ***Visceral relations:***

- Anteriorly – superior mesenteric vessels.
- Posteriorly – right ureter, right psoas major, inferior vena cava, abdominal aorta with origin of inferior mesenteric artery.
- Superiorly – the head of the pancreas.
- Inferiorly – jejunum.

The ascending part (pars ascendens)

This part runs upwards to the upper border of the second lumbar vertebra, where it turns forwards to become continuous with the jejunum at ***the duodenojejunal flexure (flexura duodenojejunalis)***. This flexure is fixed in position by the peritoneum and a band of ***the suspensory muscle of duodenum (m. suspensorius duodeni)***.

- ***Visceral relations:***

- Anteriorly – transverse mesocolon, lesser sac and stomach.
- Posteriorly – vessels and nerves, left psoas major muscle.
- Laterally – left kidney and ureter.
- Superiorly – body of the pancreas.

The jejunum (jejunum) and ileum (ileum)

- The jejunum and ileum are suspended on the posterior abdominal wall by *the mesentery (mesenterium)* and, therefore, have considerable mobility.
- The jejunum occupies upper and left part of the intestinal area. The ileum occupies lower and right part of the intestinal area.
- The jejunum is larger in diameter, its walls are thicker, and it is richer in vessels.
- In approximately 2% of cases, an appendage, *the ileal diverticulum (diverticulum ilei)* or Meckel's diverticulum is present at a distance of about 1 cm from its end. It is a remnant of the embryonic omphalomesenteric duct.

The wall of the small intestine

- *Mucosa:*
 - The absorption surface of the mucous membrane of the small intestine is considerably enlarged due to the presence of the transverse *circular folds (plicae circulares)*. These folds are formed by the mucosa and submucosa and are permanent structures, which do not disappear even when the intestinal tube is distended. These folds are absent in the ampulla of the duodenum, in the rest parts of the duodenum and in the jejunum they are high and placed closely to one another. More distally in the ileum they become lower, set less closely and disappear completely in the end of the ileum.
 - The mucosa in the ampulla has longitudinal folds like that in the pylorus.
 - The mucosa has a lusterless, velvety appearance due to the numerous *intestinal villi (villi intestinales)* covering it. The villi have a lymphatic sinus and blood vessels in the center. They are concerned with the absorption of nutrients. The number of villi is greater in the jejunum.
 - The mucosa has *intestinal glands (glandulae intestinales)*, which secrete intestinal juice. In the duodenum they are lodged in the submucosa and resemble the pyloric glands of the stomach in structure.

- *The longitudinal fold of duodenum* (**plica longitudinale duodeni**) is on medial wall of the descending part. It has two elevations which terminate as papillae:
 - The distal *major duodenal papilla* (**papilla duodeni major**) is the opening of the conjoined bile duct and the pancreatic duct.
 - The proximal *minor duodenal papilla* (**papilla duodeni minor**) is the opening of the accessory pancreatic duct.
- The mucosa has a lymphatic apparatus. It consists of *the solitary lymphoid nodules* (**noduli lymphoidei solitarii**) and *the aggregated lymphoid nodules* (**noduli lymphoidei aggregati**) called Peyer's patches. The aggregated lymphoid nodules are only found in the ileum.
- *Submucosa.*
- *Muscular layer* has two layers: external *longitudinal layer* (**stratum longitudinale**) and internal *circular layer* (**stratum circulare**).
- *Subserosa and serosa* (duodenum is retroperitoneal; jejunum and ileum are intraperitoneal organs).

THE LARGE INTESTINE (intestinum crassum)

The large intestine extends from the ileocaecal junction to the anus. It is about 1,5 m long and it is divided into the caecum, the ascending colon, the transverse colon, the descending colon, the sigmoid colon, the rectum and the anal canal (Fig. 13).

- The inferior end of the caecum has a narrow finger-like evagination called *the appendix* (**appendix vermiformis**).
- The structure of the large intestine is adapted for storage of matter reaching it from the small intestine, and absorption of fluid and solutes from it.
- The large intestine is wider in caliber than the small intestine.
- The greater part of the large intestine is fixed, except for the appendix, the transverse colon and the sigmoid colon.

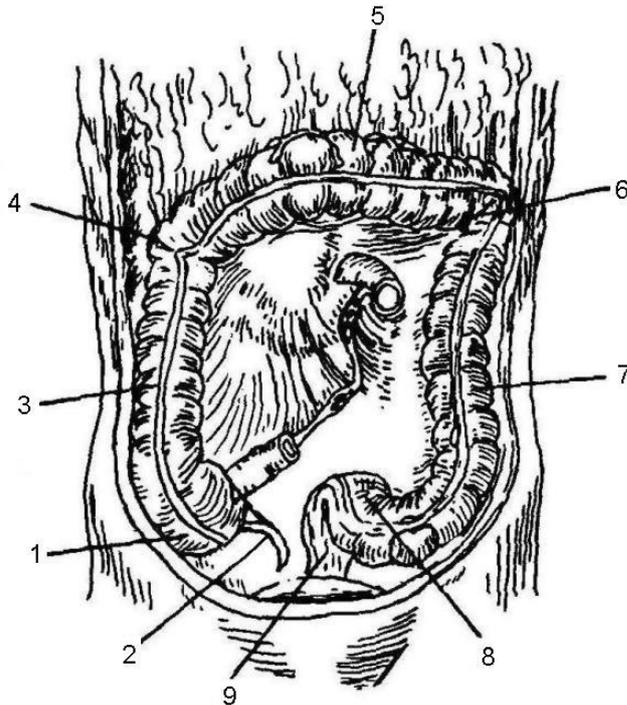


Fig. 13. The large intestine

1. Caecum
2. Appendix
3. Ascending colon
4. Right colic flexure
5. Transverse colon
6. Left colic flexure
7. Descending colon
8. Sigmoid colon
9. Rectum

- The longitudinal muscle coat forms only a thin layer in this part of the gut. The greater part of it forms three ribbon-like bands, called *the taeniae coli* (**taeniae coli**). The taeniae originate at the base of the appendix, and distally they spread out on the terminal part of the sigmoid colon to become continuous with the longitudinal muscle coat of the rectum.
 - *The mesocolic taenia* (**taenia mesocolica**) stretches along the line of attachment of the mesentery of the transverse colon.
 - *The omental taenia* (**taenia omentalis**) runs along the line of attachment of the greater omentum on the transverse colon and along the continuation of this line on the other parts of the colon.
 - *The free taenia* (**taenia libera**) stretches on the anterior surface of the caecum, ascending and descending colon; on the transverse colon it runs on the posterior surface because the colon here turns about the axis.
- Since the taeniae are shorter than the circular muscle coat, the colon has characteristic sacculations – *the haustra of colon* (**haustra coli**).

- *The omental appendices (appendices omentales)* are small bags of the peritoneum filled with fat found along the free and omental taeniae.

The wall of the large intestine

- *Mucosa:*
 - The circular folds in the larger intestine are broken up to form separate crescent folds called *the semilunar folds of colon (plicae semilunares coli)*. They are formed not only by the mucous coat but also by all the other coats of the wall. These folds are functional adjustments dependent on the activity of the intestinal nervous and muscular systems.
 - The mucosa is devoid of the intestinal villi.
 - Only the solitary lymphoid nodules but no Peyer's patches are present in the mucous membrane. Except for the appendix where the Peyer's patches are also present.
- *Submucosa.*
- *Muscular layer.*
- *Subserosa and serosa:* caecum, appendix, transverse and sigmoid colons are intraperitoneal organs; appendix, transverse and sigmoid colons have mesenteries. Ascending and descending colons are mesoperitoneal organs. The upper part of rectum is intraperitoneal, the middle one is mesoperitoneal, the lower part is retroperitoneal organ.

The caecum (caecum)

- The caecum is the first segment of the large intestine (Fig. 14).
- It is situated in the right iliac fossa, above the lateral half of the inguinal ligament.
- It communicates superiorly with the ascending colon, medially at the level of the ileocolic junction with the ileum, and posteromedially with the appendix.
- *The ileal papilla (papilla ilealis)* is at the junction of the small and large intestines. *The ileal orifice (ostium iliale)* lies on the papilla. The ileal orifice

has superior *iliocolic lip* (**labrum ileocolicum**) and inferior *ileoacaecal lip* (**labrum ileocaecale**).

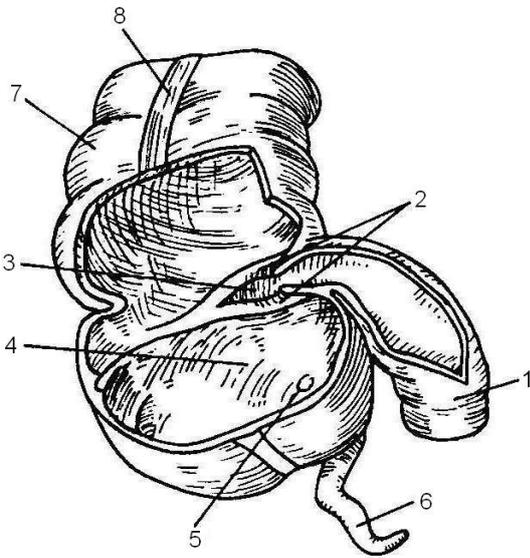


Fig. 14. The caecum and the ileocaecal junction

1. Ileum
2. Superior and inferior iliocolic lips
3. Ileal orifice
4. Caecum
5. Orifice of appendix
6. Appendix
7. Haustrae
8. Free taenia

The appendix (appendix vermiformis)

It arises from the posteromedial surface of the caecum, below the ileocaecal junction.

- It varies greatly in length (3-8 cm) and position (descending, ascending, lateral, medial etc.).
- The appendix opens into the caecum by *the orifice of vermiform appendix* (**ostium appendices vermiformis**).
- The mucosa of the appendix is relatively rich in lymphoid tissue in form of the aggregated lymphoid nodules.

The caecum and the appendix are completely invested by the peritoneum (intraperitoneal organs). The mesentery of the appendix, *the meso-appendix* (**mesoappendix**), usually extends to its very end.

- **Visceral relations:**
 - Anteriorly – the small intestine and the anterior abdominal wall.
 - Posteriorly – right iliacus and psoas major, vessels and nerves.

The ascending colon (colon ascendens)

- It extends from the caecum to the inferior surface of the right lobe of the liver. Here it bends to the left to form *the right colic flexure (flexura coli dextra)*.
- The posterior surface of the ascending colon is not covered by the peritoneum (mesoperitoneal organ).
- **Visceral relations:**
 - Anteriorly – the small intestine and the anterior abdominal wall.
 - Posteriorly – the iliacus, the quadratus lumborum, the transverse abdominis, the right kidney.
 - Laterally – the abdominal wall.
 - Medially – the small intestine.

The transverse colon (colon transversum)

- It extends across the abdomen from the right colic flexure to *the left colic flexure (flexura coli sinistra)*.
- It is completely invested by the peritoneum (intraperitoneal organ) and is attached to the posterior abdominal wall by means of its mesentery – *the transverse mesocolon (mesocolon transversum)*.
- **Visceral relations:**
 - Anteriorly – the greater omentum and the anterior abdominal wall.
 - Posteriorly – the small intestine, the descending part of the duodenum, the head of the pancreas.
 - Superiorly – the liver, the stomach and the spleen.

The descending colon (colon descendens)

- It extends from the left colic flexure to the sigmoid colon.
- The posterior surface of the descending colon usually not covered with the peritoneum (mesoperitoneal organ).
- **Visceral relations:**
 - Anteriorly – the small intestine and the anterior abdominal wall.
 - Posteriorly – the iliacus, the quadratus lumborum, the transverse abdominis, the left kidney.

- Laterally – the abdominal wall.
- Medially – the small intestine.

The sigmoid colon (colon sigmoidei)

- The sigmoid colon extends from the pelvic brim to the third piece of the sacrum, where it becomes the rectum.
- It forms a sinuous loop and hangs in the pelvis over the bladder and uterus.
- The sigmoid colon is completely invested by the peritoneum (intraperitoneal organ) and suspended by *the sigmoid mesocolon (mesocolon sigmoideum)*.
- It is covered by the small intestine anteriorly.

The rectum (rectum) and the anal canal (canalis analis)

- The rectum is the distal part of the large intestine.
- It serves for accumulation and evacuation of the faecal material. Dilatation of wall of the rectum causes the desire to defecate.
- The three cardinal features of the large intestine (sacculations, omental appendices and taeniae) are absent in the rectum.
- It is situated between the sigmoid colon above and the anal canal below.
- The rectum begins at the level of the promontory and descends into the pelvis in front of the sacrum to form two anteroposterior flexures:
 - an upper *sacral flexure (flexura sacralis)* convex to the back in conformity with the sacral concavity; part of the rectum corresponding to the sacral flexure widens in the direction of the lower perineal flexure to form *the rectal ampulla (ampulla recti)*;
 - a lower *perineal flexure (flexura perinealis)* convex to the front in the region of coccyx. The terminal part of the rectum passing to the back and downwards is called *the anal canal (canalis analis)*. The anal canal terminates as an orifice, *the anus (anus)*.
- Three parts are distinguished in the rectum according to its peritoneal relations. The upper part is completely invested by the peritoneum, a middle part is mesoperitoneal, a lower part is found extraperitoneally (retroperitoneally).

- **Visceral relations:**
 - Anteriorly – (all) - the rectovesical pouch with coils of the small intestine and sigmoid colon; (man) - the seminal vesicles and the deferent ducts, the urinary bladder, the uretra, the prostata and the bulb of penis; (woman) - the uterus, the vagina.
 - Posteriorly – the sacrum and the coccyx, the anococcygeal ligament.
- The rectal wall is composed of four coats – mucosa, submucosa, muscular layer and adventitia/peritoneum (see above).
 - **The transverse folds of rectum (plicae transversae recti)** are present in the upper part of the rectum. They are similar to the semilunar folds of colon.
 - The mucosa forms 8-10 longitudinal folds in the lower part, which are called **the anal columns (columnae anales)**.
 - The upper ends of columns form horizontal **anorectal line** (it is a surgical border between rectum and anal canal, 4-5 cm above the anus).
 - The depressions between columns are called **the anal sinuses (sinus anales)**.
 - **The anal valves (valvulae anales)** are formed between the lower ends of the anal columns. The valves form **the pectinate line (linea pectinata)** – the anatomical border between rectum and anal canal (2,5-3 cm above the anus).
 - **The anocutaneous line (linea anocutanea)** is between the mucosa and the skin at the level of lower border of the internal anal sphincter (1 cm above the anus).
 - **The anal pecten (pecten analis)** is between the pectinate line and anocutaneous line. There is the internal (involuntary) anal sphincter in muscular coat at this level.
 - **The muscular coat** consists of two layers: an inner circular and an outer longitudinal. The inner layer increases in the thickness in the anal canal and

forms here *the internal anal sphincter* (**m. sphincter ani internus**). Directly under the skin is a ring of striated muscle fibers – *the external anal sphincter* (**sphincter ani externus**), which is made by the fibers of perineal (voluntary) muscles.

THE LIVER (**hepar**)

The liver is a large, solid gland situated directly under the diaphragm in the right upper quadrant of the abdominal cavity. It occupies the right hypochondrium, the greater part of the epigastrium, and extends into the left hypochondrium.

- The liver has two surfaces (Fig. 15-17).
 - The anterosuperior *diaphragmatic surface* (**facies diaphragmatica**) is convex in correspondence to the concavity of the diaphragm with which it is in contact.
 - The inferior *visceral surface* (**facies visceralis**) faces downwards and to the back and bears some depressions produced by the abdominal viscera with which it comes in contact.
 - These surfaces are separated by a sharp *inferior border* (**margo inferior**).
- On the basis of the intrahepatic distribution of the hepatic artery, the portal vein and the biliary ducts, the liver can be divided into lobes and segments.
- The liver has two lobes, *the right lobe of liver* (**lobus hepatis dexter**) and *the left lobe of liver* (**lobus hepatis sinister**), which are separated on the diaphragmatic surface by *the falciform ligament* (**lig. falciforme**).
- In the free edge of the falciform ligament there is a hard fibrous cord, *the round ligament of liver* (**lig. teres hepatis**).
- The round ligament of liver curves around the inferior border of the liver, forms *a notch for ligamentum teres* (**incisura ligamenti teretis**) here, and then fits on the visceral surface into *the fissure for ligamentum teres* (**fissura ligamenti teretis**). It is the anterior part of the left longitudinal fissure, which is the boundary between the right and the left lobes of the liver on this

surface. The posterior part contains the continuation of the round ligament, a thin fibrous ligamentum venosum, and is called *the fissure for ligamentum venosum* (**fissura ligamenti venosi**).

- The round ligament of liver is the obliterated remnants of the umbilical vein and extends from the umbilicus; *the ligamentum venosum* (**lig. venosum**) is the obliterated ductus venosus, which communicates the umbilical vein with the inferior vena cava in the embryonic period.

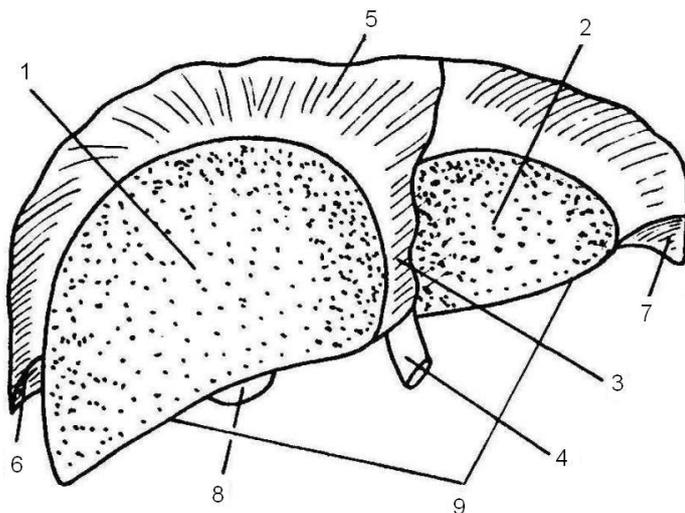


Fig. 15. The diaphragmatic surface of the liver

1. Right lobe
2. Left lobe
3. Falciform ligament
4. Round ligament
5. Coronary ligament
6. Right triangular ligament
7. Left triangular ligaments
8. Fundus of the gallbladder
9. Inferior border of the liver

- The right lobe of liver is separated by two grooves, or depressions on visceral surface.
 - One stretches parallel to the left longitudinal fissure. Its anterior part is called *the fossa for gallbladder* (**fossa vesicae biliaris**) and contains the gallbladder. The posterior, deeper part of the groove contains the inferior vena cava and is called *the groove for vena cava* (**sulcus venae cavae**).
 - The deep transverse fissure connecting the posterior ends of the fossa for gallbladder and the fissure for ligamentum teres is called *the porta hepatis* (**porta hepatis**). Through the porta hepatis the hepatic artery, portal vein and nerves enter the liver while *the common hepatic duct* (**ductus hepaticus communis**) and lymphatic vessels leave it. The common hepatic duct is formed by *the right and left hepatic ducts* (**ductus hepaticus**

dexter, sinister), which take out the bile from the right and left lobes respectively.

- **The quadrate lobe (lobus quadratus)** is a part of the liver bounded posteriorly by the porta hepatis, the fossa for gallbladder on the right and the fissure for ligamentum teres on the left.
- **The caudate lobe (lobus caudatus)** is a part of the liver bounded anteriorly by the porta hepatis, the groove for vena cava on the right and the fissure for ligamentum venosum on the left.
- The liver is covered by the peritoneum for the most part except for an area on its posterior surface where it is in direct contact with the diaphragm. This area is called **the bare area (area nuda)**.
- The peritoneum passes from the diaphragm to the diaphragmatic surface of the liver to form the falciform ligament.
- Posteriorly of the falciform ligament the peritoneum is reflected from the inferior surface of the diaphragm onto the diaphragmatic surface of the liver to form **the coronary ligament (lig. coronarium)** whose edges have the shape of triangular plates, which are called **the right and left triangular ligaments (ligg. triangulare dextrum and sinistrum)**.

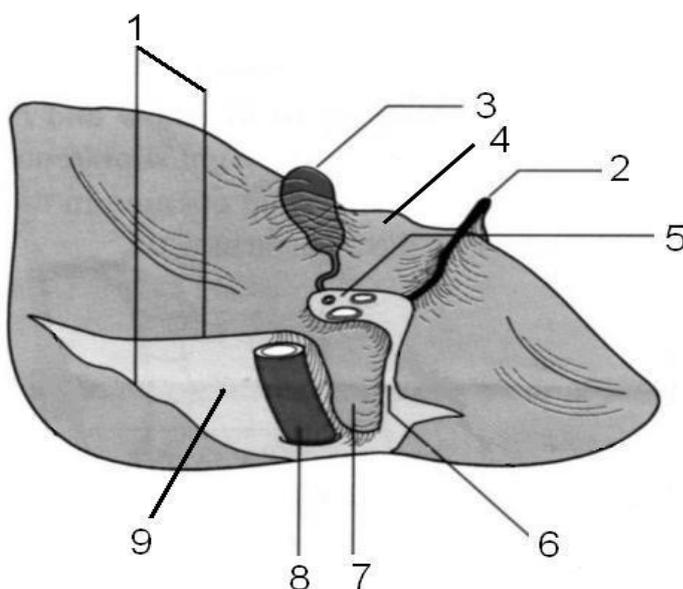


Fig. 16. The visceral surface of the liver

1. Edges of the coronary ligament
2. Round ligament of the liver
3. Gallbladder
4. Quadrate lobe
5. Porta hepatis
6. Fissure for ligamentum venosum
7. Caudate lobe
8. Inferior vena cava
9. Bare area

- The organs which come in contact with the liver form the impressions on its surface, which are named according to the contacting organ.
 - *The cardiac impression (impressio cardiaca)* is in the middle of the diaphragmatic surface.
 - *The oesophageal impression (impressio oesophageale)* and *the gastric impression (impressio gastrica)* are on the visceral surface of the left lobe.
 - *The duodenal impression (impressio duodenalis)*, *the colic impression (impressio colica)*, *the renal impression (impressio renalis)* and *the suprarenal impression (impressio suprarenalis)* are on the visceral surface of the right lobe to the right of the fossa for gallbladder.

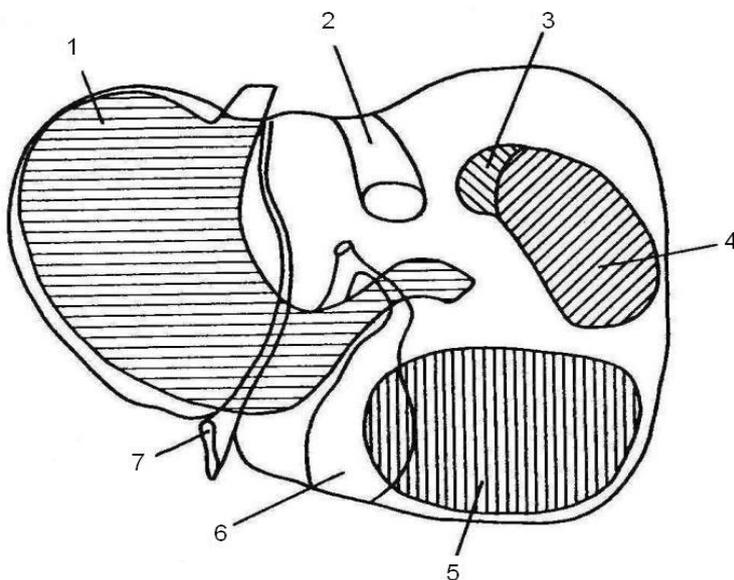


Fig. 17. Organ projections on the visceral surface of the liver

1. Stomach
2. Inferior vena cava
3. Suprarenal gland (right)
4. Kidney (left)
5. Colon
6. Gallbladder
7. Round ligament of the liver

Topography of the liver

- *The upper boundary of the liver:*
 - The right midaxillary line – 10th intercostal space.
 - The right mamillary line – 4th intercostal space.
 - The midline – the base of the xiphoid process.
 - The middle of the distance between the left sternal and left mamillary lines – 5th intercostal space.
- *The lower boundary of the liver:*
 - The right midaxillary line – 10th intercostal space.

- It passes obliquely and to the left, transects the 9th or 10th right costal cartilage, ascends obliquely to the left in the region of the epigastrium, transects the left costal arch at the level of the 7th costal cartilage.
- The middle of the distance between the left sternal and left mamillary lines – 5th intercostal space.

The functions of the liver

- Metabolism of carbohydrates, fats and proteins.
- Synthesis of bile.
- Synthesis of many proteins, cholesterol etc.
- Metabolism of drugs, toxins and their detoxication.
- Storage (glycogen, iron, fat, vitamin A and D, etc.)

THE GALLBLADDER (*vesica biliaris*)

The gallbladder is pear-shaped (Fig. 18). It serves for the storage of bile.

- Its wide end extending slightly beyond the inferior border of the liver is called *the fundus of gallbladder (fundus vesicae biliaris)*.
- The opposite narrow end is *the neck of gallbladder (collum vesicae biliaris)*.
- The middle part is *the body of gallbladder (corpus vesicae biliaris)*.
- The neck is directly continuous with *the cystic duct (ductus cysticus)*.
- The cystic ducts and the common hepatic duct join to form *the bile duct (ductus choledochus)*. It descends behind the superior part of the duodenum and drains, together with the duct of the pancreas, by means of an orifice into a dilatation inside the greater duodenal papilla, called *the hepatopancreatic ampulla (ampulla hepatopancreatica)*.
- The gallbladder is covered by the peritoneum only on the inferior surface. Its fundus is adjacent to the anterior abdominal wall in the angle formed by the right rectus abdominis muscle and the inferior border of the ribs.

The wall of the gallbladder and the ducts

- **Mucosa:**
 - It forms *the mucosal folds (plicae mucosae)*.
 - In the cystic duct and in the neck folds are arranged spirally and form *the spiral fold (plica spiralis)*.
 - The mucosa of the bile duct contains *the glands of bile duct (glandulae ductus choledochi)*.
- **Muscular layer:**
 - The circular layer of muscle in the wall of the bile duct where it opens into the duodenum is very strong and forms *the sphincter of bile duct (m. sphincter ductus choledochi)*, which regulates the flow of bile into the duodenum.
 - There is still another sphincter in the region of the ampulla - *the sphincter of ampulla (m. sphincter ampullae)*.
- **Subserosa.**
- **Serosa.**

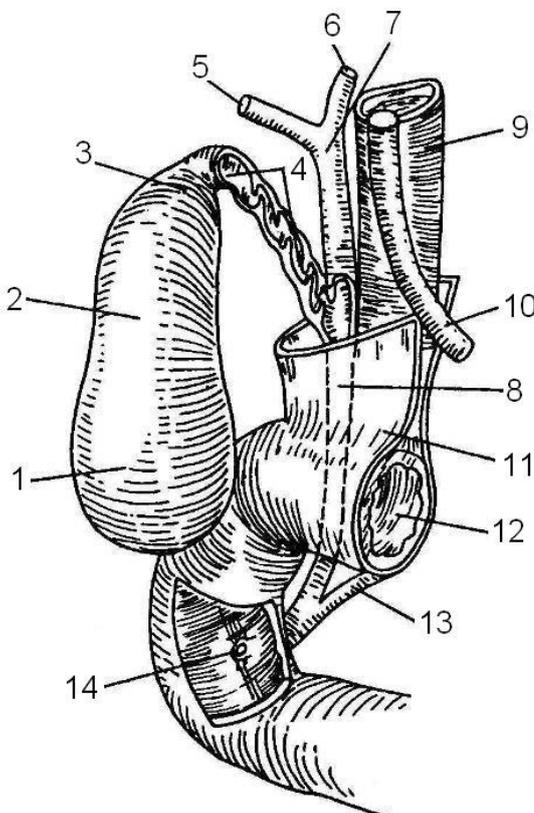


Fig. 18. The gallbladder and bile ducts

1. Fundus of gallbladder
2. Body of gallbladder
3. Neck of gallbladder
4. Cystic duct and the spiral fold
5. Right hepatic duct
6. Left hepatic duct
7. Common hepatic duct
8. Bile duct
9. Portal vein
10. Hepatic artery
11. Hepatoduodenal ligament
12. Duodenum
13. Pancreatic duct
14. Major duodenal papilla

THE PANCREAS (**pancreas**)

- The pancreas is situated behind the stomach on the posterior abdominal wall in the epigastrium. Its left part extends also to the left hypochondrium.
- It adjoins the inferior vena cava, the left renal vein and the aorta posteriorly. The peritoneum covers the anterior and inferior surfaces of the pancreas only.
- The pancreas has the head, the body and the tail.

The head of pancreas

- *The head of pancreas (caput pancreatis)* is embraced by the duodenum and it is situated on the level of the first and upper part of the second lumbar vertebra.
- *The pancreatic notch (incisura pancreatis)* is at the junction of the head with the body. The superior mesenteric artery and vein pass here.

The body of pancreas

- *The body of pancreas (corpus pancreatis)* is prismatic in shape and has three surfaces.
- *The anterosuperior surface (facies anterosuperior)* is concave and comes in contact with the stomach. Close to junction of the head and the body it usually has an elevation in the direction of the smaller omentum – *the omental eminence (tuber omentale)*.
- *The posterior surface (facies posterior)* is directed to the posterior abdominal wall.
- *The anteroinferior surface (facies anteroinferior)* faces downwards and slightly to the front.
- The three surfaces are separated from one another by three edges: *margo superior, anterior and inferior*.

The tail of pancreas

- *The tail of pancreas (cauda pancreatis)* is situated higher than the head and reaches the inferior part of the spleen.

The pancreatic duct

- *The pancreatic duct (ductus pancreaticus)* joins the bile duct and both open by means of a common orifice on the major duodenal papilla.
- In addition to the main duct there is usually *the accessory pancreatic duct (ductus pancreaticus accesorius)* which opens on the minor duodenal papilla. It drains the head of the pancreas.

Structure

- Two components are distinguished in it:
 - The main bulk of the gland is concerned with external secretion and excretes its secrets into the duodenum by way of the ducts.
 - The smaller part of the gland consists of *the pancreatic islets* (of Langerhans) (*insulae pancreaticae*) and it is endocrine structure secreting insulin, glucagon (they regulate the blood sugar content) and another hormones into the blood.

THE ABDOMINAL CAVITY (*cavitas abdominis*) and THE PERITONEUM (*peritoneum*)

The abdominal cavity is the space in the trunk below the diaphragm. It is completely filled with the abdominal organs.

- The diaphragm, serving as the superior wall of the abdominal cavity, separates it from the thoracic cavity.
- The lateral and anterior walls of the abdominal cavity are formed by the three broad abdominal muscles and the rectus abdominis muscle.
- The posterior wall is formed by the lumbar segment of the spine and the psoas major and quadratus lumborum muscles.
- Below are the iliac bones and the pelvic diaphragm.
- The abdominal cavity is lined with a serous membrane called **the peritoneum**, which also covers to a lesser or greater extent the abdominal viscera.

- The peritoneum is a closed serous sac, which communicates with the external environment only in females by means of a very small abdominal opening of the uterine tubes.
- The peritoneum consists of two layers:
 - *The parietal peritoneum* (**peritoneum parietale**) lines the abdominal wall.
 - *The visceral peritoneum* (**peritoneum viscerale**) invests the viscera and forms their serous covering.
- Both layers are in close contact and in an intact abdominal cavity there is only a narrow space between them called *the peritoneal cavity* (**cavitas peritonealis**) that contains a small amount of serous fluid.
- Being smooth due its epithelial covering and moist because of the presence of serous fluid, the peritoneum makes movement of the organs in relation to one another much easier by relieving friction between the contacting surfaces.
- A connective tissue layer between the peritoneum and the abdominal walls, containing a greater or lesser amount of fatty tissue is *the subserosa*, which is developed irregularly.
- The parietal peritoneum forms a continuous lining on the anterior and lateral walls of the abdomen and passes on to diaphragm and the posterior abdominal wall. Here it is reflected on the viscera and is directly continuous with the visceral peritoneum investing them.
- The abdominal organs, developing between the peritoneum and the wall of the abdominal cavity, with growth move away from the wall and grow into the peritoneum stretching it out after them. As a result a serous fold of two layers forms. Such peritoneal folds passing from the wall of the abdominal cavity to parts of the intestinal canal are called the *mesenteries* while those passing from the wall to the organs are called the *ligaments*.
 - An organ invested in the peritoneum is said to have an *intraperitoneal* position (e.g. the small intestine).

- The *mesoperitoneal* position is that when an organ is covered by the peritoneum on three sides (one side is devoid of a covering), e.g. the ascending colon.
- If an organ is covered by the peritoneum only in front, its position is called *extraperitoneal* (e.g. the kidneys).

The mesenteries

- *The mesentery (mesenterium)* is a fold of two peritoneal layers by means of which the small intestine is attached to the posterior abdominal wall. The posterior border of the mesentery attached to the abdominal wall is *the root of mesentery (radix mesenterii)*. The line of attachment of the root passes obliquely from the duodenojejunal flexure (L2) to the upper part of the right sacroiliac joint. Blood vessels, nerves, lymphatic vessels and lymph nodes pass in the thickness of the mesentery between two serous layers.
- *The meso-appendix (mesoappendix)* is small, triangular fold of the peritoneum which suspends the appendix.
- *The transverse mesocolon (mesocolon transversum)* is a broad fold of the peritoneum which suspends the transverse colon.
- *The sigmoid mesocolon (mesocolon sigmoideum)* is a triangular fold of the peritoneum which suspends the sigmoid colon.

Tracing of the peritoneum

In the lower part of the anterior abdominal wall the peritoneum forms five folds converging on the umbilicus:

- *The median umbilical fold (plica umbilicalis mediana)* formed by the median umbilical ligament (remnant of the urachus).
- *Two medial umbilical folds (plicae umbilicales mediales)* formed by the obliterated umbilical artery.
- *Two lateral umbilical folds (plicae umbilicales laterales)* formed by the inferior epigastric vessels.

- Between the folds there are fossa:
 - *The supramesical fossa (fossa supramesicalis)* is between the median and medial umbilical folds.
 - *The medial inguinal fossa (fossa inguinalis medialis)* is between the medial and lateral umbilical folds. It corresponds to the superficial inguinal ring.
 - *The lateral inguinal fossa (fossa inguinalis lateralis)* is outwards of the lateral umbilical fold. It corresponds to the deep inguinal ring.

Above the umbilicus the peritoneum passes from the anterior abdominal wall and diaphragm to the diaphragmatic surface of the liver to form the falciform and coronary ligaments (see liver). From the diaphragmatic surface of the liver the peritoneum folds over its sharp border to the visceral surface (Fig.19).

- From the hepatic porta to the lesser curvature of the stomach as a thin *hepatogastric ligament (lig. hepatogastricum)*.
- *The hepatoduodenal ligament (lig. hepatoduodenale)* is going to the duodenum near the stomach. The bile duct (on the right), the common hepatic artery (on the left) and portal vein (posteriorly and between these structures) pass between the layers of the hepatoduodenal ligament.
- The hepatogastric and hepatoduodenal ligaments are a continuation of one another and form together *the lesser omentum (omentum minus)*.
- The hepatogastric and hepatoduodenal ligaments are duplications of the peritoneum because two peritoneal layers are encountered in the region of the porta hepatis, one passing to the porta from the anterior part of the visceral surface of the liver and the other from the posterior part.
- On the lesser curvature of the stomach both layers of the peritoneum separate: one to cover the anterior and the other one to cover the posterior surface of the stomach.
- On the greater curvature they again join and descend in front of the transverse colon and the loops of the small intestine to form the anterior lamina of *the greater omentum (omentum majus)*. On some level both layers fold over to

ascend and form its posterior lamina (the greater omentum consists, therefore, of four layers of the peritoneum).

- The slit-like *cavity* is between the anterior and posterior lamina of the greater omentum. In adult the layers usually adhere one to another and the cavity of the greater omentum is obliterated on a considerable distance.
- The part of the greater omentum between the greater curvature of the stomach and the transverse colon is called *the gastrocolic ligament (lig. gastrocolicum)*.
- *The gastrophrenic ligament (lig. gastrophrenicum)* passes from the diaphragm to the cardia of the stomach.
- *The gastrosplenic ligament (lig. gastrosplenicum)* passes from the fundus of the stomach to the splenic hilum.
- On reaching the transverse colon two layers forming the posterior lamina of the greater omentum blend with the transverse colon and transverse mesocolon and together with the last named pass posteriorly to the anterior border of the pancreas. Here they separate, one passes upwards, and other downwards. One covers the anterosuperior surface of the pancreas and then ascends onto the diaphragm, the other, having covered the anteroinferior surface of the pancreas, is continuous with the transverse mesocolon.
- The inferior layer of transverse mesocolon is going downwards, covering the posterior wall of the abdominal cavity. On reaching the loops of small intestine (jejunum and ilium) it gives complete peritoneal covering and forms its mesentery. After that the peritoneum descends in to the pelvic cavity.

Peritoneum in pelvic cavity

The peritoneum covers the walls of the pelvic cavity and the organs contained in it.

The relations of the peritoneum here are therefore determined by the sex.

- Passing on from the anterior surface of the rectum to the posterior surface of the urinary bladder in males the peritoneum forms a pouch – *the rectovesical pouch (excavatio rectovesicalis)*. A *transverse vesical fold (plica vesicalis*

transversa) is formed by the peritoneum on the superoposterior surface of an empty bladder, which is straightened out when the bladder is filled.

- In females between the urinary bladder and the rectum there is the uterus, which is also covered by the peritoneum. As a result there are two peritoneal pouches in the female pelvis, *the recto-uterine pouch (excavatio rectouterina)* between the rectum and the uterus and *the vesico-uterine pouch (excavatio vesicouterina)* between the uterus and the urinary bladder.

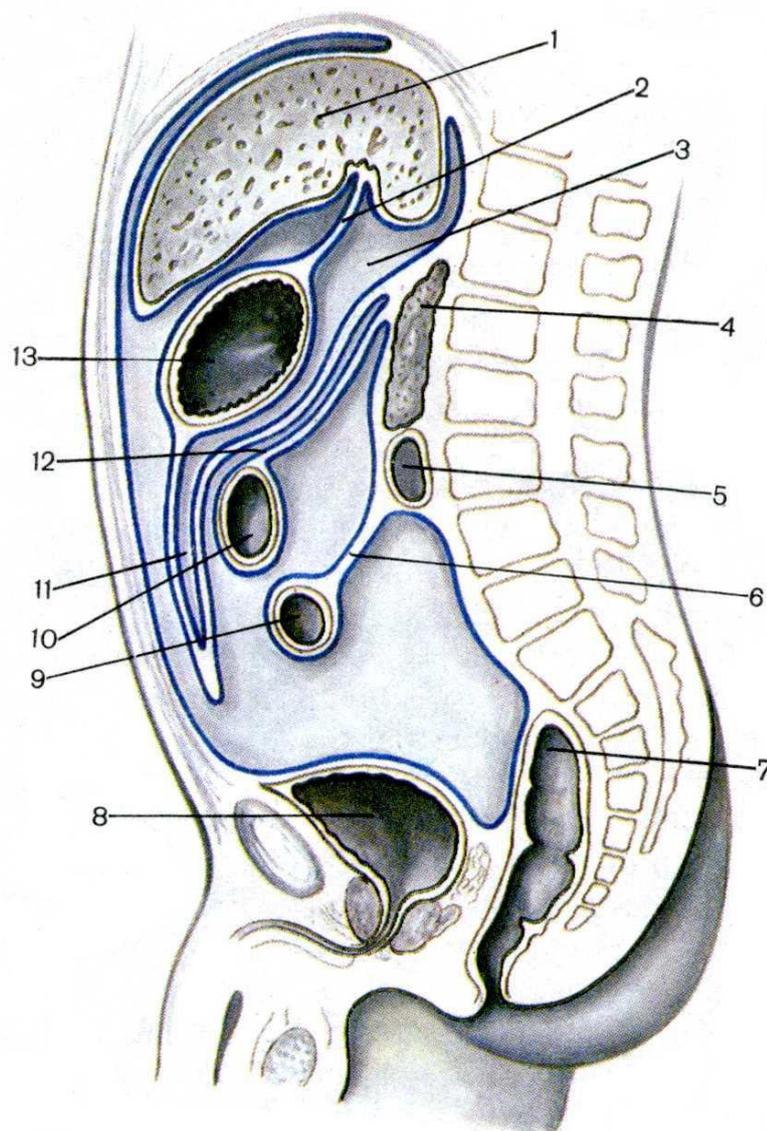


Fig.19. Topography of the peritoneum in the abdominal cavity (sagittal section)
(Sapin M.R. A Textbook of Human Anatomy, V.I, 5th ed. Moscow, Medicine, 2001, p. 568)

1. Liver
2. Lesser omentum
3. Omental bursa
4. Pancreas
5. Kidney
6. Mesentery
7. Rectum
8. Urinary bladder
9. Small intestine
10. Large intestine
11. Greater omentum
12. Transverse mesocolon
13. Stomach

We shall now trace the course taken by the peritoneum in transverse direction:

- From the anterior abdominal wall the peritoneum extends to line the lateral walls of the abdominal cavity, passes to the posterior wall on the right and thus surrounds completely the caecum and its appendix, which has a mesentery.
- The peritoneum covers the ascending colon in front and on the sides, then passes medially and forms *the root of mesentery* that is reflected to be continuous with the left layer of the mesentery. Having supplied the small intestine with a complete serous covering, the peritoneum is continuous with the left layer of the mesentery.
- Then the peritoneum is continuous with the parietal peritoneum on the posterior abdominal wall. The peritoneum approaches the descending colon, which is related to the peritoneum in the same manner as ascending colon.
- Still further laterally, on the lateral abdominal wall, the peritoneum is again reflected on the anterior abdominal wall.

Regions of the peritoneal cavity

- ***The omental bursa (bursa omentalis)***
 - It is the part of the general peritoneal cavity lying behind the stomach and the lesser omentum.
 - The omental bursa is bounded above by the caudate lobe of the liver, behind by the parietal peritoneum covering the abdominal aorta, the inferior vena cava, the pancreas, below by the posterior lamina of the greater omentum, fused with the transverse mesocolon, in front by the lesser omentum and the posterior surface of the stomach.
 - The cavity of the omental bursa communicates with the general peritoneal cavity only by means *the omental foramen (foramen omentale)*.
 - The foramen is bounded above by the caudate lobe of the liver, in front by the margin of the hepatoduodenal ligament, below by the superior part of the duodenum, behind by the peritoneal layer covering the inferior vena cava.

- *The right and left subphrenic spaces (recessus subphrenicus)* present just below the diaphragm between the latter and the liver.
- *The right and left subhepatic spaces (recessus subhepaticus)* present just below the liver. The deepest part of the right subhepatic space is called *the hepatorenal space (recessus hepatorenale)*.
- Between the lateral abdominal walls and the ascending colon and descending colon *the right and left paracolic gutters (sulci paracolici)* present respectively.
- The space bounded by the colon is divided by the root of the mesentery into *the right and left mesenteric sinuses*. Right mesenteric sinus is a triangular space between root of mesentery, ascending colon, right 2/3 of transverse colon and its mesocolon. Left mesenteric sinus lies between root of mesentery, descending colon, right 1/3 of transverse colon and its mesocolon.
- A series of peritoneal recesses are seen on the posterior parietal peritoneum. They may be the place where retroperitoneal hernias form.
 - Small pockets form at the junction of the duodenum and jejunum; they are *superior and inferior duodenal fossa (recessus duodenalis superior, inferior), retroduodenal and paraduodenal fossa (recessus retrododenalis, paraduodenalis)*.
 - At the junction of the small intestine and the colon are two recesses - *the superior and inferior iliocaecal recesses (recessus ileocaecalis superior, inferior)*.
 - A recess in the parietal peritoneum lodging the caecum is called *the retrocaecal recess (recessus retrocaecalis)*.
 - On the left side (on the lower surface of the mesocolon sigmoideum) there is *the intersigmoid recess (recessus intersigmoideus)*.

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