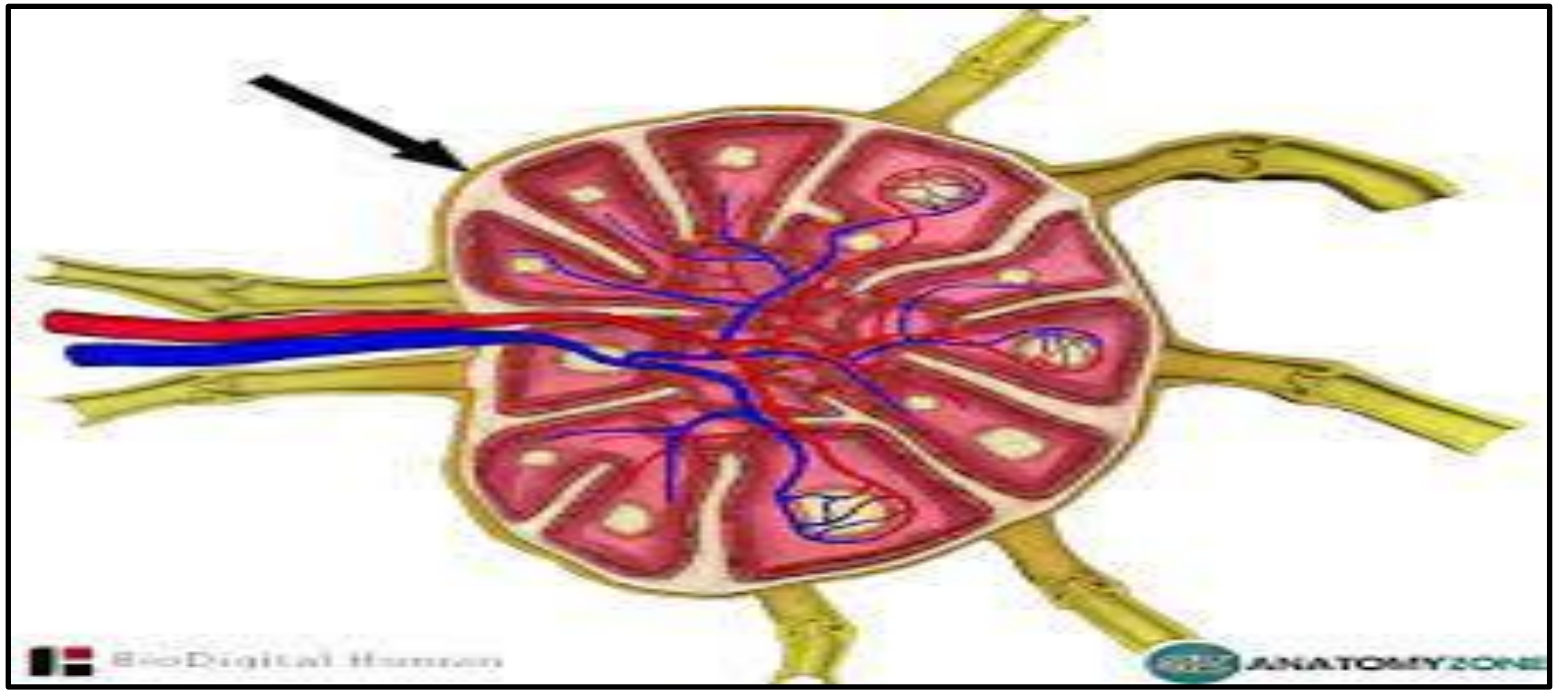
Lymphatic (Immune) System



By

Dr. Heba Sharaf Eldin

Associate Professor of Histology & Cell Biology

The lymphatic (immune) system composed of:

organs and cells

- that are mainly involved in the specific defense mechanism of the body known as **immunity.**

- The **organs** and **cells** are distributed throughout the body.

- Lymphocytes are the **main** immuno-competent cells giving the system its name.

The immune (lymphoid) system includes:

1- Lymphoid organs:

a) Encapsulated
- spleen
- thymus
- lymph nodes

b) Unencapsulated
- Tonsils
- Payer's patches
- lymphatic nodules

(walls of GIT, respiratory, urinary and genital tract)

2- Free cells:

- T and B lymphocytes
- Antigen presenting cells
- Phagocytic cells

present in
- blood
- lymph
- connective tissue.

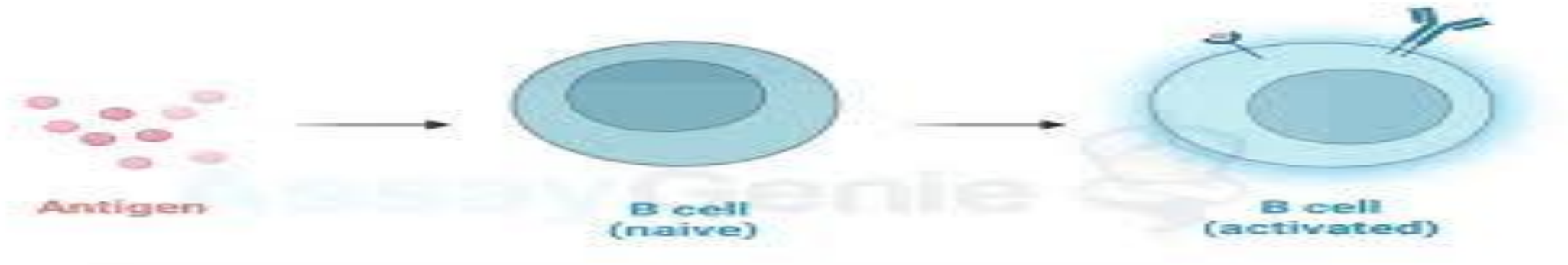
B- Lymphocytes

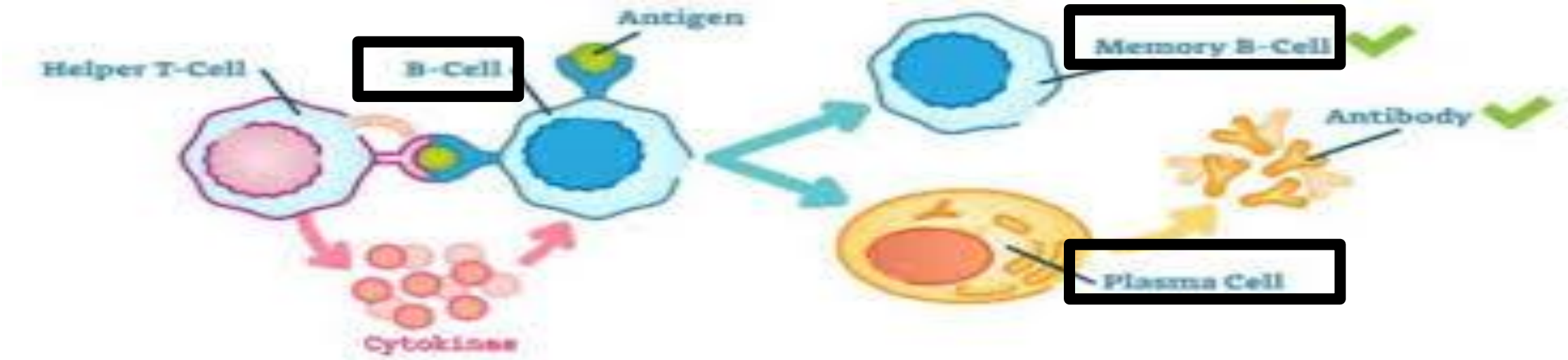
- **Origin**: from the bone marrow
- When **activated** by an appropriate antigen, they differentiate
- Plasma cells
- B-memory cells.

- Plasma cells produce antibodies that inactivate micro-organisms and their toxins.

- This process is called humoral immunity.

Activation and differentiation of B-lymphocytes





T-Lymphocytes

- Develop in the thymus.
- Responsible for cellular immunity.
- **When activated by an appropriate antigen, they differentiate into:-**

1- Cytotoxic (Killer) cells:

will secrete protein called perforins which perforate the cell membrane of foreign cells, virus infected cells or tumor cells and lyse them.

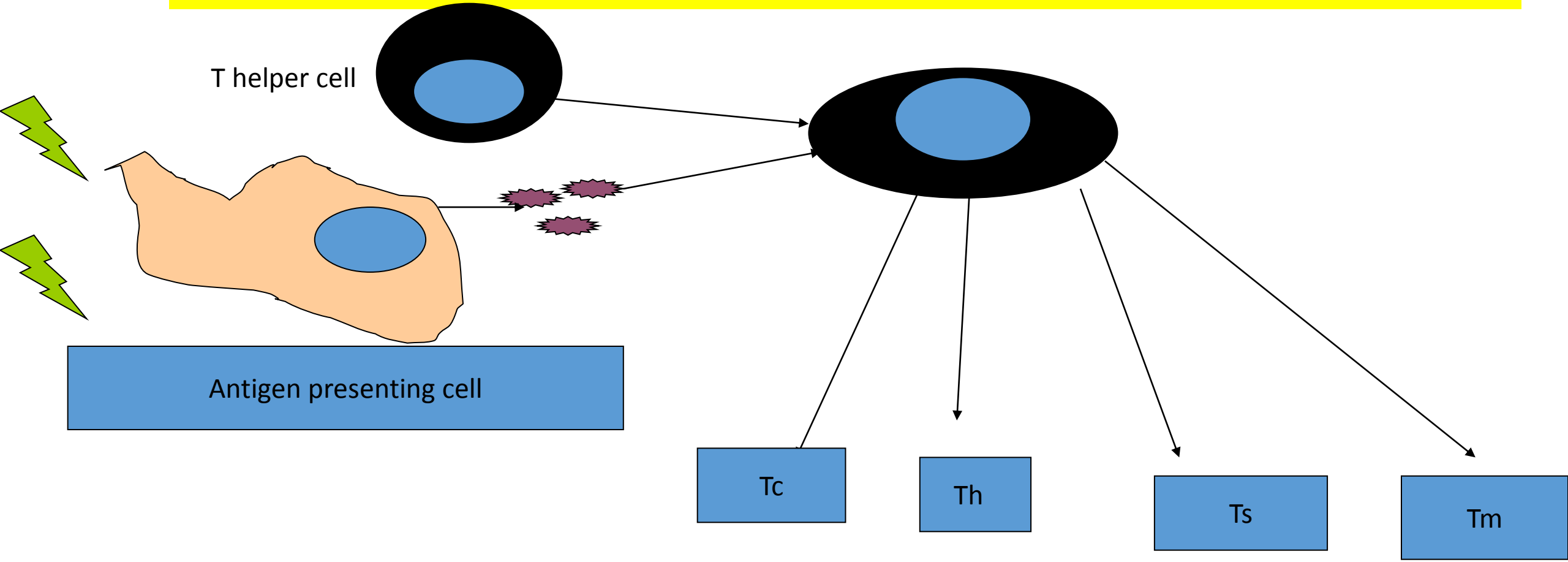
2- Helper T- cells: activate both B- and T- cells.

3- Suppressor T- cells: interfere with the immune response.

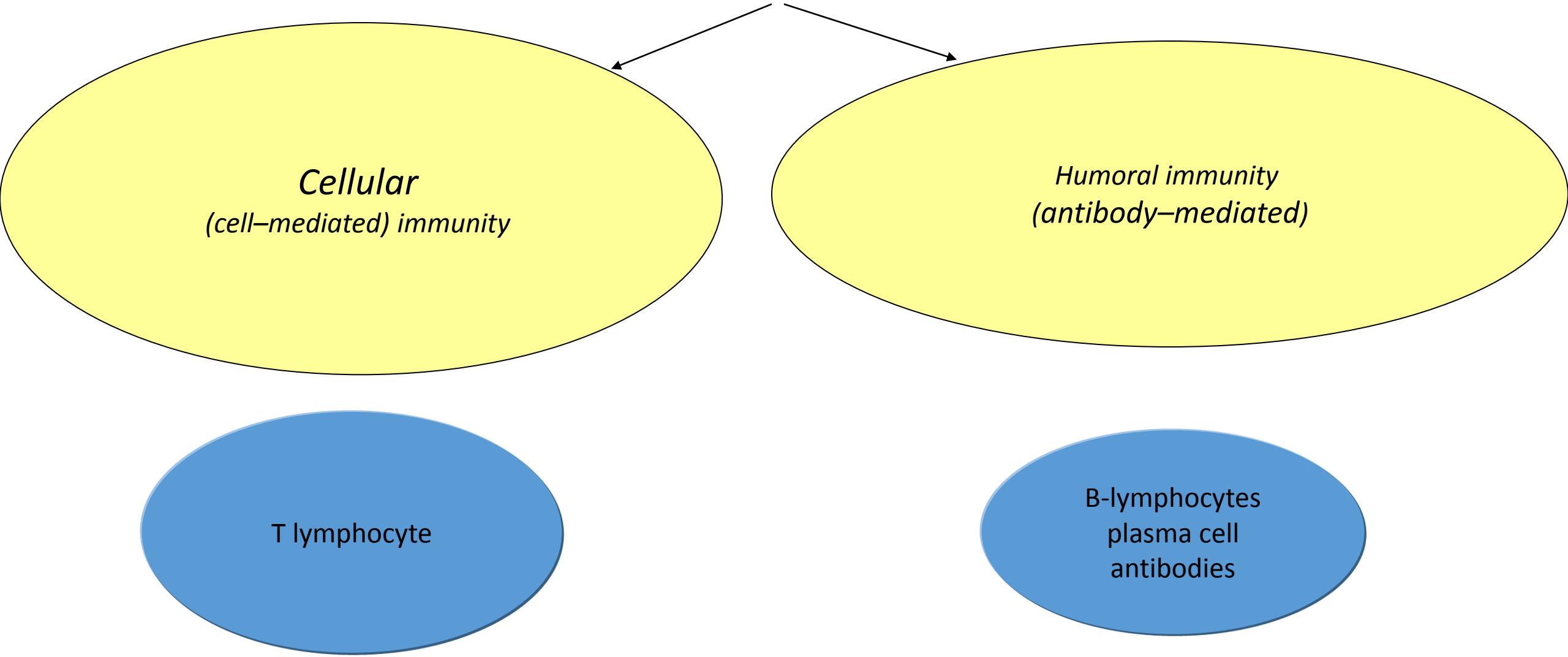
4- Memory cells:

When the same antigen enters the body again, memory cells will react against it immediately but more extensively in the same way.

Activation and differentiation of T-lymphocytes



Mechanisms of immune response



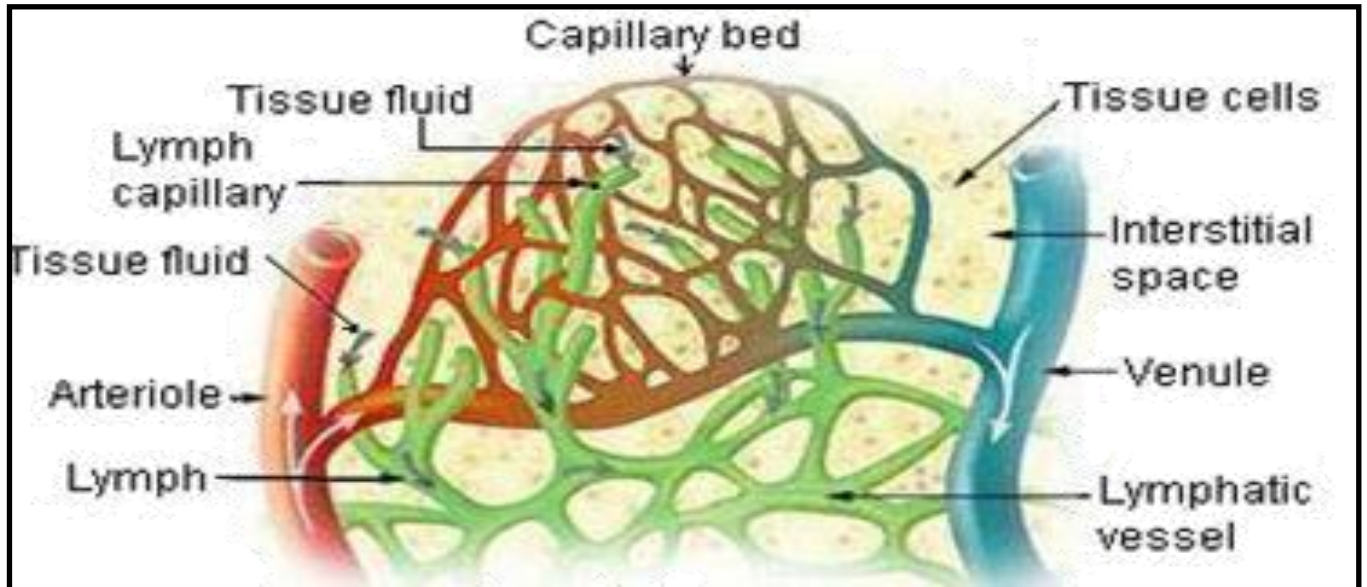
The thymus and bone marrow are called central lymphoid organs from which T & B lymphocytes originate respectively then migrate to the other lymphatic organs that are known as peripheral lymphoid organs

(e. g. **spleen, lymph nodes, tonsils, etc…).**

The lymph

The extravasated fluid that *did not enter* the circulation again is collected by blind–ended lymphatic capillaries and passes through lymphatic vessels back to the circulation.

The lymphatic vessels that absorb excess tissue fluid and returns it to bloodstream.



Lymphatic tissues contain lymphocyte aggregations embedded in reticular network and are organized into organs.

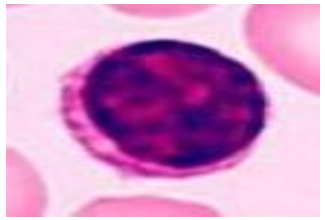
Organized into organs:

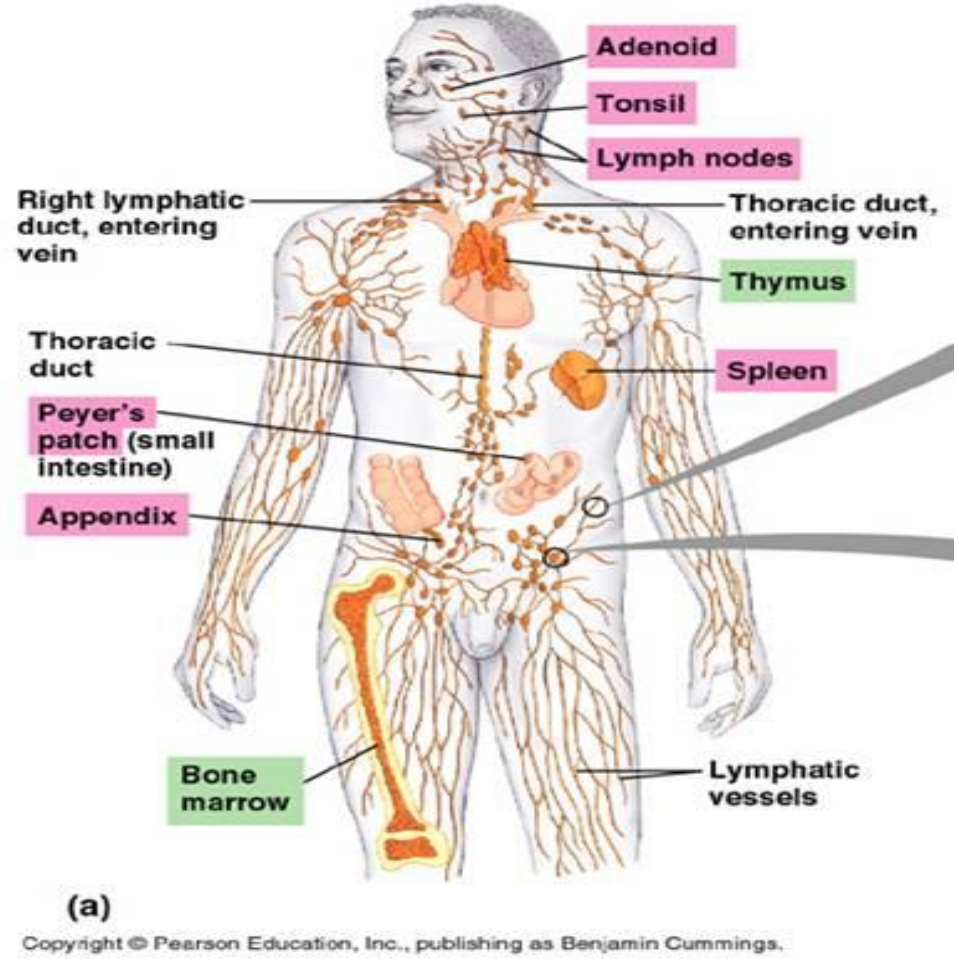
1-Thymus

2-Lymph node

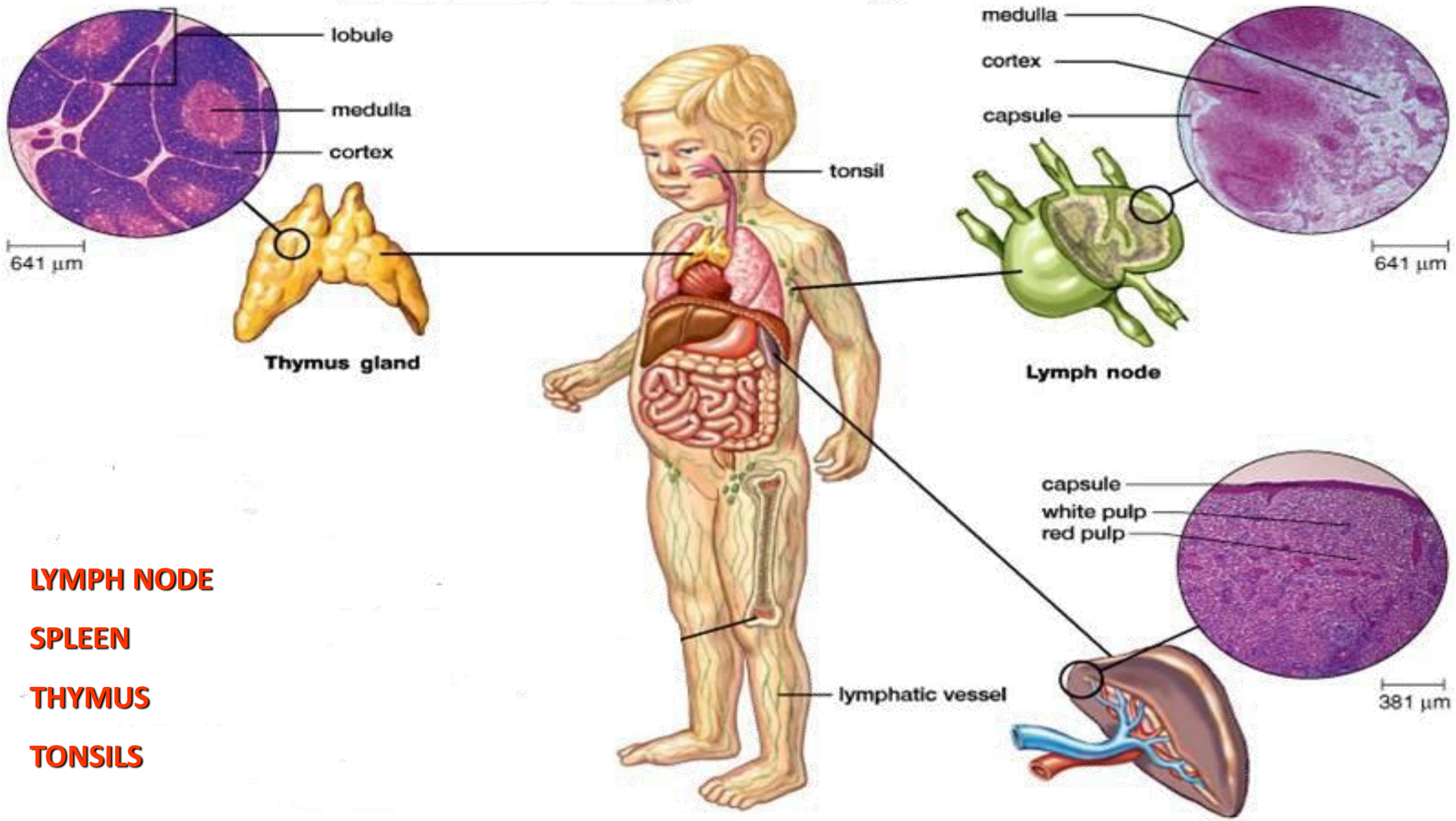
3-Spleen

4-Tonsil





Copyright © Pearson Education, Inc., publishing as Benjamin Cummings.



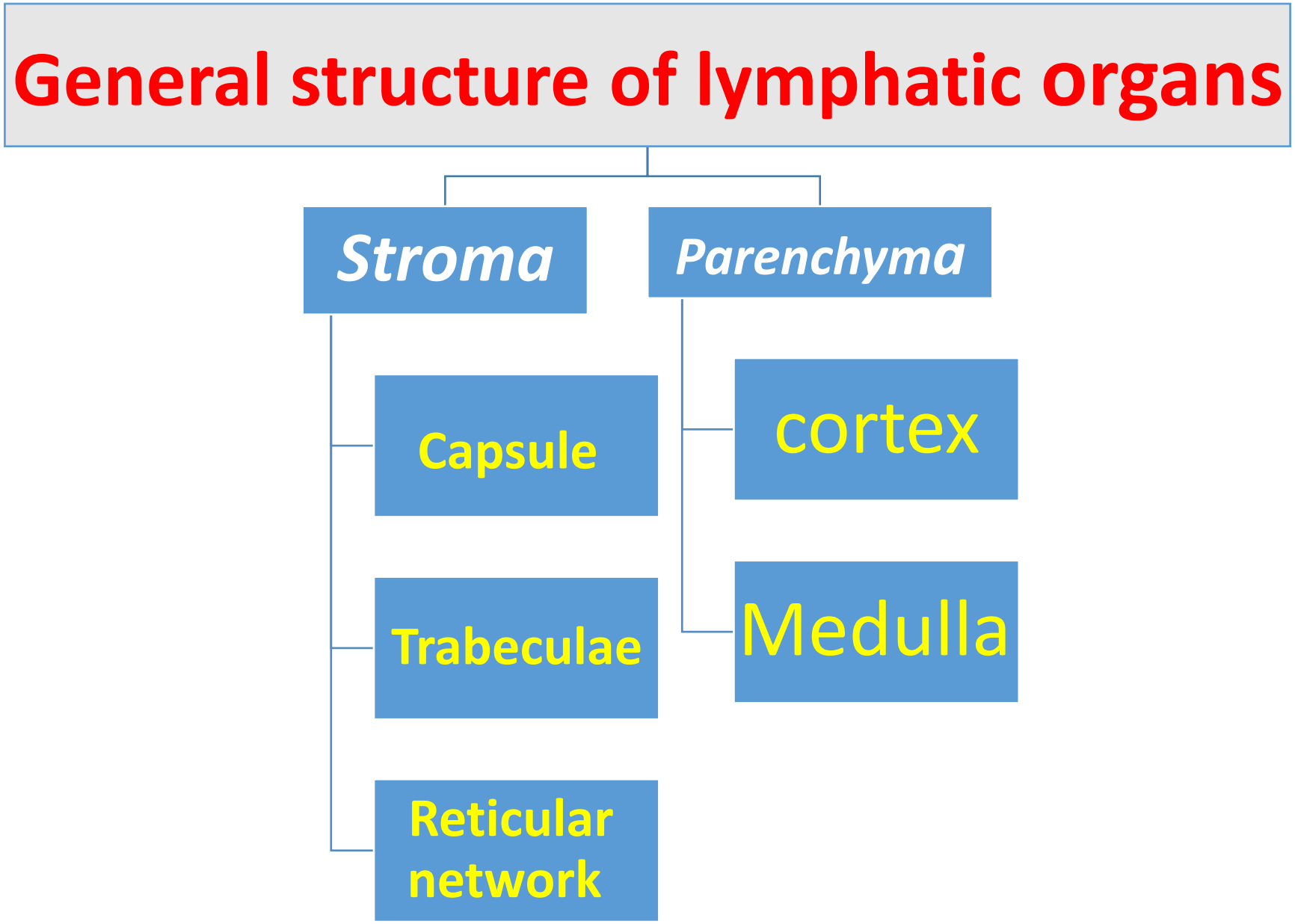
LYMPH NODE

SPLEEN

THYMUS

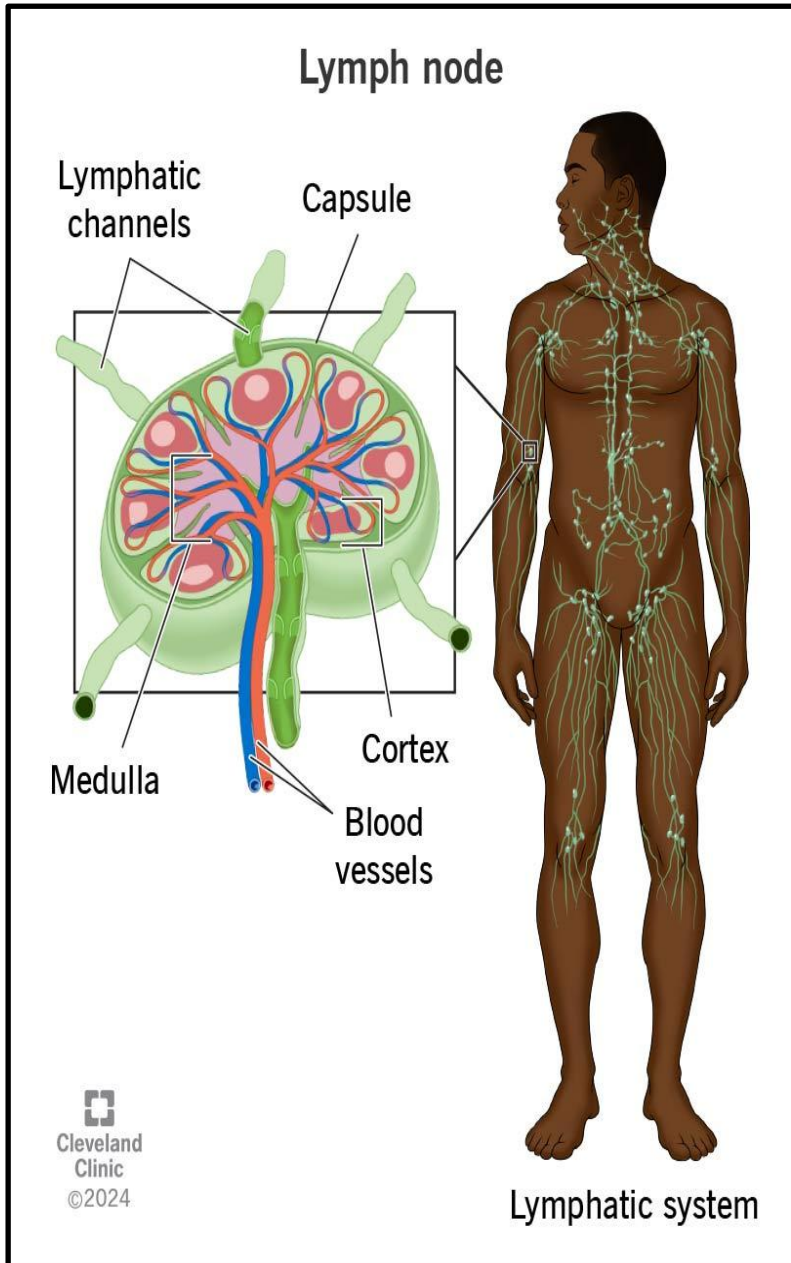
TONSILS

General structure of lymphatic organs



Lymph nodes

- They are encapsulated
- kidney shaped or rounded
- distributed throughout the course of lymphatic vessels.
- **Structure:**
- The lymph node has two surfaces a convex surface and a concave surface called **hilum.**
- The afferent lymphatic vessels enter the lymph node through the convex surface.
- and the efferent lymphatic vessels leave through the hilum.



The lymph node consists of: *Stroma* and *Parenchyma*

Stroma:

1- Capsule of connective tissue.

2-Trabeculae: which are septa originating from the capsule dividing the node into incomplete compartments.

3-Reticular network of reticular fibers and reticular cells.

Parenchyma:

The Cortex *is composed of:*

1-Outer cortex

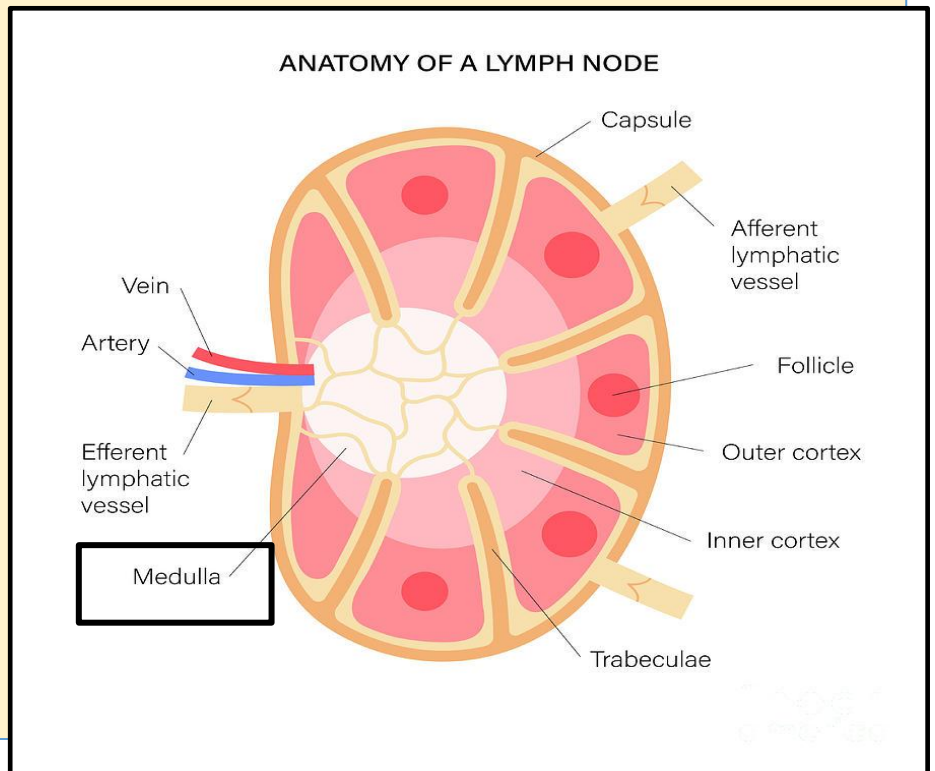
2- Inner cortex

3- Cortical sinuses

The Medulla consists of:

1- Medullary cords

2- Medullary sinuses



Parenchyma: The Cortex is composed of:

1-Outer cortex:

It contains **rounded aggregations of lymphocytes** (mainly B lymphocytes) called lymphoid **follicles (nodules)** which may be:

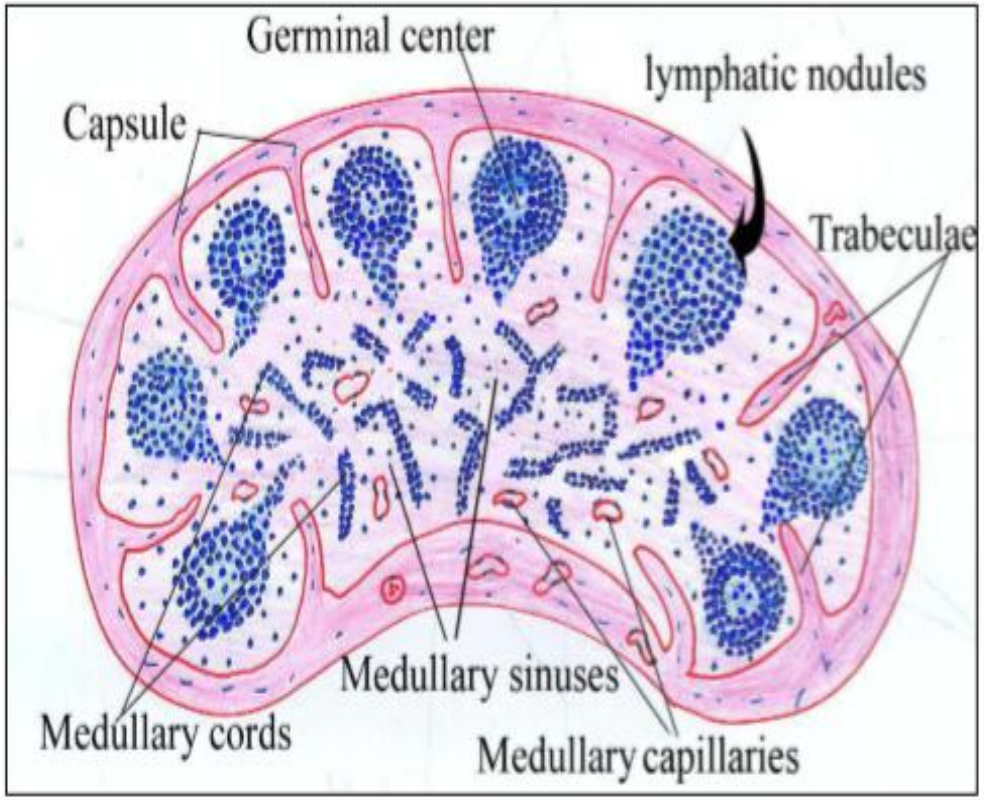
**Primary lymphatic follicle:* not exposed to antigen and without germinal center.

Secondary lymphatic follicle:* exposed to antigen and have a central pale area called "germinal center**" containing activated lymphocytes.

2- Inner cortex:

- between the outer cortex and medulla.
- **T-lymphocytes predominate** in the inner cortex, so it is called

"thymus dependant area".

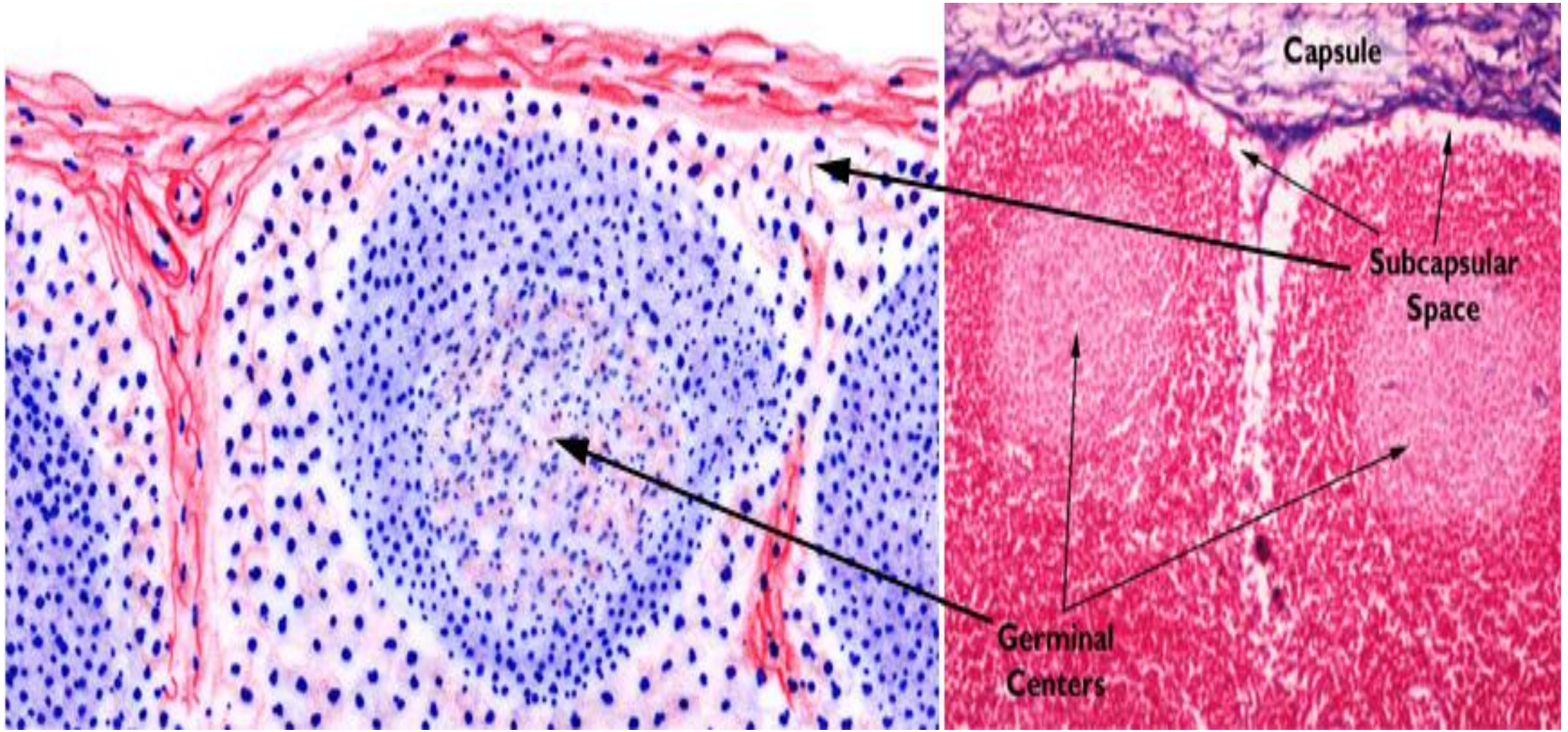


3- Cortical sinuses:

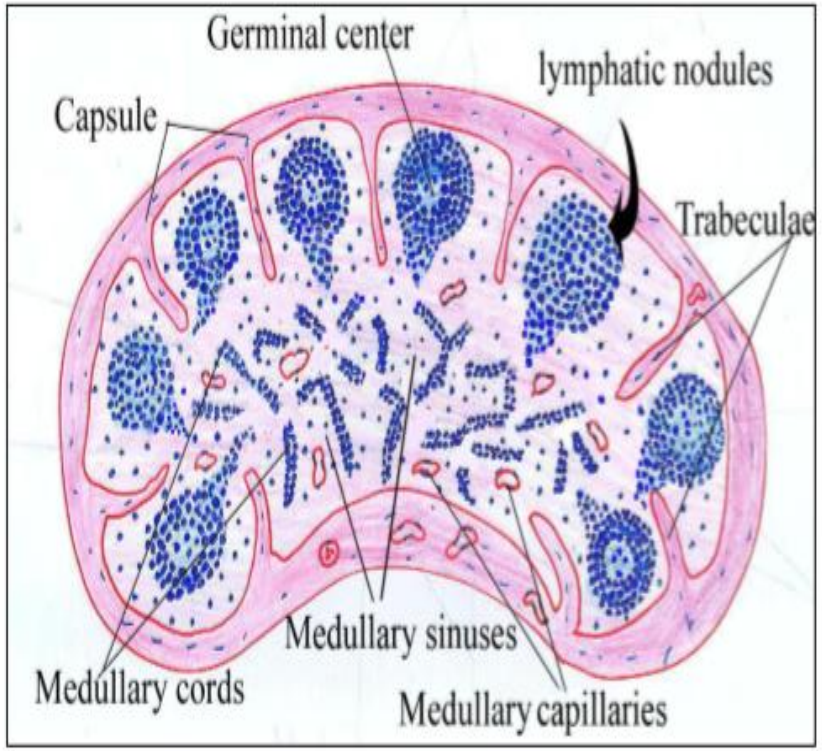
irregular spaces lined mainly by discontinuous endothelial cells associated with reticular cells, fibers and phagocytic macrophages .

a- ***Subcapsular* sinuses** (between capsule and lymphatic follicles)

b- ***Paratrabecular* sinuses** (present around trabeculae).


Capsule
Subcapsular Space
Germinal Centers

The Medulla consists of:



1- *Medullary cords*: formed of:

- lymphocytes
- plasma cells.

2- Medullary sinuses:

connect the cortical sinuses with he efferent

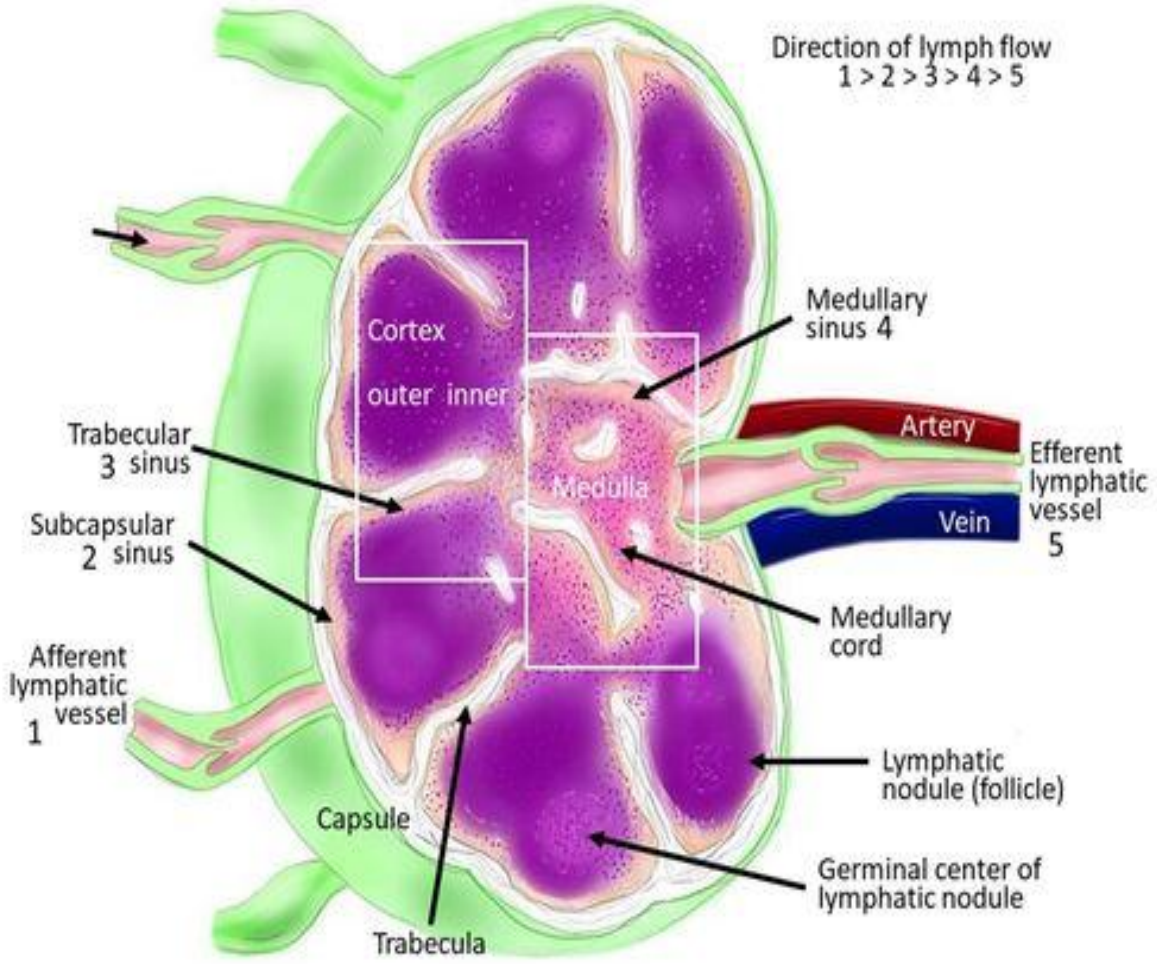
lymphatics through which lymph leaves the node.

Functions of lymph nodes:

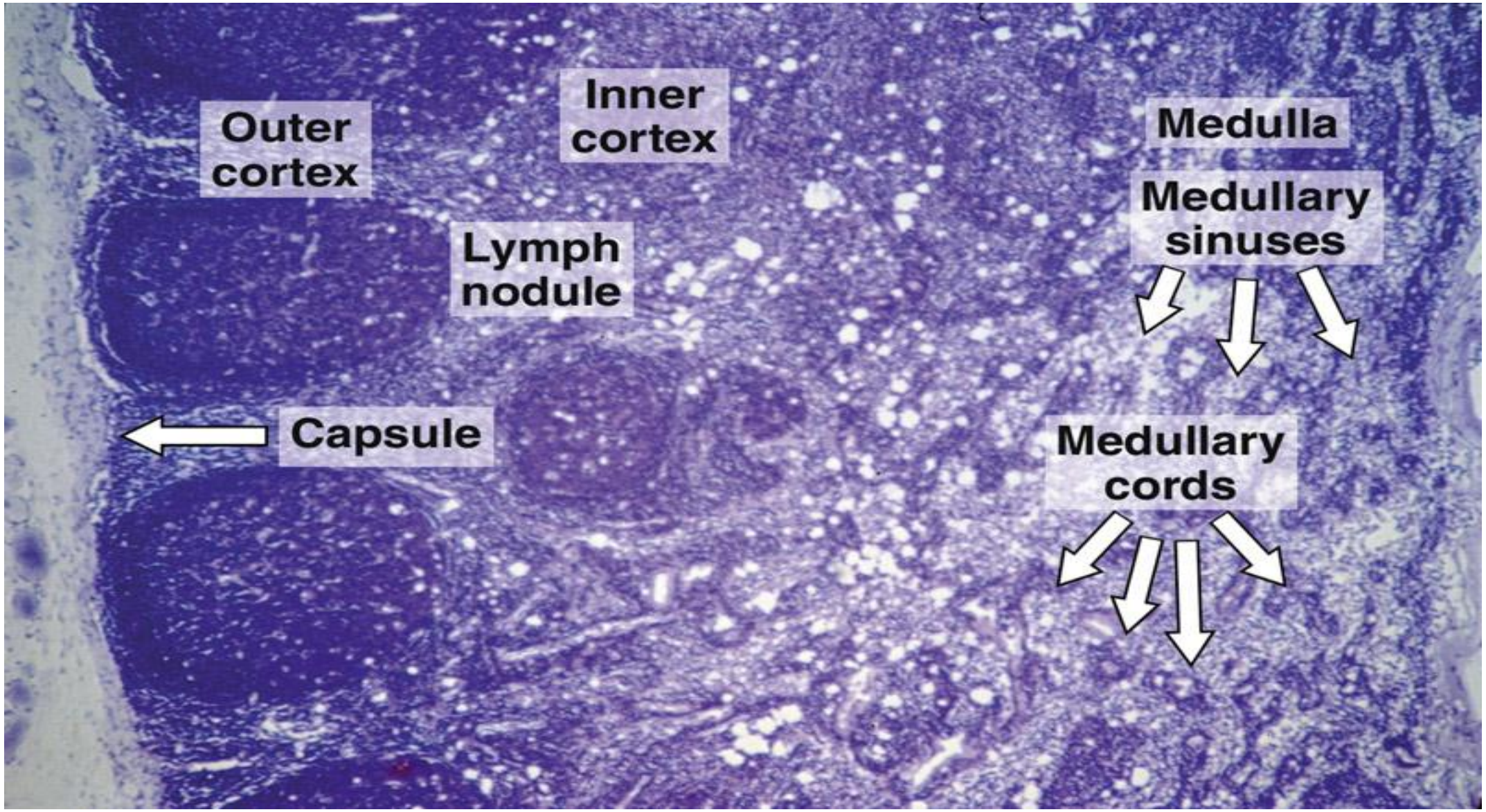
1- Filtration of lymph from microorganisms.

2- Immunological function (both cellular and humoral immunity).

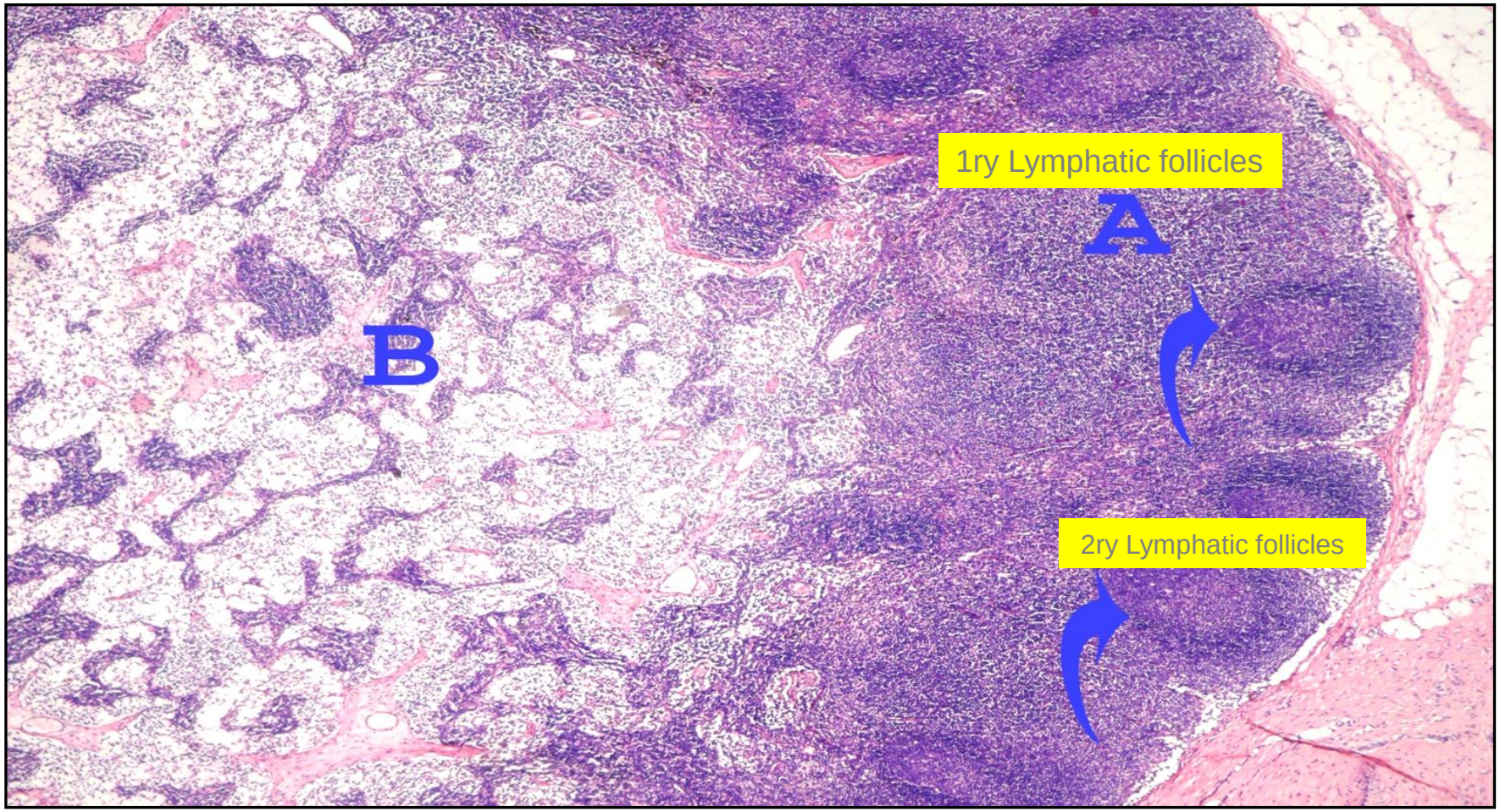
Flow of lymph through lymph node



Structure of Lymph node



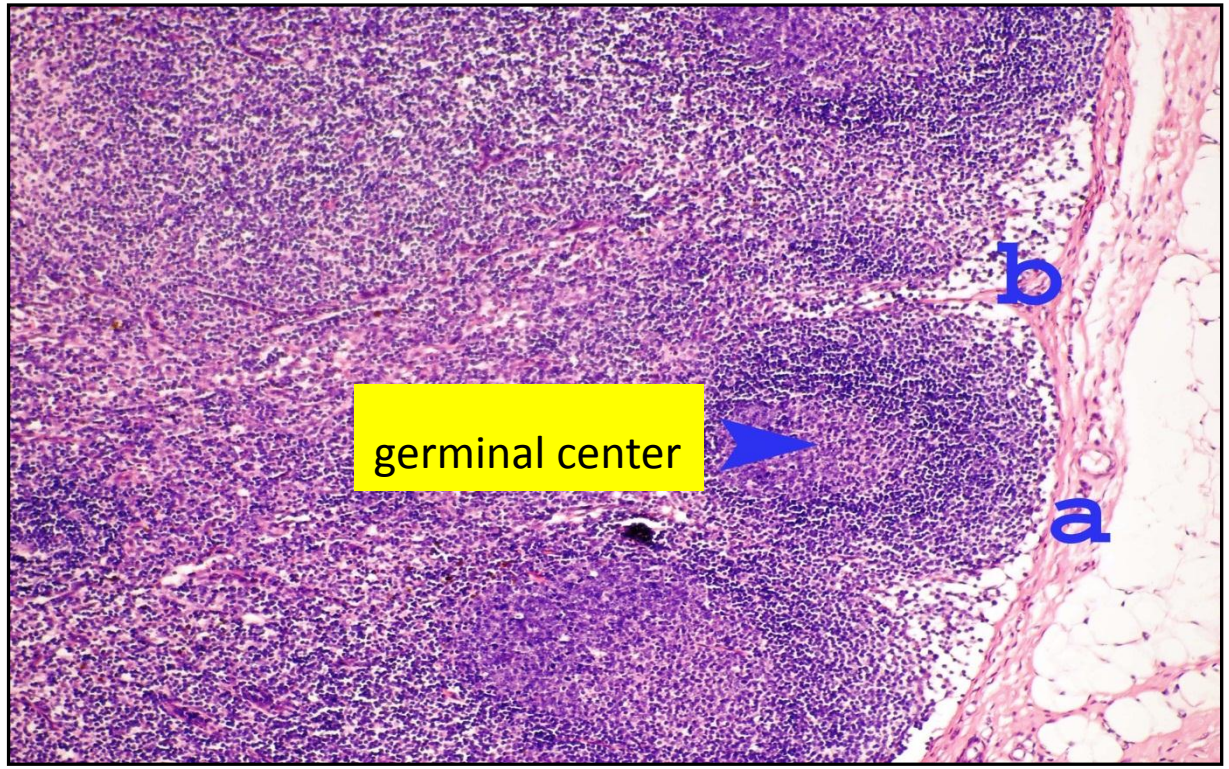
LYMPH NODE

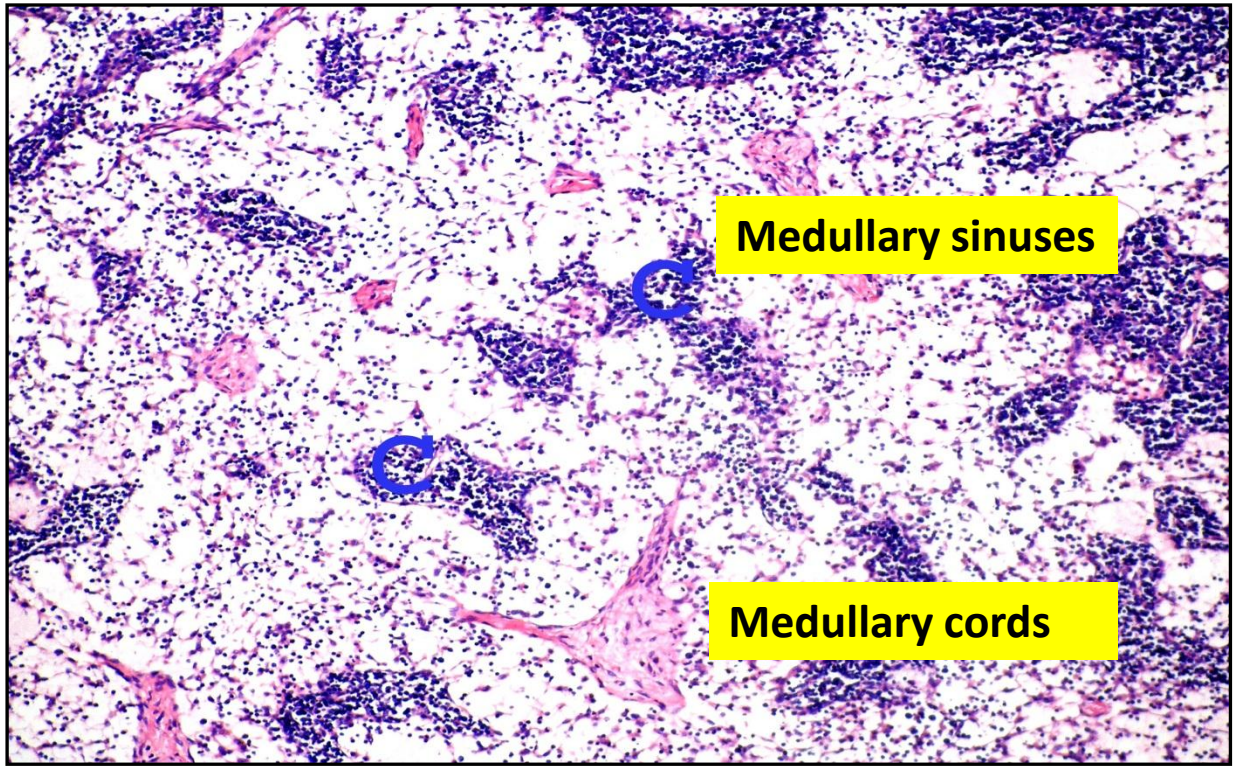


LYMPH NODE

Cortex

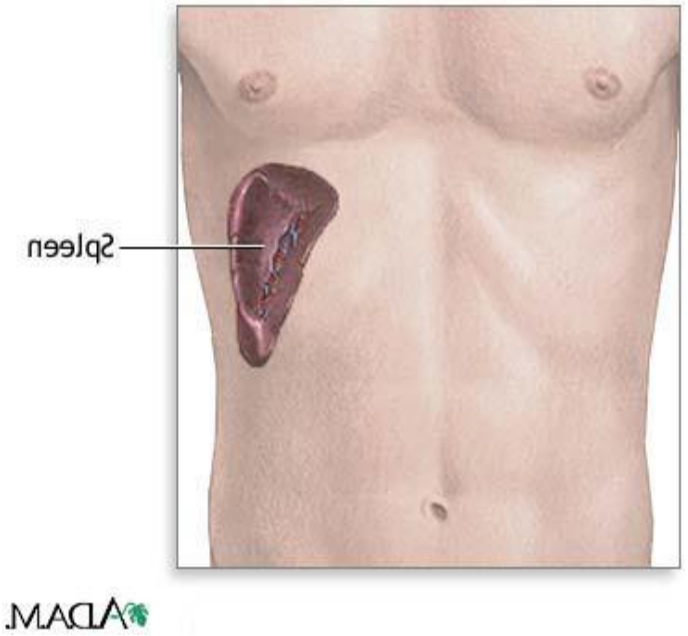
Medulla





Spleen

It is the **largest** lymphatic organ in the human.



Functions of the spleen

1- Filtration & storage of blood.

2- Cellular and humoral immunity.

3- Destruction of old RBCs.

4-Haemopoietic function in fetus.

Structure:

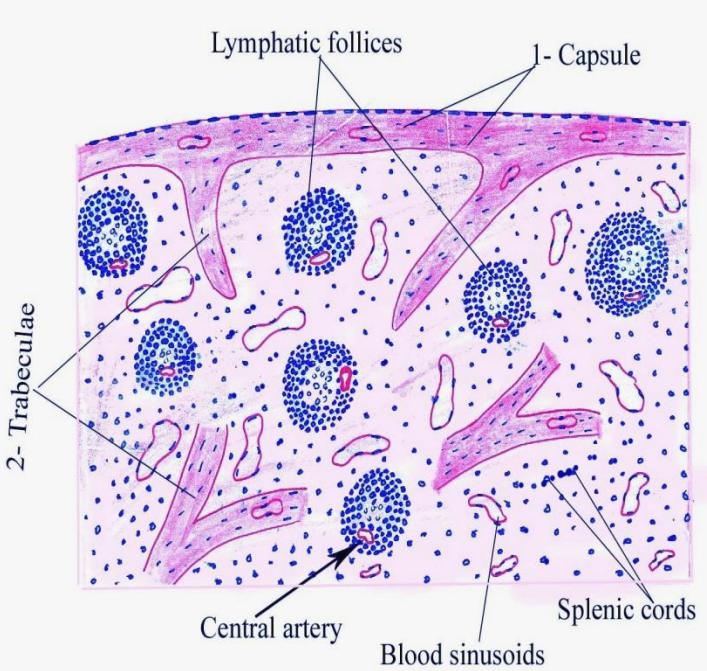
A-Stroma: is formed of:

1-Capsule dense connective tissue and some smooth muscle cells covered with mesothelium .

2- Trabeculae some extend from the capsule *and others* from the hilum they are connected with each other.

3- Reticular network formed of reticular fibers and reticular cells.

B-Parenchyma (splenic pulp)



❑ *The white pulp*

- ***The lymphoid follicles*:**

○ composed mainly of **B-lymphocytes**, they may have germinal center.

○ Small **central artery** penetrates the follicle in eccentric position.

- ***Lymphatic tissue:***

○ forms **sheaths** around the central arteries (**Periarterial lymphatic sheaths**) in the lymphatic follicles.

○ These sheaths are composed mainly of **T-lymphocytes (thymus dependent area).**

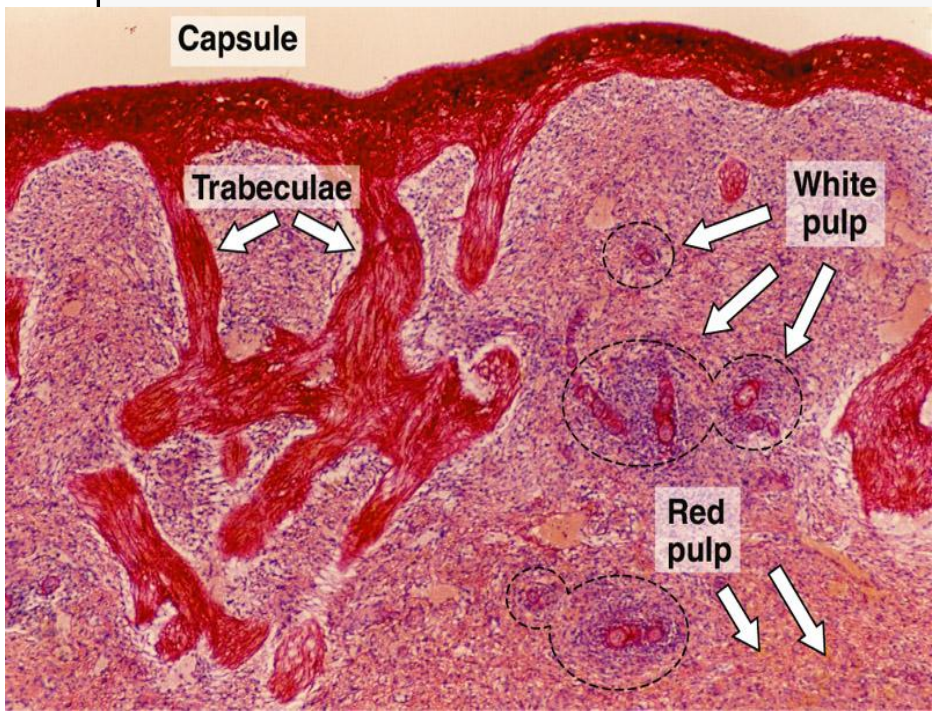
❑ *The red pulp*

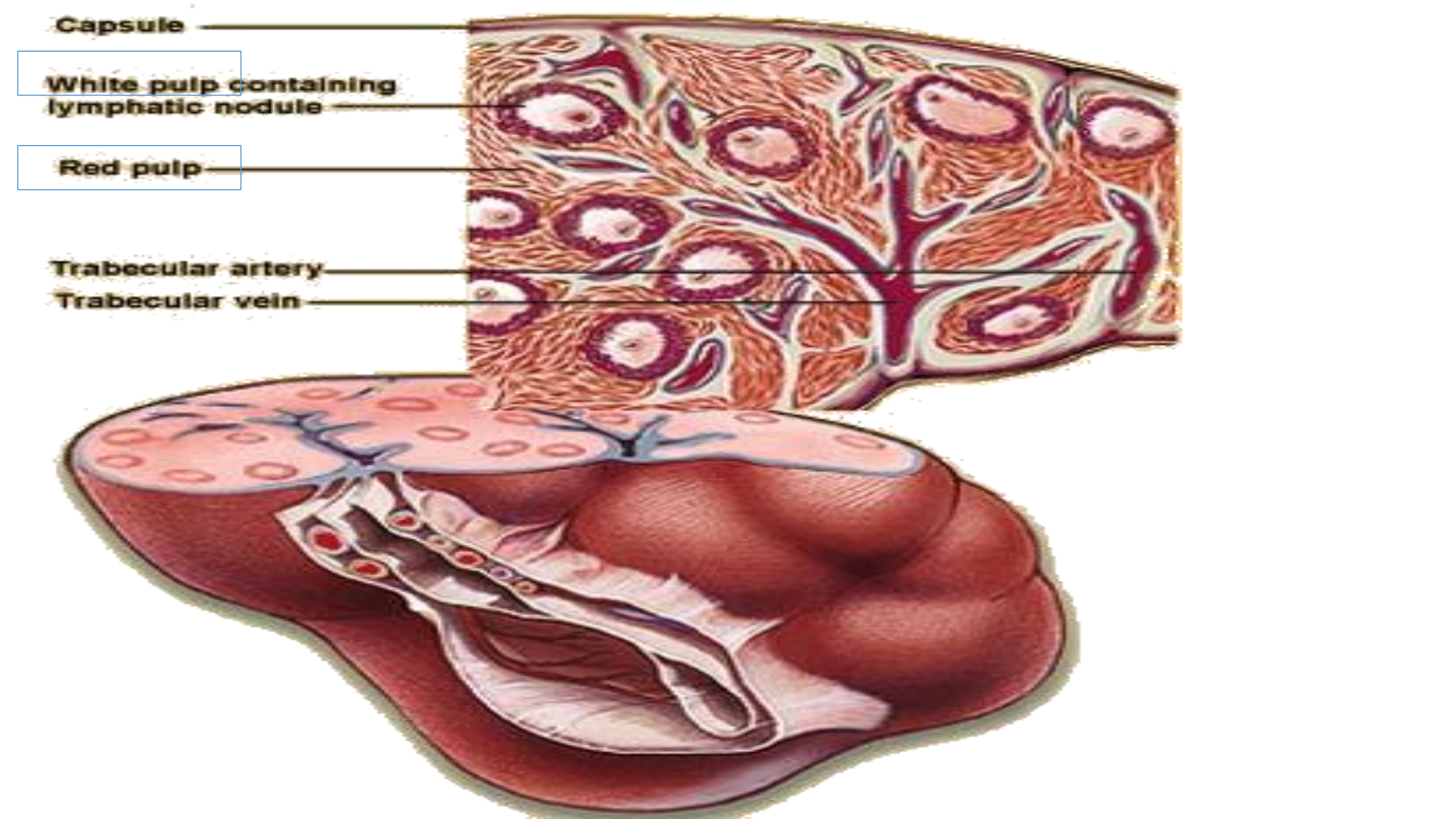
- ***Blood sinusoids*:**

irregular fenestrated blood channels lined by discontinuous endothelial cells with incomplete basal lamina associated with reticular cells and macrophages

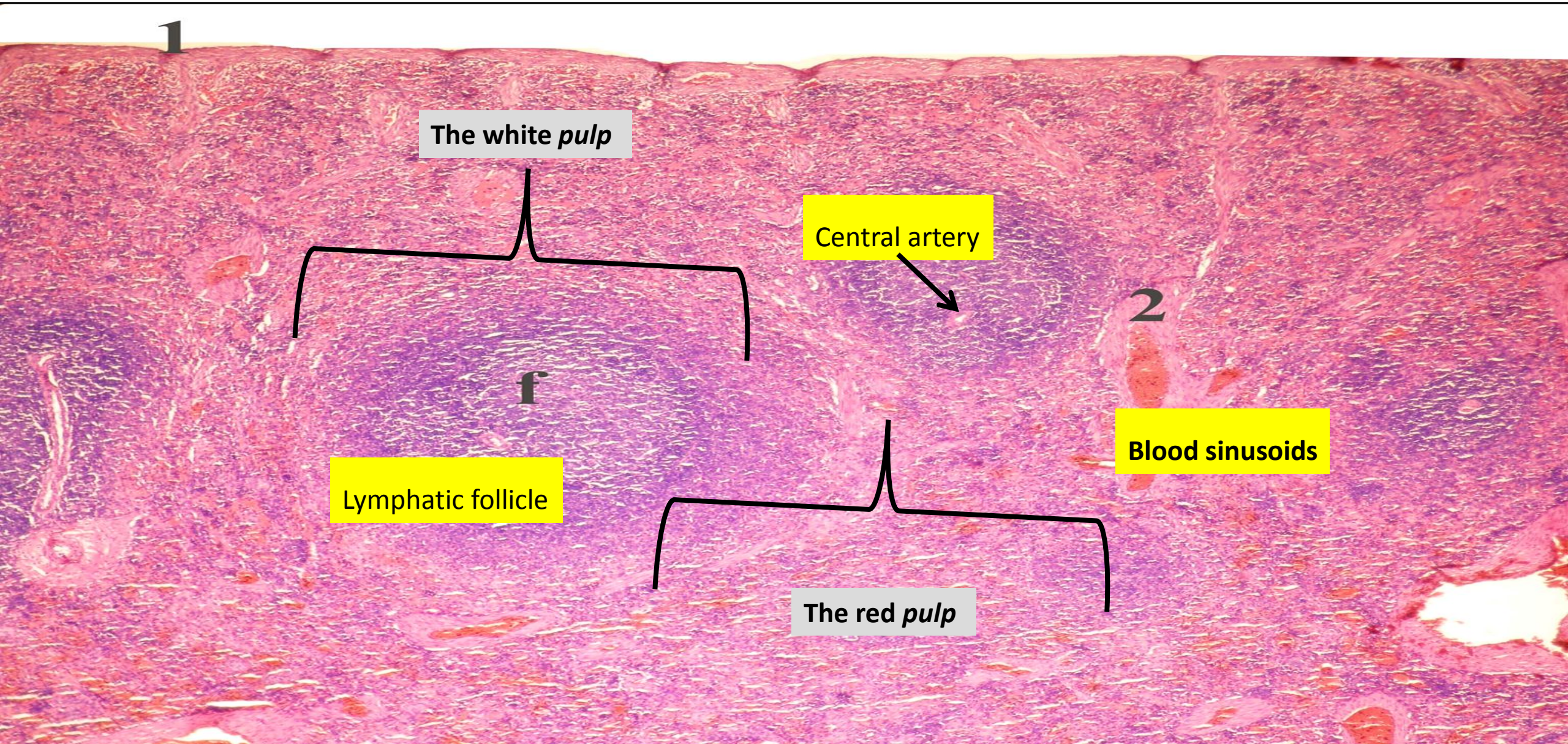
- ***Splenic cords*:**

they are **cords of cells** (plasma cells, macrophages and reticular cells) between blood sinusoids.

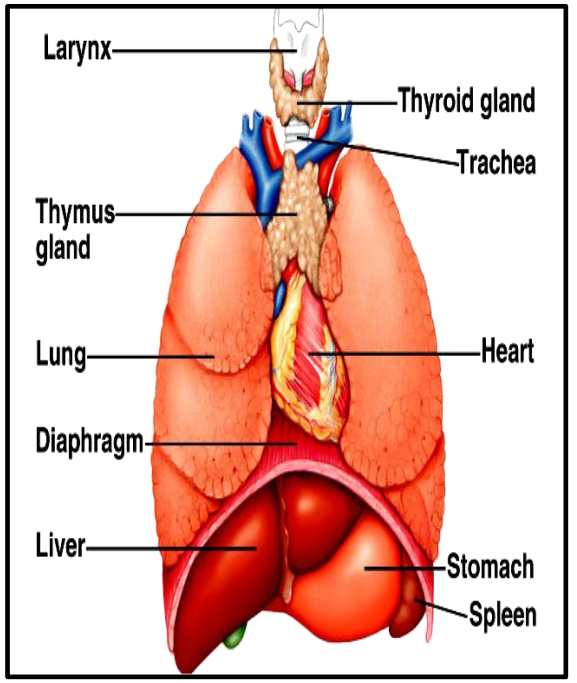



Capsule
White pulp containing lymphatic nodule
Red pulp
Trabecular artery
Trabecular vein

THE SPLEEN


1
The white *pulp*
Central artery
2
f
Blood sinusoids
Lymphatic follicle
The red *pulp*

Thymus



- It is a central lymphoid organ.
- situated behind the sternum.
- It is large during fetal life and involutes after puberty.

Function:

1- Production of T-lymphcytes.

2- Production of thymic hormones by epithelial reticular cells to regulate the proliferation, differentiation and maturation of T-lymphocytes.

Structure:

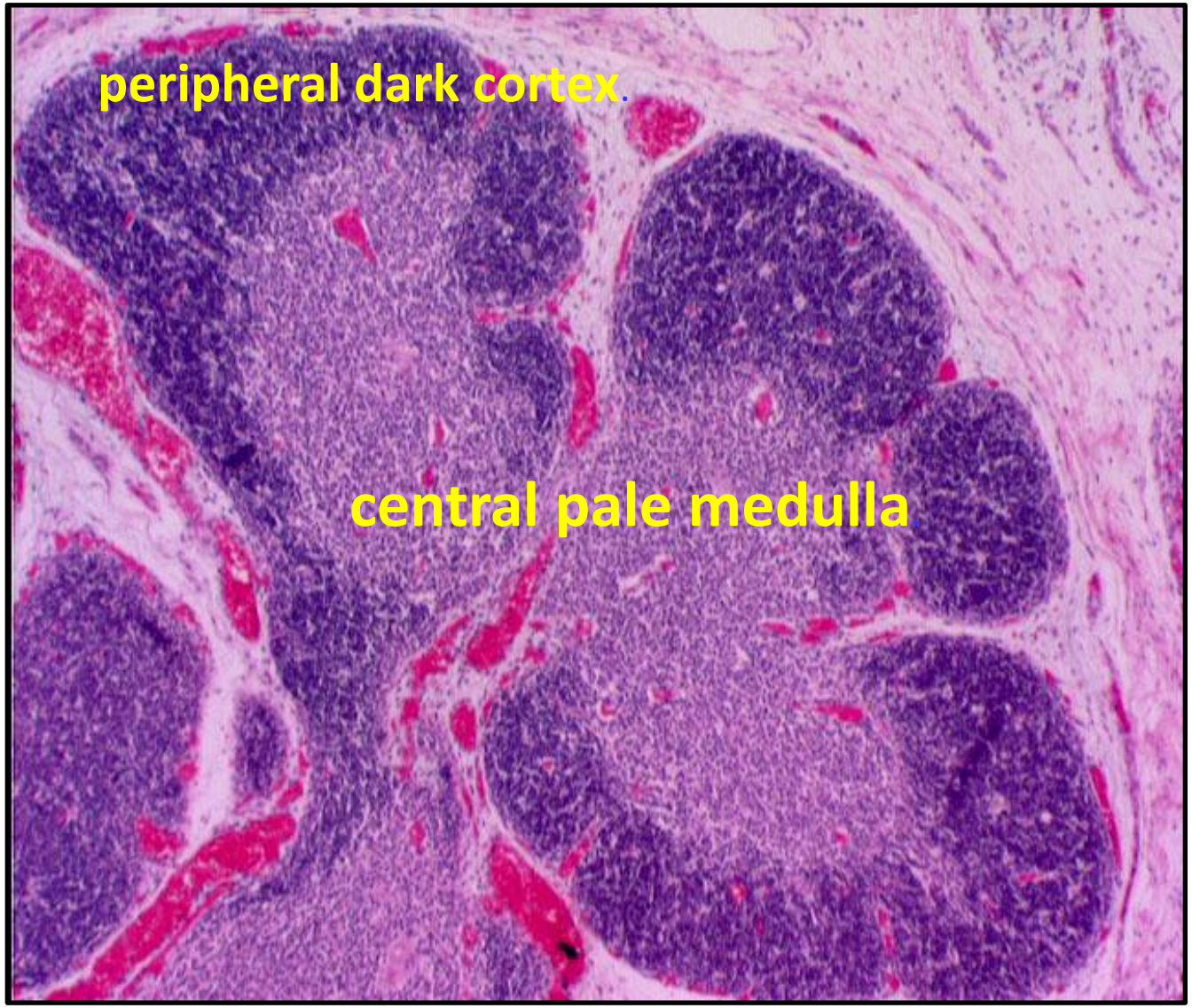
I) Stroma:

- Capsule of CT.
- Incomplete septa divide organ into incomplete lobules.

II) Parenchyma:

- Lobules of thymus continuous with each other.
- Each lobule has peripheral cortex and central medulla.

Thymus peripheral cortex and central medulla.



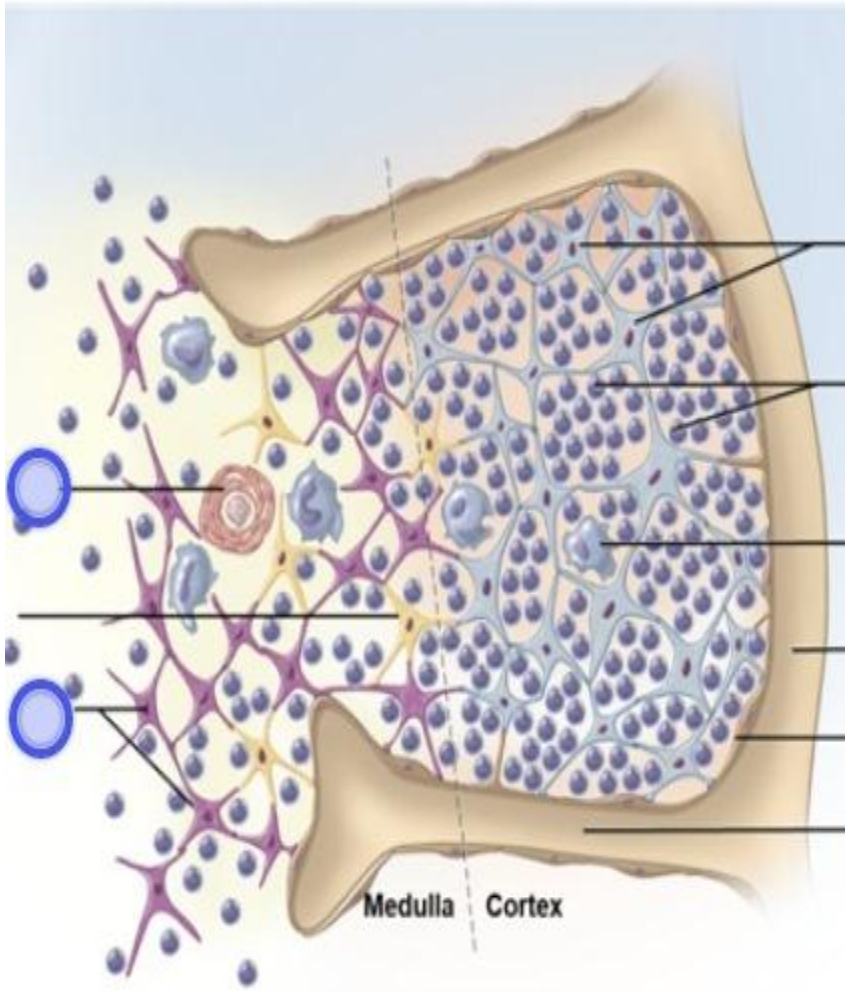
Cortex of thymus

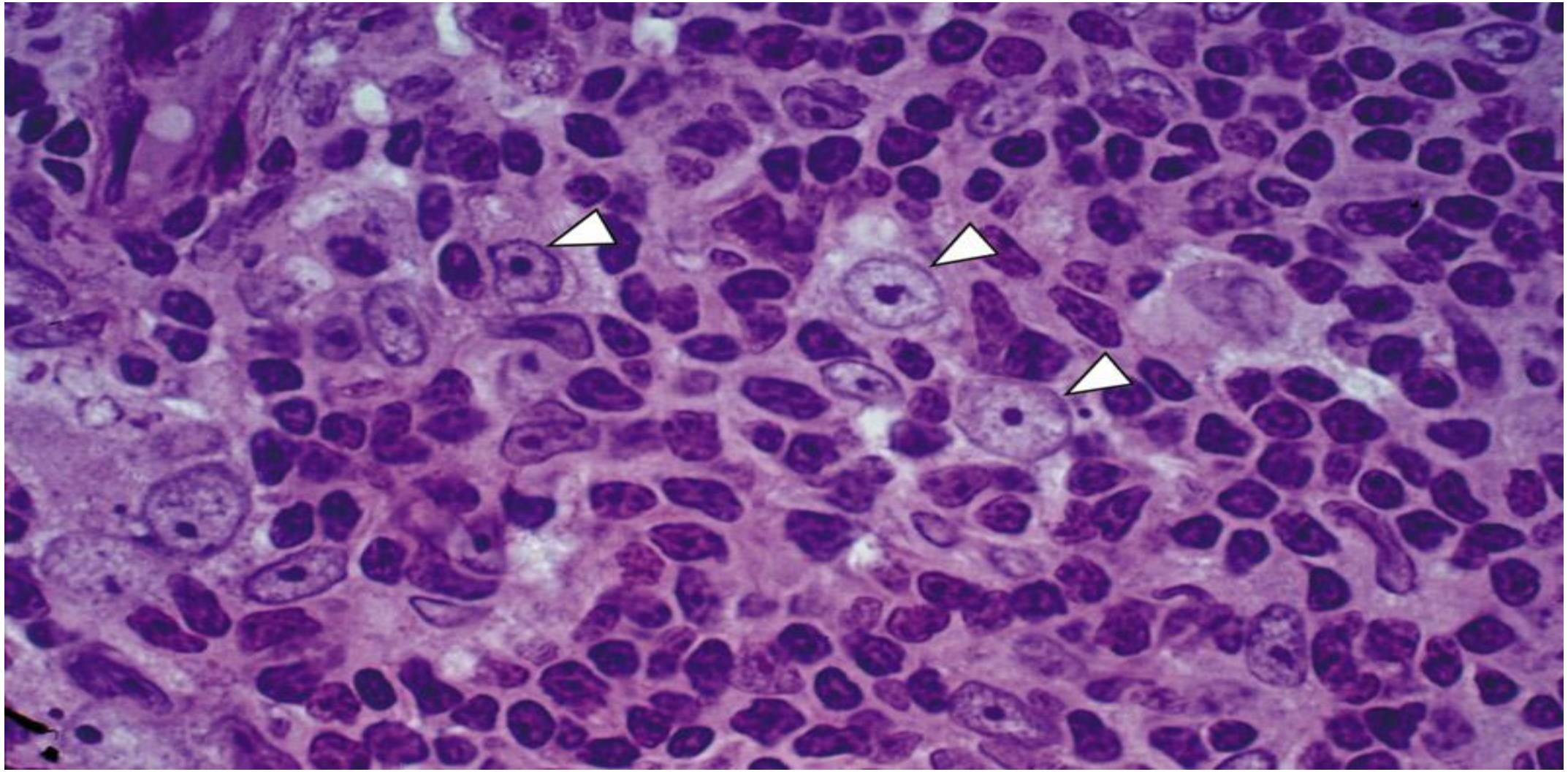
1- Small T-lymphocytes (predominant cells).

2- Epithelial reticular cells:

- Nucleus: oval pale (extended chromatin).
- Cytoplasm: cytokeratin filaments.
- Large & Branched:
  - processes joined together by desmosomes.
  - extend around lymphocytes.
  - form sheath around blood capillaries.

3- Macrophages.





Cortex: Epithelial reticular cells (arrowheads) surrounded by dark-stained T lymphocytes.

Blood- thymic barrier

- Lymphocytes proliferate in cortex producing immature T-cells.
- During programming of T-cells they are **protected from** foreign Ag in lymph and blood as follows:

- Blood thymic barrier (present only in cortex)

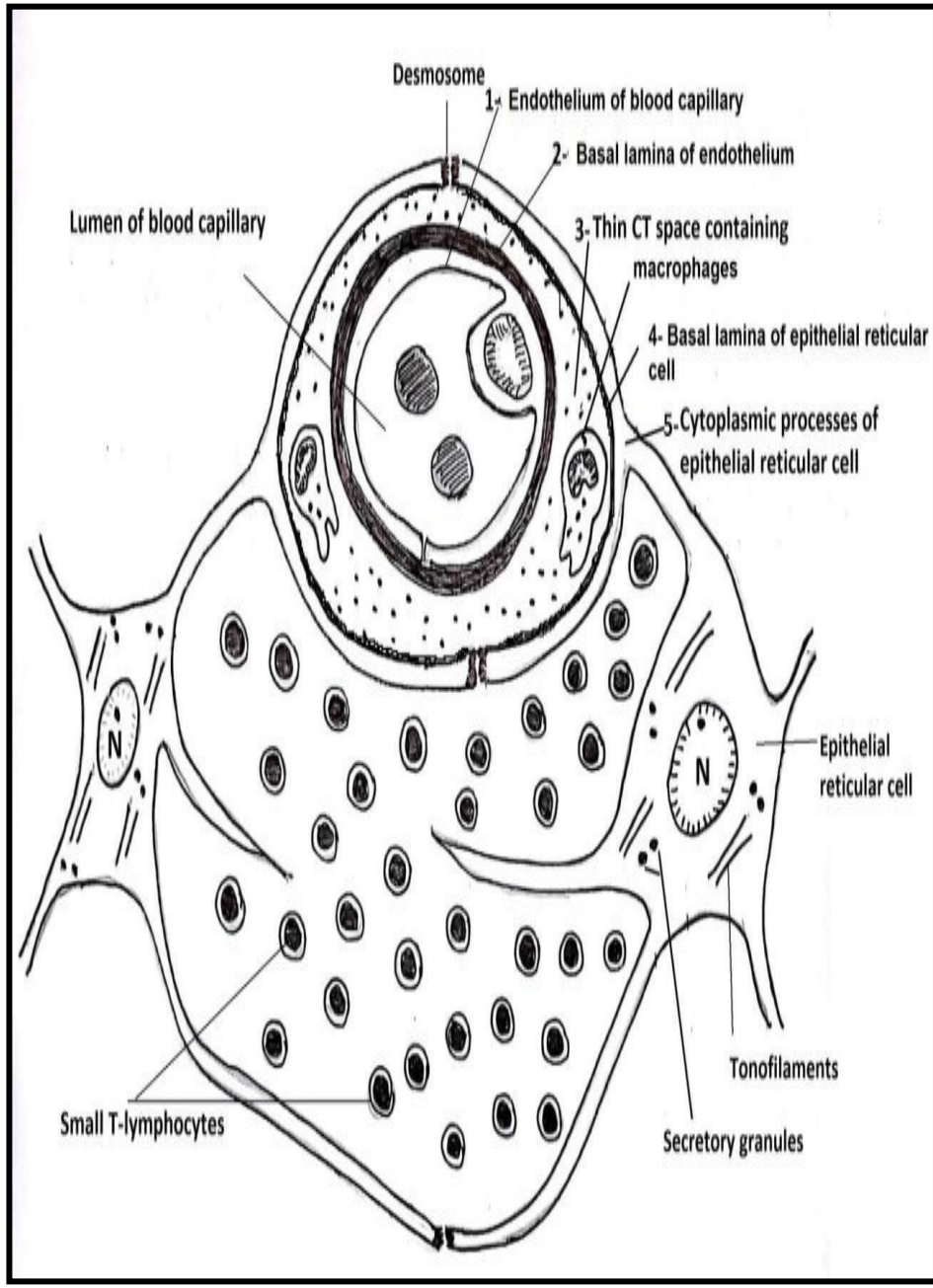
1-Continuous endothelium of blood capillaries.

2. Basal lamina of the endothelium.

3.Small connective tissue space (may contain macrophages).

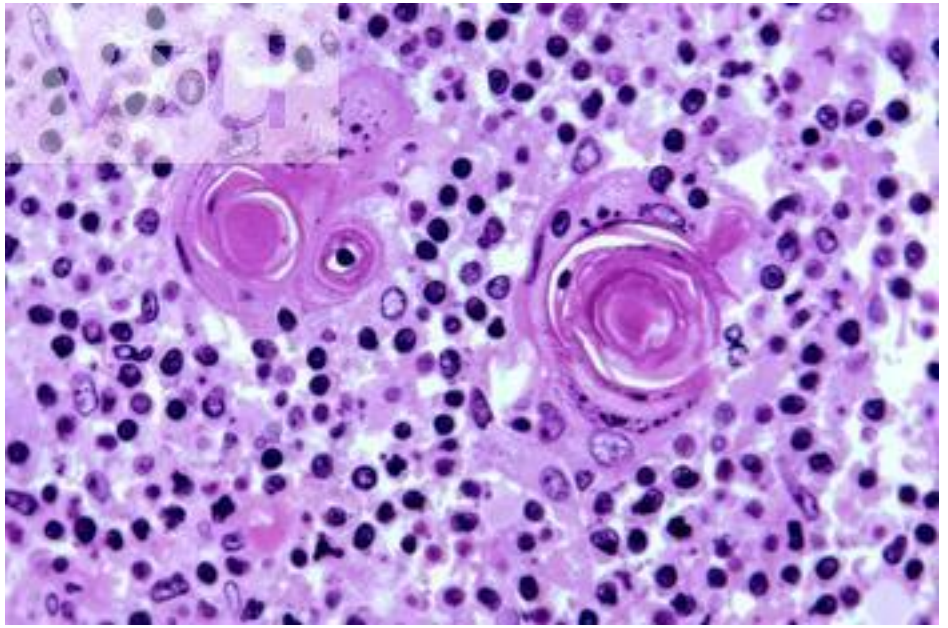
4. Basal lamina of epithelial reticular cells.

5. **Epithelial reticular cells** whose processes are joined together by **desmosomes** and form a sheath around the cortical blood capillaries



Medulla of thymus

- Lightly stained due to epithelial reticular cells and large lymphocytes with abundant cytoplasm and pale nuclei.



- Fewer small T- lymphocytes than in cortex.

- Contains Hassle's corpuscles:
  - concentric layers of epithelial reticular cells.
  - Innermost cells degenerate.
  - filled with kertohyaline granules and cytokeratin filaments.

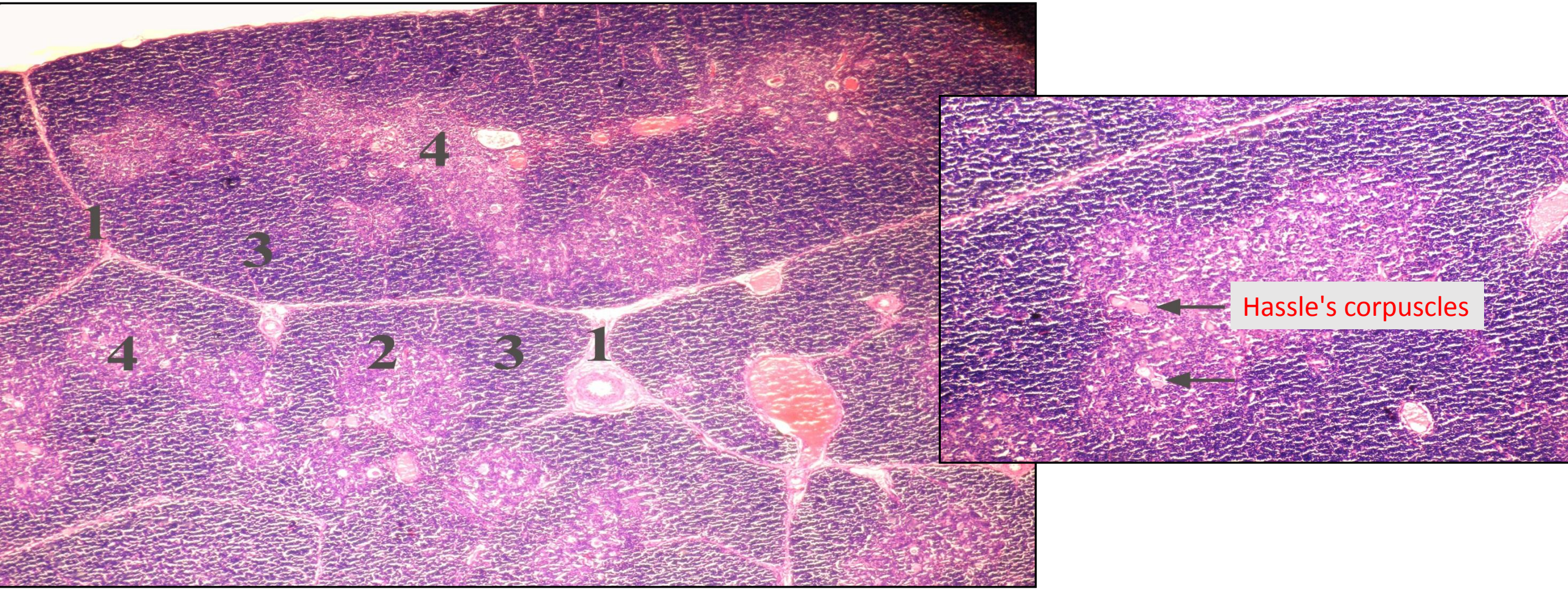
- No blood–thymic barrier in medulla as epithelial reticular cell layer is incomplete.

T-lymphocytes

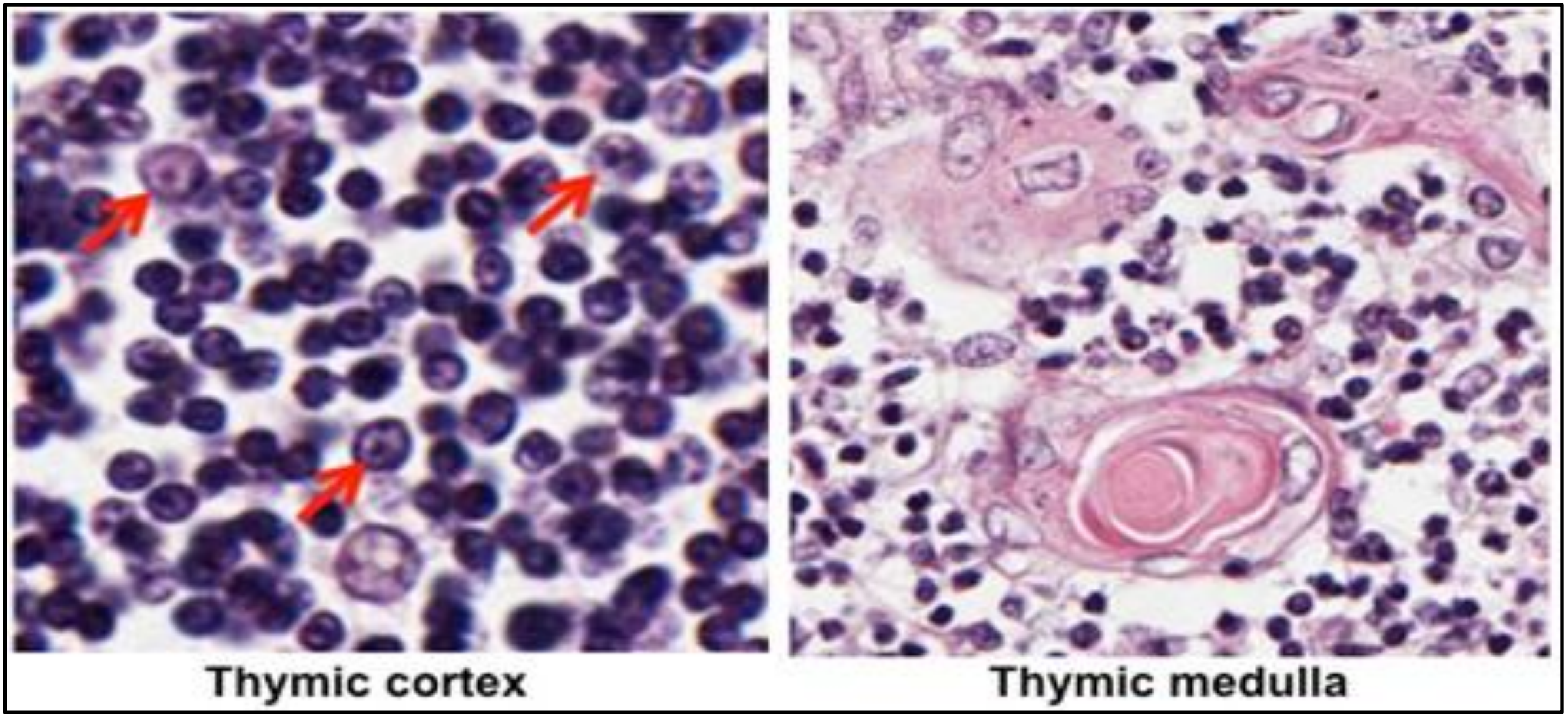
- Proliferation and programming occur in cortex of thymus.
- Others:
  - migrate to medulla.
  - pass through medullary venules to circulation to peripheral lymphoid organs (lymph nodes, spleen).
  - occupy **thymus dependent areas**.
  - ***Inner cortex of lymph node***
  - ***The white pulp of spleen***

  to perform their function

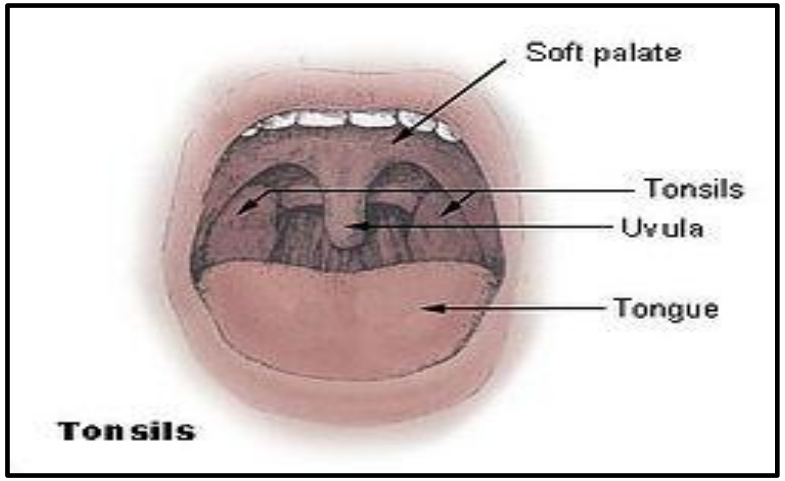
THYMUS



Thymus



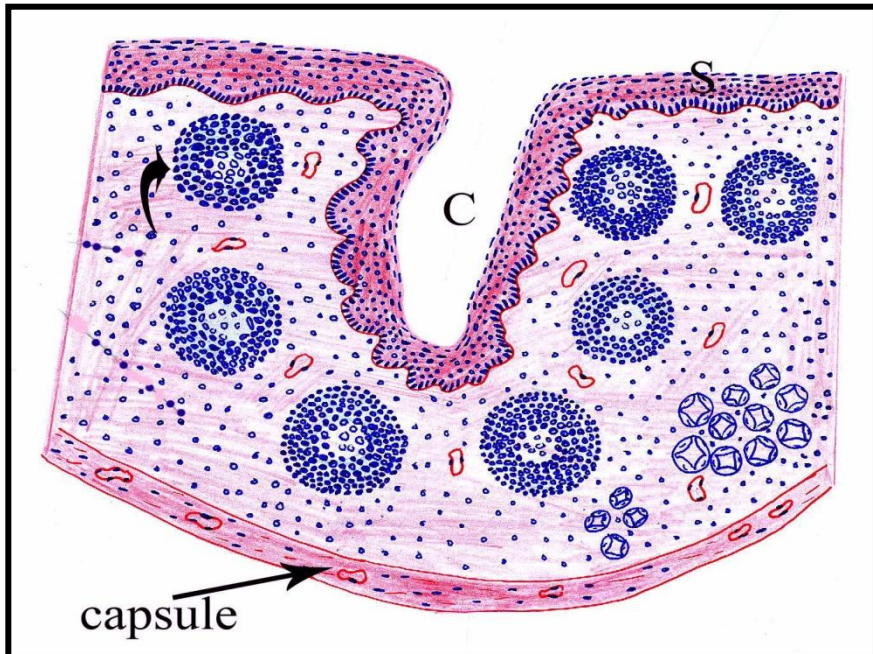
Tonsils

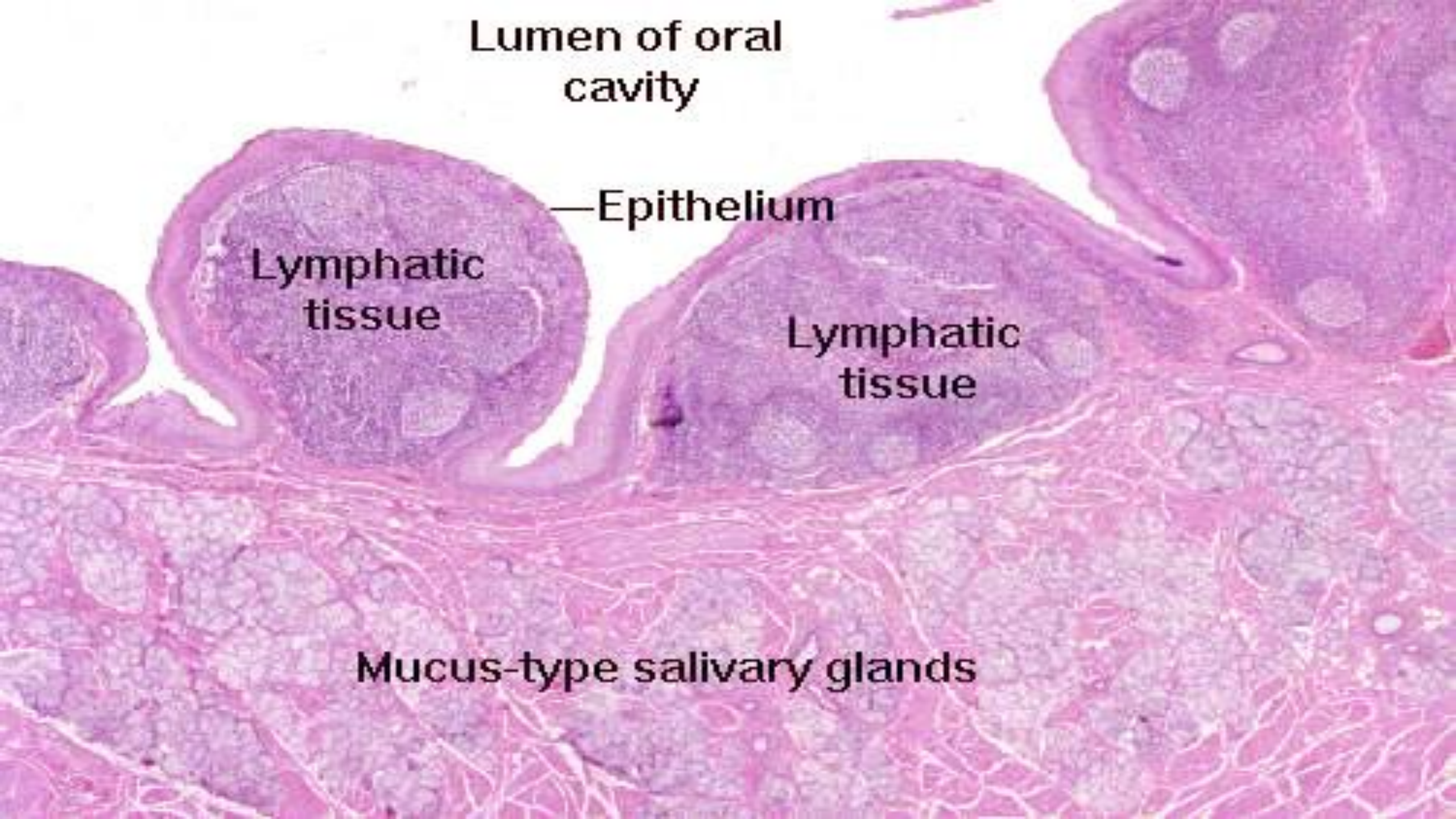


- They are incompletely encapsulated aggregation of lymphatic tissue beneath the mucous membrane of the mouth, pharynx, and tongue.
- They are palatine, pharyngeal and lingual tonsils.

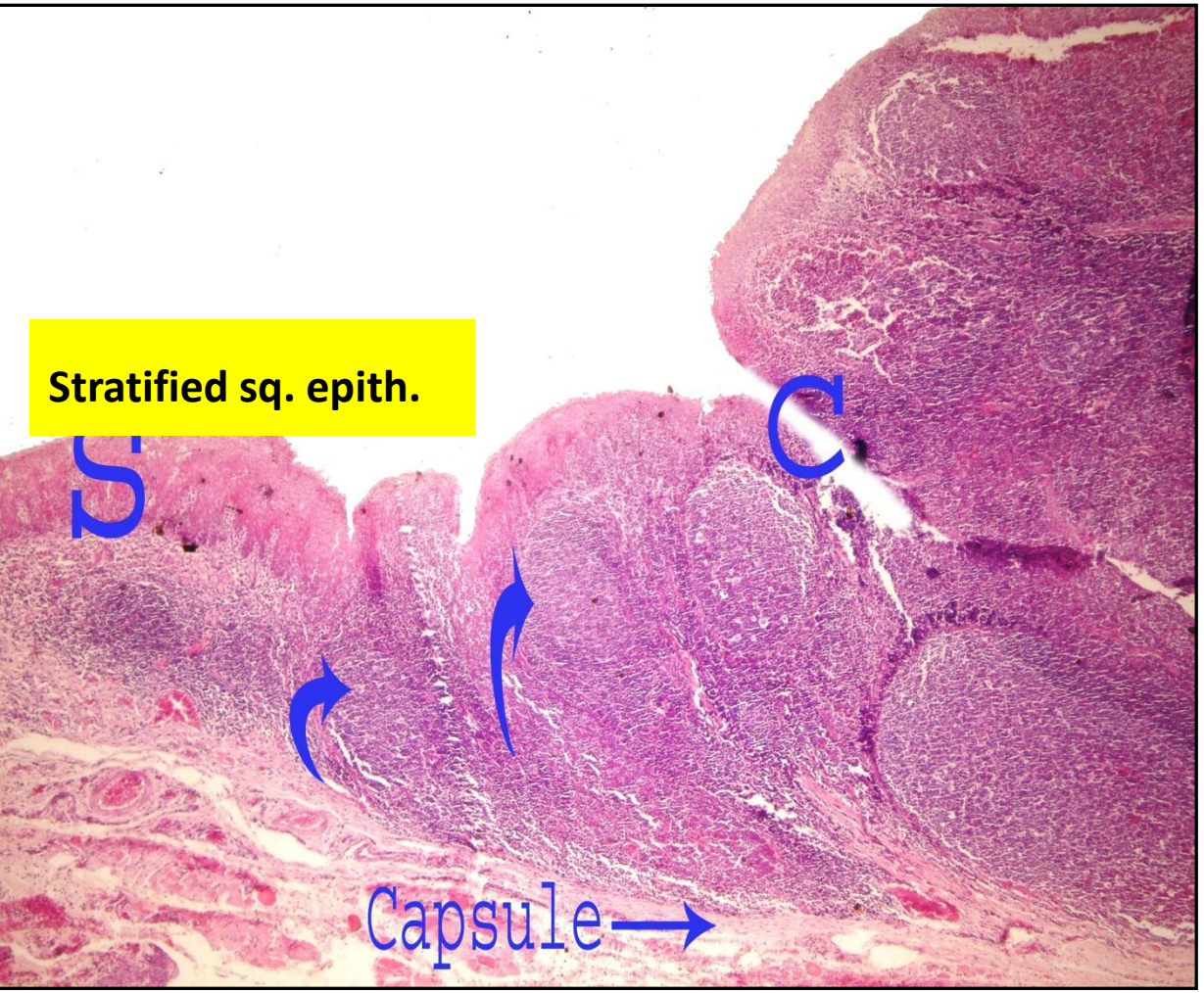
The palatine tonsils:

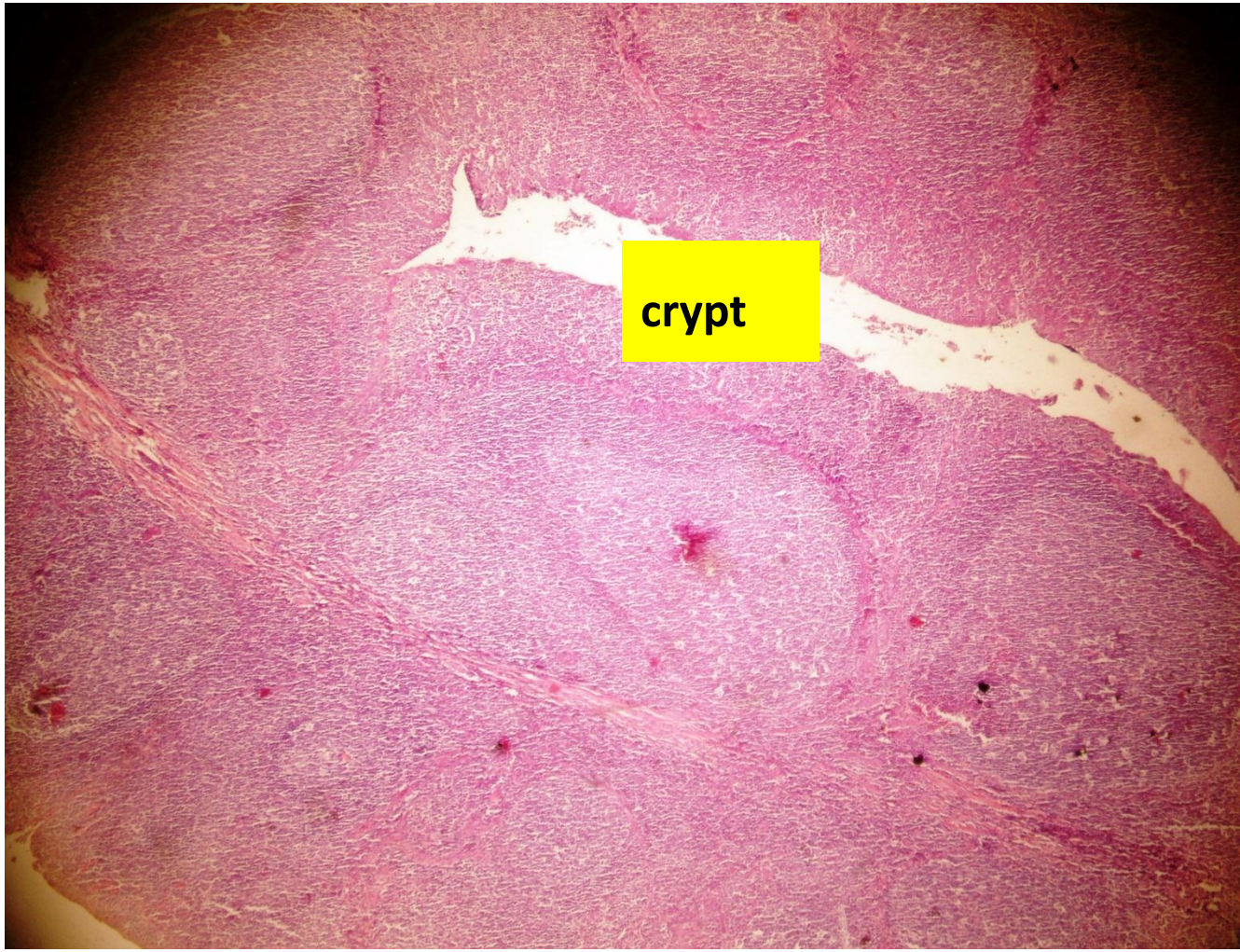
- They are 2 tonsils in the lateral walls of orophargnx.
- Formed of lymphatic tissue containing **secondary lymphatic follicles** with germinal centers.
- The lymphatic nodules are present under the epithelium and around the **crypts.**
- They are covered by **stratified squamous epithelium** that invaginate into the lymphoid tissue forming crypts.
- They are separated from the surrounding structures by dense connective tissue (capsule).




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

PALATINE TONSILS






Thank You
graphicsarcade.com