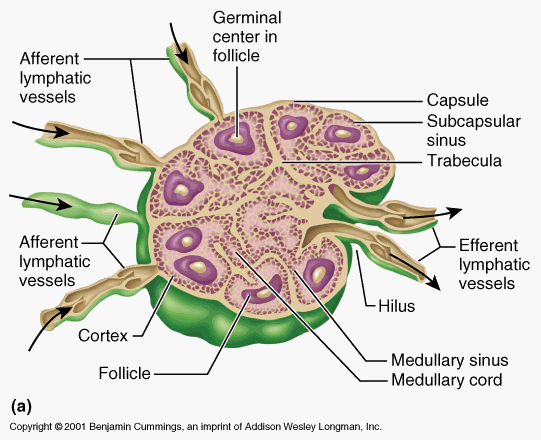
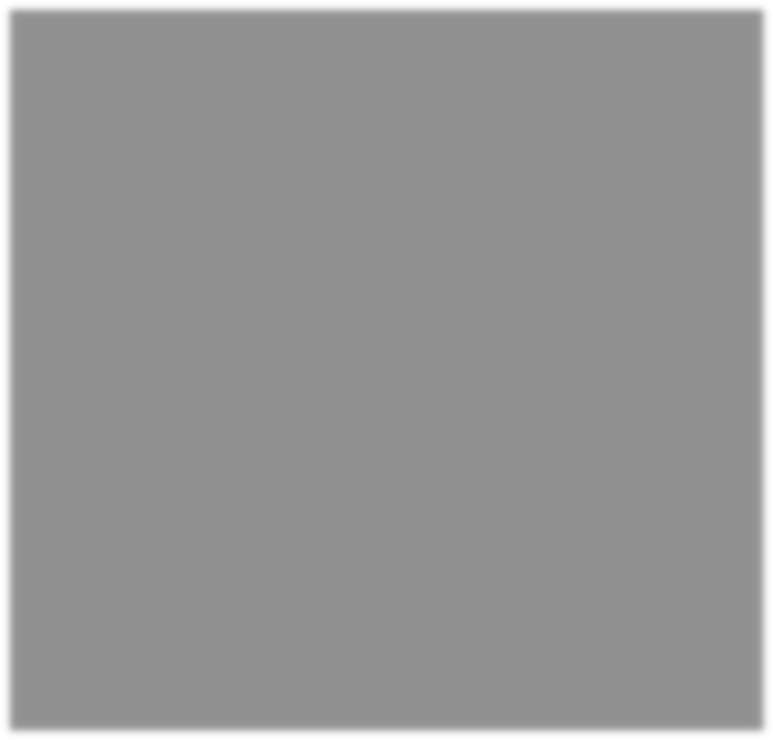
The peripheral (secondary) lymphoid tissues

**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.

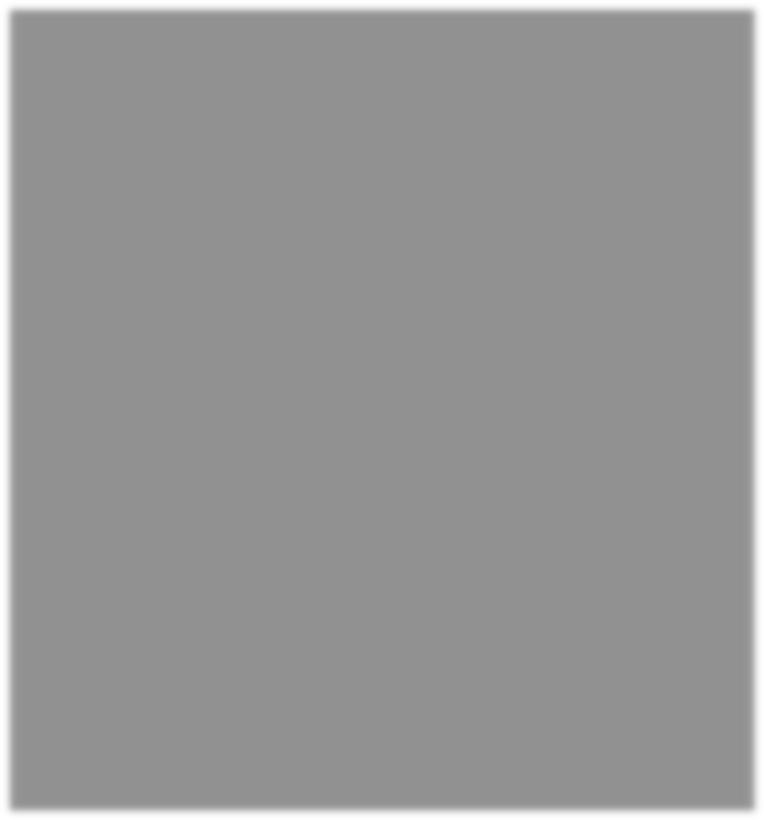


1. Lymphatic vessels leading into the node (**afferent lymphatic vessels**) are carrying lymph derived from tissue fluid in one or more organs or body regions.
2. Lymphatic vessels exiting from the node (**efferent lymphatic vessels**) carry lymph from the node to larger lymphatic vessels which eventually empty into the blood circulation in the thoracic region.
   * **Stroma:** Lymph nodes are covered by a capsule of dense fibro-elastic connective tissue (FECT) containing outer densely packed collagen fibers and an inner loose network of elastic fibers. The capsule extends as trabeculae into the lymphoid tissue. Reticular connective tissue forms a framework for the lymphoid tissue inside the lymph nodes.
   * Each lymph node is divided into an outer **cortex**, inner **medulla** and intervening

**paracortical** region.

* + **The cortex** is also referred as **B cell area**, which mainly consists of B cells. The cortex is a high traffic zone where recirculating T and B lymphocytes enter from the blood. Aggregates of cells called **follicles** are present in the cortex, which in turn may have central areas called **germinal centers**.

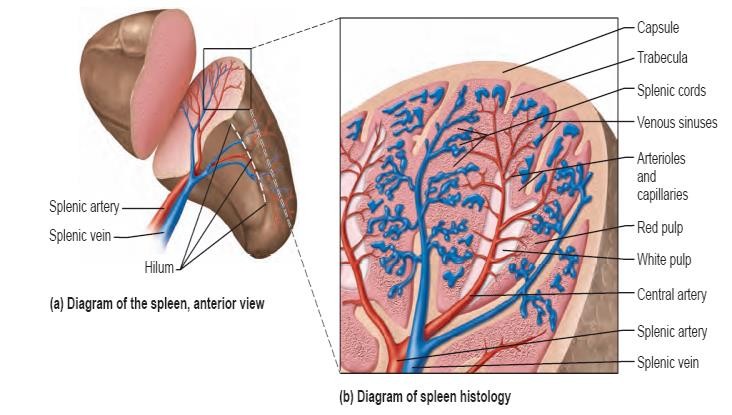
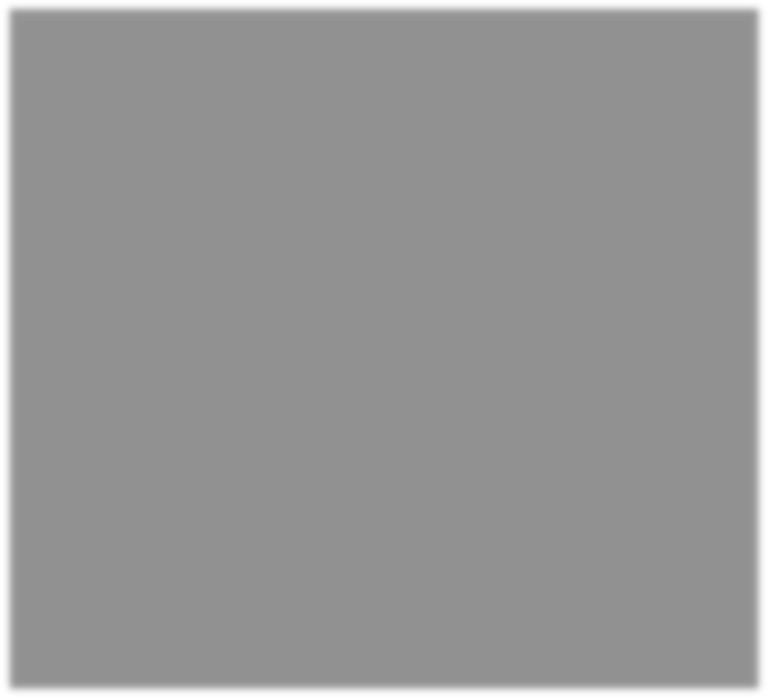
**The medulla** contains a mixture of **B cells, T cells, plasma cells and macrophages**. **Medullary cords** are branched cordlike extensions of lymphoid tissue arising from the para cortex. Medullary cords are separated by dilated spaces, frequently bridged by reticular cells and fibers, called **medullary sinuses**. **Medullary sinuses** are located in the medulla between medullary cords.



* + Between these two zones, lie the para cortex (**T cell area**) that contains T lymphocytes, dendritic cells and mononuclear phagocytes. Most of the T cells (70%) located there are CD4+ helper cells.

**Function:** Lymph nodes have several identified functions.

1. Lymph nodes **filter and screen lymph**.
   1. Afferent lymphatic vessels drain lymph into the Sub capsular 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
2. Lymph nodes are a **major** site of movement of lymphocytes from blood into lymphoid tissue.



1. Lymph nodes are a **major** site of exposure of lymphocytes to antigen and subsequent stimulation of lymphocytes for their appropriate immune responses.

# 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 blood- borne antigens. It is also the main site of destruction of aged erythrocytes.

The spleen is surrounded by a **capsule** of dense connective tissue from which emerge **trabeculae**, which partially subdivide the parenchyma or **splenic pulp.** Large trabeculae originate at the hilum, on the medial surface of the spleen; these trabeculae carry nerves and arteries into the splenic pulp as well as veins that bring blood back into the

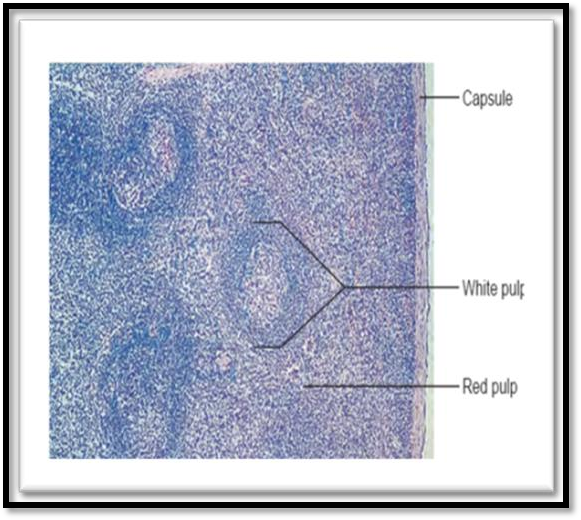
circulation. Lymphatic vessels that arise in the splenic pulp also leave through the hilum via the trabeculae.

## Stroma

The spleen is covered by a capsule consisting of **dense fibro-elastic connective tissue (FECT)**, some smooth muscle, and an outer covering of mesothelium. Trabecular extensions of the capsule (which contain blood vessels) partially subdivide the spleen into lobule-like regions (not very recognize). the parenchymal tissues are supported on a framework of reticular connective tissue.

1. Two types of **parenchyma tissue** can be identified in the spleen.

## White pulp

Most white pulp consists of typical non- nodular dense lymphoid tissue organized around arterial vessels as **periarterial lymphoid sheaths (PALS)**. The central "artery" in a PAL is really an arteriole. Most of the inner cells of PALS are recirculating T cells, but nodules containing B lymphocytes also occur.

## Red pulp

Red pulp is located between white pulp and trabeculae. Red pulp contains small arteries, capillaries (type I capillaries), venous sinuses (sinusoidal capillaries), and diffuse lymphoid tissue in the form of

cords (splenic cords). A number of different cell types are found in red pulp - reticular cells, lymphocytes, macrophages, monocytes, plasma cells, granular leucocytes, and erythrocytes.

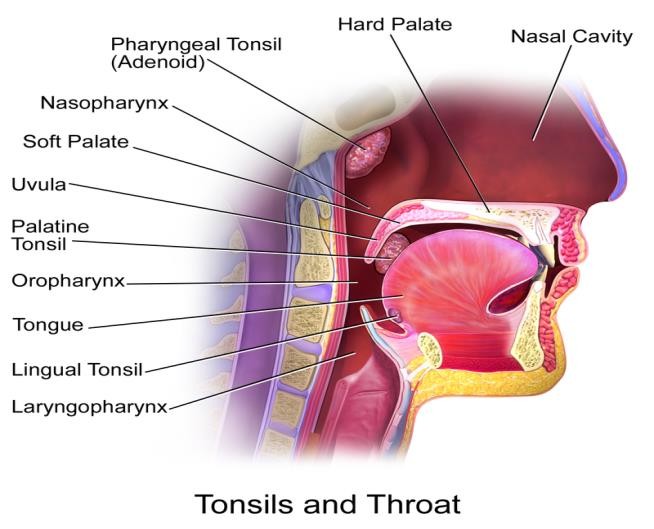
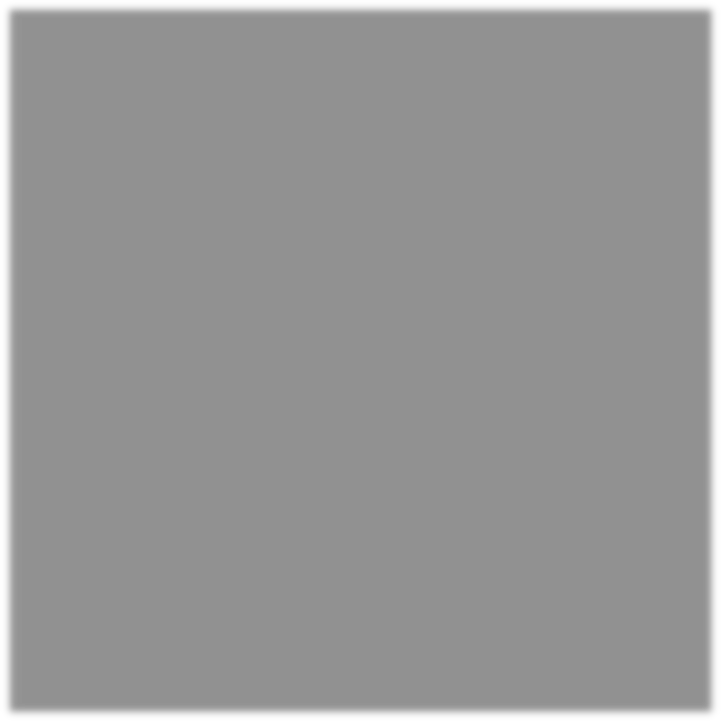
## Blood Flow:

* + - **Spleen =** major lymphoid organ that serves multiple purposes including its role in adaptive immunity
    - Has an open blood circulation through porous **splenic sinuses** (very different than a lymph node or the thymus)
    - **Splenic artery** (blood to spleen) → central arterioles (run deeper into pulp of spleen, they become lined with discontinuous endothelial cells with gaps so large, that platelets, RBCs, and leukocytes can leave the vessels and enter the sinuses that have loosely packed arrangement of cells (primarily various leukocytes)
    - **Splenic vein** (drains blood)
    - Bulk of the lymphoid tissue = arranged as a sheath around the central arterioles =

## PeriArteriolar Lymphoid Sheath (PALS)

**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.



1. B lymphocytes in the spleen are exposed to antigens present in circulating blood.
2. 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.

# MUCOSA ASSOCIATED LYMPHOID TISSUE (MALT):

Approximately >50% of lymphoid tissue in the body is found associated with the mucosal system. MALT is composed of **gut-associated lymphoid tissues (GALT)** lining the intestinal tract, **bronchus-associated lymphoid tissue (BALT)** lining the respiratory tract, and lymphoid tissue lining the genitourinary tract. The well-formed follicles include the **tonsils** (lingual, palatine and pharyngeal), **Peyer’s patches** in the intestine and **appendix**. The major function of these organs is to provide local immunity by way of IgA (also IgE) production.

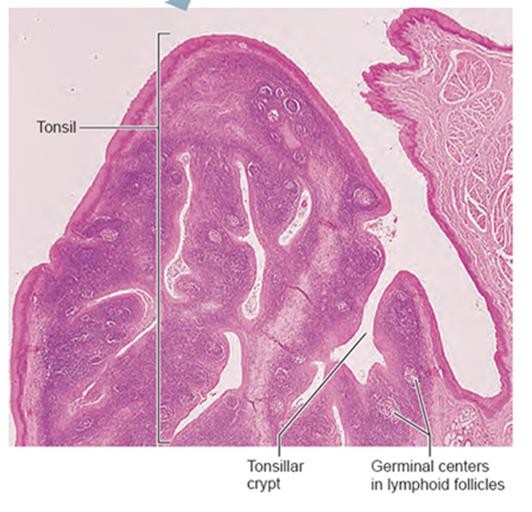
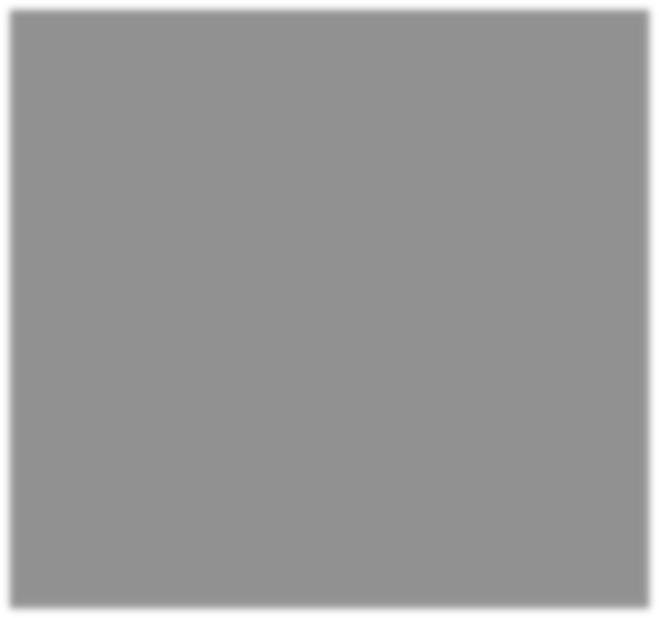
**A-Tonsils:** The tonsils are the simplest lymphoid organs. They form a ring of lymphatic tissue around the entrance to the pharynx **(**throat), where they appear as swellings of the mucosa. The tonsils are named according to location:

## palatine tonsils

1. **lingual tonsil**
2. **pharyngeal tonsil**

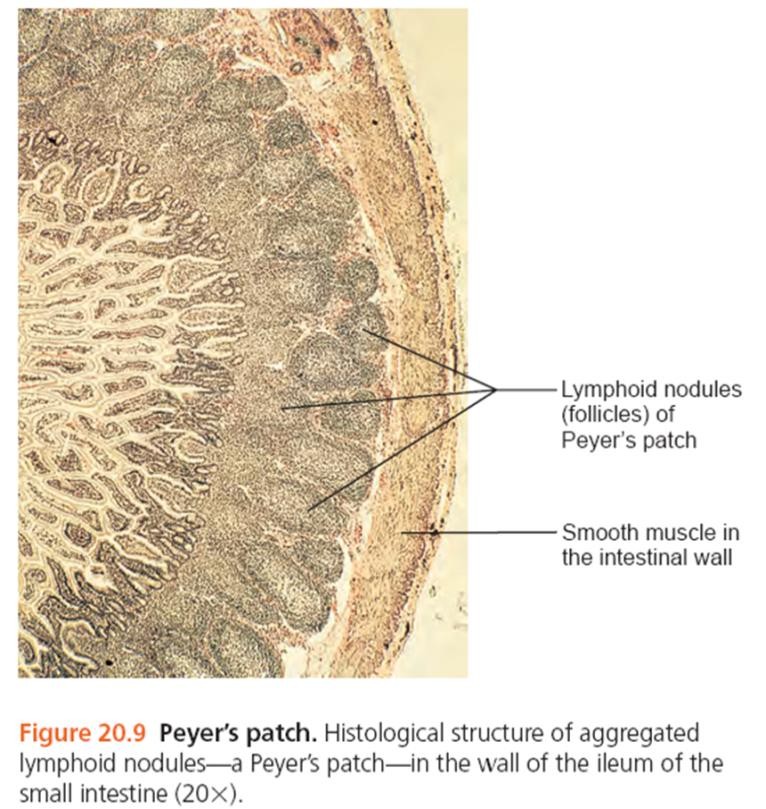
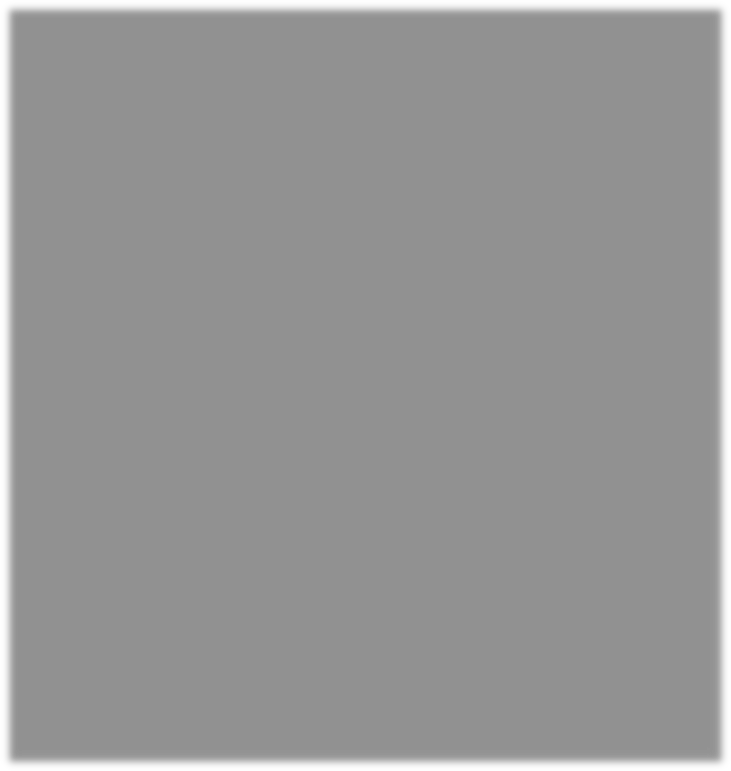
The paired **palatine tonsils** are located on either side at the posterior end of the oral cavity. These are the largest of the tonsils and the ones most often infected. They consist of dense accumulation of lymphatic tissue in the C.T. of

mucosa ,they are covered on their free surface by stratified squamous epithelium which is continuous with the epithelium of the rest of pharynx and mouth , the epithelium rests upon basal lamina.



At various places on the surfaces of tonsil , deep depressions 10-20 in number occure there are known as **tonsillar crypts.** Penetrate into interior of the tonsil and line by continuations of the surface epithelium , that becomes thinner as the deeper part of the crypt is reach.

A lumpy collection of lymphoid follicles at the base of the tongue is referred to collectively as the **lingual tonsil**.



**Tonsils function** in "screening" of oral and pharyngeal regions for foreign organisms.

# B. Peyer's patches

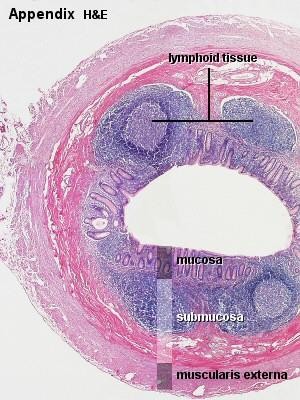
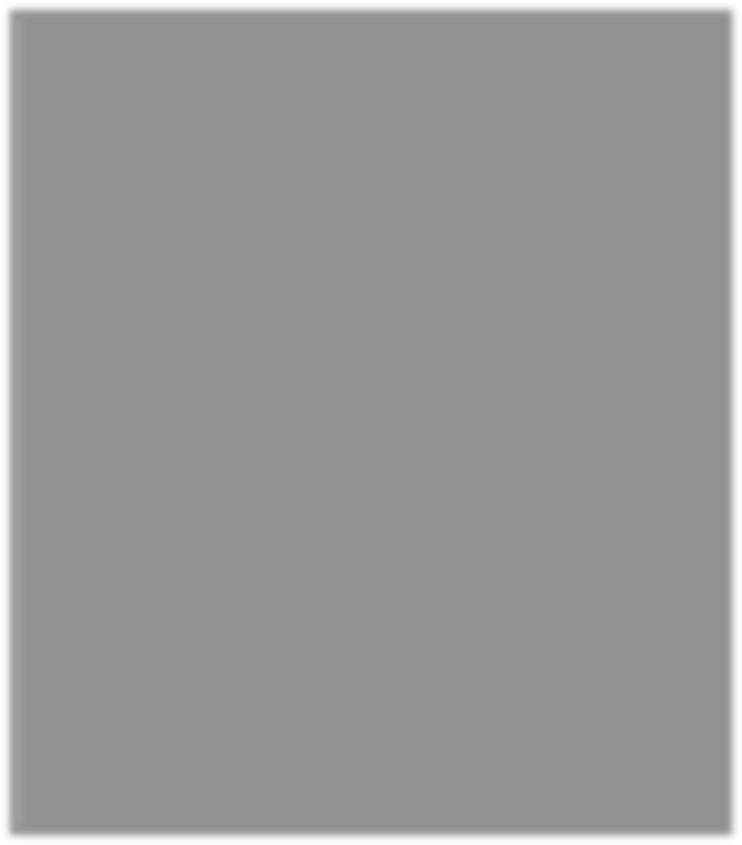
* Peyer's patches occur in the wall of the ileum (final third of small intestine).
* Peyer's patches consist of very large spherical aggregates (nodules) of dense lymphoid tissue which may show germinal centers. Most of the mass of each nodule is located in the submucosa,

but the nodule extends into the lamina propria (subepithelial loose FECT) and bulges visibly into the lumen of the ileum.

* Peyer's patches function in screening" of the lumen of the small intestine, probably to prevent colon bacteria

from migrating up into the small intestine.

* **IgA** antibodies secreted by plasma cells generated by the Peyer's patches seriously impair bacterial motility and inhibit attachment of bacteria to the intestinal walls.



# C. Appendix:

The lymphoid nodules in the appendix are similar in structure and basic function to the Peyer's patches. The nodules in the appendix probably prime the **immune** **system against microorganisms** which inhabit the colon so that if these organisms penetrate into the colon wall or the peritoneal cavity they are efficiently destroyed.