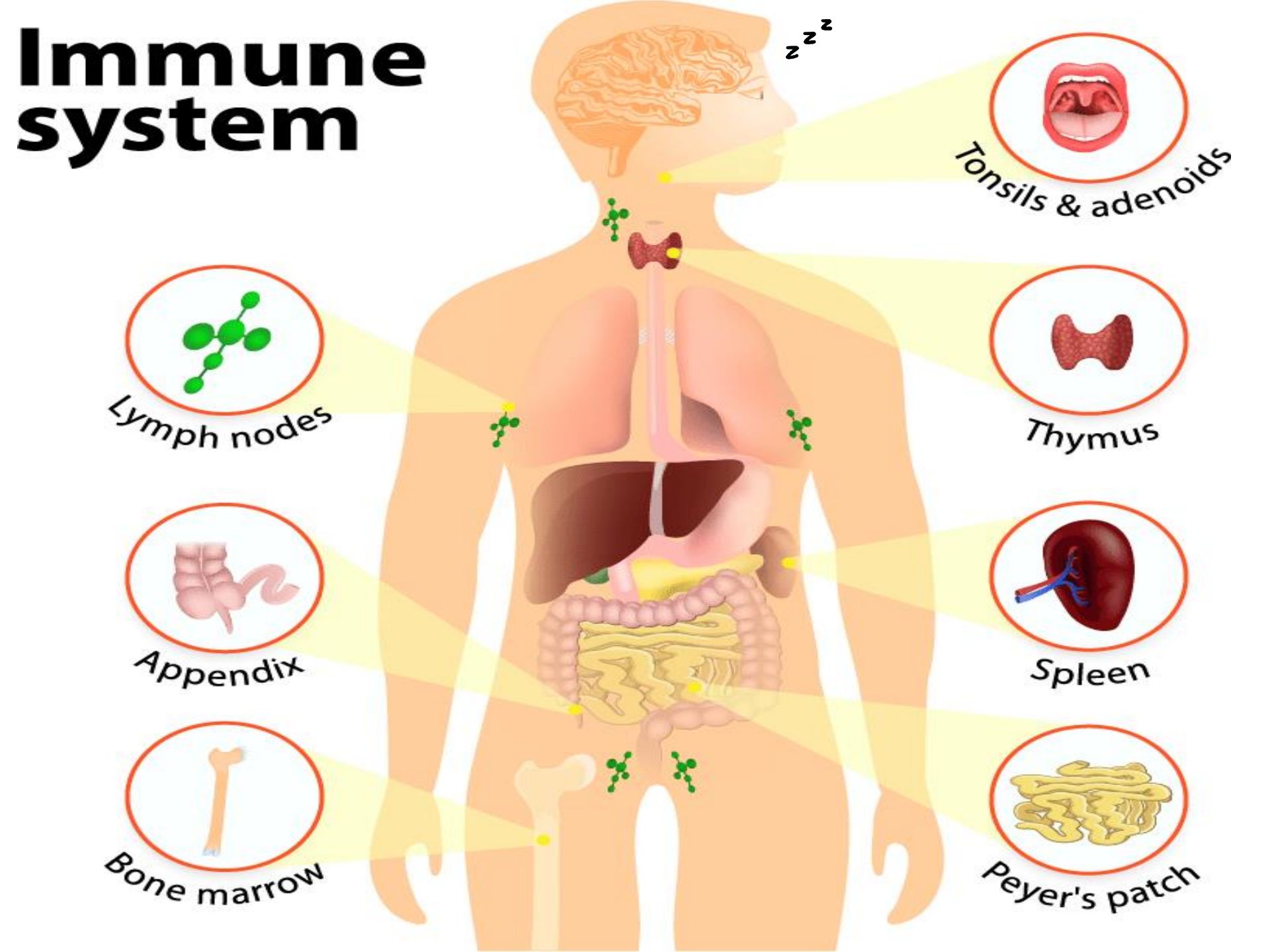
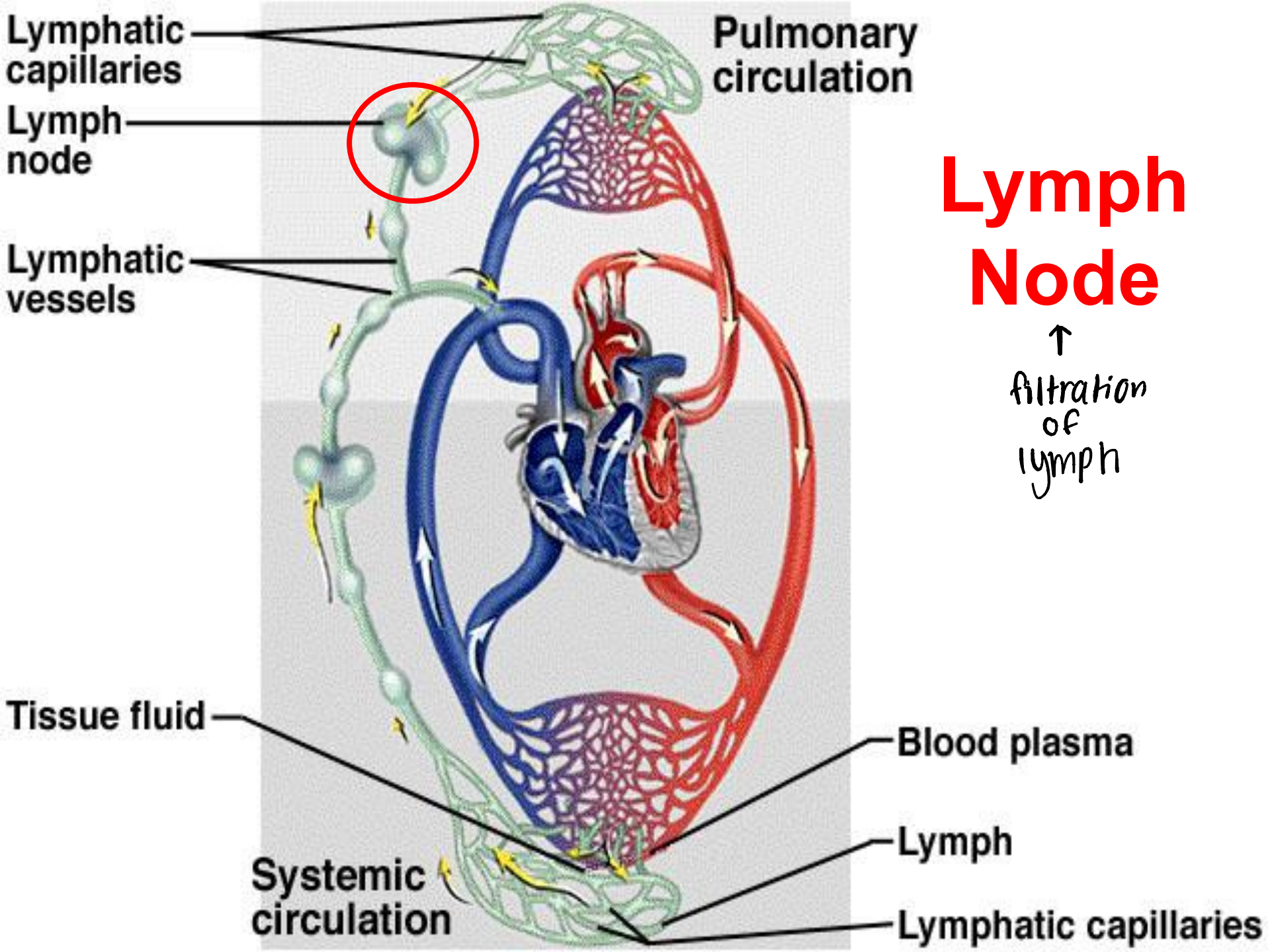
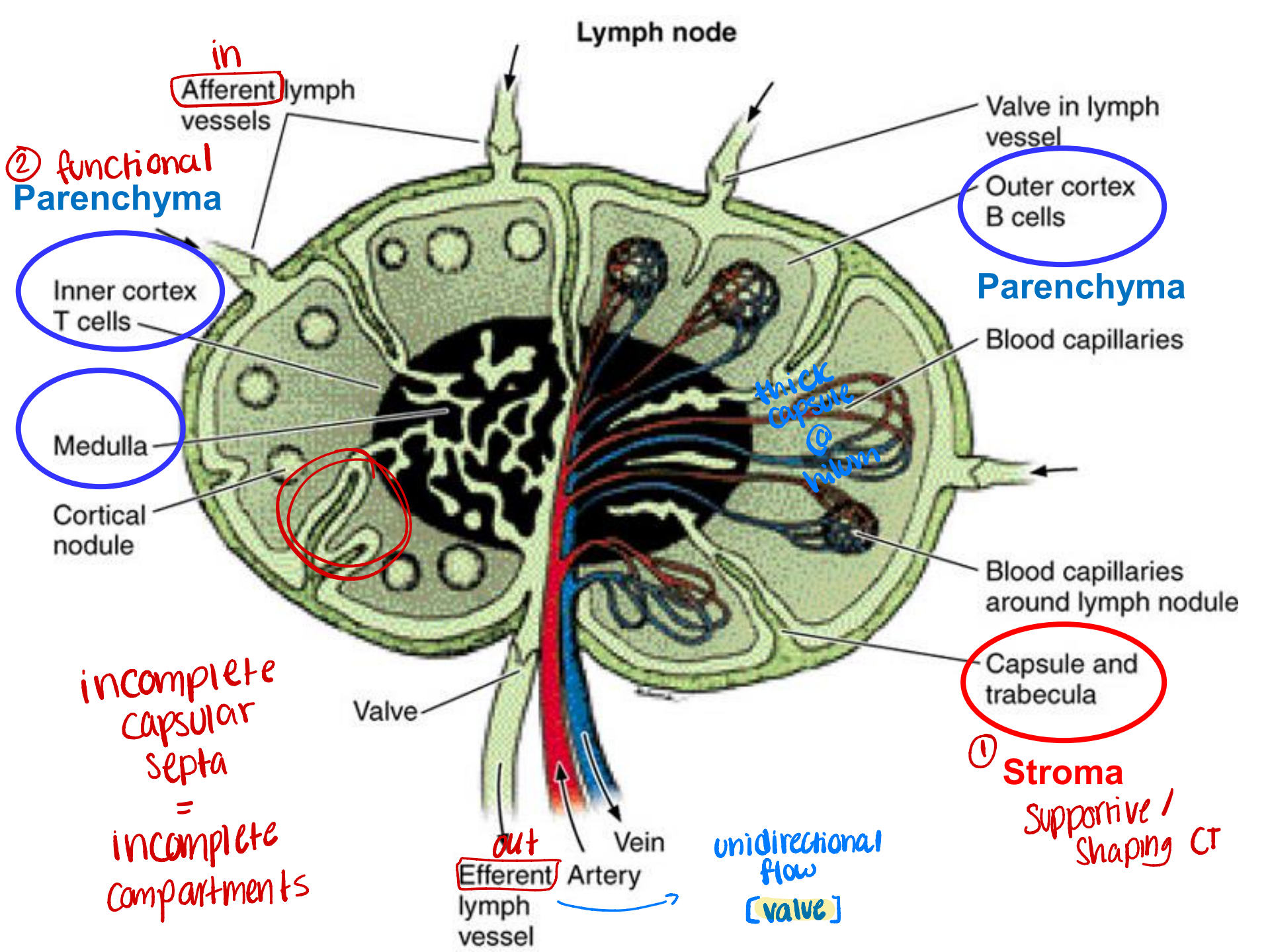
Immune system

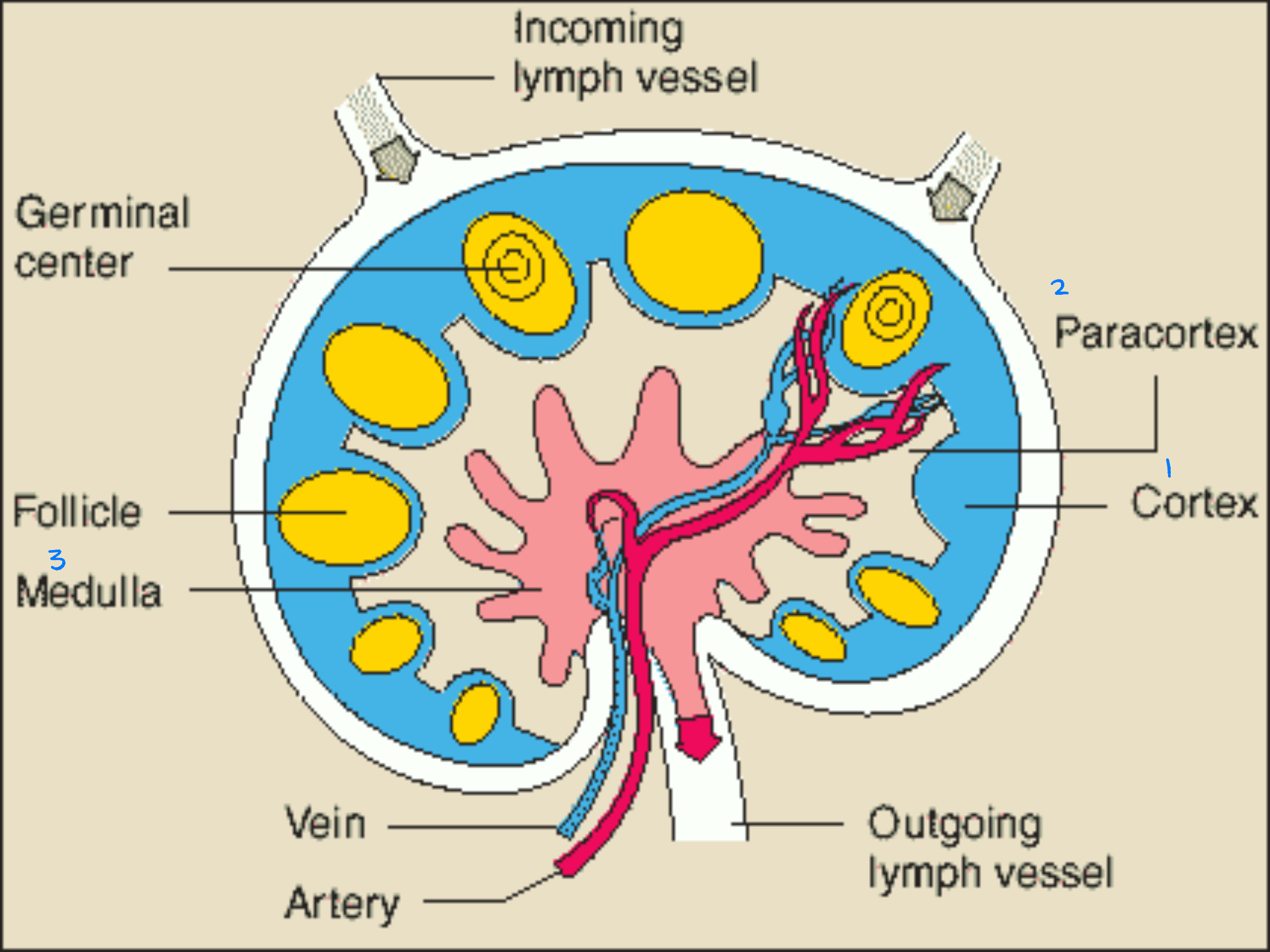




Lymph Node

↑ filtration of lymph

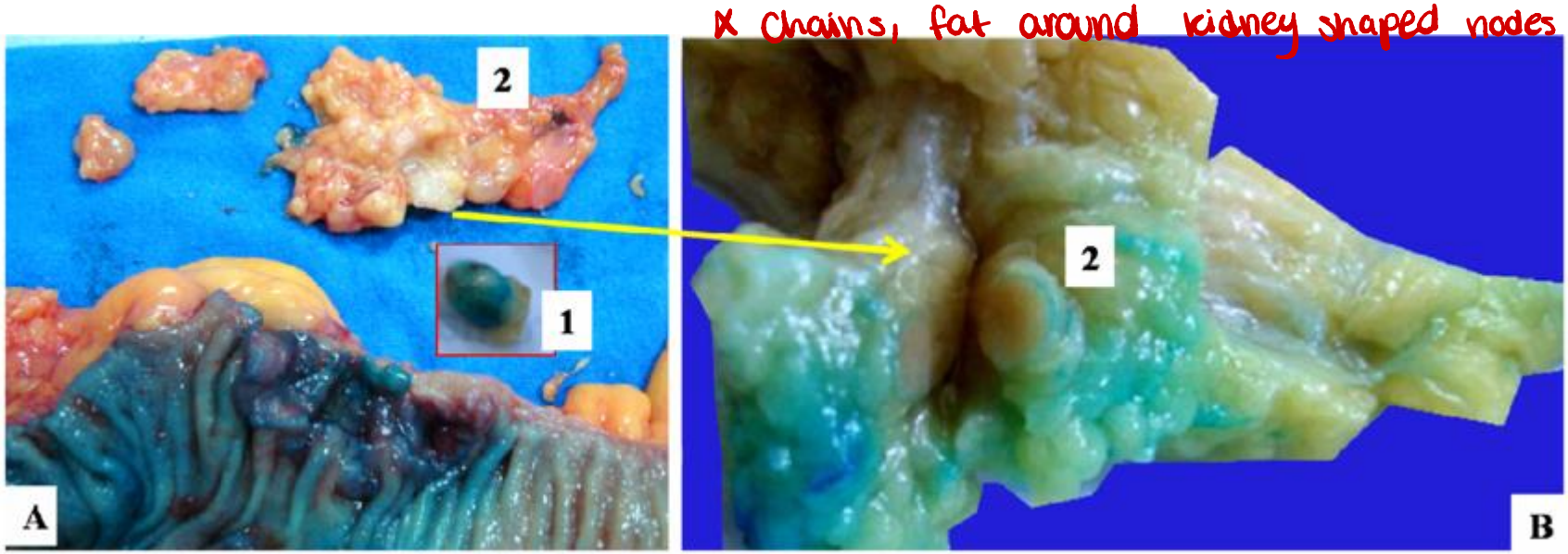

Lymph node
in
Afferent lymph vessels
② functional
Parenchyma
Valve in lymph vessel
Outer cortex
B cells
Parenchyma
Inner cortex
T cells
Medulla
Cortical nodule
Blood capillaries
thick capsule @ hilum
Blood capillaries around lymph nodule
Capsule and trabecula
① Stroma
supportive / shaping CT
Valve
incomplete capsular septa = incomplete compartments
out
Efferent lymph vessel
Artery
Vein
unidirectional flow
[valve]


Incoming
lymph vessel
Germinal
center
2
Paracortex
1
Cortex
Follicle
3
Medulla
Vein
Artery
Outgoing
lymph vessel

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.

note: ⊗ reticular in sinus

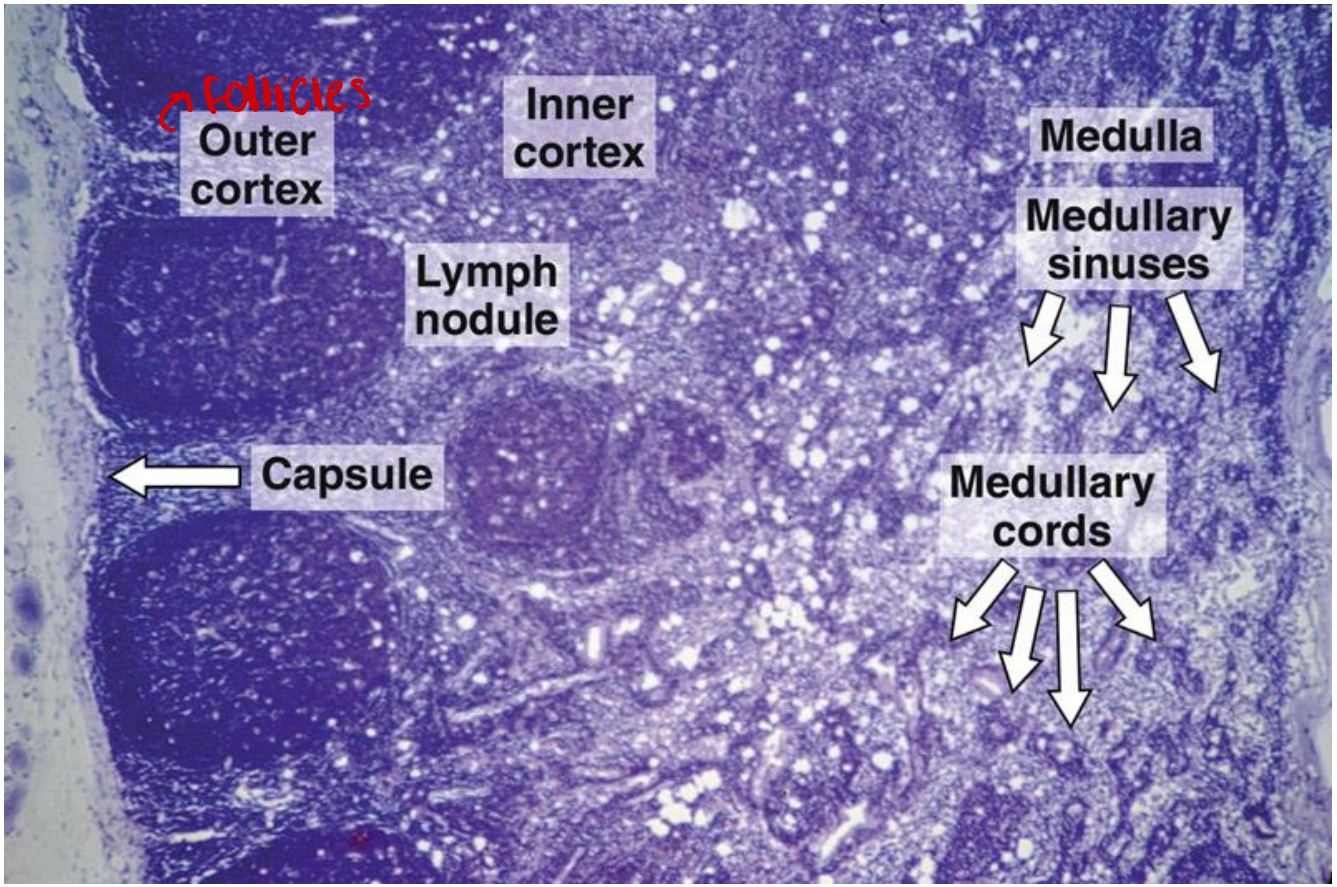
c) Reticular network: reticular cells and fibers holding parenchymal cells in its meshes

2- Parenchyma:

- Outer and inner cortex.
- medulla

A- Cortex

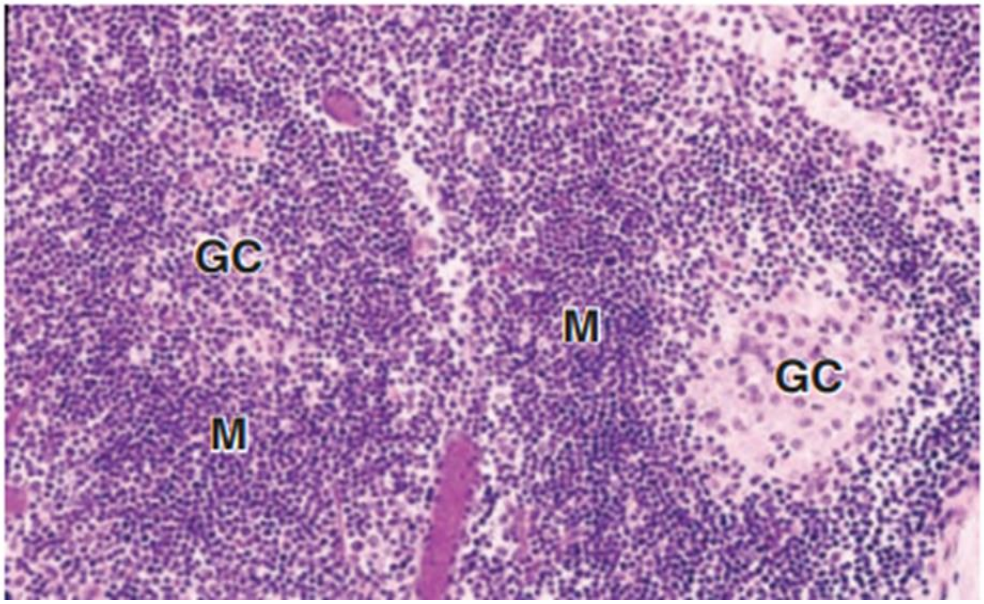
- *Outer (superficial) cortex*
- *Inner (deep) cortex*



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

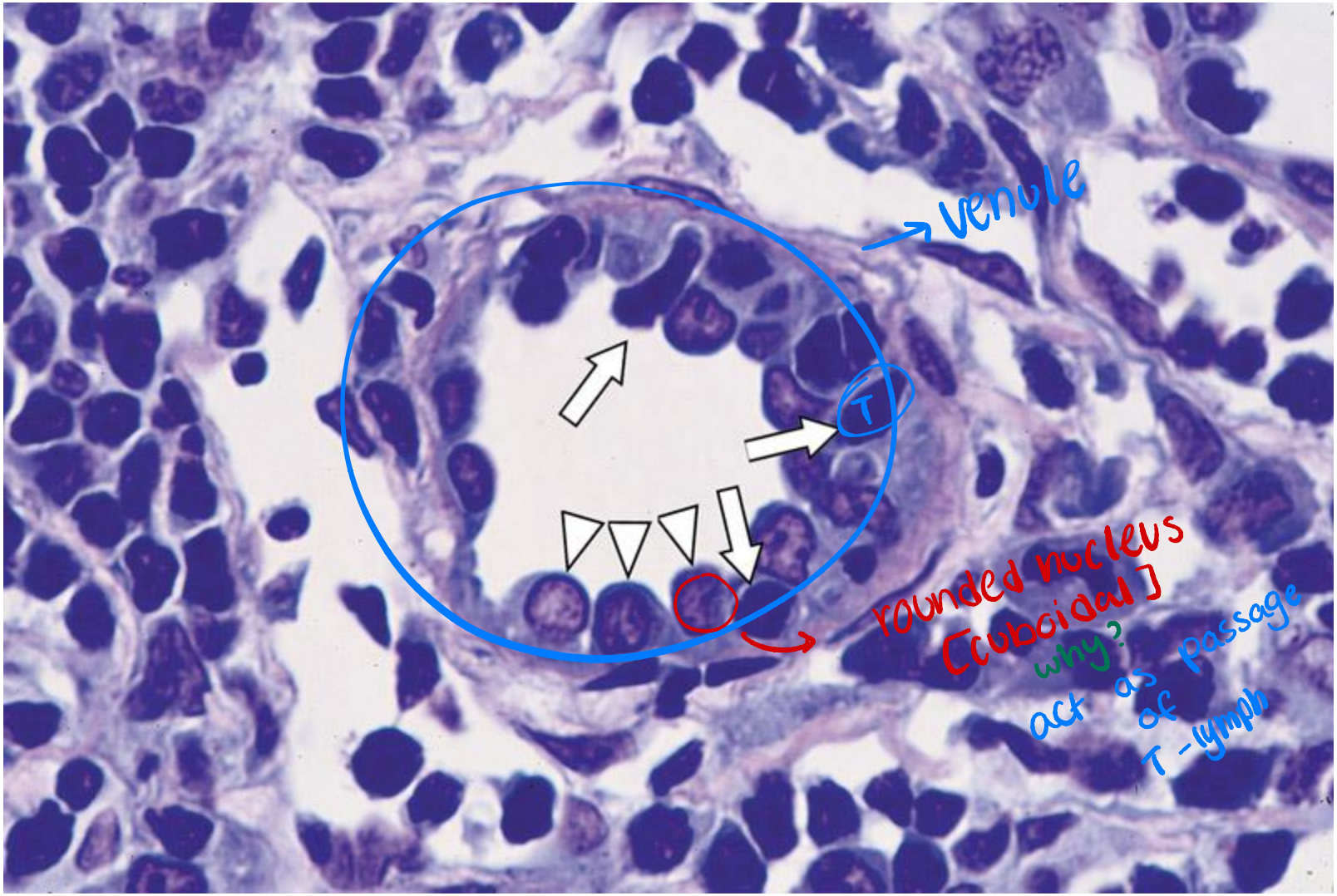


Inner cortex (paracortex) NOT FOLLICLES

- **Paracortical zone:** deeper part between outer cortex and medulla.

- **Thymus dependant zone:** contains T cells have migrated from the thymus. → to blood → LN → separate part & do not mix w/ others
- **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



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

T

Normal Lymph Node Architecture

concentrates lymph

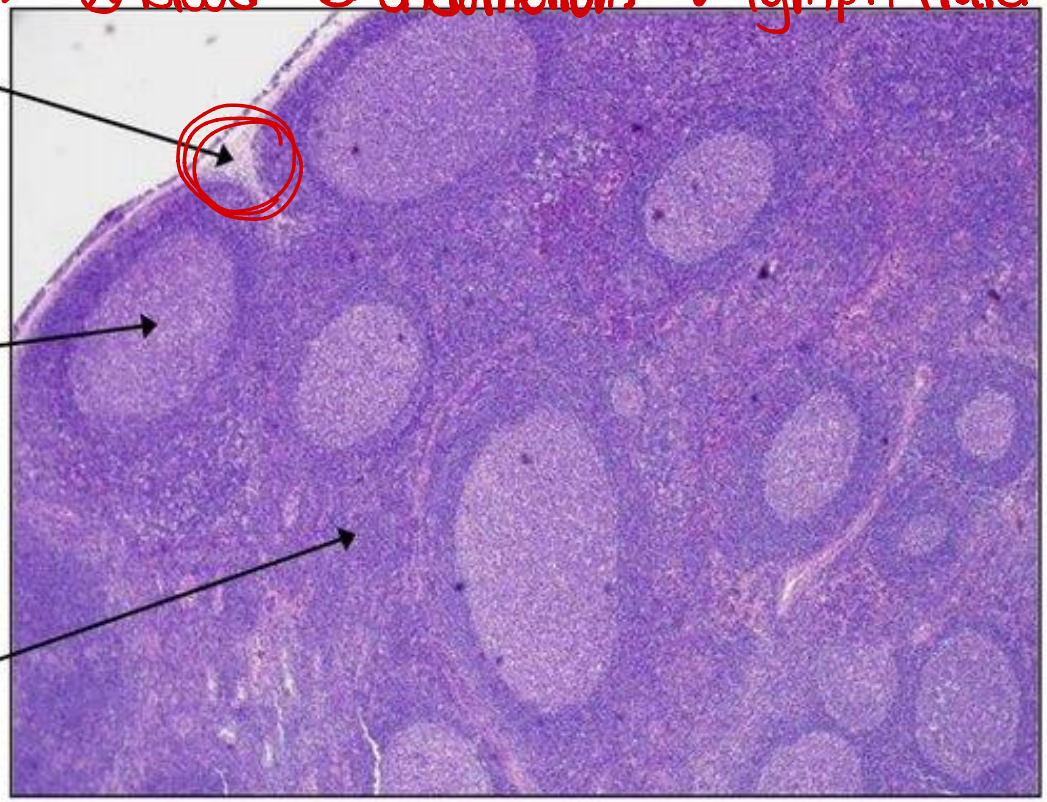
Sinuses (subcapsular and interfollicular)

paratrabicular

⊗ blood ⊗ endothelium ✓ lymph fluid

Follicles with mantle zones, germinal centers (B cells)

Interfollicular region (paracortex) (T cells)



Cortical sinuses

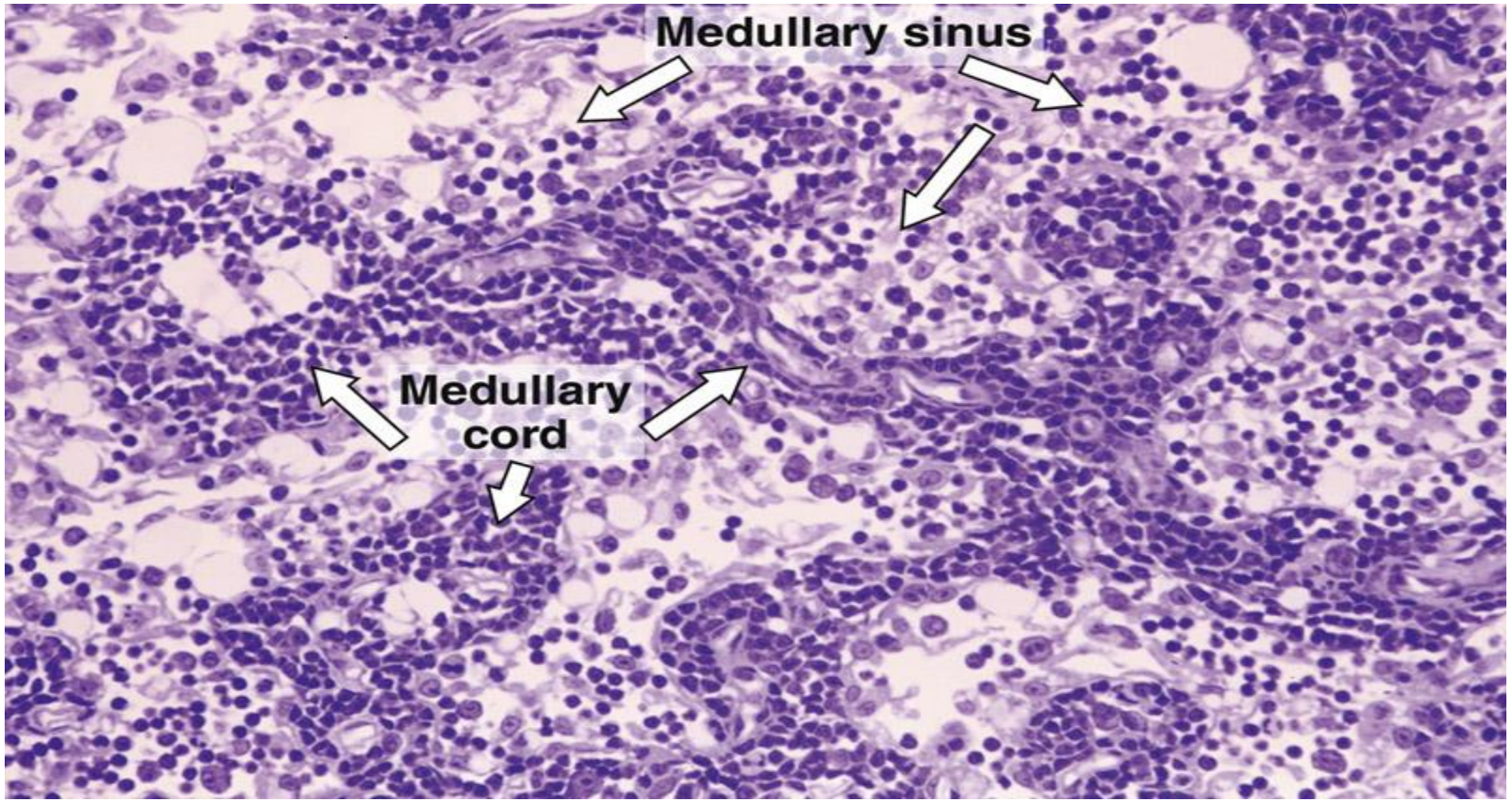
- Irregular spaces lined by reticular cells and macrophages.

  - *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*** accept from cortex



Medullary cords

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

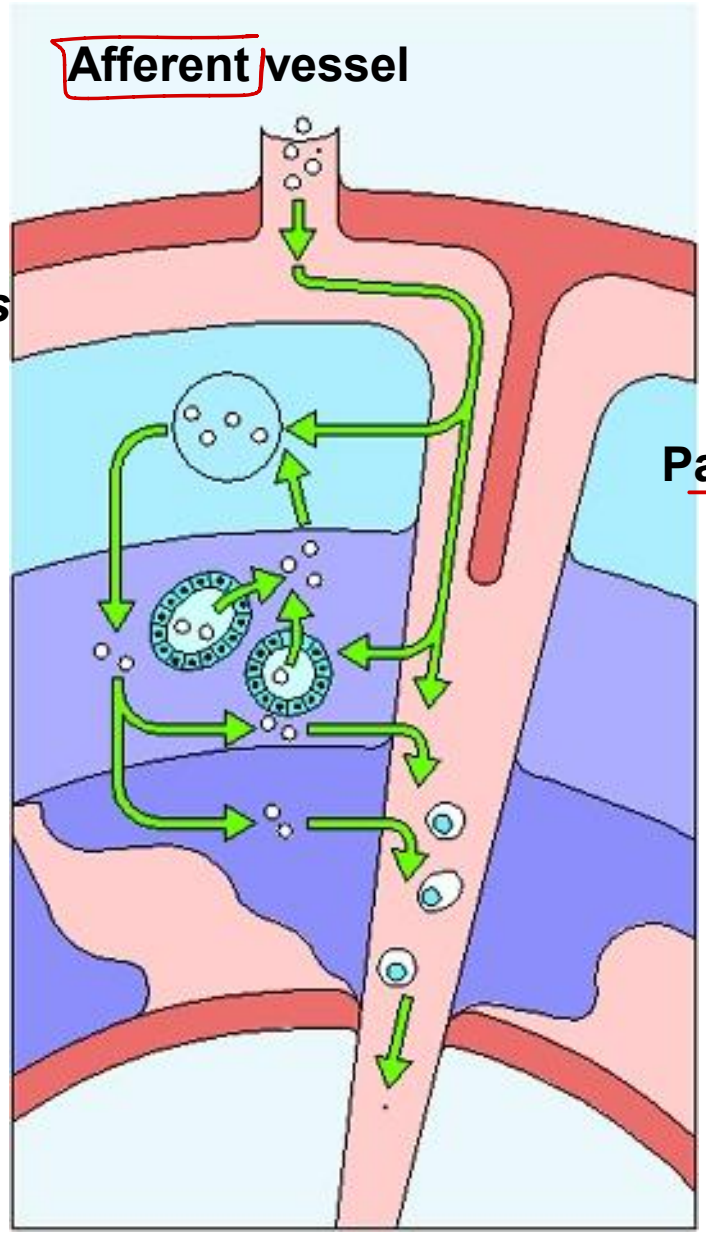
Medullary sinuses

- 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).


Afferent vessel
Subcapsular sinuses
1
2
Paratrabecular sinuses
3
Medullary sinuses
Efferent vessel

Functions of lymph nodes

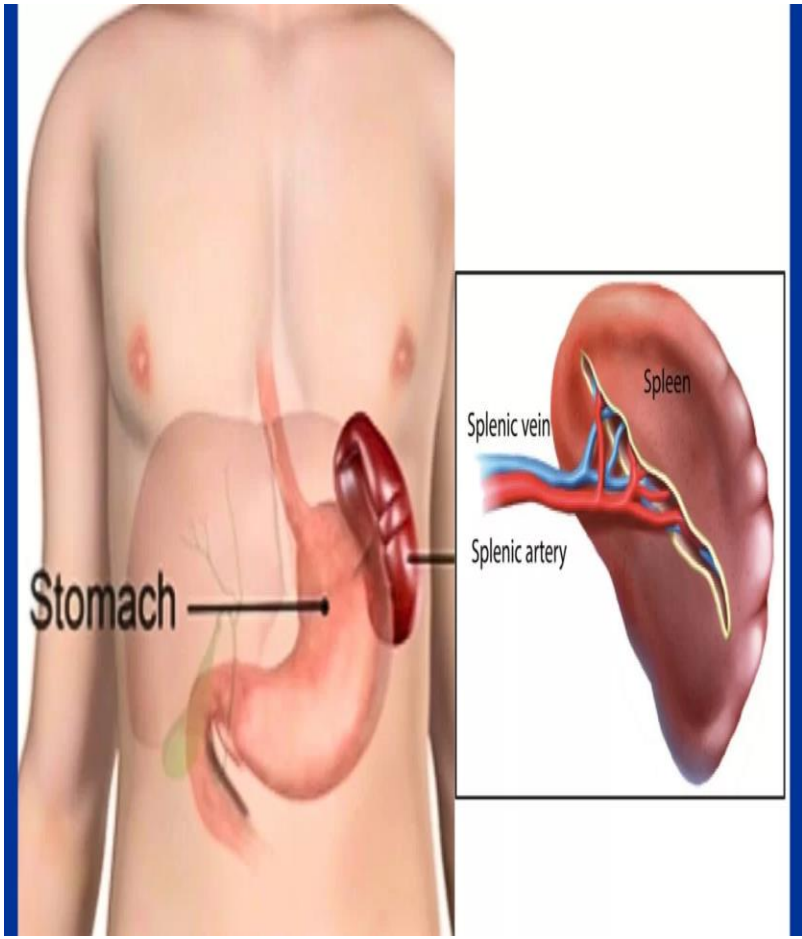
1– Immunologic reaction: cellular and humoral.

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

very important since large organ

1- ***Capsule:***

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

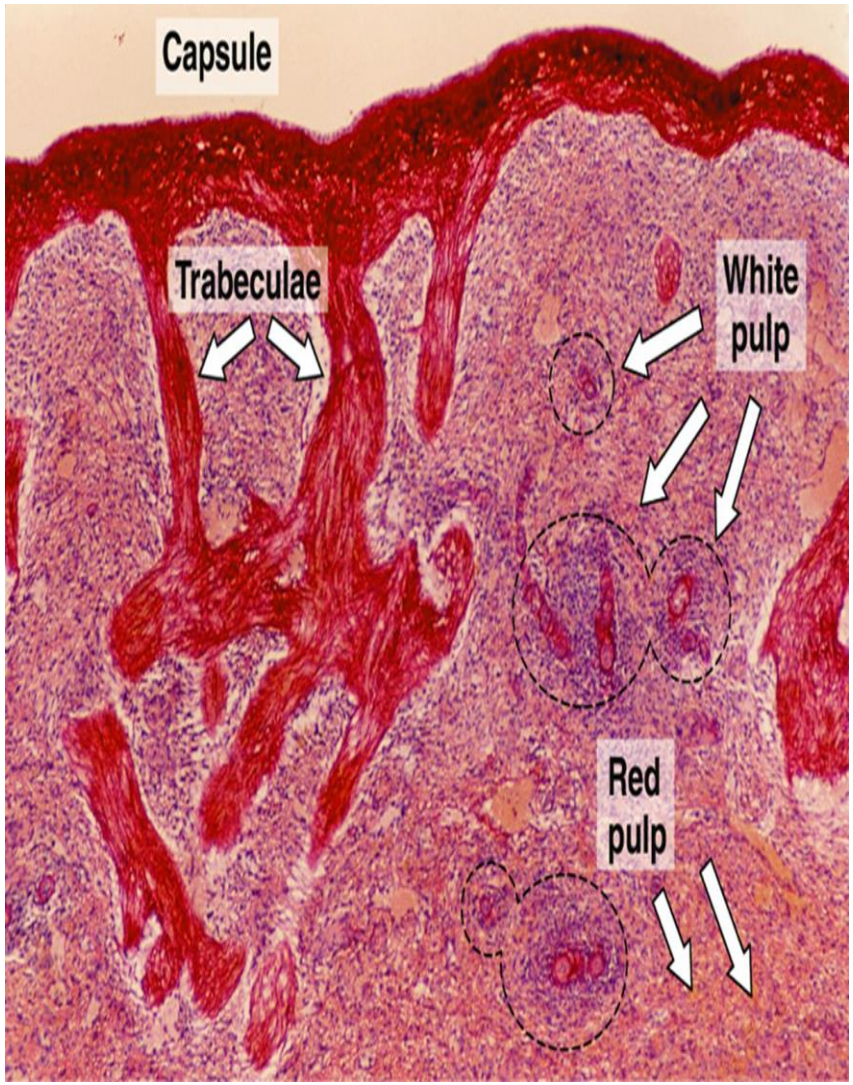
+++ ! Protection

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.

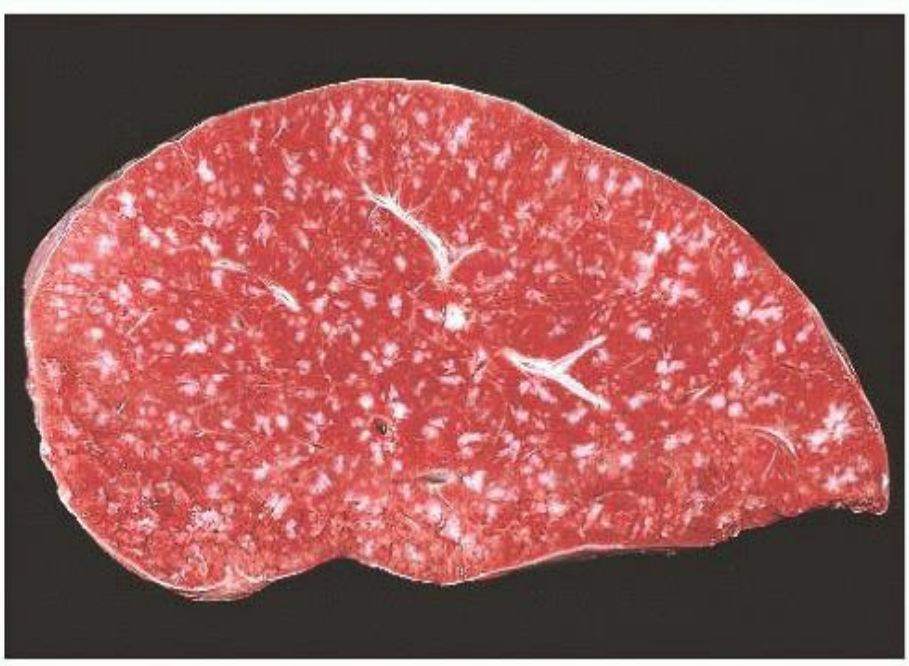
3- ***Reticular network:***

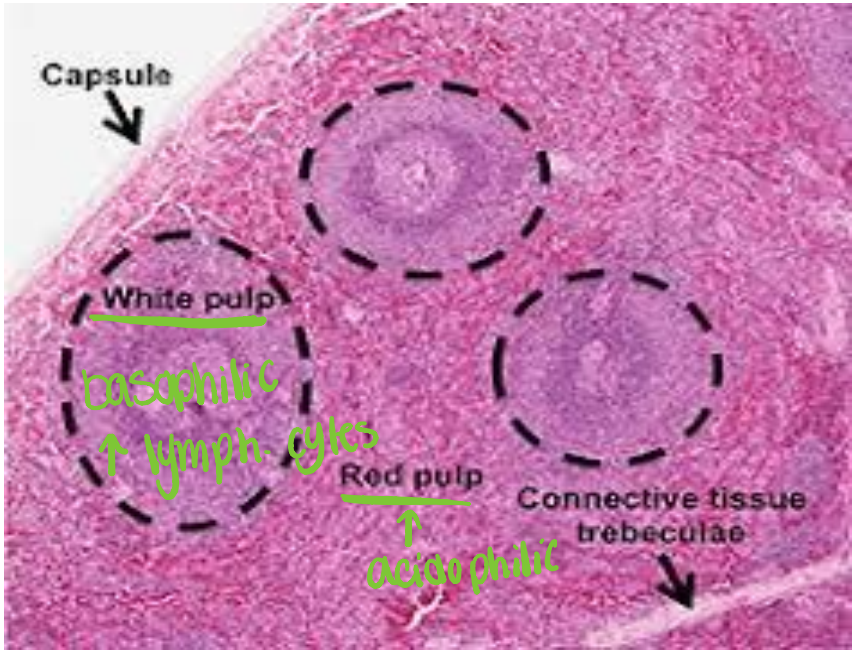
- connected to capsule and trabeculae
- contains parenchymal cells in its meshes.



Parenchyma (splenic pulp)

- Fresh section of spleen shows
  - dark red tissue (red pulp). → major, ↑ blood, ↑ sinus
  - white spots (white pulp). → minor, lymph tissues [less]





A- WHITE PULP

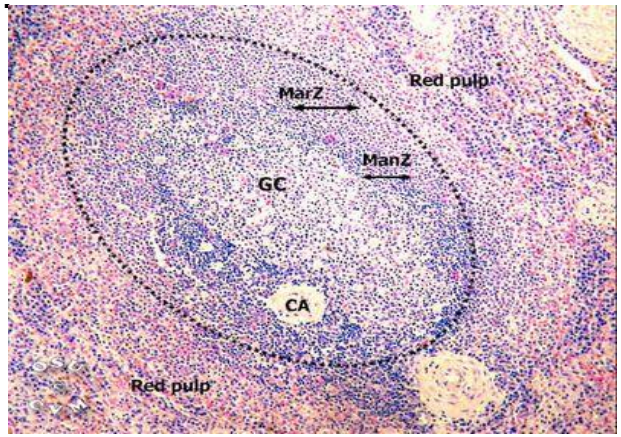
- Lymphatic tissue forms sheaths around central arteries.
- The sheath thickens at intervals to form lymphatic follicles.

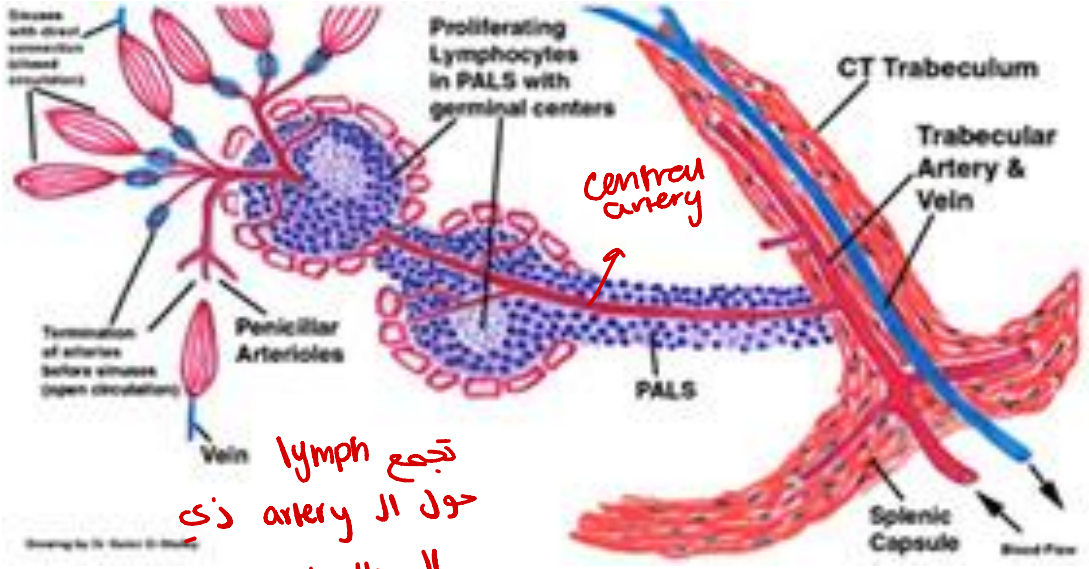
1- Periarterial lymphatic sheaths (PALs): (thymus dependant area).

T- lymphocytes here

2- Lymphatic follicles: becomes circular

- 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.





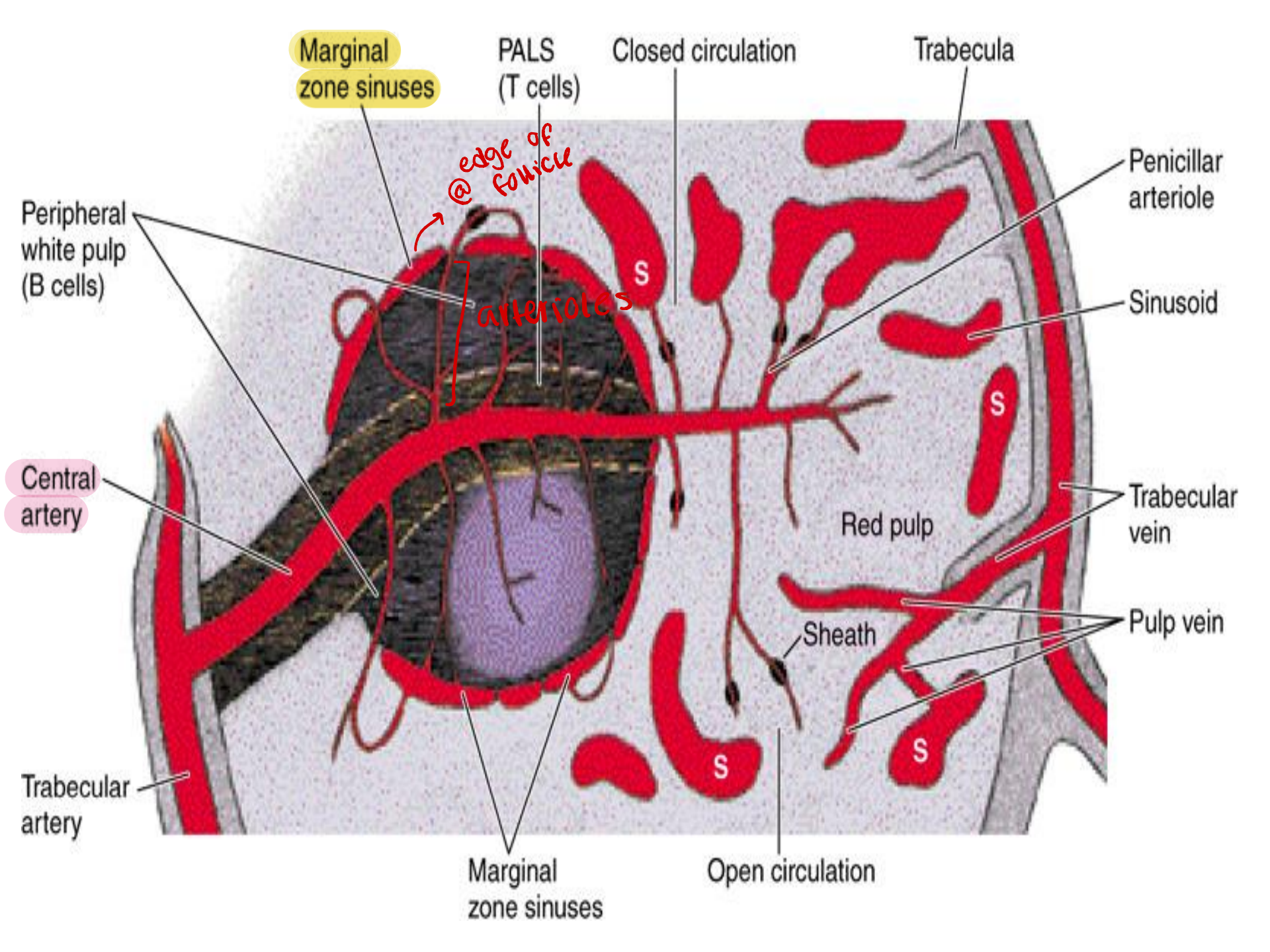
A- WHITE PULP

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.


Marginal zone sinuses
PALS (T cells)
Closed circulation
Trabecula
@ edge of follicle
Penicillar arteriole
Peripheral white pulp (B cells)
arterioles
Sinusoid
S
Central artery
Red pulp
Trabecular vein
Sheath
Pulp vein
Trabecular artery
Marginal zone sinuses
Open circulation

B- RED PULP

- major part of spleen
- red because of large number of erythrocytes.

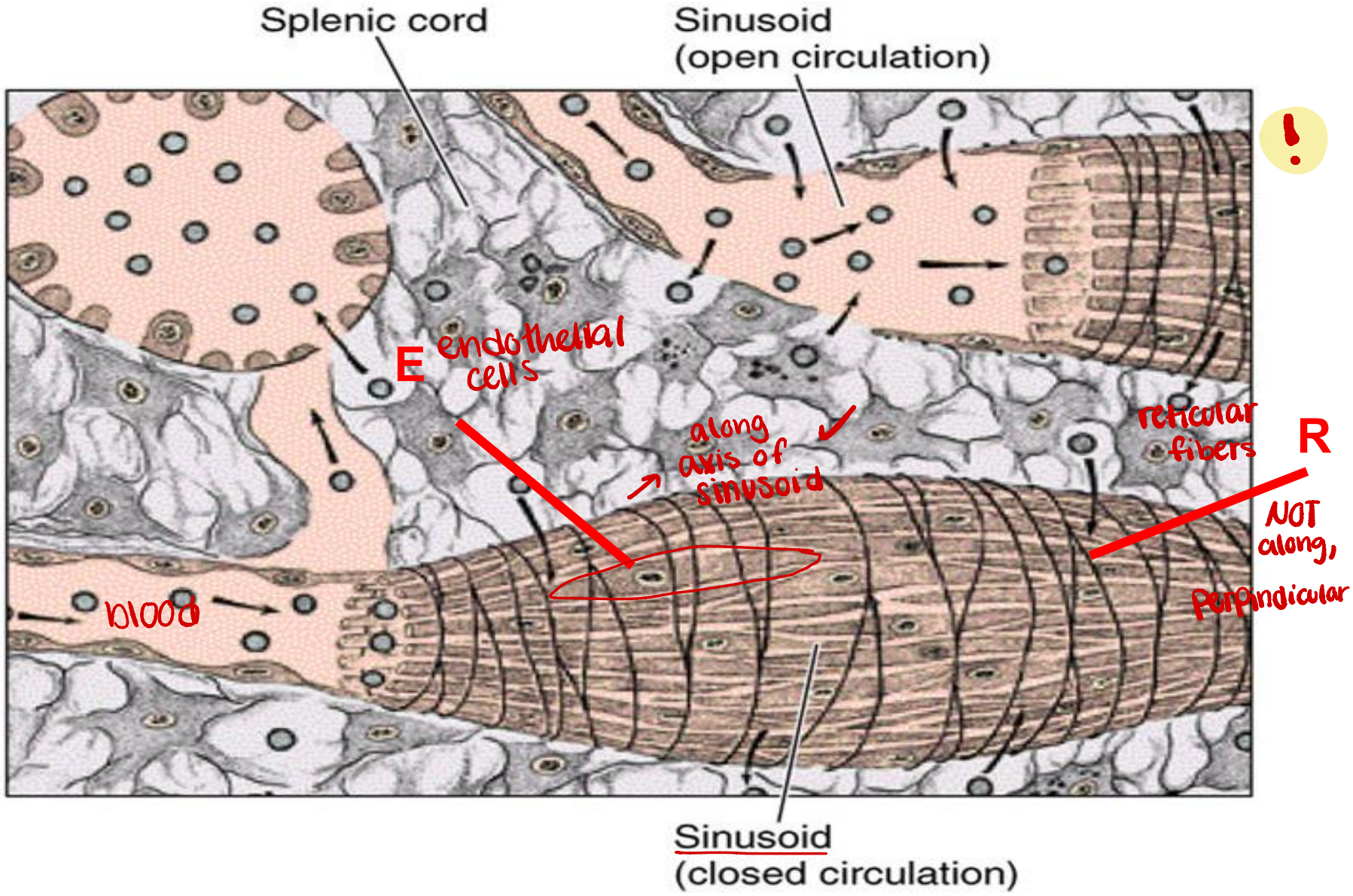
- composed of:

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.

anatomy

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.*

→ histo !

- **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.

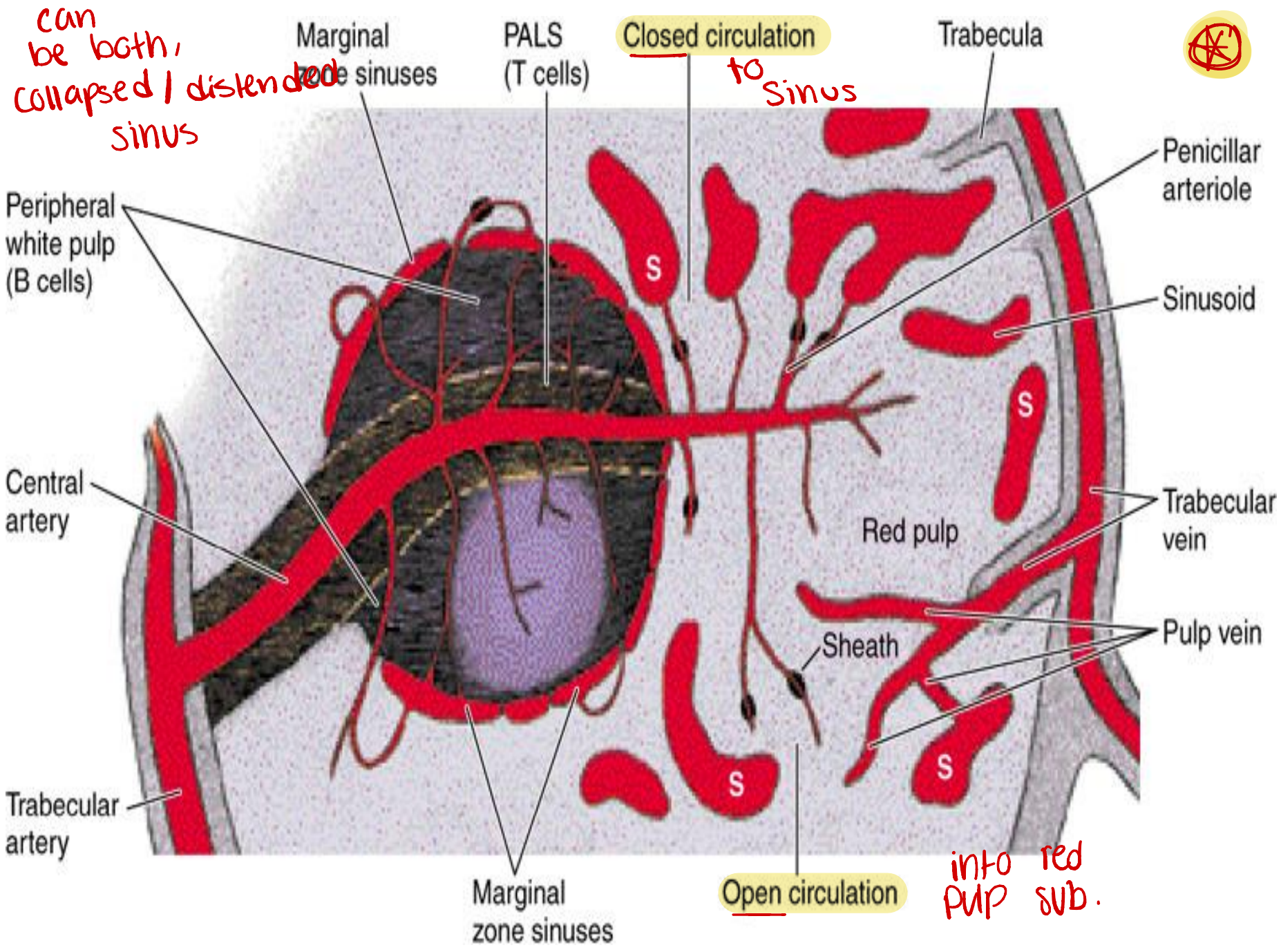
2- Open circulation:

- capillaries open into red pulp.

3- Open – closed circulation:

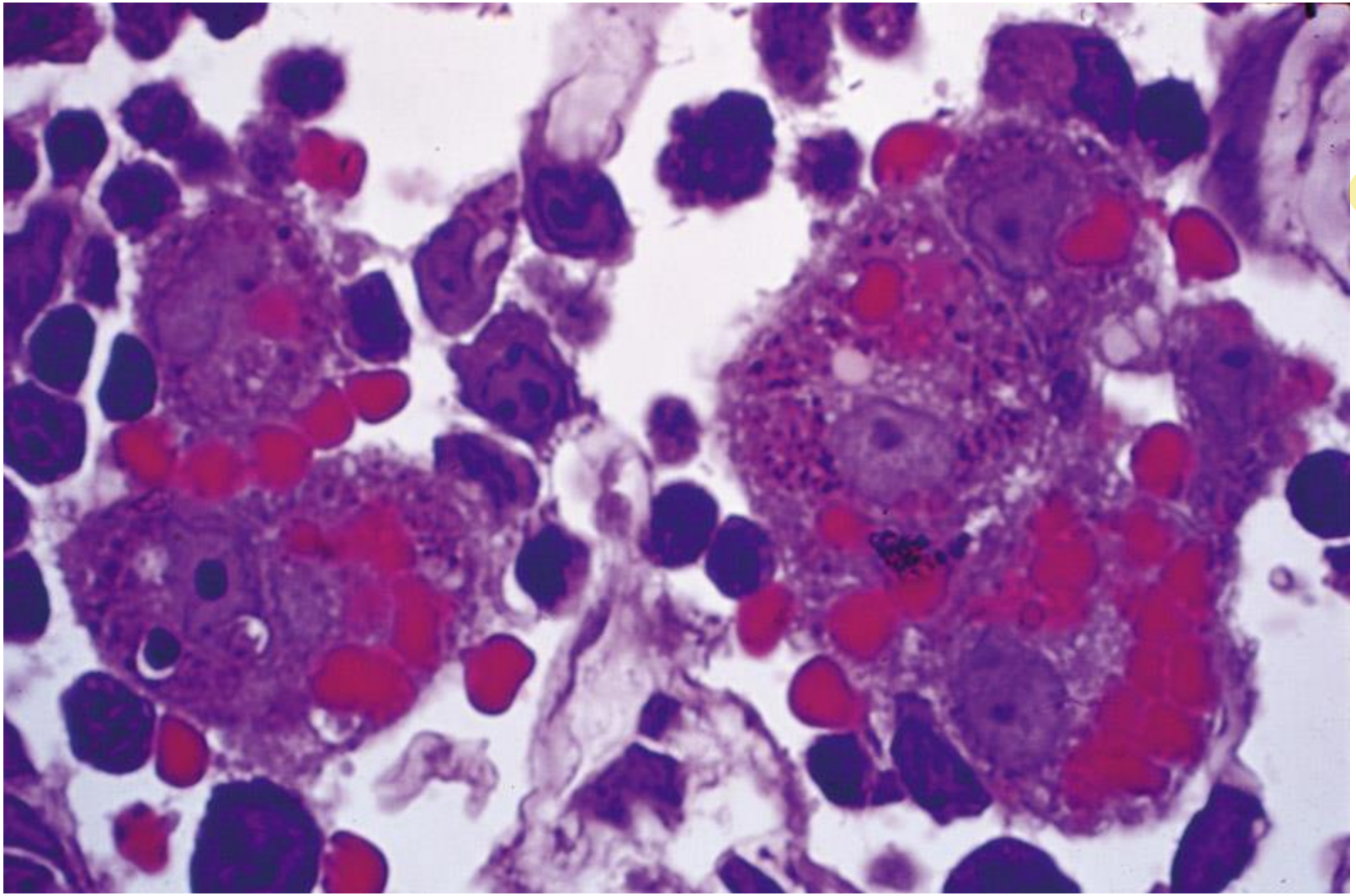
- closed circulation In collapsed spleen.
- open circulation in distended spleen.

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


can be both, collapsed / distended sinus
Marginal zone sinuses
PALS (T cells)
Closed circulation
to Sinus
Trabecula
Penicillar arteriole
Peripheral white pulp (B cells)
Sinusoid
S
Central artery
Red pulp
Trabecular vein
Pulp vein
Sheath
Trabecular artery
Marginal zone sinuses
Open circulation
into red pulp sub.

Functions of spleen

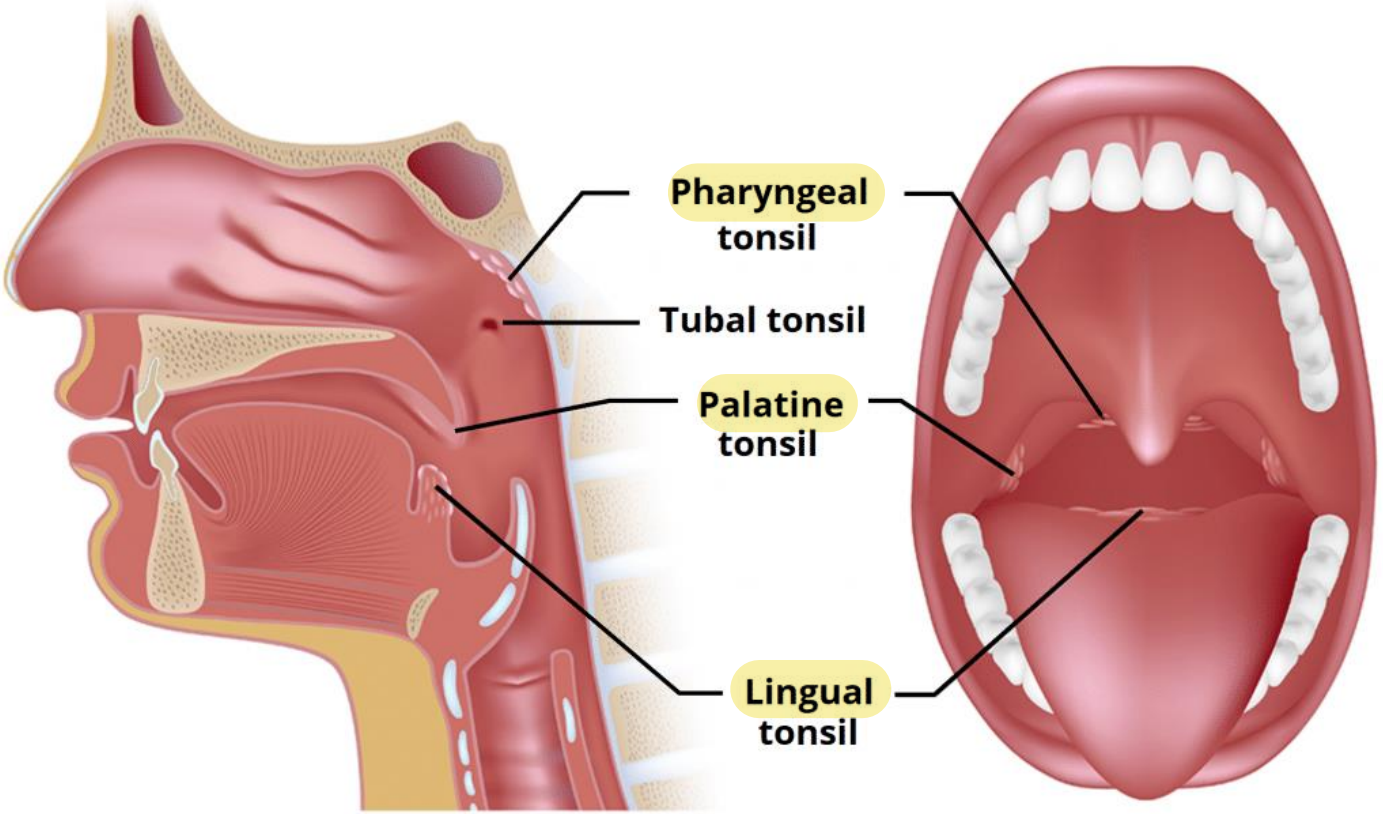
1- Immunity (Cellular and humoral).
2- Filtration of blood (Immunologic).
3- Destruction (old RBCs).
4- Haematopoietic function (in fetus).
5- Storage of blood (in animals).



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

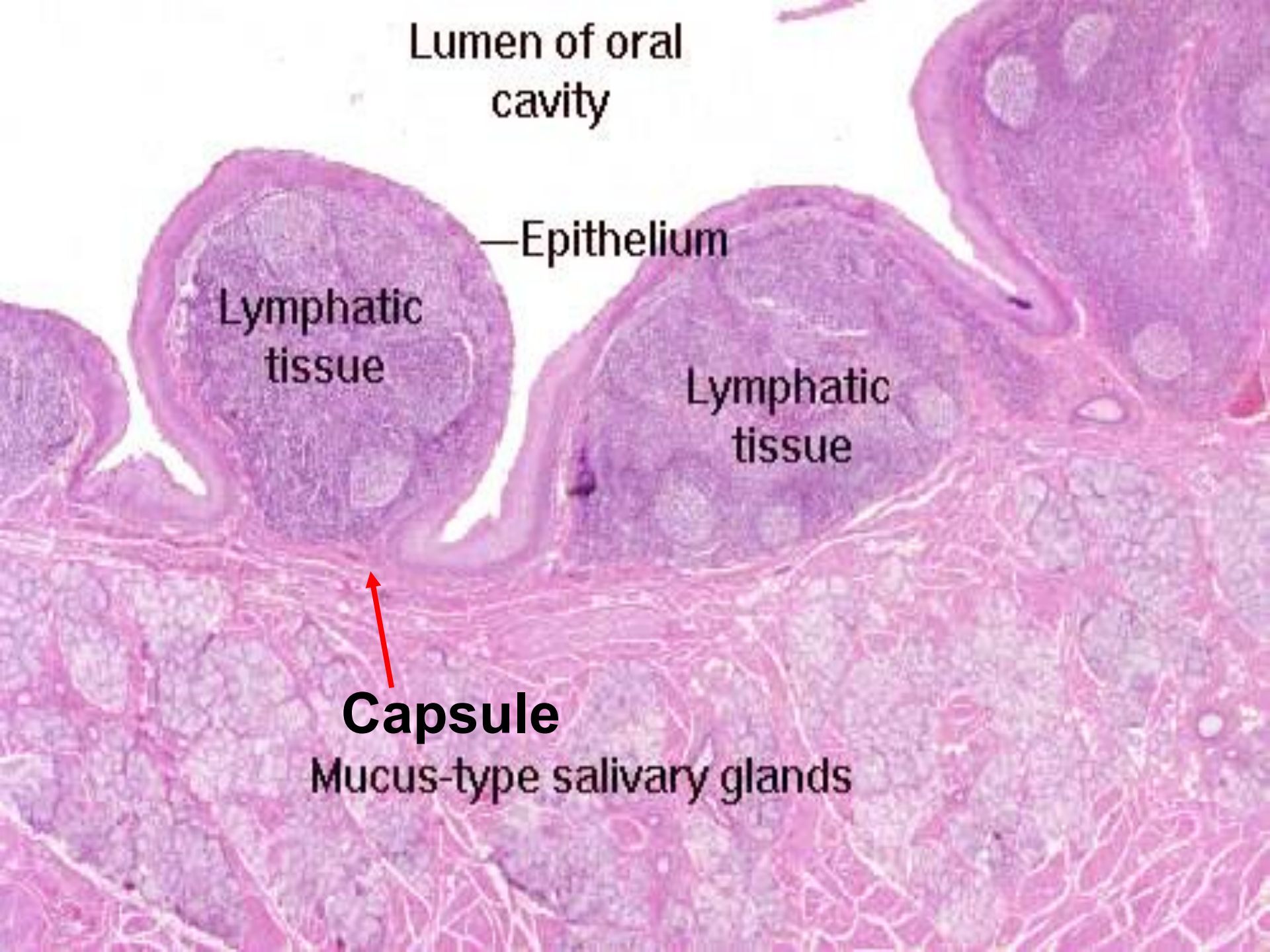
TONSILS

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



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

بتحب الدكتورة دقيق ع الجداول !

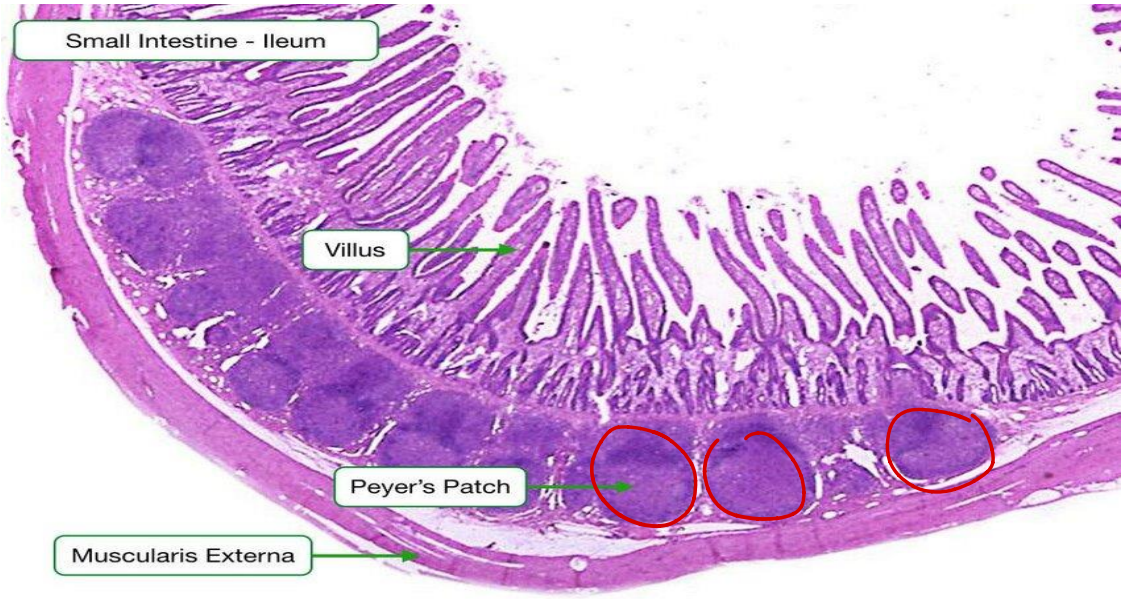

Lumen of oral cavity
Epithelium
Lymphatic tissue
Lymphatic tissue
Capsule
Mucus-type salivary glands

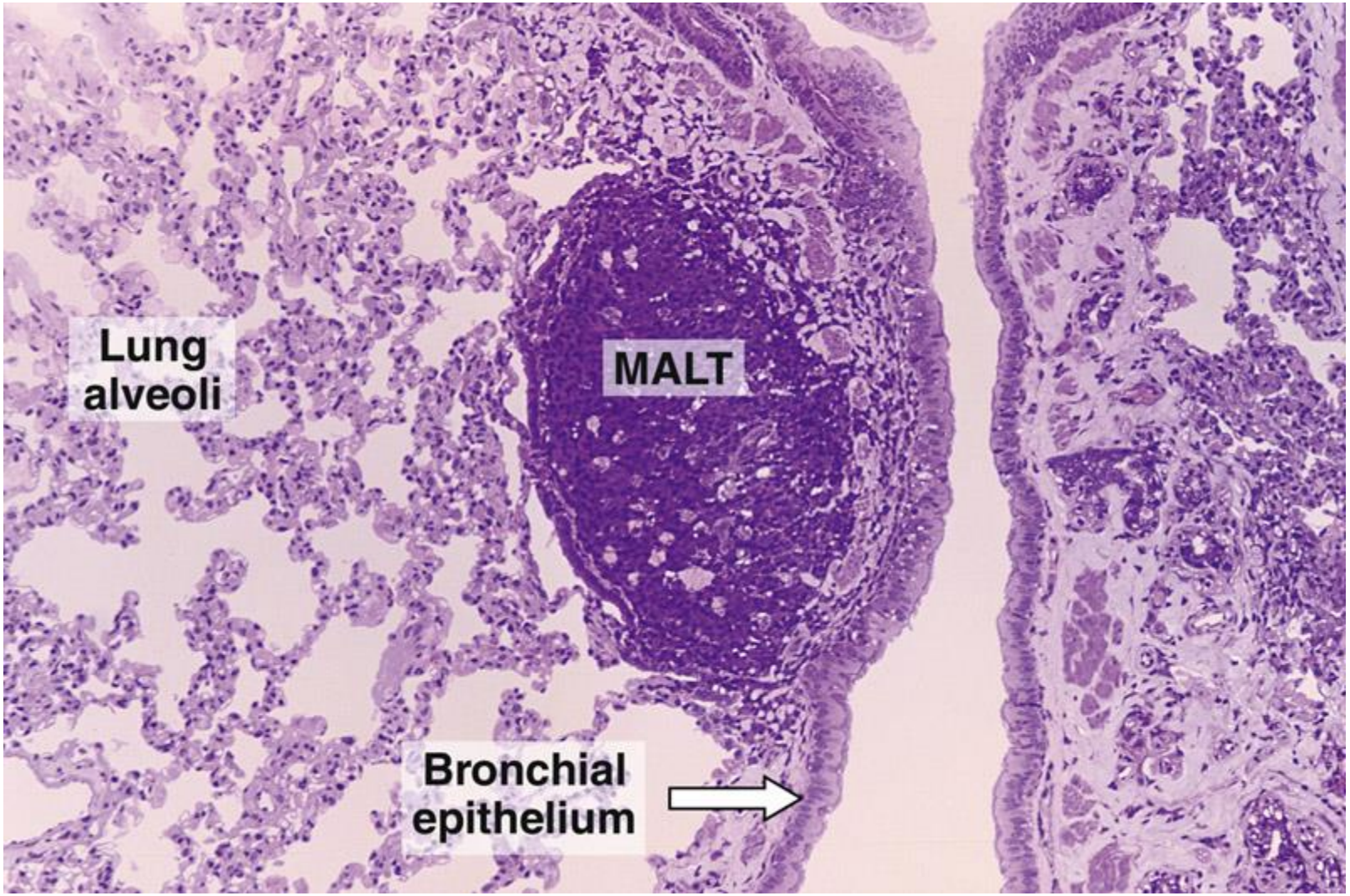
Mucosa-associated lymphoid tissue (MALT)

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

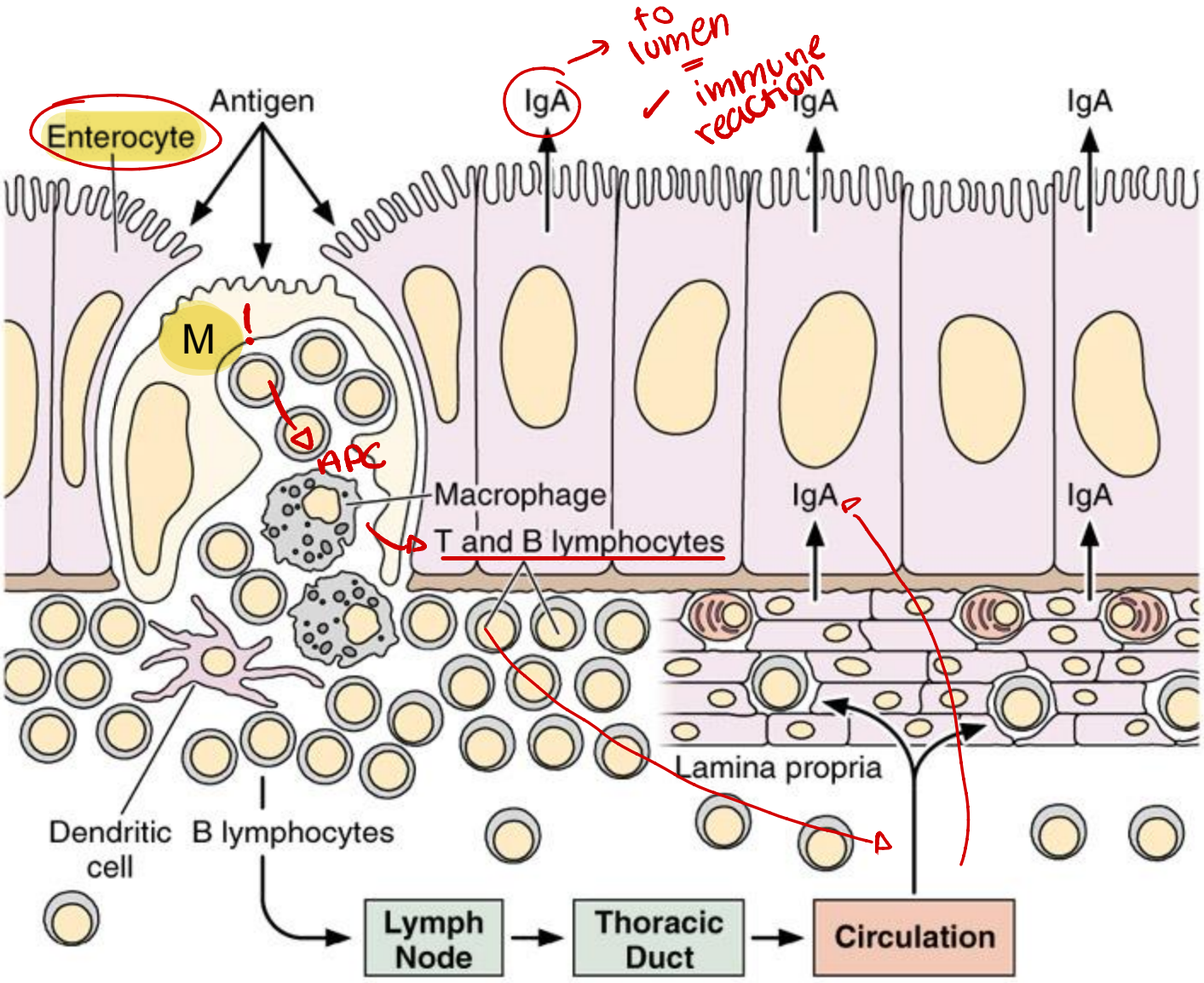




•lung showing lymphocytes in CT of bronchiolar mucosa,
•example of mucosa-associated lymphoid tissue (MALT).

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.


Antigen
Enterocyte
IgA
to lumen
immune reaction
IgA
IgA
M
APC
Macrophage
T and B lymphocytes
IgA
IgA
Lamina propria
Dendritic cell
B lymphocytes
Lymph Node
Thoracic Duct
Circulation