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# FEATURES OF THE IMMUNE SYSTEM STRUCTURE OF THE MUCOSA OF THE SMALL INTESTINE OF MICE

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**Abstract**
Afferent and efferent units of immune system of mucous membrane of the small intestine in white outbred rats have been studied light-and electron microscopically. On the basis of the received findings it was established that afferent unit stimulates and regulates T-, B - blast's coo relation. Action of epithelium, stimulated T- and B - lymphocytes and cells of connective tissue has been integrated in efferent unit.

**Keywords:** immune system, small intestine, mucous membrane, white rats, epithelium, lymphocyte, structure, cells, integration, loose connective tissue.

Afferent and efferent links of the mucous membrane immune system of the small intestine were studied in light and electron microscopic studies in white outbred rats. Based on the results obtained, it was found that the afferent link stimulates and regulates the antigens interaction and T-, B-lymphocytes. The afferent link integrates the epithelium activity, stimulated T- and B-lymphocytes and cells of loose connective tissue.

The digestive tube, being on the border of the external and internal body environments, is constantly exposed to the chemical substances effects of different nature. As a result, structures are formed in the intestinal wall, which function is to ensure the internal environment constancy of the body [2,3,9,10,11]. The immune structures of the mucous membrane (ISMM) of the small intestine are among such formations. The structure and functional significance of them attract the close attention of many researchers. [9,12,13]

This study purpose was to study the structural features of the afferent and efferent ISMM units of the small intestine of sexually mature rats.

## Material and research methods

Pieces of the mucous membrane of the jejunum and lymphoid (Peyer's) plaques of the ileum were studied in 3 months old white outbred rats (n = 6). After decapitation of anesthetized animals, the abdominal cavity was opened along the white line. After separation of the small intestine from the mesentery under an MBS-2 microscope, the number and linear parameters of lymphoid plaques, the distance between them, and their mass were determined.

Fixation of intestine and lymphoid plaques pieces for light microscopy was carried out in Carnoy mixture; for electron microscopy, the pieces were fixed in a buffered 2.5% glutaraldehyde solution (20 min) and 1% $OsO_4$ (1.5 hours). After passing through alcohols of increasing concentration, pieces of intestine were poured into paraffin or araldite. Paraffin sections with 5-6 microns thickness are stained

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with hematoxylin-eosin, semi-thin sections - with the main fuchsin - methylene blue. For electron microscopy, ultrathin sections were contrasted with uranyl acetate and lead citrate and viewed under a JEM-100S microscope. On semi-thin sections in the lymphoid plaques of sexually mature rats, the ratio of individual cells types was calculated. Quantitative studies were processed by the generally accepted methods of variation statistics [8].

**Results and its discussion**

In sexually mature rats, lymphoid plaques are located singly or in groups in the lamina propria of the mucous membrane and the small intestine submucosa. Their total number varies from 17 to 28 (on average 23,8+1,4). The distance between adjacent lymphoid plaques ranges from 5 to 180 mm (on average 55,1+2,2 mm). If the entire small intestine is divided into 3 equal parts, then in the distal direction, the number of plaques is 26,6+3,9(I), and 40,2+2,3(II) and 33,4+3,1%(III).

A significantly greater number of lymphoid formations in the II and III parts of the small intestine, compared to 1, is explained by the fact that it is in these departments that during the digestion and absorption of food digestion products, the antigens bulk is formed, which affect the intestinal walls and immune structures.

The mass of individual lymphoid plaques varies from 30 to 52 μg (on average 29,6+0,5 μg); total mass is 704,5+6,2 μg.

In accordance with modern concepts, in individual lymphoid nodules of the lymphoid plaque, zones are distinguished: germinal (central), peripheral (marginal) and dome. Each lymphoid nodule, which has a rounded shape, is separated from the neighboring thin nodules by an inter-nodular zone. Lymphoid nodules located in the peripheral parts of the lymphoid plaques, without sharp boundaries, pass into the loose connective tissue of the lamina propria of the mucous membrane and submucosa.

Lymphoid plaques bulge into the intestinal lumen in a semi-ball or cone form, and are surrounded by crypts at the periphery. As a result, a depression is formed, which probably contributes to a more perfect contact between the epithelium and the intestinal contents.

The epithelium that covers the lymphoid plaques surface is single-layered prismatic, abundantly infiltrated with lymphocytes. At the base, where the crypts are located, single goblet cells are revealed. Above the level of crypts, they are almost not detected.

A lymphoid nodules feature of lymphoid plaques is the zonal arrangement of their cells. Reticular cells interact with each other and are clearly distinguished between zones.

In a relatively light breeding center, small and large lymphoblasts, single macrophages are present. It is surrounded in a rim form by a marginal zone formed by densely located small lymphocytes. The dome is a relatively narrow area where, along with small lymphocytes, relatively many macrophages are detected. The proportion of large lymphocytes in the proliferation zone and in the dome is 23,7+1,1 и 16,1+1,2%, respectively. The relative proportion of reticular cells in all zones is almost the same.

Electronomicroscopic lymphoblasts in the lymphoid nodules proliferation centers have a large rounded nucleus, less often with a bay-shaped depression. The narrow rim of the cytoplasm contains single small mitochondria, flattened short cisterns, and Golgi complex vesicles; ribosomes are numerous and

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ubiquitous. Gathering 3-4, they form small rosettes. Groups of lymphoblasts are separated by long-process reticular cells. Occasionally, mitotically dividing lymphoblasts are found at the pro - and metaphase stage.

The marginal and near-nodular zones are formed mainly by small lymphocytes, occasionally large lymphocytes can be located between them. In the small lymphocytes cytoplasm, mitochondria are small, single, the Golgi complex consists of single cisterns and venules. The lymphoid nodules dome of lymphoid plaques differs in ultrastructure from its other zones. In it, along with small, medium and large lymphocytes, macrophages containing polymorphic lysosomes are often found. If in some lysosomes the nucleus and fragments of phago-cited cells differ, in others there are residual bodies or myelin formations. The cytoplasm also contains small smooth-walled vesicles, mitochondria with a clear matrix, reduced cristae. The macrophages nucleus is large, located eccentrically. The lymphoid nodules dome, in comparison with other areas, has more blood capillaries. If from the blood capillaries some lymphoblasts go into lymphoid nodules zones, then at the same time others, stretched out in a chain, go into the lymphatic capillaries. Radioautographic examination after one, two and three times injections of $H_3$– thymidine, we have shown that lymphocytes migrate at a high speed to the marginal and near the nodular zone into the nodules dome. Within 10-12 hours, lymphocytes from all zones migrate to the dome, where they interact with T-lymphocytes, macrophages, preparing highly specific antigens. After stimulation with antigens, the lymphocytes migrate to the lymphatic capillaries [1]. T- and B-lymphocytes enter the lymphoid plaques from the central organs of the immune system (bone marrow, thymus). Subsequently, after stimulation with antigens, after 10-12 hours they migrate into the lymph and bloodstream. Antigens of microorganisms (mainly) and food, affecting lymphocytes, provide a tense immune potential of the whole organism, mucous membranes and skin in particular. The lymphocytes movement from the central organs of the immune system to the afferent link of the ISMM, and after stimulation to the efferent sites (lamina propria of the mucous membranes, skin), allows regulating the antigens transport from the external environment and maintaining homeostasis of the internal body environment.

The lymphoid plaques surface is covered with several epithelial cells types, between which there are numerous (up to 90%) T-lymphocytes. Among epithelial cells, there are M-neuroreceptor and limb cells typical in structure [6, 11]. M- Neuroreceptor cells are detected from 1 to 4%, are found in the fornix region of lymphoid plaques. M-cells carry out constant endocytic transport of antigens from the intestinal lumen to T-lymphocytes and macrophages. In their ultrastructure, neuroreceptor cells are almost identical to brush alveolocytes [5], receptor cells of the organ of Corti [4].

Based on the results obtained, as well as the literature on the lymphoid plaques structure, we come to the conclusion that antigens of normal microflora and food provide constant stimulation of T- and B-lymphocytes, lymphoid plaques macrophages. Unlike other immune system organs that are not associated with the gastrointestinal tract, they are distinguished by the highest ability to migrate into the lymph and bloodstream. The presentation of antigens by M-cells by T-lymphocytes, macrophages and -blasts presupposes their regulation and their activation. Migrating through the lymphatic vessels, through the nodes into the blood and spleen, they settle in the lamina propria of the mucous membranes

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(ISMM efferent zone), along the ducts of the exocrine glands, into the mammary glands (during lactation). The T-lymphocytes bulk (helpers, killers, sup-springs, etc.) infiltrate the inter-epithelial space. Cytotoxic CD8+, being between the villi enterocytes of the small intestine, bind bacterial antigens penetrating from the intestinal lumen, are involved in their presentation and cytokine production [10]. In the food digestion dynamics, endocrine and neuroreceptor cells, under the influence of the resulting substrates ("signaling molecules"), regulate blood and lymph flow, enterocytes renewal, the interaction of connective tissue and epithelial cells, and nerve formations.

**Conclusions**

1. The afferent link of the ISMM, due to its structural features, both stimulates T- and B-lymphocytes, and regulates it.
2. The efferent link integrates the functional epithelium activity, T- and B-lymphocytes populations and cells of loose connective tissue.

**Резюме**

К статье: Осбайов М.И. «Особенности строения иммунной системы слизистой оболочки тонкого кишечника мышей».

Свето- и электронномикроскопически изучены структуры иммунной системы слизистой оболочки тонкой кишки у белых беспородных половозрелых крыс. Установлено, что афферентное звено представляет собой ассоциированную с эпителием лимфоидную ткань. Эпителий состоит из М-, нейрорецепторных и каемчатых энтероцитов, обильно инфильтрированных лимфоцитами. Лимфоидная ткань имеет по структуре различающиеся купол, фолликулярную, пара фолликулярную и герминативную зоны. Эфферентное звено состоит из меж эпителиальных лимфоцитов, лейкоцитов и клеток рыхлой соединительной ткани, деятельность которых интегрируется.

**Summary**

To the article of M.I.Osbayov, “Features of the immune system structure of the mucosa of the small intestine of mice”.

Afferent and efferent units of immune system of mucous membrane of the small intestine in white outbred rats have been studied light – and electron microscopically. On the basis of the received findings it was established that afferent unit stimulates and regulates T-, B – blast’s coo relation. Action of epithelium, stimulated T- and B – lymphocytes and cells of connective tissue has been integrated in efferent unit.

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