HISTOLOGE OF LYMPHATIC SYSTEM

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Objectives

:By the time you have finished this topic, you should know

1.The general properties of primary and secondary lymphoid tissues

2.The structure and function of the thymus gland

3.The histological structure of four different types of lymph nodes, tonsils, Mucosa associated lymphoid tissue and the spleen, and how their structure is adapted to their different functions.

What is Lymphoid Tissue?

A fluid called lymph, (lymph = clear fluid) flows in lymphatic vessels, lymphatic tissue and red bone marrow.Fluid filters out of capillaries and drains into lymphatic vessels to become lymph.The content of lymph is the same as interstitial fluid, the fluid around tissue cells.Lymph eventually drains into venous blood.Lymph drains interstitial fluid, transports dietary lipids and facilitates immune responses.

Primary lymphatic organs are where lymphocytes are formed and mature. They provide an environment for stem cells to divide and mature into B- and T- cells: There are two primary lymphatic organs: the red bone marrow and the thymus gland. The development of white blood cells (haemopoesis) was covered briefly in the section on blood. Both T-cell and B-cells are 'born' in the bone marrow. However, whereas B cells also mature in the bone marrow, T-cells have to migrate to the thymus, which is where they mature in the thymus.

Secondary lymphoid tissues are arranged as a series of filters monitoring the contents of the extracellular fluids, i.e. lymph, tissue fluid and blood. The lymphoid tissue filtering each of these fluids is arranged in different ways. Secondary lymphoid tissues are also where lymphocytes are activated. These include: lymph nodes, tonsils, spleen, Peyer's patches and mucosa associatedlymphoid tissue (MALT)..

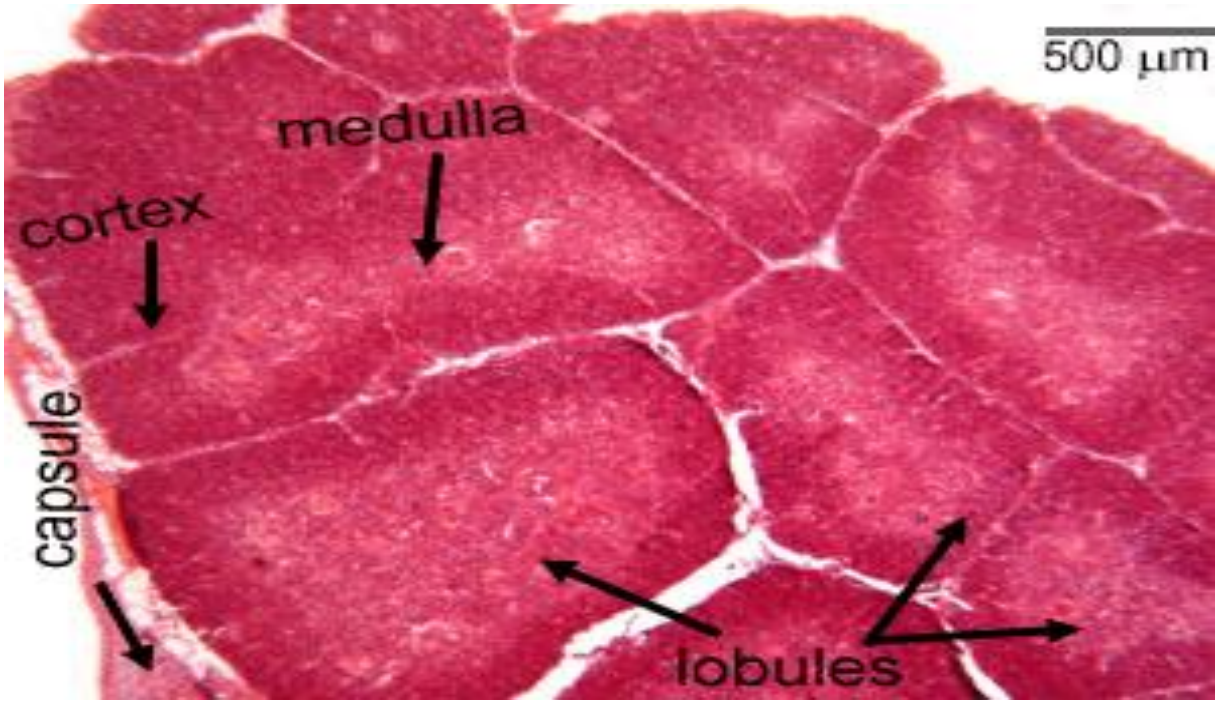
Filtering lymph the lymph is filtered by lymph nodes, which are examples of encapsulated lymphoid tissue. There are around 100-200 of these which mostly occur in the neck, thorax, abdomen and pelvis They contain B- and T-cells, which mostly enter the nodes via the blood stream, and also contains macrophage

Tissue fluid is filtered by non-encapsulated (or partially encapsulated) aggregations of lymphoid tissue (sometimes called Mucosa Associated Lymphoid Tissue (MALT)). This makes up 85% of lymphoid tissue, in the non-sterile mucosa. They are usually small, around 1mm in diameter, with the exceptions beting the tonsils, peyers patches and the appendix. These lymphoid aggregations are frequently found close to moist epithelial surfaces e.g mucous membranes of the digestive, respiratory and reproductive systems. Although the epithelia of these tissues has mechanisms to keep bacteria etc out of the body, this is not foolproof. Thus the lymphoid cells in these areas are able to respond to any bacteria or micro-organisms that do get through the epithelia. Activated B-cells in these areas can develop into plasma cells, and produce antibodies, in situ. Lymphocytes from the larger permanent organs (such as the tonsils) are able to patrol the surrounding tissue, and quickly respond to foreign antigens.

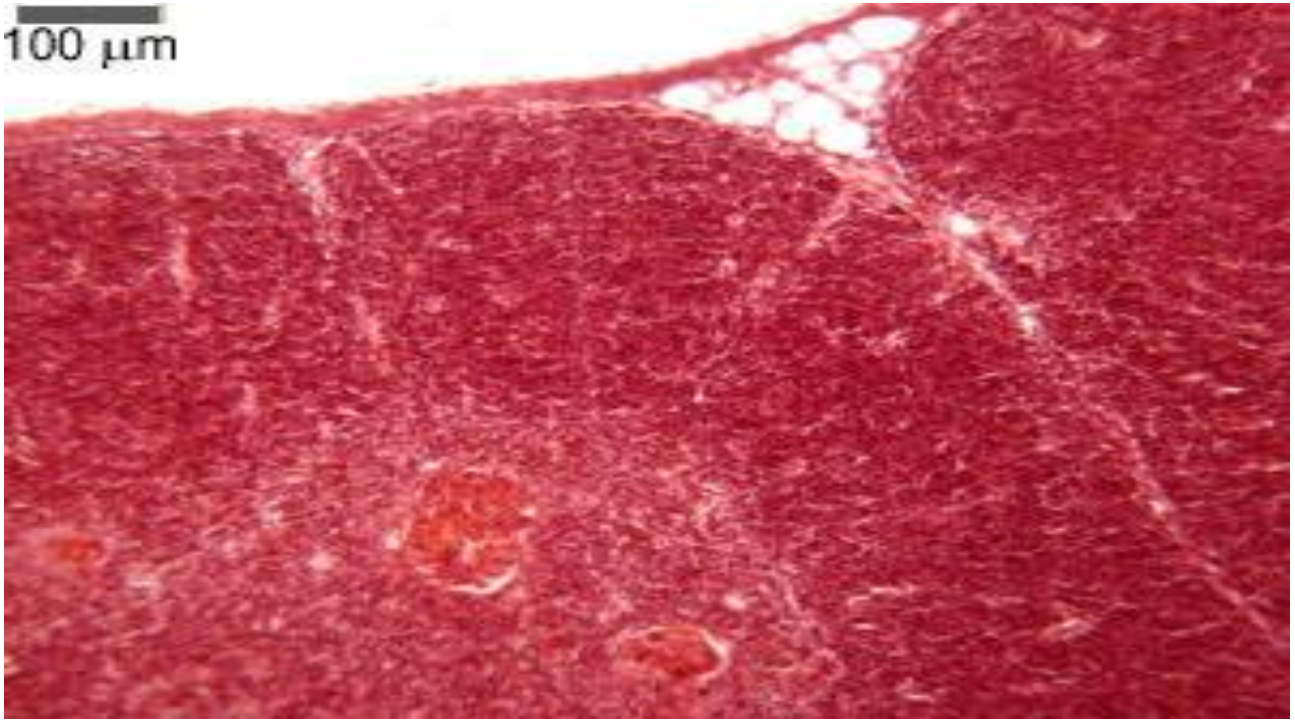
Tonsils are large partially-encapsulated masses of lymphoid tissue, found in the walls of the pharynx and nasopharynx, and at the base of the tongue. They form an incomplete ring around the gastrointestinal and respiratory tracts, where they cross over.
Peyer's patches are large masses of confluent lymphoid follicles, found in the walls of the ileum, part of the small intestine
The blood is filtered by the spleen, another example of encapsulated lymphoid tissue. This is the body's largest lymphatic organ. It is important for antibody production, facilitating immune responses to blood borne antigens, and it also eliminates worn-out blood cells and platelets. The spleen is a large encapsulated organ in left upper part of abdomen, the outer capsule is fibro-elastic.

Thymus is a primary lymphoid organ found within the superior mediatinum, behind the upper part of 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. It has two lobes divided up into many lobules. The outer, more darkly staining region is the cortex, and this is highly cellular. The inner lighter staining region is the medullar, and this region is less cellular. It has an outer connective tissue capsule and septa. This organ is important for development of immunocompetent T-cells, proliferation of clones of of mature T-cells, developing immunological self-tolerance, and secretion of hormones for T-cell development. At least three hormones are made: thymosin, thymulin and thymopoietin. These hormones are produced by reticular epithelial cells in the cortex.

The cortex stains more darkly (is more basophilic) than the medulla, because it contains more lymphocytes than the medulla. The epithelial network in the cortex is more finely branched than in the medulla - and this gives this network the name 'reticular'. The epithelial cells are connected to each other by desmosomes, and the intermediate filament protein keratin is present in their cytoplasm. This photograph shows a low power image of the thymus, showing the more darkly staining cortex, and paler staining medulla. You can also see the outer capsula, and the lobules.



At this magnification, you can't see individual lymphocytes, but you can see Hassal's corpuscles in the medulla. These are made up of flat non-secreting epithelial cells arranged in a concentric layers that have keratinised. These structures are only found in the thymus.



Lymph nodes these are about 100-200 100 bean shaped organs, which are found along lymphatic vessels, and which filter micro-organisms etc from lymph.

The nodes are covered by a capsule of dense connective tissue, and have capsular extensions, of connective tissue, called the trabeculae, which provide support for blood vessels entering into the nodes.

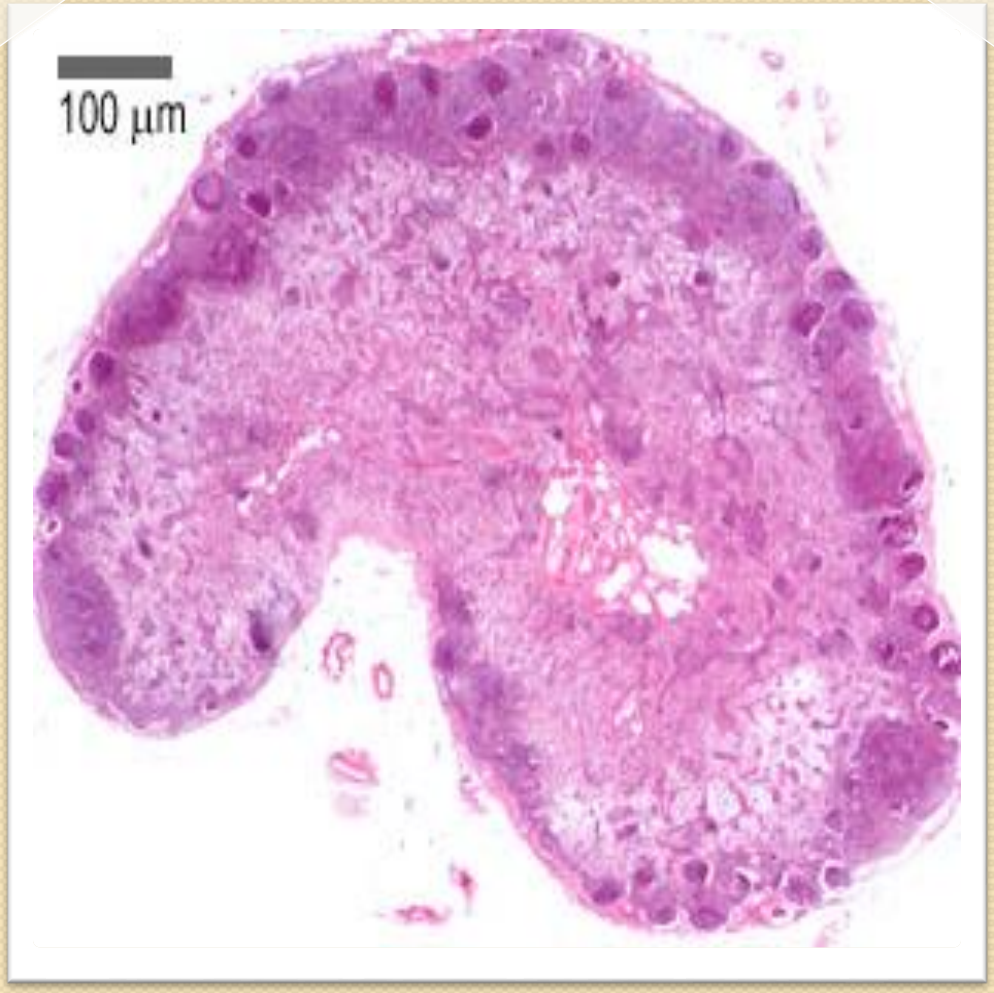
Lymph, containing micro-organisms, soluble antigens, antigen presenting cells, and a few B-cells, enters the lymph node via afferent lymphatic vessels which enter the subcapsular sinus. It then runs through cortical sinuses into medullary sinuses and leaves through the efferent lymphatic vessels, at the Hilium as efferent lymph. This contains lots of T-lymphocytes, B-lymphocytes, plasma cells and antibody.

All the blood sinuses are lined by a discontinuous layer of simple squamous endothelium, and they also contain lymphocytes and macrophages. Reticular fibres provide additional support to the matrix/stroma.

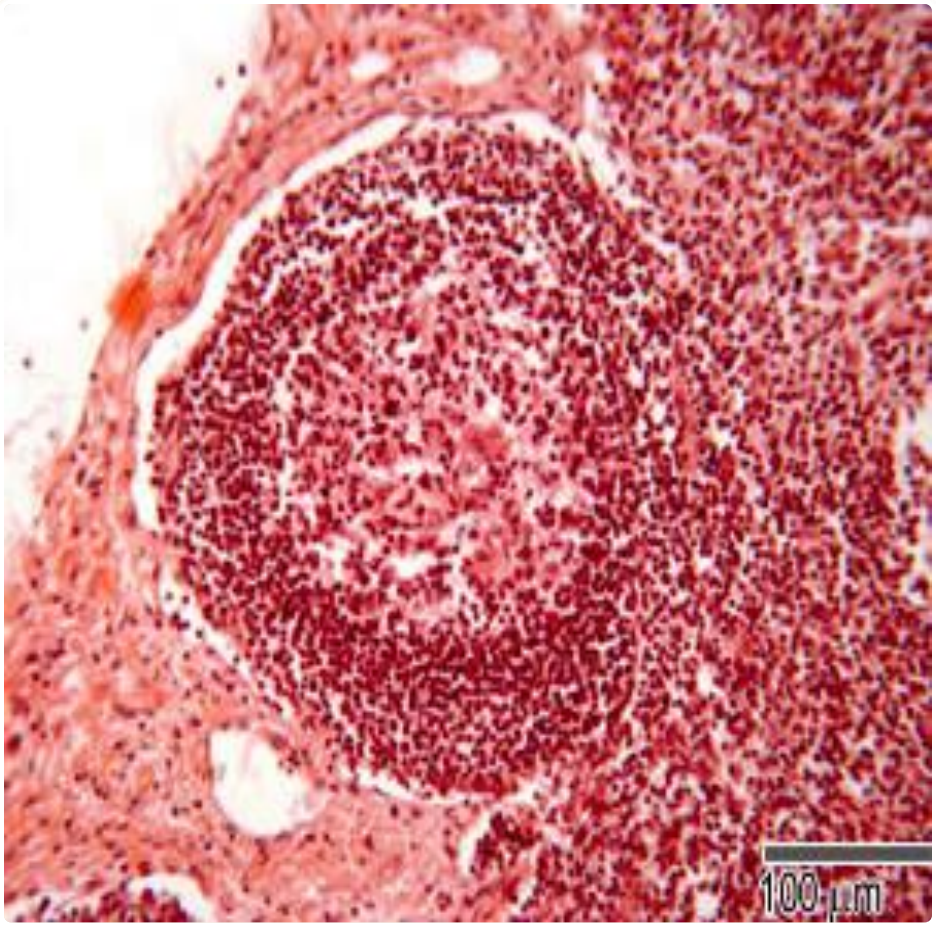
The cortex is divided into an outer and an inner cortex.

The outer cortex has lymphatic nodules that mostly contain B-cells. Small lymphocytes sit in the spaces between the reticular fibre meshwork in the cortex. (see the picture below). The lighter staining areas are germinal centres, where the B-cells proliferate into antibody secreting plasma cells (see B-and T-lymphocytes). Macrophages are also present in these regions, together with dendritic cells, and some T-cells. Both the macrophages, and the dendritic cells trap antigens and present them on their surfaces to B-cells. The inner cortex contains mostly T-cells. The deep cortical, and medullary cords contain B-cells and plasma cells. Plasma cells live for 3 days, and make IgG type antibodies.

Most of the lymphocytes enter the lymph nodes via blood vessels, and about 10% enter through the lymph. The structure of the post-capillary venule, in the deep cortex (paracortex) is unusual in that it is not lined by simple squamous epithelium, but by a simple cuboidal epithelium. These are called high endothelial venules (HEVs) (see the picture below). Lymphocytes recognise and adhere to these endothelial cells, and squeeze through them into the deep cortical regions of the nodes. This region of the lymph has lots of T-cells, as well as the antigen presenting dendritic cells. T-cells entering here become activated in the cortex, between lymphoid follicles.

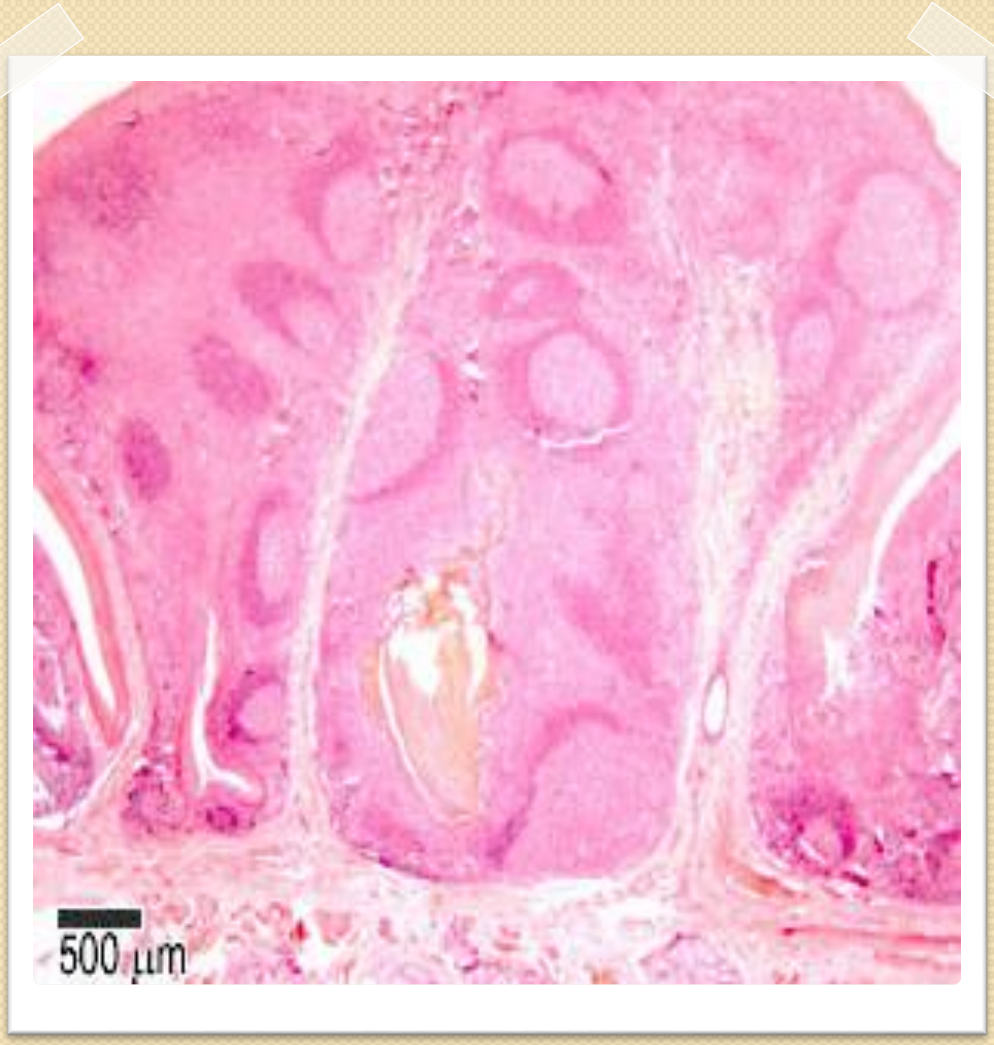


-This is an H&E stained section of a lymph node at low magnification. See if you can recognise the outer capsule, trabeculae, cortex and medulla, afferent lymphatic vessels, lymphoid follicles, medullary cords, the Hilium and efferent lymphatic vessels.



This picture shows a lymphoid follicle in more detail. You should be able to recognise the paler germinal center, and the outer corona

Tonsils are large non-encapsulated (or partially encapsulated) masses of lymphoid tissue, that lie in the walls of the pharynx and nasopharynx and at the base of the tongue. The luminal surface of the tonsils are covered with a stratified squamous epithelium (in common with the oral epithelia). The tonsils have many invaginations which form blind crypts. Below the epithelium, there are many lymphoid follicles beneath which have germinal centres like the lymph nodes. The epithelial cells are able to phagocytose bacteria, and transfer them to macrophages, which then present the foreign antigens to B-cells, which are activated (with the help of T cells). Again, like the MALT, the activated cells mostly secrete IgA type antibodies, which are secreted locally.



This is a low power photograph of a tonsil.

Spleen is the largest mass of lymphatic tissue in the bod, and is found between stomach and diaphragm. Like the lymph nodes, it also has a hilus (hilium) which is where the major blood vessels enter and leave. Like the thymus, it only has efferent lymph vessels, which leave from the hilium, and it does not have afferent lymph.As well as acting as a store for platelets, it has two main functions:it reacts to blood borne antigens, by producing antibodies. In fact is it the main source of circulating antibodies.it removes defective red blood cells and platelets from the circulation

There two main types of tissue in the spleen are specialised for its two main functions: White pulp contains lymphoid aggregations, mostly lymphocytes, and macrophages which are arranged around the arteries. The lymphocytes are both T (mainly T-helper) and B-cells. Red pulp is vascular, and has parencyhma and lots of vascular sinuses. These are sinuosoids - a specialised type of capillary, which is very leaky. The lining endothelial cells have wide slits between their lateral margins, that act as a filter. The blood cells have to move through these slits, before they can leave the spleen and worn out, or defective blood cells are damaged during this process. The damaged cells are then phagocytosed by the numerous macrophages in the red pulp, that lie just next to the sinusoids. The spleen is covered by a dense capsule, and there are connective tissue trabeculae, which provide internal support for the spleen, and carry the blood vessels into the spleen.

Lymphoid: Mucosa Associated Lymphoid Tissue and Peyer's Patches

The mucosa of the digestive, respiratory and urinary tracts often contains small aggregations of lymphocytes called lymphoid follicles. These are called 'Mucosa associated lymphoid tissue' (MALT).

In some cases, these aggregations are large, and confluent. This happens in the tonsils, peyers patches and the appendix.

Peyers patches mostly contain T-cells, but also can have germinal centres that contain B-lymphocytes, as well as macrophages.

Peyer's patches to not have any afferent lymphatics. The activated lymphocytes pass out in efferent lymphatics and travel to the lymph nodes

The epithelium of the mucosa contains special flat epithelial cells called M (membrane-like) cells or FAE (follicle associated epithelial cells). These specialised cells take up small amounts of gut antigens entering the gut lumen, and pass them onto antigen presenting cells, and lymphocytes of the MALT. Diffuse B-lymphocytes in gut react to micro-organisms that cross the mucosa, and they make IgA type antibodies, which are then secreted directly onto the gut lumen. These antibodies help to prevent micro-organisms in the gut from sticking to the gut epithelium, and can neutralise toxins and viruses.

This is a section through part of the ileum, showing the peyer patches.

THANK YOU…