

THE VASCULAR SYSTEM 2



CVS MODULE

Semester 1, Year 3

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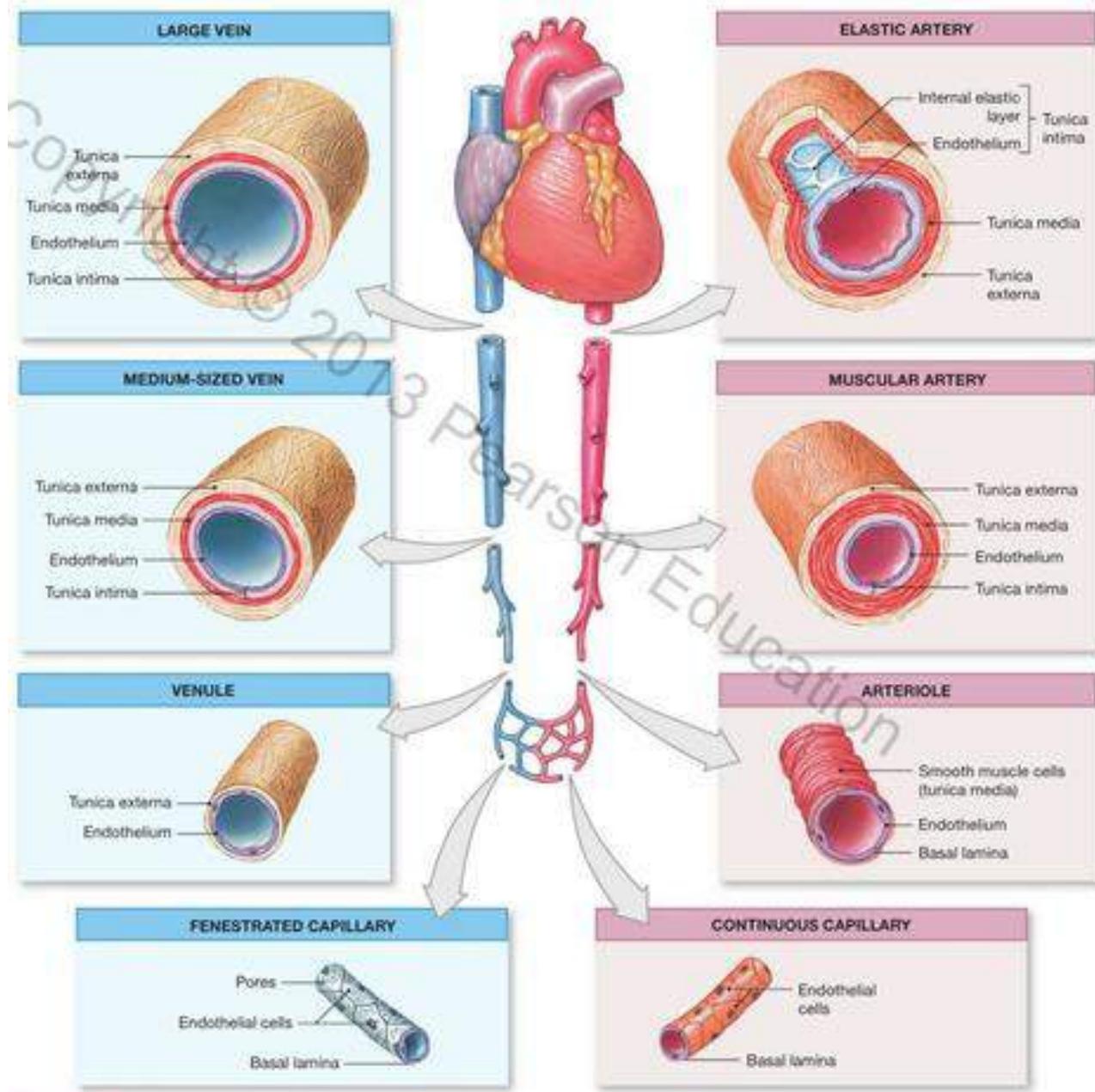


Figure 19-2 **Histological Structure of Blood Vessels.** Representative diagrammatic cross-sectional views of the walls of arteries, capillaries, and veins. Notice the relative sizes of the layers in these vessels.

Arterioles

•Function:

the peripheral resistance. They control blood flow into the capillaries.

They have a relatively thick wall compared to their narrow lumen.

1 -The intima:

has thin internal elastic lamina which disappears when the arteriole is smaller in diameter.

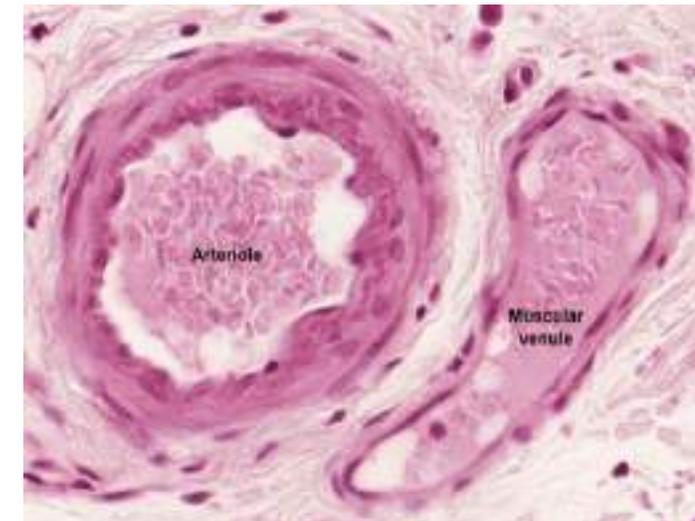
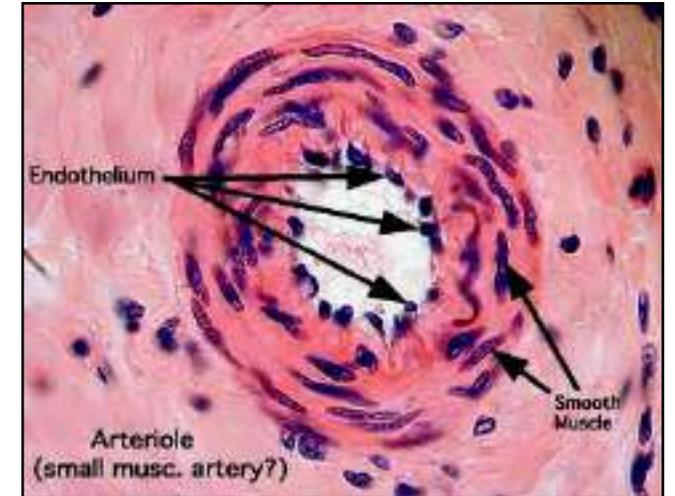
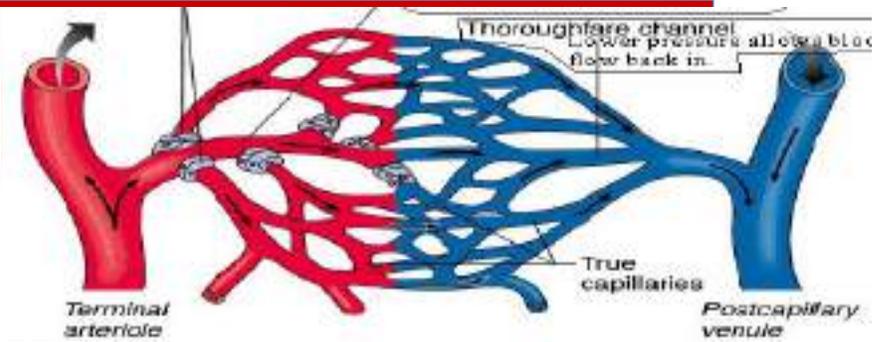
2 -The media:

is formed of one to two layers of smooth muscle fibers.

No external elastic lamina.

3 -The adventitia:

thin -posses **autonomic** nerve fibres to control the size of the lumen which is responsible **peripheral resistance**



Tunica	Large Artery (Elastic, Conducting)	Medium-sized Artery (Muscular, Distributing)	Arteriole
T. Intima	Endothelium, Subendothelium Int elastic lamina: Not evident ≈10% thickness	Endothelium, Subendothelium Int elastic lamina: Evident	Thin or absent (~60 μm)
T. Media	≈70% thickness Fenestrated elastic lamellae (distension & elastic recoil) Ext elastic lamina: Not evident	≈50% thickness Smooth muscle (distributing, control diameter) Ext elastic lamina: Evident	1–2 layers of smooth m. fibers (regulate blood flow & resistance) Ext elastic lamina: Absent
T. Adventitia	≈20% thickness Prominent Contains vasa vasorum	≈50% thickness Not prominent	Thin Absent

Smooth muscles



Elastic fibers

Venules

- They are classified into:

1- Post-capillary venules:

Diameter: 15–30 μm .

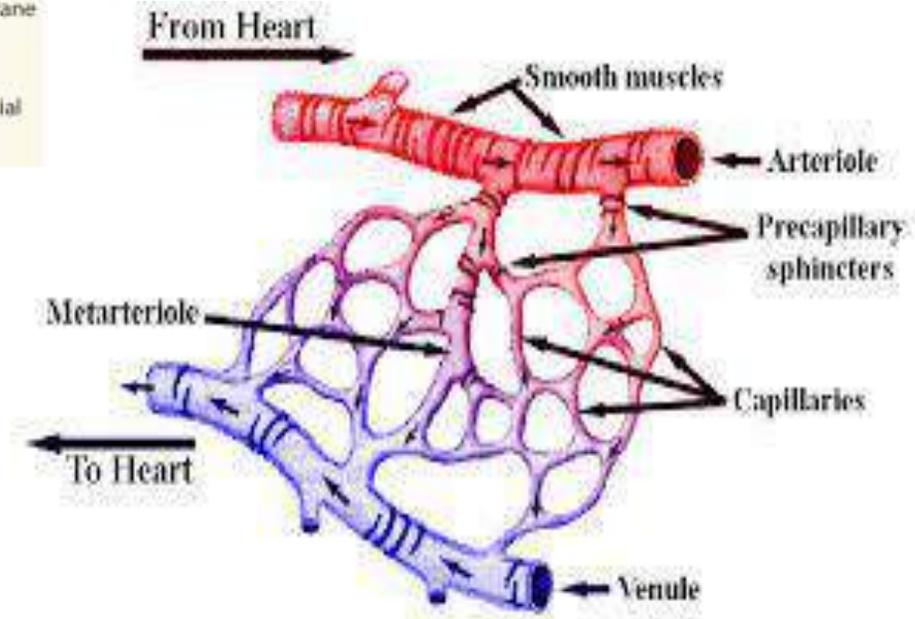
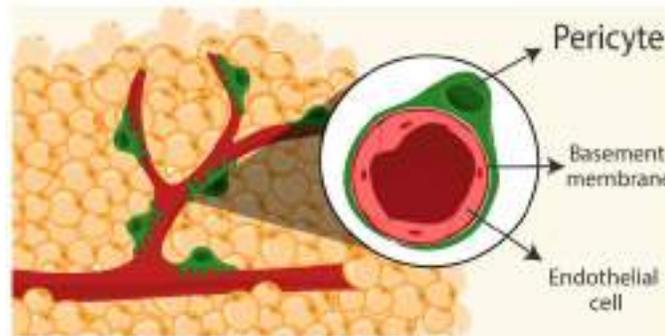
Structure: a single layer of endothelial cells resting on basal lamina surrounded by pericytes.

Function: They are the site of transmigration of WBCs during inflammation.

2- Muscular venules:

The media: is formed of one to two layers of smooth muscle fibers.

The adventitia: thin.



Special Types of medium sized Arteries – Coronary

1- Tunica intima:

it shows normal, musculo-elastic thickenings, that may contribute to development of atherosclerosis.

musculo-elastic thickenings

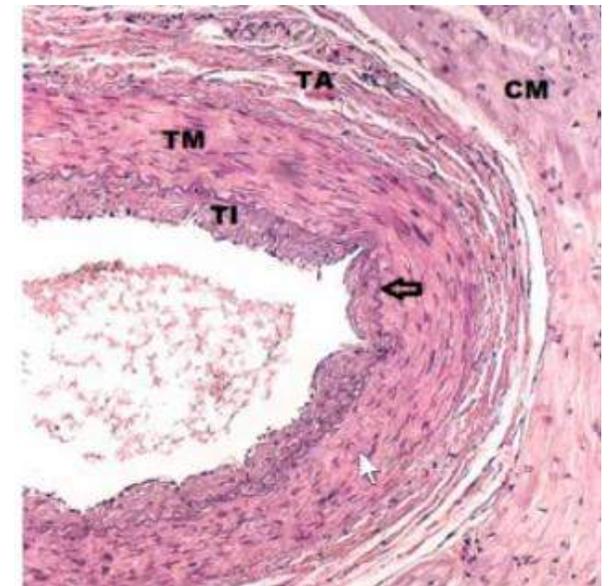
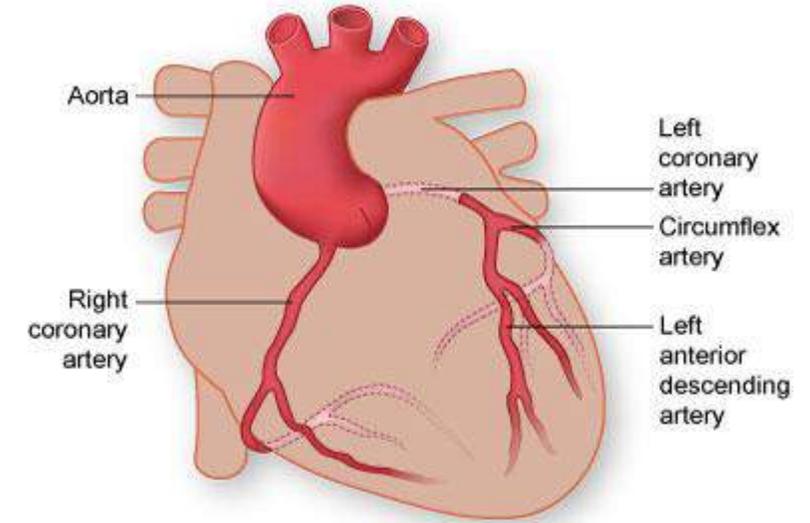
2- Tunica media:

is thicker compared to that of muscular arteries of the same size.

3- Tunica adventitia:

is unique in its high collagen-to-elastic fiber ratio, which reflects high tensile strength and relatively low stretchability.

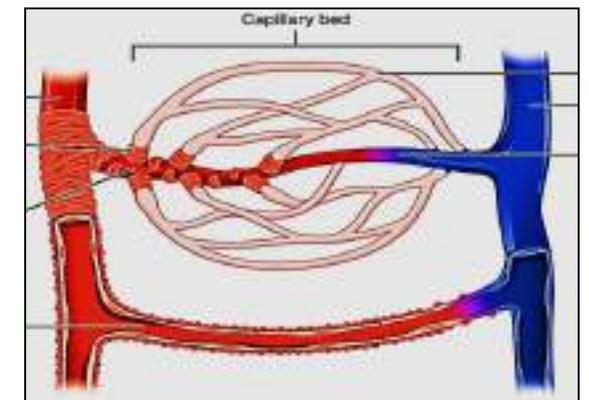
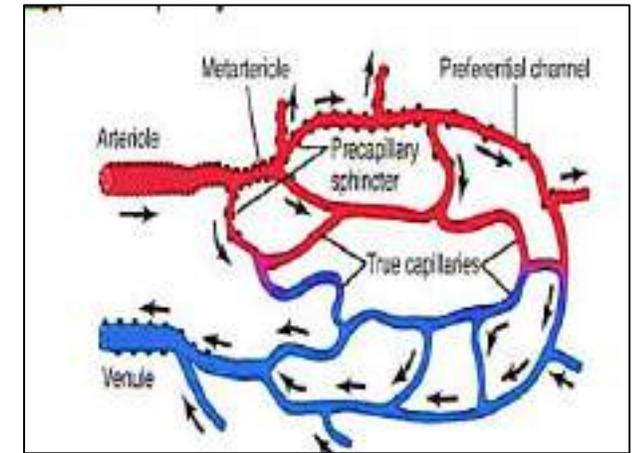
high collagen-to-elastic fiber ratio



Peripheral Circulation (Arterio-Venous Connections)

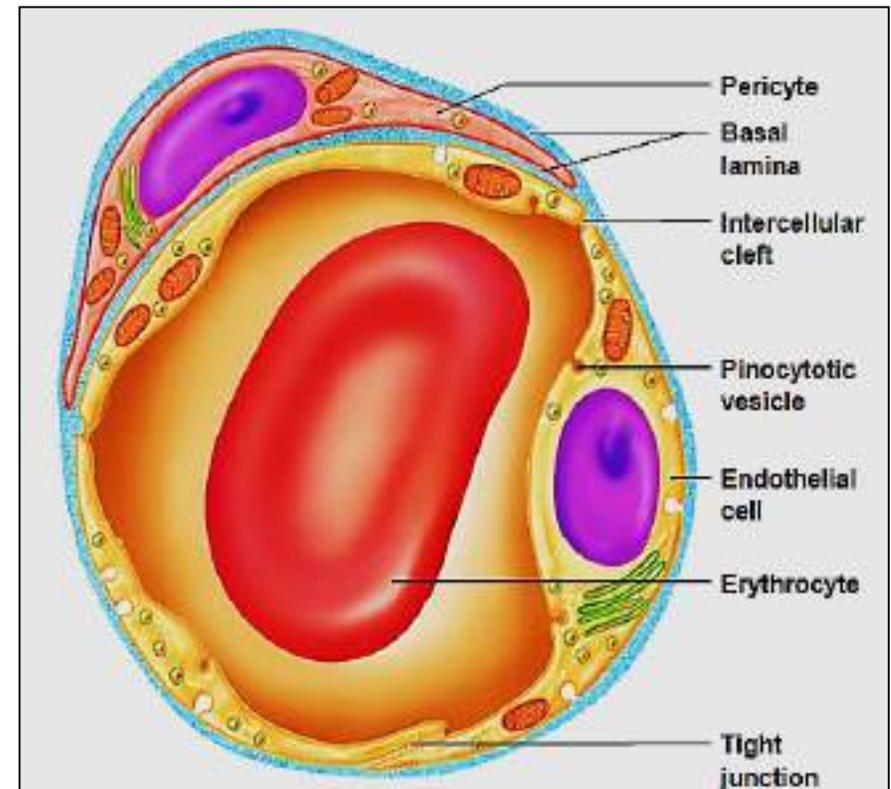
I- Blood Capillaries:

- Terminal arterioles are continued into plexuses of thin vessels called capillary bed, which supply the tissues.
- They have variations in arrangement and density in tissues to adapt variable metabolic activities between blood & tissues, e.g. more denser around lung alveoli, for gas exchange and around intestinal villi for absorption.



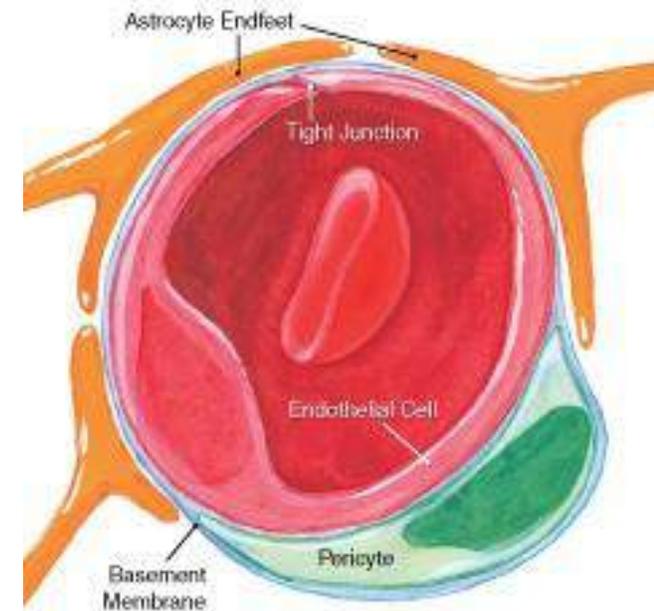
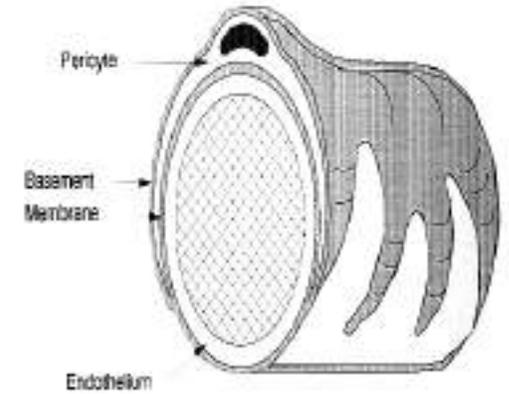
Structure of Capillaries:

- They are formed of single layer of endothelial cells, held together by occluding junctions, that roll to produce a narrow tube, the external surface of endothelial cells rests on a basal lamina. The basement membrane splits to enclose small cells called pericytes.
- **Origin:** mesenchymal (UMCs).

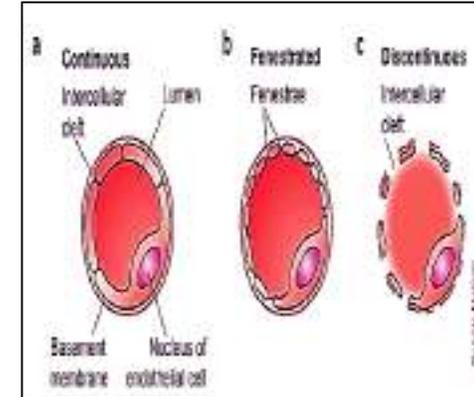
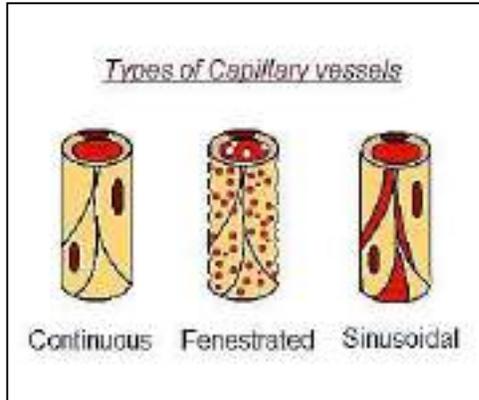


Pericytes

- They are perivascular undifferentiated mesenchymal cells, enclosed in the basement membrane of the capillary endothelial cells.
- Their cytoplasm contains actin, myosin and tropomyosin filaments, giving them contractile ability to regulate the blood flow.
- They are considered the media of capillaries.
- Their processes wrap around capill. or venule
- They can differentiate into endothelial cells, fibroblasts & smooth m. in response to injury



Types of capillaries



**Continuous
(Somatic)**

**Fenestrated
(Visceral)**

**Discontinues
(Sinusoidal)**

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

Types of Capillaries

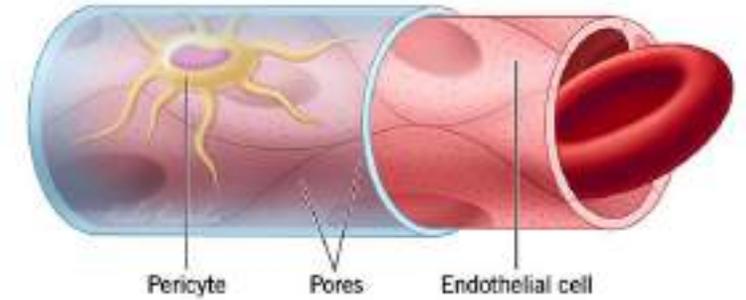
1- Continuous (somatic):

Most common type, no pores in their walls.

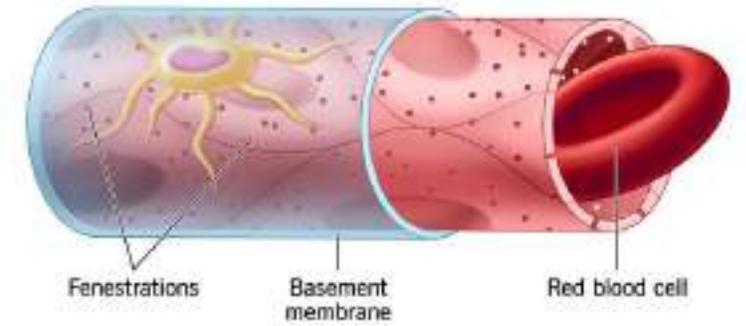
- **Sites:** found all over the body; e.g.: C.T., skeletal m., bone, skin, exocrine g. and brain
- **Structure:** Endothelium forms a continuous layer, resting on continuous basement m.

N.B. brain capillaries are lined by continuous endothelial cells that joined by tight j., lying on thick basal lamina

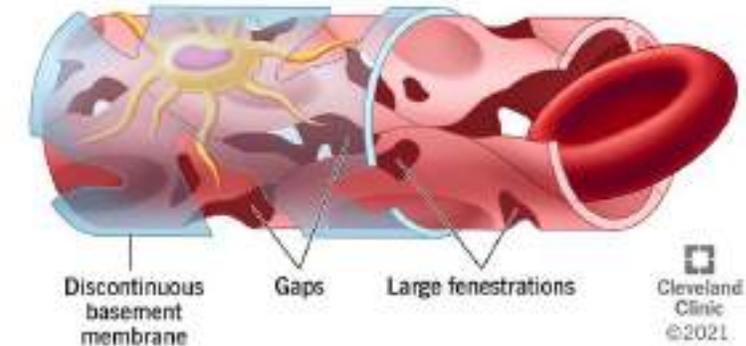
Continuous Capillary



Fenestrated Capillary



Sinusoidal Capillary

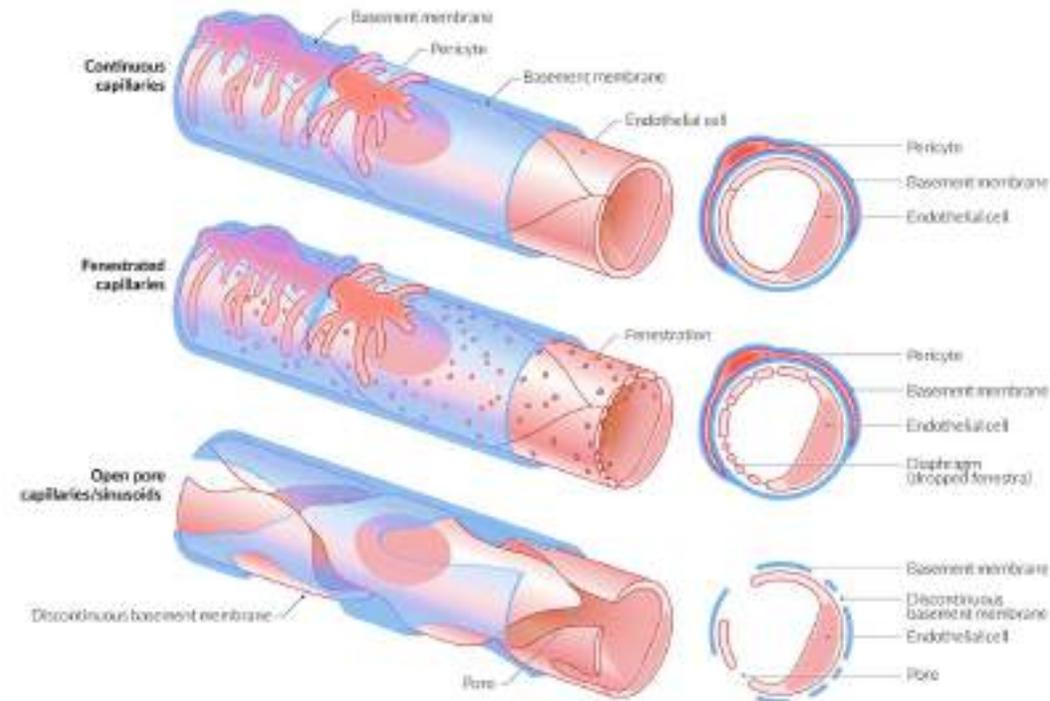


2- Fenestrated (visceral):

- **Structure:** endothelial cells contain pores, which are discontinuation of cell memb., they rest on thin continuous basement membrane. Fenestrae are covered by thin diaphragms, which are thinner than cell membrane.
- **Sites:** They are found at sites where rapid exchange is needed; e.g:

- Endocrine glands (transport hormones to bl.)
- Kidney glomeruli (for blood filtration).
- Intestine (for absorption).

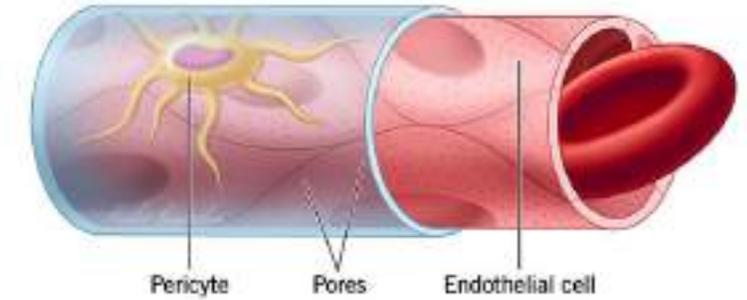
N.B.: **No diaphragm:** Kidney glomeruli,
Diaphragm: intestine & endocrine G



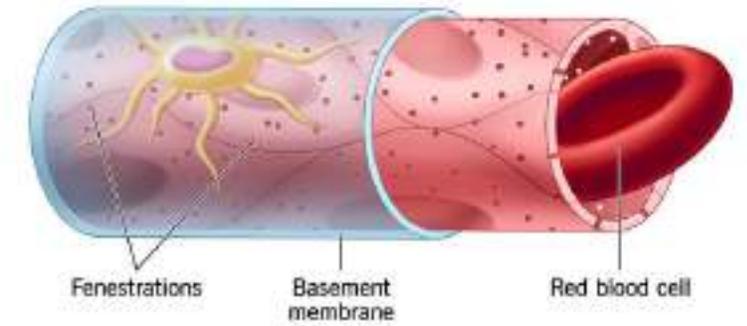
3- Sinusoidal capillaries (Blood sinusoids)

- **Structure:** - Tortuous dilated capillaries; have irregular wide lumens of 5-40 μm in diameter. This leads to slowing of circulation.
- **Their thin walls** are formed only of endothelium lying on basal lamina.
- **Endothelium:** have multiple fenestrae without diaphragms, cells are separated by large gaps and rest on discontinuous basal L.
- **Macrophages** are found in sinusoidal wall, extend their pseudopodia into sinusoidal bl. to phagocytose foreign bodies.

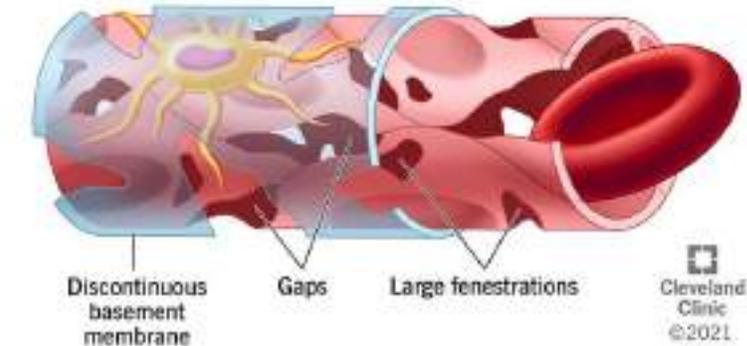
Continuous Capillary



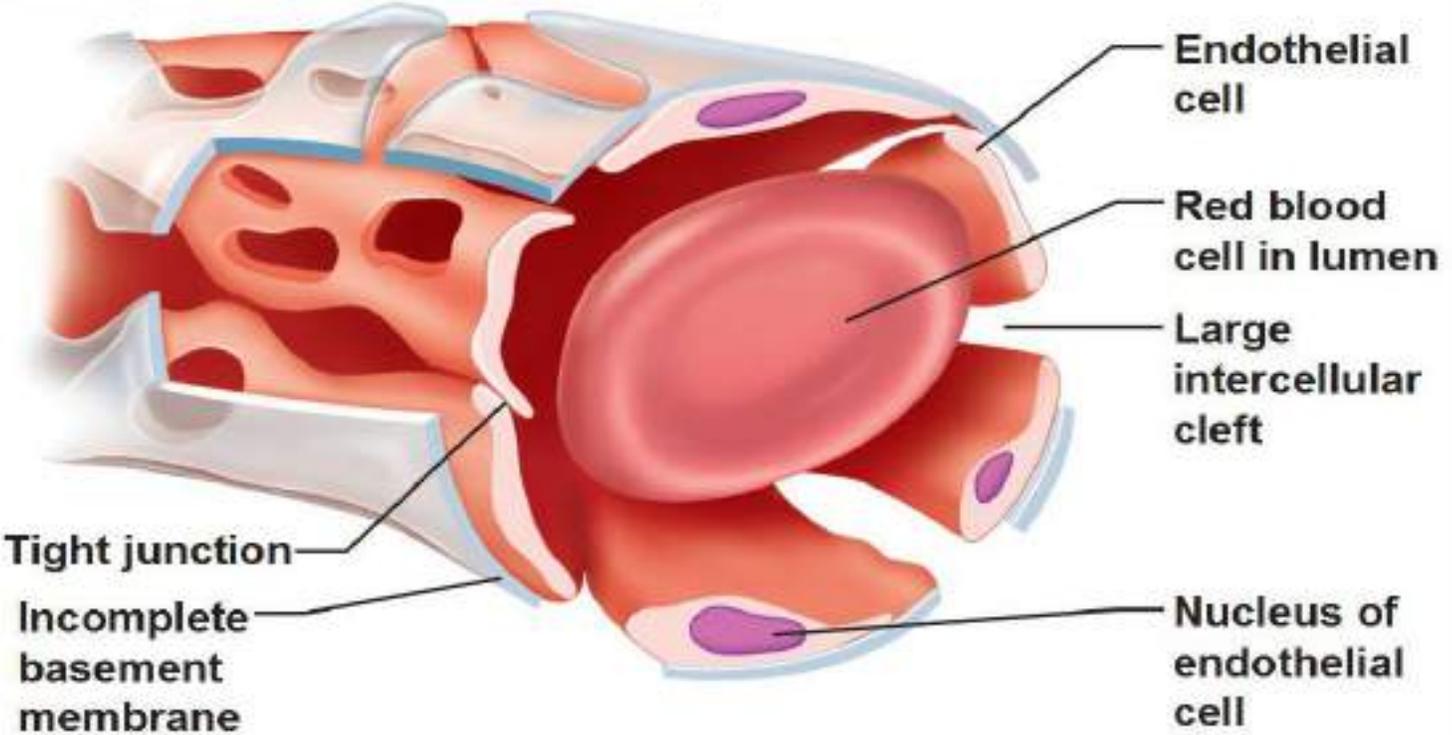
Fenestrated Capillary



Sinusoidal Capillary

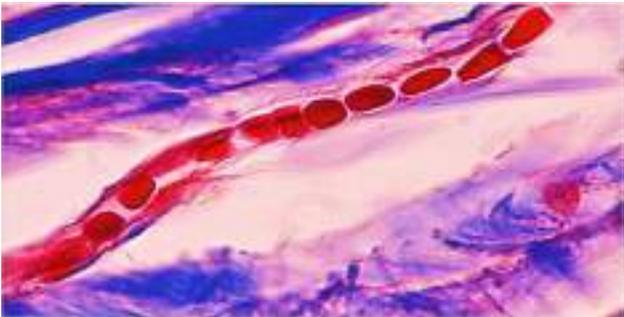
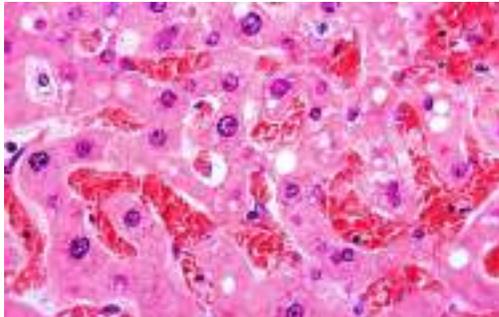


Structure of Capillaries: Sinusoids have big fenestrations, few tight junctions, and wide intercellular clefts, as well as incomplete basement membranes, allowing for exchange of large molecules (whole cells)

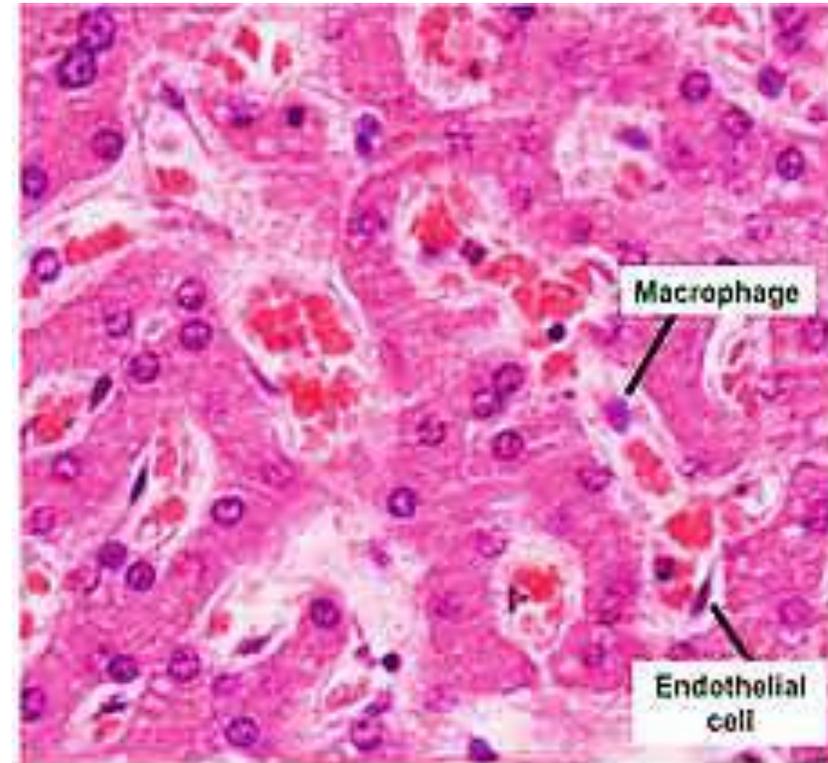
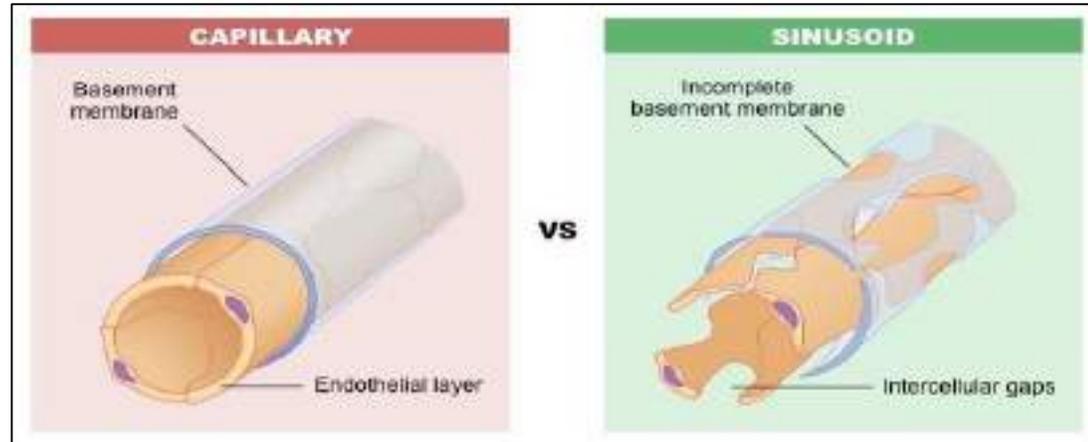


(c) Sinusoidal capillary. Most permeable. Occurs in special locations (e.g., liver, bone marrow, spleen).

Sinusoidal capillaries

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 & 

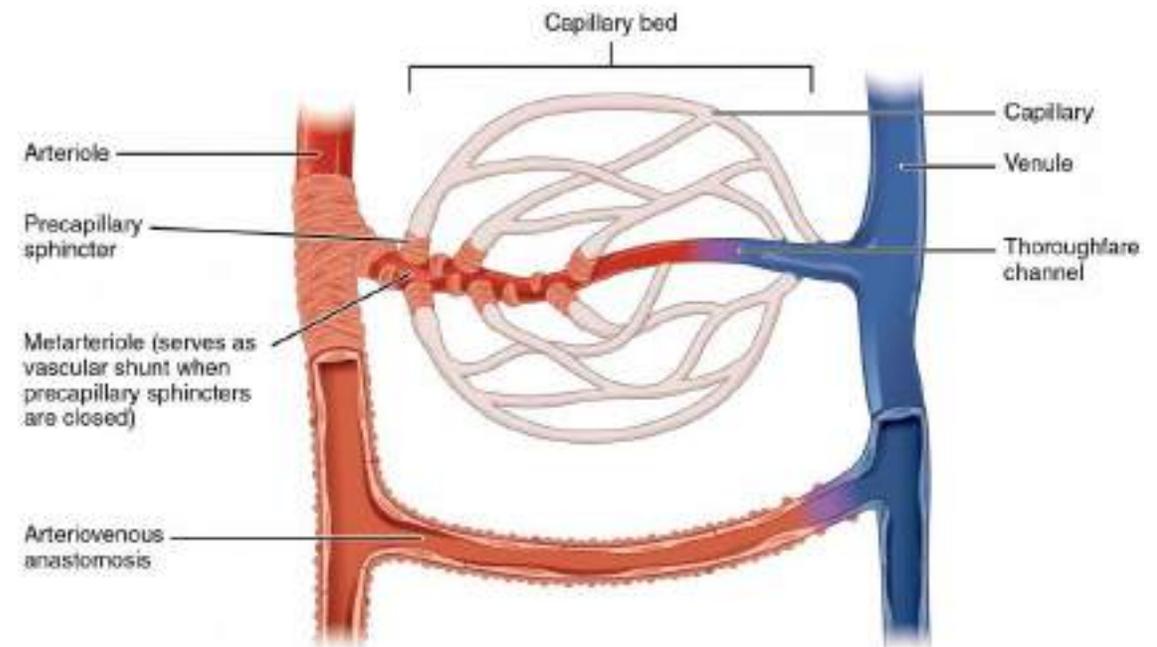
Capillary vs Sinusoid



Hepatocytes and sinusoids

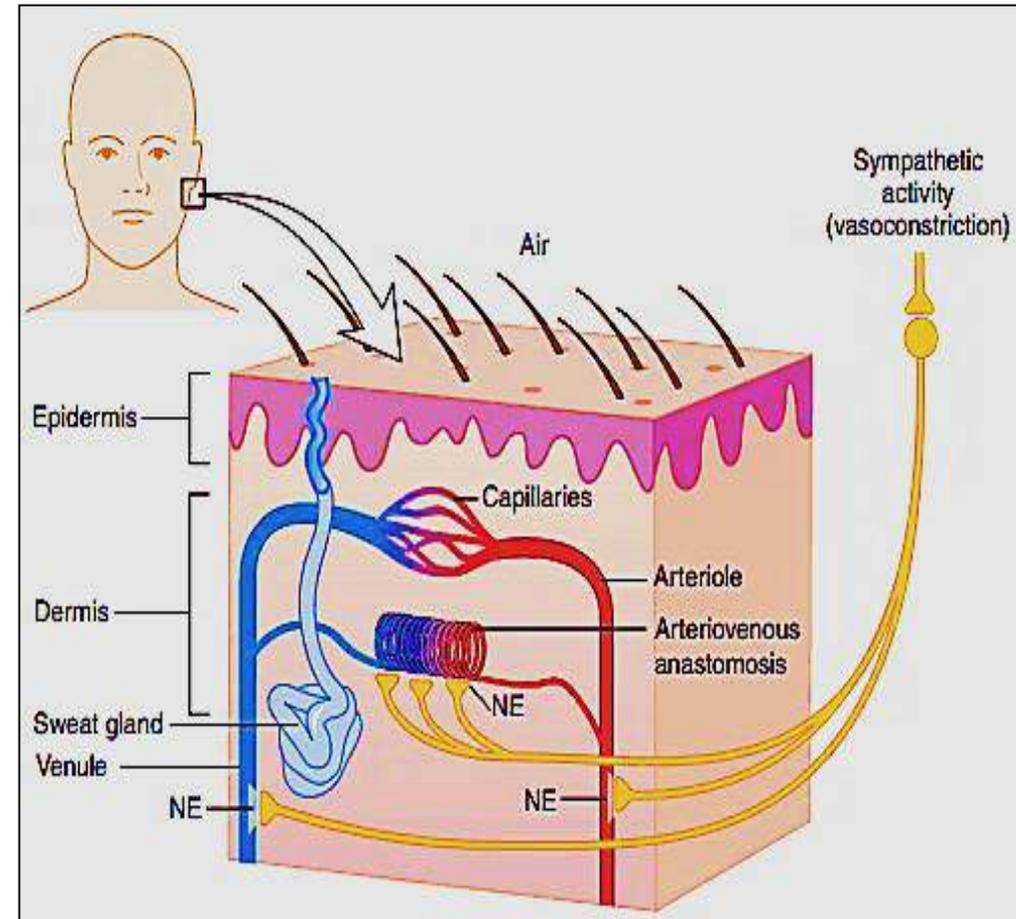
II. Arterio-Venous Anastomoses

- ❖ They are direct connections between arteries and veins.
- ❖ They arise as side branches from arterioles to venules, without passing through capill.
- ❖ They allow a short and rapid circulation of blood to certain areas of the body.



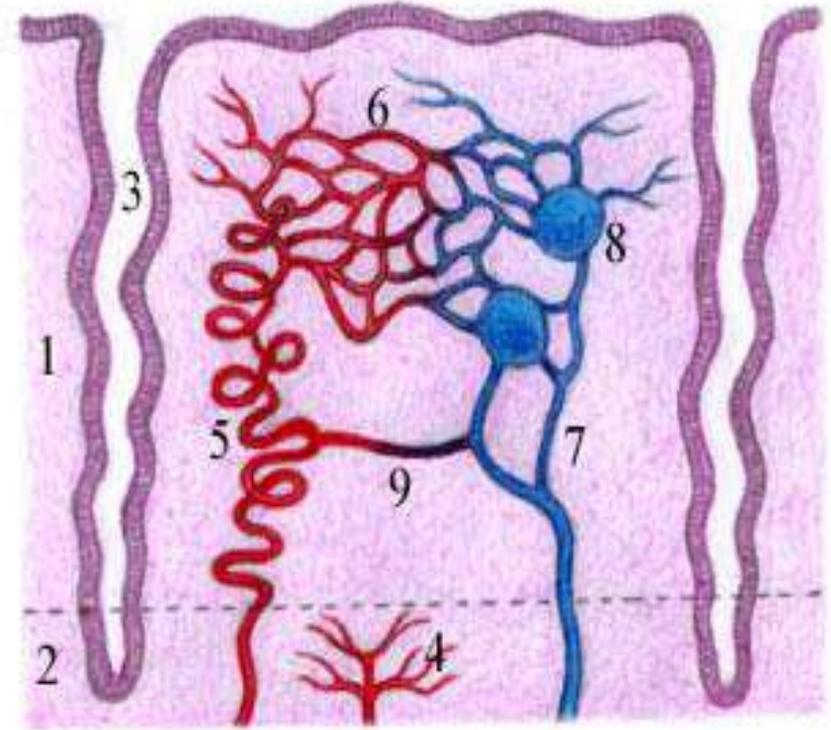
Functions of A-V anastomoses (shunts):

Regulate body temperature, they dilate in cold weather, so blood is shunted away from the skin to conserve heat, and constrict in hot to release heat to the environment.



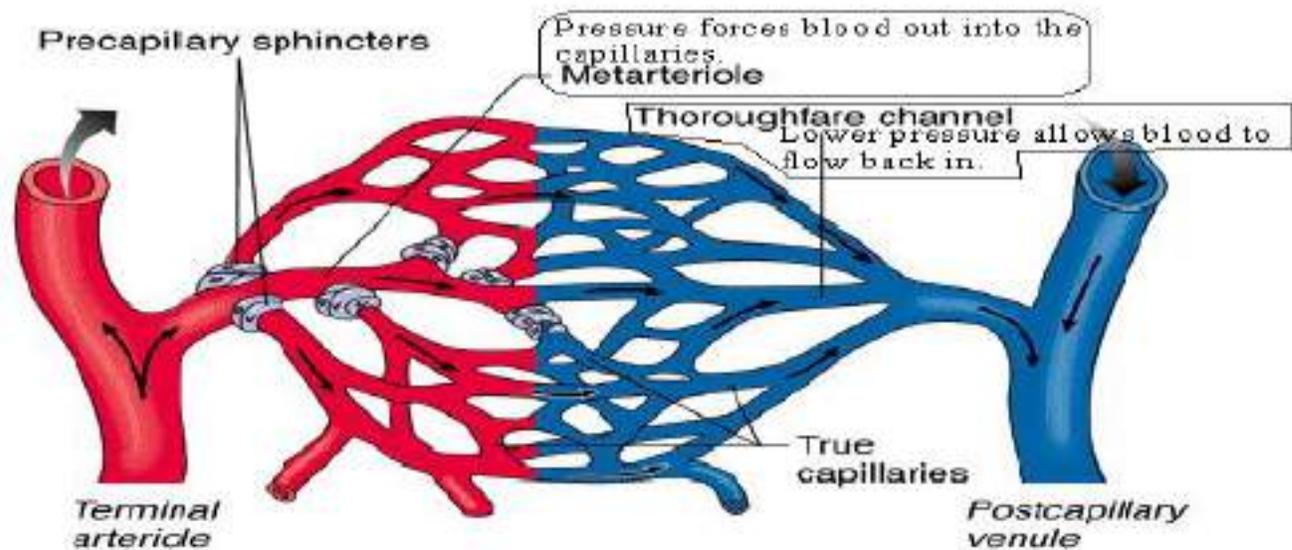
Sites:

- They are present in exposed parts as:
Tips of fingers, external ears, tip of nose, lips
- In some internal organs as: placenta, penis, endometrium of uterus and thyroid glands

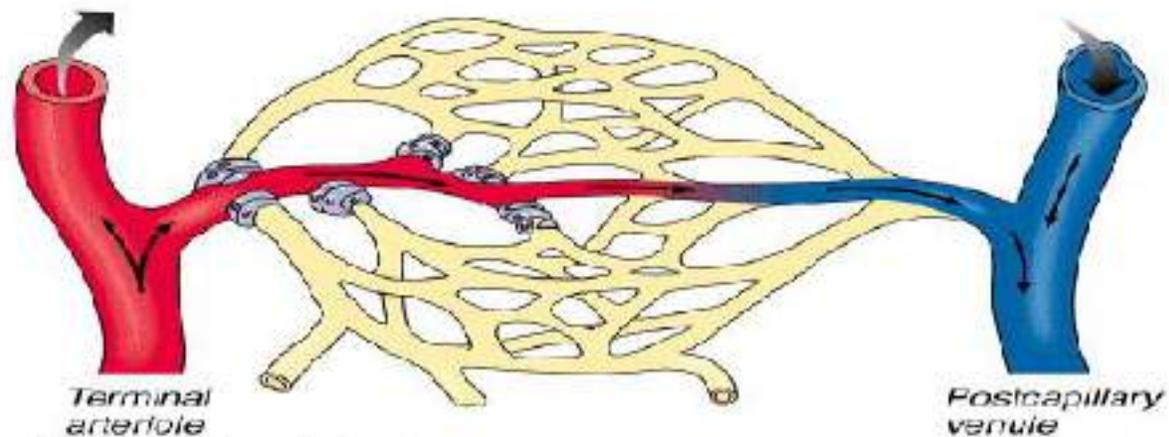


1. Endometrial Functional Layer
2. Endometrial Basal Layer
3. Endometrial Gland
4. Straight Artery
5. Spiral Artery
6. Capillary Plexus
7. Veins
8. Venous Lake
9. Arteriovenous Anastomosis

Arteriovenous Anastomosis



(a) Sphincters open



(b) Sphincters closed

The Lymphatic System

- **Definition:**

It is a drainage system that collects the excess interstitial fluid in the form of lymph and returns it to the blood.

- **It consists of:**

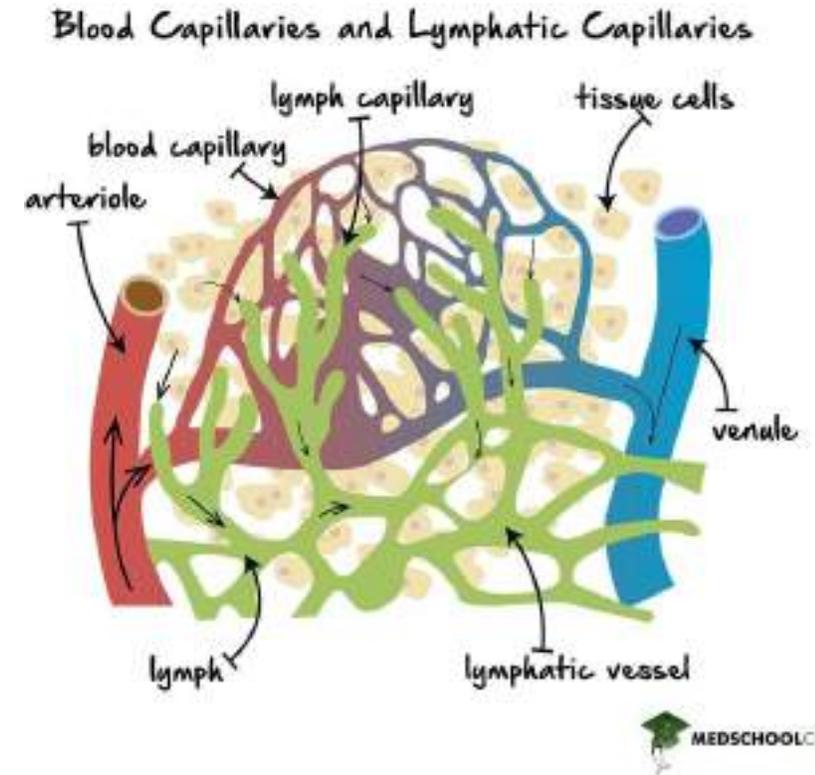
the lymph, lymph vessels and lymphoid tissue.

- **The lymph:**

a viscid substance formed of:

- 1- Protein-rich fluid: removed from the intercellular spaces.
- 2- Lipids: that are too large to cross the fenestrations of the intestinal capillaries.

Both components cannot be reabsorbed by the venous side of the blood circulation due to their large molecular size.



lymph circulation: interstitial fluid will drain into

lymph capillaries



lymph vessels



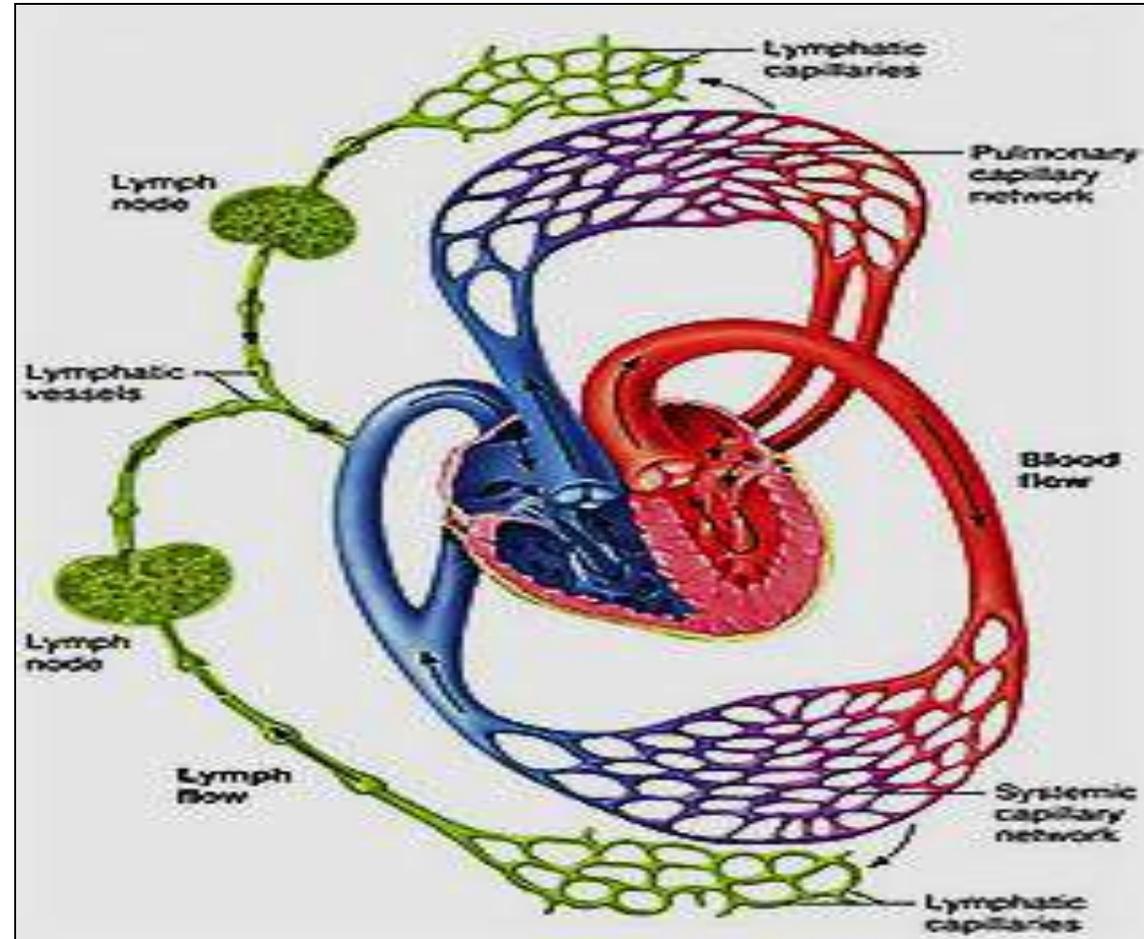
lymph nodes



Lymphatic vessels



Lymphatic duct



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

The Lymph Vessels – Lymphatic Capillaries

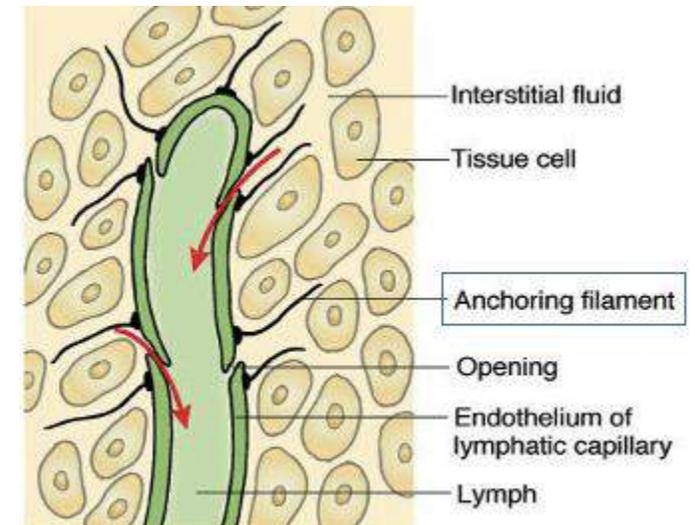
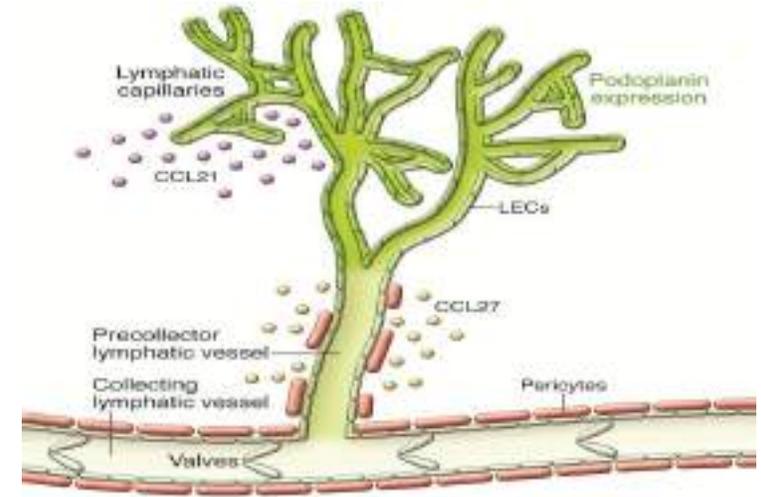
- **Structure:**

Blind ended channels.

Irregular in shape.

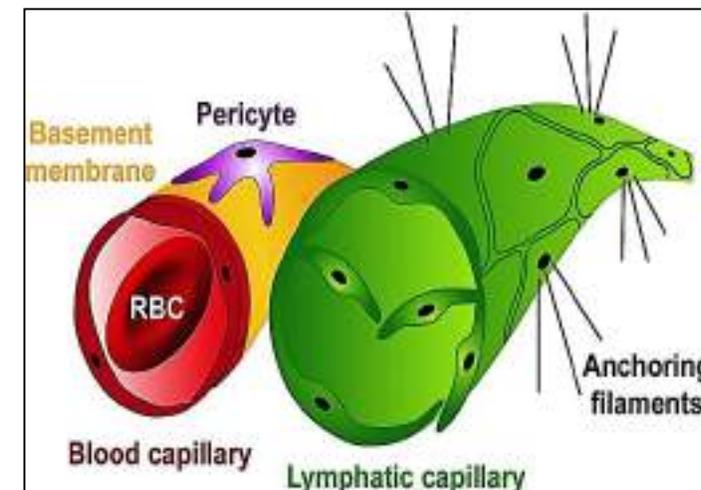
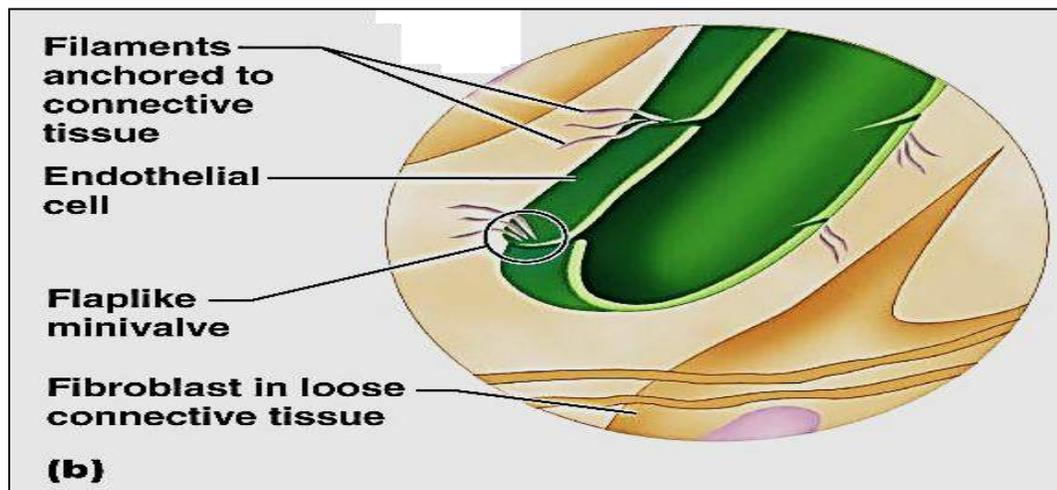
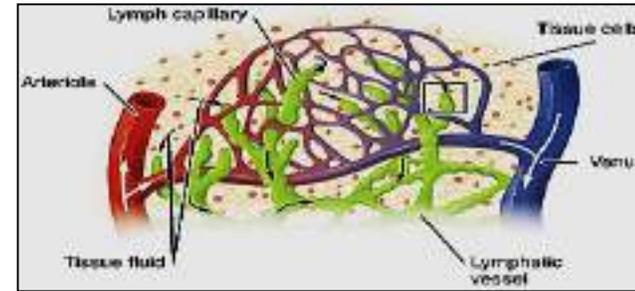
Lined by endothelial cells resting on an incomplete basal lamina.

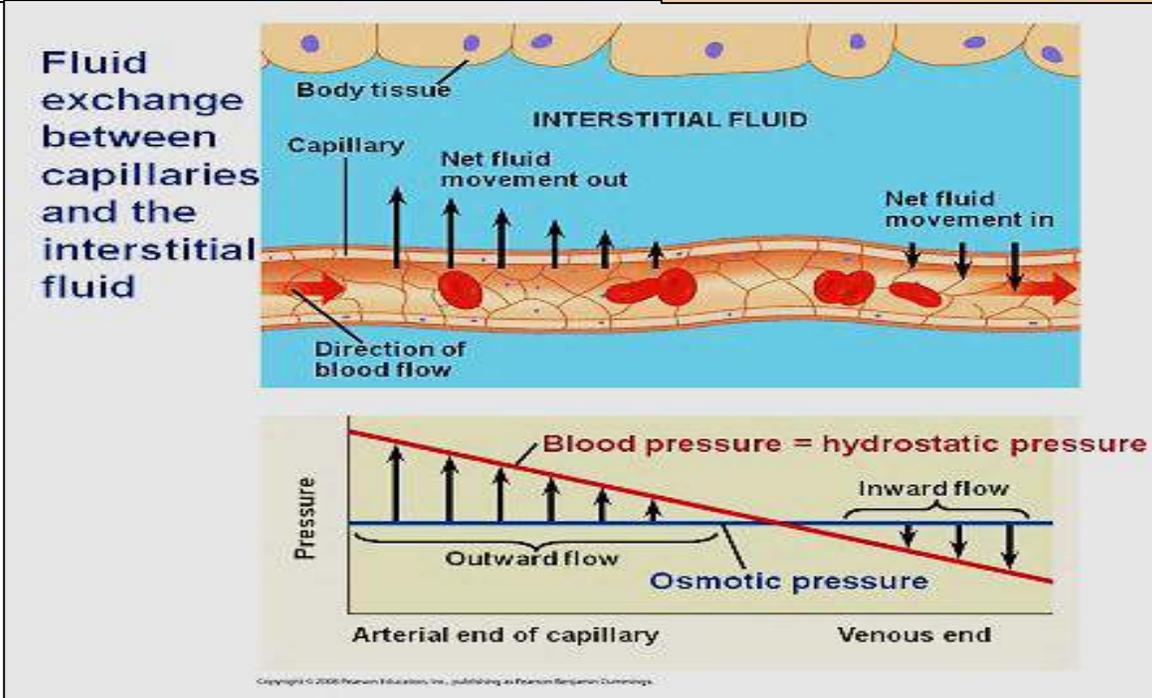
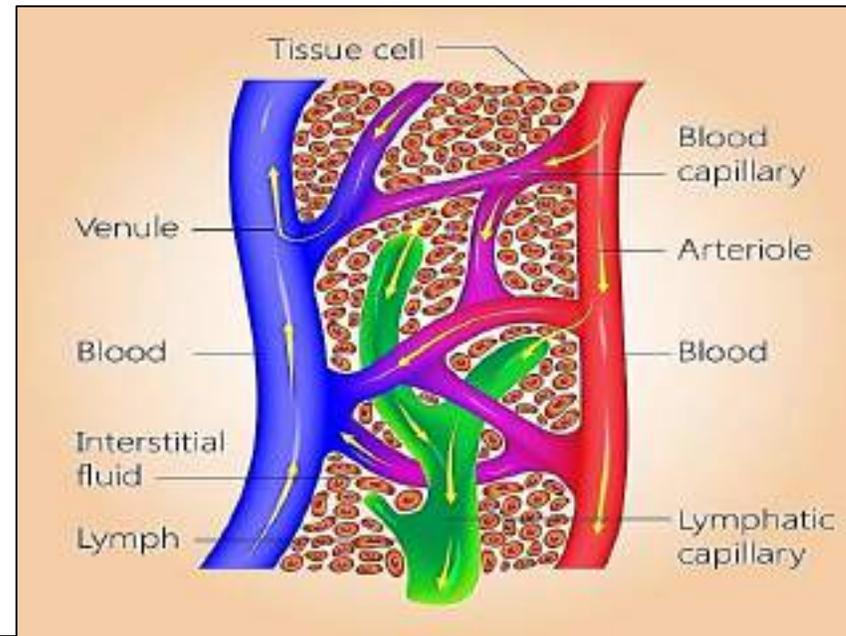
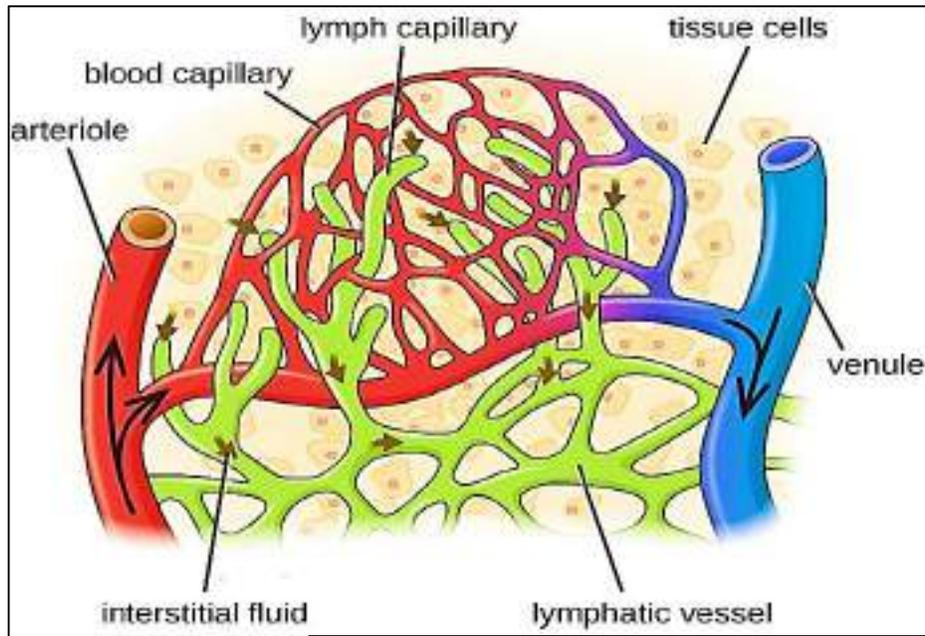
*Openings between endothelial cells are kept open by **anchoring filaments** that bind to surrounding connective tissue.*



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)





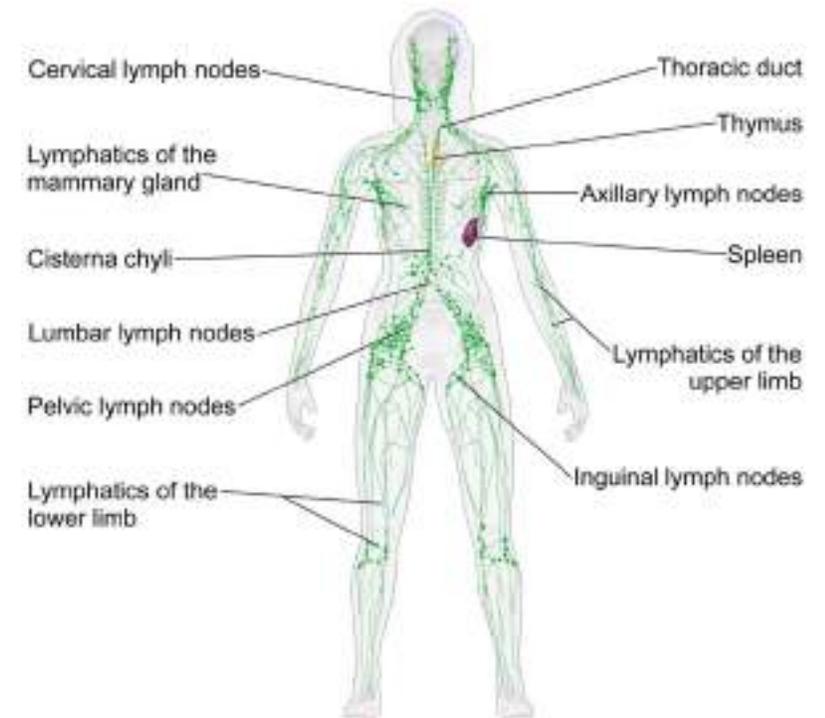
The Lymph Vessels – Large Lymphatic Vessels

- **Structure:**

Similar to that of veins, having valves to keep the lymph flow unidirectional.

But, they have thinner walls and without a clear separation between layers (intima, media, and adventitia).

Lymphatic vessels converge to form the thoracic duct and the right lymphatic duct which empty lymph back into the blood.



	Lymphatic capillary	Blood capillary
Connection	Blind end	Open at both end
Lumen	Wide	Narrow
Shape	Irregular and easy collapsed	Regular and rounded
Basal lamina	Lack continuous basal lamina	Have basal lamina and pericytes
Content	Carry lymph	Carry blood

A white, cloud-shaped sticker with a small tail at the bottom left is affixed to a brown corkboard. The sticker contains the text "Thank you!!" written in a black, casual, handwritten-style font. The words "Thank" and "you!!" are arranged on two lines, with "you!!" being indented to the right.

Thank
you!!