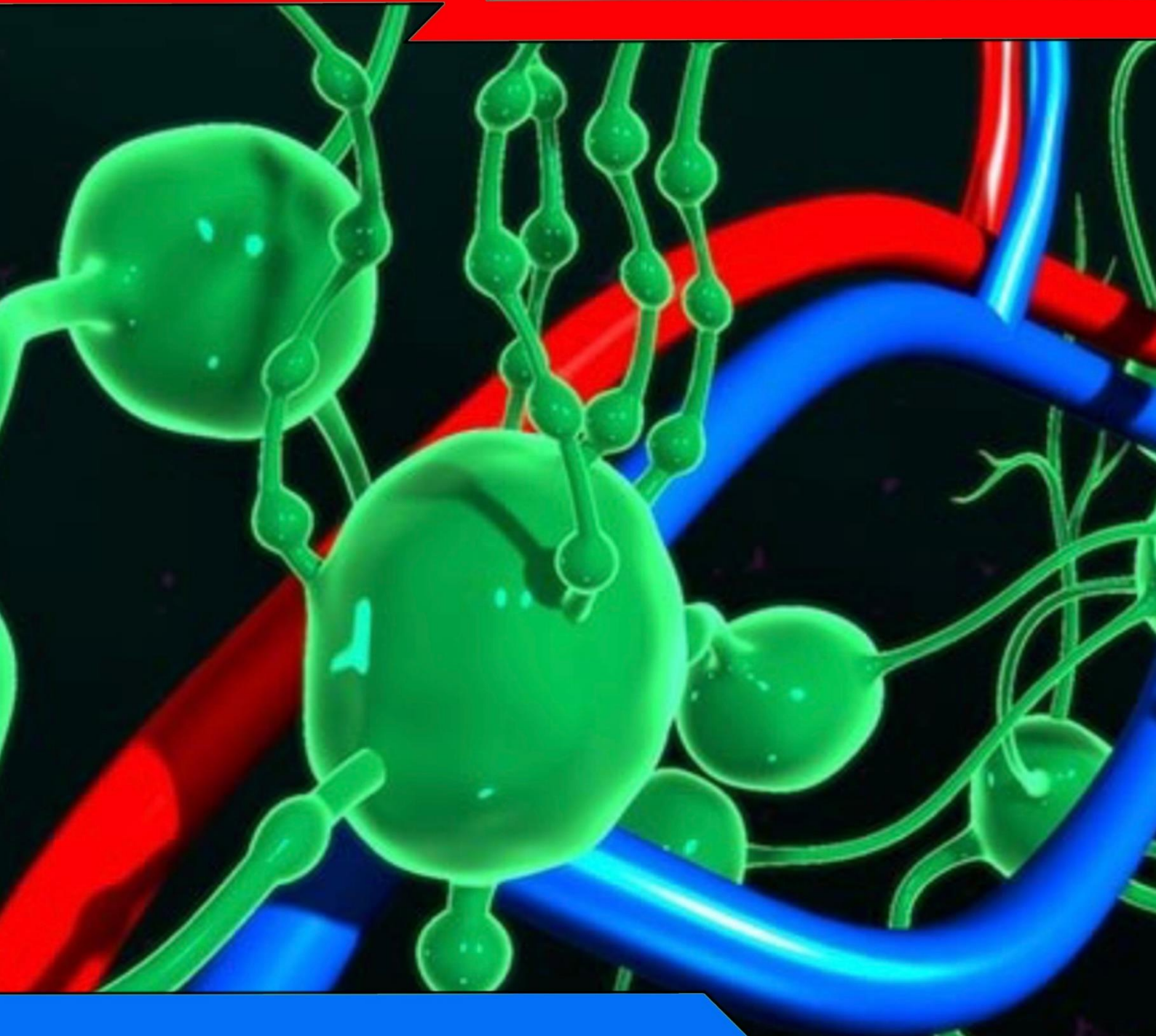


HATAHET ANATOMY



Lymphatic system

Lecture: 21

Pages: 8

Lecture 21: Lymphatic system

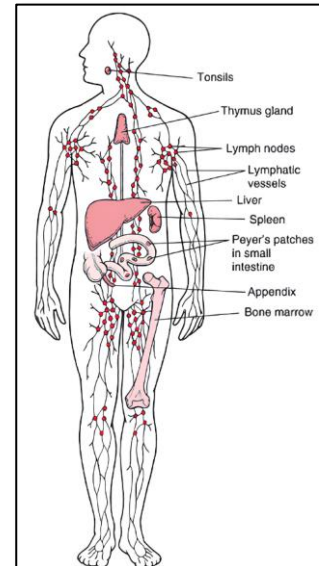
Introduction

- **Lymphatic system** is a network of vessels and organs that regulates the amount of fluid in the body and fights infections
- components of lymphatic system:

- ① **Lymph** → the ISF that filtrates in capillaries to extracellular space, contains: lymphocytes, pathogens, and cell debris
- ② **Lymphatic vessels and plexuses** → the tubes where the lymph circulates
- ③ **Lymphoid organs and tissues** → divided into: Primary & Secondary
- ④ **Lymph nodes** → checkpoints that filter lymph and store lymphocytes
- ⑤ **Lymphocytes** → the immune cells circulating in blood and lymph

- functions of lymphoid system:

- ① Drains excess interstitial fluid; the majority of ISF is drained back into blood by capillaries, and the rest is drained back by the lymphatic system
- ② Transports dietary lipids from intestines
- ③ Immune responses



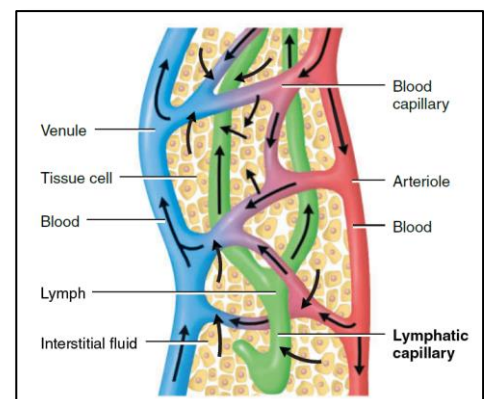
Anatomy of Lymphatic vessels

Lymph

- Lymph is a clear yellowish fluid within the lymphatic capillary and vessels
- an exception is the (Chyle); milky white
- origin of the Lymph:

- ① The plasma diffuses through the blood capillary into the Tissues
- ② 90% of fluid reabsorbed into the Bloodstream
- ③ 10% of the fluid stays in the Extracellular space as ISF
- ④ that remaining ISF gets absorbed into the lymphatic capillaries and becomes the Lymph

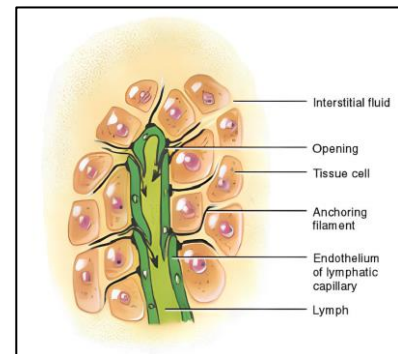
- **Chyle**: the lymph produced in the GIT, it is rich in fats which gives it a creamy white color
- **Lacteal**: specialized lymphatic capillaries in the GIT that absorb the chyle



Lymphatic capillaries (smallest) → **Lymphatic vessels** → **Lymphatic trunks** → **Lymphatic ducts** (largest)

Lymphatic Capillaries

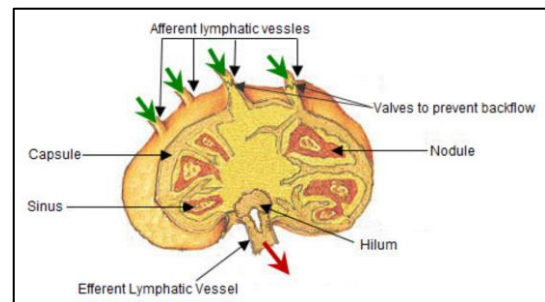
- **Lymphatic capillaries** are the smallest branches of the lymphatic system
- they collect the excessive ISF (Lymph) from the tissues
- characteristics of lymphatic capillaries:
 - ① closed ends; has one open side and one closed side
 - ② one-way tubes; lymph will not go back into the extracellular space
- characteristics of lymphatic vessels endothelium compared to blood vessels:
 - ① attenuated (كميته قليلة)
 - ② has no basement membrane
 - ③ internal overlapping between endothelium
 - ④ anchoring fibers that fix the lymphatic capillaries to surrounding tissue, and when the amount of ISF increases, these fibers will be tensed, and this tension is also applied to the endothelium; dilating those capillaries to hold more lymph



Lymphatic Vessels

- **Lymphatic vessels** are the thin tubes that carry lymph fluid throughout the body
- they have valves that prevent backflow of lymph
- divided into 2 main groups:

- ① **Superficial lymphatic vessels**
 - ♦ collect lymph from subcutaneous layer (under the skin)
 - ♦ follow the veins
 - ♦ drain into deep lymphatic vessels
- ② **Deep lymphatic vessels**
 - ♦ collect lymph from the viscera (internal organs)
 - ♦ follow the arteries



- lymphatic vessels run through the **Lymph nodes** that monitor the content of the lymph, and each node will have

- **Afferent lymphatic vessels** → carries lymph to the lymph node; entering the node
- **Efferent lymphatic vessels** → carries lymph from the lymph node back to lymph vessels after filtration

*****Note:** There are some tissues & organs that lack lymphatic vessels: (Cornea, Cartilages, CNS, Bone marrow, Teeth)

Lymphatic Trunks

- **Lymphatic trunks** are larger vessels that converge into the lymphatic ducts
- they are named according to the region of the body:

① 4 Paired Trunks

- A. Lumbar → drains: (Abdominal wall, Pelvic wall, Pelvic organs, Lower limbs)
- B. Bronchomediastinal → drains: (Lungs, Heart, Chest wall)
- C. Subclavian → drains: (Upper limbs)
- D. Jugular trunk → drains: (Head and Neck)

- ② **1 Unpaired trunk** → Intestinal trunk, drains (GIT organs) and opens in the Cisterna chyli

Lymphatic Ducts

- **Lymph ducts** are the largest lymphatic vessels
- they drain lymph from lymphatic trunks and return it to the bloodstream
- they drain at the junction between (**Internal jugular vein**) and (**Subclavian vein**)
- there are 2 lymphatic ducts in the body:

① **Right lymphatic duct**, collects lymph from the:

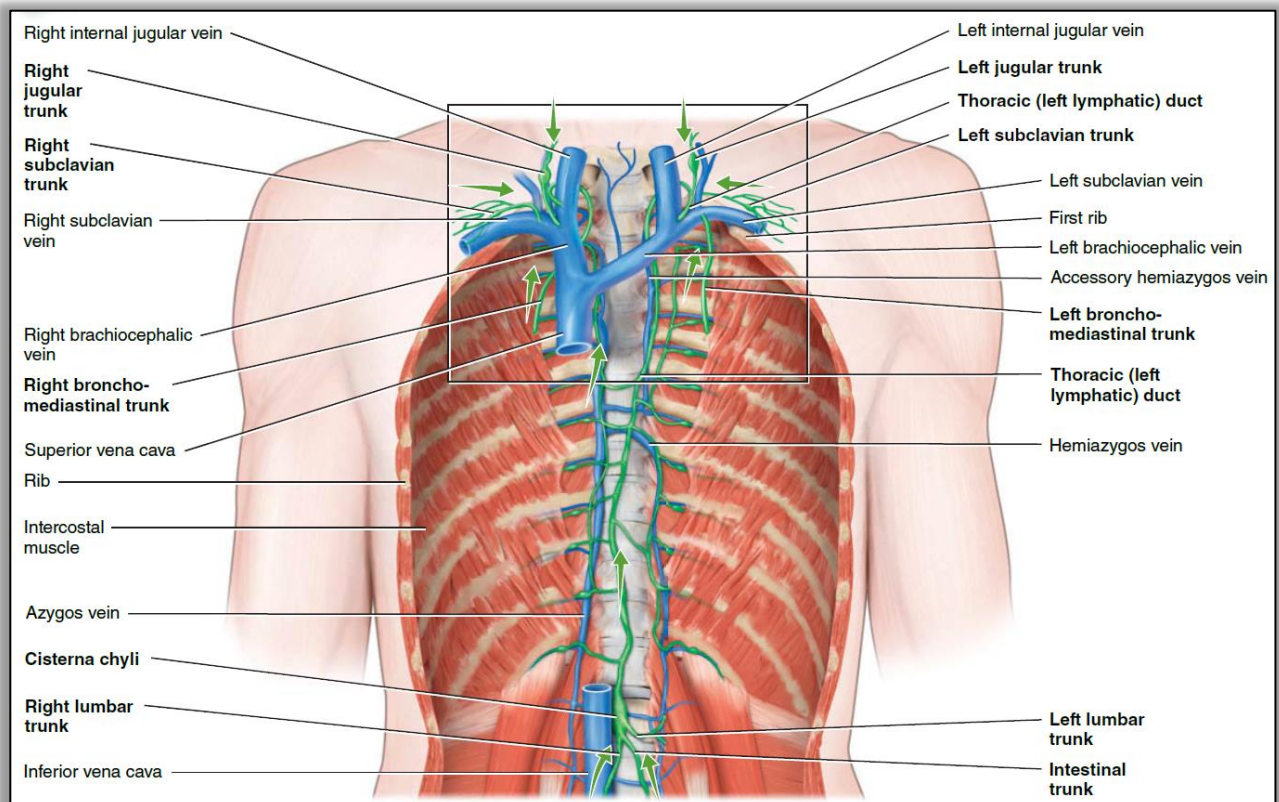
- R. Jugular trunk
- R. Subclavian trunk
- R. Bronchomediastinal trunk

② **Left lymphatic duct (Thoracic duct)**, begins at the **Cisterna chyli**, and collects lymph from the:

- L. Jugular trunk
- L. Subclavian trunk
- L. Bronchomediastinal trunk
- R&L. Lumbar trunks
- Intestinal trunk

▪ **Cisterna chyli**: lymphatic dilatation anterior to **L2** vertebral body, formed by the 2 Lumbar & the 1 Intestinal trunks

***Note: The thoracic duct initially ascends anterior and **right** to the vertebral column, then it will cross to the **left** side at the level of **T4-T5 IV disc** (سؤال امتحان)



Blood capillaries → Extracellular space → Lymphatic capillaries → Lymphatic vessels → Lymphatic ducts → Junction of the internal jugular vein and subclavian vein

Anatomy of Lymphatic organs

Primary organs

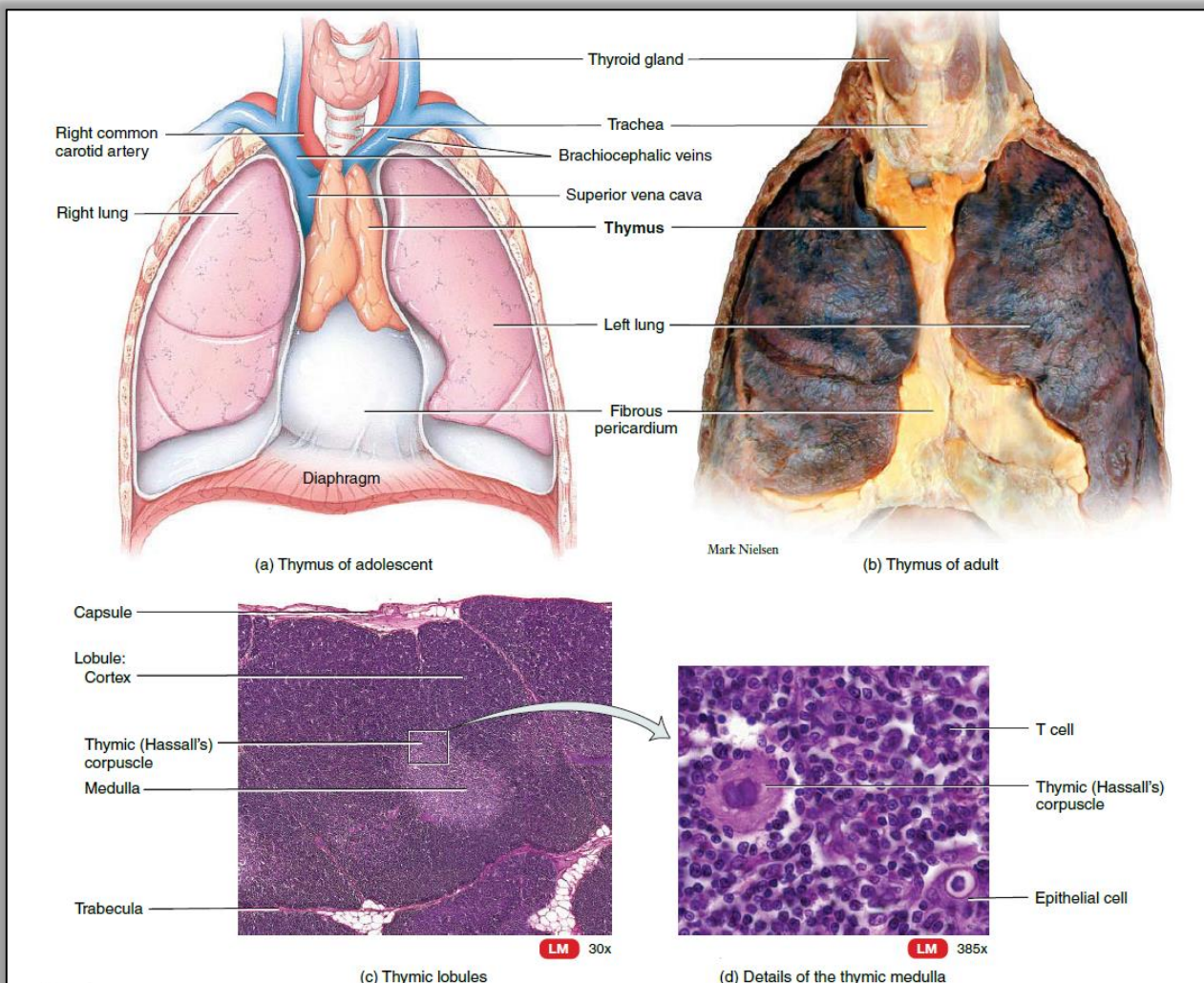
- these are the organs where stem cells divide & become **Immunocompetent** (mature & can stimulate immune response)
- consist of 2 organs:

➤ Bone marrow

- contains the stem cells of B&T lymphocytes
- the site of **B-lymphocytes** maturation & differentiation

➤ Thymus

- a bilobed organ in the thorax
- located between the sternum and aorta superior mediastinum
- the site of **T-lymphocytes** maturation & differentiation
- has a CT capsule that separates the 2 lobes
- divided into small lobules by inward extension of the capsule called (**Trabeculae**)



- each lobule consists of:

① Cortex

- ♦ the outer, deep-stained part
- ♦ contains: (immature “Naïve” T-cells)
- ♦ it is the site of Positive selection of T-cells, aided by Dendritic cells & Epithelial cells

② Medulla

- ♦ the inner, light-stained part
- ♦ contains: (Mature T-cells)

- T-cells leave the thymus via the blood migrate to the secondary lymphoid organs
- by the time of maturity, the gland considerably undergo Atrophy (الاضمحلال)

- **Thymic (Hassall's) corpuscles:** concentric layers of flat epithelial cells that degenerate and become filled with Keratin

Secondary organs

Secondary organs are the organs where T&B lymphocytes migrate after their maturation, these are:

➤ Lymph nodes

- scattered along the lymphatic vessels
- contain immune cells that monitor pathogens
- their hilum is at the concave side where the efferent vessels leave
- the parenchyma (aka the functional part) of a lymph node is divided into:

① Cortex, which is further divided into:

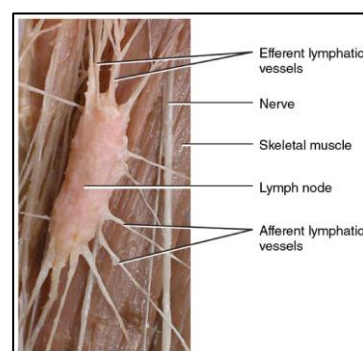
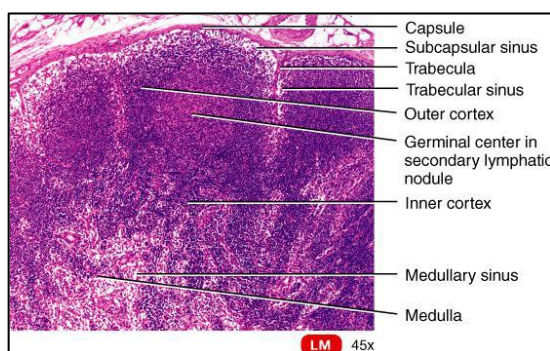
A. Outer cortex:

- ♦ houses aggregations of B-cells
- ♦ contains follicles called (Primary lymphatic nodules)
- ♦ when there is an immune response, the B-cells will become active by what is called (Antigen challenge), and the lymphatic nodules will transform into the **Secondary lymphatic nodules** with lightly-stained **Germinal centers**

B. Inner cortex:

- ♦ houses the T-cells and Dendritic cells
- ♦ **devoid of lymph nodules**

② Medulla, contains: (B-cells, Plasma cells, Macrophages)



Afferent vessels → Subcapsular sinus → Trabecular sinuses → Medullary sinuses → Efferent vessels

➤ Spleen

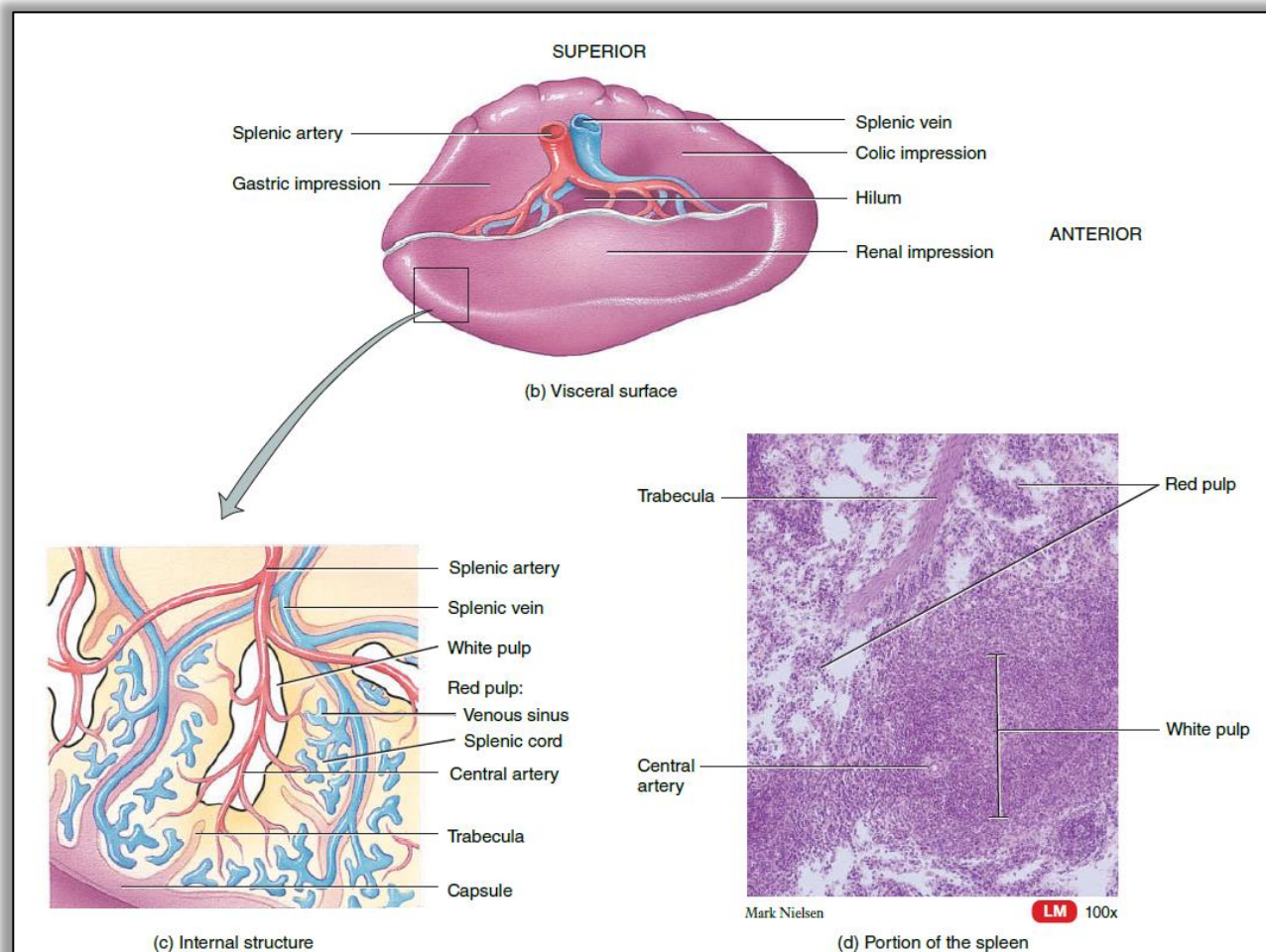
- it is the largest single mass of lymphatic tissue
- lies between the stomach and diaphragm
- its medial (visceral) surface has 3 impressions:
 - Gastric impression (anterior) → Stomach
 - Colic impression (inferior) → Left colic flexure
 - Renal impression (medial) → Left kidney
- splenic hilum lies on the visceral (medial) surface of the spleen
- the parenchyma of spleen is divided into:

① White pulp

- ♦ lymphocytes & macrophages are arranged around a Central artery
- ♦ functions in immunity in general

② Red Pulp

- ♦ composed of 2 structures:
 - Blood-filled venous sinuses
 - Splenic cords (Cords of Billroth), contains: (RBCs, Macrophages, Lymphocytes, Plasma cells, Granulocytes)
- ♦ functions:
 - removal of defective blood cells
 - storage of platelets (33% of all body platelets are stored in the spleen)
 - hemopoiesis (production of blood cells) during fetal life



Lymphatic tissues

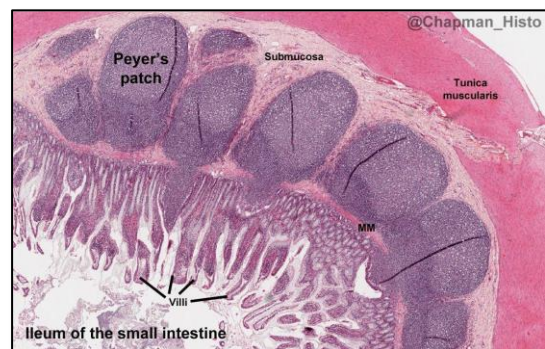
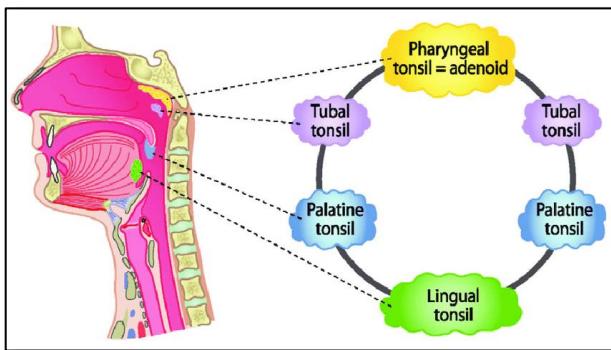
"The difference between a lymphatic organ and a lymphatic tissue is **the presence of a capsule** that divides it into lobes"

- considered a Secondary organs/tissues
- these are:

➤ Appendix

➤ MALT (Mucosa-Associated-Lymph-Tissue)

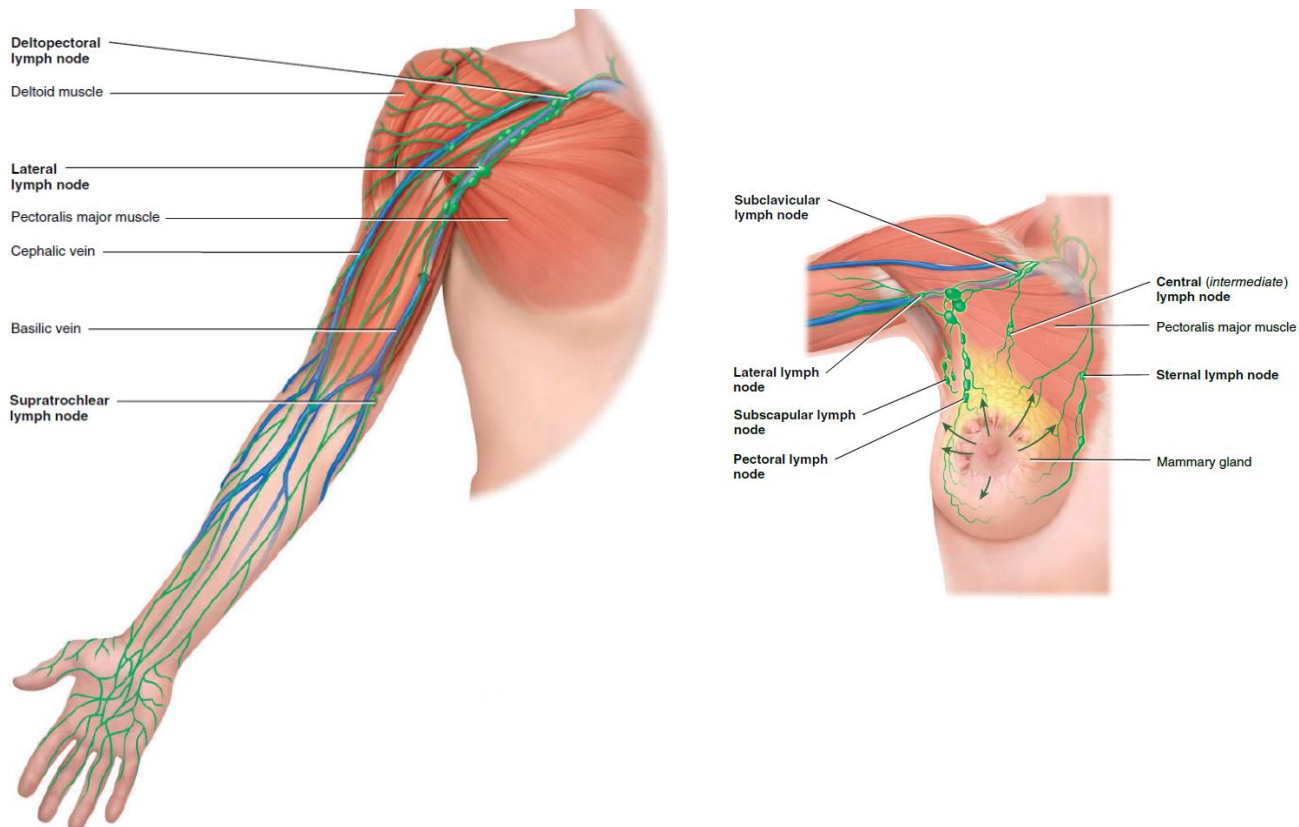
- MALT are masses of lymphatic tissue
- found within the lamina propria of: (GIT, UGS, RS)
- many of them are small and solitary (singular), and some are large aggregations like:
 - ❶ Tonsils in nasopharynx and oropharynx
 - ❷ Peyer's patches (GALT - Gut-Associated Lymphatic Tissue) in the ileum of small intestine



Lymph nodes to memorize

Axillary lymph nodes

Lymph node	Location	Drainage
Lateral nodes	medial and posterior to axillary artery	- the entire upper limb
Pectoral nodes (Anterior)	inferior border of Pectoralis minor	- anterior and lateral thoracic wall - central and lateral of breast
Subscapular nodes (Posterior)	subscapular artery	- posterior thoracic wall - posterior part of neck
Central nodes (Intermediate)	base of axilla	- lateral, anterior, and posterior nodes
Subclavicular nodes (Apical)	superior and posterior to pectoralis minor	- deltopectoral nodes



Inguinal lymph nodes

Lymph node	Location	Drainage
Popliteal nodes	in adipose tissue in popliteal fossa	- knee - portions of leg and foot, especially heel
Superficial inguinal nodes	parallel to Great saphenous vein	- anterior and lateral abdominal wall to umbilicus - gluteal region, external genitals, perineal region - superficial lymphatics of lower limb
Deep inguinal nodes	medial to Femoral vein	- deep lymphatics of lower limb - penis in males and clitoris in females

