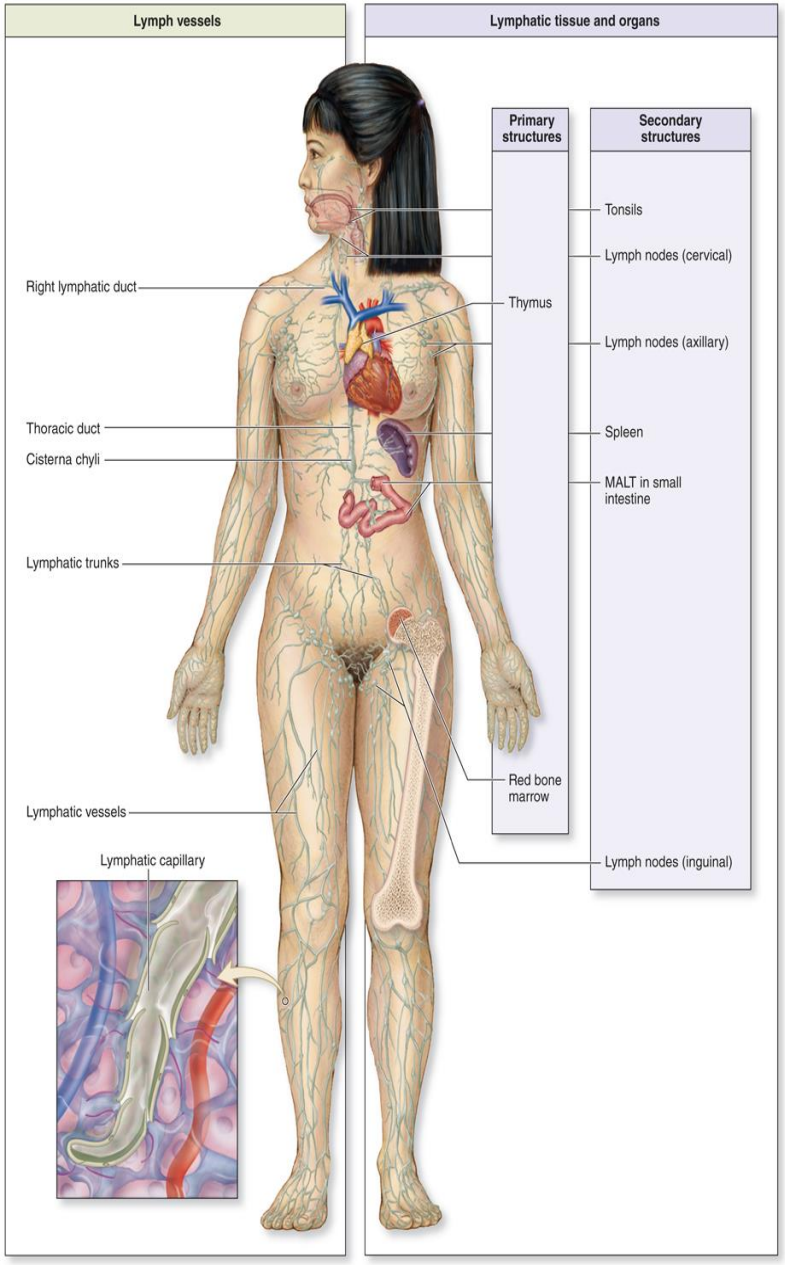
Lymphoid system

Lecturer / histology

Dr. Shatha Salah Asaad

Anatomy Department

Al-Kindy College of medicine



The lymphoid system

- Consists of **capsulated lymphoid tissues** (thymus, spleen, tonsils, and lymph nodes)

- **Diffuse lymphoid tissue**

- **lymphoid cells**, primarily T lymphocytes (T cells), B lymphocytes (B cells), and macrophages.

- The immune system provides **defense** or immunity against infectious agents ranging from **viruses** to multicellular **parasites**. Histologically this system consists of a large, diverse population of **leukocytes** located within every tissue of the body and lymphoid organs interconnected only by the blood and lymphatic circulation.

- The immune system has two components, **the innate immune system (nonspecific)** and the **adaptive immune system (specific).**

Cells of the immune system

Cells of the immune system include

1. Clones of T and B lymphocytes.

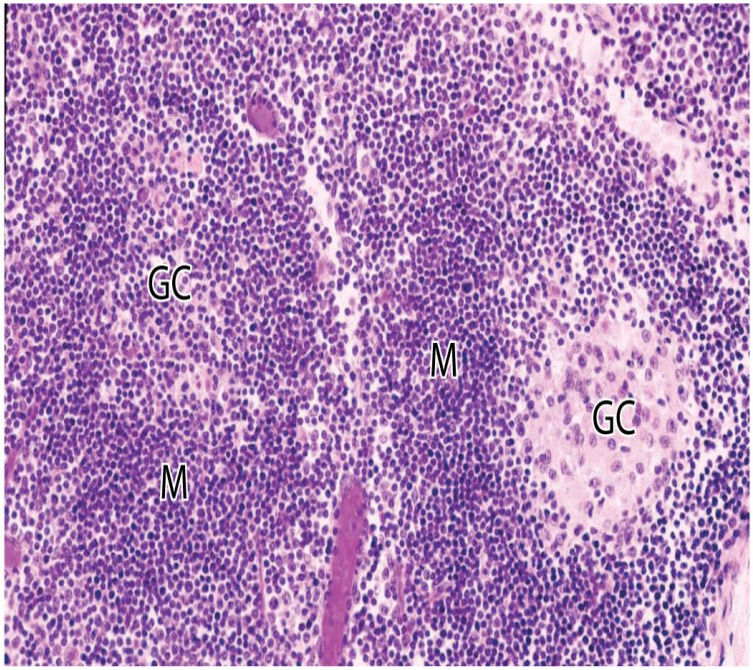
A clone is a small number of identical cells that can recognize and respond to a single or a small group of related **antigenic determinants (epitopes**). Exposure to antigen and one or more cytokines induces activation of resting T and B cells, leading to their proliferation and differentiation into effector cells .

2. **APCs** (e.g., **macrophages, lymphoid dendritic cells, Langerhans cells, follicular dendritic cells, M cells, and B cells**), **mast cells**, and **granulocytes** are also cells of the immune system.

- The lymphocytes and APCs for **adaptive immunity** are distributed throughout the body in the **blood**, **lymph**, and **epithelial** and **connective tissues**.
- Lymphocytes are formed initially in **primary lymphoid organs (the thymus and bone marrow),** but most lymphocyte activation and proliferation occur in **secondary lymphoid organs (the lymph nodes, the spleen, and diffuse lymphoid tissue** found in the **mucosa** of the digestive system, including the tonsils, Peyer patches, and appendix).
- The immune cells located **diffusely** in the digestive, respiratory, or urogenital mucosae comprise what is collectively known as mucosa-associated lymphoid tissue (**MALT**).
- in the secondary structures of MALT are arranged in small spherical lymphoid nodules.
- The wide distribution of immune system cells and the constant traffic of lymphocytes through the blood, lymph, connective tissues, and secondary lymphoid structures provide the body with an elaborate and efficient system of surveillance and defense.

MUCOSA-ASSOCIATED LYMPHOID TISSUE

Secondary lymphoid structures, where most lymphocytes are activated by antigen presentation, include the MALT, the **lymph nodes**, and the **spleen**. The mucosa or inner lining of the digestive, respiratory, and genitourinary tracts is a common site of invasion by pathogens because their lumens open to the external environment. To protect against such invaders mucosal connective tissue of these tracts contains large and diffuse collections of lymphocytes, IgA-secreting plasma cells, APCs, and lymphoid nodules, all of which comprise the MALT. Lymphocytes are also present within the epithelial lining of such mucosae. Most of the immune cells in MALT are dispersed diffusely in the connective tissue; others are found in aggregates forming large, conspicuous structures such as the **tonsils**, the **Peyer patches** in the ileum, and the **appendix**.

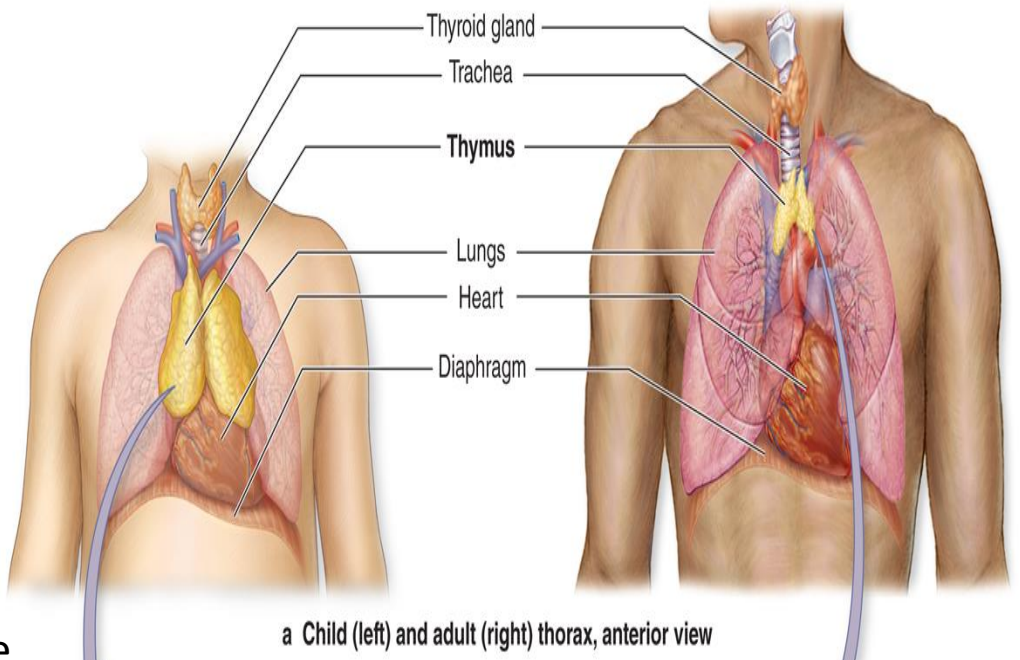


Collectively the MALT is one of the largest lymphoid organs, containing up to **70%** of all the body's immune cells. Most of the lymphocytes here are **B cells**; among **T cells**, CD4+ helper T cells predominate. Tonsils are large, irregular masses of lymphoid tissue in the mucosa of the posterior oral cavity and nasopharynx where their cells encounter antigens entering the mouth and nose. Named by their location these masses are the palatine, lingual, and pharyngeal tonsils.

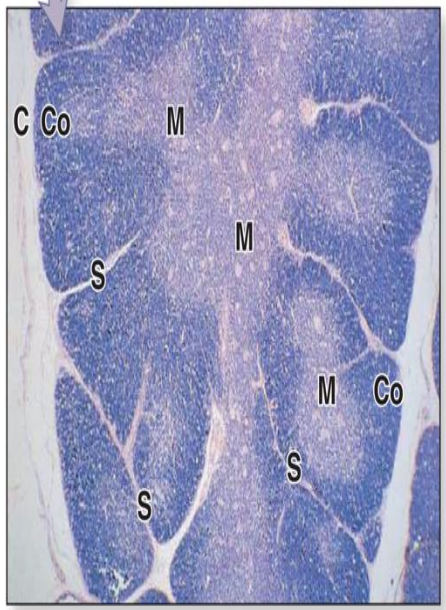
THYMUS

While immature B lymphocytes emerge from the bone marrow, the primary or central lymphoid organ in which **T cells** are produced is the thymus, a bilobed structure in the mediastinum a main function of the thymus is **induction of central tolerance**, which along with regulatory T cells prevents autoimmunity.

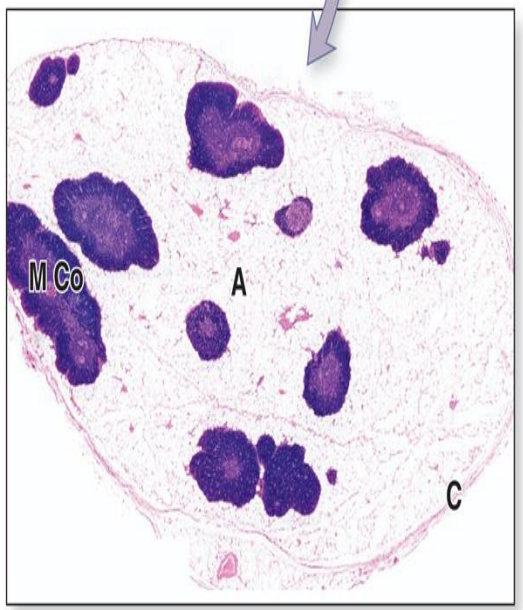
The thymus has **a vascularized** connective tissue capsule that extends septa into the parenchyma, dividing the organ into many incompletely separated **lobules**. Each lobule has an outer darkly basophilic **cortex** surrounding a more lightly stained **medulla**. The staining differences reflect the much greater density of **lymphoblasts** and **small lymphocytes** in the cortex than the medulla.



a Child (left) and adult (right) thorax, anterior view



b Micrograph of child's thymus

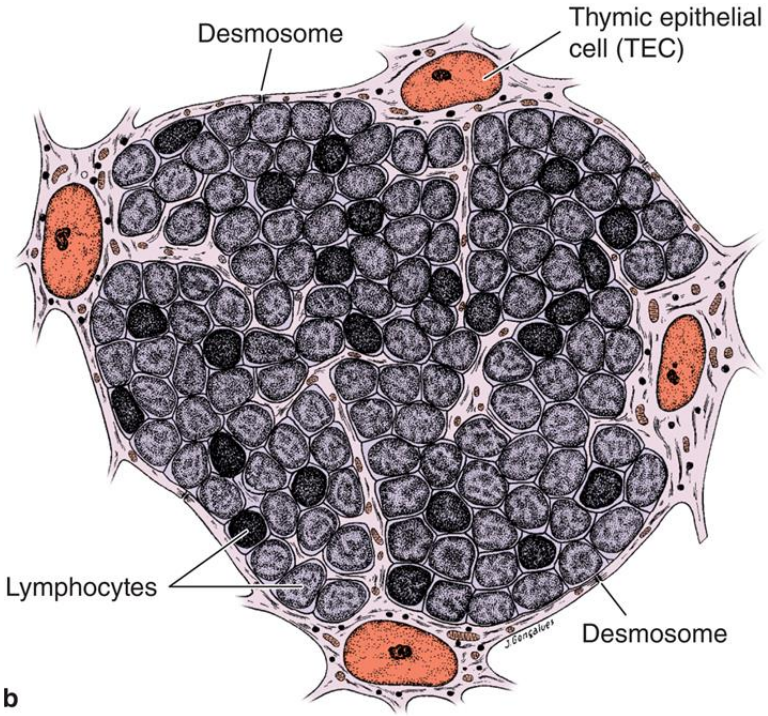


c Micrograph of adult's thymus

a. The thymic cortex is supplied by arterioles in the septa; these arterioles provide capillary loops that enter the substance of the cortex. The cortex is the region in which T-cell maturation occurs , and contains an extensive population of **T lymphoblasts(thymocytes**), some newly arrived via venules, located among numerous **macrophages** and associated with the unique **thymic epithelial cells** (TECs) that have certain features of both epithelial and reticular cells.

(1) Epithelial reticular cells

- These cells originate from endoderm and form a meshwork with interstices in which T cells are tightly packed.
- They are pale cells and have a large ovoid lightly **staining nucleus** that often displays a **nucleolus**.
- They possess long processes that surround the thymic cortex, isolating it from both the connective tissue septa and the medulla. These processes, which are filled with bundles of **tonofilaments**, form **desmosomal** contacts with each other.
- They manufacture **thymosin**, **serum thymic factor**, and **thymopoietin**, hormones that function in the transformation of immature T lymphocytes into immunocompetent T cells.
- Epithelial reticular cells are of six types, each with different surface markers and presumably different functions.



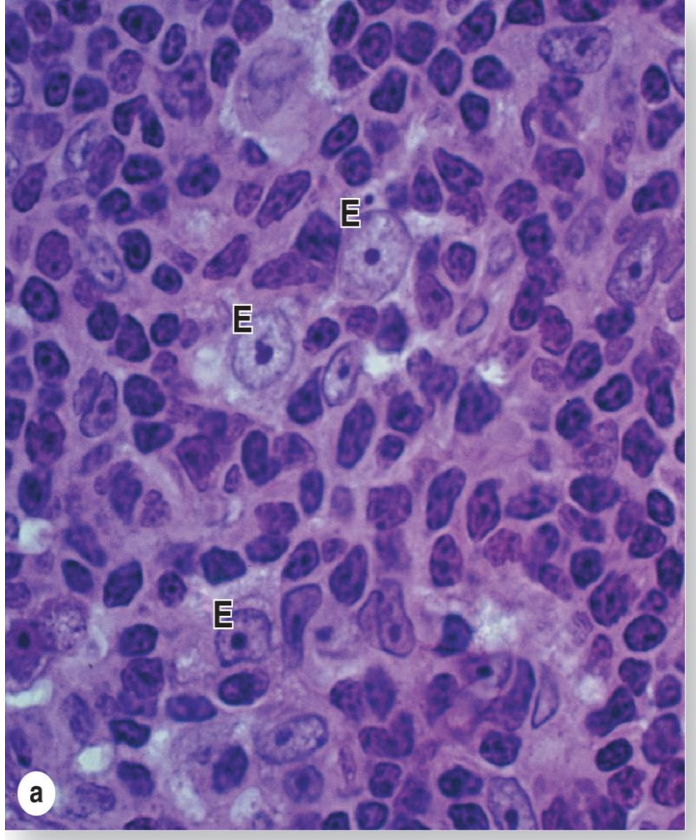
(2) Thymocytes

•Thymocyte plasmalemma possesses receptors that permit these cells to respond to cytokines released by epithelial reticular cells to become T cells.

•Thymocytes are surrounded by processes of epithelial reticular cells, which help segregate thymocytes from antigens during their maturation.

•They migrate toward the medulla as they mature; however, T cells that cannot recognize self proteins are forced into apoptosis and never reach the medulla. Most T cells die in the cortex, and the dead cells are phagocytosed by macrophages.

•Surviving T cells are naïve. They leave the thymus and are distributed to secondary lymphoid organs by the vascular system.



Blood–thymus barrier

(a) This barrier exists in the **cortex only,** making it an immunologically protected region.

(b) It ensures that **antigens escaping** from the bloodstream do not reach developing T cells in the thymic cortex.

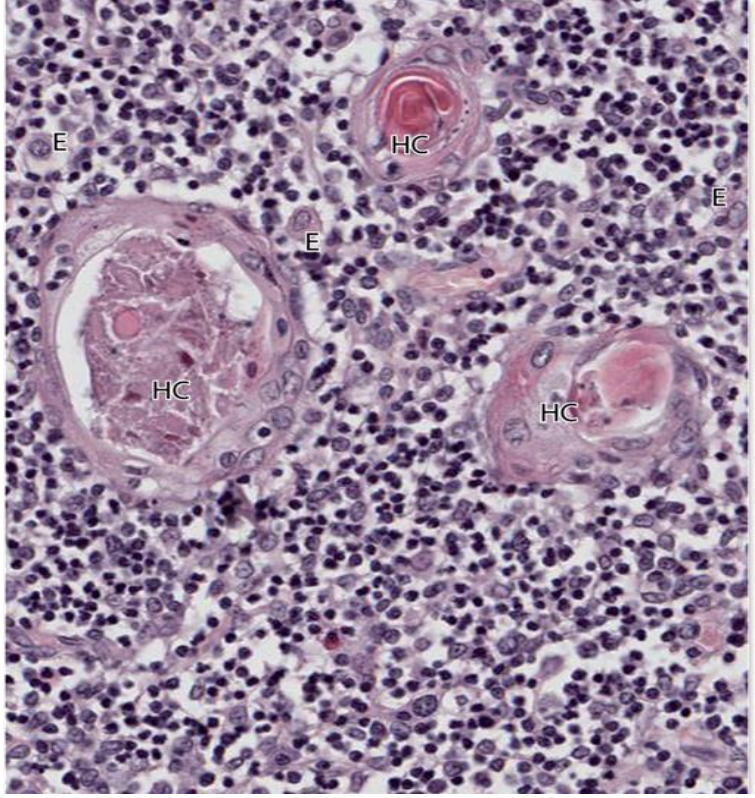
(c) It consists of the following layers: **endothelium** of the thymic capillaries and the associated **basal lamina**, perivascular **connective tissue** and cells (e.g., **pericytes** and **macrophages**), and **epithelial reticular cells** and their **basal laminae**.

b. Thymic medulla

The thymic medulla is continuous between adjacent lobules and contains large numbers of epithelial reticular cells and mature T cells, which are loosely packed, causing the medulla to stain lighter than the cortex .

It also contains large aggregates of TECs, sometimes concentrically arranged called **Hassall corpuscles** (thymic corpuscles). These structures display various stages of **keratinization** and increase in number with age. Their cells secrete several cytokines that control activity of local dendritic cells, including factors promoting development of regulatory T cells for peripheral tolerance.

Mature T cells exit the thymus via venules and efferent lymphatic vessels from the thymic medulla. The T cells then migrate to secondary lymphoid structures.



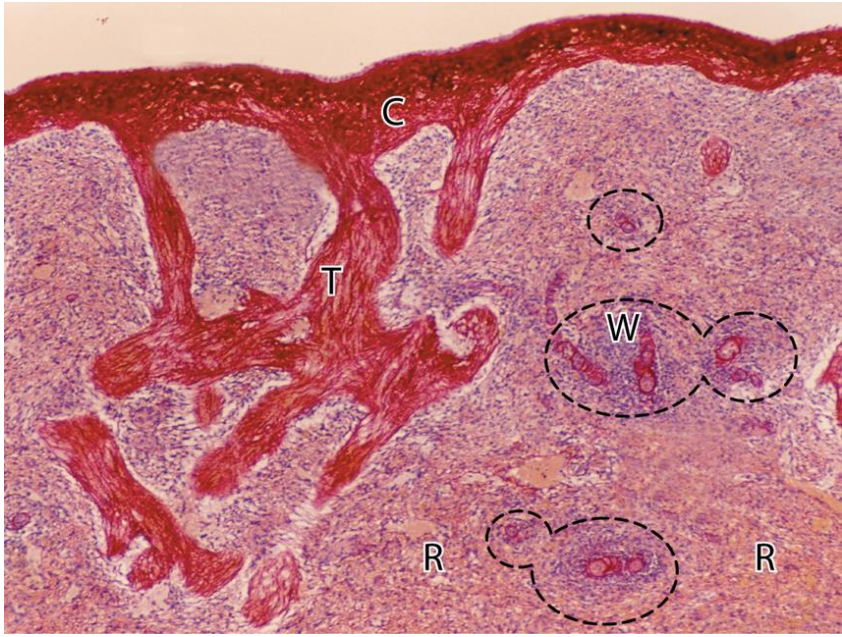
Spleen

Spleen a simple squamous epithelium (peritoneum) covers the dense irregular collagenous connective tissue capsule of the spleen, which sends trabeculae into the substance of the spleen to form a supportive framework

The spleen is similar to lymph nodes in that it possesses a **hilum** but differs from both the thymus and lymph nodes in that it **lacks** a cortex and medulla. It further differs from lymph nodes because it has no afferent lymphatic vessels.

The spleen is divided into **red pulp** and **white pulp**; the latter contains lymphoid elements. These two regions are separated from each other by the **marginal zone**

Function—Spleen. The spleen filters blood, stores erythrocytes, phagocytoses damaged and aged erythrocytes, and is a site of proliferation of B and T lymphocytes and the production of antibodies by plasma cells

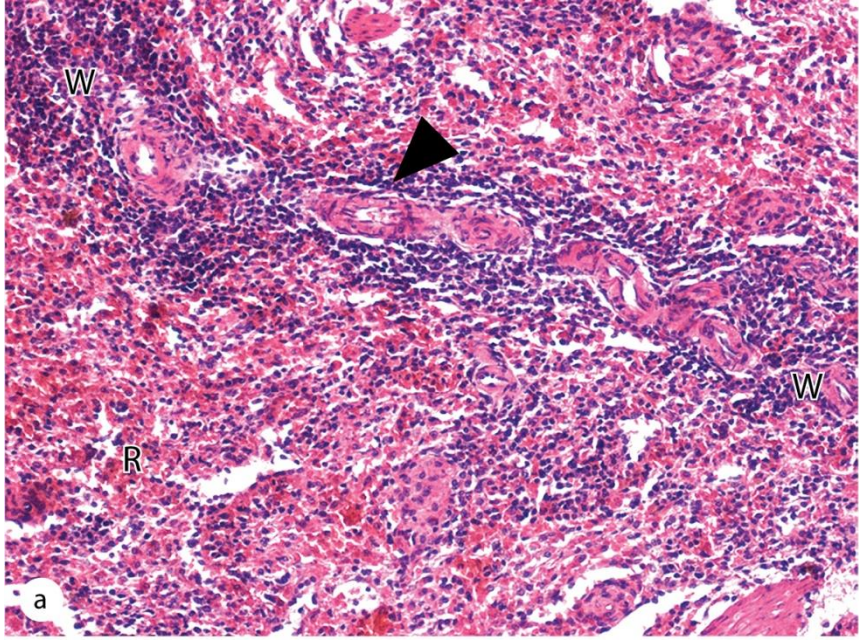


a. White pulp of the spleen includes all of the organ's lymphoid tissue (diffuse and nodular), such as lymphoid nodules (mostly B cells) and periarteriolar lymphoid sheaths PALS (mostly T cells) around the central arteries. It also contains macrophages and other APCs.

The marginal zone of the spleen

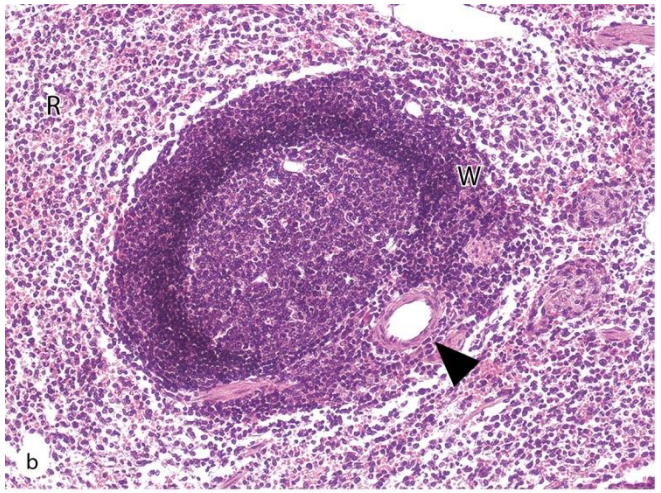
(1) is a sinusoidal region between the red and white pulps at the periphery of the PALS (Figure 12.4).

(2) receives blood from capillary loops derived from the central artery and thus is the first site where blood contacts the splenic parenchyma.



(3) is richly supplied by avidly phagocytic macrophages and other APCs.

(4) is the region where circulating T and B lymphocytes enter the spleen before becoming segregated to their specific locations within the organ and where interdigitating dendritic cells are able to display their MHC-epitope complex for recognition by T cells.



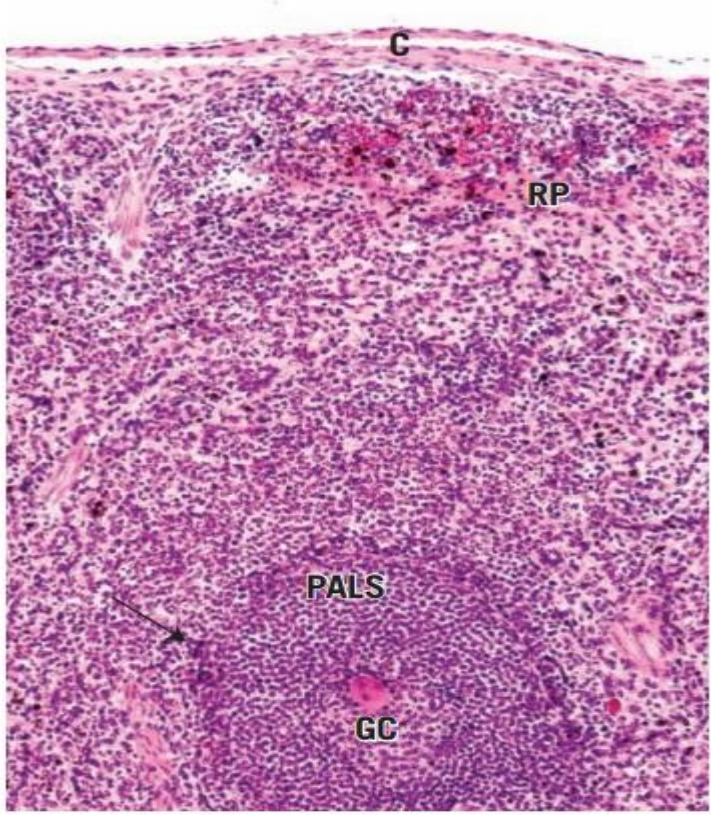
b. Red pulp of the spleen is composed of an interconnected network of sinusoids supported by a loose type of reticular tissue (splenic cords).

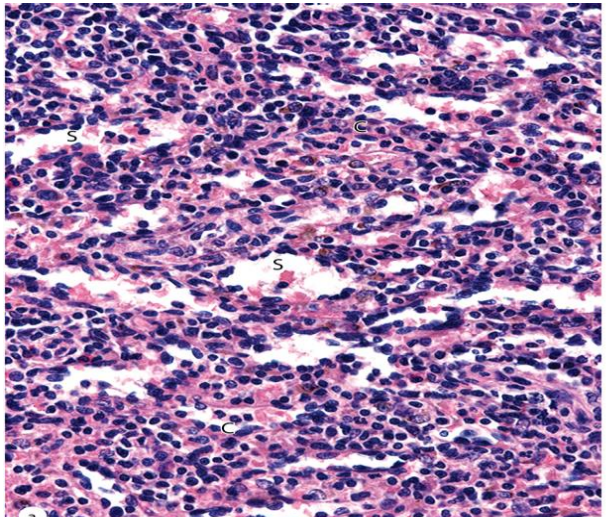
(1) Sinusoids

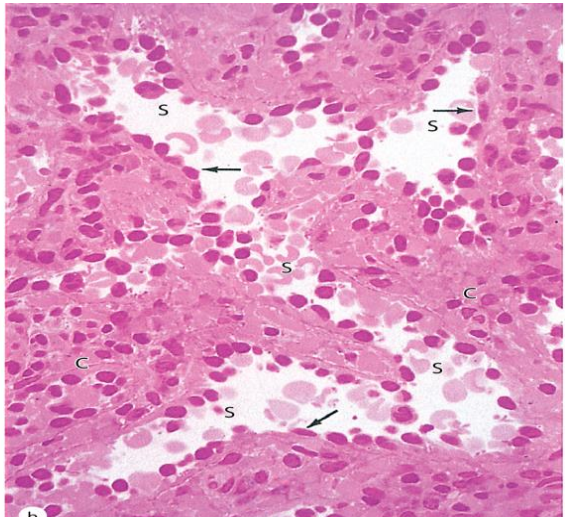
(a) are lined by long fusiform endothelial cells separated by relatively large blood containing intercellular spaces.

(b) have a discontinuous basal lamina underlying the endothelium and circumferentially arranged ribs of reticular fibrils.

(2) Splenic cords (cords of Billroth) contain plasma cells, stellate reticular cells, blood cells, and macrophages enmeshed within the spaces of the reticular fiber network. Processes of the macrophages enter the lumina of the sinusoids through the spaces between the endothelial cells.

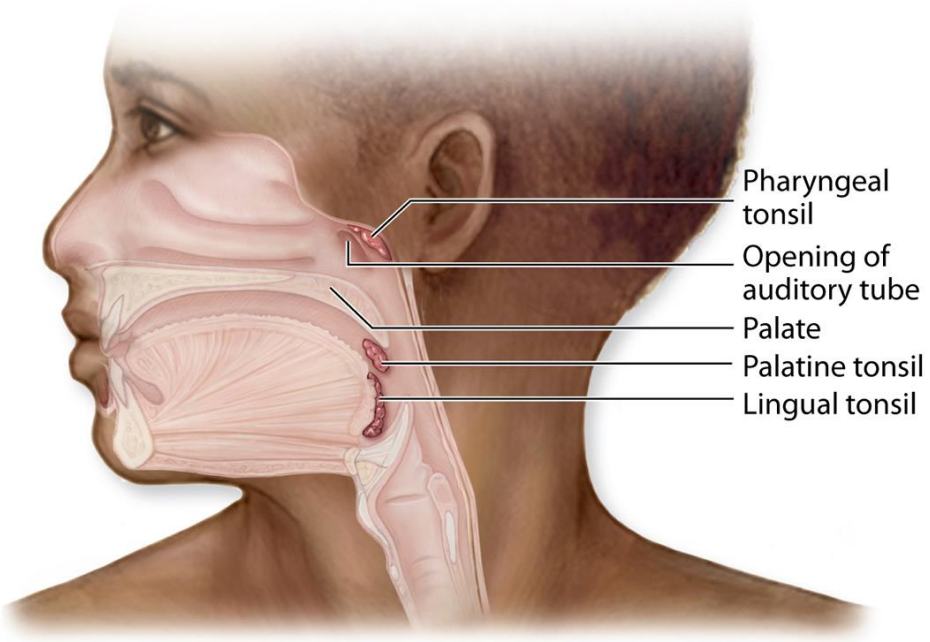






Tonsils

are aggregates of **lymphoid tissue**, which sometimes lack a capsule. All tonsils are in the upper section of the **digestive** tract, lying beneath but in contact with the epithelium. Tonsils assist in combating antigens entering via the nasal and oral epithelia.



a

1. **Palatine tonsils**

a. possess **crypts**, deep invaginations of the **stratified squamous epithelium** covering of the tonsils, frequently containing debris.

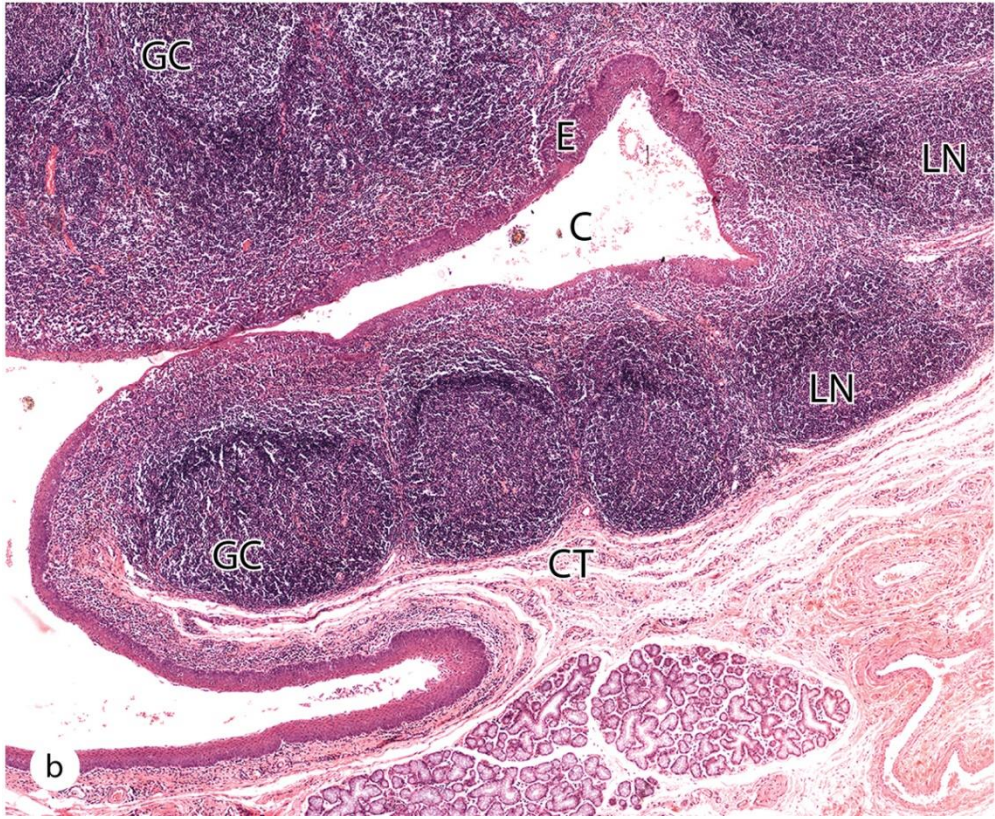
b. possess lymphoid nodules(with germinal centers)

c. are separated from subjacent structures by a connective tissue capsule.

2. The pharyngeal tonsil

is a single tonsil in the posterior wall of the nasopharynx.

a. It is covered by a **pseudostratified ciliated columnar epithelium**.
b. Instead of crypts, it has longitudinal pleats **(infoldings**).



3. Lingual tonsil

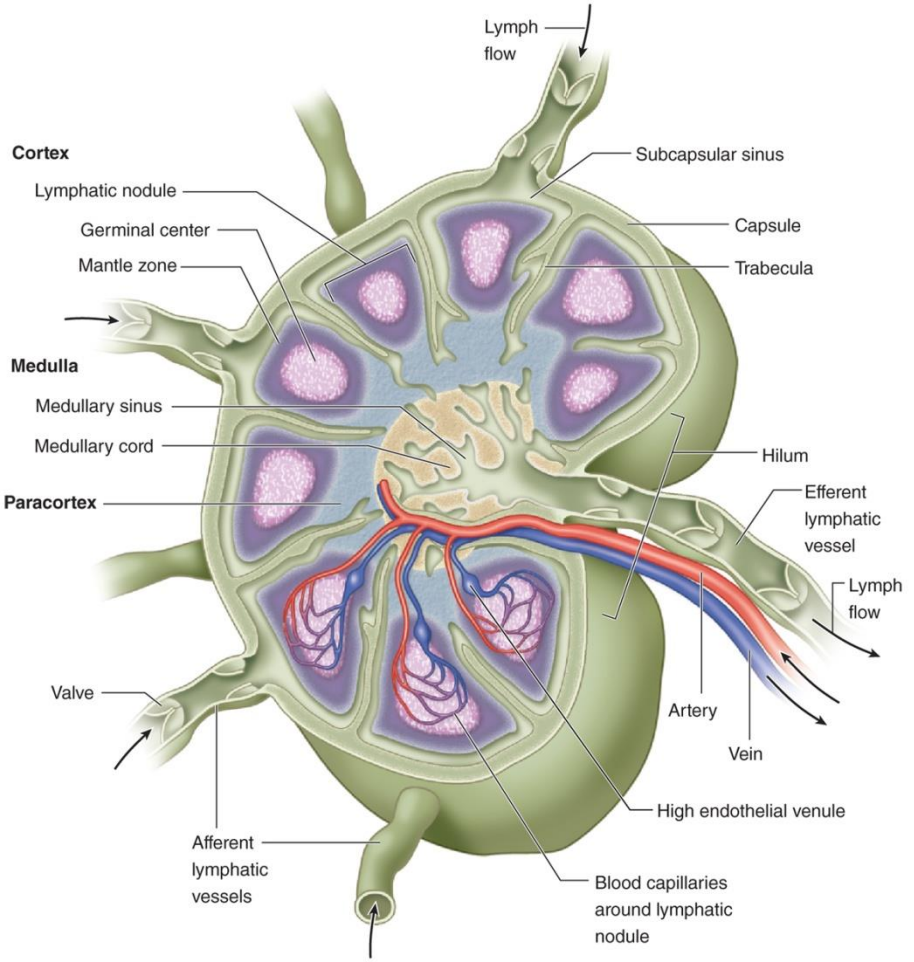
a. is on the dorsum of the posterior third of the tongue and is covered by a **stratified squamous nonkeratinized epithelium.**
b. possesses deep **crypts**, which frequently contain cellular debris. Ducts of the posterior mucous glands of the tongue often open into the base of these crypts.

Lymph nodes

Lymph nodes alymph node is a small, **encapsulated** ovoid to kidney-shaped structure with a capsule that sends **trabeculae** into the substance of the node .

The **convex** surface of a lymph node receives **afferent** lymphatic vessels, whereas the **concave** surface (the hilum) is the site where arterioles enter and venules and **efferent** lymphatic vessels exit. Lymph nodes possess a stroma composed of a supportive framework rich in **reticular fibers**.

Function. Lymph nodes **filter** lymph, **maintain** and produce T and B cells, and **possess** memory cells (especially T memory cells). Antigens delivered to lymph nodes by APCs are recognized by T cells, and an immune response is initiated.



Lymph nodes are divided into three regions, the outermost **cortex**, the middle **paracortex**, and the innermost **medulla**

a. The cortex of lymph nodes

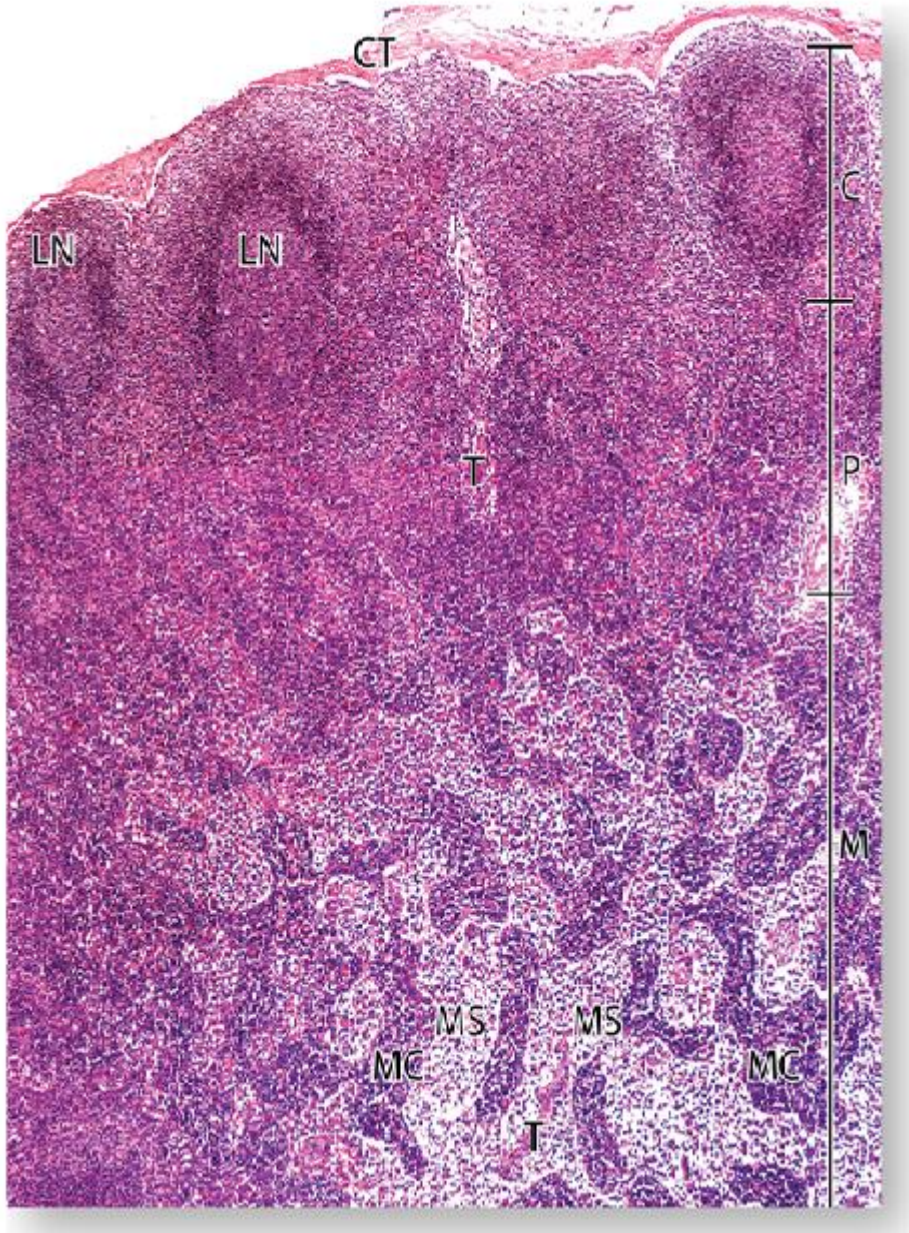
(1) lies deep to the capsule, from which it is separated by a subcapsular sinus.

(2) is incompletely subdivided into compartments by connective tissue septa derived from the capsule.

(3) contains lymphoid nodules and sinusoids.

(a) Lymphoid nodules are composed mainly of **B** cells but also of some **T** cells, **follicular dendritic cells**, **macrophages**, and **reticular cells**. They may possess a germinal center.

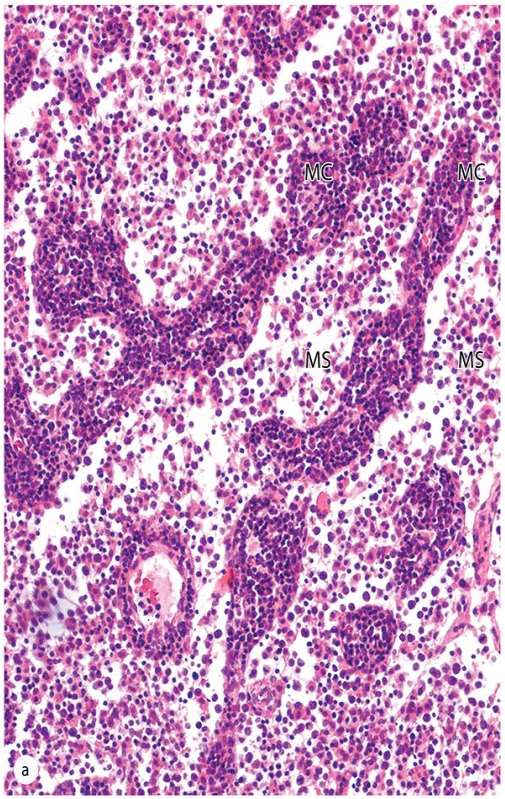
b)Sinusoids are endothelium-lined lymphatic spaces that extend along the capsule and trabeculae and are known as subcapsular and cortical sinusoids, respectively.

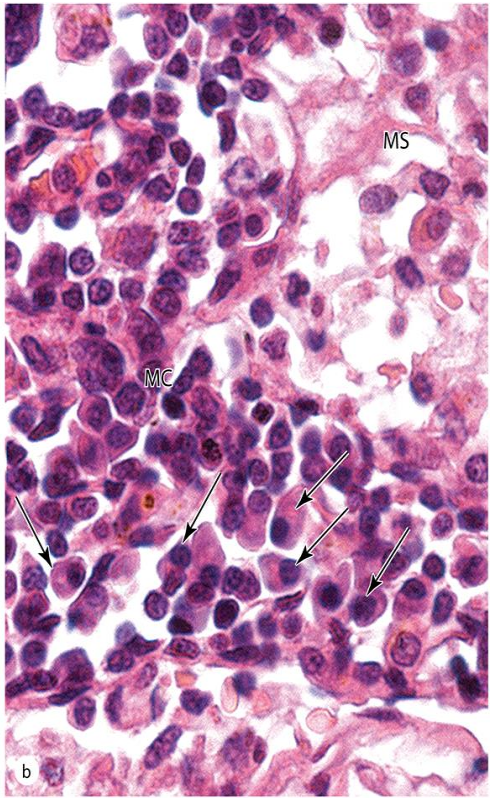


The paracortex of the lymph node is located between the cortex and the medulla. (1) It is composed of a nonnodular arrangement of mostly **T lymphocytes** (the thymus dependent area of the lymph node). (2) The paracortex is the region where circulating lymphocytes gain access to lymph nodes via postcapillary (high endothelial) venules.

The medulla of a lymph node lies deep to the paracortex and cortex, except at the region of the hilum. It is composed of medullary **sinusoids** and medullary **cords**. (1) Medullary **sinusoids** are **endothelium**-lined spaces supported by **reticular fibers** and **reticular cells**. They frequently contain **macrophages**. Medullary sinusoids receive lymph from the cortical sinuses.

(2) Medullary **cords** are composed of **lymphocytes** and **plasma cells**.






THANK YOU
Students....