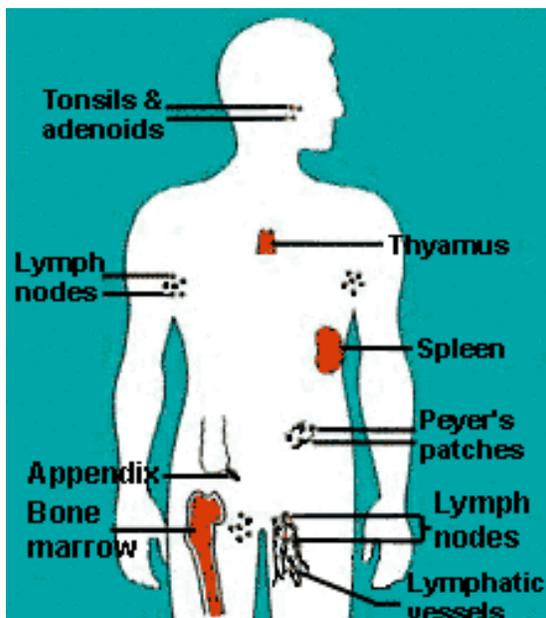


Lymphoid Organ

Lymphocytes are found circulating in the blood. A large proportion of them are found either in discrete cluster or organised in specific tissue. The component of this lymphoid system may be categorised as primary, Secondary or tertiary lymphoid tissue.

- Primary lymphoid tissue: Bone marrow, Bursa of fabricius, Thymus.
- Secondary lymphoid tissue: Lymph node, Spleen.
- Tertiary lymphoid tissue: Mucosa-associated lymphoid tissue, Intra-epithelial lymphocytes.



1- Primary lymphoid tissue: Major sites of lymphopoiesis (lymphocyte differentiated from lymphoid stem cell, proliferate and mature to functional effector cells) and include:

Bone marrow: all lymphocytes develop initially from haematopoietic stem cells in the bone marrow. Immature B cells remain in the bone marrow and develop into mature cells. This process is influenced by many factors including surface ligands and cytokines (particularly IL-7).

Bursa of fabricius: The bursa is an epithelial and lymphoid organ that is found only in birds. Its function includes development and differentiation of B-lymphocytes. It is composed of numerous lobes, each having a cortical and medullary area. The cortex contains mostly large undifferentiated lymphoid cells, while the medulla contains small, mature cells.

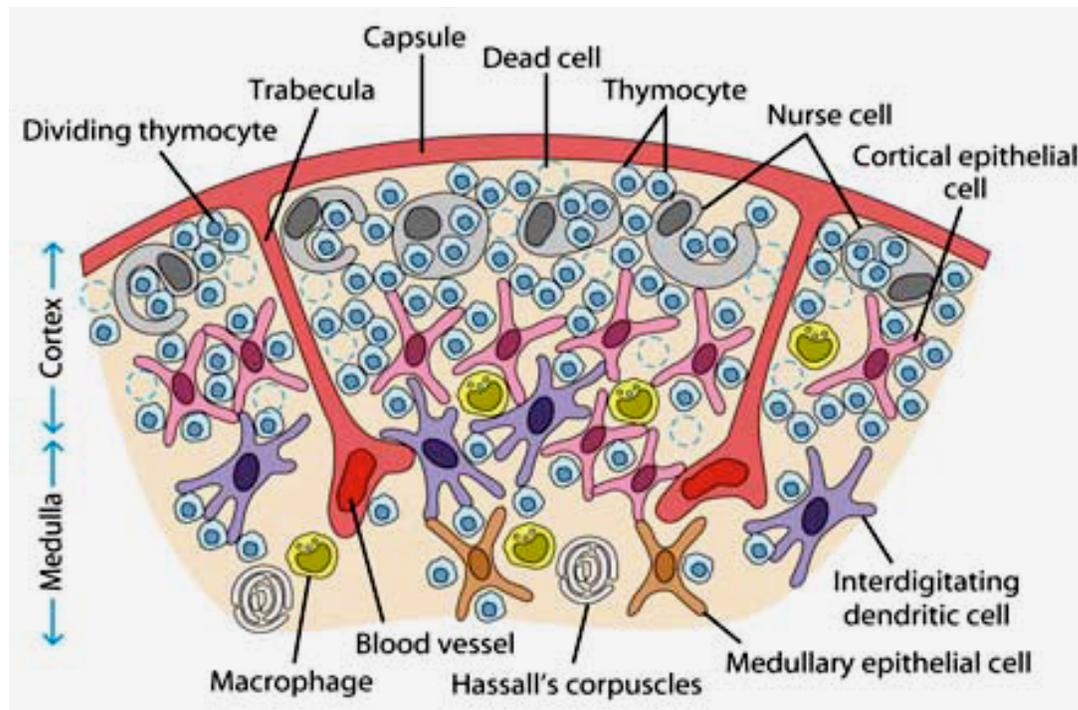
Thymus: thymus in mammals is a bilobed organ, located in the thoracic cavity, the 2 lobes divided by trabeculae into lobules, each of which has an outer cortex and an inner medulla.

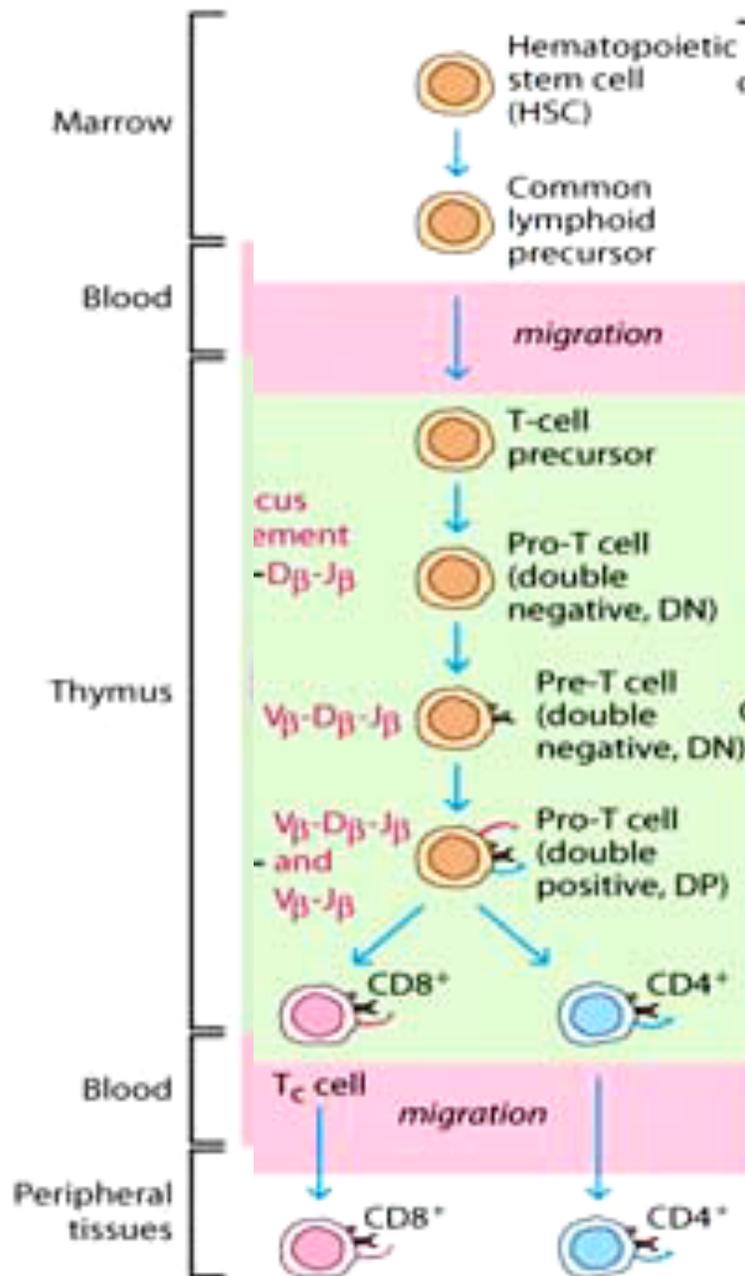
Epithelial cell in the cortex “thymic nurse cells” made up of squamous cells that make and secrete factors that attract T-cell precursors from the blood and promote subsequent maturation within thymus. These factors include:

- 1- Chemokine: called thymus-expressed cytokine (TECK)
- 2- Hormones: thymulin, thymosin, and thymopoietin

Naïve cells enter the thymus from subcapsular sinus. They migrate through the cortex and medulla and undergo differentiation, express CD3 and either CD4 or CD8 and leave thymus as mature T cells.

Thymus is relatively large and highly active at birth (22gm) reach its peak weight at puberty (35gm) thereafter it begins to involute as the lymphoid components recede and replaced by fatty C.T. Little more than 6gm of thymic tissue persists in adulthood.



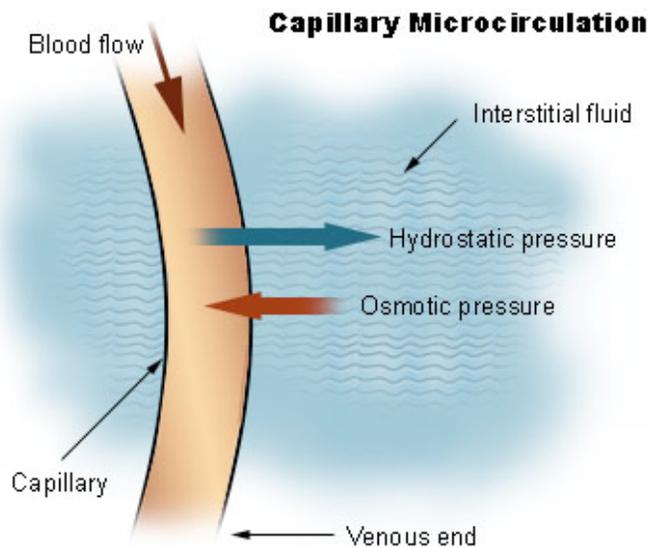


If thymus surgically removed in neonates, they became severely immunodeficient and fail to thrive and babies without functional thymus lead to disease called DiGeorge Syndrome. Adult have developed enough mature T cell that removal of thymus or reduction of its function has milder effect.

2- Secondary lymphoid tissue: are sites of accumulation and presentation of Ag to both virgin and memory lymphocyte populations.

Lymphatic circulation: water and low molecular weight solutes leach out from blood vessel walls into the lower pressure interstitial space.

Most of this fluid returns to bloodstream through the walls of nearby venules, but a substantial amount does not. Instead, this portion flows through the tissues, carrying Ag and collected in a branching network of lymphatic vessels. Once the fluid enters these vessels it is known as lymph.

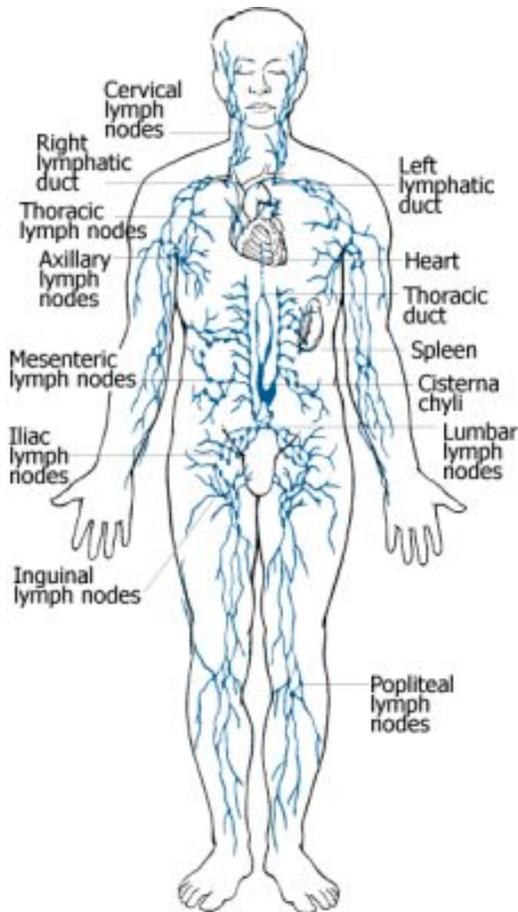


After passing through secondary lymphoid organ, lymph empties into larger lymphatic vessels. Thoracic duct and right lymphatic duct which drain their contents into right and left subclavian veins in the thorax.

Lymph: interstitial fluid surrounding cells in tissue or organ low in protein content than blood plasma.

Lymphatic vessels: (lymphocytes + dendritic) cell + lymph

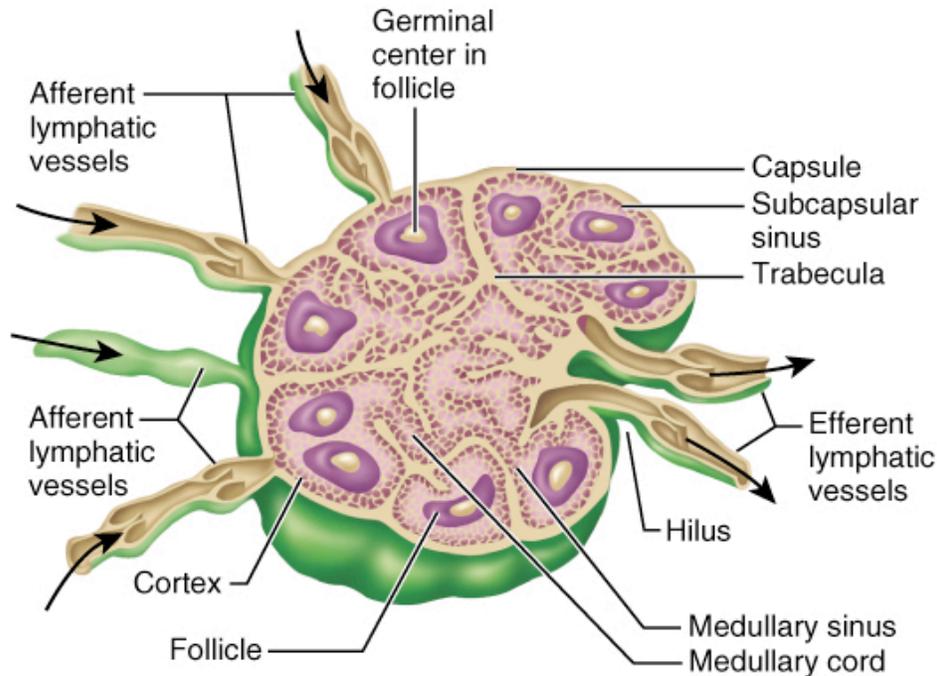
Blood vessels: (lymphocytes + RBC + monocyte + neutrophil + Basophil + eosinophil + Mφ) + plasma



Lymph node: the lymph nodes form part of a network which filters antigens from the interstitial tissue fluid and lymph during its passage from the periphery to the thoracic duct and the major collecting duct.

Human lymph nodes are 2-10 mm in diameter and round or kidney shaped with blood vessels enter and leave the node from hilus. A collagenous capsule surrounds it. Radical trabeculae with reticular fibers support cellular components.

The lymph node consist of a B-cell area (cortex), a T-cell area (paracortex) and a central medulla containing T- cells, B-cells, abundant plasma cells and macrophages.lymph node cortex contain cellular aggregation called lymphoid follicles which composed of memory B-lymphocytes, smaller number of T-cell and follicular dendritic cell.



(a)

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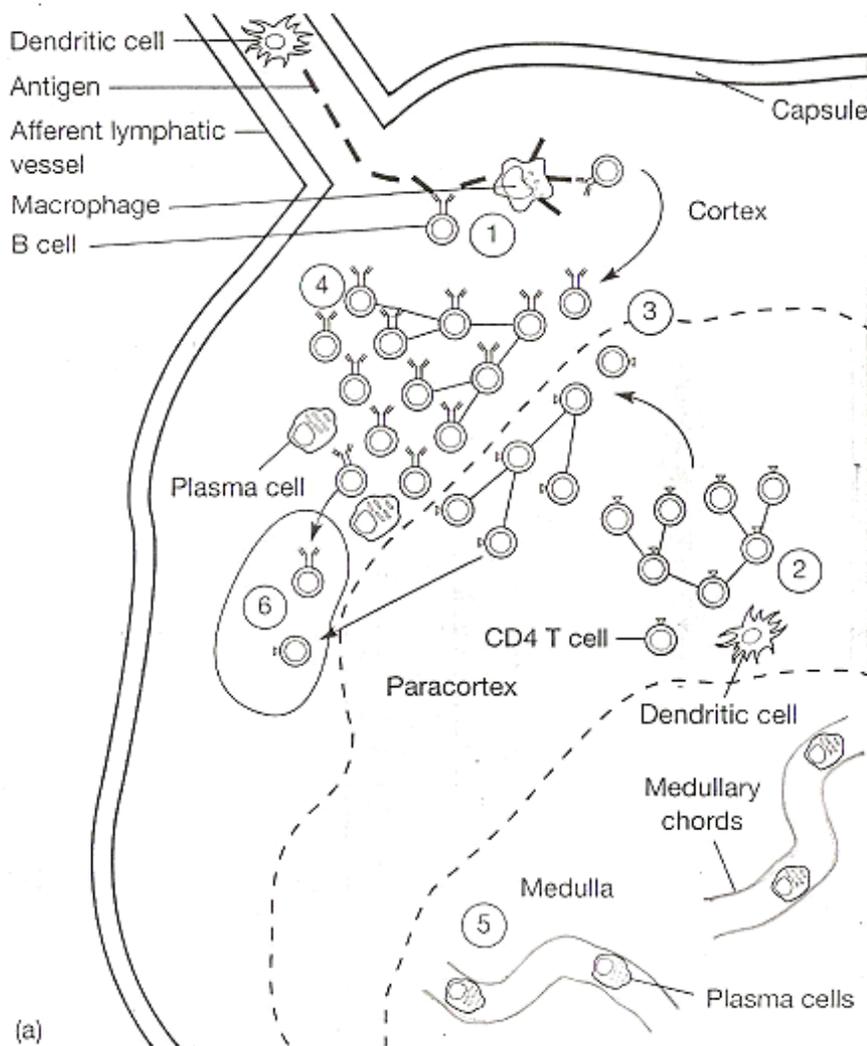
Lymphoid follicles re of 2 types:

- Primary follicles: contain mature resting B-cells.
- Secondary follicles: with germinal center contain various stages of activation and blast transformation with numerous macrophage and occasional plasma cells may be seen.

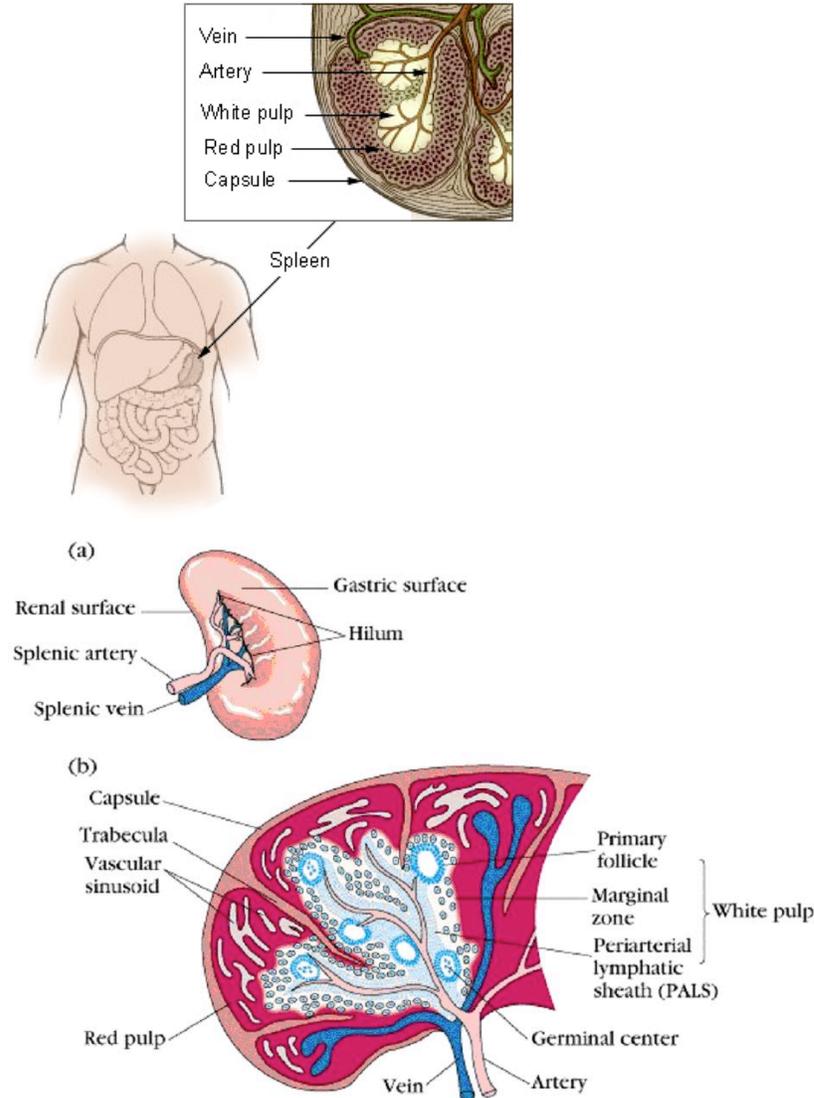
The paracortex contains specialized capillary vessels (high endothelial venules-HEV) that allow traffic of lymphocytes out of the circulation in to lymph node (lymphocyte traffic). The lymph that flows into a node may carry with it microorganism or other foreign matter from tissue. When such substance enters lymphocytes and macrophage in the node respond by activation as a result, some of the resident lymphocytes begins to proliferate, inflammatory mediators are released locally, blood flow to the node increases and node may become noticeably enlarged when infection develop. The swelling decrease when the infection ends.

The early events in Antibody production in lymph node.

Ag stimulates B cells in follicles in the cortex and CD4 T cells (presented by dendritic cells) in the para cortex 2- Stimulate B cells and CD4 cells, migrate to the border of the cortex and paracortex 3- where B cells present antigenic peptide on class II MHC to the CD4 T cells, which in turn give signals to the B cells to proliferate and differentiate 4- Some of B cell differentiate into plasma cells, which migrate to the medullary cords and secrete antibody 5- A few of the B cell and some CD4 T cells enter a primary follicle 6- where they will form a germinal center.



Spleen: the spleen filters blood much as the lymph nodes filter lymph. Its located just below the diaphragm on the left side of the abdomen, the spleen weight 150gm in adult and enclosed in a thin connective tissue capsule. Most of the spleen consists of red pulp and whit pulp.



Function of red pulp:

Blood enters the spleen via the splenic artery, which divides into many arteries called central arteries. These arteries become thinner arterioles, which eventually enter the red pulp. The red pulp contains thin-walled blood vessels called venous sinusoid and in between these sinusoids are called splenic cords.

Blood cells are emptied out of the arteries directly into the splenic cords. To re-enter the blood circulation, blood cells must transverse the splenic cords

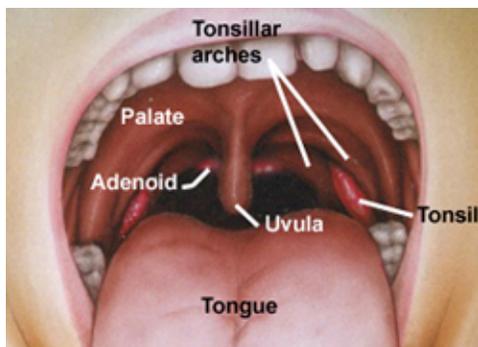
and enter the venous sinusoids. Venous sinusoids lined with macrophage and the splenic cords are full of macrophage. These macrophage recognize and phagocytose old or damaged red cells and platelets preventing their re-entry in to the blood. Beside old red cells membranes are less elastic and unable to squeeze through the wall of endothelium of venous sinusoids to re-enter the blood stream.

Each arteriole is encased in lymphoid tissue that consists mainly of mature T- cells and is called the periarteriolar lymphoid sheath (PALS). Adjacent to PALS is the B-cell area containing primary follicles and secondary follicle with germinal centres. Between the white pulp and the red pulp is the area called the marginal zone, which contains B-cells and macrophage.

3- Tertiary lymphoid tissue: tissues in the body possess poorly organised collections of lymphoid cells. Such collections include mucosa-associated lymphoid tissue and intraepithelial lymphocytes (IEL).

Mucosa-associated lymphoid tissue: diffuse lymphoid tissue found in sub mucosal regions and constitute the largest lymphoid organ, containing roughly half the lymphoid cell in the body including: Gut associated lymphoid tissue (GALT), Bronchus associated lymphoid tissue(BALT). GALT consist of peyers patches that present beneath the mucosal epithelium of the small intestine. Its function is secreting antibodies across the mucosal surface as a defense against external pathogens. BALT consists of large collection of lymphocytes (majority B cells) found along the main bronchi in the lungs.

At other sites, cells are organized in stable anatomic structures e.g. Tonsils (are nodular aggregates of macrophage and lymphoid cells located immediately beneath the stratified squamous epithelium).



Intraepithelial lymphocytes: Large numbers of lymphocytes are intrinsically associated with the epithelial surfaces of the body particularly reproductive tract, the lung and skin. These collections of lymphoid cells play a key role in the development of both local and systemic specific immune responses to antigens present at the body surface.