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Morphological Characteristics of Spleen Lymphoid Tissue

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Abstract: The spleen is an amazing lymphoid organ that combines innate and adaptive immunity in a coordinated way, and helps to remove blood-borne microorganisms and old erythrocytes from the blood circulation. This article provides information on the morphofunctional characteristics of lymphoid cells of the spleen.

Keywords: spleen, lymph, morphology, cells.

Relevance. The functions of the spleen are aimed at systemic blood circulation. Thus, it has no afferent lymphatic vessels. It consists of two functionally and morphologically different sections: red pulp and white pulp. The red pulp is a blood filter that removes foreign substances and damaged erythrocytes. It is also a storage place for iron, erythrocytes and platelets. An example is the site of hematopoiesis in rodents, especially in fetal and neonatal animals. The spleen is also the largest secondary lymphoid organ, containing one-quarter of the body's lymphocytes, and initiates immune responses against blood-borne antigens (Cooper et al., 2022; Nolte et al., 2022; Balogh et al., 2022). et al., 2014). This function is assigned to the white pulp surrounding the central arterioles. The white pulp consists of three subparts: periarteriolar lymphoid sheath (PALS), follicles, and marginal zone.

The spleen is surrounded by a capsule consisting of dense fibrous tissue, elastic fibers and smooth muscles. The outermost layer of the splenic capsule consists of mesothelial cells, which may not be evident on histological section. -Irregularly arranged trabeculae of smooth muscle and fibroelastic tissue emerge from the capsule to the splenic parenchyma. These trabeculae also contain blood and lymph vessels and nerves. Lymphatic vessels are efferent vessels through which lymphocytes pass to the splenic lymph nodes.

Being a blood filter, the spleen is a highly vascular organ. Blood flow through the spleen is a more complex but important and sometimes controversial concept. Blood enters the spleen at the hilus through the splenic artery. The splenic artery is divided into trabecular arteries located within the trabeculae entering the splenic parenchyma. Small arterioles branch off from trabecular arteries, enter the red pulp and become central arterioles surrounded by lymphoid tissue. Small arterioles branch off from the central arterioles and feed the capillary units of the white pulp. Some of them end in the marginal sinus at the junction of the white pulp and the marginal zone, others end in the marginal zone, and a few go beyond the white pulp and end in the red pulp. Blood entering the marginal sinus and marginal zone passes through the marginal zone in the direction of the red pulp. Blood passes through the marginal zone and flows directly into the adjacent venous sinuses, the open ends of which are continuous with the marginal zone, the so-called "fast way", or into the reticular network of the red pulp. , enters the "slow path". About 90% of the total splenic blood flow bypasses the reticular network of the red pulp and passes through the adjacent venous sinuses. As the central arterioles continue, the white pulp recedes and they become penicillary arteries surrounded by red pulp. They give rise to arterial capillaries that terminate in the reticular network of the red pulp in rodents. Blood from the red pulp collects in the venous sinuses, which enter the trabeculae and merge into the trabecular veins. The trabecular veins then join at the hilus to form the splenic vein, which drains into the hepatic portal system.

Red pulp. The red pulp consists of a three-dimensional network of splenic cords and venous sinuses. Splenic cords consist of reticular fibers, reticular cells and associated macrophages. Reticular cells are

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thought to be myofibroblasts and may play a role in the contraction of the spleen. As seen with an electron microscope, reticular fibers are actually covered by reticular cells and their processes. Reticular fibers consist of collagen and elastic fibers, microfibrils, basal layers of reticular cells and unmyelinated adrenergic nerve fibers.

The spaces between the follicles contain blood cells, including erythrocytes, granulocytes, and circulating mononuclear cells. It is also associated with the follicular pulps of the spleen, which contain lymphocytes and hematopoietic cells, as well as plasma cells and plasmablasts, which migrate to the follicles and the outer periarteriolar lymphoid sheath after antigen-specific differentiation. Red pulp macrophages are actively phagocytic, removing old and damaged erythrocytes and blood particles.

Extra medullary hematopoiesis is common in the red pulp of rodents, especially in fetuses and newborn animals. Any combination of erythroid, myeloid, and megakaryocytic cells may be evident.

Venous sinuses can be found along the red pulp, including, as mentioned above, directly connected to the marginal zone. They are covered by a network of loose endothelial cells located in the basement membrane between the endothelial cells and the reticular fibers of the red pulp (Saito et al., 2018). Penicillary arteries and arteriolar capillaries are also located in the red pulp, but they are more difficult to identify with a light microscope.

Different pigments can be present in the spleen. Accumulation of hemosiderin in the cytoplasm of macrophages in the red pulp, and sometimes also in the white pulp, is a typical finding. In fact, iron pigments (i.e., hemosiderin and ferritin) are the most abundant pigments in red pulp macrophages. The iron in the hemoglobin of phagocytosed erythrocytes is converted to hemosiderin for storage in the spleen. According to historical surveillance data from the National Toxicology Program (NTP), hemosiderin pigmentation is more common in women than in men (Ward et al., 1999). Ceroid and lipofuscin, derived from lipid oxidation, are also commonly found in the spleen, but are less abundant than hemosiderin (Ward et al., 1999). Melanin-containing melanocytes can be found in the spleen, especially in black mice, usually in trabeculae or in the red pulp (Ward et al., 1999).

White pulp. The white pulp is divided into periarteriolar lymphoid sheath (PALS), follicles and marginal zone. It consists of lymphocytes, macrophages, dendritic cells, plasma cells, arterioles, and capillaries, arranged in a reticular framework similar to that found in the red pulp. When the central arterioles enter the red pulp, they are surrounded by PALS consisting of concentric layers of lymphocytes and reticular fibers and flattened reticular cells. PALS is divided into internal and external PALS. Intrinsic PALS, which are T-cell dependent, may stain slightly darker than extrinsic PALS due to their cellular arrangement, which is predominantly composed of small lymphocytes. However, the difference is not uniformly present and is usually very subtle and difficult to detect with light microscopy (Stefanski et al., 2020). Intrinsic PALS cells are predominantly CD4 + T-cells, but smaller numbers of CD8 + T-cells, as well as interdigitating dendritic cells and migratory B-cells (Van Rees et al., 1996). The external PALS is filled with small and medium lymphocytes (both B- and T-cells), macrophages, and plasma cells as a result of antigenic stimulation. It is an important site of lymphocyte movement where plasma cell formation occurs. Follicles are continuous with PALS and are usually located at bifurcation sites of ¬central arterioles. They consist mainly of B-cells with fewer follicular dendritic cells and CD4 + T-cells, but usually no CD8 ¬+ T-cells. Follicles have larger lymphocytes in the follicular center, which are surrounded by a mantle zone or crown composed of small and medium-sized lymphocytes. Follicles may contain antigen-stimulated germinal centers, which stain less because of the presence of fewer cells and contain body macrophages and apoptotic B-cells.

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Recent studies have shown that pathological changes in the spleen are specific symptoms of various infectious diseases. However, many researchers have begun to study the standard structural and histological composition of the spleen in various laboratory animals, such as white rats Rattus norvegicus (Maynard and Downes, 2019), albino mice Mus musculus (Cesta), after severe disease. However, the lack of available information on the anatomical, histological and histochemical characteristics of the spleen in viral infection represents a significant gap in our understanding of the structure of this organ and its function in this species. Studying the morphological parameters of the spleen under the influence of lymphocyte activity is important in clinical, pathological and functional studies and provides valuable insight for ongoing medical and biological research.

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