Lecture 12

ESS_2nd semester

Microscopic structure and function of lymphatic organs

- Thymus
- Lymph nodes
- Spleen
- Tonsils
- Classification of lymphocytes and their distribution in the human body
- Mononuclear phagocyte system

Lymphatic organs include:

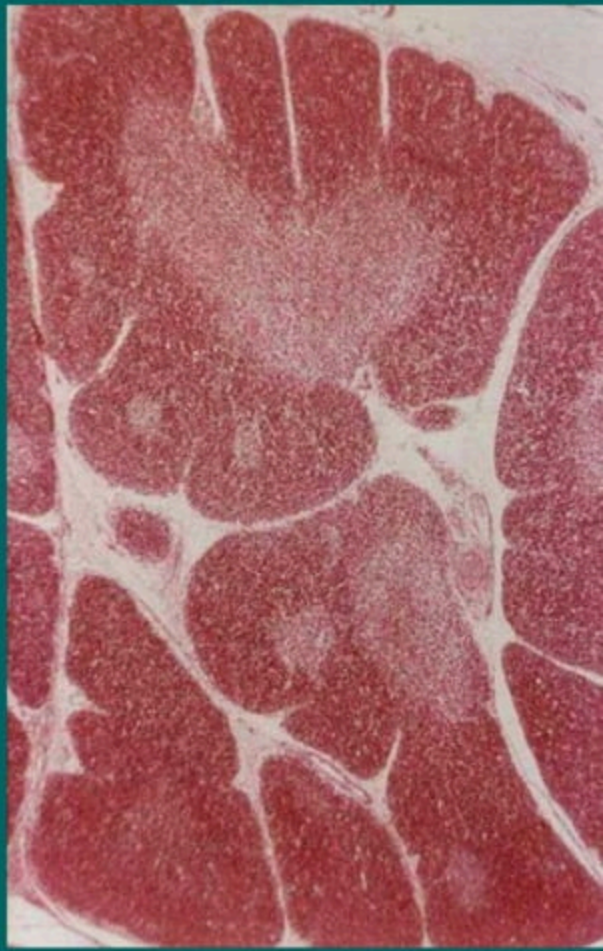
- **thymus**
- **lymph nodes**
- **spleen**
- **tonsils**
- **lymph nodules**

in the wall of intestine (lymphonoduli solitarii and lymphonoduli aggregati or Peyer's patches) and in the wall of respiratory and urinary passages (**GALT** or **MALT**)

Thymus

occupies a central position among lymphatic organs
it is located behind the sternum

the thymus varies in size and development with the age, being the largest around puberty - **weight 15 - 17 gram**



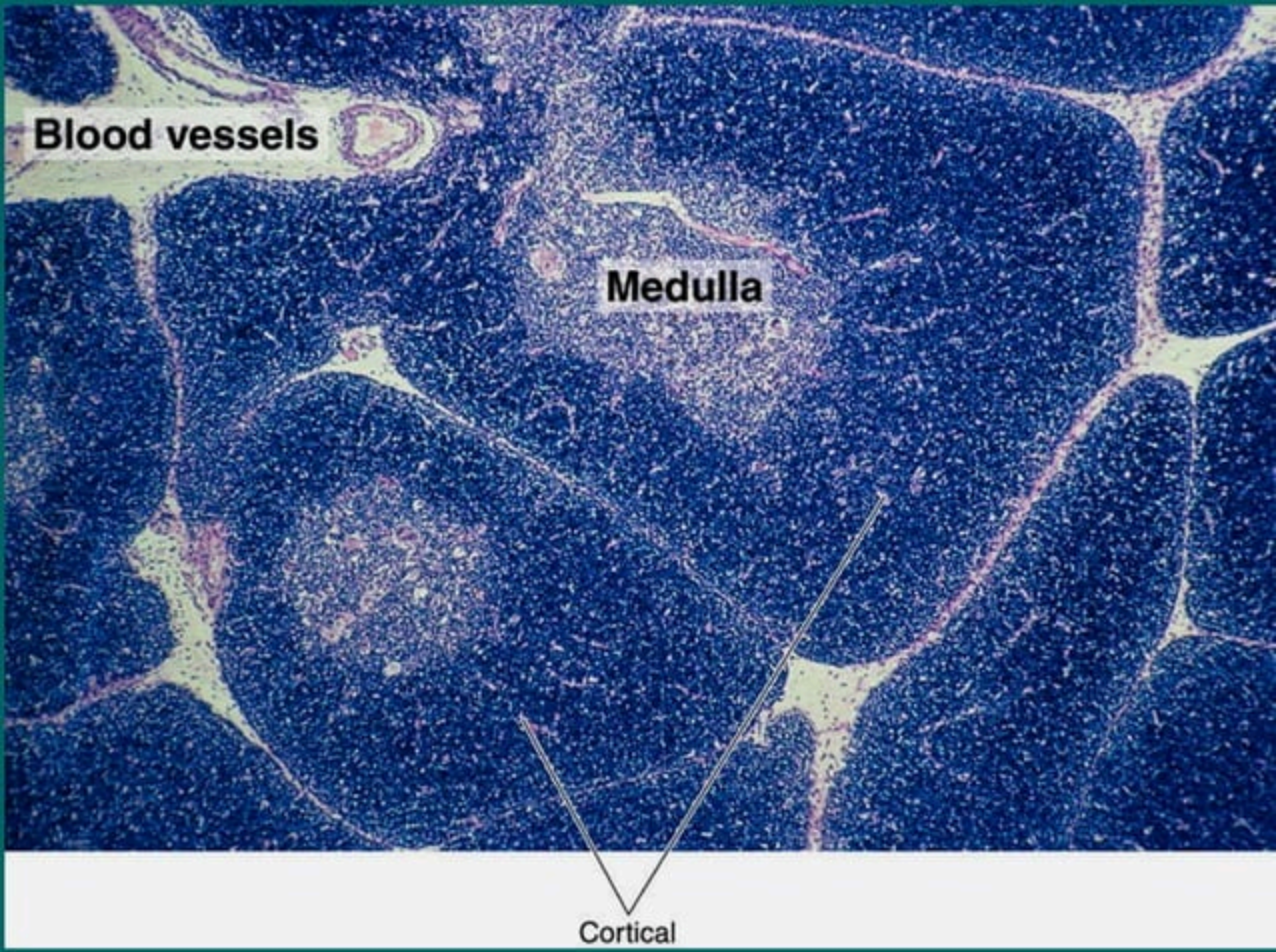
it shows a texture of true lymphoepithelial tissue, being composed of **epithelial reticular cells ERC** and **thymocytes**
the former are of endodermal origin (endoderm of the 3rd pharyngeal pouch), the latter are of mesenchymal origin

thymus consists of **2 lobes** connected each other by **isthmus**

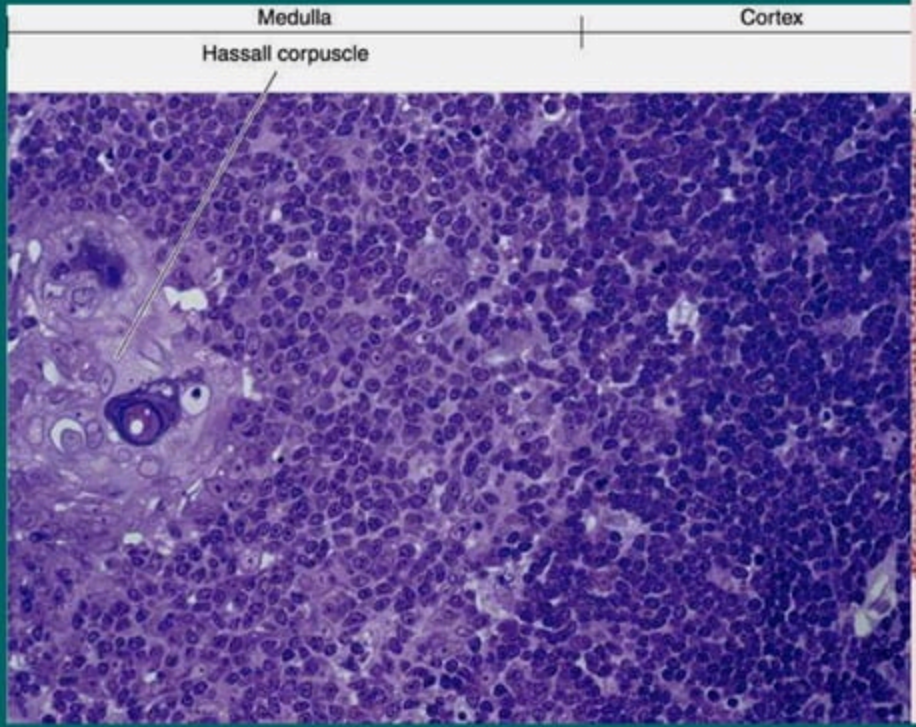
surface of the organ is covered with a delicate **connective tissue capsule**, from which thin connective tissue septa penetrate into the **parenchyma**

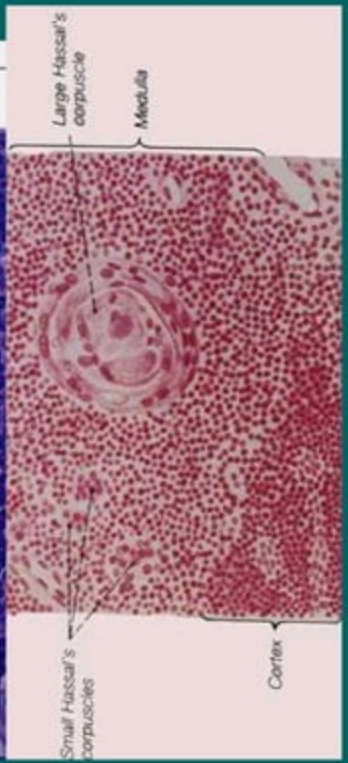
parenchyma consists of innumerable **lobules**
in sections, they are seen to consist of - **denser peripheral cortex** and **looser central medulla**
cortex and medulla contain the same cells - epithelial reticular cells and thymocytes whose density differs between them conspicuously

while in the **cortex masses of thymocytes prevail** and epithelial reticular cells are not numerous and have elongated form and pale nuclei
in the **medulla, the density of both cell types is just inverted**


Blood vessels
Medulla
Cortical

in addition, the medulla contains eosinophilic and neutrophilic granulocytes, plasma cells, and
concentric **corpuscles of Hassall** -
resemble acidophilic bodies of 50-200 μm in diameter composed of concentrically arranged epithelial reticular cells that degenerate

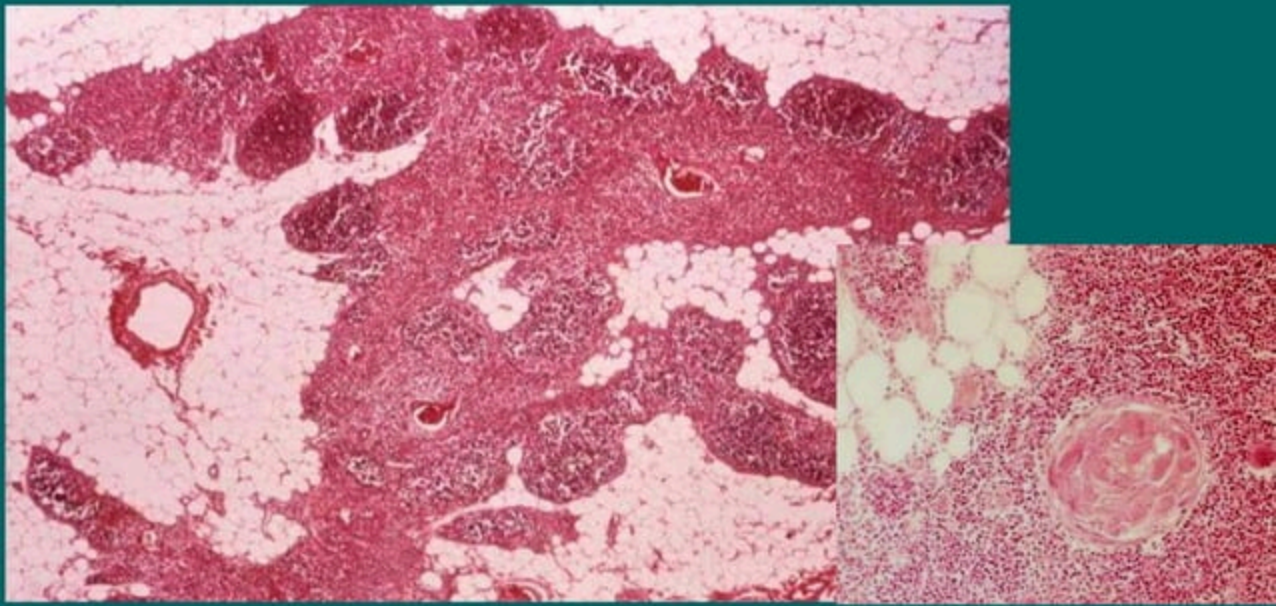




thymus reaches its maximum size at puberty, and then begins to involute

the involution process involves:

- a gradual decrease in size of the whole organ,
- a gradual diminuation of lymphocytes and epithelial reticular cells that are replaced by adipose tissue,
- a compression of the cortex and an increase in medulla, in which the Hassall corpuscles appear larger and numerous



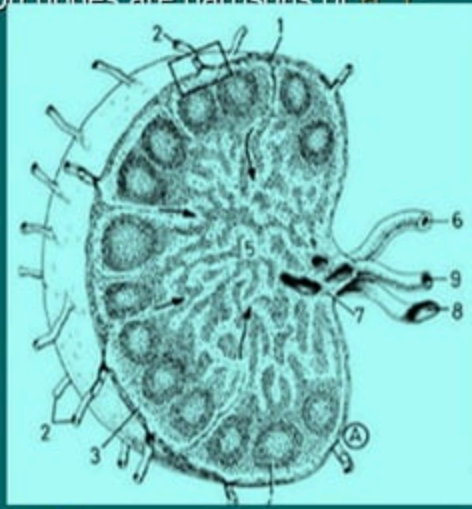
Function of the thymus: **IMPORTANT**

- **differentiation of immunocompetent T-lymphocytes**
- **production of the thymosin** (low-weight polypeptide) that stimulates proliferation of T-lymphocytes

Lymph nodes (nodi lymphatici)

They are small bean shaped organs, whitish in colour in the fresh specimen

are scattered along the course of the lymphatic's. Lymph nodes are garrisons of B, T and other immune cells.
Which are released into blood/ lymph?



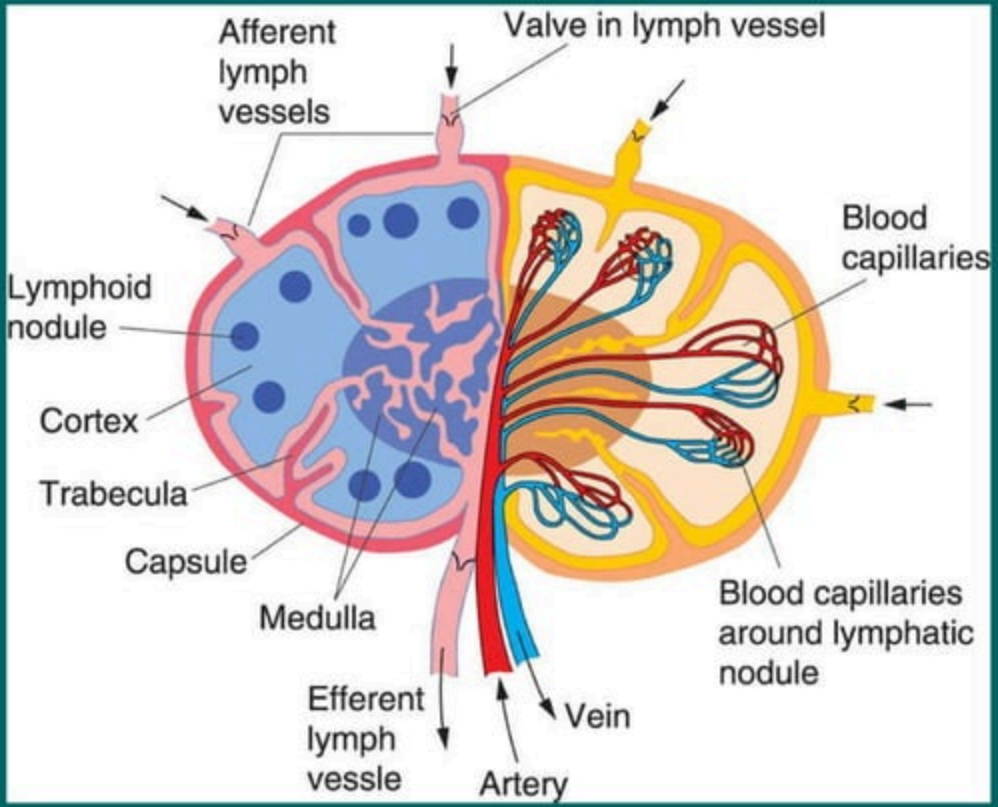
a slight depression at one side of node is called **hilum**: here the blood vessels enter and leave, and the efferent lymphatic vessels (1-2) leave the node

a lymph node is surrounded by a dense connective tissue capsule that may contain smooth muscle cells fibrous septa (trabeculae) penetrate the lymphoreticular tissue.

It consists of **reticular connective tissue network** and free cells - **lymphocytes**

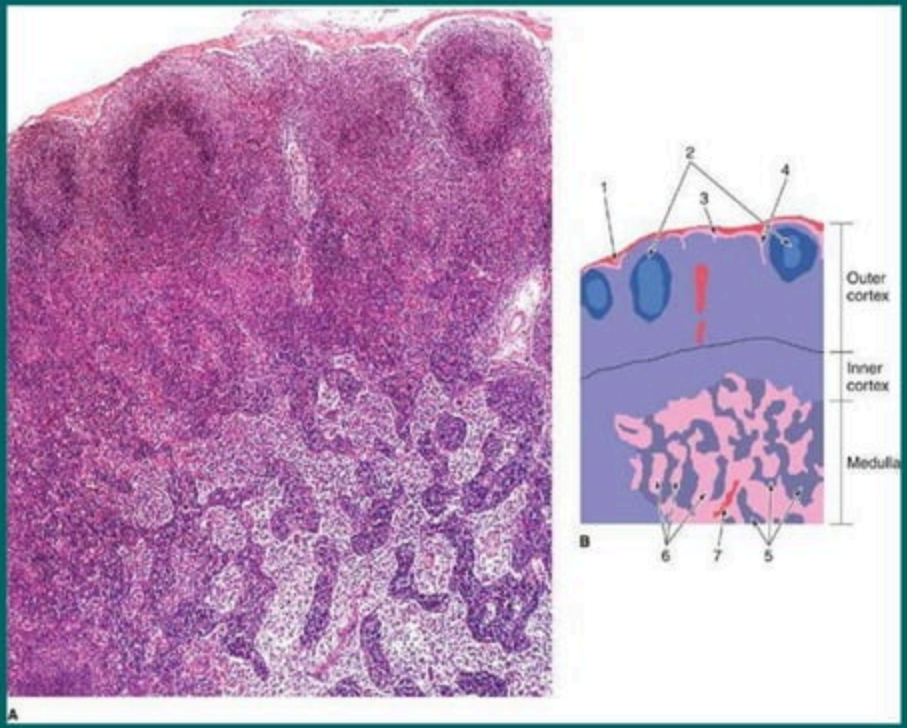
Lymphoreticular tissue of nodes is arranged as a dense

- **cortex** and less densely packed
- **medulla**

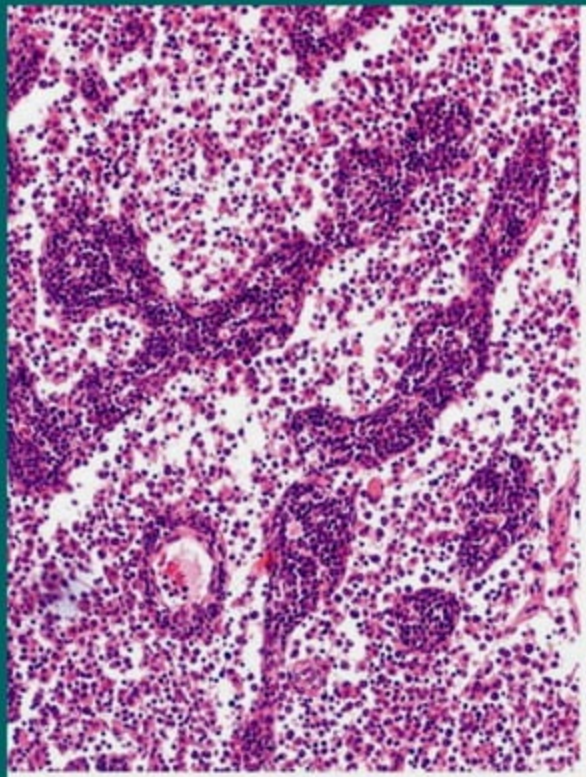


The cortex - is composed of **lymph nodules (or follicles),** from which many contain germinal centres, in ordinary stained preparations they are lighter than the periphery of the nodule

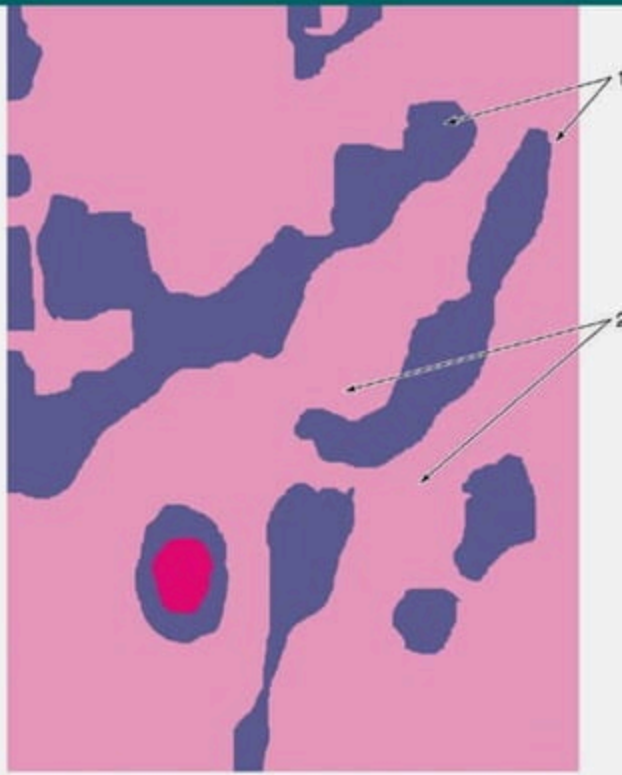
lighter staining is due the occurrence of **lymphoblasts** with pale nuclei (dispersed euchromatin)



the medulla - consists of **medullary cords** of irregular shape that anastomose each other, spaces between cords are occupied with medullary sinuses



A



B

paracortical zone - is a delicate zone interposed between the cortex and medulla

the zone is enormously rich in T-lymphocytes

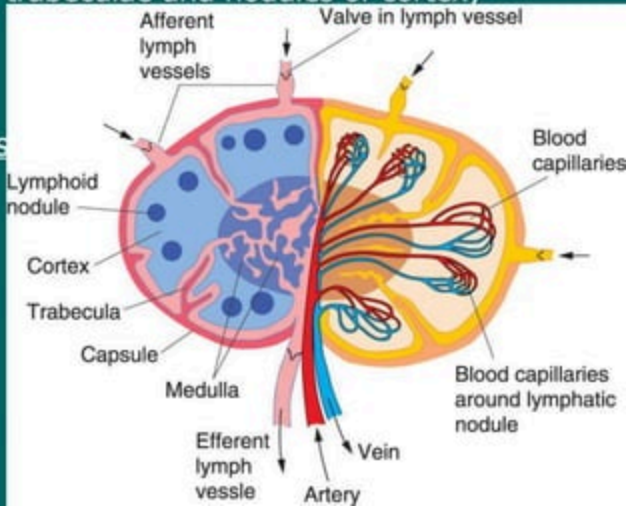
in ordinary stained slides the zone is not visible but may be visualized by immunohistochemistry

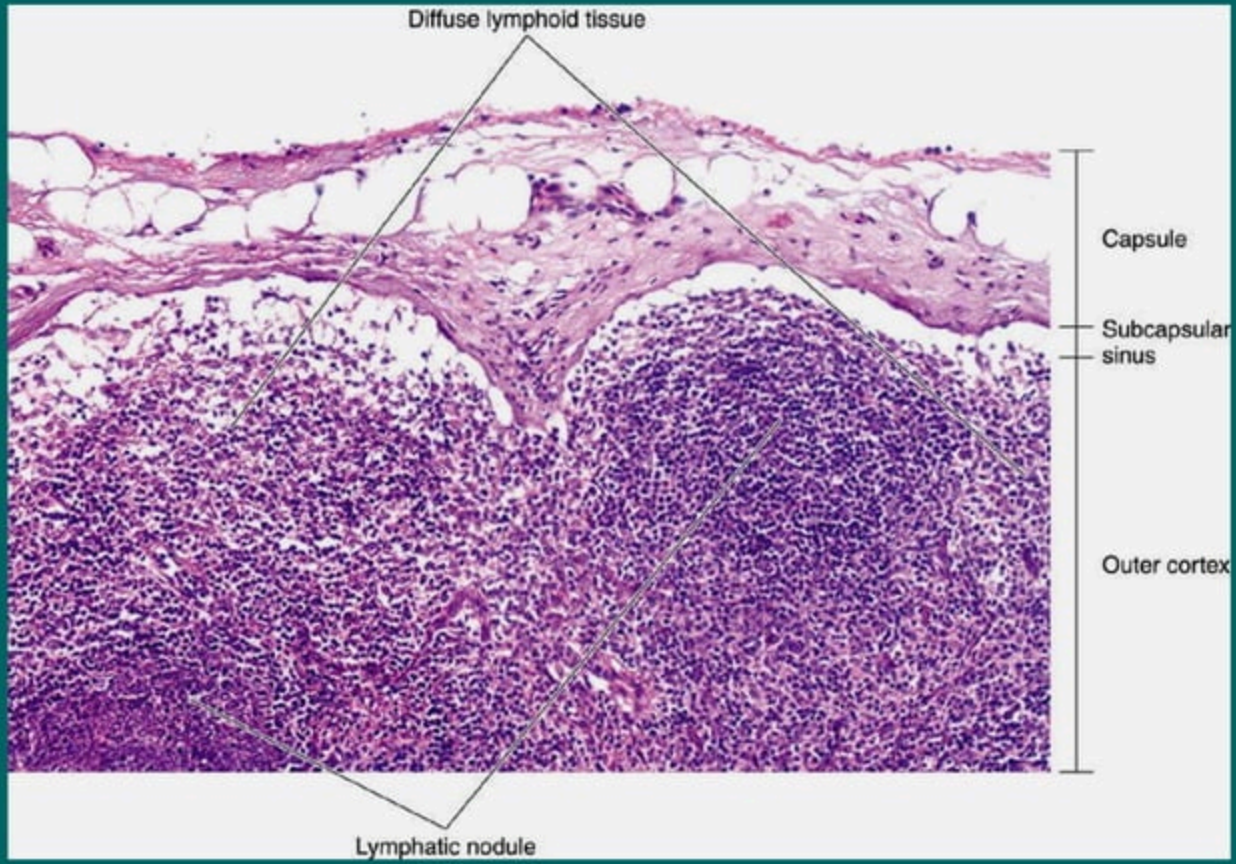
Sinuses and lymph circulation

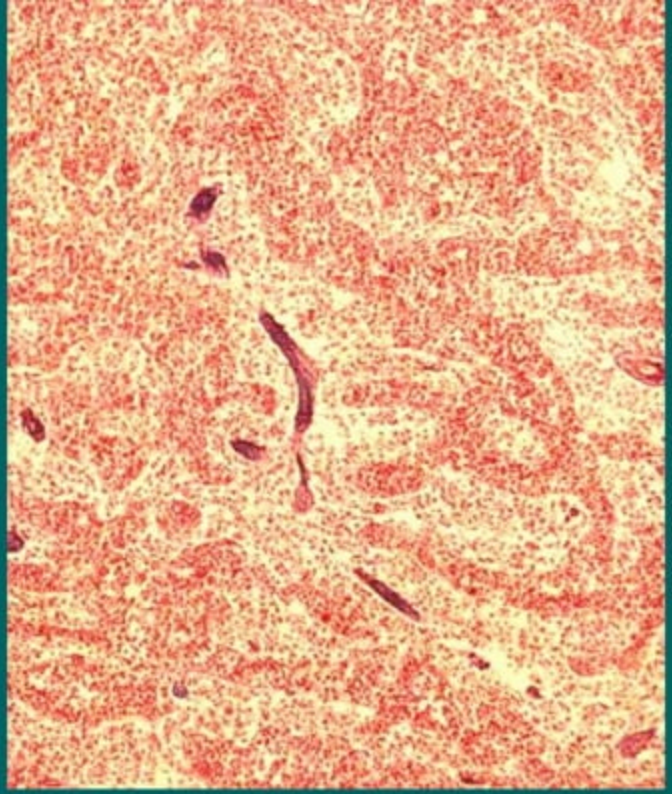
sinuses are classified as follows:

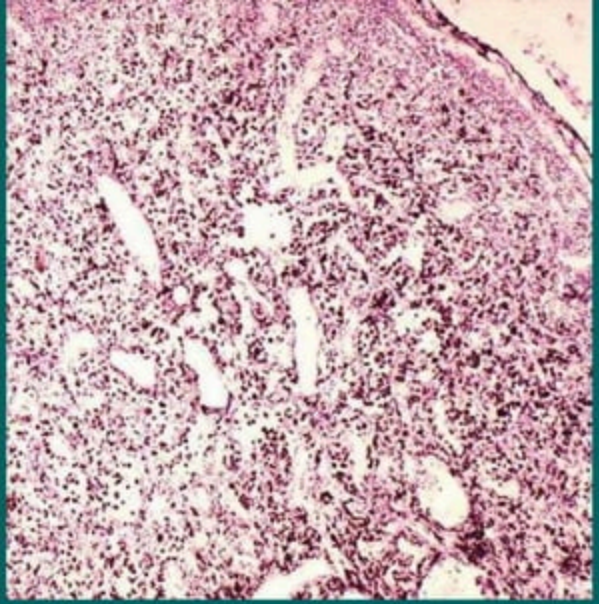
- **subcapsular** or **marginal sinuses** (they are between the capsule the cortex)
- **cortical** sinuses (run along the sides of trabeculae and nodules of cortex)
- **medullary** sinuses (lie between the cords and the trabeculae of the medulla

- The wall of the sinuses is not continuous It consists of modified reticular cells and fixed macrophages, supported by few reticular fibers.
- Afferent lymphatic vessels conduct the lymph into marginal sinuses, it flows through the cortical and finally medullary ones the lymph leaves the node via 1 to 2 efferent vessels that exit at hilum.



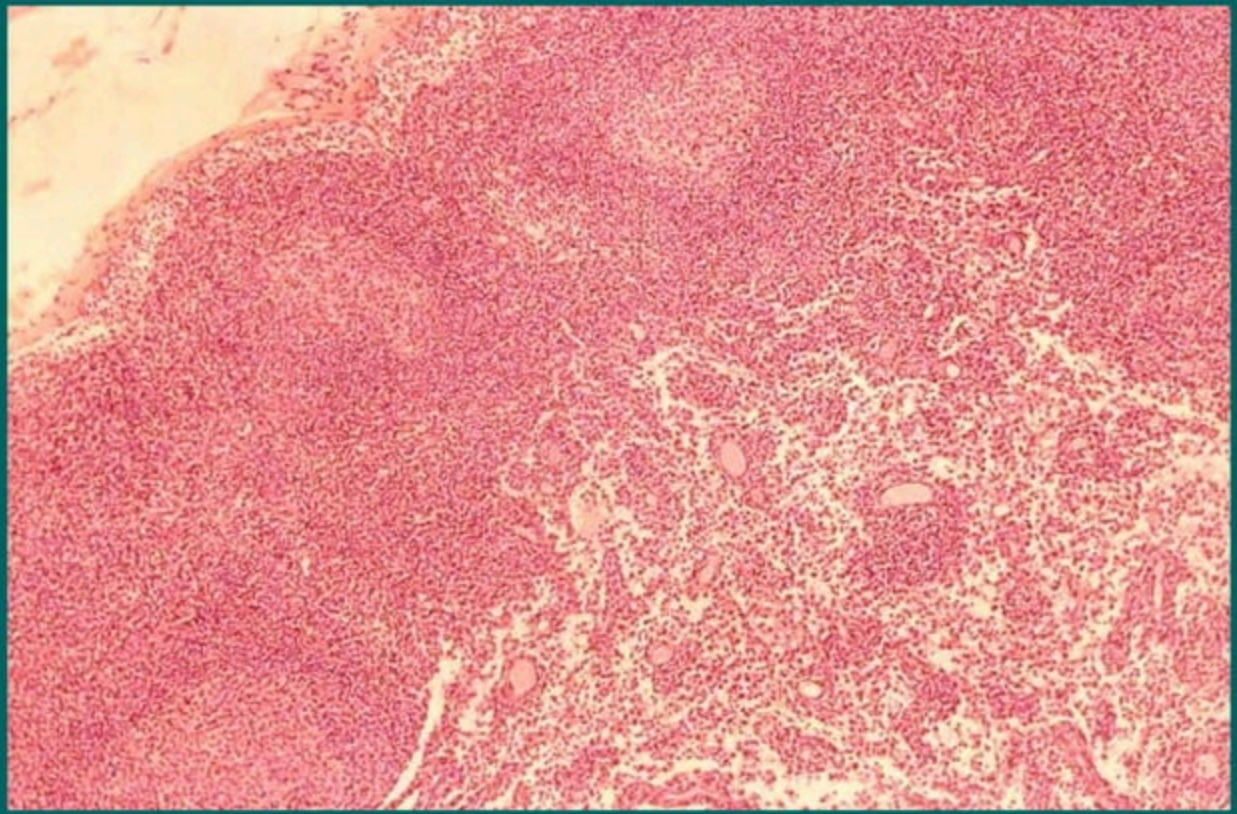

Diffuse lymphoid tissue
Capsule
Subcapsular
sinus
Outer cortex
Lymphatic nodule

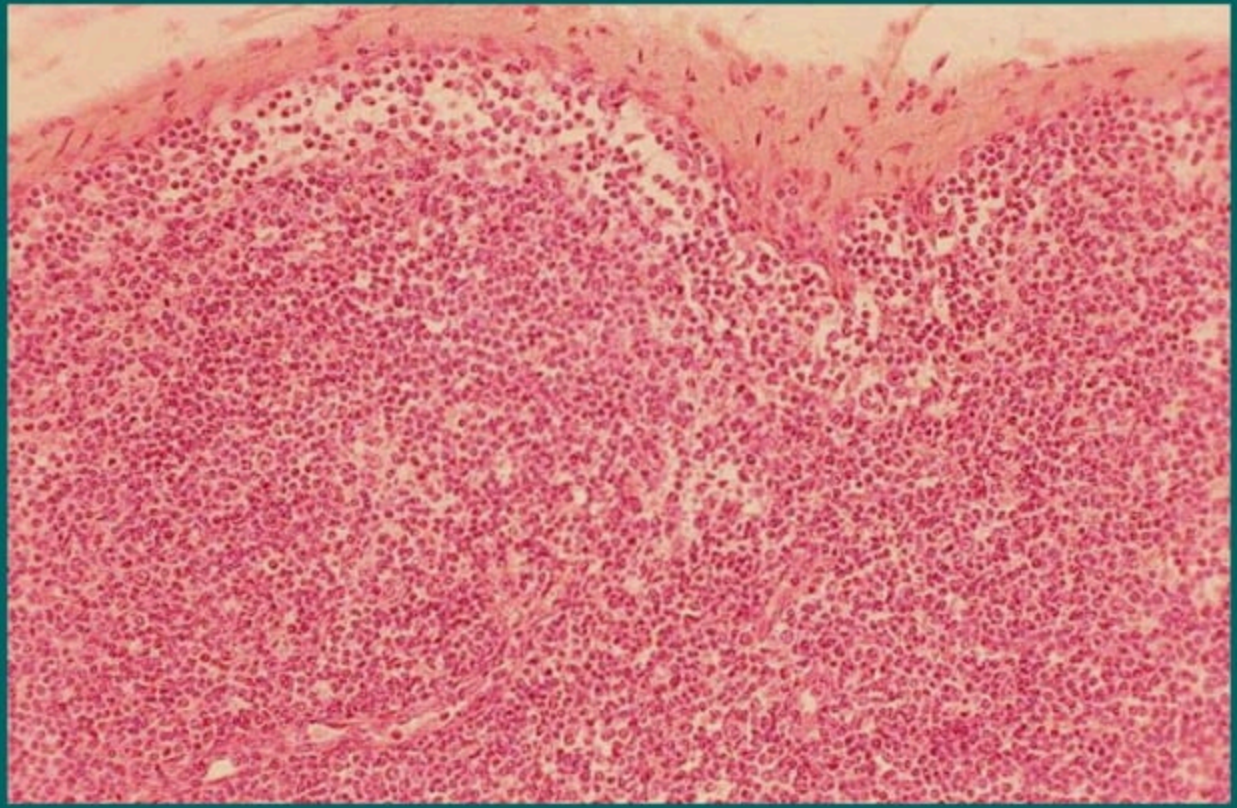




Functions of the lymph nodes:

lymphopoiesis
filtration of the lymph
Elaboration, utarbetande, **of antibodies**





Spleen (l. lien; gr. splen)

in the abdominal cavity, below the diaphragma, 150 gram

character of true lymphoreticular tissue has only the white pulp

the spleen consists of :

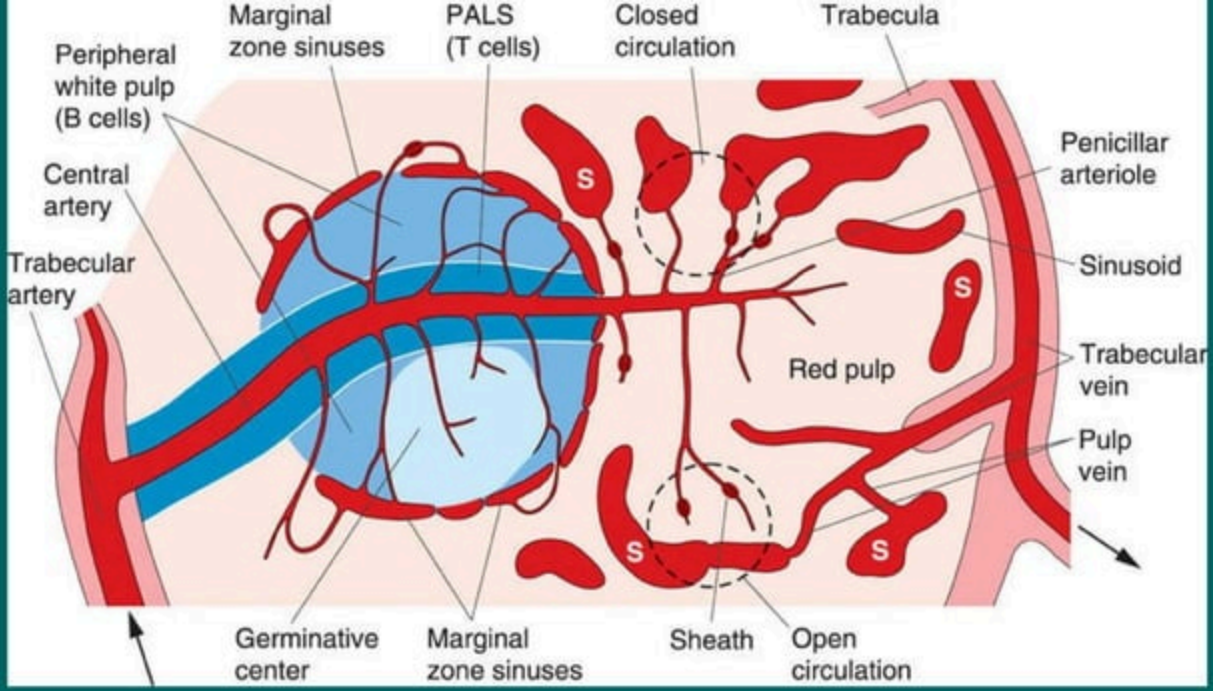
- **connective tissue capsule and trabeculae**
- **splenic pulp**
- **blood vessels**

connective tissue capsule is covered by peritoneum and consist of collagen and elastic fibres, fibroblasts and smooth muscle cells

it sends off trabeculae into the splenic pulp
the trabeculae, carrying the larger blood vessels, branch and anastomose, and are ultimately continuous with the branching reticular fibres and cells in the splenic pulp

splenic pulp involves two distinct types:

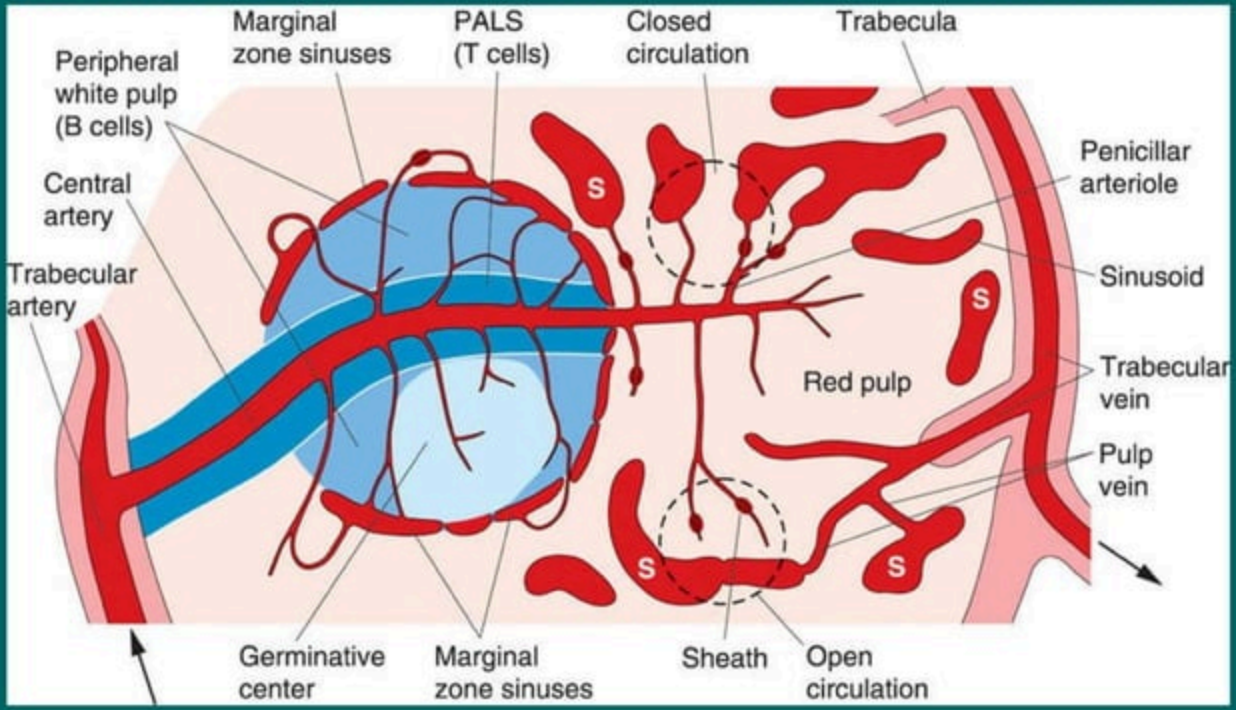
white and **red pulp**



White pulp

It consists of reticular connective tissue and lymphocytes
it follows the arteries (called **central arteries**) and forms along them **periarterial lymphatic sheaths** (PALS)
at intervals it is thickened into ovoid bodies, called the **splenic nodules** (or **Malpighian bodies (which may show GC)**

marginal zone forms the surface of periarterial lymphatic sheaths and nodules - it consists of densely packed reticular cells and T-lymphocytes

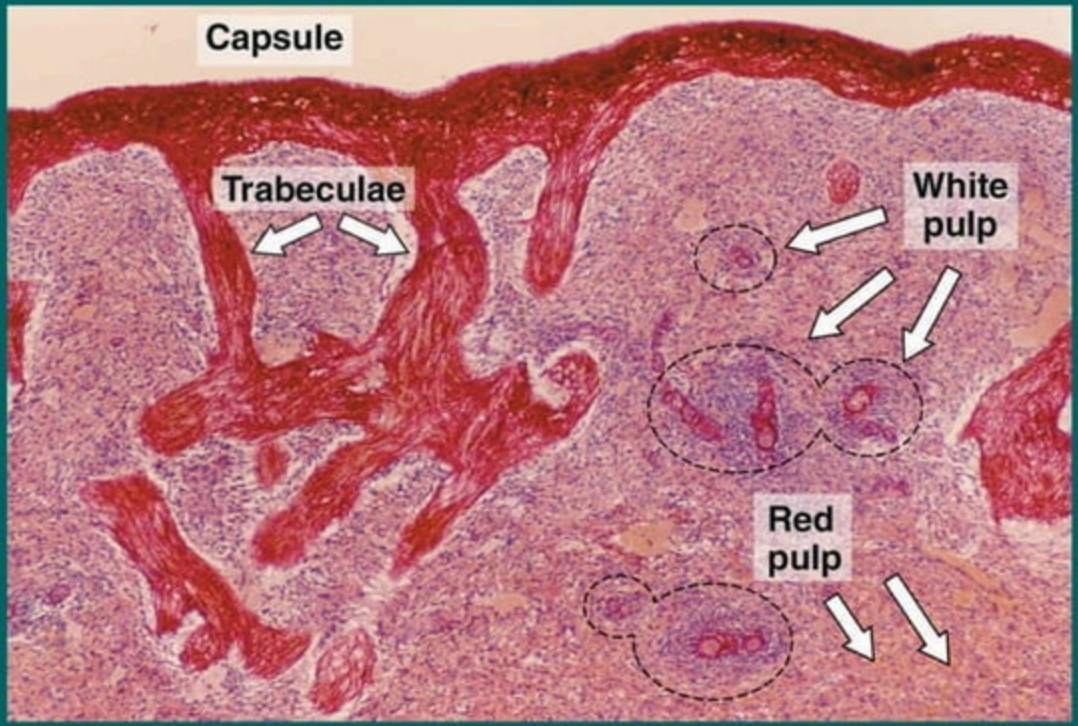


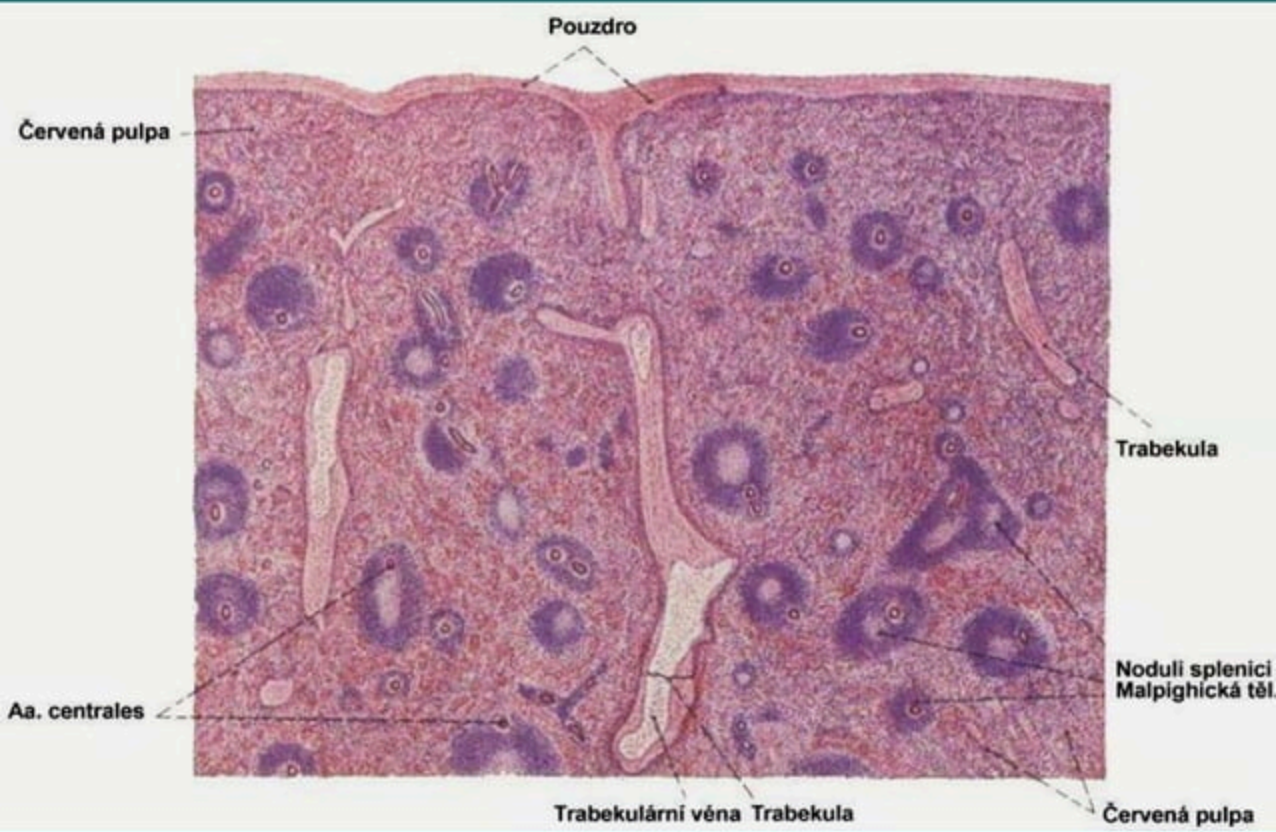
Red pulp

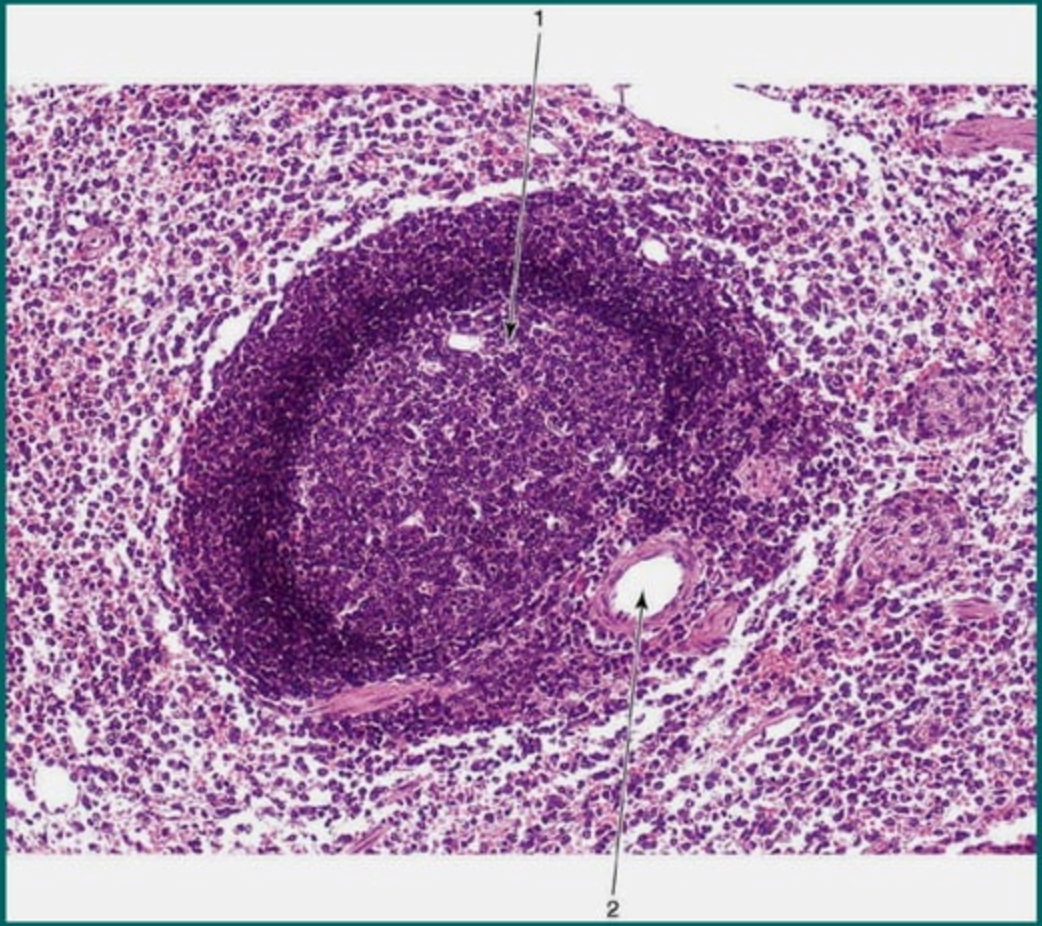
is more abundant and occupies all space not utilized by trabeculae (from the connective tissue capsule) and white pulp, it forms plates or cords called as **Billroth cords**

the support of the red pulp is typical reticular connective tissue that is infiltrated mainly by erythrocytes, partly lymphocytes, macrophages, and a few eosinophilic granulocytes

splenic sinuses occupy spaces between cords of Billroth




Pouzdro
Červená pulpa
Trabekula
Noduli splenici
Malpighická tě
Aa. centrales
Trabekulární véna
Trabekula
Červená pulpa


1
2

Blood vessels

the splenic artery enters the spleen at the hilum and divides into **trabecular branches** (pass along the trabeculae)

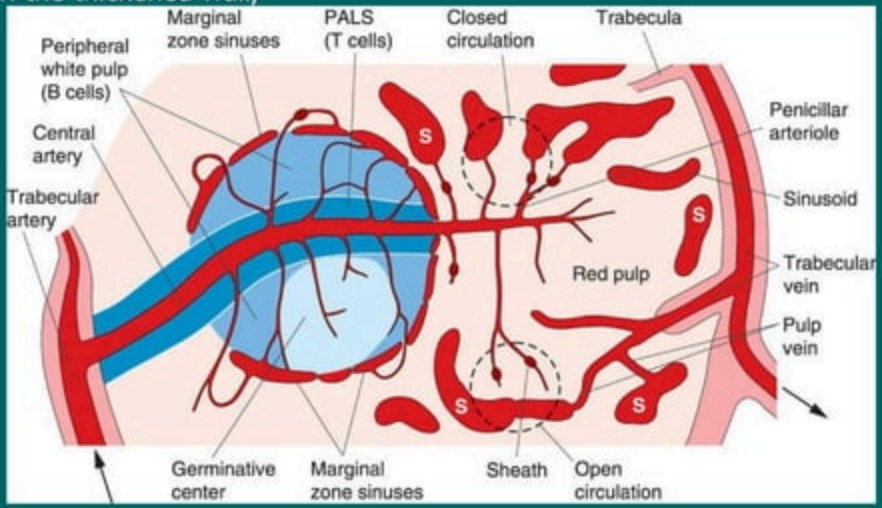
when reduced to a diameter of app. 0.2 mm, they leave the trabeculae to enter the white pulp as the **central artery**

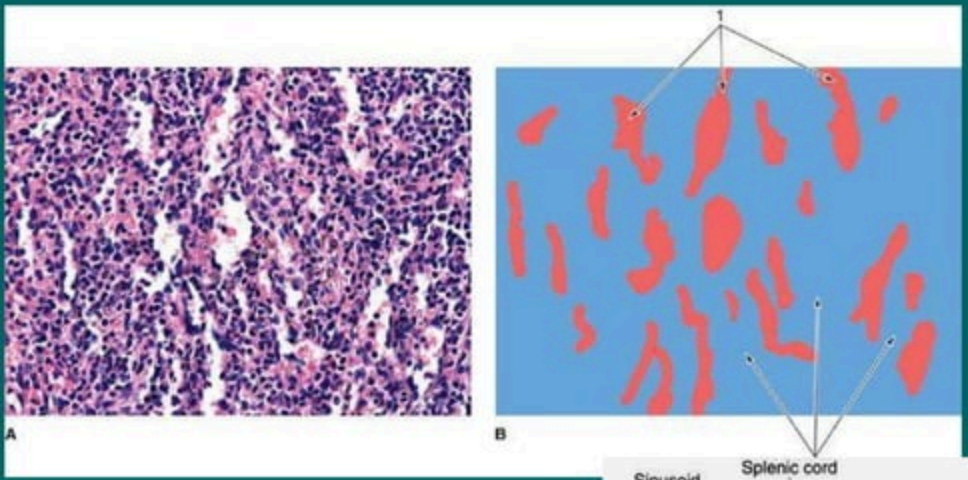
in sites where the white pulp ends, the central artery breaks up into a tuft of straight arterioles, **penicilli**

the penicilli vessels show 3 successive segments:

- **pulp arteriole** - is the longest segment,
- **sheathed arteriole** with the thickened wall,
- **terminal capillary**

that opens into the system of venous sinuses

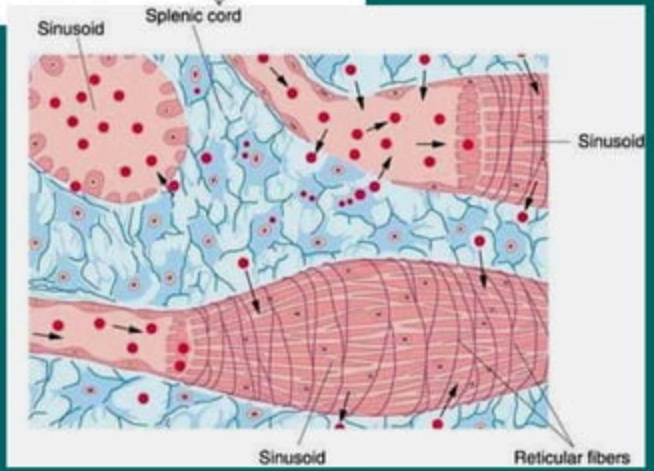




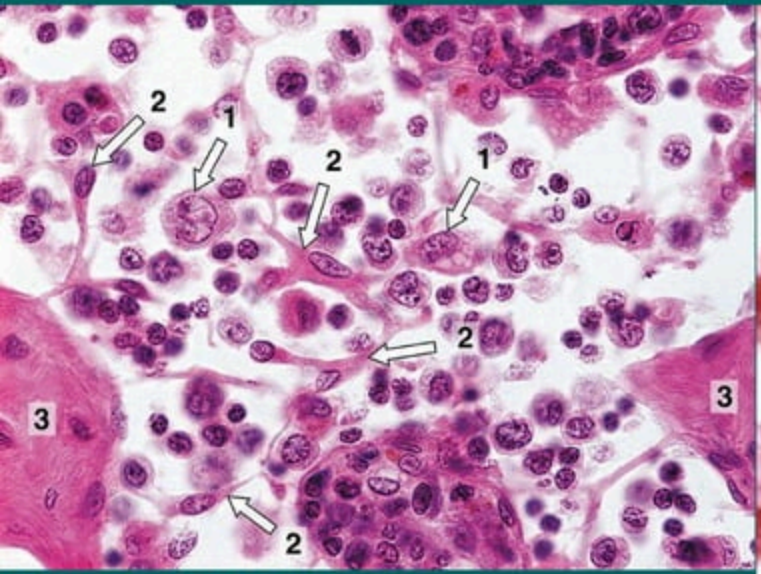
venous sinuses have irregular lumina

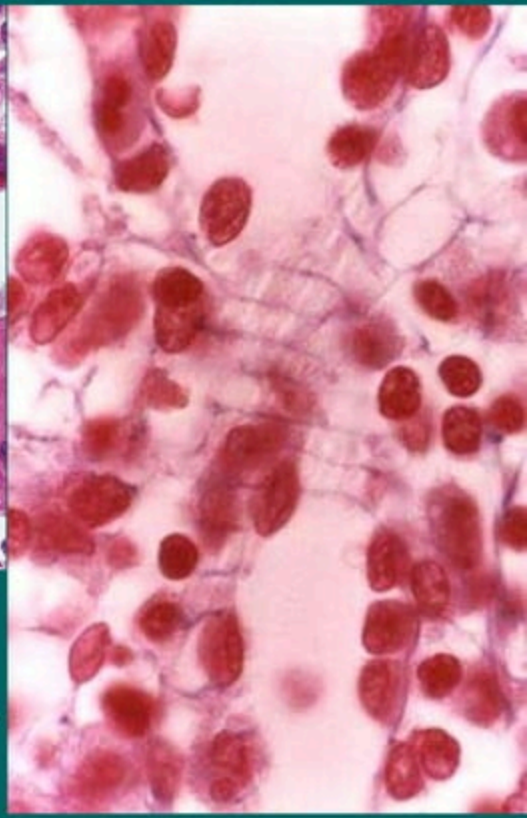
The venous sinuses empty into the **pulp veins**, which leave the pulp and unite to form **trabecular veins**

they join up to form finally the **splenic vein**



venous sinuses are lined with specialized reticular cells that are phagocytic





functions of the spleen:

- **lymphopoiesis -** refers to the generation of lymphocytes
- **filtering** (consists into remove the foreign particles, bacteria, degenerating leukocytes and erythrocytes from the blood)
- **production of antibodies** and
- the function of **the reservoir of blood**

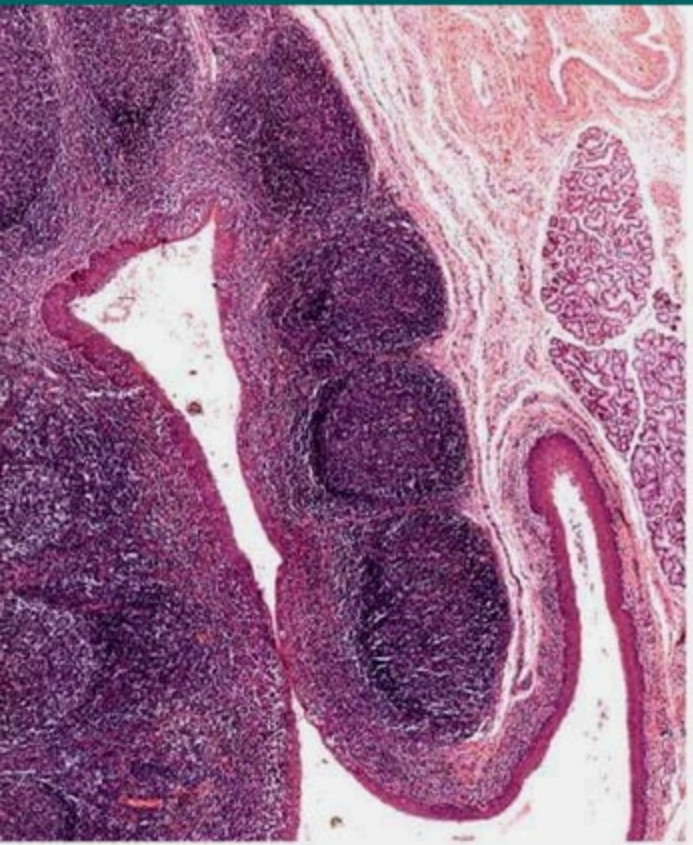
Tonsils (tonsillae)

tonsils form a ring lymphoreticular tissue surrounding the pharynx, where the nasal and oral passages unite WALDEYERS RING

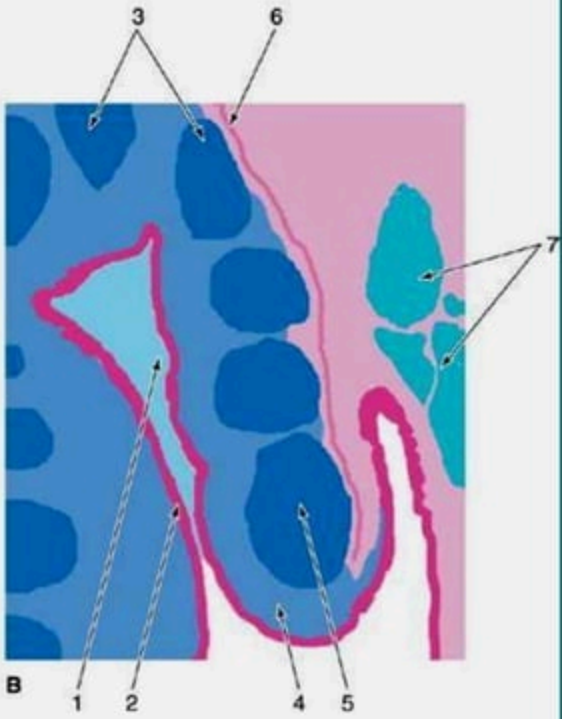
- **the palatine (or faucial) tonsils**
- **the lingual tonsil**
- **the pharyngeal tonsil and**
- **the tubal tonsil, tonsil of Gerlach** (it lies near the pharyngeal opening of the auditive /Eustachian/tube)

tonsils are characterized by **accumulation of the lymphoreticular tissue** in the **lamina propria** of the mucosa and presence of indentation called as
tonsillar crypts

tissue is often differentiated into lymph nodules with typical germinal centres



A

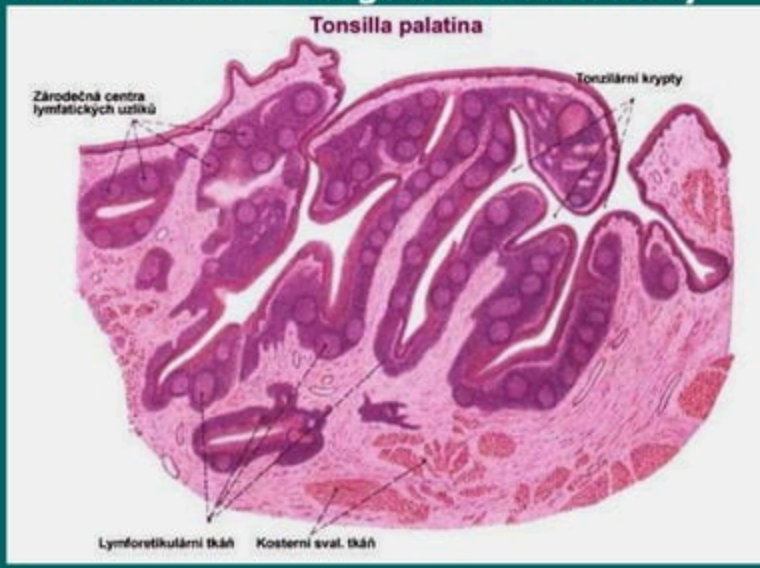


The **Palatine tonsil**

is paired organ located between the arches of the palate
the tonsil is covered by a stratified squamous epithelium
tonsilar surface is very uneven and deepens in **10 to 20 narrow and long crypts on their bottoms ducts of small mucous glands occasionally may open**

- The basal layers of epithelium are often infiltrated with lymphocytes

- A thin capsule separates the base and sides of tonsil from the surrounding tissues



The **Lingual tonsil**

is located on the root of the tongue, behind the circumvallate papillae
the crypts are shallow and wide
are lined by **squamous stratified epithelium**; the connective tissue capsule is not developed
ducts of mucous glands (**Weber's glands**) often open into the crypts

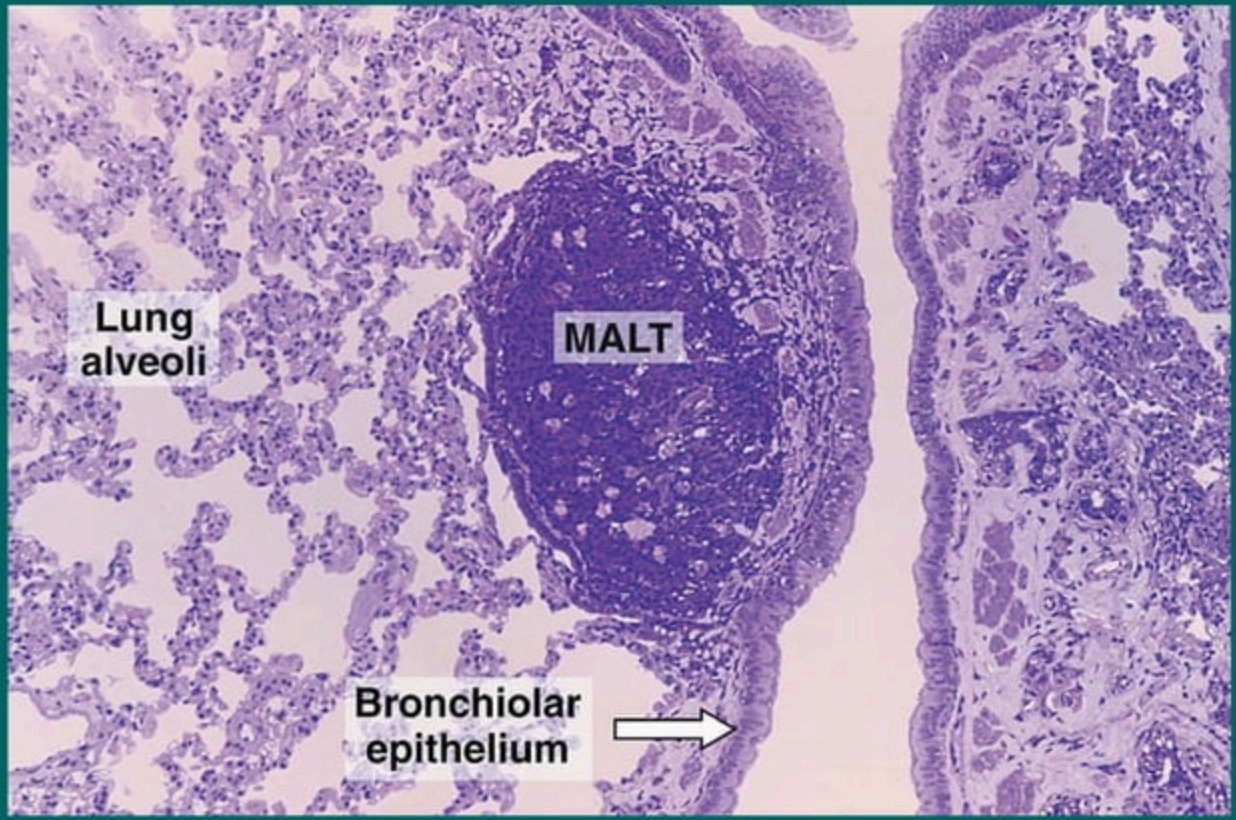
The **Pharyngeal tonsil**

is located on the top of pharynx
is covered by **pseudostratified columnar epithelium**, with goblet cells and cilia
the crypts are not deep; the capsule is developed only weak

the ducts of seromucous glands may open onto the bottom of the crypts

lymph nodules

in the wall of respiratory passages (MALT)



Distribution of T + B lymphocytes in lymphatic organs

Organ	T-Ly regions	B-Ly regions
thymus	cortex + medulla	none
lymph nodes	paracortical zone	nodules+medullary cords
spleen	periarterial sheaths + marginal zone	splenic nodules (Malpighian bodies)
other lymphatic organs	internodular parts	nodules

The immune system

overview of its morphology

the immune system serves to protect body against invasion by pathogenic organism and malignant transformation of its own cells

system involves:

- **lymphatic organs** - thymus, lymph nodes, spleen and tonsils "MALT"

- **lymphocytes of the peripheral blood**:
  - B - Ly comprise approx. 65 % of the circulating lymphocytes and primarily are responsible for humoral immunity (production of specific serum immunoglobulins directed against environmental antigens)
  - T - Ly comprise about 35 % of the circulating lymphocytes and are responsible for a complex phenomenon known as cellular immunity

- **Mononuclear Phagocyte System** (MPS) - previously called as Reticular endothelial system (RES)

  the MPS includes phagocytic and movable cells that derive from bone marrow stem cells or monocytes

MPS constitutes:

- **monocytes**
- **macrophages** - are monocytes that migrated across the capillary wall into the connective tissue (diapedesis)
- **Kupffer cells** - phagocytic cells in hepatic sinusoids
- **osteoclasts** - phagocytes in the bone
- **alveolar macrophages** - phagocytes in the lung
- **microglia** - phagocytes in the central nervous system