Lymphatic System

Lec 8

to

Second stage students

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by

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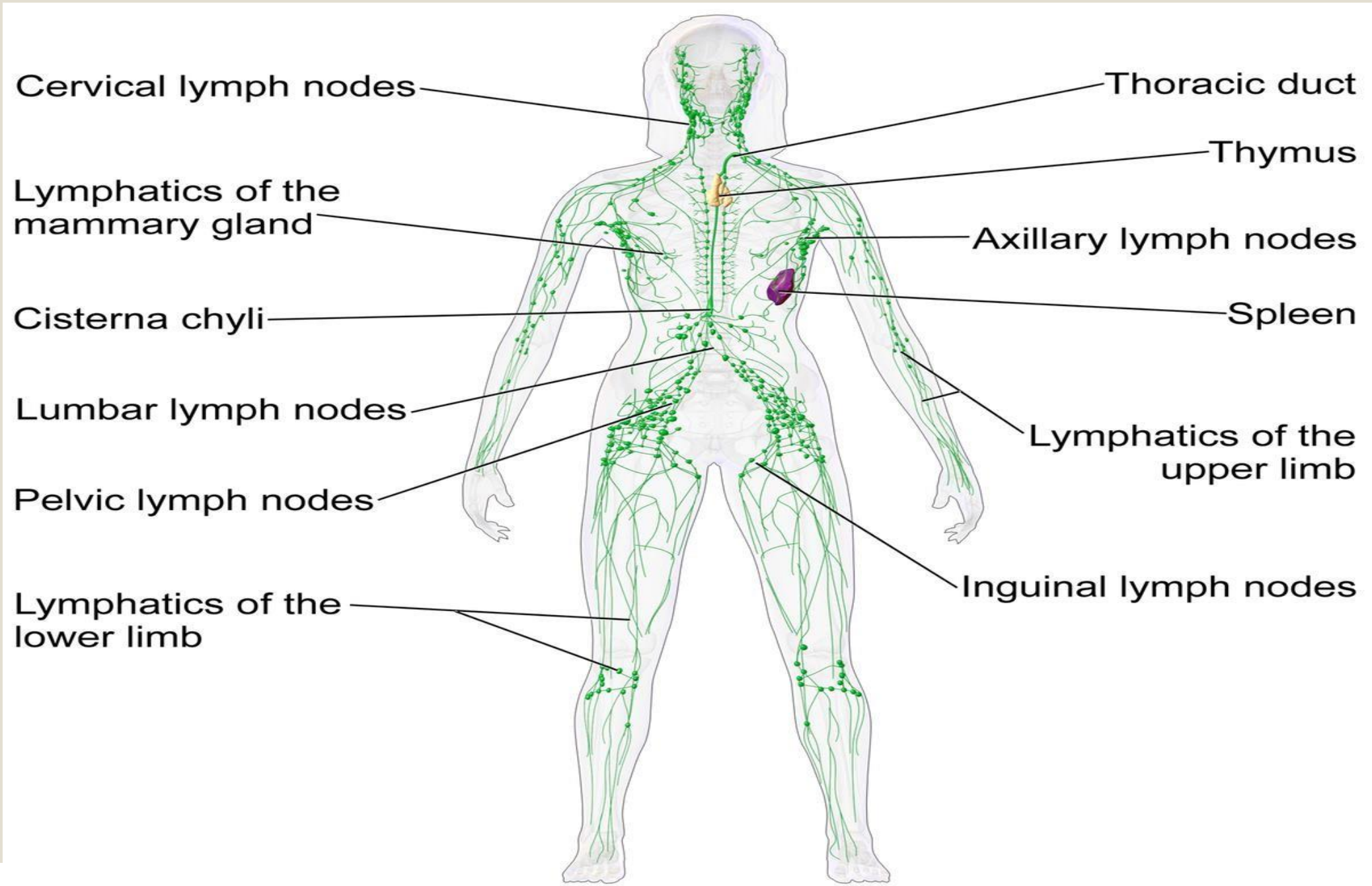
Lymphatic System

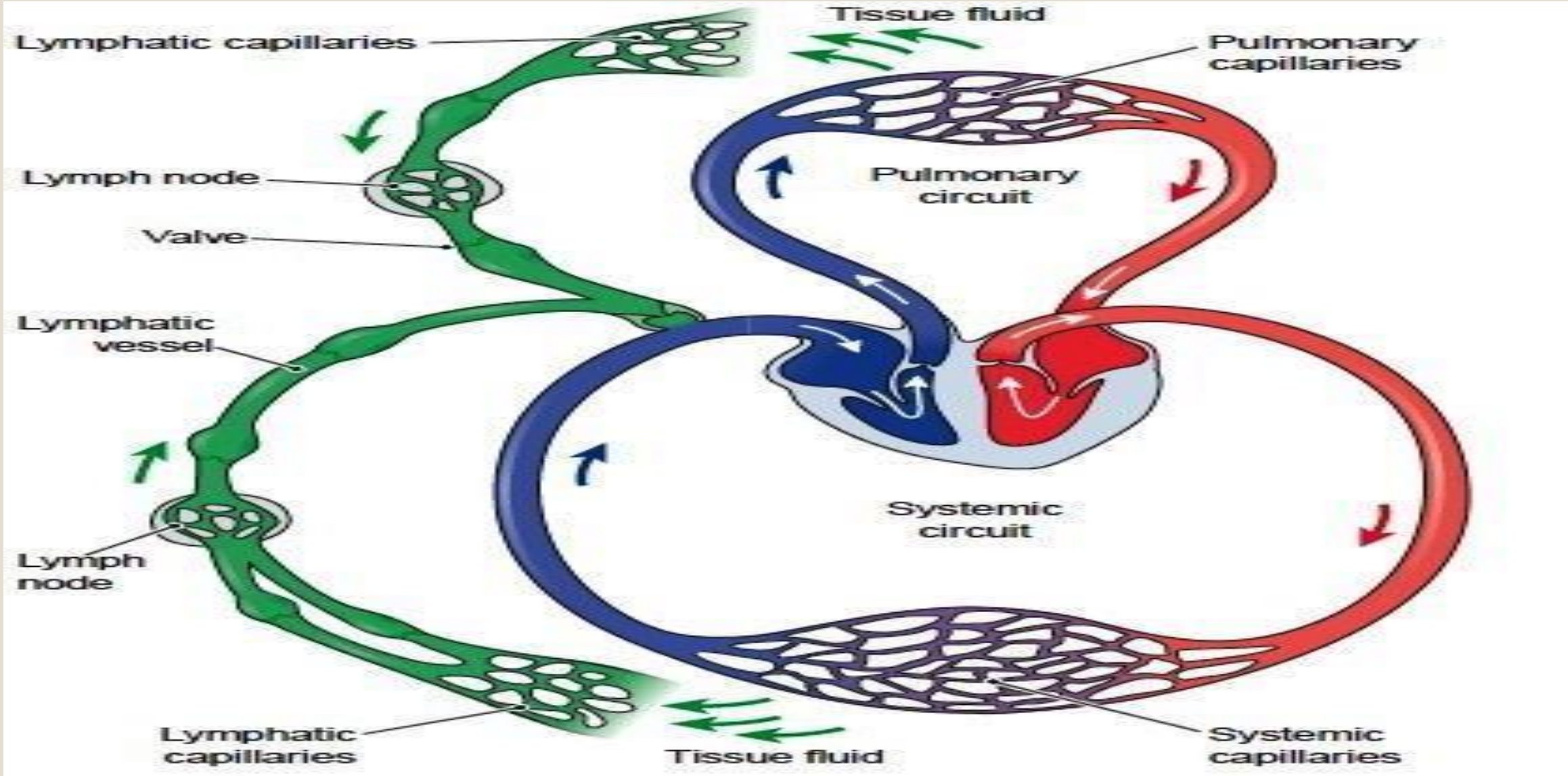
This system is a functional system which provides protection against invasion of the body by microorganisms and against some types of endogenous cells which have become abnormal. Histologically the immune system includes all organs and structures that have lymphoid tissue as parenchyma. Lymphoid tissue consists of an accumulation of lymphocytes on a framework of reticular connective tissue.


Cervical lymph nodes
Lymphatics of the mammary gland
Cisterna chyli
Lumbar lymph nodes
Pelvic lymph nodes
Lymphatics of the lower limb
Thoracic duct
Thymus
Axillary lymph nodes
Spleen
Lymphatics of the upper limb
Inguinal lymph nodes

Functions of the Lymphatic System

Defense against harmful organisms and chemicals.

Specific defense = immunity - Humoral immunity involves B cells that become plasma cells which produce antibodies that bind with specific antigens b- Cell-mediated immunity involves T cells that directly destroy foreign cells.


Tissue fluid
Lymphatic capillaries
Pulmonary capillaries
Lymph node
Pulmonary circuit
Valve
Lymphatic vessel
Systemic circuit
Lymph node
Lymphatic capillaries
Tissue fluid
Systemic capillaries

Lymphatic System consists of

Cells -

A-B Lymphocytes: small lymphocyte morphology while inactive, may have more cytoplasm while actively dividing, immunoglobulins attached to plasma membrane, develop into plasma blasts and then into plasma cells when stimulated.

B-Plasma cells: - which secrete antibodies, derived from B-cells, eccentrically located nucleus, basophilic cytoplasm.

C-The (helper or CD4+ T) Lymphocytes: small lymphocyte morphology, enhance activation of B and Tc lymphocytes and macrophages.

D-Tc (cytotoxic or CD8+ T) Lymphocytes: small lymphocyte morphology, kill virus-infected cells and some types of cancer cells.

E-Large granular lymphocytes:

more cytoplasm than in small cytoplasm contains scattered acidophilic granules, function ,lymphocytes as natural killer cells by killing some types of viral-infected cells and - cancer cells, function as antibody

dependent cellular cytotoxicity (ADCC) cells by killing cells with bound antibody

F-Antigen Presenting Cells

Macrophages: which engulfs micro-organisms and presents antigens on its surfaces to lymphocytes and regulate some The functions B lymphocytes.

Tissues

A-Loose or diffuse lymphoid tissue

Lymphocytes and related cells are present in larger numbers than are typically found in loose connective tissues, but there is no nodular organization of the lymphocytes and very little delineation of the lymphoid tissue from surrounding tissue.

B-Dense lymphoid tissue

Dense lymphoid tissues can be divided into 2 categories

A-Non-nodular dense lymphoid tissue :is not organized into nodules. Areas of this tissue associated with nodular dense lymphoid tissue are usually enriched in Th and Tc lymphocytes.

B-Nodular dense lymphoid tissue: is organized into spherical masses, referred to as nodules. The tissue is clearly recognized from surrounding tissue and the nodules are enriched with B lymphocytes.

Organs

Can be divided into two major categories

A-The central (primary) lymphoid organs are the thymus and bone marrow.

B-The peripheral (secondary) lymphoid tissues are the lymph nodes spleen, Mucosal associated lymphoid tissue (MALT).

A. Bone marrow

All the cells of the immune system are initially derived from the bone marrow through a process called hematopoiesis.

gradually by the bone marrow. During hematopoiesis, bone marrow derived stem cells differentiate into either mature cells or into precursors of cells that migrate out of the bone marrow to continue their maturation in thymus.

The bone marrow produces B cells, natural killer cells, granulocytes and immature thymocytes, in addition to red blood cells and platelets. It is both a primary and secondary lymphoid organ. The bone marrow also contains antibody secreting plasma cells, which have migrated from the peripheral lymphoid tissues.

Functions of bone marrow

1- The site of generation of all immunocytes

2- The site of differentiation and maturation of immunocytes

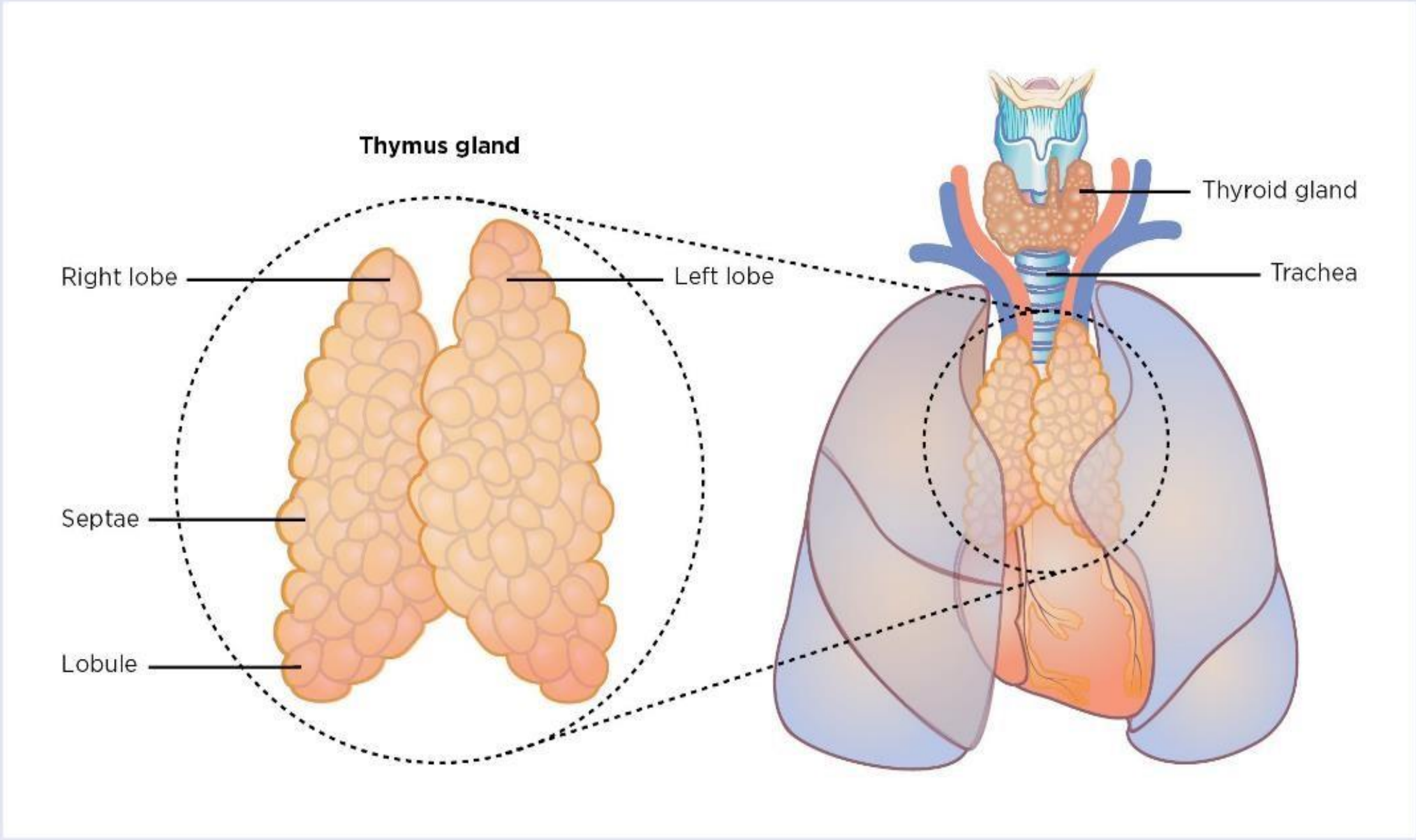
3-The site of immune response of B cell immune response

b- Thymus

The thymus is the site of T cell differentiation and maturation. It is found in the inferior neck and extends into the superior thorax, where it partially overlies the heart deep to the sternum. This organ is active in children, but at the start of puberty, until old age, it starts to atrophy, producing fewer T-cells. The thymus also produces thymic hormones that support the growth and differentiation of T-cell progenitors.

The thymus is a lobed organ with each lobe subdivided into lobules. Each lobe is covered by a loose to moderately dense fibro-elastic connective tissue (FECT), capsule which extends as septae between lobules and as trabeculae which extend into the lymphoid tissue. Since the thymus is of endodermal origin, the tissue framework is formed by epithelial reticular cells (rather than connective tissue) which form a network on which the other cells reside. Each lobule of the thymus is subdivided into two
layers:

Fig 4. **Thymus gland**



a. Outer cortex

Appears more darkly stained

Consists of densely packed thymocytes/T lymphocytes, supported by a network of finely-branched epithelial reticular cells, which is continuous with a similar network in the medullary portion. This network forms an adventitia to the blood vessels. The cortex is the location of the earliest events in thymocyte development.

b. Inner medulla

Appears more lightly stained

Consists of thymocytes (less densely packed than in the cortex) The network of reticular cells is coarser than in the cortex, the lymphoid cells are relatively fewer in number, and there are concentric, nest-like
bodies called Hassall's corpuscles.

These concentric corpuscles are composed of a central mass, consisting of one or more granular cells, and of a capsule formed of epithelial cells. Each follicle is surrounded by a vascular plexus, from which vessels pass into the interior, and radiate from the periphery toward the center, forming a second zone just within the margin of the medullary portion. In the center of the medullary portion there are very few vessels and they are of minute size.

The medulla is the location of the latter events in thymocyte development. Thymocytes that reach the medulla have already successfully undergone T cell receptor gene rearrangement and positive selection, and have been exposed to a limited degree of negative
selection.

Cells in thymus and thymus microenvironment

Thymus stroma cells (TSC) Thymus epithelial cells (TEC), Fibrocyte

Macrophages, Dendritic cells

Thymocytes: The cells migrate from the bone marrow to the thymus and then become thymocytes

Thymus microenvironment: Thymus epithelial cells (TEC) are secretion thymus hormones and cytokines.

Function of Thymus:

1.Development and differentiation of T lymphocytes in thymus

2.TSC secrete various cytokines and thymus hormones

3.Thymocytes secrete various cytokines

4.Immune regulation of the thymus

The peripheral (secondary) lymphoid tissues

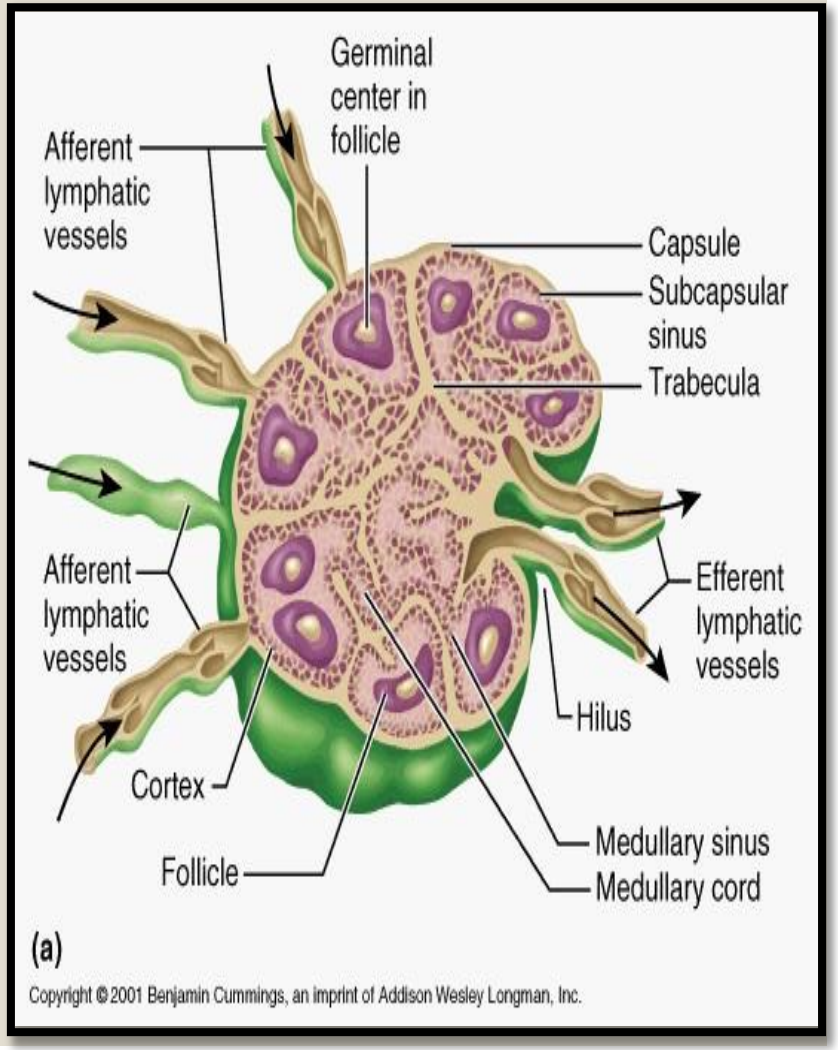
The peripheral (secondary) lymphoid tissues :

are the lymph nodes, spleen, Mucosal associated lymphoid tissue (MALT). All secondary lymphoid organs have one anatomical feature in common: they all contain **lymphoid follicles.**

1-Lymph nodes : Lymph nodes vary in shape and size, but most are bean shaped and less than 2.5 cm (1 inch) in length. Lymph nodes are located along lymphatic vessels.

•Lymphatic vessels leading into the node (**afferent lymphatic vessels**) are carrying lymph derived from tissue fluid in one or more organs or body regions.

•Lymphatic vessels exiting from the node (**efferent lymphatic vessels**) carry lymph from the node to larger lymphatic vessels which eventually empty into the blood circulation in the thoracic region.



Function : Lymph nodes have several identified functions. a.

Lymph nodes **filter and screen lymph**.

1-Afferent lymphatic vessels drain lymph into the Subcapsular Sinus

2-Lymph then passes to the Trabecular sinuses

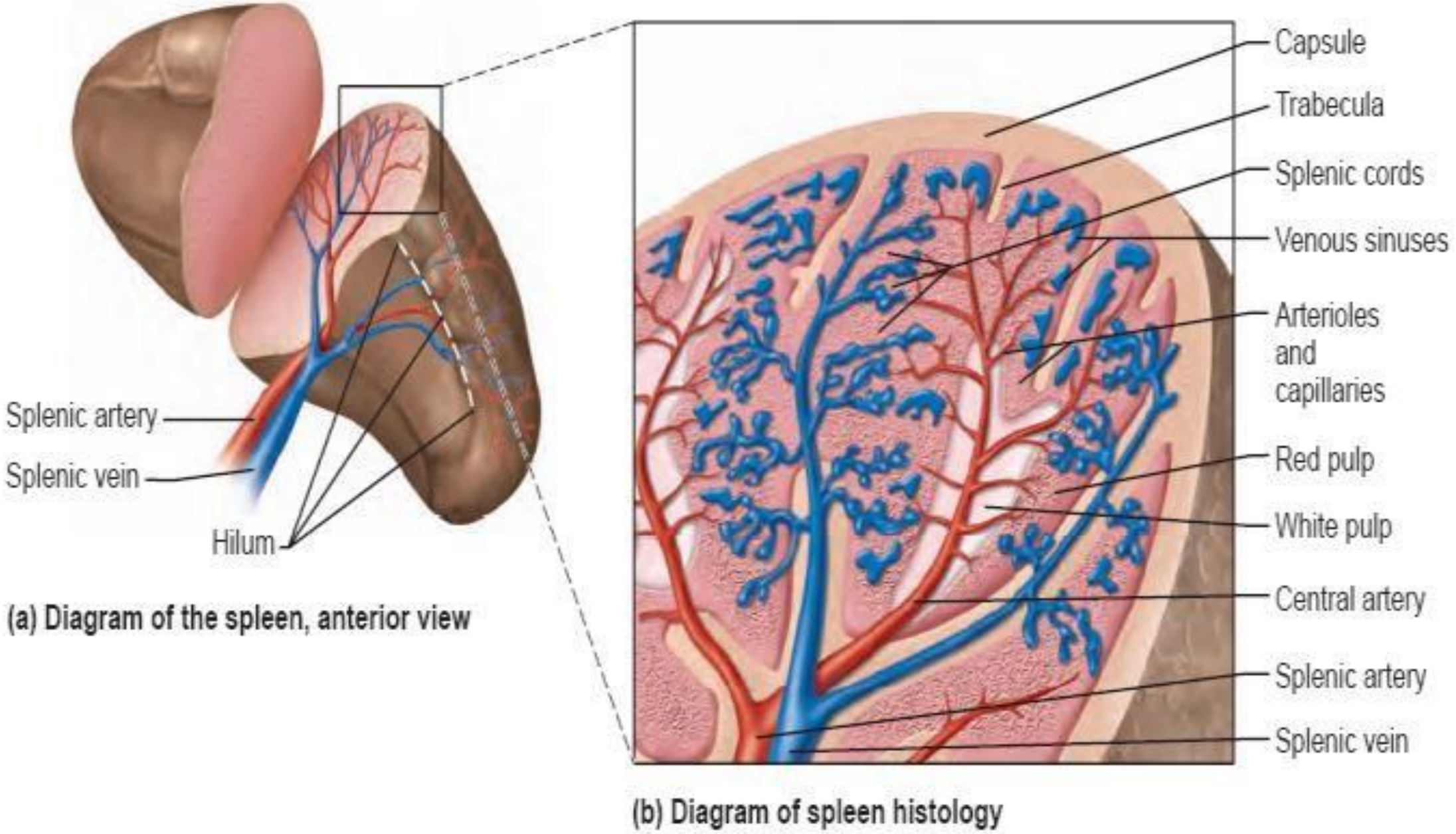
3-From there, the lymph goes to the Medullary sinuses.

4-Lymphocytes and macrophages pass easily between these sinuses and the tissue of the lymph node.

5-Macrophages in sinuses monitor the fluids. Macrophages phagocytose the antigenic material and present it to T- and B-cells

- **Spleen :**

The spleen is the largest single accumulation of lymphoid tissue in the body and the only one involved in filtration of blood, making it an important organ in defense against bloodborne antigens. It is also the main site of destruction of aged erythrocytes



(a) Diagram of the spleen, anterior view

(b) Diagram of spleen histology

Numerous functions are carried out as blood passes through red pulp in the spleen:

1. Macrophages in the spleen remove old, abnormal, and damaged blood cells from the blood by phagocytosis.

2-Antigen-presenting cells in the spleen activate T lymphocytes against antigens present in circulating blood.

3-B lymphocytes in the spleen are exposed to antigens present in circulating blood.

4. The blood (especially the RBCs) in the spleen can be returned to the circulation rapidly in an emergency, so the blood in the spleen can be viewed as a reserve supply.


Thank you for
listening