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Intestinal Lymphoid Tissue as the Basis of the Immune System of the Digestive Tract

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ABSTRACT

The article summarizes the basic provisions on the emerging ideas about the so-called immune system of the mucous membranes and, in particular, the intestine. Previously, the idea of cellular and humoral immunity was formed, then about the system of mononuclear phagocytes and, obviously, it is quite acceptable to isolate the immunity of the intestinal mucosa.

The gastrointestinal tract is a highly specialized organ that participates in the absorption of processing and assimilation of nutrients. In addition, it performs other equally important functions. The intestine is an important organ of the immune system: it is constantly in contact with a large number of substances and environmental agents, as well as factors affecting the vital activity of the whole organism. The article presents the characteristics of the components of the immune system of the digestive tract and their role in the formation of the body's immune response to antigenic effects.

Exposure to environmental antigens is a key factor in the development of protective reactions against various pathogenic microorganisms and many organic and inorganic substances, including carcinogens [7]. The intestine is the main area where immunocytes are sensitized, which then populates other mucous membranes and serves as a starting point for cell circulation between various organs. Immunocompetent tissues of the digestive tract are called lymphoid tissue. This tissue plays an important role in protecting the body from antigens. It should be noted that mucus secretion and intestinal motility also belong to the mechanisms of protection.

Lymphoid tissue in the wall of the digestive tract exists in four anatomical zones:

1) lymphocytes located basally between the epithelial cells of the mucous membrane — intraepithelial lymphocytes;
2) lymphocytes located in the connective tissue of their own layer of the mucous membrane-lymphocytes of their own layer;

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3) specific accumulations of lymphoid cells in the mucous membrane of the small intestine, in particular in the jejunum — Peyer's plaques;

4) solitary lymphoid follicles of the mucous membrane [1, 5].

Salivary glands, pharyngeal lymphoid tissue, regional lymph nodes and reticuloendothelial liver tissue are important components of the immune system of the digestive tract.

Intraepithelial lymphocytes are localized basally between the epithelial cells of the mucous membrane, especially in those places that come into contact with the external environment. The average number of lymphocytes of this type is 21 per 100 epithelial cells. These lymphocytes differ in their shape and size, as well as in the content of granules in the cytoplasm. They can migrate in both directions through the basement membrane. Granules of intraepithelial lymphocytes and mast cells are similar in their structure and chemical composition, therefore, some assumption is made that these lymphocytes are T-lymphocytes that are specifically associated with mast cells of the intestinal mucosa. T- and B-lymphocytes have been isolated among intraepithelial lymphocytes, but their exact division into groups is still unknown [1]. Although lymphocytes of their own layer have been studied by many specialists more intensively than intraepithelial lymphocytes, but the data on them are very scattered and contain many contradictions. It has been established that in the mucous membrane of the small intestine of a person they contain up to 11,000 per mm. Among lymphocytes, B cells predominate, their number is more than 50%, containing surface IgA. The remaining part of B-lymphocytes is represented by cells with surface IgM and IgG. T-lymphocytes are also present, but practically nothing is known about their subclasses, except that they produce antibodies and can penetrate into the intestinal mucosa in direct contact with plaques [3].

The most important property of the intestine is the phenomenon of lymphocyte recirculation. Sensitized by antigens (both food and infectious), the lymphocytes of Peyer's plaques migrate to the mesenteric lymph nodes, and from there through the lymphatic vessels through the thoracic duct and circulatory system are directed to their own layer of the intestinal mucosa, mainly as cells secreting IgA. This mechanism ensures the formation of clones of lymphocytes and the formation of specific antibodies in the areas of the mucous membrane remote from the focus of primary sensitization. In the process of sensitization of plasma cells, followed by cloning of lymphocytes that produce antibodies with certain properties (similar to those that acted as a matrix), not only native immunoglobulin molecules are involved. Antigens trapped in the intestinal lumen or on the mucous membranes are recognized by memory immunoglobulins (IgG), after which the information is transmitted to immunocompetent cells of the mucous membrane, where plasma cells responsible for the synthesis of IdA and IdM are cloned from sensitized lymphocytesAs a result of the protective activity of these immunoglobulins, the mechanisms of immunoreactivity or immunotolerance are activated. The immune system "remembers" antigens, which is facilitated by genetic factors, as well as IgG antibodies transmitted, for example, from the mother to the fetus during pregnancy, and immunoglobulins entering the gastrointestinal tract of a child with breast milk. As a result of lymphocyte recirculation and cloning, the immune response covers all gastrointestinal mucosa [3, 4].

The main function of intestinal immunoglobulins (Ig) is immune rejection at the surface of the mucous membrane. It is known that IgA predominates among immunoglobulins in all secretions and in the intestinal lamina proper. Secretory IgA, which plays the role of the main antigen destroyer and immunomodulator of the gastrointestinal mucosa, is retained near epithelial cells as a result of interaction with glycocalyx, largely due to the presence of intestinal microflora. IgA occupies a favorable position that prevents the absorption of antigens. The two-dimensional IgA molecule can function as agglutinin, reducing the adhesion of bacteria to enterocytes. Particular importance in the immunological functions of the gastrointestinal tract is attached to

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the small intestine, in which the organized lymphoid tissue is represented by grouped lymph nodes, appendix and lymph nodes of the breeches. These organs include a zone with follicular structures containing mainly B-lymphocytes and an intrafollicular (paracortical) zone consisting mainly of T-lymphocytes located around highly endothelial venules. Epithelial structures of grouped lymph nodes are specialized in the absorption of antigens by macrophages [2]. Peyer's plaques are structurally organized and decorated clusters of lymphoid cells in the submucosal layer of the small intestine. So in humans, they appear along the course of the entire small intestine already at the 24th week of intrauterine development. Peyer's plaques are surrounded by M-cells, which are devoid of villi and are responsible for transport and partly metabolic processes. These include the ability to transport macromolecules and particles from the intestinal lumen to the lymphocytes of Peyer's plaques. Plaques are poorly developed in animals raised in sterile conditions. Peyer's plaques contain up to 40% of T-lymphocytes, which are located in the interfollicular space [5, 6]. The highest concentration of Peyer's plaques was noted in the appendix — the vermiform process of the cecum. It is known that not all animals have it, for example, cats do not have it, but it is present in humans, monkeys, rabbits and a number of ruminants. The main function of this organ is to protect the intestine and its microflora from pathogenic agents. The appendix also performs a number of secondary functions: synthetic (produces amylase and lipase) and hormonal (produces hormones involved in the contraction of intestinal sphincters and regulating its peristalsis) [2, 4].

Solitary lymphoid follicles are contained in the mucous membrane and submucosal base of the intestine. But unlike Peyer's plaques, they do not have a close connection with the epithelium. This type of lymphatic formation contains T cells, B cells, and macrophages. Sensitized lymphocytes later migrate to mesenteric lymph nodes, and from there to the thoracic duct and the blood supply system to their own intestinal layer. An important role is played by the immunogenesis system in the activity of the colon, which is directly in contact with various bacterial antigens. It contains a large number of cells carrying Ig. The cells carrying IdA and IdM are located mainly in the surface epithelium, and the IgG carriers are located in the basal parts of the colon mucosa. IgG-secreting cells are mainly detected in the own plate of the mucous membrane [2]. The mucous membrane of a healthy mammal cannot completely block the penetration of antigens from the intestinal cavity into its wall, and then into the circulating blood. For example, botulinum toxin, once in the intestine, does not linger in the lumen of the intestine, but passes through the intestinal wall into the interstitial lymph. It is assumed that such a workaround of antigen migration bypassing the IgA system may be some kind of adaptation of the intestine to protect against antigens or a manifestation of a complex multi-stage strategy of protecting the intestine from antigens [4]. Thus, throughout the intestine, lymphatic tissues and their elements are very widely represented. They are diverse in structure and function. The cellular immunity of the intestine, in contrast to the system of antibodies secreted by it, has not been sufficiently studied. It is known that after oral exposure to antigens, systemic cellular immune reactions are rarely detected. It is possible that when a healthy organism receives harmless antigens (for example, antigens of normal microflora), cellular immunity reactions do not develop in the intestinal mucosa. Or if an immune reaction occurs, then the immune cells of the intestine cannot store information about the antigen in the memory cells. This indicates the presence of immune memory mechanisms in the intestine, but they, unlike the systemic immune response, are not of a long-term nature.

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