Lymphoid System
Lec.15
part 2

Histology

Second year

A.T. Hadeel Kamil

Functional Correlations: Lymph Nodes

Lymph nodes are important components of the defense mechanism. They are distributed throughout the body along the paths of lymphatic vessels and are most prominent in the inguinal and axillary regions. Their major functions are lymph filtration and phagocytosis of bacteria or foreign substances from the lymph, preventing them from reaching the general circulation.

Trapped within the reticular fiber network of each node are fixed or free macrophages that destroy any foreign substances. Thus, as lymph is filtered, the nodes participate in localizing and preventing the spread of infection into the general circulation and other organs.

Lymph nodes also produce, store, and recirculate B cells and T cells. Here the lymphocytes can proliferate and the B cells can transform into plasma cells. As a result, lymph that leaves the lymph nodes may contain increased amounts of antibodies that can then be distributed to the entire body. B cells congregate in the lymphatic nodules of lymph nodes, whereas T cells are concentrated below the nodules in the deep cortical or paracortical regions.

Lymph nodes are also the sites of antigenic recognition and antigenic activation of B cells, which give rise to plasma cells and memory B cells.

All of the lymph that is formed in the body eventually reaches the blood, and lymphocytes that leave the lymph nodes via the efferent lymph vessels also return to the bloodstream.

The arteries that supply the lymph nodes and branch into capillaries in the cortical and paracortical regions also provide an entryway for lymphocytes into the lymph nodes. Most of the

lymphocytes enter the lymph nodes through the postcapillary venules located deep in the cortex.

Here, the postcapillary venules exhibit tall cuboidal or columnar endothelium containing specialized lymphocyte-homing receptors. Because these venules are lined by taller endothelium, they are called **high endothelial venules**. The circulating lymphocytes recognize the receptors in the endothelial cells and leave the bloodstream to enter the lymph node. Both B and T cells leave the bloodstream via the high endothelial venules. These specialized venules are also present in other lymphoid organs, such as **Peyer's patches in the small intestine, tonsils, appendix, and cortex of the thymus**; high endothelial venules are **absent from the spleen.**

FUNCTIONAL CORRELATIONS: Thymus Gland

The thymus gland performs an important role early in childhood in immune system development.

Undifferentiated lymphocytes are carried from bone marrow by the bloodstream to the thymus gland. In much of the thymic cortex, the epithelial reticular cells, also called thymic nurse cells, surround the lymphocytes and promote their differentiation, proliferation, and maturation. Here, the lymphocytes mature into immunocompetent T cells, helper T cells, and cytotoxic T cells, whereby they acquire their surface receptors for recognition of antigens. Furthermore, the developing lymphocytes are prevented from exposure to bloodborne antigens by a physical blood-thymus barrier, formed by endothelial cells, epithelial reticular cells, and macrophages.

Macrophages outside of the capillaries ensure that substances transported in the blood vessels do not interact with the developing T cells in the cortex and induce an autoimmune response against the body's own cells or tissues. After maturation, the T cells leave the thymus gland via the bloodstream and populate the lymph nodes, spleen, and other thymus-dependent lymphatic tissues in the organism.

The maturation and selection of T cells within the thymus gland is a very complicated process that includes positive and negative selection of T cells. Only a small fraction of lymphocytes generated in the thymus gland reach maturity. As maturation progresses in the cortex, the cells are presented by antigen-presenting cells with self and foreign antigens.

Lymphocytes that are unable to recognize or that recognize self-antigens die and are eliminated by macrophages (negative selection), which is about 95% of the total. Those lymphocytes that recognize the foreign antigens (positive selection) reach maturity, enter the medulla from the cortex, and are then distributed in the bloodstream.

In addition to forming the blood-thymus barrier, the epithelial reticular cells secrete hormones that are necessary for the proliferation, differentiation, and maturation of T cells and expression of their surface markers. The hormones are **thymulin, thymopoietin, thymosin, thymic humoral factor, interleukins, and interferon.** The epithelial reticular cells also form distinctive whorls called thymic (Hassall's) corpuscles in the medulla of the gland, which are characteristic features in identifying the thymus gland.

The thymus gland involutes after puberty, becomes filled with adipose tissue, and the production of T cells decreases. However, because T lymphocyte progeny has been established, immunity is maintained without the need for new T cell production. If the thymus gland is removed from a newborn, the lymphoid organs will not receive the immunocompetent T cells and the individual will not acquire the immunologic competence to fight pathogens. Death may occur early in life as a result of complications of an infection and the lack of a functional immune system.

FUNCTIONAL CORRELATIONS: The Spleen

The spleen is the largest lymphoid organ with an extensive blood supply. It filters blood and is the site of immune responses to bloodborne antigens. The spleen consists of red pulp and white pulp. Red pulp consists of a dense network of reticular fibers that contains numerous **erythrocytes, lymphocytes, plasma cells, macrophages, and other granulocytes.** The main function of the red pulp is to filter the blood. **It removes antigens, microorganisms, platelets, and aged or abnormal erythrocytes from the blood.**

The white pulp is the immune component of the spleen and consists mainly of lymphatic tissue. Lymphatic cells that surround the central arteries of the white pulp are primarily T cells, whereas the lymphatic nodules contain mainly B cells. Antigen-presenting cells and macrophages reside within the white pulp. These cells detect trapped bacteria and antigens and initiate immune responses against them. As a result, T cells and B cells interact, become activated, proliferate, and perform their immune response.

Macrophages in the spleen also break down hemoglobin of worn-out erythrocytes. Iron from hemoglobin is recycled and returned to the bone marrow, where it is reused during the synthesis of new hemoglobin by developing erythrocytes. The heme from the hemoglobin is further degraded and excreted into bile by the liver cells.

During fetal life, the spleen is a hemopoietic organ, producing granulocytes and erythrocytes. This hemopoietic capability, however, ceases after birth. The spleen also serves as an important reservoir for blood. Because it has a sponge like microstructure, much blood can be stored in its interior. When needed, the stored blood is returned from the spleen to the general circulation.