

**I. V. Gaivoronskiy, M. G. Gaivoronskaya,  
A. A. Kurtseva, G. I. Nichiporuk**

**DIGESTIVE SYSTEM**  
**ПИЩЕВАРИТЕЛЬНАЯ СИСТЕМА**

**The manual for medical students**

*Учебное пособие для медицинских вузов  
(специальность «Лечебное дело»)*

Санкт-Петербург  
СпецЛит  
2017

УДК 611.3  
П36

**Авторы:**

*Гайворонский Иван Васильевич* — доктор медицинских наук, профессор, заведующий кафедрой морфологии медицинского факультета Санкт-Петербургского государственного университета и кафедрой нормальной анатомии Военно-медицинской академии им. С. М. Кирова;

*Курцева Анна Андреевна* — кандидат медицинских наук, доцент кафедры анатомии человека Курского государственного медицинского университета;

*Гайворонская Мария Георгиевна* — доктор медицинских наук, доцент кафедры морфологии Санкт-Петербургского государственного университета и ассистент кафедры челюстно-лицевой хирургии и хирургической стоматологии Военно-медицинской академии им. С. М. Кирова;

*Низипорук Геннадий Иванович* — кандидат медицинских наук, доцент кафедры морфологии Санкт-Петербургского государственного университета

П36 **Пищеварительная система** : учебное пособие для медицинских вузов / И. В. Гайворонский, М. Г. Гайворонская, А. А. Курцева, Г. И. Ничипорук. — Санкт-Петербург : СпецЛит, 2017. — 95 с.

ISBN 978-5-299-00849-4

УДК 611.3

# CONTENTS

<b>List of abbreviations</b> .....	5
<b>Preface</b> .....	6
<b>1. General splanchnology</b> .....	8
1.1. Principles of structure of hollow organs.....	9
1.2. Principles of structure of parenchymatous organs .....	11
Test questions .....	12
<b>2. Alimentary system.</b> .....	13
2.1. Oral cavity .....	13
2.2. Teeth.....	16
2.3. Tongue .....	23
2.4. Salivary glands.....	29
2.5. Palate .....	31
Test questions .....	34
Clinicoanatomical problems .....	35
2.6. Pharynx .....	36
2.7. Oesophagus.....	40
2.8. Stomach .....	43
Test questions .....	46
Clinicoanatomical problems .....	48
2.9. Small intestine .....	48
2.9.1. Duodenum .....	50
2.9.2. Mesenteric part of small intestine .....	52
2.10. Large intestine .....	53
Test questions .....	59
Clinicoanatomical problems .....	61
2.11. Liver .....	61
2.12. Gallbladder .....	67
2.13. Pancreas .....	68
Test questions .....	70
Clinicoanatomical problems .....	71

---

---

2.14. Morphofunctional features of peritoneum .....	72
2.15. Review of abdominal viscera .....	80
2.16. Anatomical and topographical features of peritoneal cavity .....	84
2.17. Development of digestive organs .....	87
2.18. Development of face .....	88
2.19. Developmental anomalies of face .....	90
2.20. Development of peritoneum .....	90
2.21. Developmental anomalies of digestive organs .....	93
Test questions .....	94
Clinicoanatomical problems .....	95

## LIST OF ABBREVIATIONS

- Art., art. — articulatio  
Artt., artt. — articulationes  
For., for. — foramen  
Lig., lig. — ligamentum  
Ligg., ligg. — ligamenta  
M., m. — musculus  
Mm., mm. — musculi  
N., n. — nervus  
Nn., nn. — nervi  
R., r. — ramus  
Rr., rr. — rami  
S., s. — sulcus

## PREFACE

The creation of the manual «Alimentary System» in English meets the requirement of modern Russian medicine and education. Nowadays many English-speaking oversea students study in Medical Universities of Russia. Besides, many Russian school leavers have a good command of the English language so they will be able to use this manual taking into consideration the fact that many Russian specialists in medicine work abroad after graduating from the universities or take part in different international conferences and symposiums.

The English version of the manual is based on the Russian manual by professor Gayvoronskiy I. V. «Normal Human Anatomy» which has been published in Russia 9 times and is approved by the Ministry of education of Russia.

This manual introduces the main principles of Russian Anatomy School such as: detailed study of the general aspects and items of Anatomy including the development of organs and anomalies of the development. If we compare theoretical approaches to Anatomy in Russia and in other countries we'll see that our approach is based on the system descriptions of organs, i.e. we describe separately Skeletal system, Articulations, Muscular system etc. Moreover, we use Latin terminology while describing the organs and discuss clinicoanatomical and functional problems. As for the manuals in other countries many of them describe Anatomical systems in accordance with the regional and topographical principles.

The structure of our manual meets the requirements of modern standards of medical education in Russia which in their turn correspond to the major European standards. After each chapter we give test questions and clinicoanatomical problems. The English and Latin terminology is given in accordance with International Anatomical Nomenclature.

The authors strongly believe that the manual will allow future doctors to form the morphological foundation for the further study of theoretical and clinical disciplines. We also hope that it will be of great help to Anatomy teachers.

## ПРЕДИСЛОВИЕ

Создание учебного пособия «Пищеварительная система» на английском языке является требованием современной системы медицинского образования в России. В настоящее время в медицинских университетах нашей страны обучаются студенты из различных регионов дальнего зарубежья. Кроме того, многие выпускники российских школ хорошо владеют английским языком, поэтому они также смогут пользоваться данным пособием, принимая во внимание, что зачастую русские специалисты в медицине после окончания университета уезжают работать за рубеж или принимают участие в различных международных конференциях и симпозиумах.

Английская версия пособия базируется на русском учебнике профессора И. В. Гайворонского «Нормальная анатомия человека», который был издан в России 9 раз и одобрен Министерством образования Российской Федерации.

Данное пособие познакомит читателей с главными принципами Русской анатомической школы, которые заключаются в подробном изучении общих вопросов, в том числе развития органов и аномалий развития. В России преподавание анатомии ведется с функционально-клинических позиций и основано на описании органов по системам, т. е. отдельно изучается опорно-двигательная система, артросиндесмология, миология и другие системы. Также при описании строения органов акцентируется внимание на латинской терминологии. Что касается зарубежных руководств по анатомии человека, многие из них основываются на регионально-топографическом принципе без использования латинской терминологии.

Структура данного пособия соответствует современным стандартам медицинского образования в России, которые, в свою очередь, соответствуют важнейшим европейским стандартам. После каждой главы мы приводим контрольные вопросы и ситуационные клинические задачи. Английская и латинская терминология приведена в соответствии с Международной анатомической номенклатурой.

Авторы выражают уверенность, что данное пособие позволит будущим докторам сформировать морфологический фундамент для последующего изучения теоретических и клинических дисциплин. Мы также надеемся, что оно принесет определенную пользу и преподавателям анатомии человека.

# 1. GENERAL SPLANCHNOLOGY

Splanchnology is the science of viscera. The viscera, *viscera seu splanchna*, are the internal organs, mainly located within the thoracic and abdominal cavities of the human body (fig. 1.1). The thoracic cavity contains the heart, lungs, thymus, oesophagus. The abdominal cavity contains most viscera: the stomach, liver, pancreas, small and large intestine, spleen, kidneys, adrenal glands, ureters,

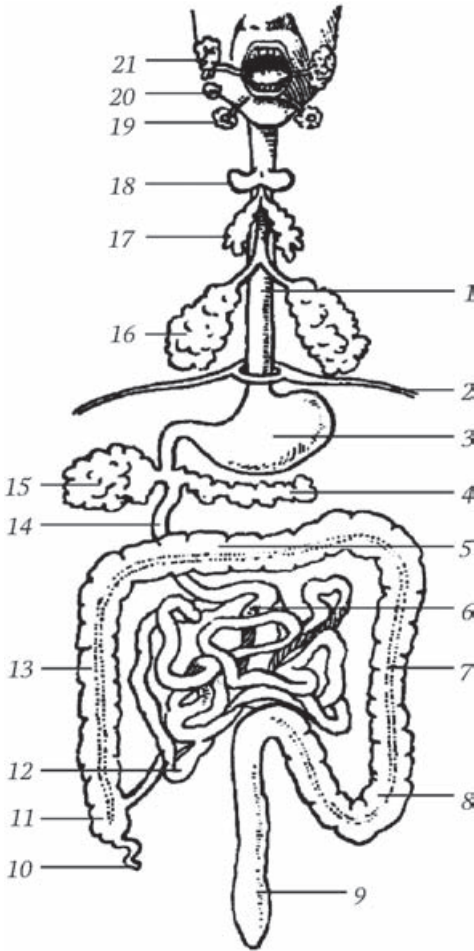


Fig. 1.1. The organs of neck, thoracic and abdominal cavities (scheme):

- 1 – oesophagus; 2 – diaphragm; 3 – stomach; 4 – pancreas; 5 – transverse colon; 6 – jejunum; 7 – descending colon; 8 – sigmoid colon; 9 – rectum; 10 – vermiform appendix; 11 – caecum; 12 – ileum; 13 – ascending colon; 14 – duodenum; 15 – liver; 16 – lungs; 17 – thymus; 18 – thyroid gland; 19 – submandibular gland; 20 – sublingual gland; 21 – parotid gland

spleen, kidneys, adrenal glands, ureters, urinary bladder, prostate (in males), uterus, ovaries, uterine tubes (in females). But not all the internal organs are inside the cavities, some of them are outside (e. g. the external reproductive organs in males and females). Some organs are in the head and neck. The larynx, pharynx, thyroid gland, parathyroid glands and also the part of the oesophagus are in the neck. The tongue, teeth, salivary glands are organs of the head.

Thus, the viscera form the alimentary, respiratory, urogenital systems; they partly form the endocrine system. The heart, as the central organ of the cardiovascular system, also belongs to the internal organs. The brain and the spinal cord do not belong to the viscera.

The listed organs have various forms, sizes and certain functions. According to the structure, most organs can be divided into two groups: hollow and parenchymatous. The hollow, or tubular, organs are similar in the structure of the wall and have a cavity inside. Such organs are the oesophagus, stomach, intestine, ureter etc. The parenchymatous organs are structured from homogenous mass termed the parenchyma (e. g. the liver, kidneys, pancreas etc.). Only few organs have specific structure: the tongue (muscular organ), the teeth (comprised of solid tissues), the prostate (organ having a mixed structure (muscular-parenchymatous-tubular)).

Taking into account the complex structure of the viscera, we suggest an indicative plan for the study and description of the organs:

- 1) general description of an organ (shape, configuration, sizes, weight);
- 2) external structure of an organ (parts, surfaces, borders, grooves and so on);
- 3) internal



structure of an organ (tissular architecture) and structural units; 4) topography of an organ; 5) data of radiographic, tomographic, ultrasonic examination of an organ; 6) function of an organ; 7) blood and lymphatic vessels of an organ; 8) innervation of an organ.

The form, external structure and position of the viscera are various. Also it is necessary to take into account the age changes of the viscera. The sexual differences of the organs are not significant (certainly except the reproductive organs).

For the doctors it is especially important to know the topography of the organs: holotopy, skeletotopy and syntopy. The holotopy is the relations of the viscera to the body regions (regions of head, neck, chest, back, abdomen and perineum): it means the projection of the organ to the body surface. The skeletotopy is the relation of the organ to the parts of the skeleton or to the certain bony projections which can be easily palpated in a living person or can be seen in radiograph. The syntopy is the relation of the organ to the adjacent viscera, vessels and nerves.

The position of the organs is mainly determined by the body type physique. For example, in normosthenic body type physique, the stomach is hook-shaped; in asthenic body type physique, it is like an elongated hook; in hypersthenic body type physique, the stomach lies horizontally, like a horn.

### 1.1. Principles of Structure of Hollow Organs

The wall of the hollow (tubular) organs is a series of layers, arranged from inside outwards as follows: mucous membrane, muscular coat and adventitia (or serous membrane).

**Mucous membrane**, *tunica mucosa*, lines the inner surface of the hollow organs of the alimentary, respiratory and urogenital systems. The mucosa of the different hollow organs is similar in structure (fig. 1.2). It consists of the epithelial layer, the basement membrane called the lamina propria, lamina muscularis and submucous layer. The structure of the mucous epithelium, *epithelium mucosae*, is specific for each organ. It can be multi-layered, as in the oral cavity, or single-layered, as in the stomach and intestine. Owing to small thickness and transparency of the epithelial layer, the mucous membrane has a certain color (from pale pink to vermilion). The color depends on the depth of localization and quantity of the blood vessels in the lamina propria. The epithelium itself has no vessels.

The lamina propria of mucous membrane, *lamina propria mucosae*, is under the

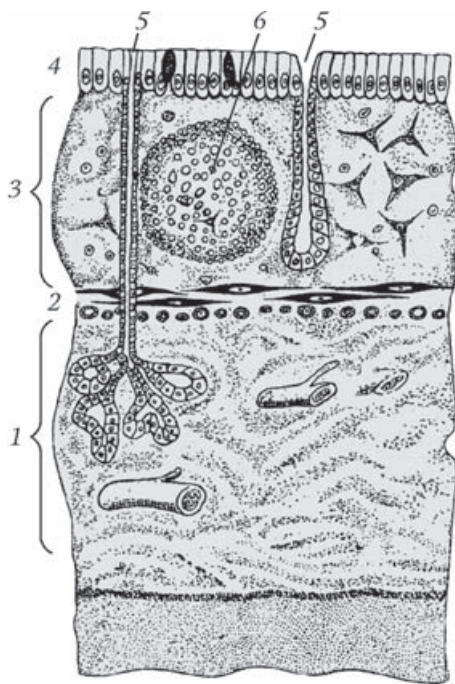


Fig. 1.2. Scheme of the structure of mucosa:

1 – tela submucosa; 2 – lamina muscularis mucosae; 3 – lamina propria mucosae; 4 – epithelium; 5 – glands; 6 – solitary lymphatic follicle

epithelium; it bulges into the epithelium like tiny projects termed papillae, *papillae*. Loose connective tissue of the lamina propria contains the branches of the blood and lymphatic vessels, the nerves, glands and lymphoid tissue.

The glands of the mucous membrane are formed by the aggregation of the epithelial cells which penetrate into the underlying tissue.

It should be noted, that they penetrate not only the lamina propria of mucous membrane but even the submucous layer. The glandular cells elaborate the mucus or the secretion for the chemical digestion of food. The glands may be unicellular or multicellular. For example, the goblet cells of the mucous of the large intestine, producing the mucus, are unicellular. The multicellular glands produce the special secretion: saliva, gastric and intestinal juice. The terminal parts of the glands deeply penetrate the mucosa; this provides their abundant blood supply. The multicellular glands of the mucous layer differ in form; they may be tubular (in the form of a tube), alveolar (like a vesicle) and tubulo-alveolar (combined) glands.

The lymphoid tissue of the lamina propria mucosae is comprised of the reticular tissue which is rich in lymphocytes. It may be diffuse, or may collect in small masses, termed the lymphoid follicles (nodules). The lymphoid follicles may be solitary, *noduli lymphoidei solitarii*, (their diameter is about 0,5–3 mm), or aggregated, *noduli lymphoidei aggregate* (their diameter is about 10–15 mm).

The lamina muscularis mucosae, *lamina muscularis mucosae*, adjoins the submucosa and consists of 1–3 layers of smooth muscle cells. The mucosa of the tongue, palate, gum, tonsils has no lamina muscularis.

The submucosa lies between the mucous and muscular layers. It is well-developed in most viscera; rarely the mucous membrane lies immediately over the muscular layer. The submucous layer provides the firm fixation of the mucous membrane. It is formed by loose connective-tissue containing the submucous vascular (arterial, venous, lymphatic) and nerve plexuses. Hence it contains the main intraorganic vessels and nerves. The submucous layer possesses a high mechanical durability. It is firmly linked with the lamina propria and muscularis of mucous membrane and loosely linked with the muscular layer. Due to this, the mucous membrane is able to displace relatively to the muscular layer.

The role of the mucous membrane is multifarious. First of all the epithelium provides the mechanical and chemical protection of the organs. The contraction of the mucous membrane itself and the mucus facilitates the transport of the content of the hollow organs. The aggregation of the lymphoid tissue in the lymphoid follicles or lymphoid tonsils plays the important role in biological protection of the body. The secretions of the glands (mucus, enzymes, digestive juices) work as catalysts or the components of the metabolic processes. At last, the mucous membrane of some digestive organs absorbs the nutrients and liquids. In these organs the area of the mucous membrane is greatly increased due to the folds and microvilli.

**Muscular coat**, *tunica muscularis*, is a middle layer in the wall of a hollow organ. Most commonly it is formed by two layers of smooth muscle tissue, having the different orientation. The circular layer, *stratum circulare*, is internal; it immediately surrounds the submucous layer. The longitudinal layer, *stratum longitudinale*, is external. The architecture of the muscular layer is specific for each viscus. The different organs have certain structure of muscle fibers, number of muscular layers, arrangement and degree of development of muscle fibers. Most commonly the muscle fibers of the wall of a hollow organ

*Учебное пособие*

**DIGESTIVE SYSTEM**  
**ПИЩЕВАРИТЕЛЬНАЯ СИСТЕМА**

**The manual for medical students**

Компьютерная верстка *Тархановой А. П.*  
Подписано в печать 06.03.2017. Формат 70×100<sup>1</sup>/<sub>16</sub>.  
Печ. л. 6. Тираж 1000 экз. Заказ №

ООО «Издательство „СпецЛит“».  
190103, Санкт-Петербург, 10-я Красноармейская ул., 15  
Тел./факс: (812) 495-36-09, 495-36-12  
<http://www.speclit.spb.ru>

Отпечатано в типографии «L-PRINT»,  
192007, Санкт-Петербург, Лиговский пр., 201, лит. А, пом. 3Н