HEMATOPOIETIC & LYMPHATIC SYSTEM

SUBJECT : ANATOMY

LEC NO. : 2

DONE BY : ALI ABUGHAZLEH

وَقُل رَّبِّ زِدْنِي عِلْمًا

Histology of the Lymphatic System

Lymphatic System

- Consists of lymphatic organs, tissue, cells, lymph, and lymph vessels
- It is a part of the immune system
- Organs include:

Thymus

Tissues in the form of MALT

mucosa-associated lymphoid tissue (MALT)

Tonsils

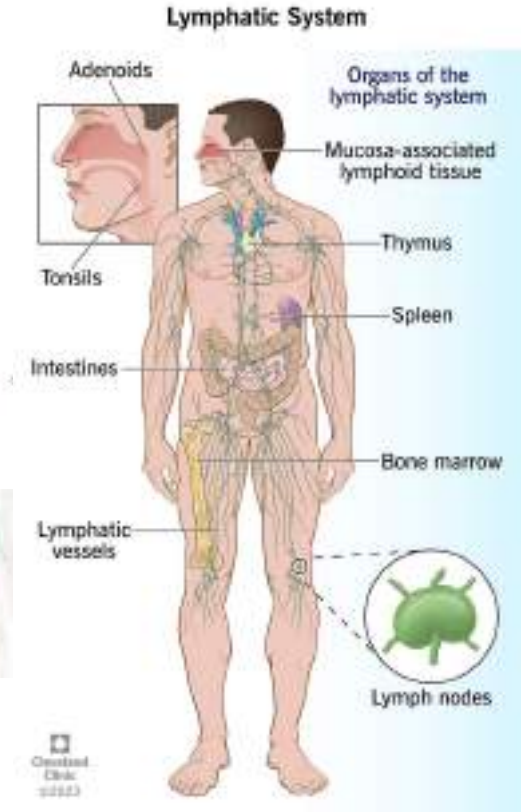
Peyer patches

Peyer's patches are clusters of subepithelial, lymphoid follicles found in the intestine.

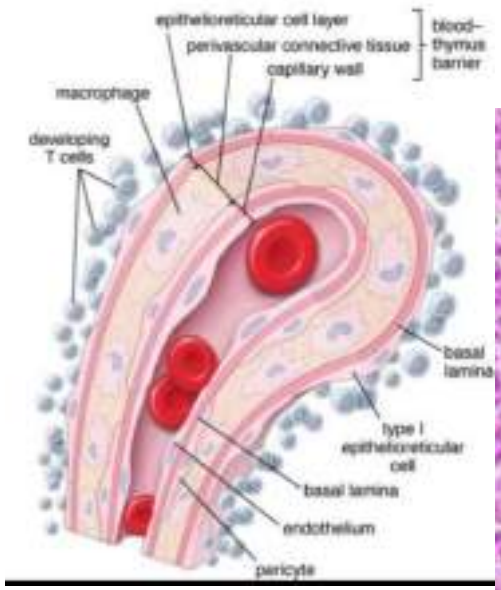
Appendix

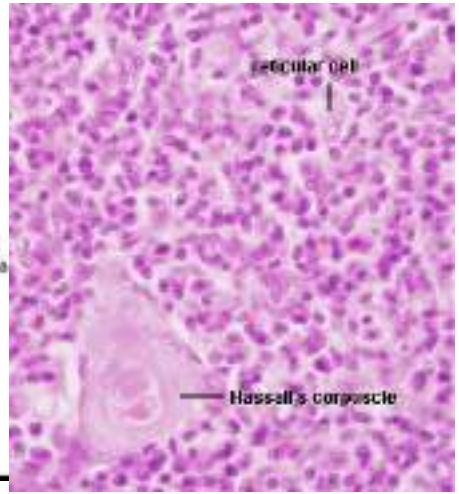
Lymph nodes

Spleen



They have efferent lymphatic ONLY



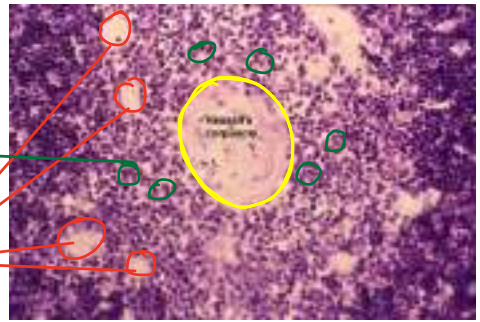


Thymus Gland

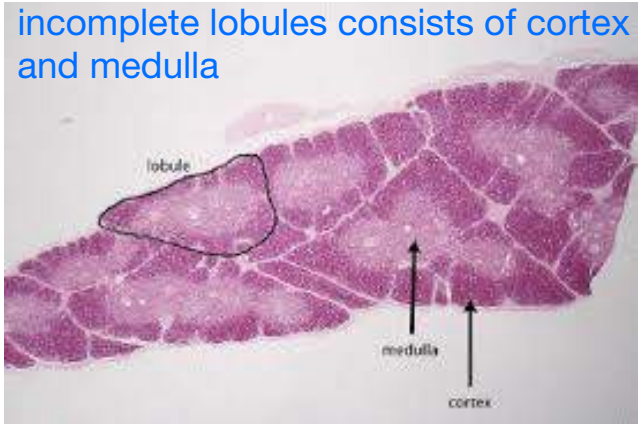
- **Location** On the chest mediastinum, retrosternally
- **Development and Growth**
- **Structure**
  1. **Capsule and lobules**
  2. **Cortex (T-Cell precursor (lymphoblast), Reticuoepithelial cells, abundant Macrophages)**
  3. **Medulla (T-Cells, Hassall corpuscles)**
  4. **Thymic blood barrier**

2% of T cells in medulla give the dark Color

Reticuloepithelia cells



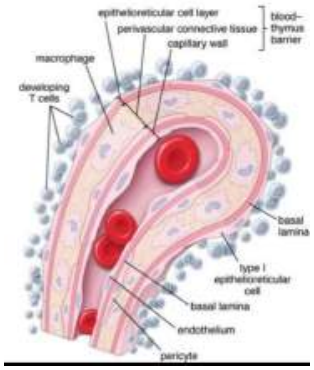
The picture below shows numerous incomplete lobules consists of cortex and medulla



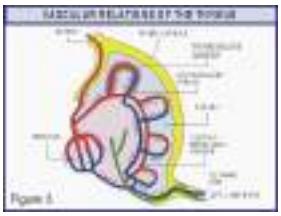
originates from endodermal tissue, specifically the third branchial pouch, during embryonic development. After they are located on mediastinum ,retrosternally .
They undergo several changes include increase on size and functiona which is maximum during puberty then start to decline on size and function and by 70 y old half of the tissue are replaced by fat .

composed of two Loops each Loop is covered by dense connective tissue capsule, and the capsule will send That send a trabeculae (white septa) that dividing the parenchyma into darker area (cortex) ,why cortex is dark ¿ because of the presence of large amounts of the precursor of T lymphocytes (lymphoblast) or immature T lymphocytes they are found on large amount there and can be divide by mitosis to give more blast cells ,in addition to blast cell we have reticuloepithelia cells or (thymic epithelial cells) ,abudunt macrophages ON THE OTHER HAND the lighter area (medulla) that contains only 2% of T lymphocytes (mature cells) and the rest lymphocytes 98% in cortex will dyes before reaching the medulla , and we can see on the medulla cells called nasal corpuscles this is a large magnification of part of the medulla and considered one type of reticuloepithelial cells that make hole shape appearance (Like layers of cabbage)

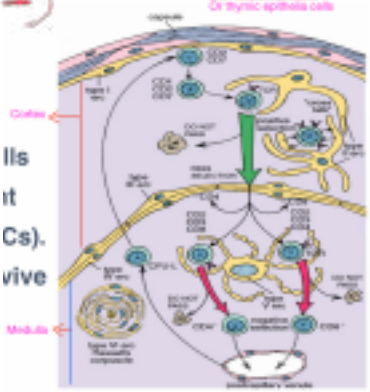
Bloode supply for thymus enter through the capsule and reach different part of thymus parenchyma via branches along with trabeculae to make a network that supply all parts of thymus.



Immature T cells comes from this capillary and enter the thymic parenchyma so it must pass from endothelial lining of capillary and pass basement membrane and cytoplasm of the pericyte outside of capillary and then pass through the connective tissue (macrophages and the green small dots which is a mature lymphocytes) and pass through a new cell that called reticuloepithel cells layer and then reach the parenchyma of thymus to become fully maturation at the end the bloode leaves through post capillary veins the following picture shows how blood enter and exit the thymus



1)



The first thing is enter of (CFU- L) through capillary and go to the cortex and this cell don't have any type of receptors and it starts acquiring the receptors which is a surface proteins (T cell receptors) then go to erc type 2 that have a MHC molecule

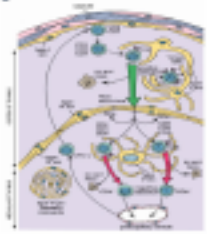
T cells that ONLY have a receptors they interact with MHC molecule (still survive) (+ve selection) ,after that these cells continue to medulla to become fully maturation the above is the first step of maturation of T cells
Cells don't acquiring the receptors die

When we take about maturation it sleek about acquiring the receptors
During the journey when pass to medulla they acquiring more receptors like CD4,8 .

2)

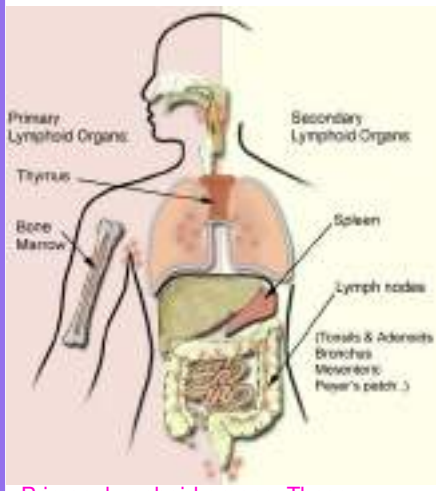
T-Cells Differentiation Cont.,

- In the medulla, cells are attached to self-antigens bound to class I and II MHC on the surface of TECs, dendritic cells, and macrophages, if accepted they will die (-ve selection) and other cells will continue the maturation
- Positive and negative selections
- Mature T-cells with receptors leave the thymus via capillaries or efferent lymphatic



erc type 5 (dendritic cells) express MHC molecule type 1,2 with self antigen (body antigen) if the T cell (CD4,8) that come from the cortex attach and bind to these self antigen the T cell will die(- ve selection) because if we continue the maturation they tend to attack body cell and destroy cells (autoimmune disorder)
T cell (CD4,8) that not bind the MHC completel to become fully maturation and then to blood or secondary lymphoid organ like spleen ,lymph nodes

Look at the picture below



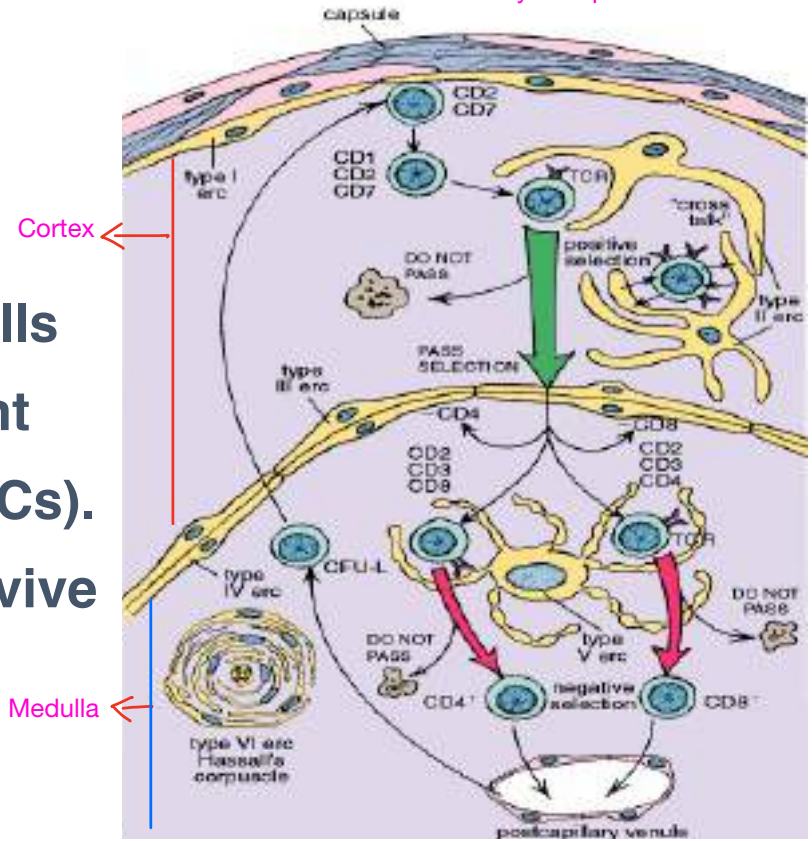
Primary lymphoid organs: These organs include the bone marrow and the thymus. They create special immune system cells called lymphocytes.
Secondary lymphoid organs (SLOs) include lymph nodes (LNs), spleen, Peyer's patches (PPs) and mucosal tissues- the nasal associated lymphoid tissue (NALT), adenoids, and tonsils.

شرح السلايدان الي تحت

T-Cells Differentiation

- It is the site of terminal differentiation, maturation, and selection of T-lymphocytes
- No receptors on the cell surface of precursor cells
- In the cortex, they divide by mitosis and present to MHC molecules on thymic epithelial cells (TECs).
- Cells that interact with MHC molecules will survive (+ve selection) and pass to the medulla, others will die by apoptosis and will be eliminated by macrophages

erc : reticuloepithelia cells
Or thymic epithelia cells



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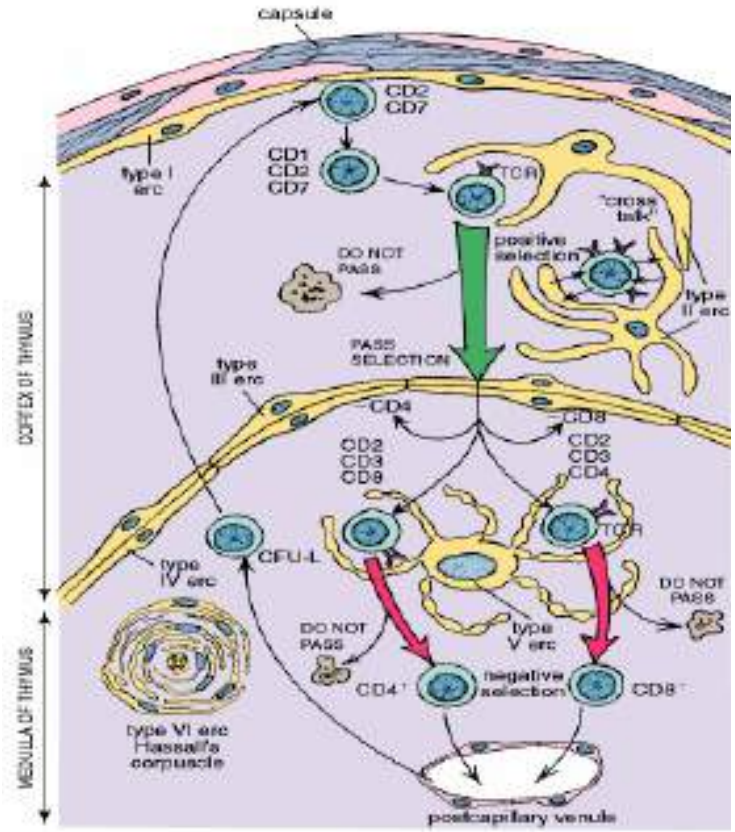
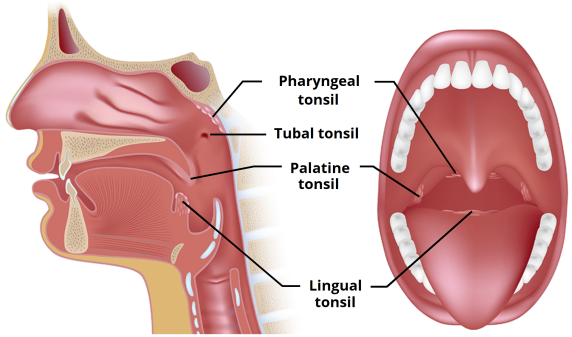


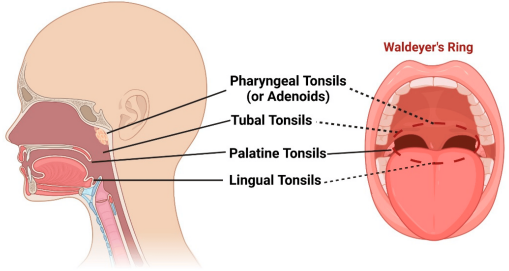
If there's no capsule they are considered collection of lymphoid follicles on mucosa of different organs

Tonsils

- They belong to MALT but considered organs because they are partially encapsulated
- Tonsils are covered by epithelium
- They include:
    1. Palatine tonsils
    2. Pharyngeal tonsils
    3. Lingual tonsils
    4. Tubal tonsils
- Waldeyer's ring

They cover by epithelium which varies into stratified squamous epithelium
Or pseudo stratified ciliated colomner epithelium





It is ring of lymphatic tissue that considered as first line of defence against pathogens / foreign material that enter through mouth

Palatine Tonsils

- A pair of them located in the oropharynx lodged between the palatoglossus and palatopharyngeus and the superior constrictor
- Covered by stratified squamous epithelium
- 10-20 crypts in each one
- A Sheet of lymphatic nodules and free lymphocytes below the mucosa
- A dense capsule separates it from the subjacent tissues

Because presence of capsule we considered palatine tonsils as an organ
The capsule separated it from the connective tissue of the base of the mouth

Covering epithelium is psudodstratifed ciliated columner epithelium
And this epithelium always used to differentiate it from palatine tonsil
(the only different thing)

Pharyngeal Tonsil

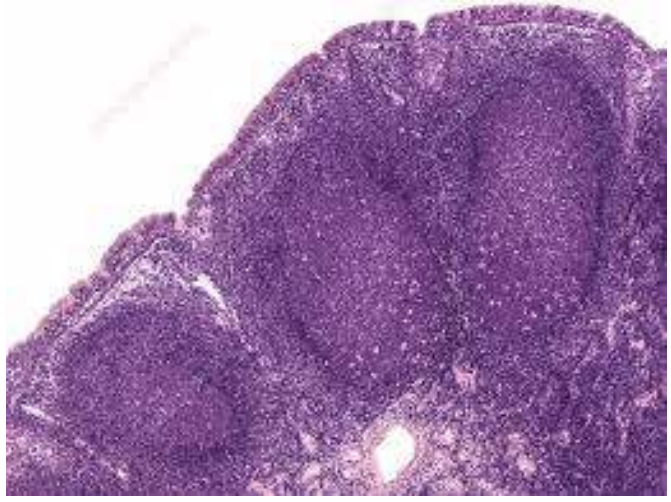
In the case of the pharyngeal tonsil, it tends to reach its largest size during early childhood, typically between the ages of 3 and 7 years old. As a child grows older, usually around puberty, the pharyngeal tonsil gradually begins to shrink in size as part of the normal aging process.

Pharyngeal tonsil enlargement, also known as adenoid hypertrophy when it becomes swollen or enlarged. This condition is common in children and can lead to various symptoms, including: suffocation

Adenoidectomy, the surgical removal of the adenoids, may be recommended for persistent or severe symptoms that do not respond to other treatments.

Roof

- One in the nasopharynx covered by pseudostratified columnar epithelium
- Form a thin sheet of lymphoid nodules and diffuse lymphocytes
- No crypts
- Very thin capsule
- Adenoid



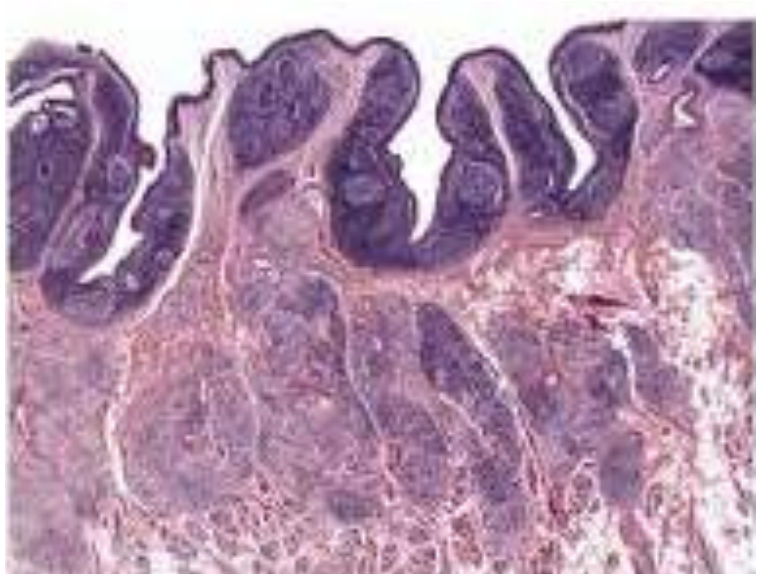
Lingual Tonsils

- They are multiple small ones at the base on the tongue
- Covered by stratified epithelium
- One crypt for each tonsil

. They have a sheets of lymphoid follicles.

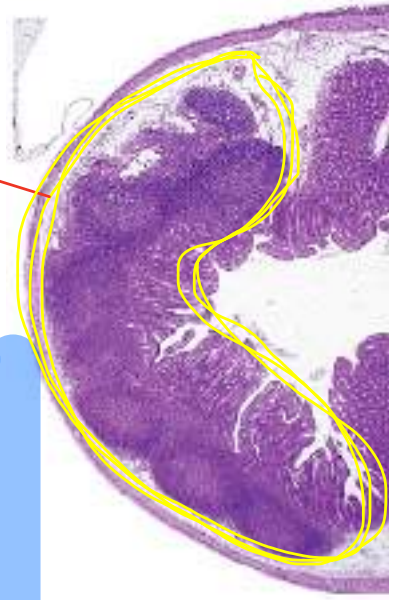
. They are separated by connective tissue.

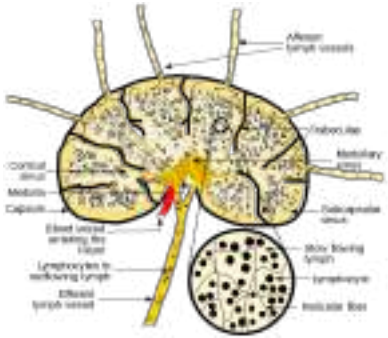
If we find behind a skeletal muscles and mucus gland (meaning look to tounge)
So we can differentiate it .



Appendix

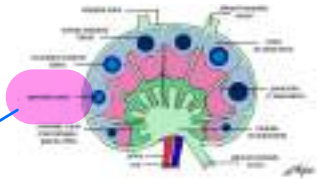
Just look for appendix that found at the end of small intestine and beginning of large intestine
The mucosa is embedded with a collection of lymphoid follicles
That's part of lymphatic system





Afferent lymph vessels bring unfiltered fluids from the body into the lymph node where they are filtered. Efferent vessels, meaning away from, carry the clean fluid away and back to the bloodstream where it helps form plasma.

Lymphatics fluids inter through afferent vessels then continue to become subcapsular sinuses then as trabeculaer sinuses then they meet each other to form medullary sinuses

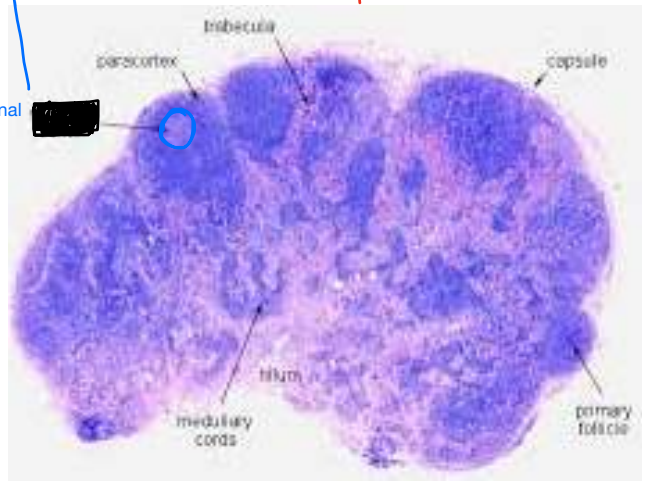


Germinal center are mainly made of plasma cells that secrete antibody's

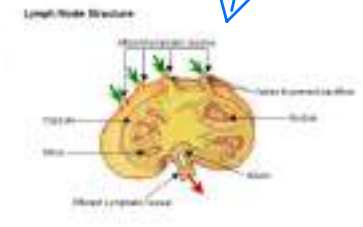
Once we eliminate the pathogens these plasma cells are dies and the germinal center disappear to replace this center with new NORMAL B CELLS

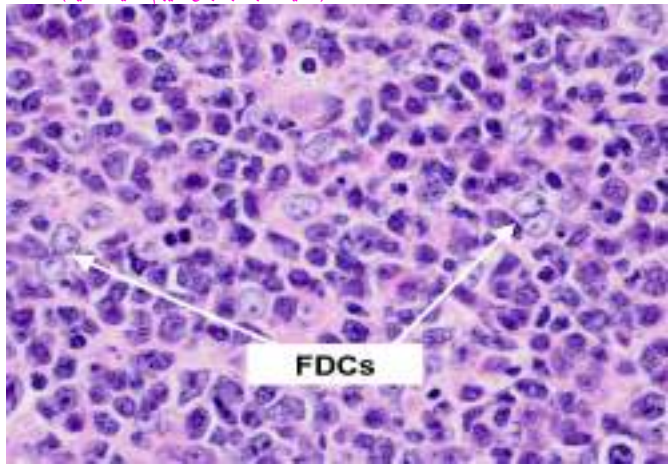
Lymph Node

- **Shape** Bean shaped ,have a convex surface and concave surface (hilum) .
- **Structure** The lymph node is surrounded by dense connective tissue capsule and send trabeculae in the parenchyma that dividing the lymph node into two compartments . The darker area is cortex (collection of lymphoid follicles) , and the light area called medulla (there's a cords of lymphocytes - medullary cords)
  in addition to very light area that are sinuses - lymphatic fluid vechicales -that's formed by union of the trabeculaer sinuses)
- **Cortex**
- **Medulla**
- **Cells**
  - there's a reticular cells (زي الخليه العصبية) that secreate reticular fiber making a network of fibers
  - (هاي الشبكة بتتجمع عليهم خلايا اللمفية)

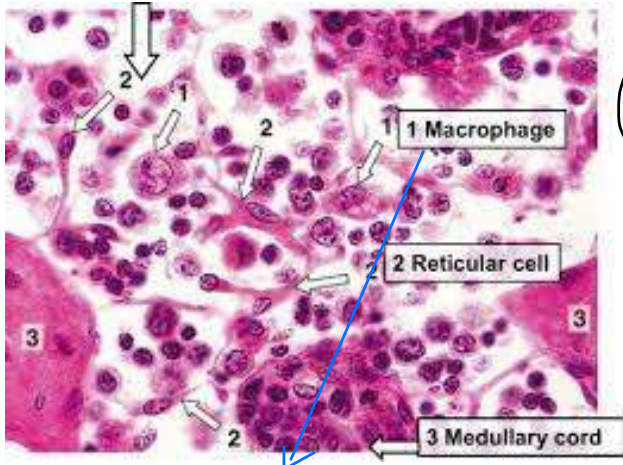


Lymphatic follicles (lymphatic nodules) are spherical or ovoid structures composed of aggregated lymphocytes and a meshwork of reticular cells.

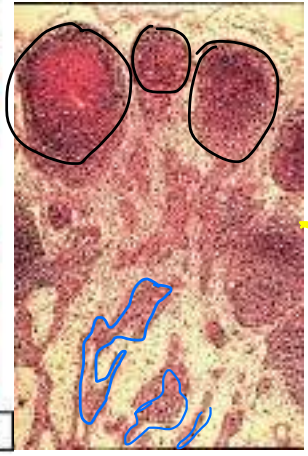




- Inside the lymphatic nodule there's a follicular dendritic cells FDCs That function is to catch the antigens destroy it and present it to the lymphocytes



- There's a lot of macrophages



Here on the third picture we can see a cortical lymphatic nodules (consists of plasma cell) on the top of the picture and under it we see a medullary (consist of medullary cords - lymphocytes- and the white colour is medullary sinuses

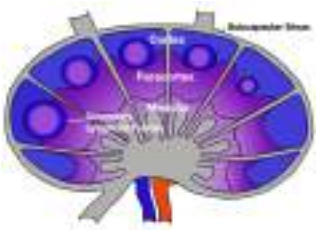
Lymph Node Cont.,

We see the afferent vessels that bring lymphatic fluid from somewhere else to subcapsular sinuse then trabecular sinus then medullary sinuses (collect together on medullary sinuses) to give a one efferent lymphatic

They enter from convex surface and exits from hilum (concave surface)

السائل الليمفاوي يكون محمل بالاجسام الغريبة ومسببات الامراض لكن عندما يدخل الى العقد الليمفاوية يصبح مع اتصال مباشر مع خلايا المناعة B CELL تتفعل هذا الخلايا لتصبح plasma cell هذه الخلايا تفرز الاجسام المضادة التي تهاجم الجسم الغريب وتتخلص منه بعد ذلك يصل السائل الليفي الى (paracortical zone) تصبح على اتصال مع الخلايا التائية T cell وتتفاعل لتهاجم الباثوجين لكن ليس بشكل كلي على سبيل المثال اذا دخل عنا ١٠٠ باثوجين سيتم القضاء على ٥٠٪ في المنطقة السوداء المنقطة في ثم يتم القضاء على ٣٠٪ في medulla اما الباقي فياخذه سائل الليمف الى عقدة ليمفاوية اخرى او ينتهي به المصير الى الدم

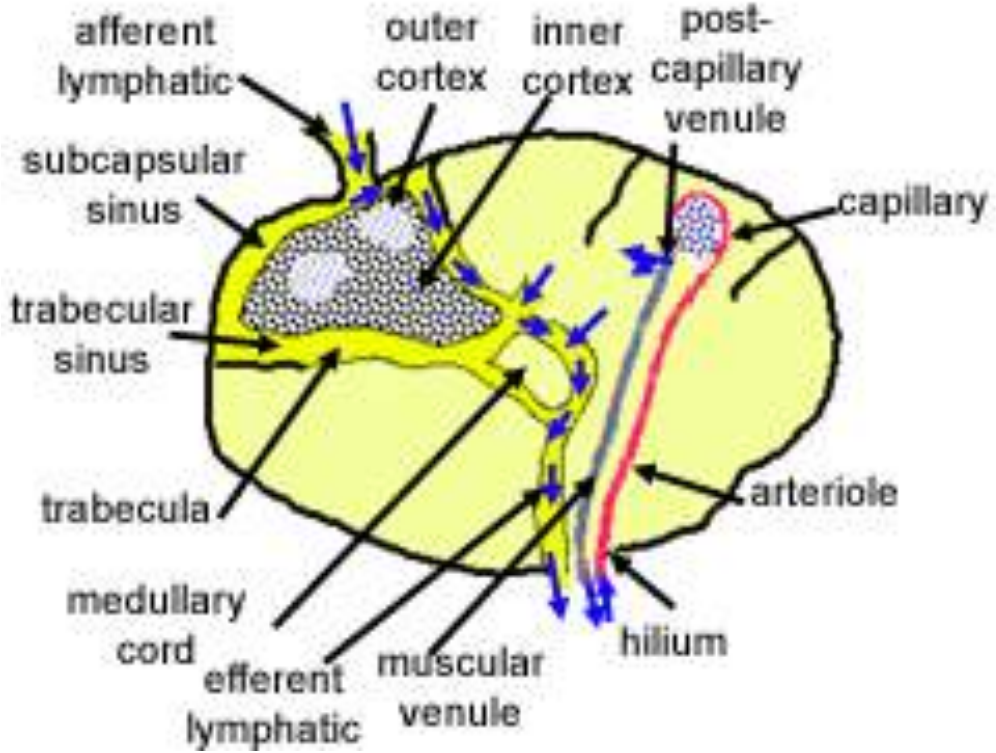
- **Lymph circulation**



Paracortical zone as shown above is considered as T cell dependent zone .

We say on the previous slides that mature T cell leaves thymus and circluate on blood (vascular system) and other through lymphatic vessels go to lymph node (paracortex) .

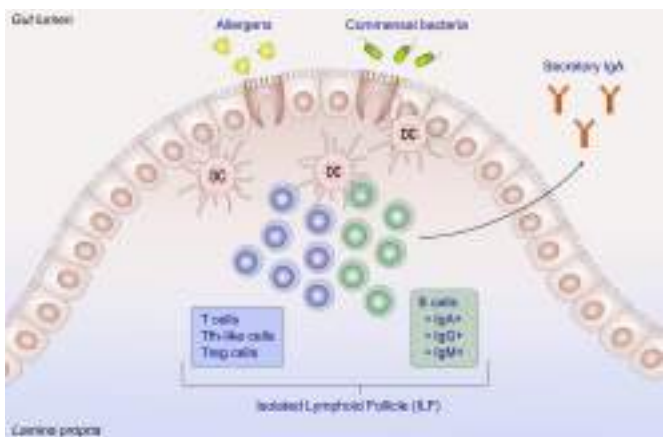
Lymph node are consider as lymphatic filter and the only that have afferent and efferent lymphatic



Hilium are site where efferent vessels exit and where artery , veins , nerve fibre enter and exit

Peyer Patches

- A collection of lymphoid follicles in the lamina propria of the ileum
- It made of a collection of B lymphocyte
- It has a role in immunity by attacking antigens or other particles
- M-cells between the columnar enterocytes has a role in this process



M cells are specialized epithelial cells found in the mucosa-associated lymphoid tissues (MALT) of the intestines, particularly in the Peyer's patches of the small intestine. These cells play a crucial role in immune surveillance and defense against pathogens in the intestinal lumen.

At some area where the lymphatic nodules are found the behind columnar epithelium theses columnar cells transforms into M CELLS that has the ability to attach the pathogens and transport it towards the dendritic cells and lymphocytes

DC take the antigen and present it to lymphocytes to be activated and become plasma cell that secrete a secretory anti body IgA this antibodies go to lumen of ilium to attach antigen
M cells don't transport all antigens the transport 1 or 2 just to present it to lymphocytes to become active and secreate the antibodies

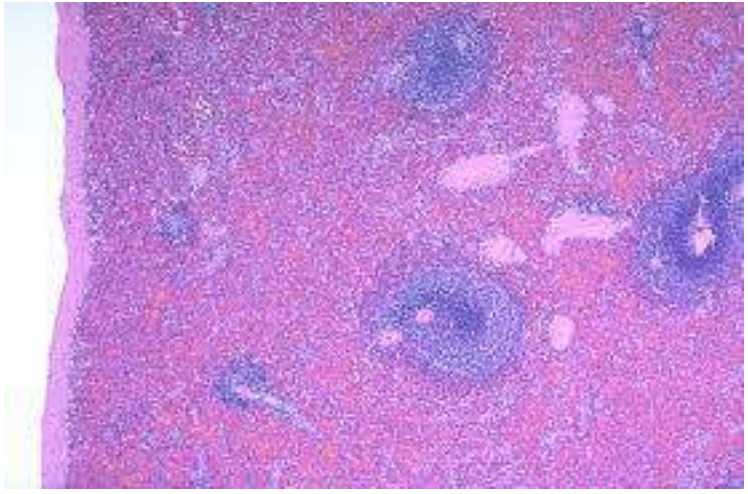
The Spleen

Spleen like other lymphoid organ have a dense connective tissue capsule that divide it by trabecular fibers to trabecula (allowing blood supply to pass through it to reach parenchyma and the others veins ,and nerves) and on the medial surface of spleen they are show the hilium where the artery , vein, nerve enter and exit

The spleen have an efferent lymphatic ONLY that exit from hilum

- **Largest lymphoid organ**
- **Contains of large number macrophages**
- **It is a blood filter**
- **Structure: capsule, trabeculae, splenic pulp**

We say on the above slides (slides about lymph node) that the lymph node considered as lymphatic filter but not completely destroy the pathogens so the remaining pathogens go to other lymph nodes or to BLOOD that distributed and then reach the spleen and lymphatic tissue of spleen will kill the rest of the pathogen so it called the blood filter

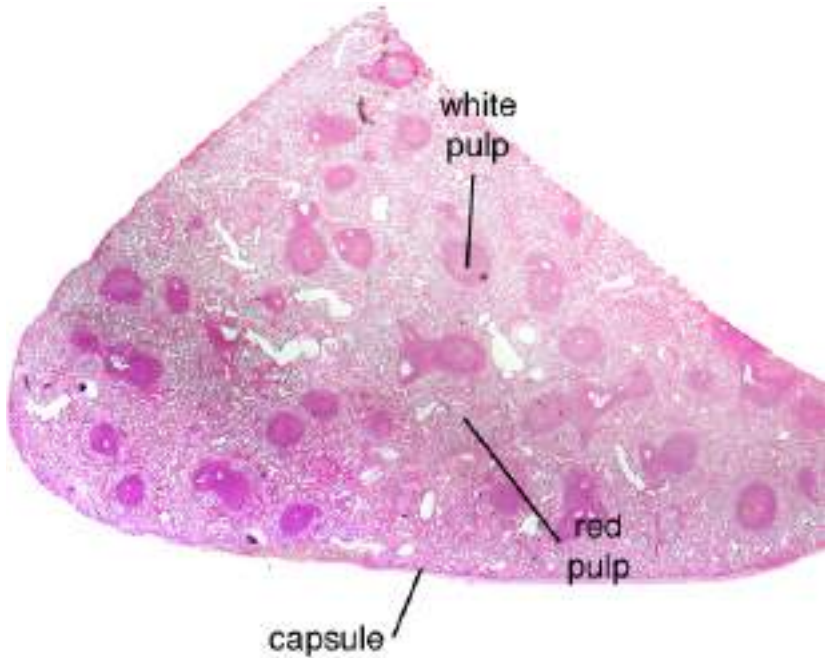


spleen is located in the upper left region of your abdomen – just behind your stomach and under your diaphragm

Splenic pulp

Supports various cells on the surface of the spleen

- Spleen composed of a network of reticular tissue with reticular cells, lymphocytes, other blood cells, macrophages and APCs
- White pulp Dark area
- Red pulp The rest area of the spleen



The name white come from that when we cut the fresh spleen we see this pulp with whit colour

White Pulp

Blood supply

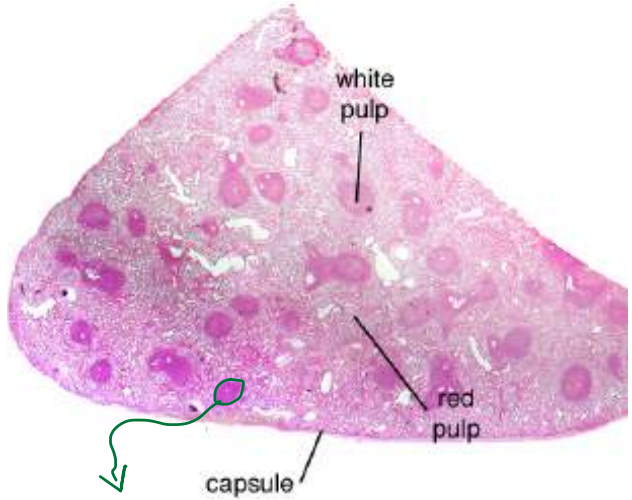
Periarterial lymphatic sheath (PALS)

Lymphoid nodule

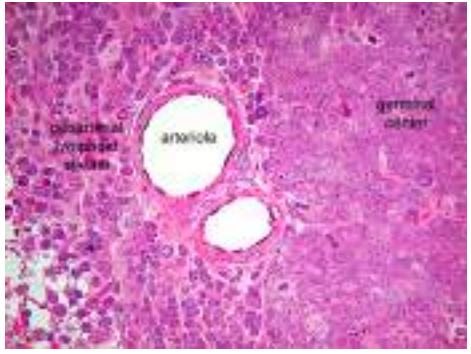
Marginal zine

Penicillar arteries

The last branches of the central arteriol

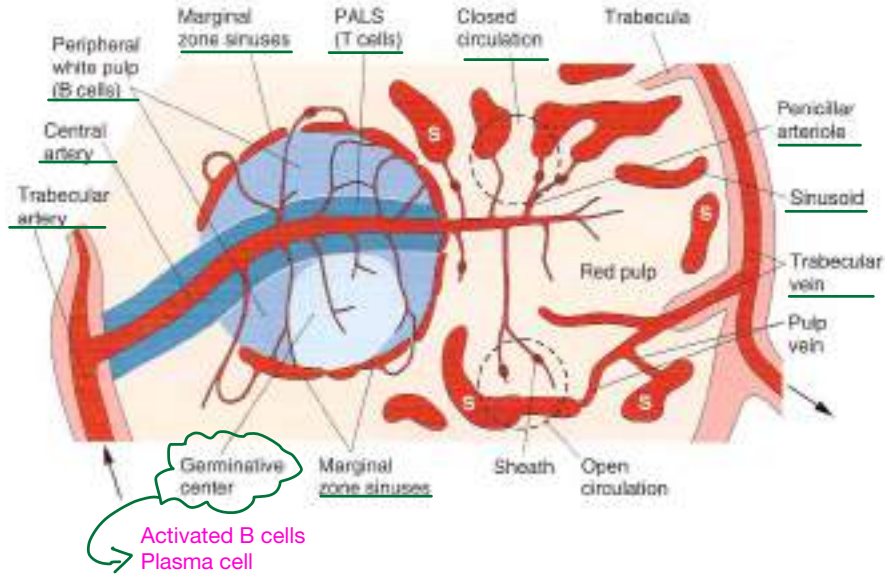


الدكتور حكى الاجزاء الي تحتهم خط
قبل شوي حكينا الي بظل من الميكروبات والاجسام الغريبة الي ما تخلصت منها العقد الليمفاوية بتوصل الدم ومن الدم للطحال وهون بصير مواجهة ثانية مع الخلايا المناعية التائية والبائية للتخلص من هذه الاجسام الغريبة



They are separate the red and white pulp from each other and they are consider as the most active part where pathogens are killed

2 ways for blood one is end on closed circulation then to the sinusoid then to veins the other way is to open circulation to red pulp (where there's abundant macrophages) directly where OLD RBCs destroy

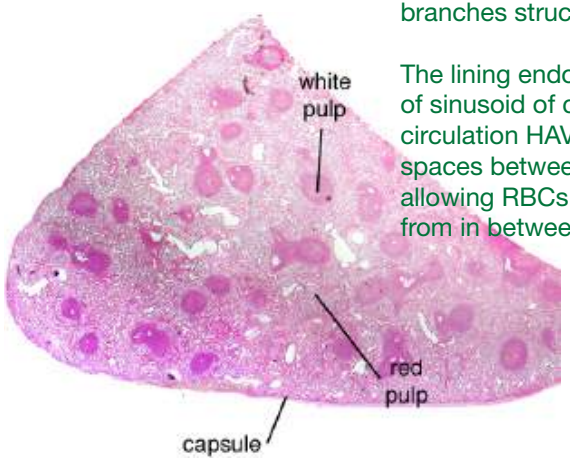


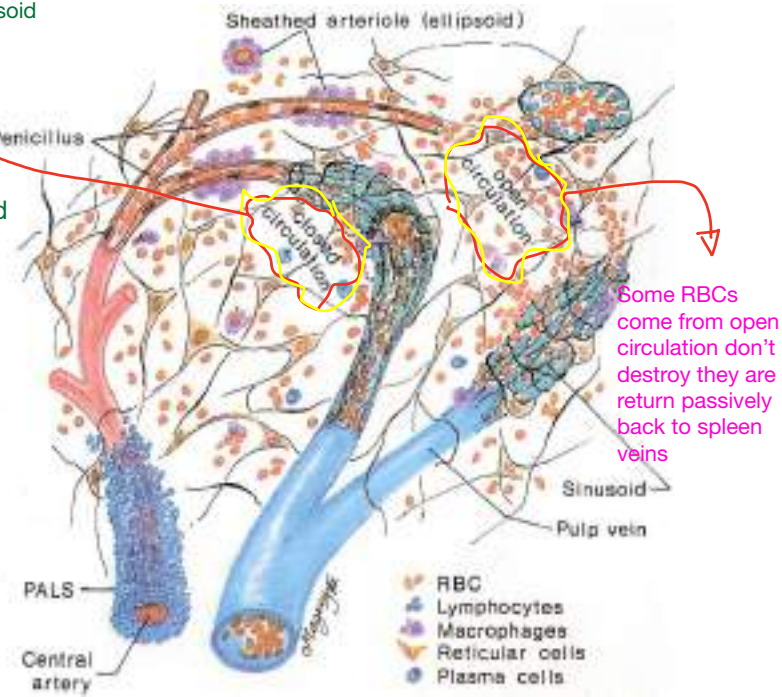
Red Pulp

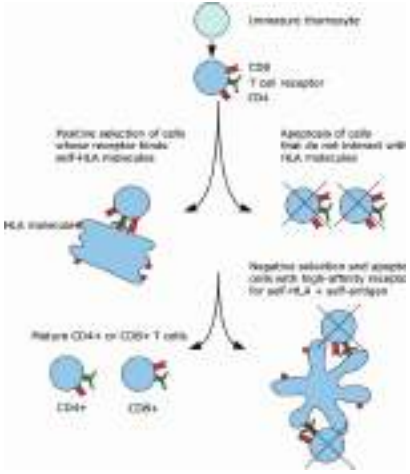
- Splenic cords are supported by reticular fibers and contain T-cells, B-cells, macrophages, plasma cells, and many blood cells.
- Splenic sinusoids (Sava cells) Endothelial lining of the spleenic sinusoid
- Closed circulation
- Open circulation

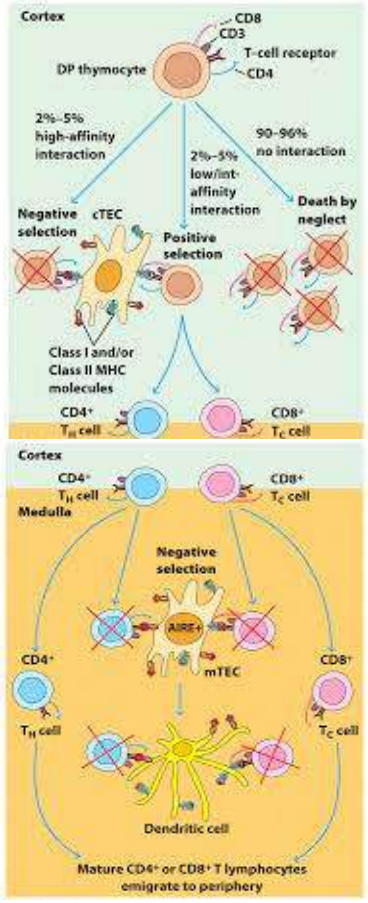
They have a dilated and branches structure .

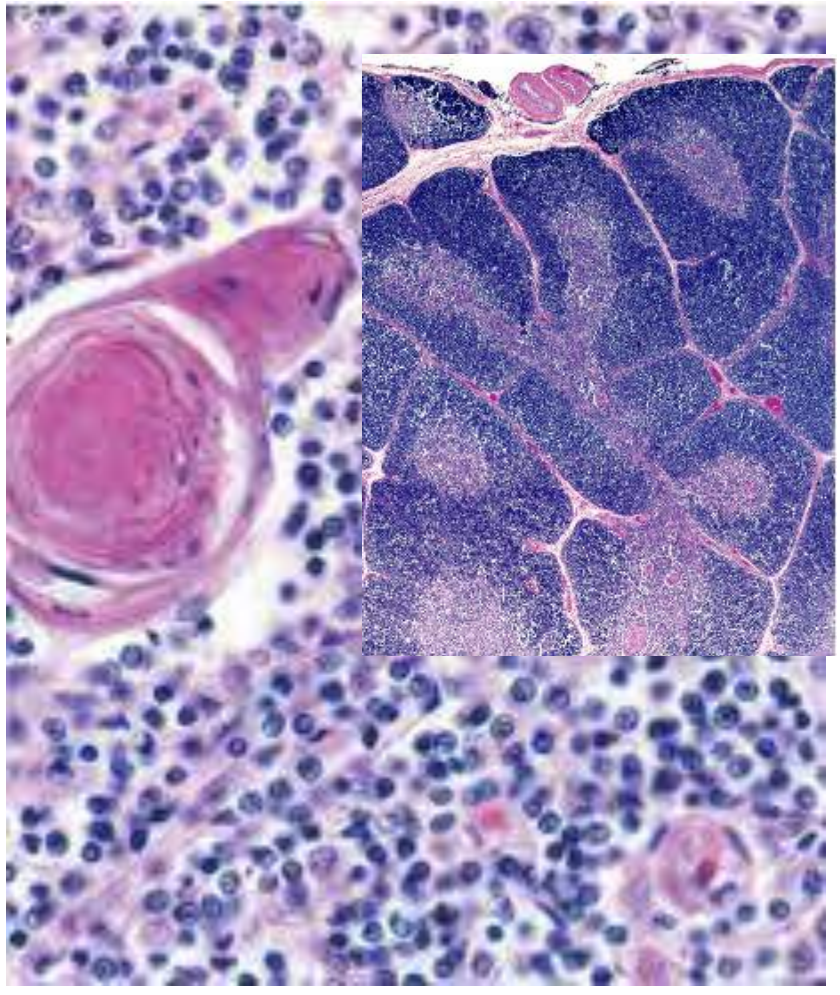
The lining endothelium of sinusoid of closed circulation HAVE a spaces between allowing RBCs to leave from in between .

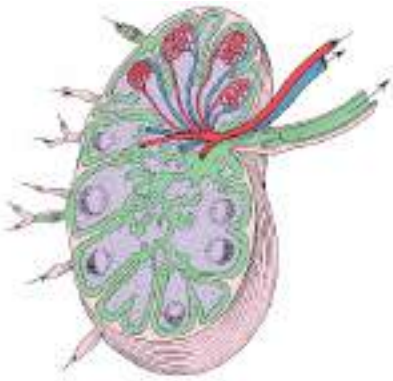


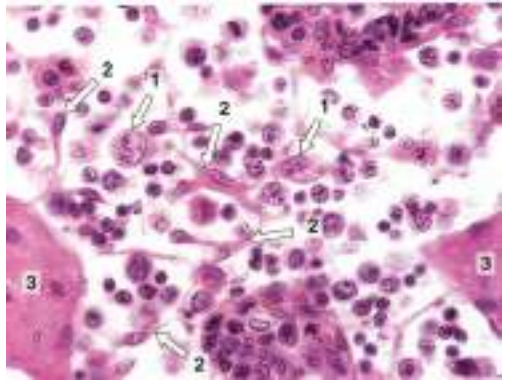





Cortex
CD8
CD3
T-cell receptor
CD4
DP thymocyte
2%–5%
high-affinity
interaction
2%–5%
low/int-
affinity
interaction
90–96%
no interaction
Negative
selection
cTEC
Positive
selection
Death by
neglect
Class I and/or
Class II MHC
molecules
CD4+
TH cell
CD8+
TC cell
Cortex
CD4+
TH cell
CD8+
TC cell
Medulla
Negative
selection
AIRE+
mTEC
CD4+
TH cell
CD8+
TC cell
Dendritic cell
Mature CD4+ or CD8+ T lymphocytes
emigrate to periphery



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