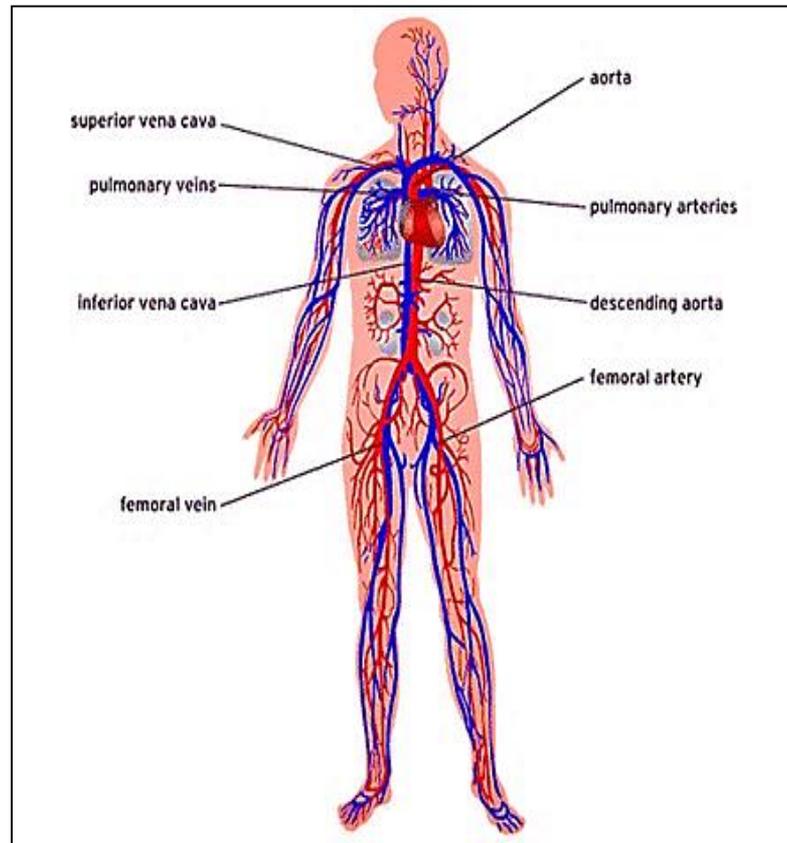


The vascular system

Professor Dr. Hala El-mazar 2022
(Lecture 2)



Professor Dr. Hala El-mazar

microcirculation

Composed of :

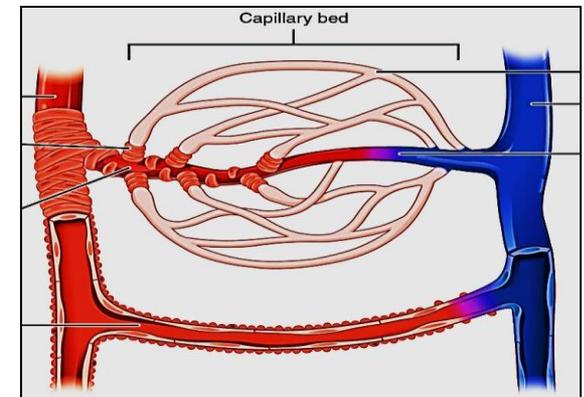
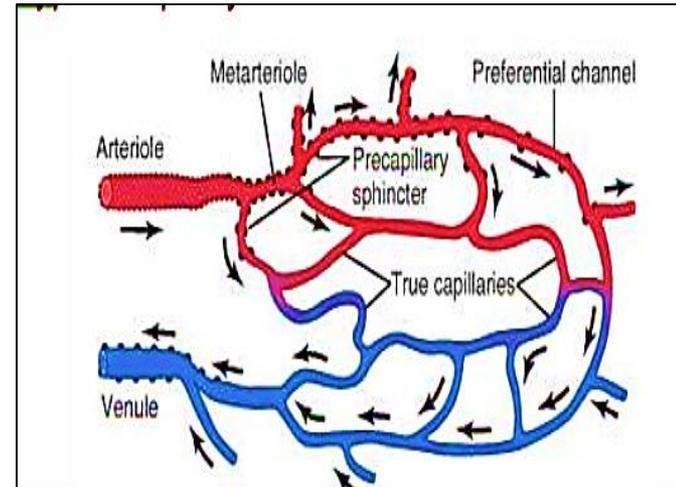
- Terminal arterioles → metarterioles → capillaries → Thoroughfare channel → post-capillary venules

- Capillaries are where exchange between blood & tissue fluids occur

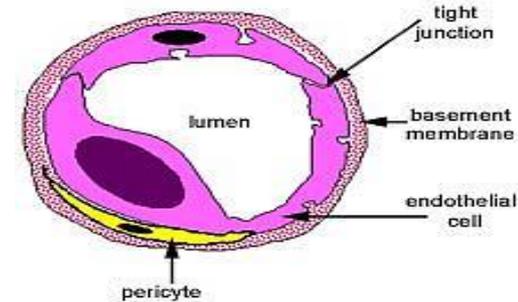
- **Capillaries:**

- * Continuous
- * Fenestrated
- * Sinusoidal

- **Arterio-venous anastomosis**



- Most of microcirculation are lined by **one or two endothelial cells** and many of them are **surrounded by pericytes**



Function of endothelial cells:

1. Permeability

- Allows exchange of water, CO₂ and metabolites between blood and tissue
- Allows migration of leucocytes from blood to tissue (diapedesis) during inflammation.
- Forms Blood Brain Barrier by the tight junctions between the endothelial cells

2. Metabolic function:

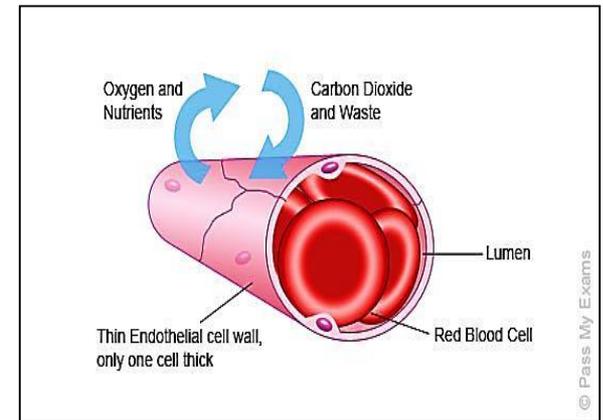
- Activates angiotensin I to Angiotensin II, cuz the endothelial cells have the converting enzyme (role in bl pressure)
- Inactivates bradykinin, serotonin, prostaglandin, norepinephrine & thrombin into inert compounds
- Breaks down lipoproteins into triglycerides and cholesterol

3. Nonthrombogenic function

- Platelets normally do not adhere to an intact endothelium because Prostacyclin is released by endothelium which is a powerful inhibitor of platelet aggregation and thus prevents clot formation

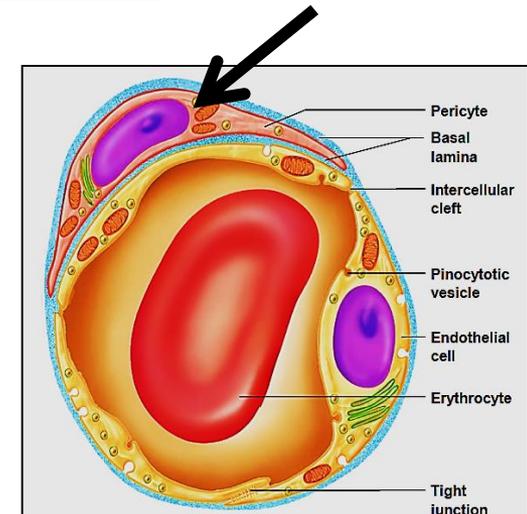
Capillaries

- the smallest blood vessels 5- 8 μm
- 90% of all blood vessels of body

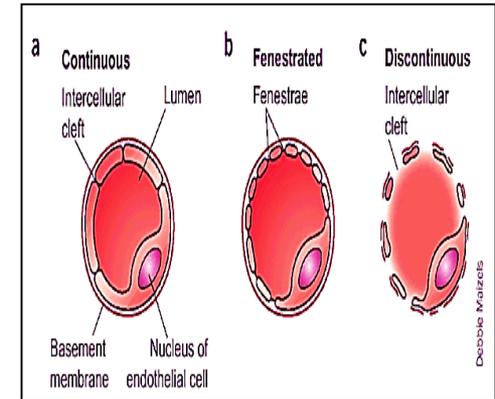
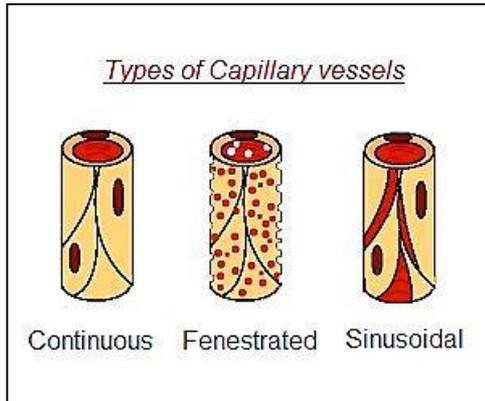


- Is where exchange of water and nutrients occur between blood and tissues hence called (Exchange vessels)
- Wall is formed by a single layer of endothelial cells + Pericytes + basal lamina , **NO smooth ms cells**

Pericytes: branched cells, stabilize capillary wall, control permeability (contract) , play role in vessel repair



Types of capillaries



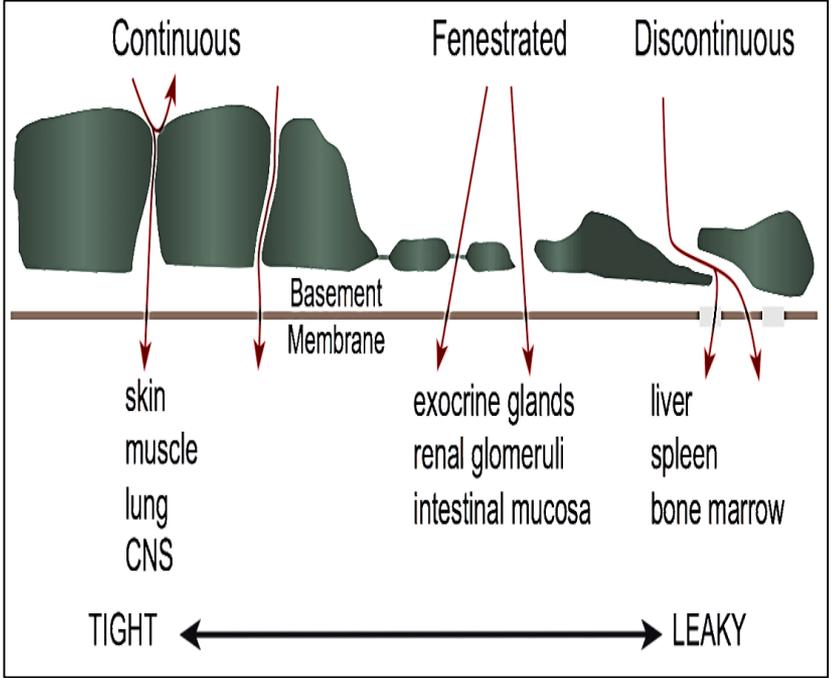
**Continuous
(Somatic)**

**Fenestrated
(Visceral)**

**Discontinues
(Sinusoidal)**

**Depends on the continuity of endothelial cells (pores & intercellular clefts)
& the basal lamina**

- **Continuous (somatic):** tight junctions between the cells .Continuous basal lamina
- has the lowest permeability (water, ions, lipid soluble m)
(diffusion , transcytosis)
- **Fenestrated (visceral):** cells have pores may be/ may be not covered by diaphragm, continues basal l. relatively high permeability

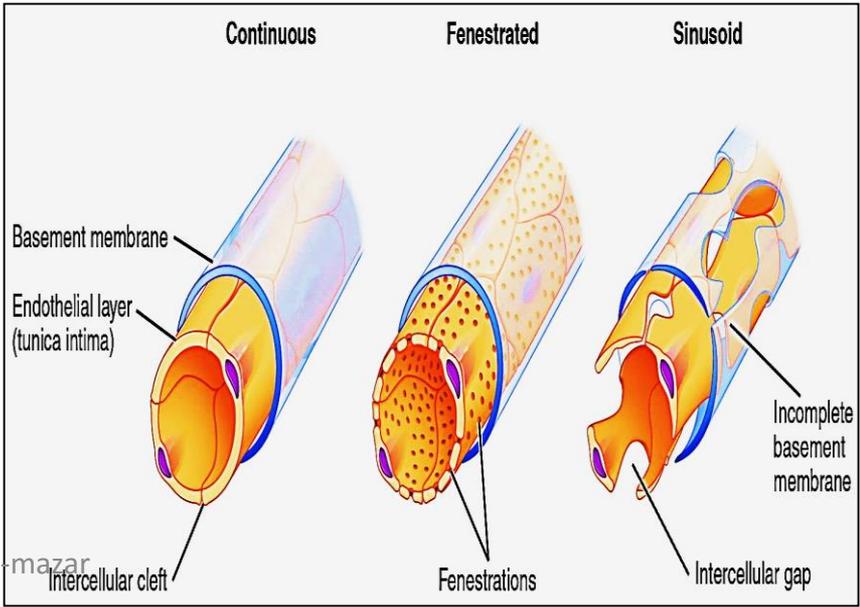


(active filtration, reabsorption, hormone secretion)

No diaphragm: renal glomeruli

Has diaphragm: intestine & endocrine gland , pancreas

- **Sinusoidal:** Extremely highly permeable (permit cross of cells & serum proteins)
Liver, spleen , bone marrow



Blood capillary

Blood sinusoid

1- Narrow regular lumen
(5-8 μm)

1-Wide irregular lumen
(30-40 μm)

2- Uniform diameter

2- Variable diameters & tortuous

3-Continuous or fenestrated
endothelium

3- Always fenestrated

4- Complete basal lamina

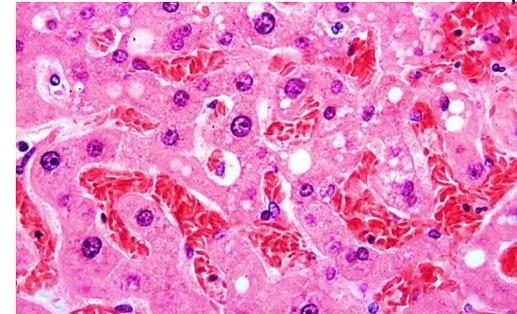
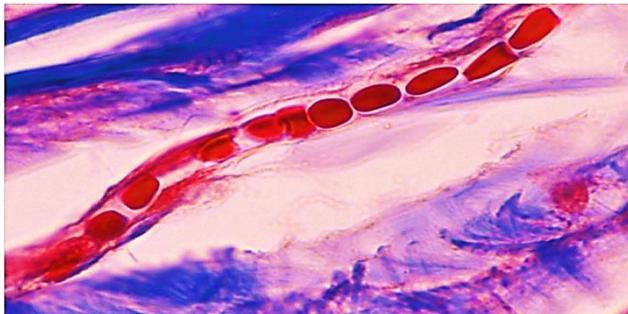
4- Incomplete basal lamina

5-Surrounded with
Pericytes

5- Contain macrophages e.g. **Littoral cells (spleen), Kupffur cells (liver)**

6-Present in all tissues

6- present in certain sites as :bone marrow, spleen, liver & Endocrine glands.

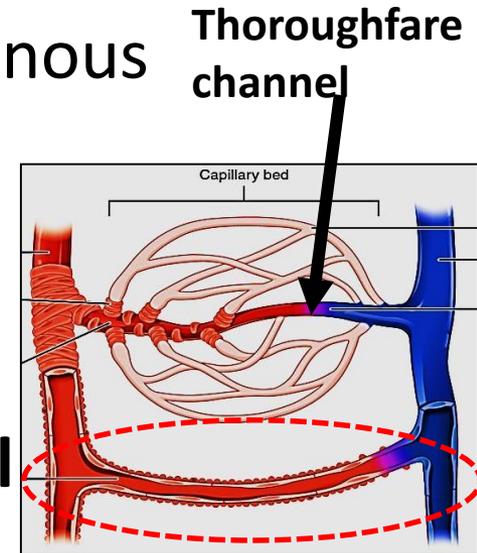


Arterio- venous anastomoses (AVA)/ Shunt

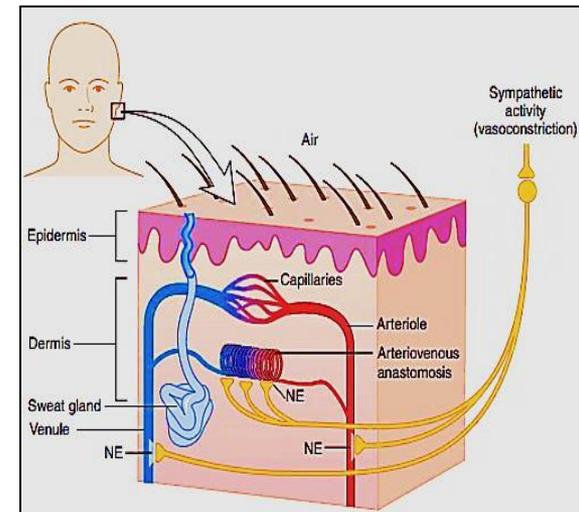
Direct connection between arterioles & venules without passing through capillary bed → ↑ venous return to the heart

Conditions:

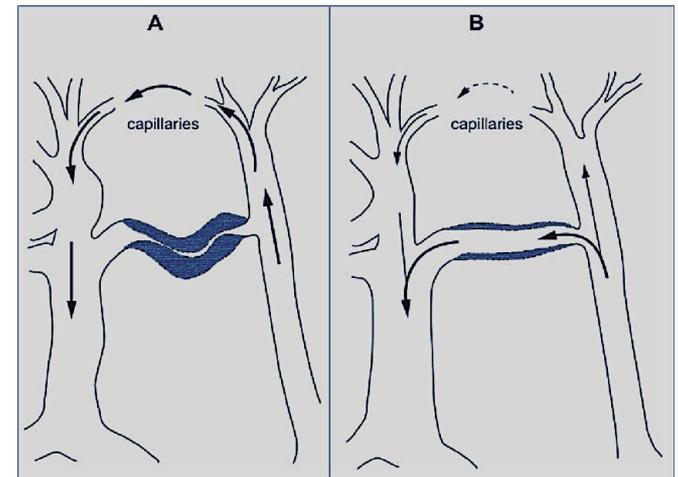
A- contraction of pre- capillary sphincters → Blood will pass through **thoroughfare channel**



B- AV anastomosis: small vessels connect directly arterioles to venules

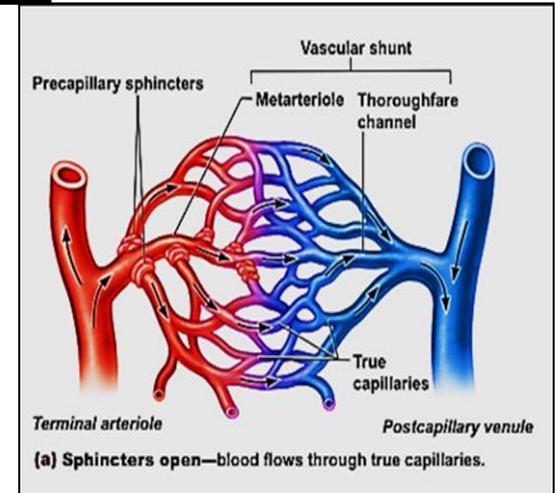


- The AVAs are short vessel with a large inner diameter 10 - 150 μm & a thick muscular wall , with no capillary section between them
- They are densely innervated by adrenergic fibers When they open they provide a low resistance connection between arteries and veins
- AVAs play important role in temperature regulation
e.g. skin (hands & feet)
Blood flow in genital organs



Post -capillary venules

- Post- capillary venules form when capillaries re-unit ,they drain the capillary bed
- Its structure is similar to capillaries
- Porous , allow passage fluids & WBCs into tissues (as capillaries do)



- The post capillary venules in paracortex of lymph node are lined by tall cuboidal endothelial cells and are called high endothelial venules (HEV) (entrance of T lymphocytes to LN)
- Respond to vasoactive agents e.g. histamine H., also site of exchange of materials between tissue fluid & blood
- The venules converge to form collecting venules → muscular veins

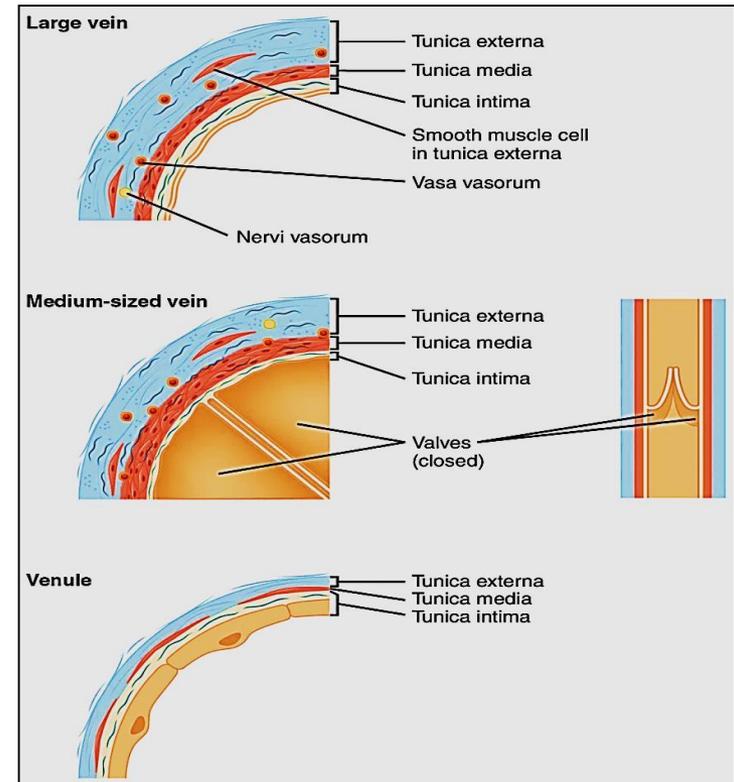
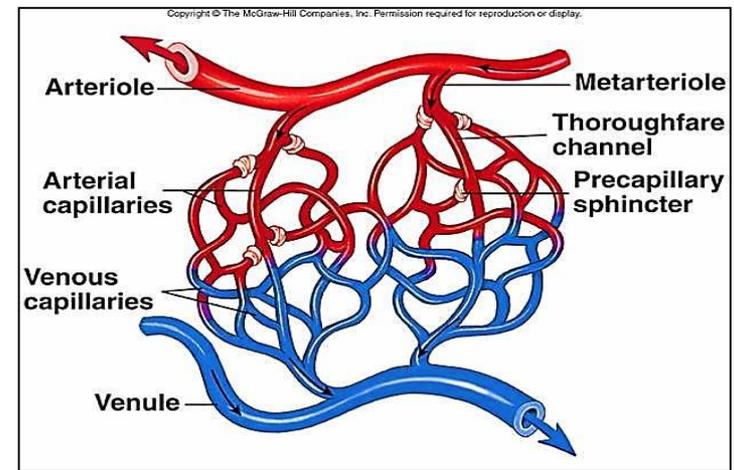
venules

- The smallest veins (20- 30 μm)

Intima: endothelium

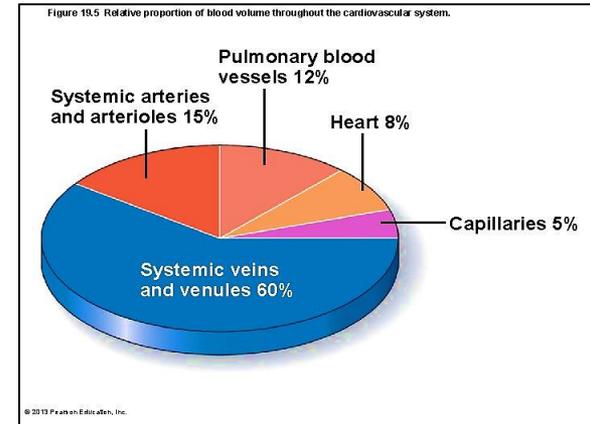
Media: 1 or 2 layers of smooth ms. cells, The thickness \uparrow as the vessel diameter increases

Adventitia: relatively thick



Medium size veins

- Carry blood toward → heart.
- The blood pressure in veins is much lower than arteries

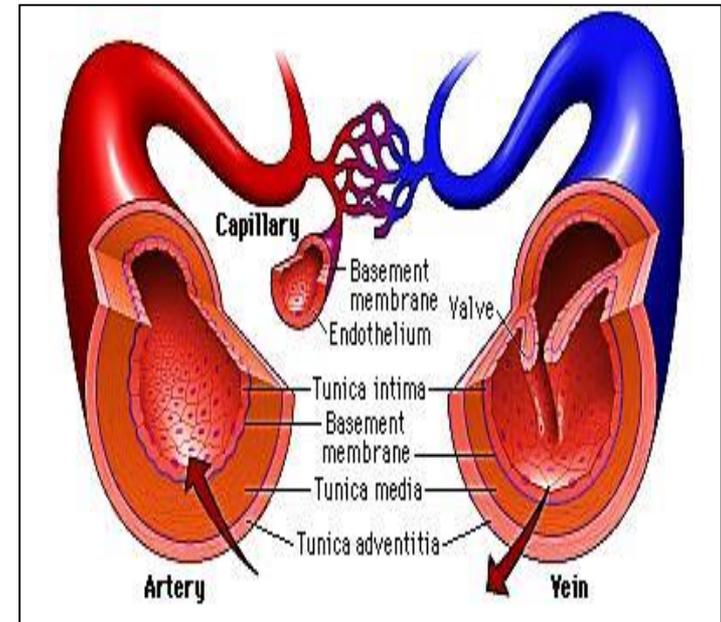


- Veins have 3 tunics, but thinner walls with wider lumen comparing with corresponding arteries... cuz they can hold most of the blood, called capacitance vessels

- Tunica media is thin , adventitia is thick

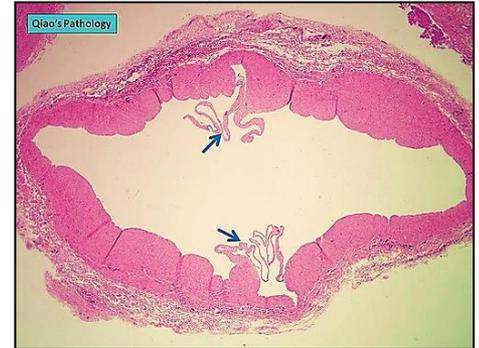
- **Valves are** special adaptation in the veins helps return of blood to heart & prevents its back flow

- **Valves absent in small & large veins**

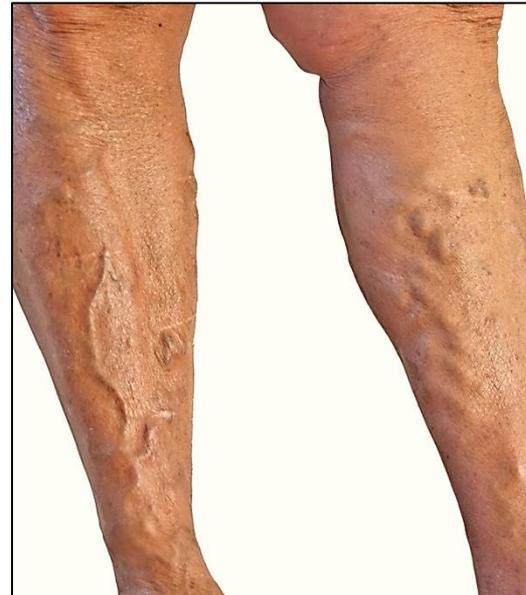
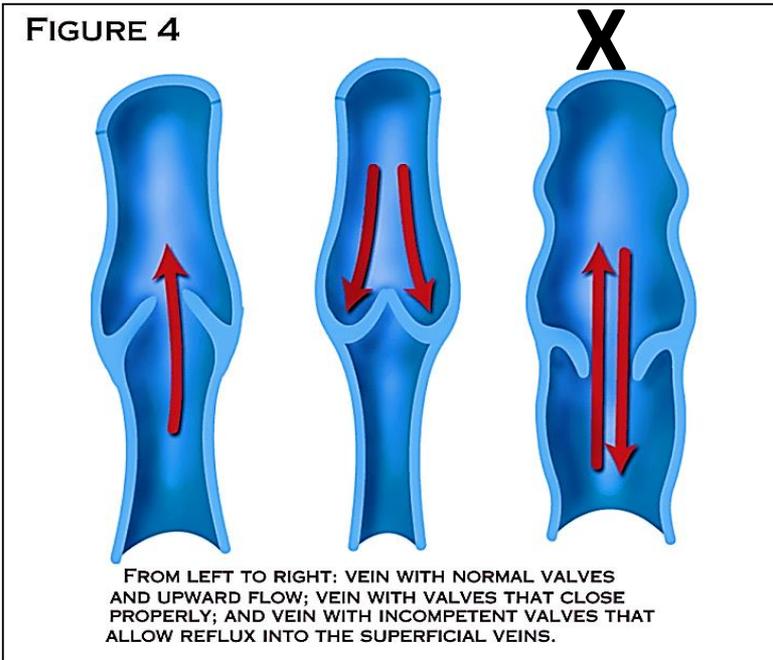


Valves:

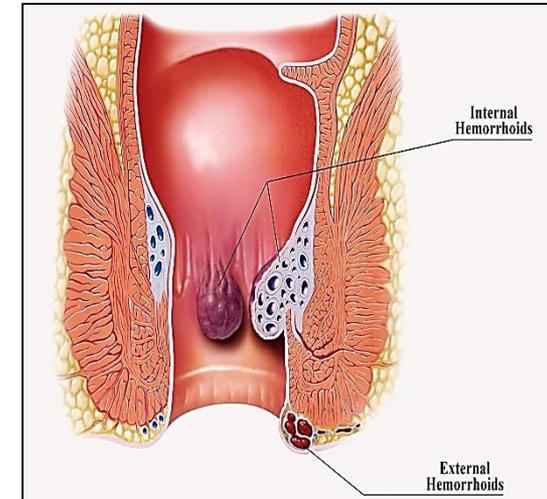
- are folds project from intima into lumen of the vein
- Lined on both sides by endothelium,
- their core formed of elastic tissue
- Most abundant in veins of limbs



Valves



Varicose veins



Hemorrhoids

Vena cava (inferior & superior)

Tunica intima: thin

Endothelium – sub-endothelial CT– **No IEL - No valves**

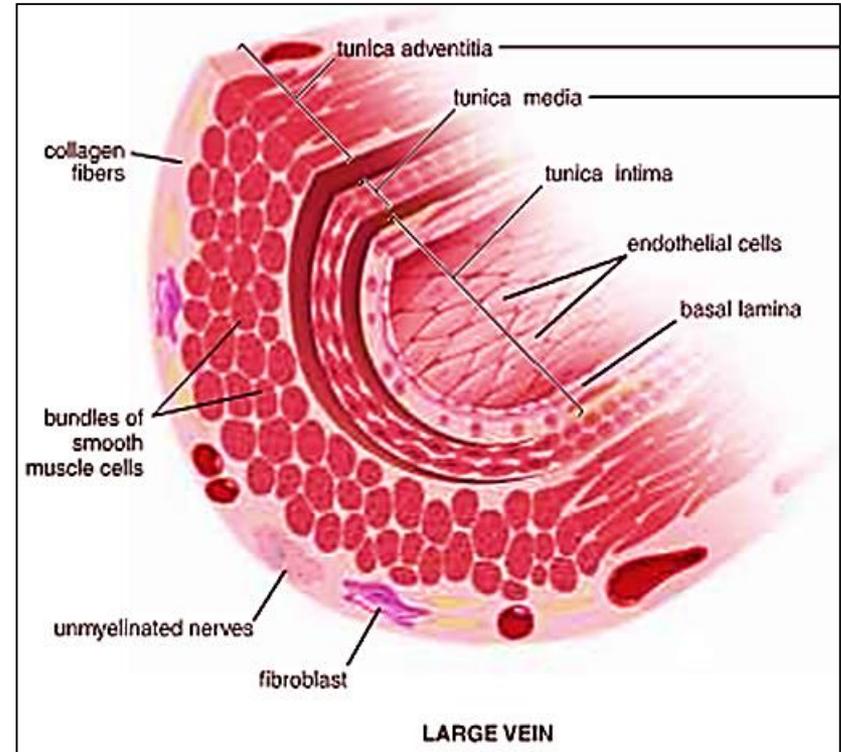
Tunica media:

thin layer, smooth ms, elastic, collagen fibers

Tunica adventitia:

Thick, contains **longitudinal bundles of smooth ms fibers**

facilitate shortening & elongation of the vena cava with respiration.



Medium sized

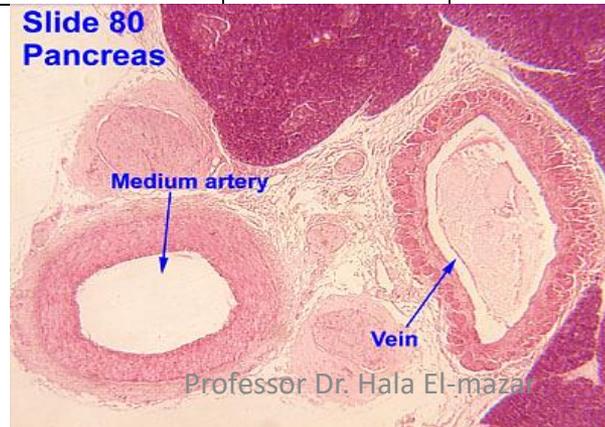
artery

and

vein

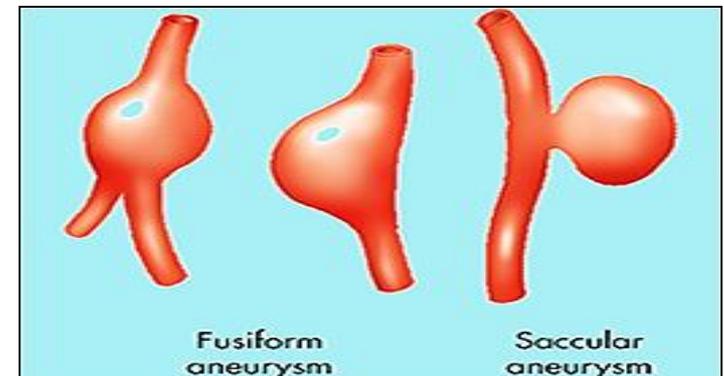
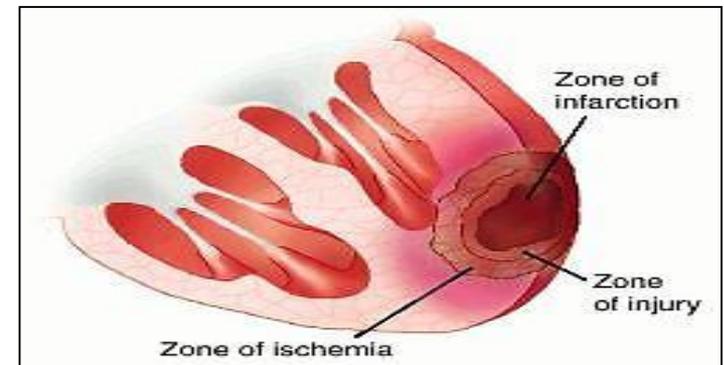
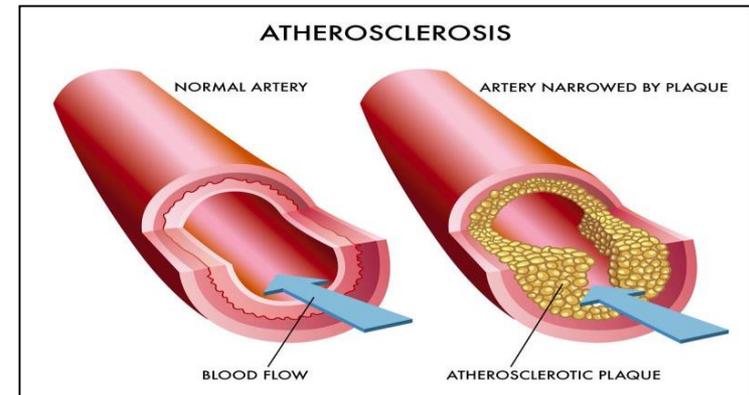
- Narrow lumen
- Thick wall
- No valves
- Intima (thick, IEL)
- Media (thick)
- Adventitia (thin)
- Rapid flow of blood

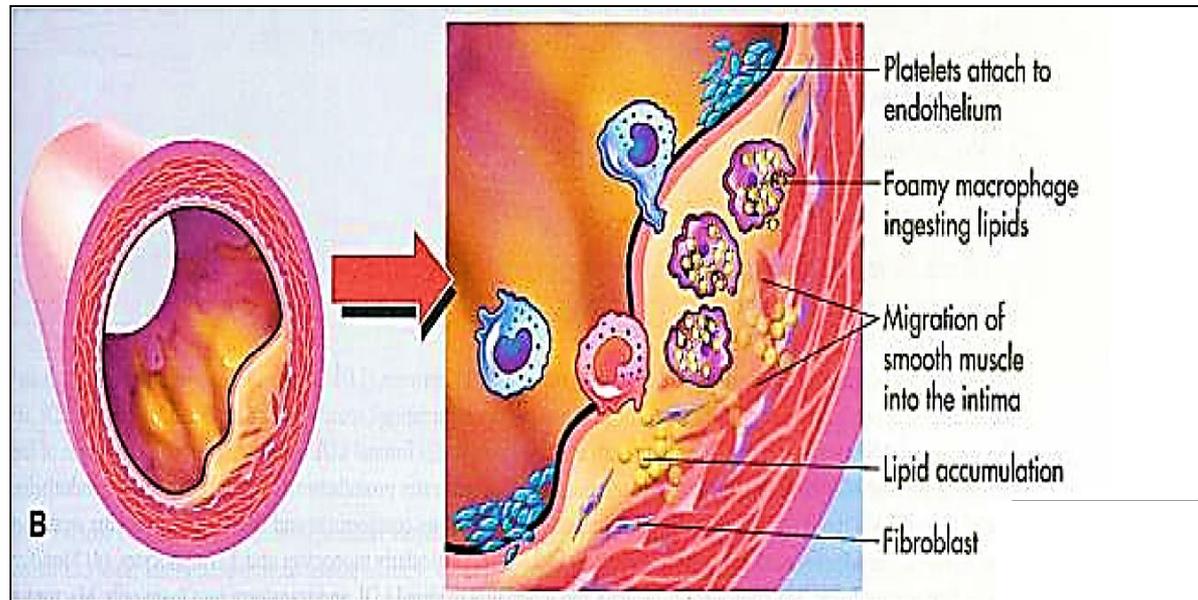
- Wide lumen (offer little resistance)
- Thin wall
- Valves
- Thin, no IEL
- Media (thin)
- Thick
- Slow flow of blood



Medical applications

- **Atherosclerosis:** focal thickening of the intima of arteries due to deposition of cholesterol (lipid plaques) (Foam cells)
- **Infarction:** death of tissue due to lack of blood supply
- **Aneurysm:** marked dilation of BV due to weakening of tunica media → rupture & hemorrhage.





Foam cells

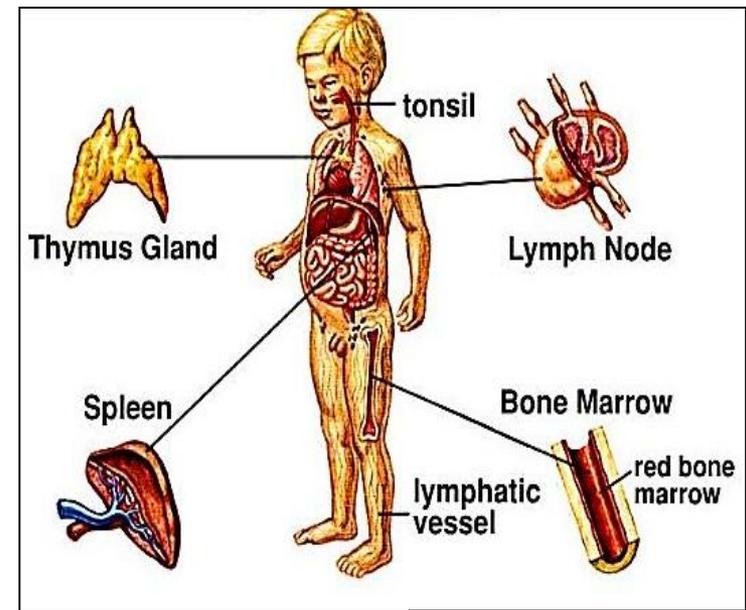
Atherosclerosis: when the endothelial cells damage → ↑ permeability of arterial wall → LDL enter to tunica intima → damaged endothelial cell will attract WBCs , WBCs will squeeze itself and enter by diapedesis to reach intima layer. WBCs will release free radicals that will oxidize LDL molecules.

**Macrophages in tunica media start to engulf the LDL particles → foamy appearance
Accumulating lipid & dead cells will form plaque, the plaque will deposit Ca⁺ → hardening of the wall as atherosclerosis .**

If endothelial over the plaque is compromised blood clots can form (thrombus) which may break → emboli

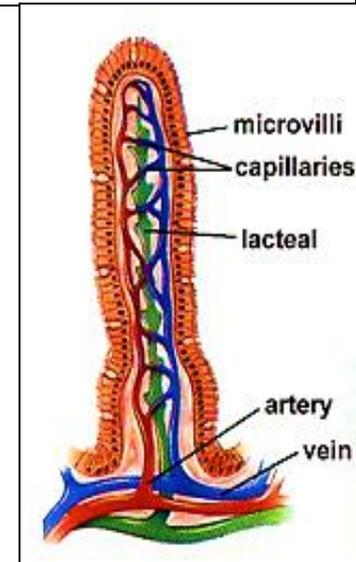
Lymphatic system consists of:

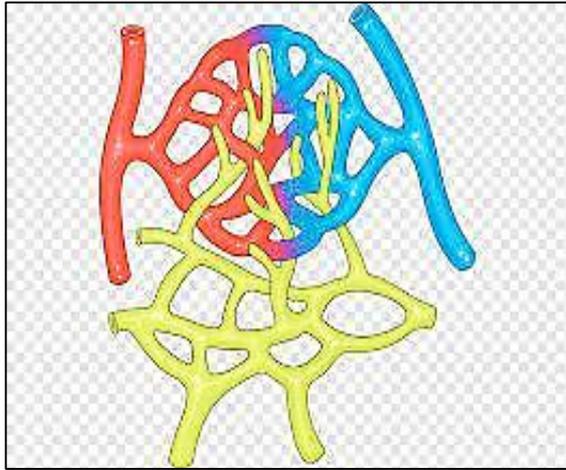
- Lymph fluid
- Lymphatic vessels
- Lymphoid tissues & organs



Function of lymphatic system :

- Fluid balance: carry excess tissue fluid back to circulation
- Fat absorption: transport fat from GIT to blood
- Immunological & defense function : Produces, maintains & distributes lymphocytes and filtrate lymph & blood





Lymphatic vessels

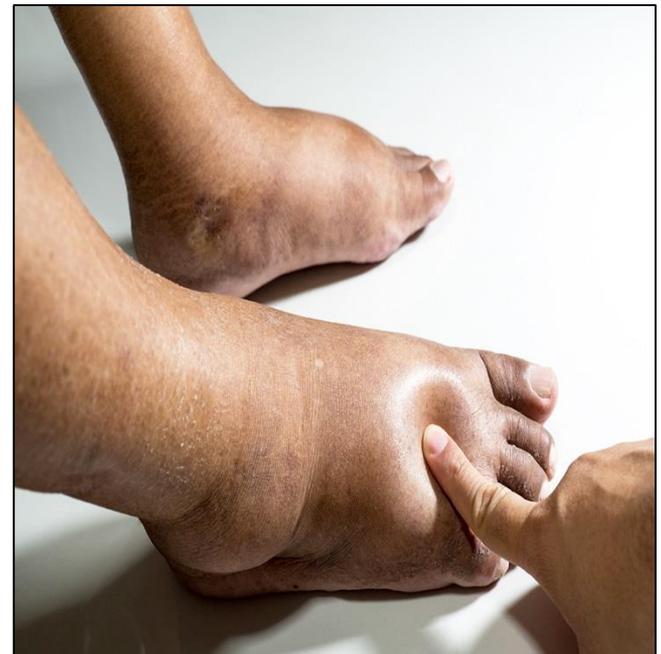
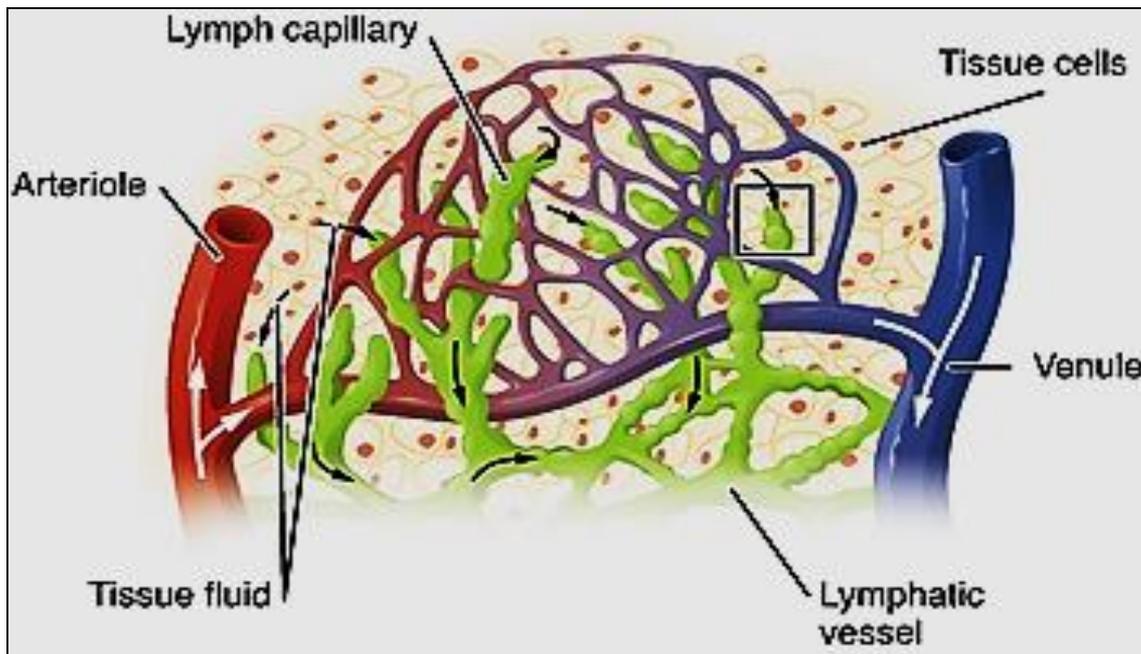
L. Capillaries
(Blind ended)

**Medium
size L.
vessels**
(Valves)

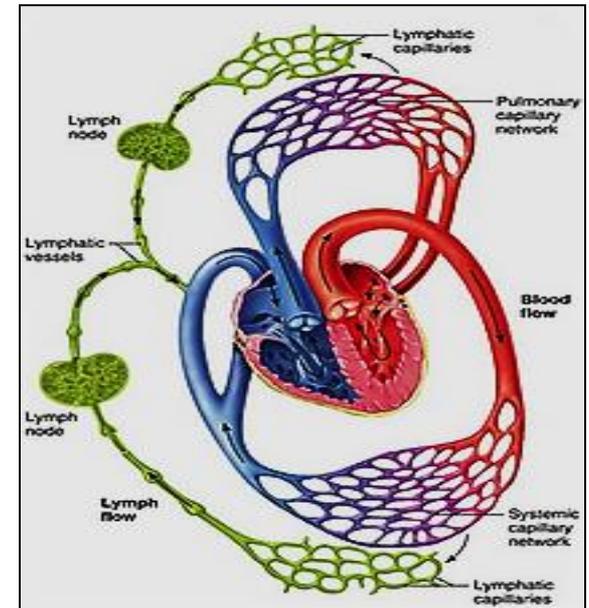
L. Ducts
(like veins)

Lymph

- **Lymph** is a colorless fluid that circulates through the lymphatic system
- The lymph is formed when the interstitial fluid is collected through lymph capillaries



- lymph composition continually changes as the blood and the surrounding cells continually exchange substances with the interstitial fluid
- Generally similar to blood plasma + water + immune cells WBCs (lymphocytes & macrophages)
- Lymph returns proteins and excess interstitial fluid back to the blood stream. Venous blood
- Lymph may pick up bacteria & pathogens and large particles (fat) and bring them to lymph nodes where they are destroyed by immune cells → blood stream



lymph circulation: interstitial fluid will drain into

lymph capillaries



lymph vessels



lymph nodes



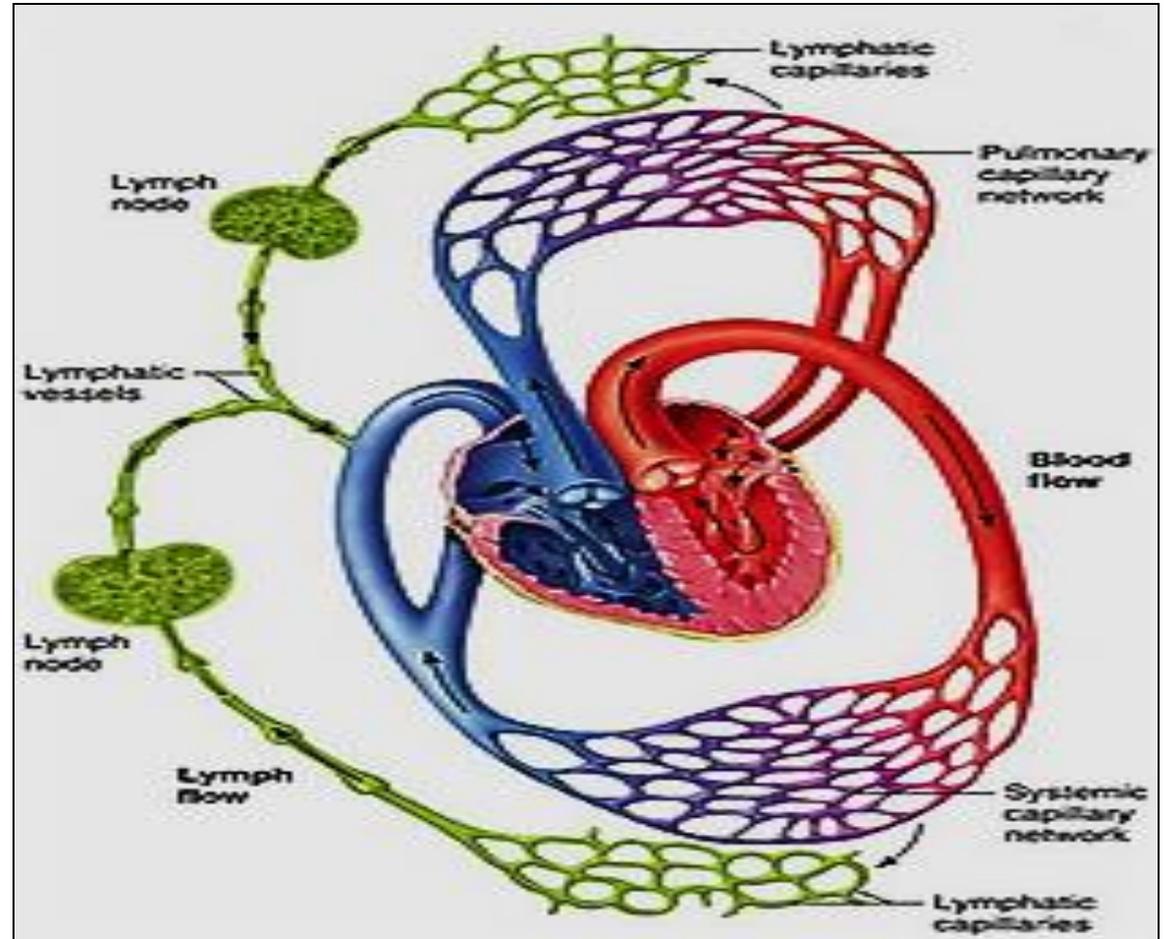
Lymphatic vessels



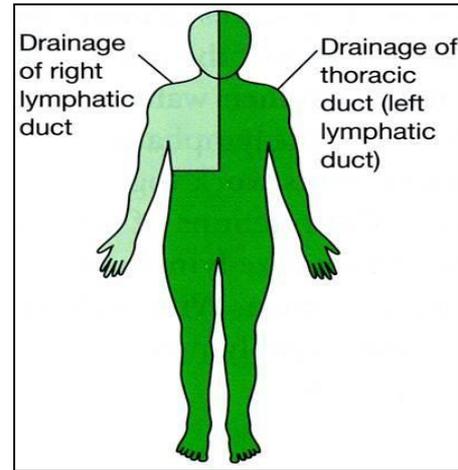
Lymphatic duct



ultimately emptying into the **right** or the **left subclavian vein**, where it mixes back with blood.



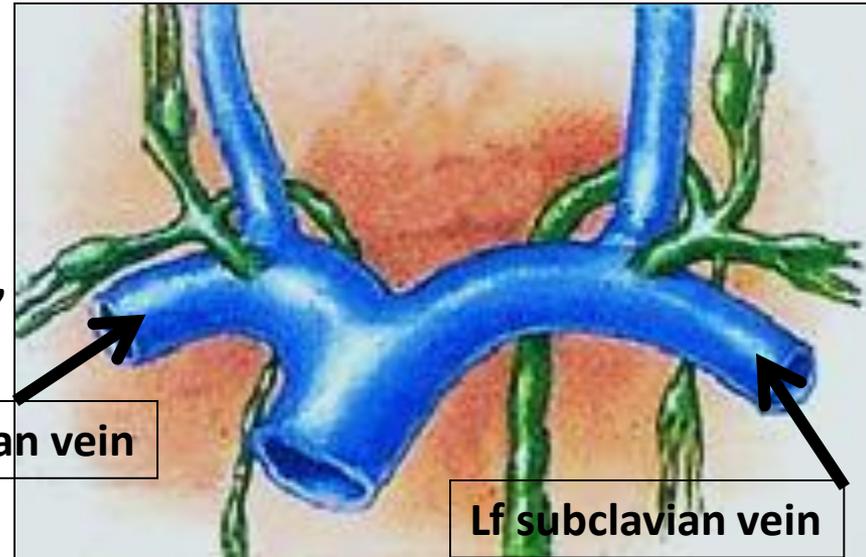
- lymph vessels similar to veins in structure
One direction & contain valves
- they pass through the lymph nodes where filtration of the lymph from bacteria occurs



- Lymphatic vessels ultimately drain lymph into 2 main ducts:

➤ Right lymphatic duct

Drains right side of head & neck, right arm, right thorax → into the right subclavian vein

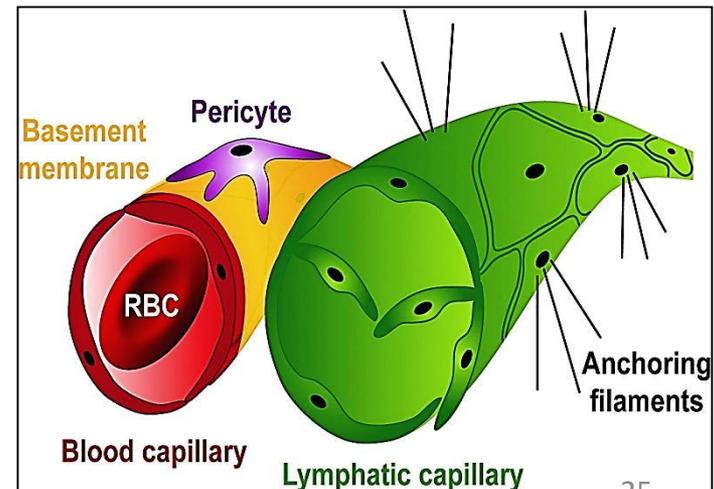
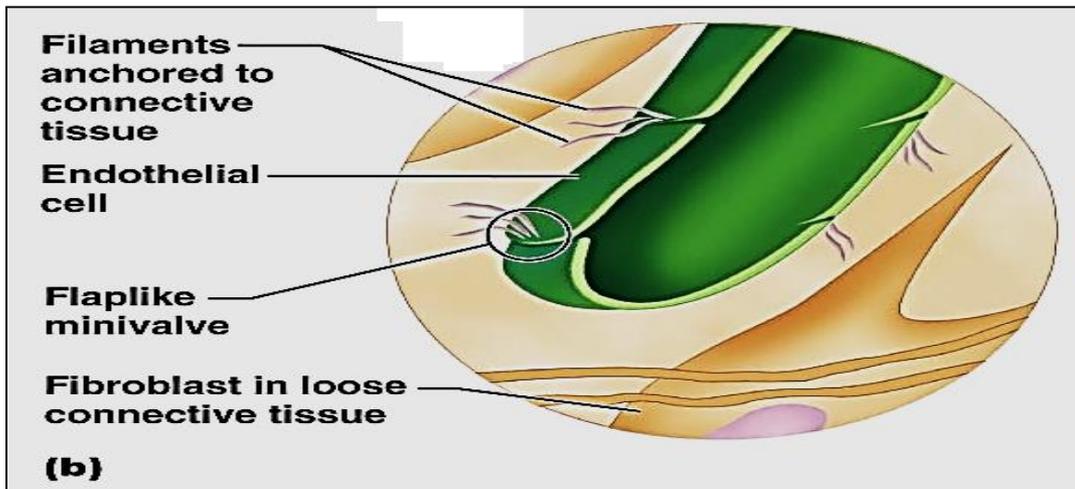
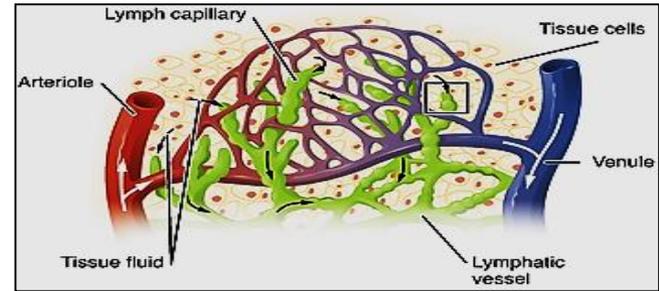


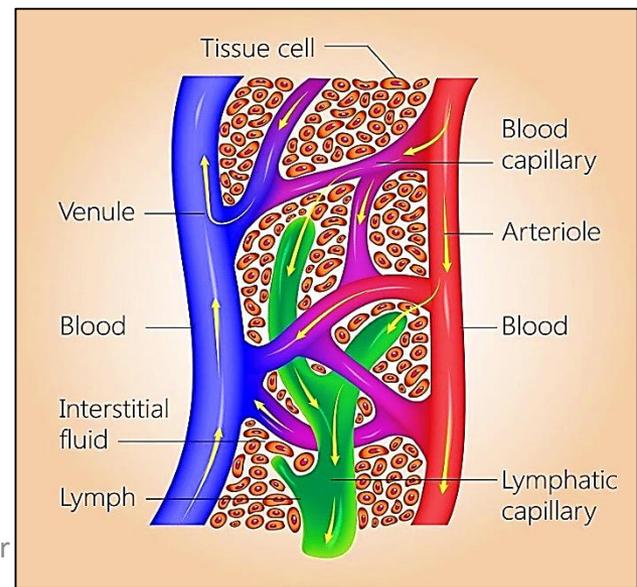
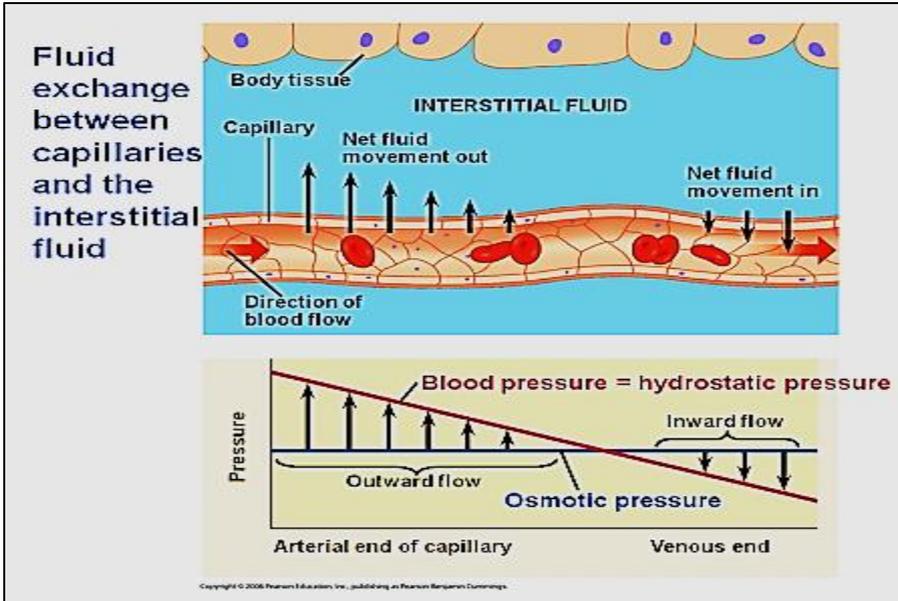
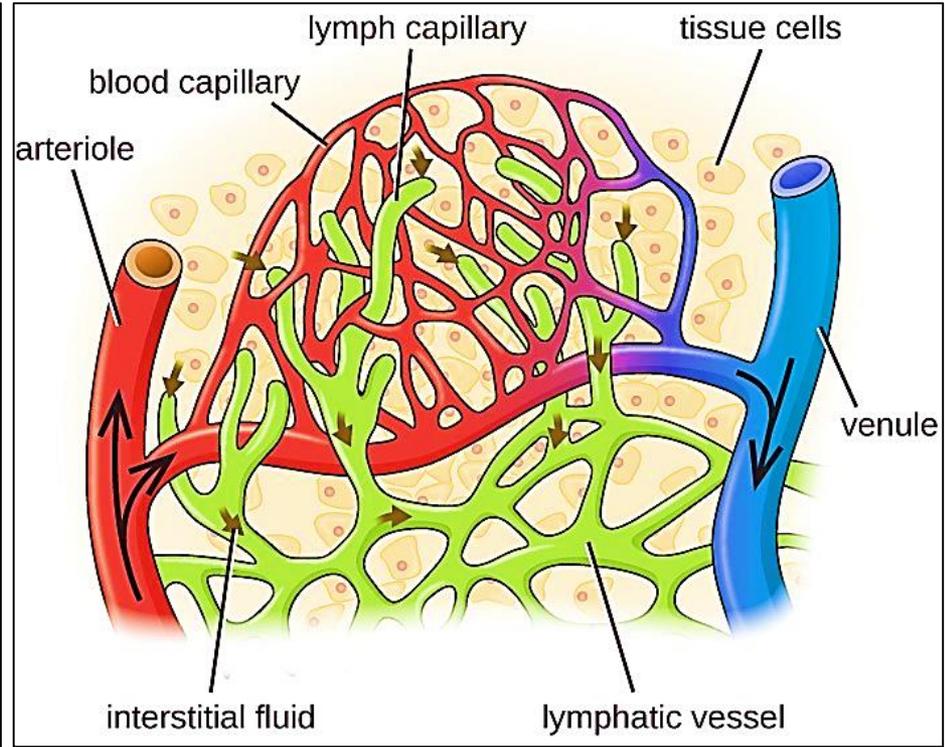
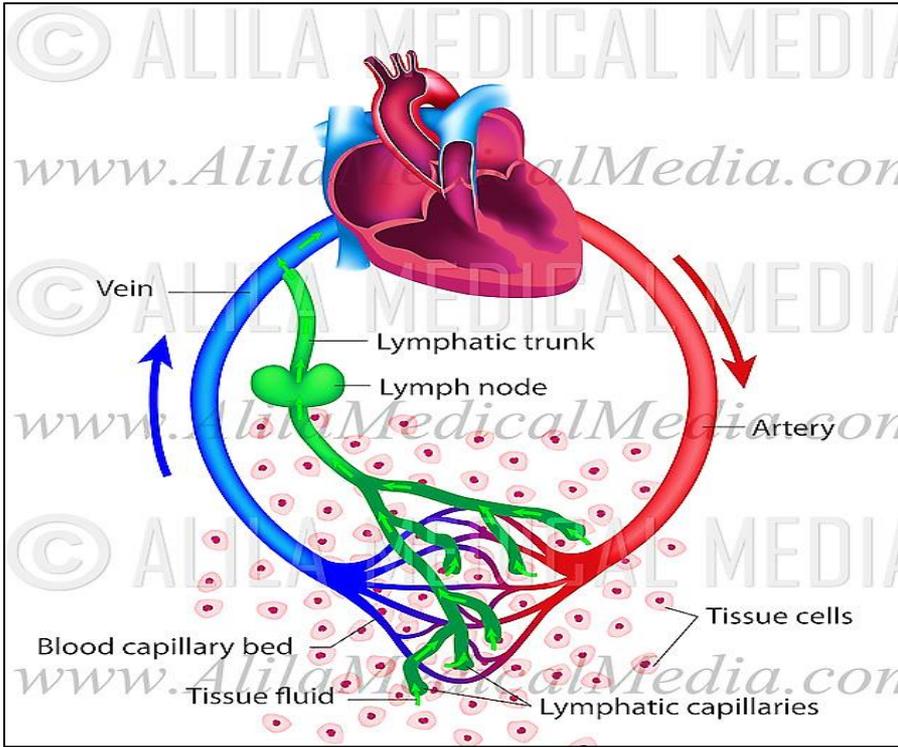
➤ Thoracic duct

Drains the rest of the body → into the left subclavian vein

Structure of Lymphatic capillaries

- Begin with a blind end
- Have similar structure to blood capillaries but larger & more permeable ,considered as microcirculation
- Made of single layer of overlapping endothelium with interrupted basal lamina
- its endoth. Has NO (fenestrae, tight junction, pericytes)

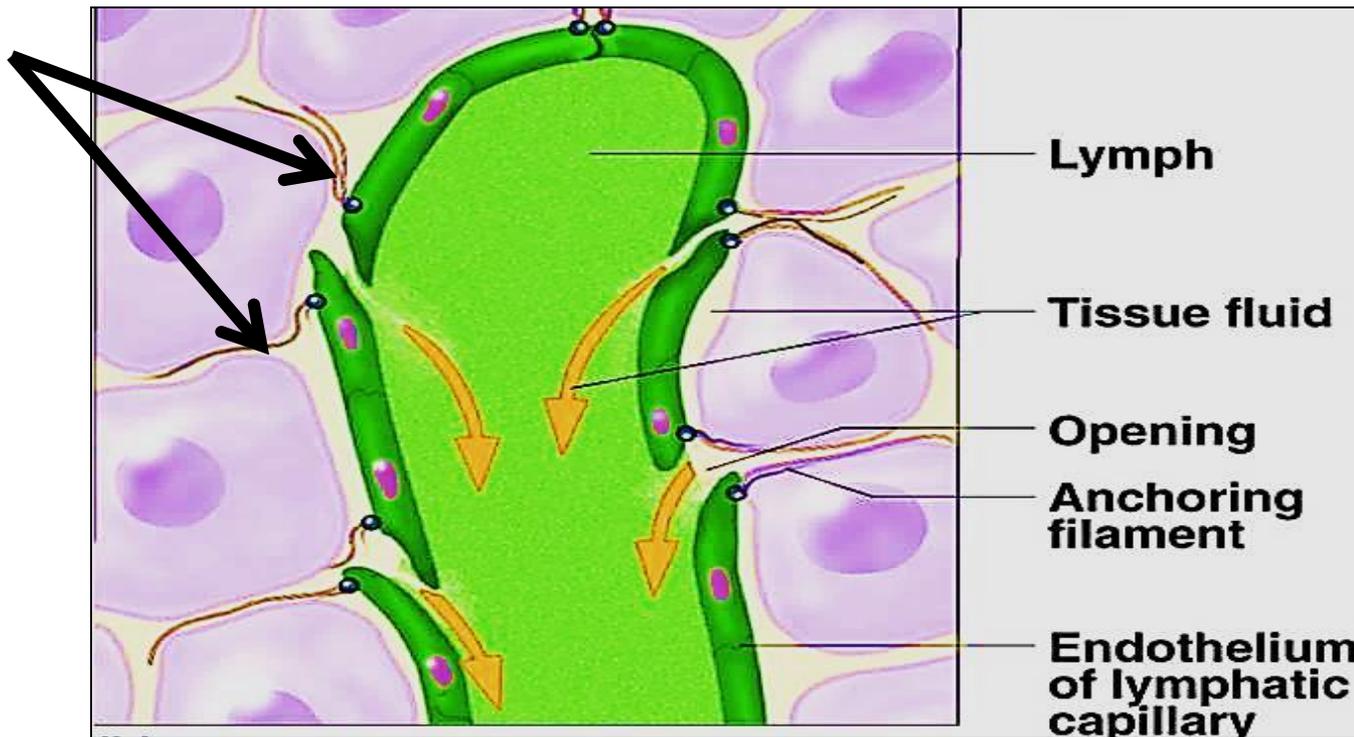




- Lymphatic endothelial cells attached to anchoring filaments made of elastic fibers which

1- attach endothelial cells to surrounding tissue.

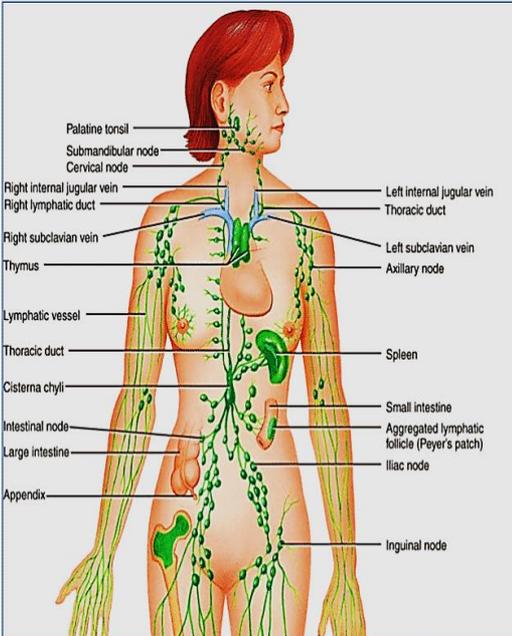
2- pull on → widen gap between endothelial cells → draw more fluid into lymphatic capillary



Endothelial cells are one-way swinging door

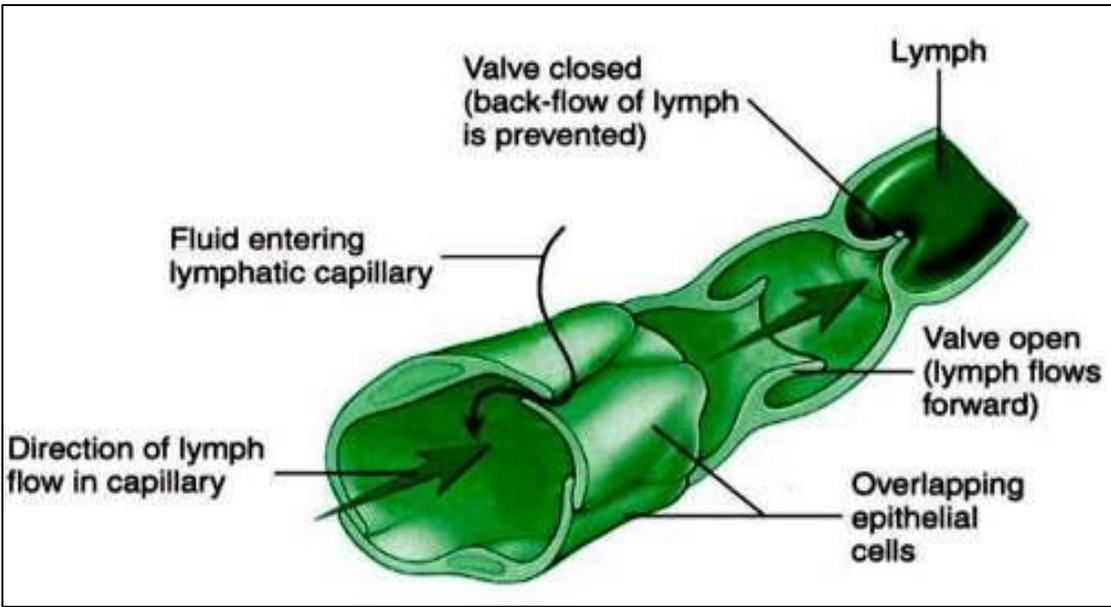
Structure of Lymphatic vessels:

- Thinner wall + large lumen+ **valves**
- Drain lymph from lymph capillaries
- Lymph nodes are found along their course



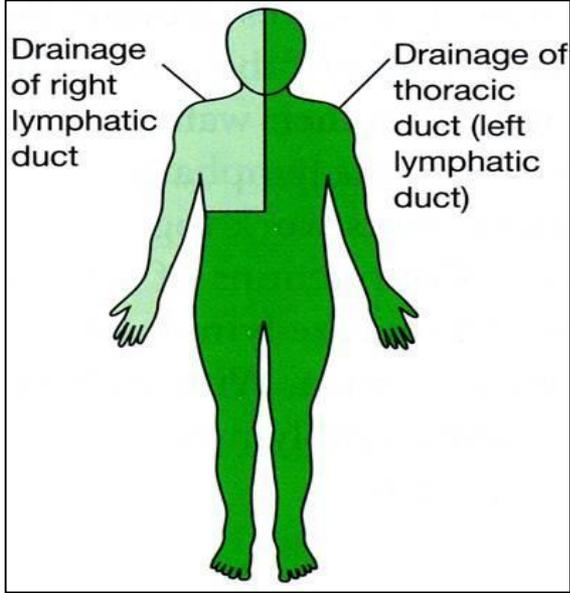
Structure:

Endothelium / valves , media (few smooth muscle cells) - adventitia

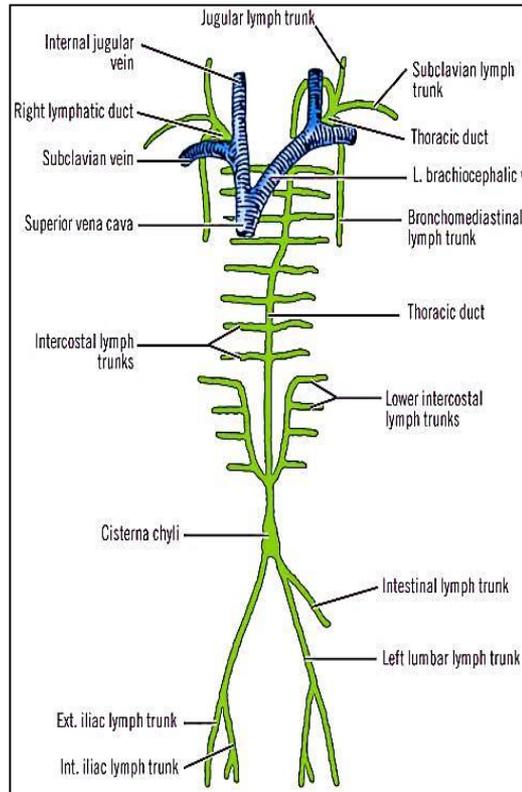


Structure of Lymphatic duct:

- Large vessel that drain lymph into one of the subclavian veins



- 2 lymph ducts:
 - **Right lymphatic duct**
 - **Thoracic duct**



Similar in structure to large veins

- Tunica intima: endothelium + CT
- Tunica media: smooth ms. + elastic fibers
- Tunica adventitia: CT + smooth ms.

Thank you

