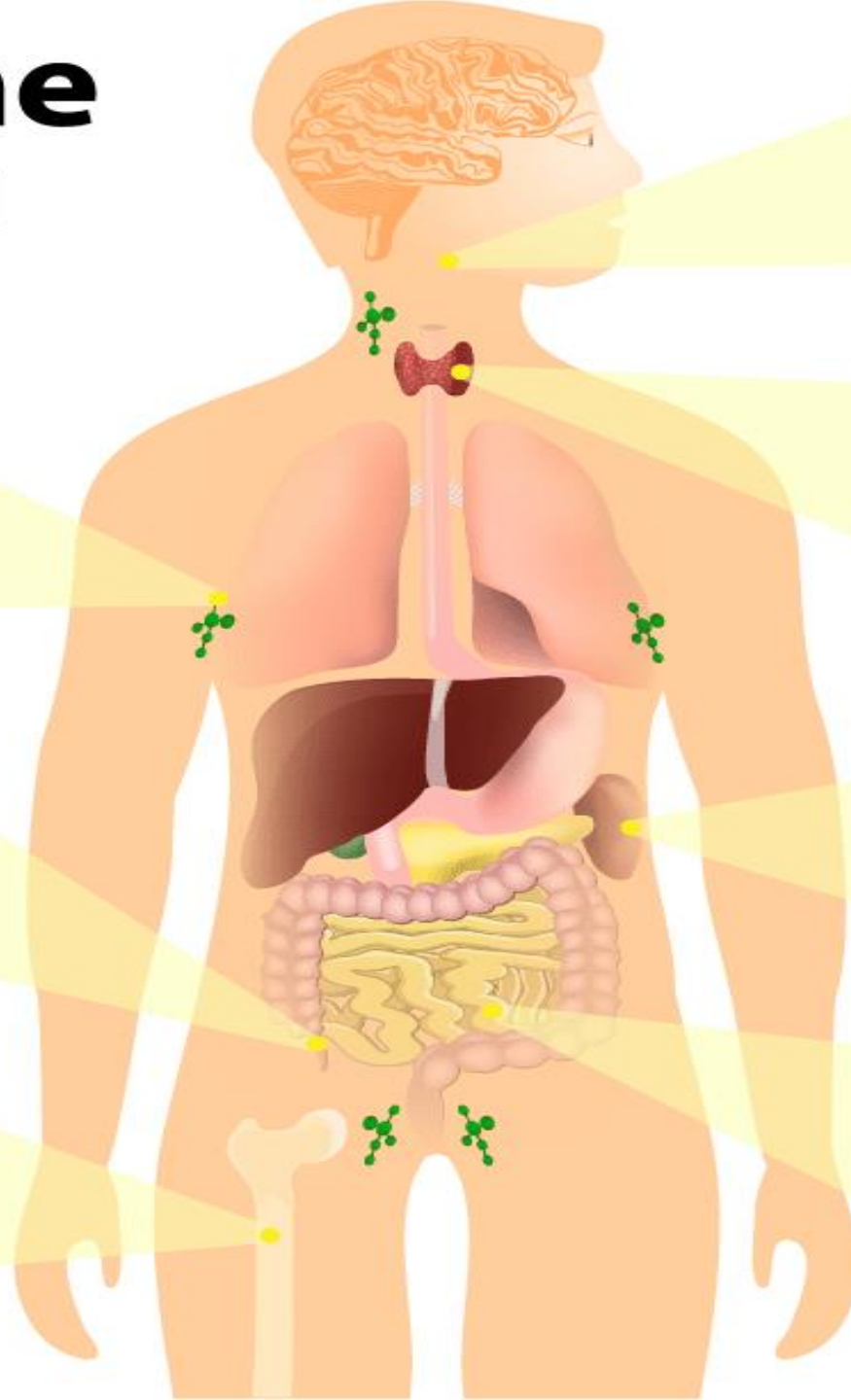
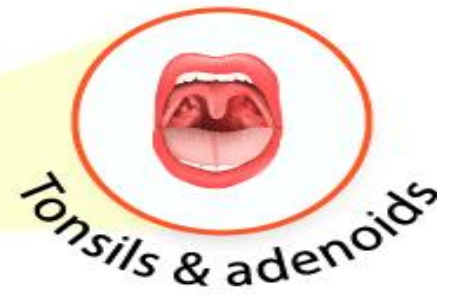
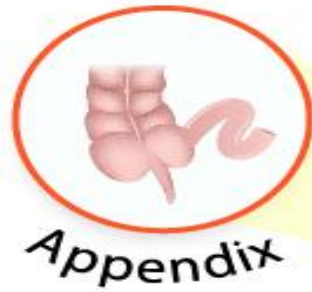
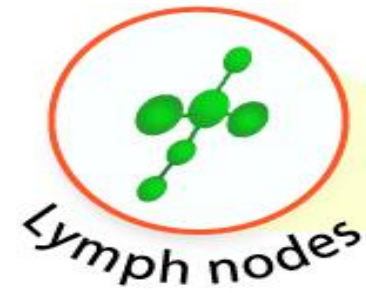
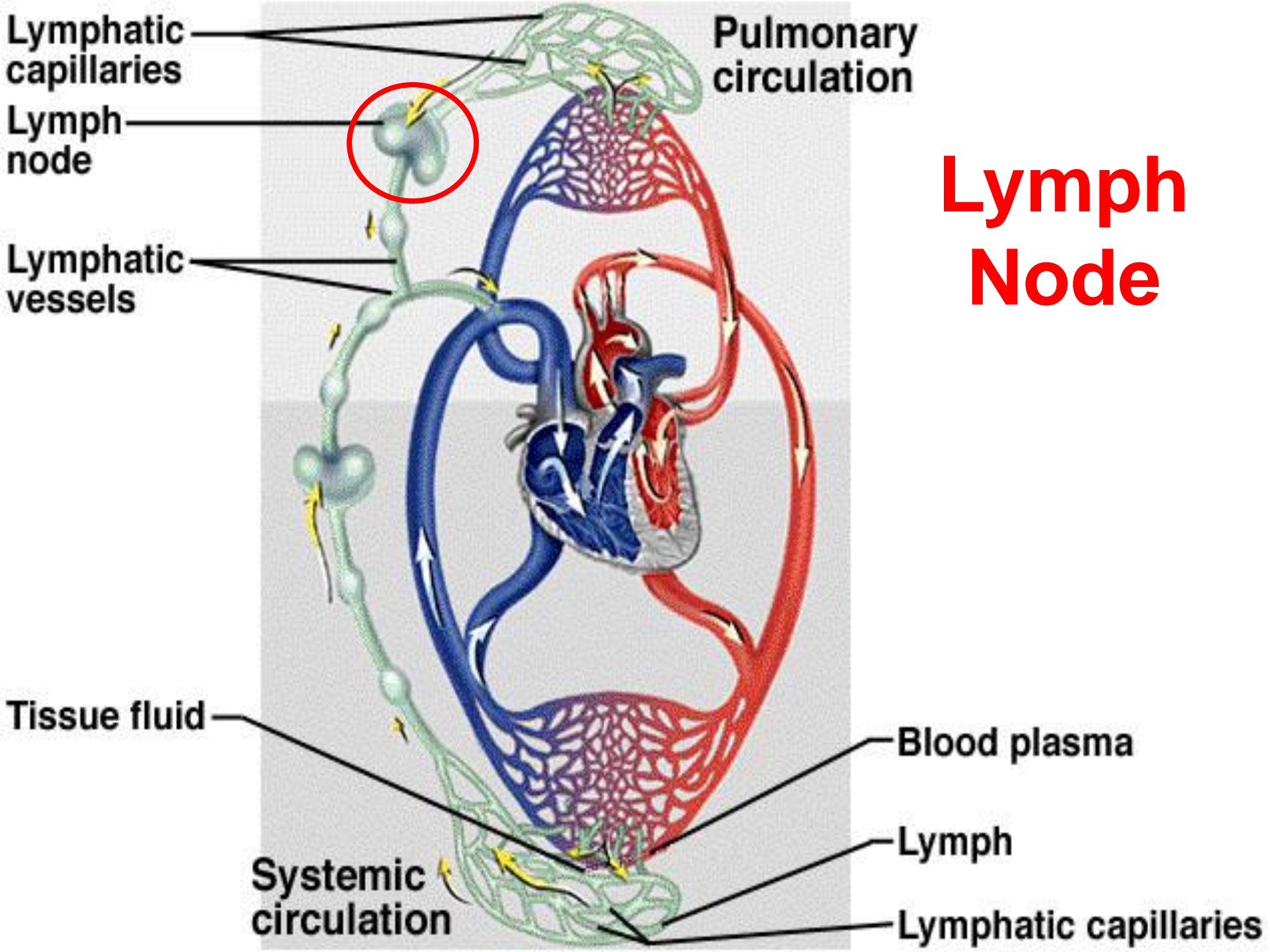


# Immune system







# Lymph node

Afferent lymph vessels

Valve in lymph vessel

Outer cortex  
B cells

**Parenchyma**

Blood capillaries

Blood capillaries  
around lymph nodule

Capsule and  
trabecula

**Stroma**

Efferent lymph vessel  
Artery  
Vein

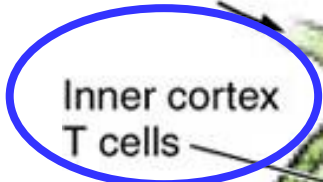
Valve

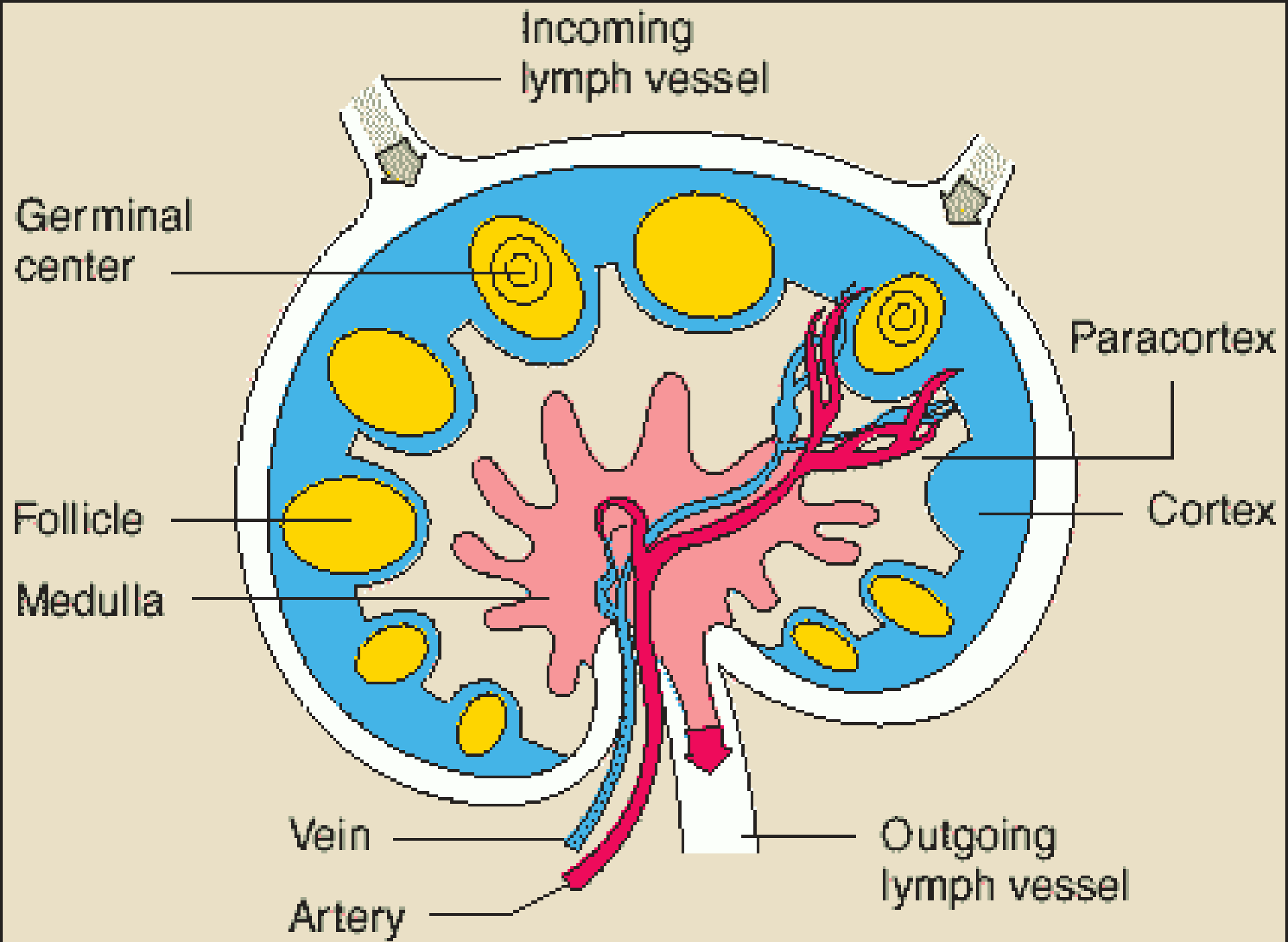
Inner cortex  
T cells

Medulla

Cortical  
nodule

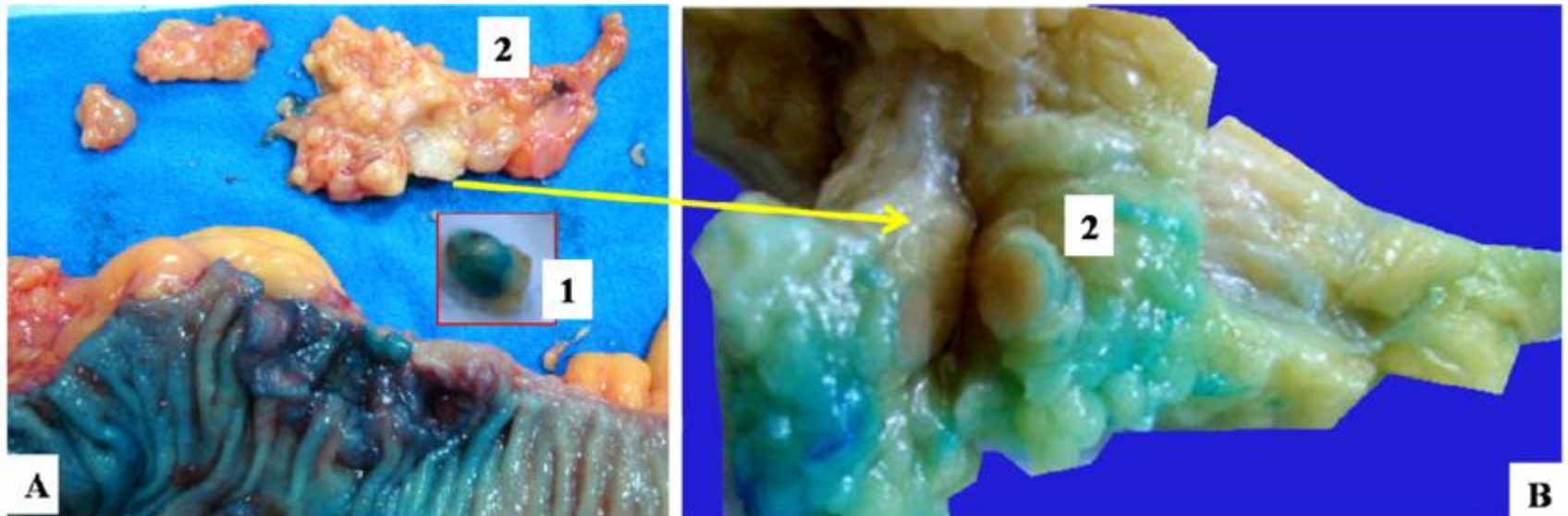
**Parenchyma**





# Lymph node

- **Shape:**
  - Encapsulated.
  - kidney shaped, convex surface and depression (hilum).
- **Site:**
  - Distributed throughout the body.
  - Along lymphatic vessels (neck, axilla, groin, thorax, and abdomen).



# Structure

## 1- **Stroma** (supportive CT):

- a) **Capsule**: dense CT thickened at hilum and form sheath around the BV enter the LN.
- b) **Septa**: divide node into incomplete compartments.
- c) **Reticular network**: reticular cells and fibers holding parenchymal cells in its meshes

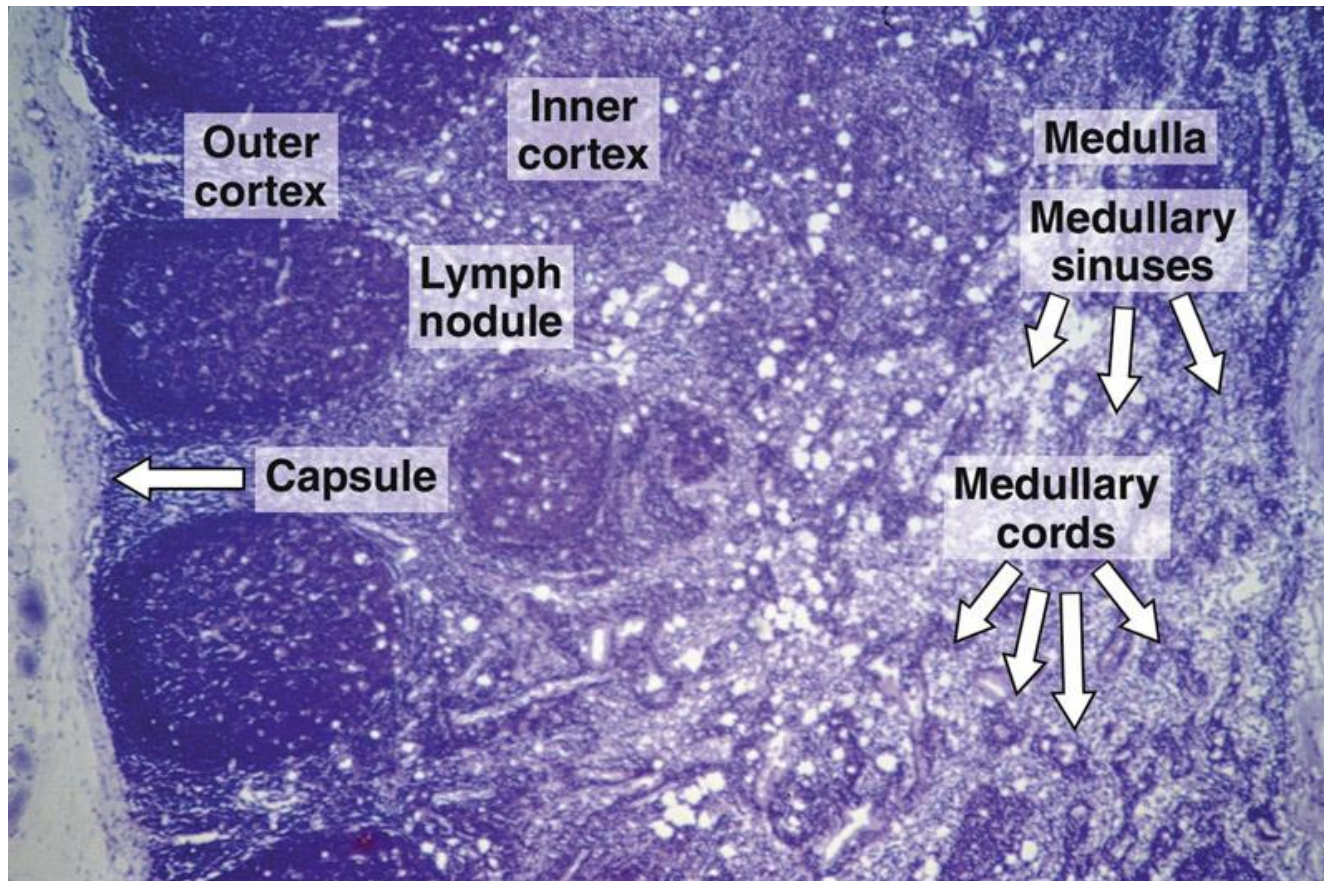
## 2- **Parenchyma**:

- Outer and inner cortex.
- medulla



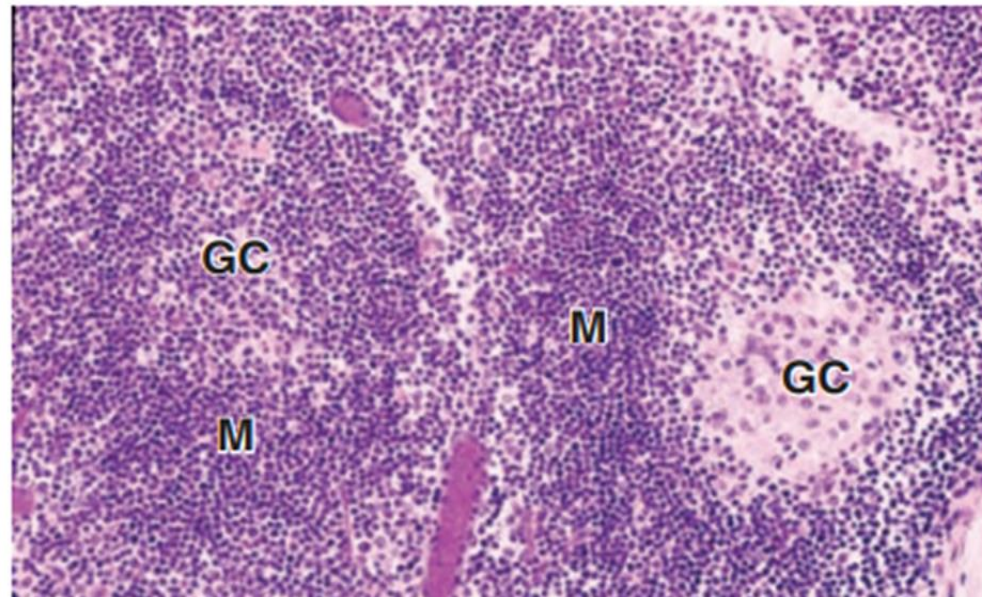
# A- Cortex

- *Outer (superficial) cortex*
- *Inner (deep) cortex*



# Outer cortex

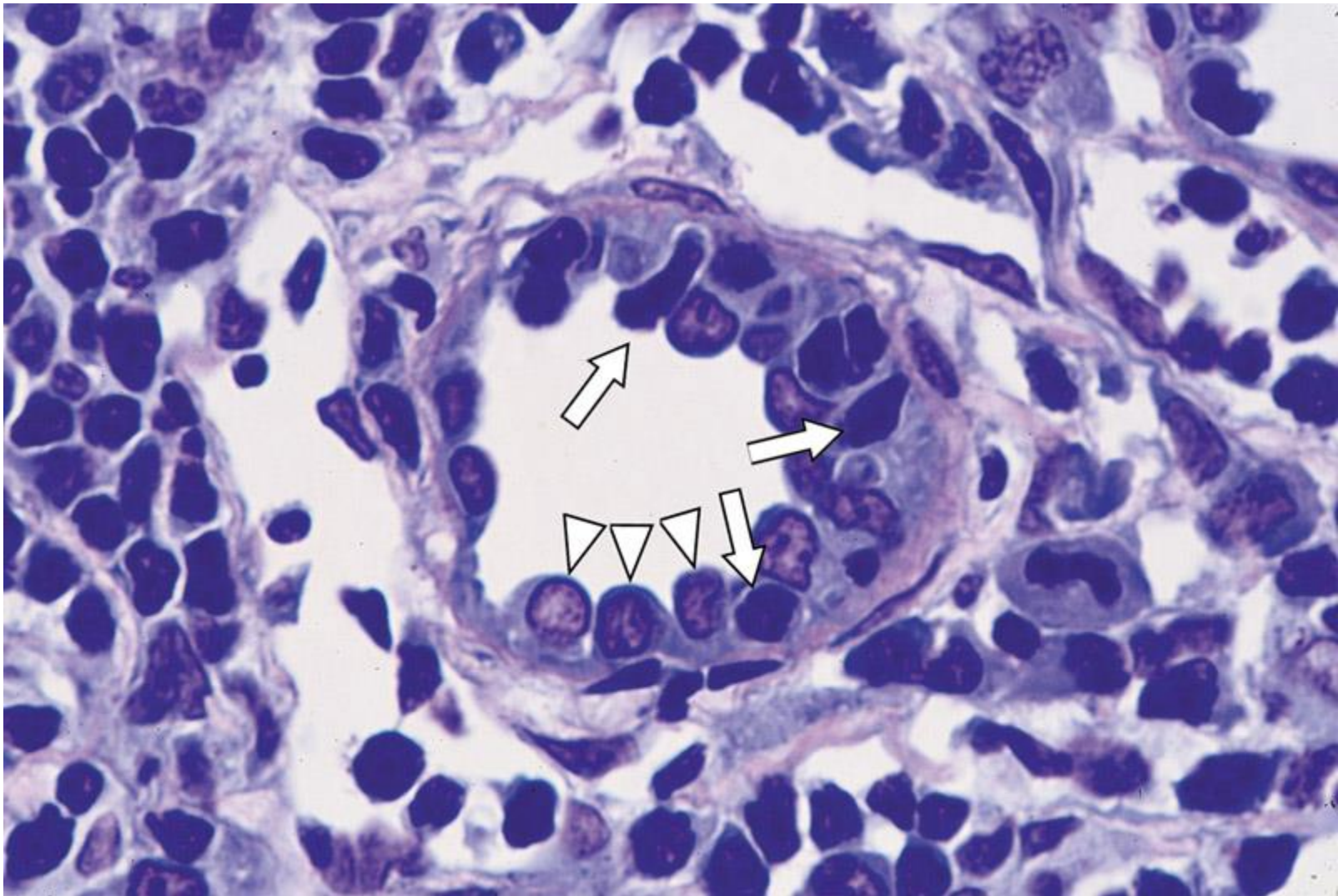
- Round aggregations of lymphocytes called **lymphatic follicles** with loose lymphocytes inbetween.
- 2 types of lymphatic follicles:
  - 1ry lymphatic follicles:
    - **not** exposed to Ag
    - contains **B-cells**, some T-cells, macrophages, reticular cells and Ag presenting cells (follicular dendritic cells).
    - **No** germinal center.
  - 2ry lymphatic follicle:
    - **exposed** to Ag
    - contains **activated** B-cells
    - central pale **germinal center**
    - + **Mantle zone**





# *Inner cortex (paracortex)*

- **Paracortical zone:** deeper part between outer cortex and medulla.
- **Thymus dependant zone:** contains T cells have migrated from the thymus.
- **HEV:** is the point of entry of T cells from blood to lymph node • its endothelial lining is unusual • is cuboidal to facilitate movement of T cells into LN



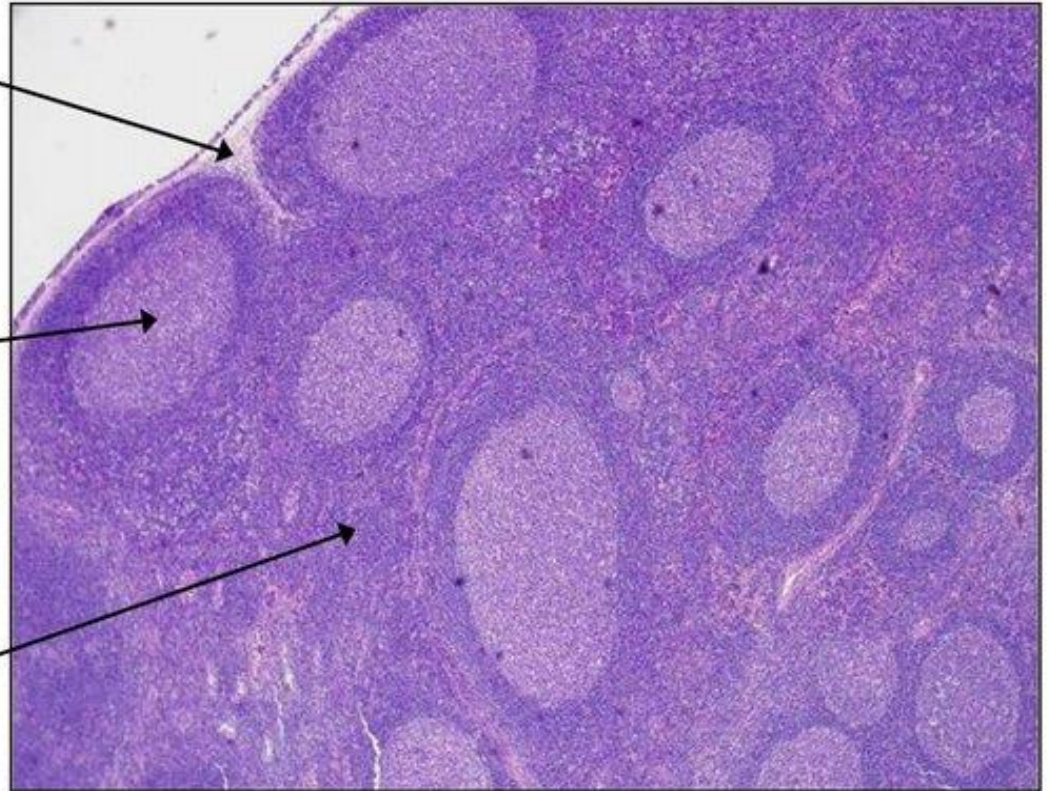
High endothelial venule in a lymph node.  
High endothelial cells (arrowheads).  
The venule is crossed by lymphocytes (arrows).

# Normal Lymph Node Architecture

Sinuses (subcapsular and interfollicular)

Follicles with  
mantle zones,  
germinal centers  
(B cells)

Interfollicular region  
(paracortex) (T cells)



@KyleBradleyMD

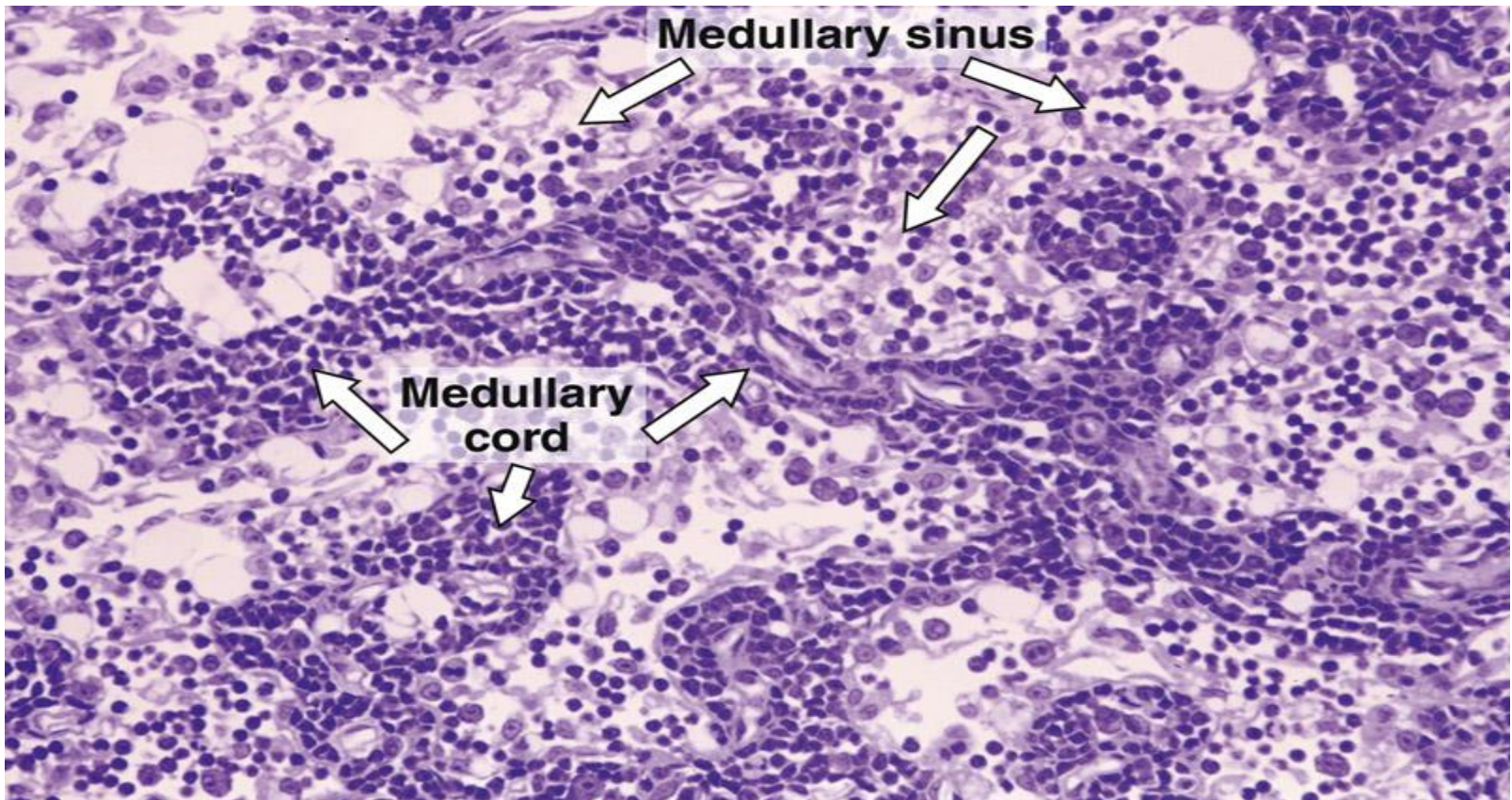


# *Cortical sinuses*

- Irregular spaces lined by reticular cells and macrophages.
  - *Subcapsular sinuses* receive lymph from afferents.
  - *Paratrabecular sinuses* connect subcapsular to medullay.
- Lymph passes through sinuses to be filtered.

# B- Medulla

- *Medullary cords*
- *Medullary sinuses*



# Medullary cords

- Cord like extensions of deep cortical lymphoid tissue.
- Lymphocytes and many plasma cells.

# Medullary sinuses

- Receive lymph from cortical sinuses.
- communicate with efferent vessels
- through which lymph leaves the node.
- Movement of lymph is **unidirectional** due to **valves** in afferent and efferent lymphatic vessels.

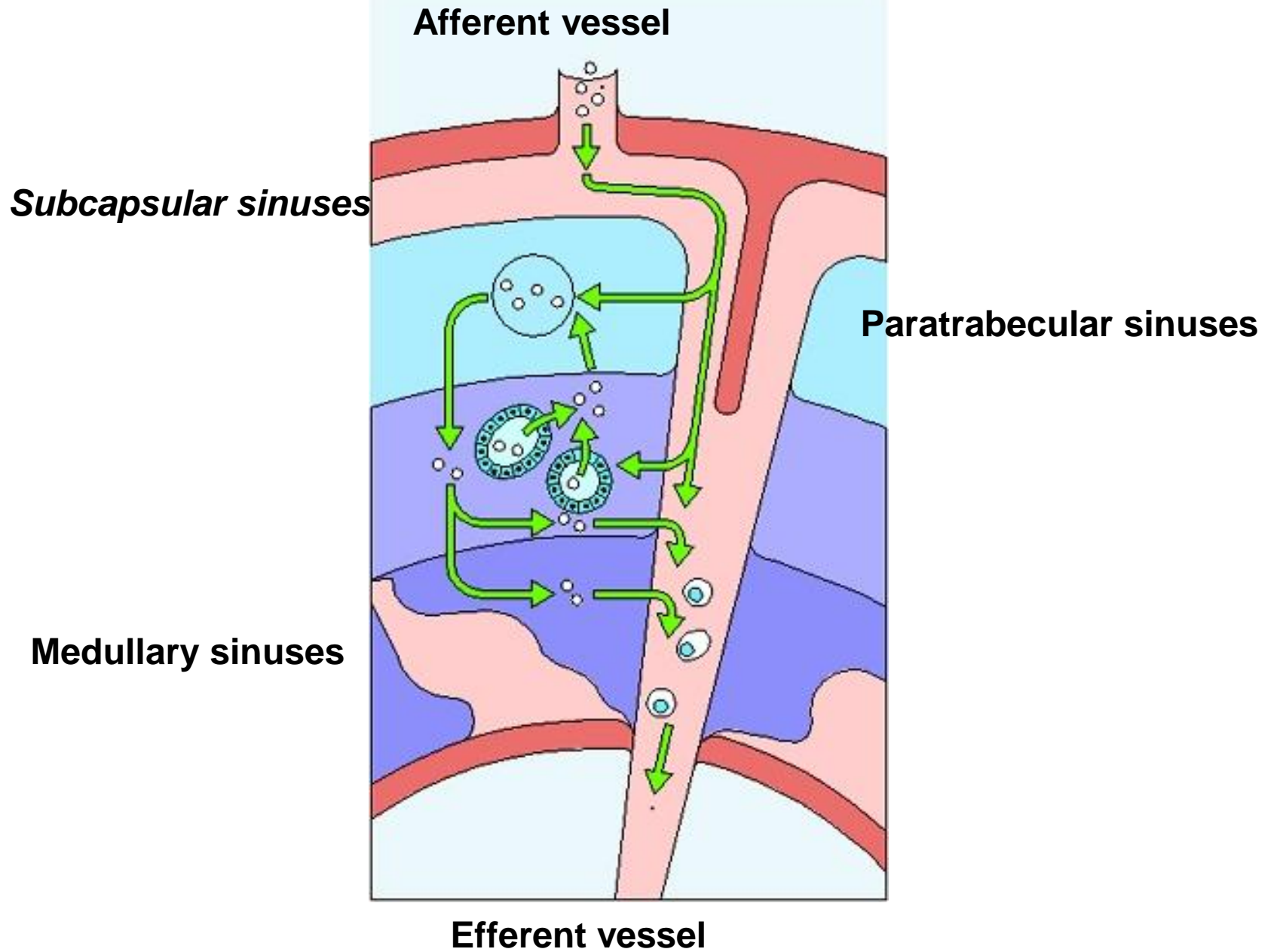


- **Lymphatic vessels:**

- Afferent enter through convex surface.
- Efferent leaves through hilum with BV & nerves.

- **Lymph circulation:**

- Lymph enters through convex surface and leaves through hilum.
- Lymph expose its contents to defensive cells (macrophages, lymphocytes, APCs).



# Functions of lymph nodes

1– **Immunologic reaction**: cellular and humoral.

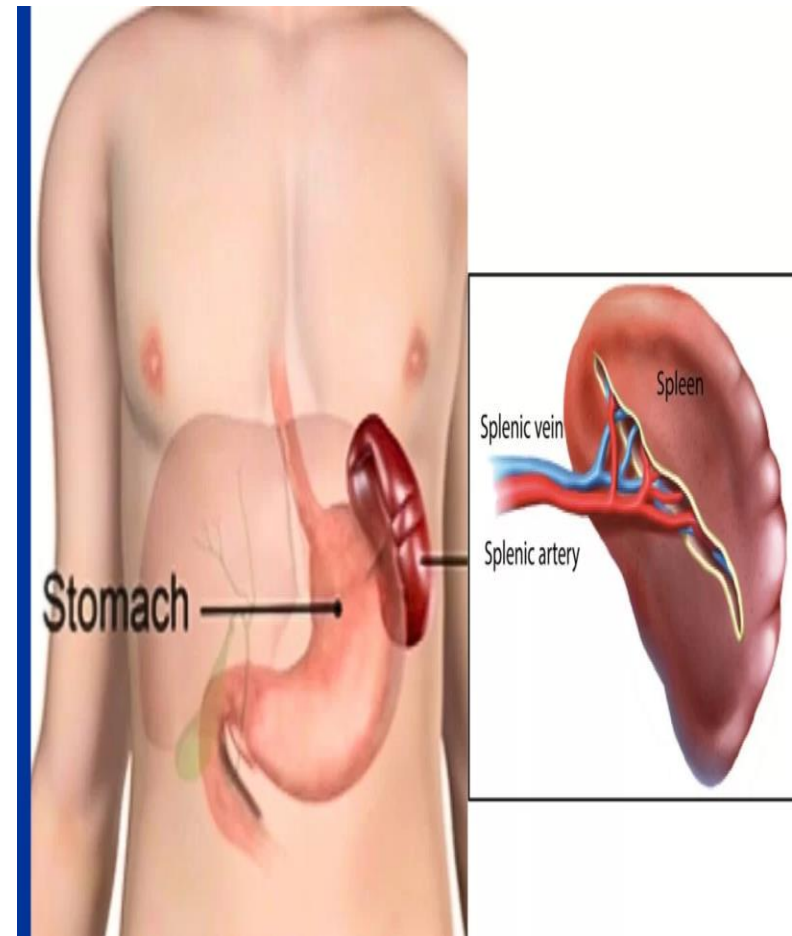
2– **Filtration of lymph**:

- Each node receives lymph from limited area of the body.
  - 99% of Ag removed by phagocytoses in sinuses.
  - 1% passes through follicles to be presented to lymphocyte by APCs.



# Spleen

- **Size:**
  - The largest lymphatic organ in body.
- **Site:**
  - Lying along course of circulatory system.
  - In left side of abdomen beneath diaphragm.
- **Structure:**
  - Stroma
  - Parenchyma



# Stroma

## 1- **Capsule:**

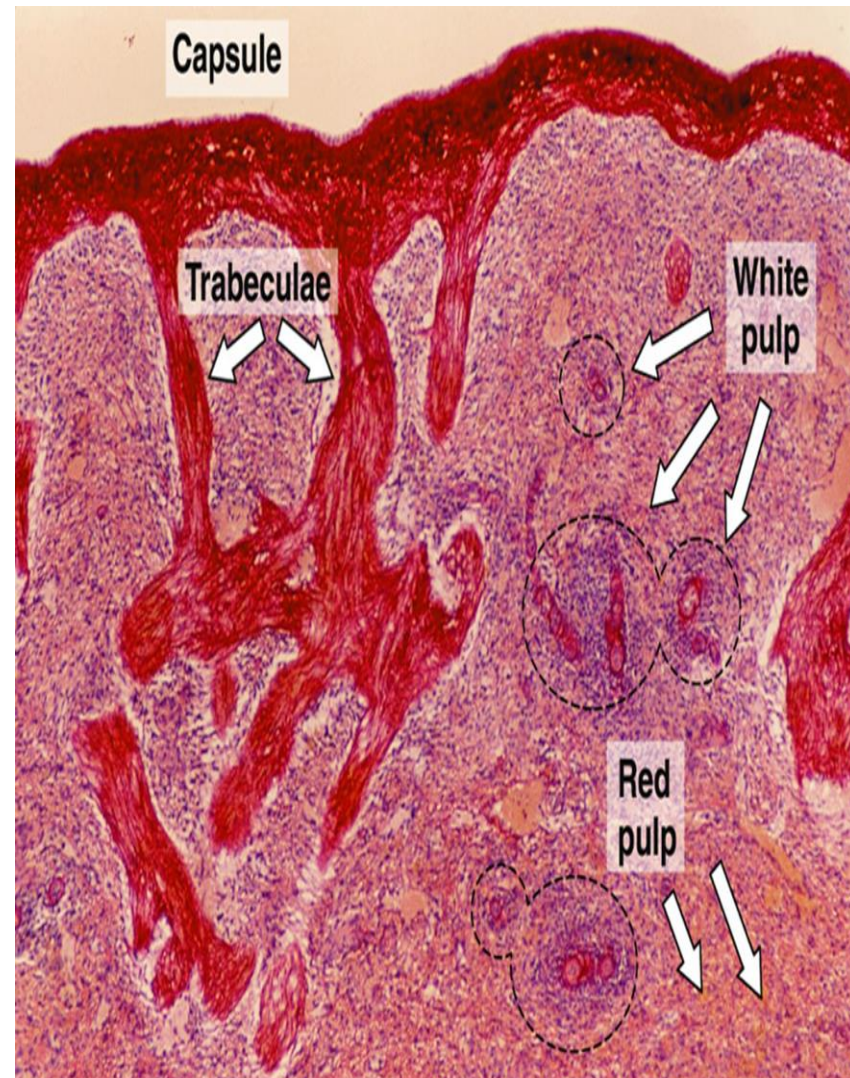
- dense C.T.
- few smooth muscle fibers.
- thickened at hilum
- covered by peritoneum.

## 2- **Trabeculae:**

- some extend from **capsule**
- others extend from **hilum** like branching tree.
- trabeculae from hilum connect to those of capsule
- convey BV and nerves.

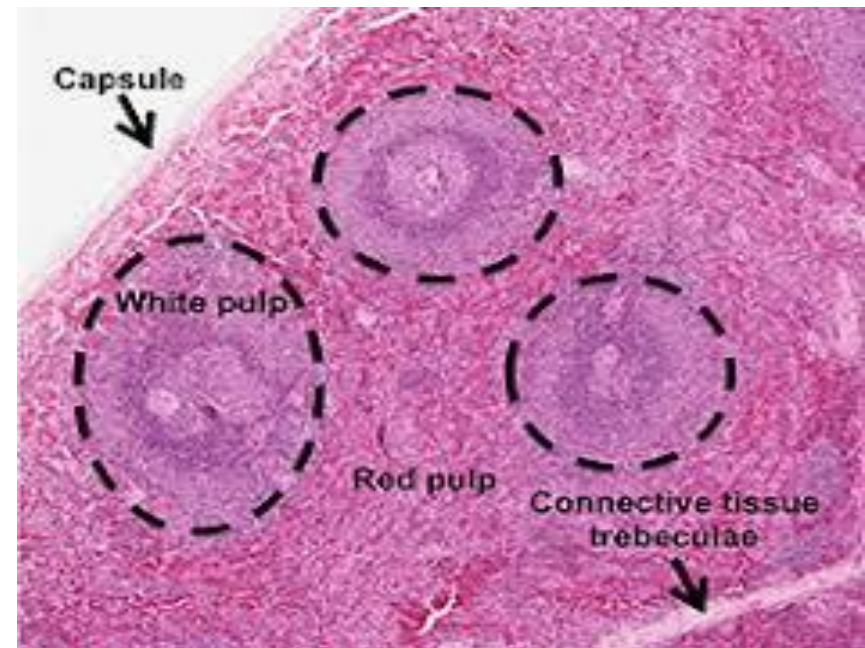
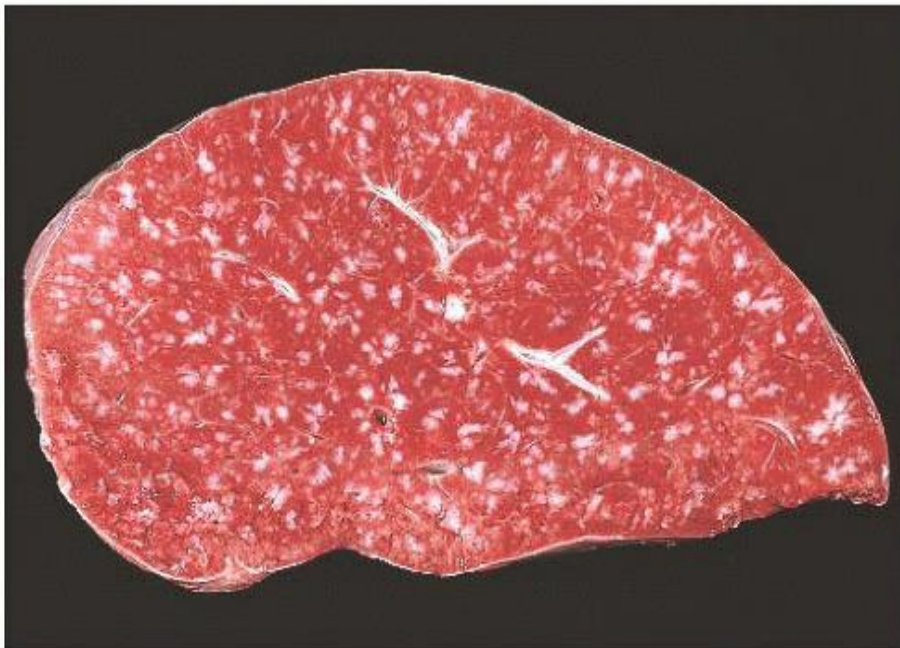
## 3- **Reticular network:**

- connected to capsule and trabeculae
- contains parenchymal cells in its meshes.



# Parenchyma (splenic pulp)

- **Fresh** section of spleen shows
  - dark red tissue (**red pulp**).
  - white spots (**white pulp**).





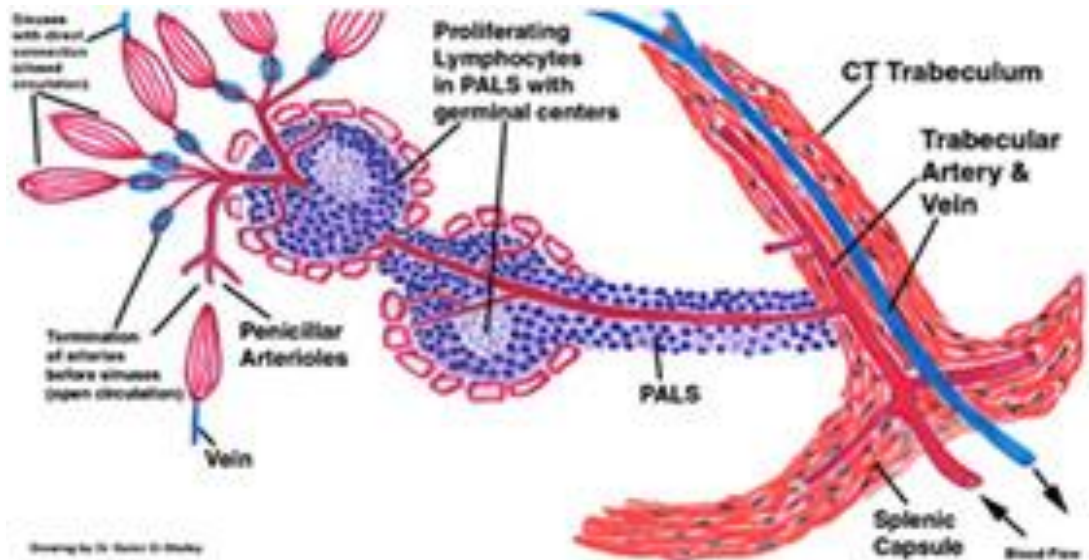
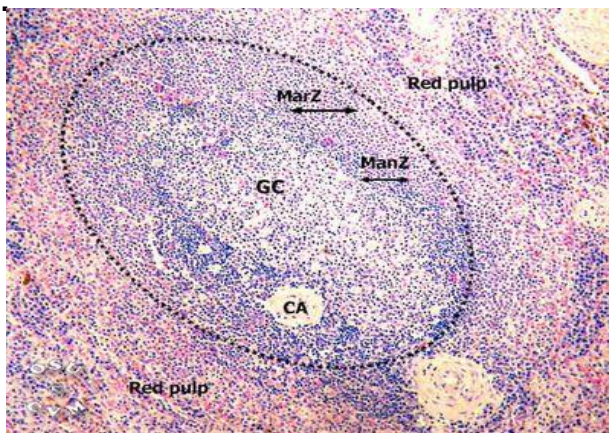
# A- WHITE PULP

- Lymphatic tissue forms sheaths around central arteries.
- The sheath thickens at intervals to form lymphatic follicles.

**1- Periarterial lymphatic sheaths (PALs):** (thymus dependant area).

**2- Lymphatic follicles:**

- B- cells.
- splenic Malpighian corpuscles: with pale germinal centers: contain B cells, activated B cells, plasma cells & macrophages+ mantle zone
- central artery penetrates follicles in eccentric position.

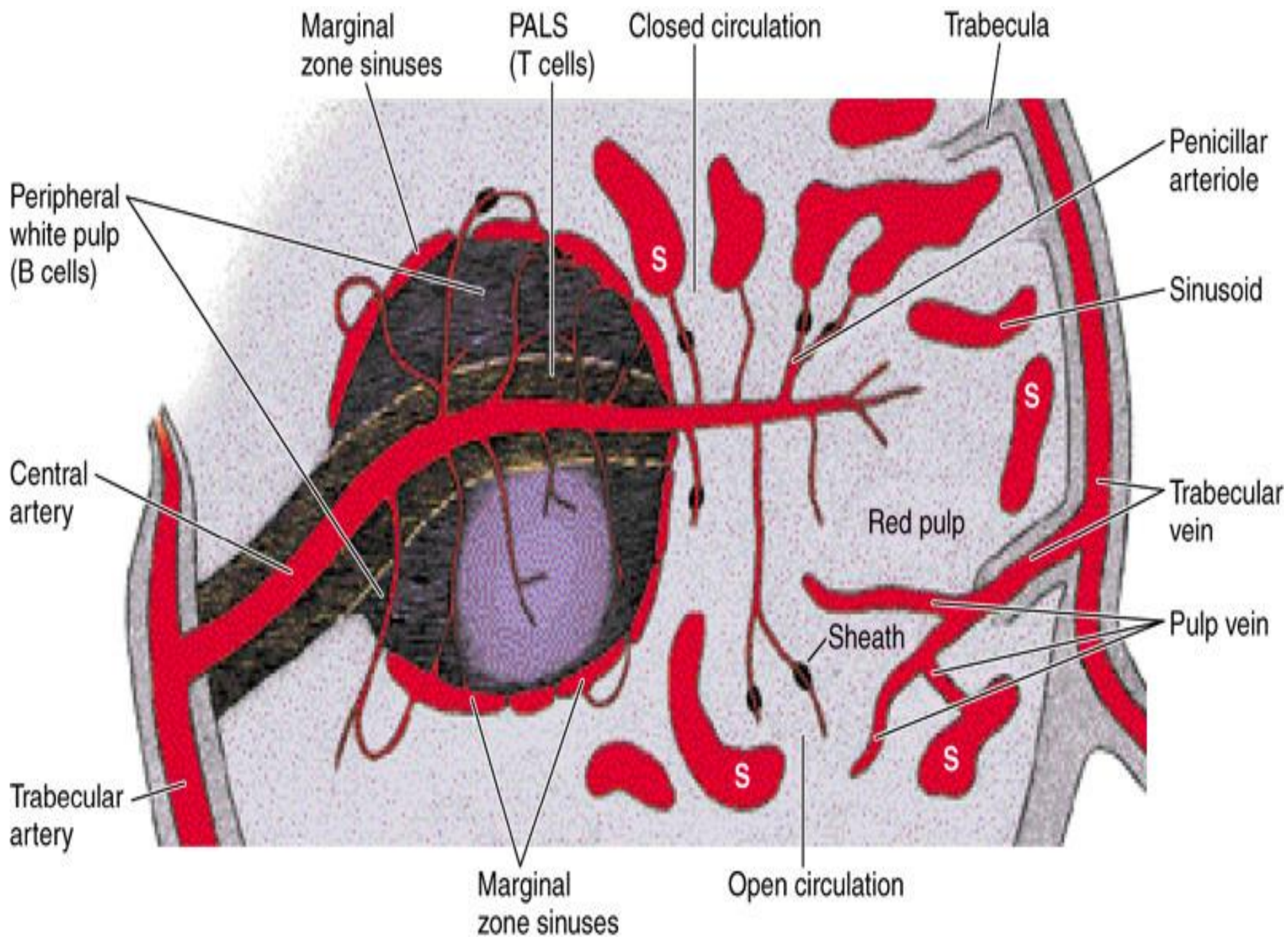




# A- WHITE PULP

## 3- Marginal zone:

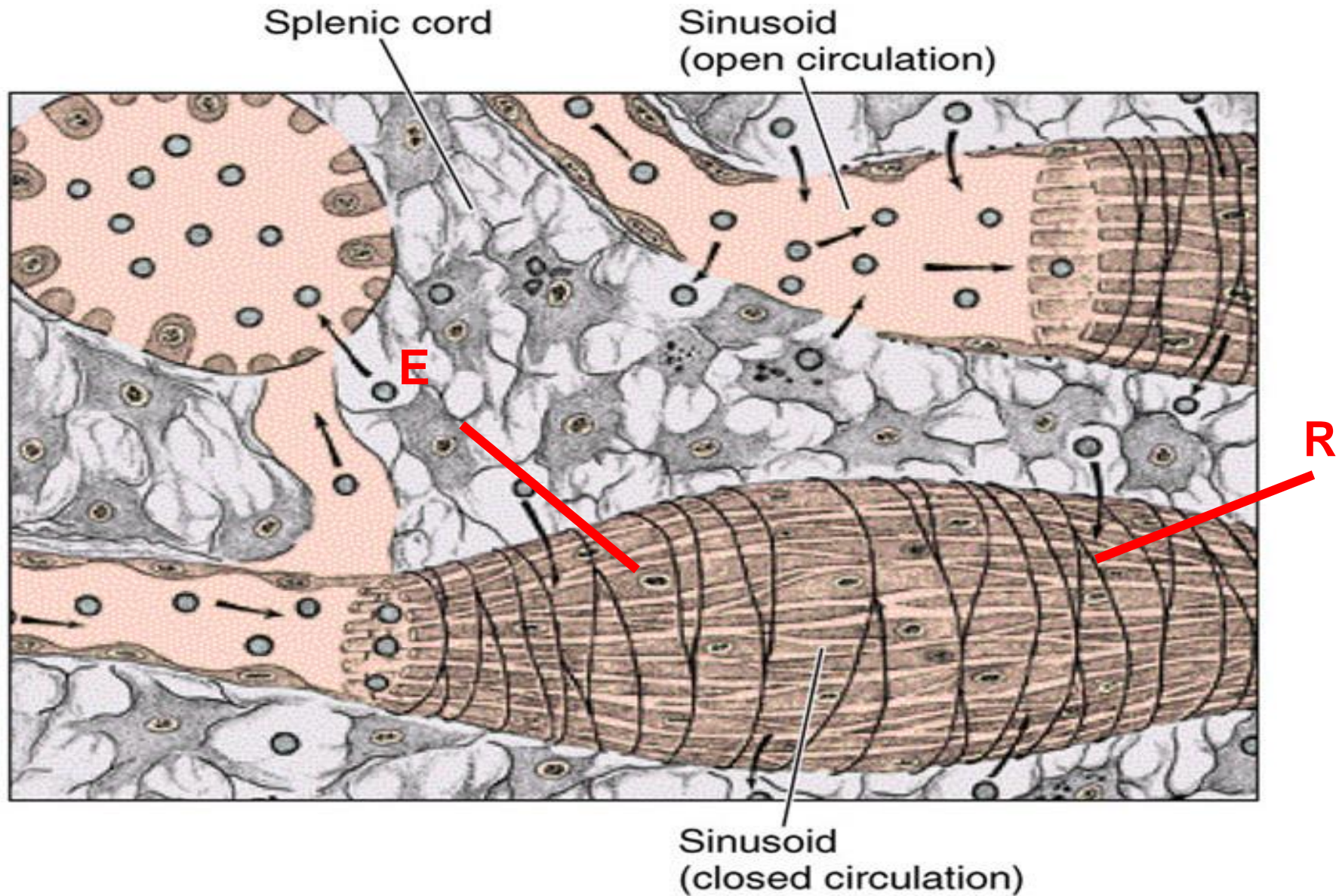
- between white and red pulp.
- lymphatic tissue and blood sinuses around lymphatic follicles and periarterial sheaths.
- macrophages, dendritic cells, B-cells and some T-cells.
- central artery gives branches through the follicle and end in sinuses.
- Sinuses have two roles:
  - Traps Ag presented to lymphocytes by APCs.
  - Route for entry of B- and T- cells to white pulp from blood.
- T-cells migrate to periarterial lymphatic sheaths (PALs).
- Activated B-cells migrate to germinal centers to change to plasma cells that migrate to red pulp releasing AB into sinusoids.



# B- RED PULP

- major part of spleen
- red because of large number of erythrocytes.
- composed of:
  - 1– Blood sinusoids**
    - Large thin walled dilated spaces containing blood.
    - Lined by endothelial cells :
      - discontinuous layer.
      - parallel to long axis of sinusoids.
      - with slit-shaped gaps
      - allowing exchange of cells between blood in sinusoids and adjacent tissue.
      - enveloped by reticular fibers perpendicular to long axis of sinusoids.
  - 2– The splenic (Billroth cords)**
    - Cords of cells between blood sinusoids.
    - Contain blood elements, reticular cells, macrophages and plasma cells.





- **Red pulp:** sinusoids and cords with reticular cells and macrophages.
- reticular fibers perpendicular to long axis of sinusoid.



# Blood circulation

- **Splenic artery**
  - enters hilum and branches into *trabecular arteries*.
- **Trabecular artery**
  - enters white pulp as *central artery*.
- **Central artery**
  - surrounded by periarterial lymphatic sheath.
  - occupies eccentric position in lymphatic follicles.
  - leaves white pulp to red pulp as *pulp artery*.
- **Pulp artery**
  - subdivides into *penicillar arterioles*.
- **Penicillar arterioles**
  - surrounded near their termination by ellipsoid sheath of macrophages, reticular cells and lymphocytes.
  - continue as *capillaries*.

- **Capillaries** carry blood to red pulp sinusoids in various ways:

### 1- Closed circulation:

- capillaries open into sinusoids.

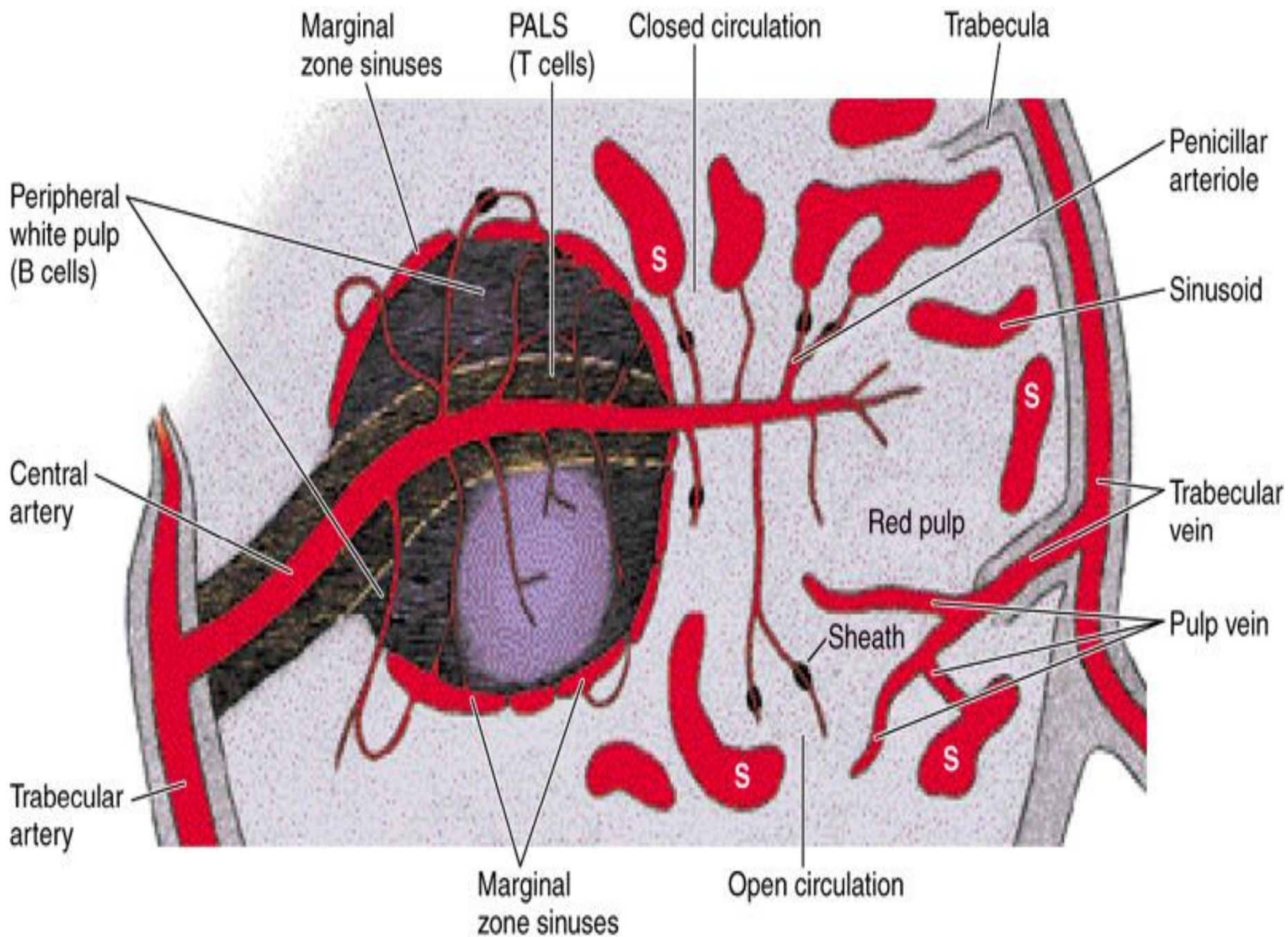
### 2- Open circulation:

- capillaries open into red pulp.

### 3- Open – closed circulation:

- closed circulation in collapsed spleen.
- open circulation in distended spleen.

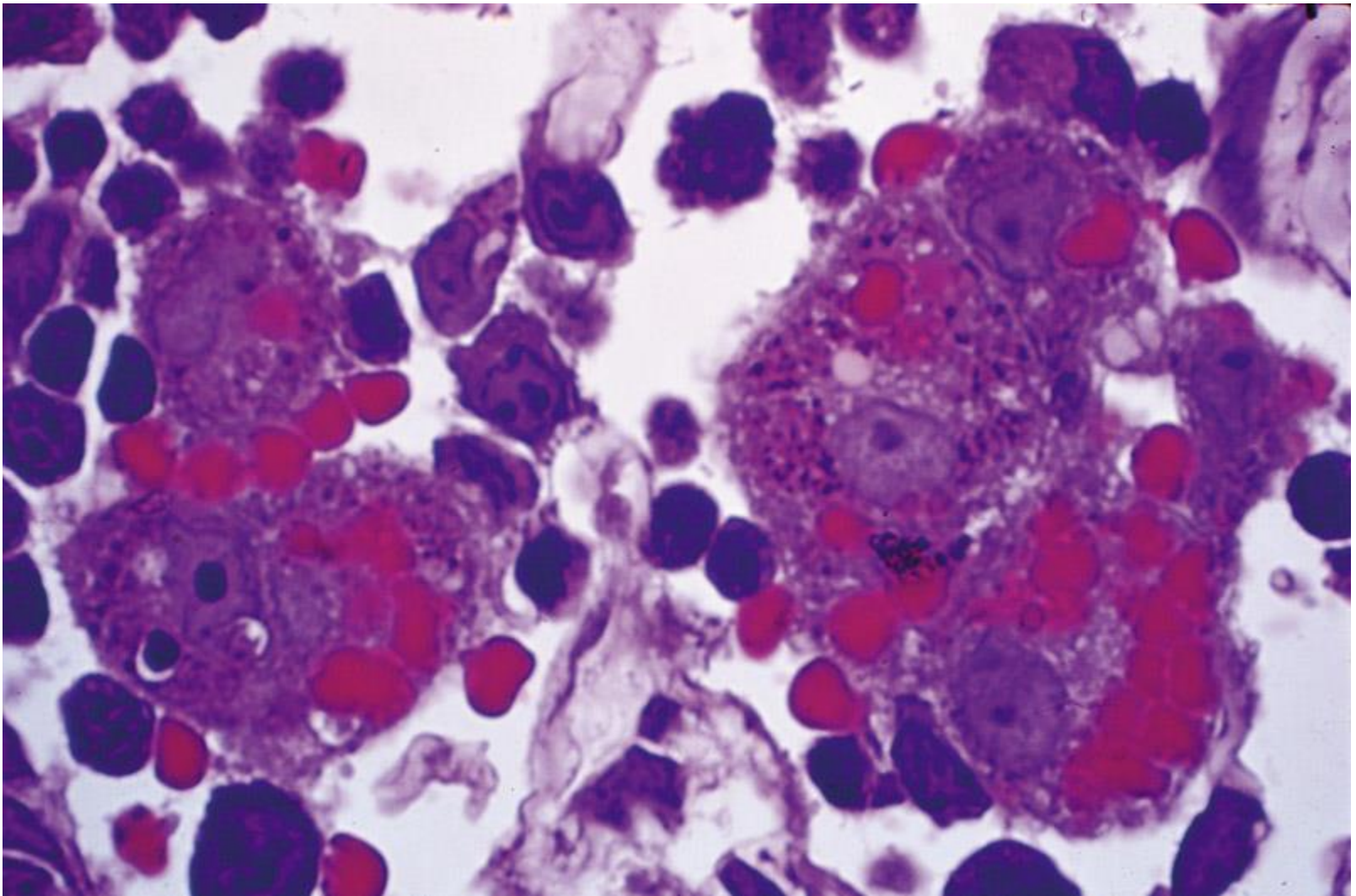
- From sinusoids, blood passes to
  - pulp veins
  - trabecular veins
  - splenic vein that merges from hilum.



# Functions of spleen

- 1- Immunity (Cellular and humoral).
- 2- Filtration of blood (Immunologic).
- 3- Destruction (old RBCs).
- 4- Haematopoietic function (in fetus).
- 5- Storage of blood (in animals).

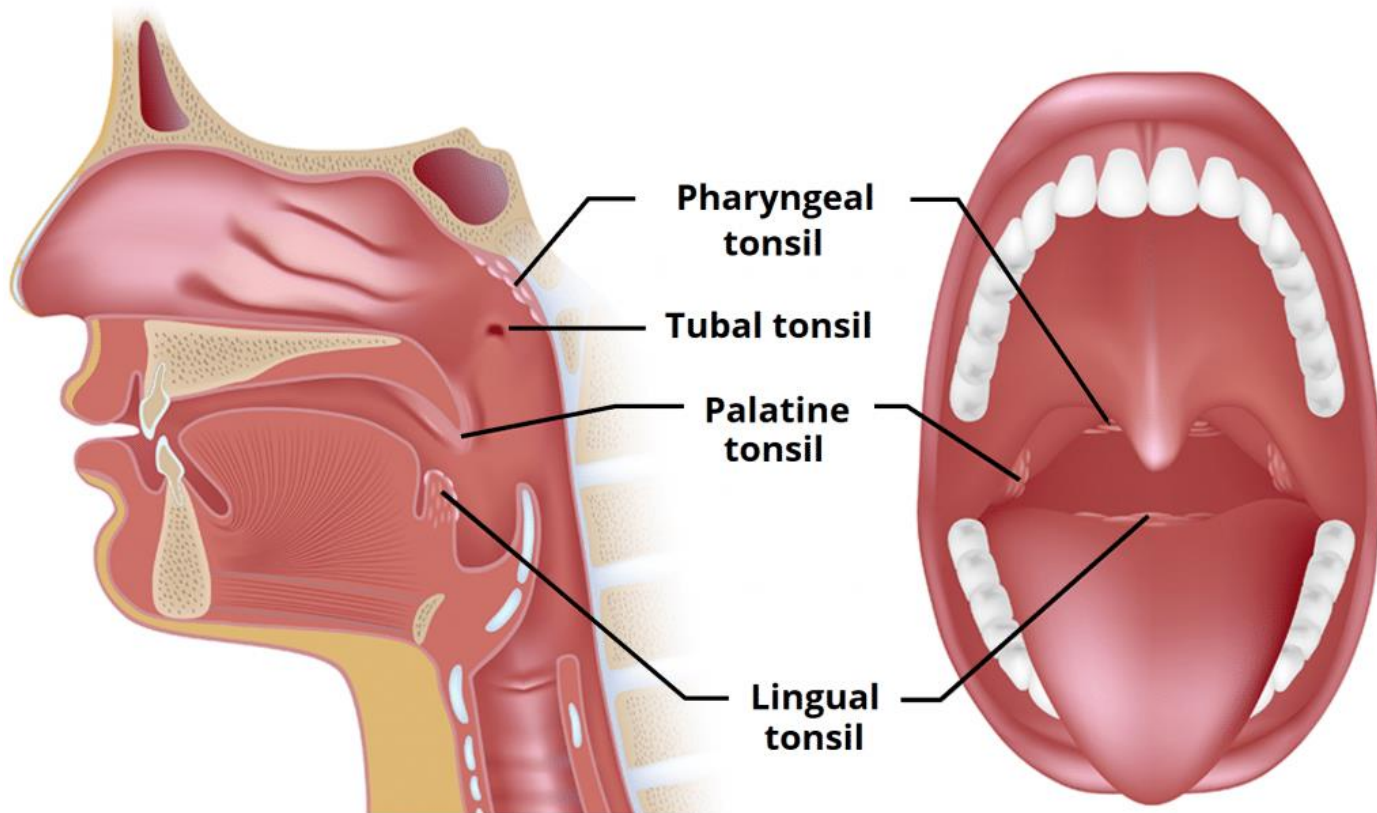




5 spleen macrophages in active phagocytosis of erythrocytes  
in different stages of degradation.

# TONSILS

- Incompletely encapsulated aggregates of lymphoid tissue
- Beneath epithelium of initial part of digestive tract.



<b>Tonsils</b>	<b>Palatine</b>	<b>Pharyngeal (adenoids)</b>	<b>Lingual</b>
<b>Number</b>	Two (Each contain lymphoid follicles)	One	More numerous (smaller)
<b>Site</b>	oropharynx	nasopharynx	base of tongue
<b>Epithelium</b>	stratified squamous	pseudostratified columnar ciliated	Stratified squamous
<b>Capsule</b>	dense C.T	Thin	Thin
<b>Crypts</b>	10-20	No	Each has a single crypt



Lumen of oral  
cavity

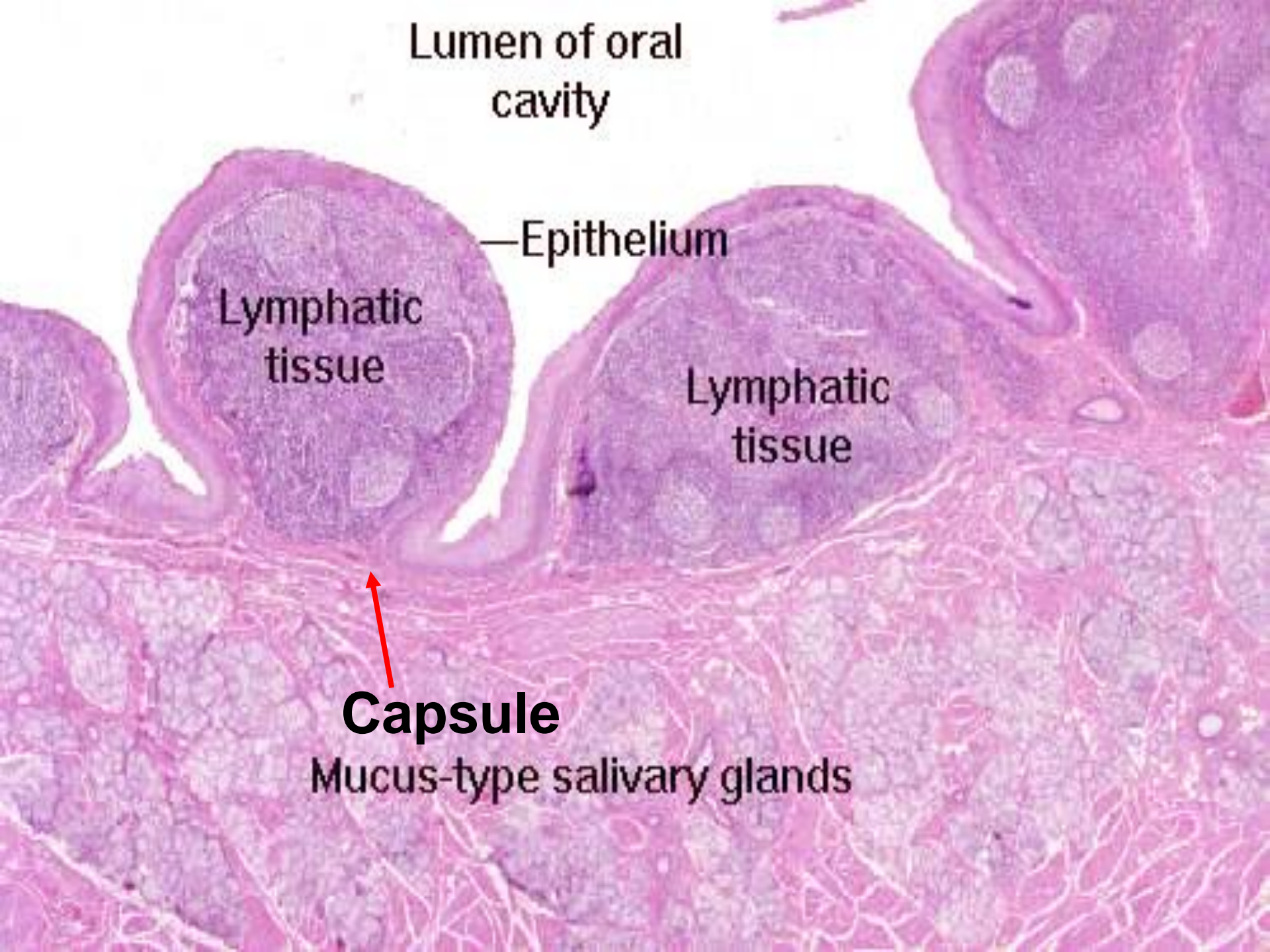
—Epithelium

Lymphatic  
tissue

Lymphatic  
tissue

**Capsule**

Mucus-type salivary glands



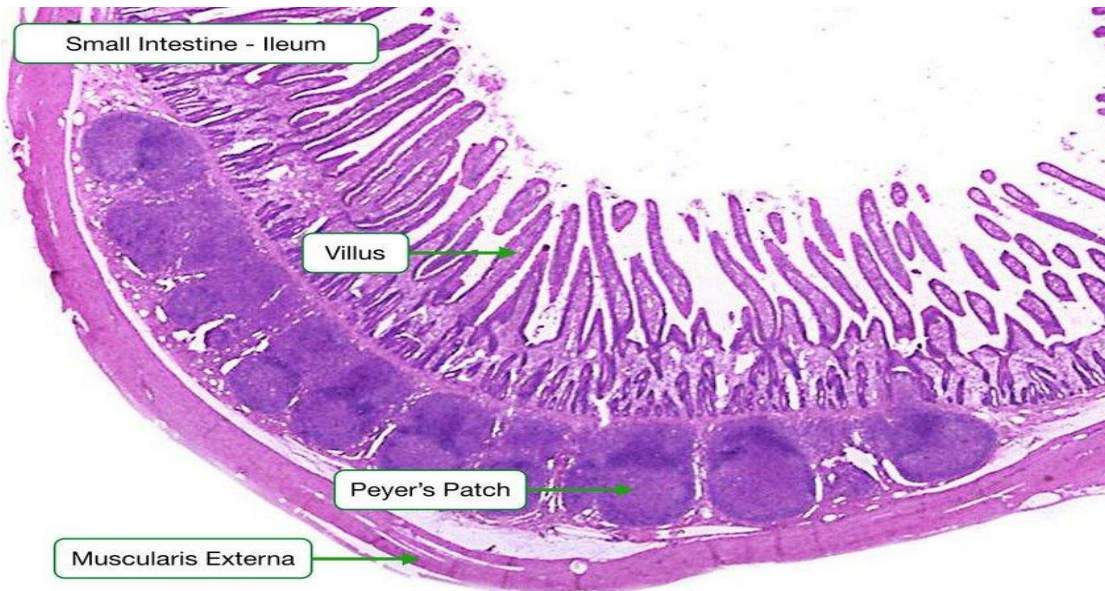


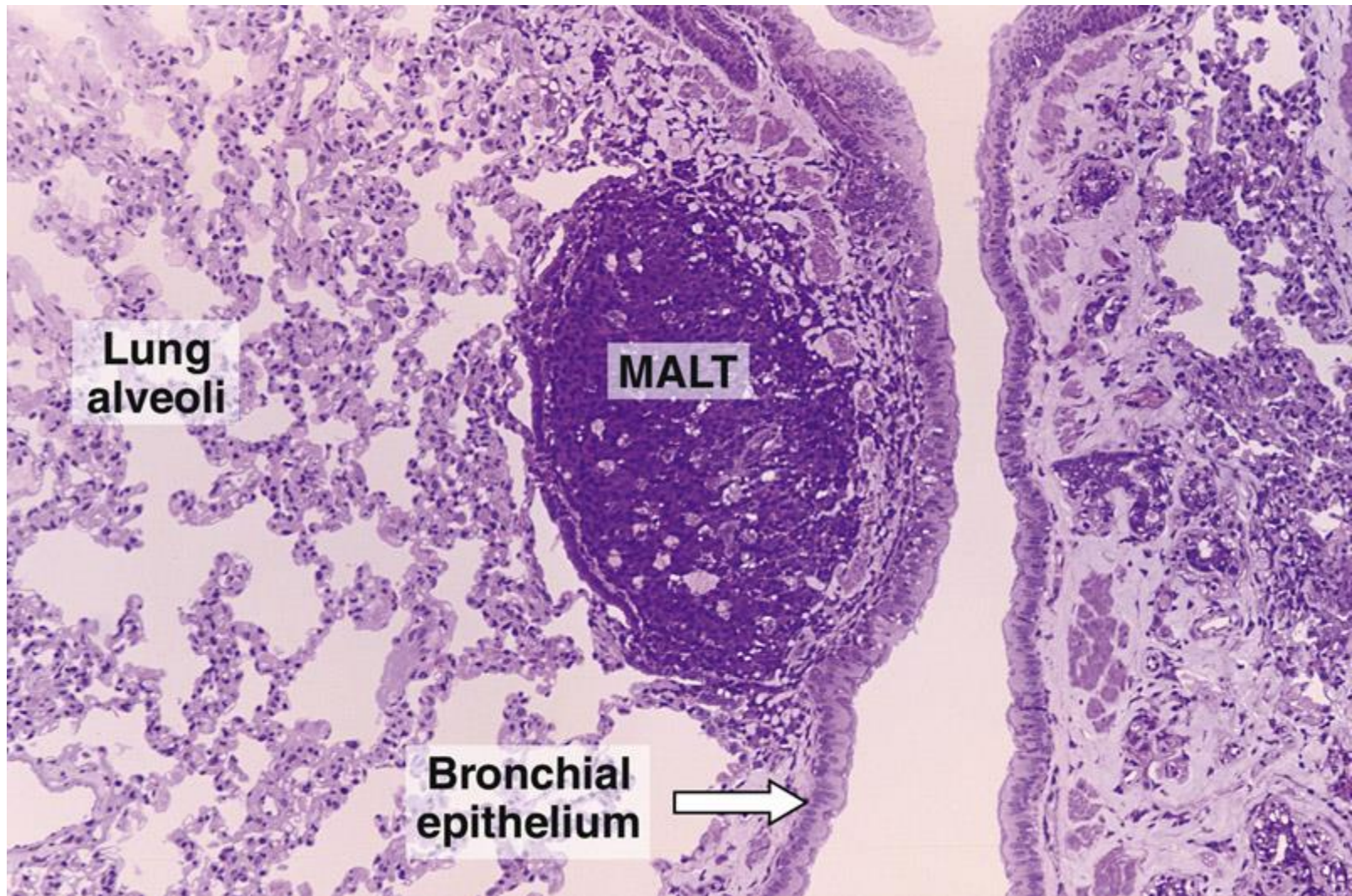
# Mucosa-associated lymphoid tissue (MALT)

Many bacteria permanently inhabit the digestive and respiratory tracts.

\*To fight these invaders, MALT is especially abundant under the mucosa.

\*Examples are: Peyer's patches of ileum and MALT of appendix, lymphocytes in CT of bronchiolar mucosa



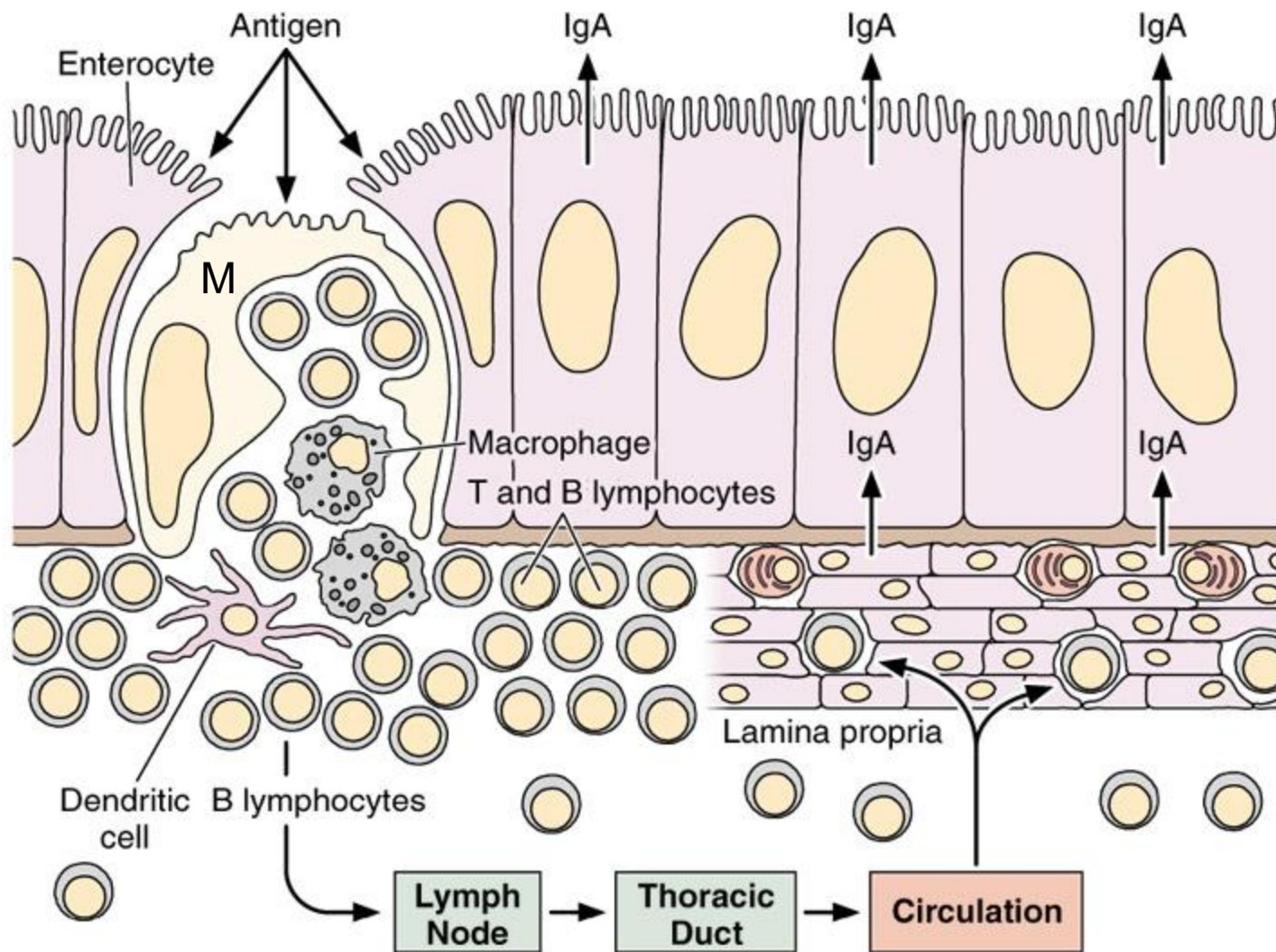


- lung showing lymphocytes in CT of bronchiolar mucosa,
- example of mucosa-associated lymphoid tissue (MALT).

# Mucosa immunity in intestine

- Luminal Ag are captured by M cells in Peyer's patches.
- Transported to:
  - Lymphocytes
  - Macrophages
  - dendritic cells.
- Macrophages and dendritic cells stimulate B and T cells.
- Stimulated lymphocytes enter lymphatic circulation and later blood circulation.
- They return to mucosa lamina propria, where plasma cells produce IgA.









Thank you