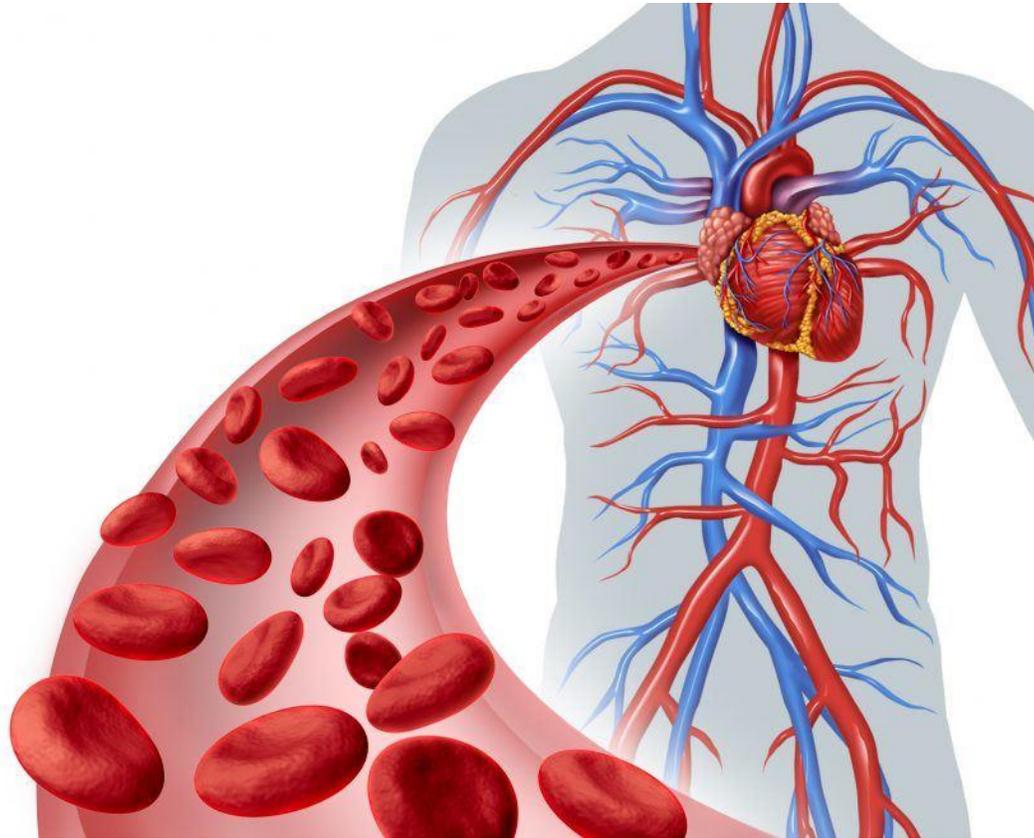




# General Histology / Year 2



## *circulatory system* Blood Vessels Lecture 3

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# Blood Vessels

- **The cardiovascular system has three types of blood vessels:-**
- **Arteries (and arterioles) – carry blood away from the heart.**
- **Capillaries – where nutrient and gas exchange occur.**
- **Veins (and venules) – carry blood toward the heart.**
- **Blood Vessels:- A blood vessels is a hollow tube that transports blood.**
- **Histologically, the different types of arteries and veins are distinguished from each other by the thickness of the vascular wall and differences in the composition of the layers.**

# Histological Structure of Blood Vessels

- The three layers of the vascular wall, from the lumen outward are the following.
- The **tunica intima** has one lining layer of endothelial cells (simple squamous epithelium). supported by a thin subendothelial layer of loose connective tissue with transverse smooth muscle cells.
- In arteries the intima is separated from the media by an ( internal elastic lamina), beneath the sub endothelial layer ,is composed of elastin which is fenestrated sheet that permits the diffusion of substances in to the deeper region of the vessel wall to nourish the cells there.
- As a result of the loss of blood pressure and contraction of the vessel at death, the tunica intima of arteries may have slightly folded appearance in tissue section.

# Histological Structure of Blood Vessels

- The **tunica media**, or middle layer, consists primarily of circumferentially arranged layers of smooth muscle cells. In arteries, this layer is relatively thick and extends from the internal elastic membrane to the external elastic membrane.
- The external elastic membrane is a layer of elastin that separates the tunica media from the tunica adventitia.
- The **tunica adventitia**, or outermost connective tissue layer, is composed of connective tissue (fibroblast, collagen fibers and a few elastic fibers) surrounding the vessel.

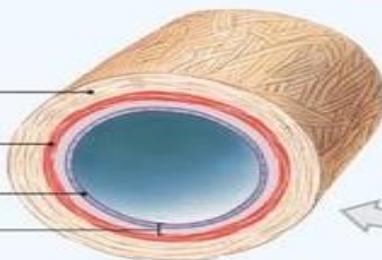
# Histological Structure of Blood Vessels

- These connective tissue elements gradually merge with the loose connective tissue surrounding the vessels. The tunica adventitia ranges from relatively thin in most of the arterial system to very thick in the venules and veins, where it is the major component of the vessel wall.
- The tunica adventitia of large arteries and veins contains a system of vessels called the vasa vasorum that supplies blood to the vascular walls themselves, Large veins typically have more vasa vasorum than arteries, because they carry deoxygenated blood.
- as well as a network of autonomic nerves called nervi vascularis that control contraction of the smooth muscle in the vessels.

# Histological Structure of Blood Vessels

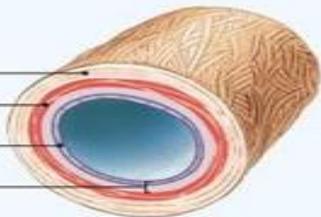
## Large Vein

Tunica externa  
Tunica media  
Endothelium  
Tunica intima



## Medium-Sized Vein

Tunica externa  
Tunica media  
Endothelium  
Tunica intima



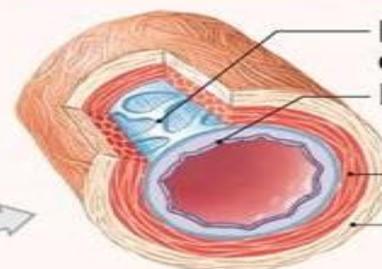
## Venule

Tunica externa  
Endothelium



## Elastic Artery

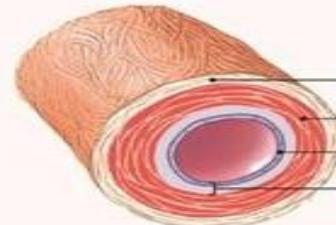
Internal elastic layer  
Endothelium } Tunica intima



Tunica media  
Tunica externa

## Muscular Artery

Tunica externa  
Tunica media  
Endothelium  
Tunica intima



## Arteriole

Smooth muscle cells  
(Tunica media)  
Endothelium  
Basement membrane

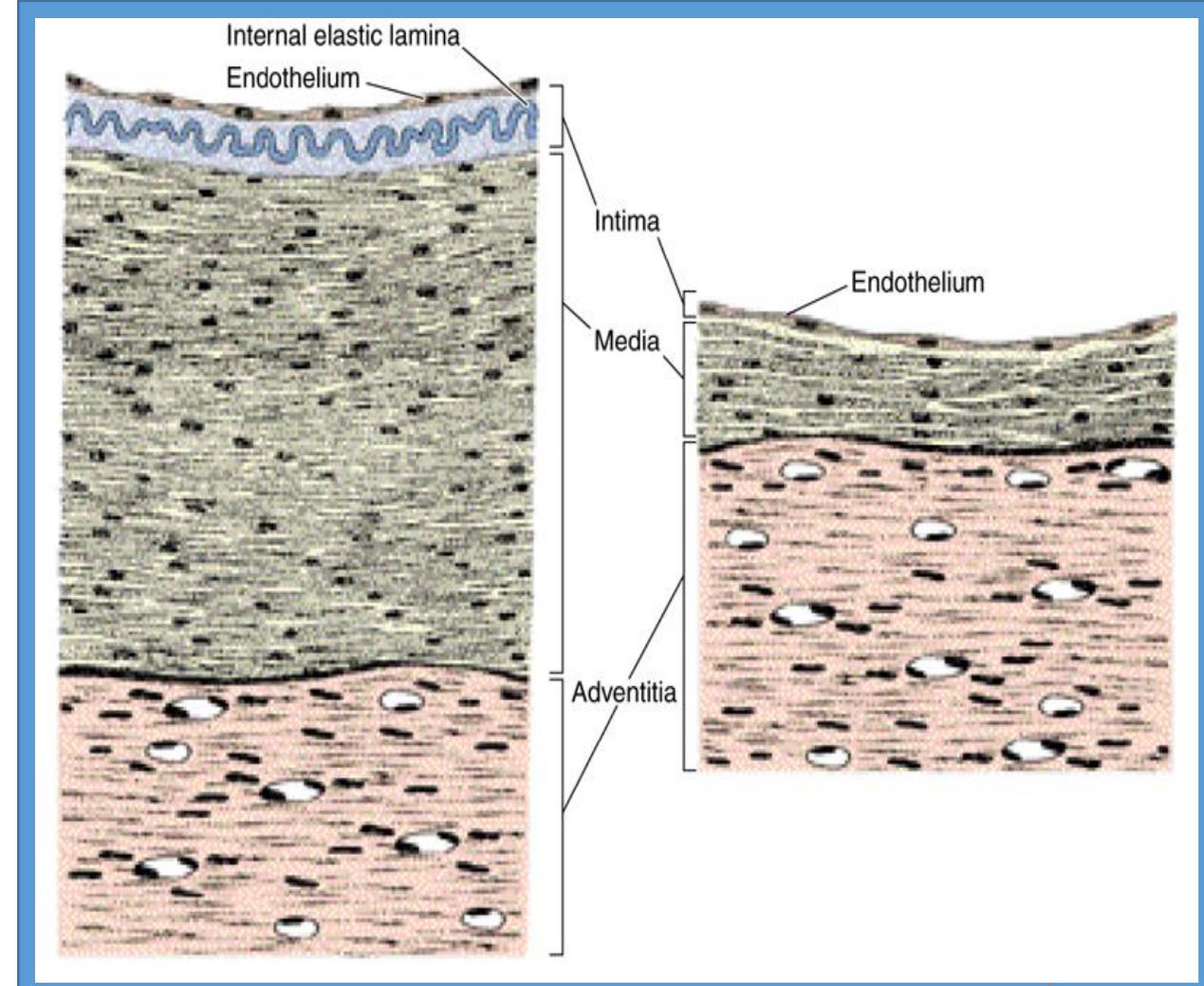
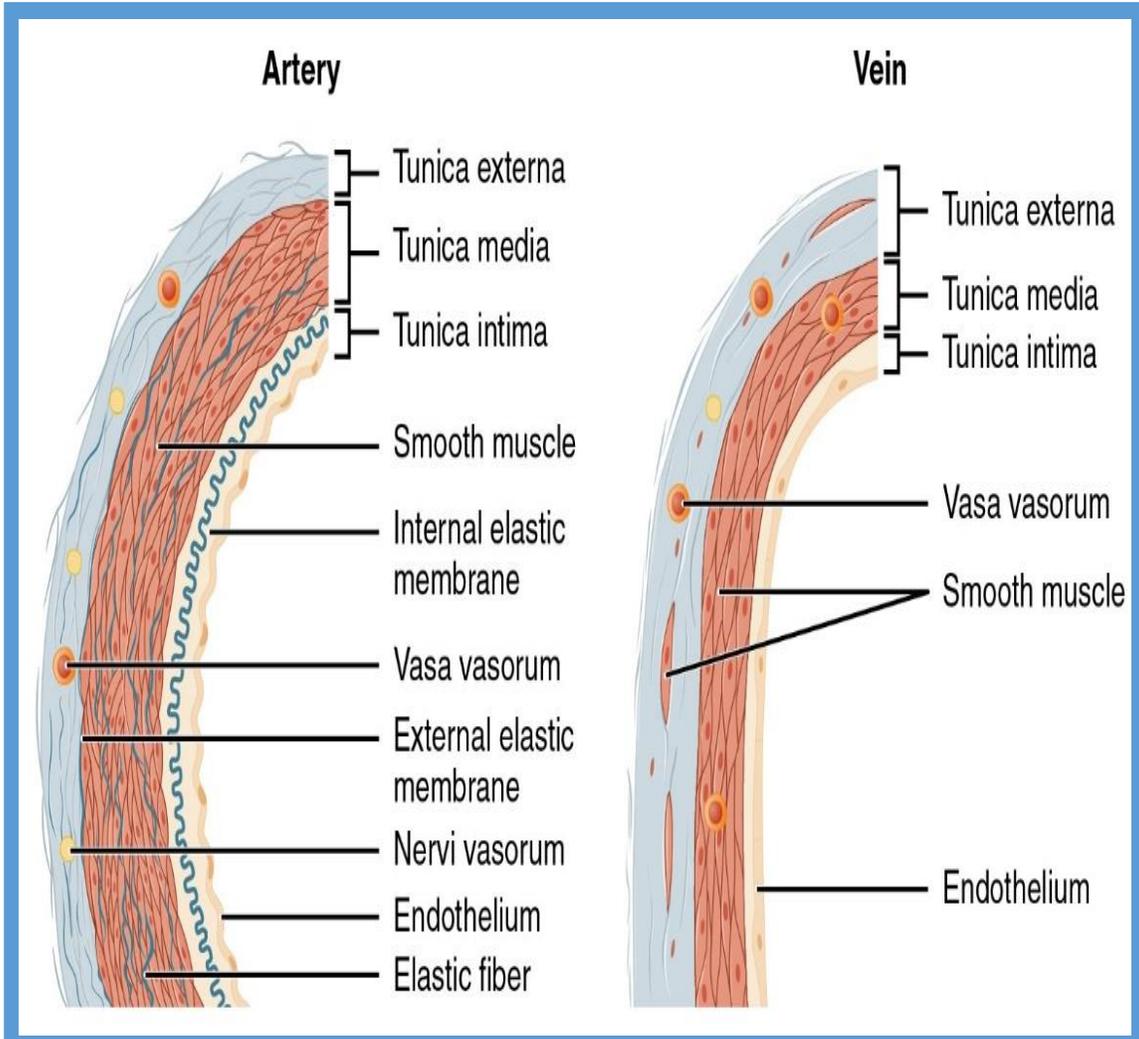


## Capillary

Endothelial cells  
Basement membrane



- **The walls of arteries are thicker than those of veins. The smooth muscle and elastic fibres that make up their walls enable them to withstand the high pressure of blood as it is pumped from the heart.**



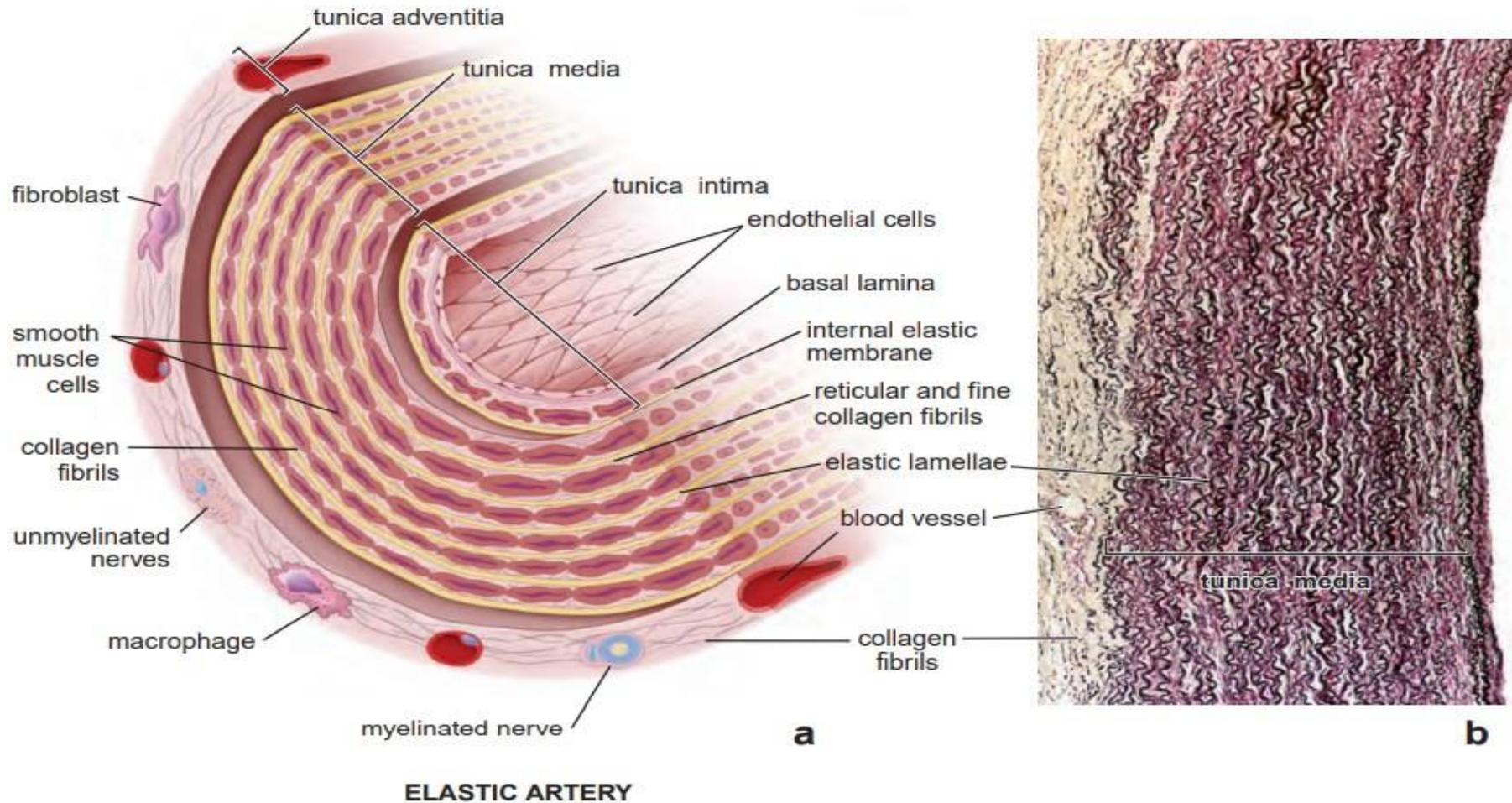
# Large arteries (also called elastic arteries or conducting arteries)

- Include the aorta and its largest main branches.
- Structure
  - **A. Tunica intima** - thin (relative to other layers in this type of vessel).
    - (1) Endothelium.
    - (2) Subendothelial layer contains some smooth muscle, elastic fibers, collagen fibers.
    - (3) Internal elastic lamina - not as distinct as in other arteries
  - **B. Tunica media** – thick.
    - (1) 40 – 60 concentric layer of elastic laminae.
    - (2) Between elastic laminae - fibroblasts, elastic fibers, collagen fibers, spiral (to circular) smooth muscle.

# Large arteries (also called elastic arteries or conducting arteries)

- **C. Tunica adventita** - thin consists mainly of collagen fibers, blood vessels, nerves some elastic fibers, fibroblasts, macrophages may also be present.
- **Function:-** to conduct blood from the heart to smaller arteries. The presence of elastic laminae gives these vessels elastic properties. They expand as the heart contracts (to modulate blood pressure and store energy) and recoil during ventricular relaxation (to maintain more even pressure in large arteries).
- Large elastic arteries help to stabilize the blood flow.

# Large artery (elastic artery)



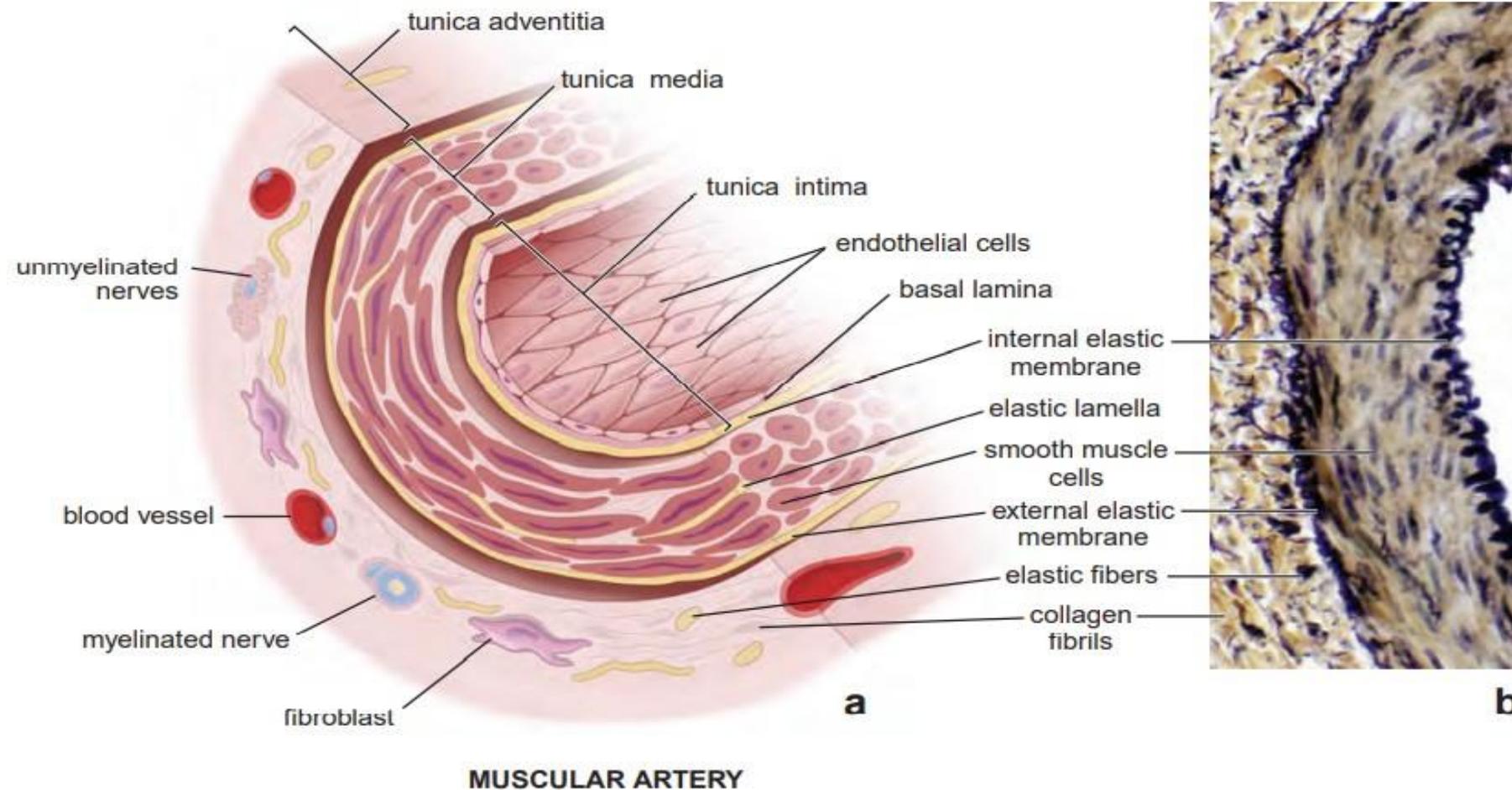
# Medium to small arteries (also called muscular arteries)

- Structure
- **A. Tunica intima** - thin
  - (1) Endothelium.
  - (2) Thin subendothelial layer consisting of scattered fine collagen and elastic fibers and a few fibroblasts.
  - (3) Internal elastic lamina - very distinct, usually folded.
- **B. Tunica media** – thick.
  - (1) Circular smooth muscle, 5 - 40 layers.
  - (2) Small amount of Connective Tissue with collagen fibers and elastic fibers between muscle.

# Medium to small arteries (also called muscular arteries)

- (3) Thickness decreases as diameter of vessel decreases.
- (4) External elastic lamina (May be indistinct in smaller muscular arteries).
- **C. Tunica adventita** - thick loose Connective Tissue.
- **Function:-** to distribute blood to smaller arterial vessels. The muscular wall resists damage due to relatively high blood pressure in these vessels.

# Medium to small artery (muscular artery)



# Arterioles

- **Structure**
- **A. Tunica intima** – (1) very thin consisting only of endothelium.
- (2) Internal elastic lamina - usually present except in smaller arterioles.
- **B. Tunica media** - 1 to 5 layers of smooth muscle, some elastic fibers.
- **C. Tunica adventita** - thin, consisting of longitudinally arranged collagen and elastic fibers.
- **Function:-** to redistribute blood flow to capillaries and to alter blood pressure by altering peripheral resistance to blood flow. Arterioles can change diameter therefore affecting blood pressure and flow patterns.

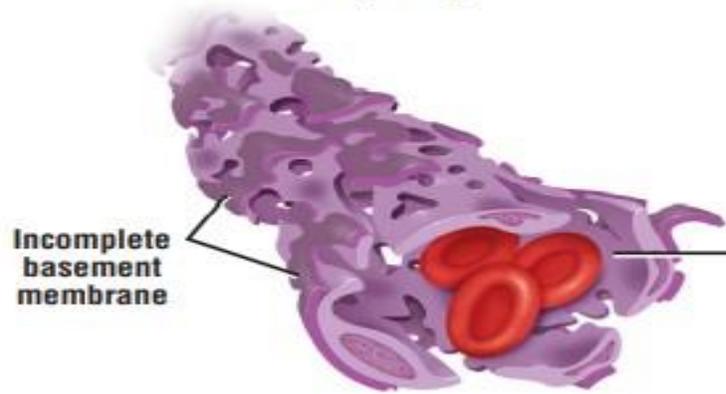
# Capillaries

- **Capillaries are the smallest blood vessels. Their average diameter is about 8  $\mu\text{m}$ , which is about the size of an erythrocyte (red blood cell [RBC]).**
- **Site of exchange of metabolism, wastes, and gases between the vascular lumen and extravascular tissue.**
- **Each capillary consists of a thin endothelium, an underlying basal lamina, and an incomplete layer of cells surrounding the capillary, the pericytes.**
- **There are three types of capillaries: continuous capillaries, fenestrated capillaries, and sinusoids.**

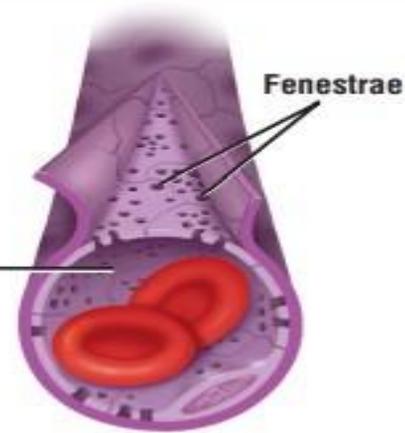
# Types of Capillaries

- **1- Continuous capillaries** are the most common.
- They are found in muscle, connective tissue, nervous tissue, skin, respiratory organs, and exocrine glands. In these capillaries, the endothelial cells are joined and form an uninterrupted, solid endothelial lining. Tight junctions, and gap junctions are seen in these capillaries.
- **2- Fenestrated capillaries** are characterized by openings or fenestrations (pores) in the cytoplasm of endothelial cells designed for rapid exchange of molecules between blood and tissues. Fenestrated capillaries are found in those organs/tissues where exchange of substances occurs between tissues and blood. Endocrine tissues and glands, the small intestine, the kidney glomeruli, and the choroid plexus in the brain ventricles are organs that display fenestrated capillaries.
- **3- Sinusoidal (discontinuous) capillaries** are blood vessels that display irregular, tortuous paths. Their much wider diameters slow down the flow of blood. Endothelial cell junctions are rare in sinusoidal capillaries, and wide gaps exist between individual endothelial cells. Also, because a basement membrane underlying the endothelium is either incomplete or absent, direct exchange of molecules occurs between blood contents and cells. Sinusoidal capillaries are found in the liver, spleen, and bone marrow.

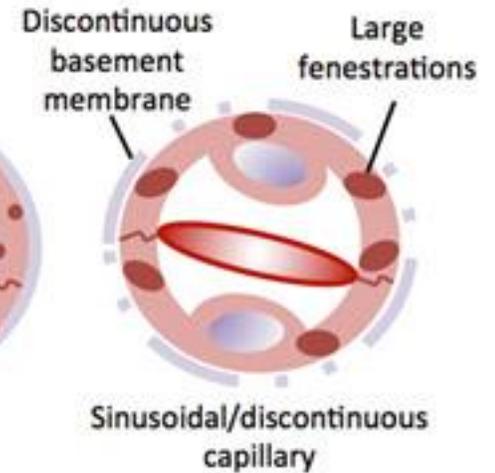
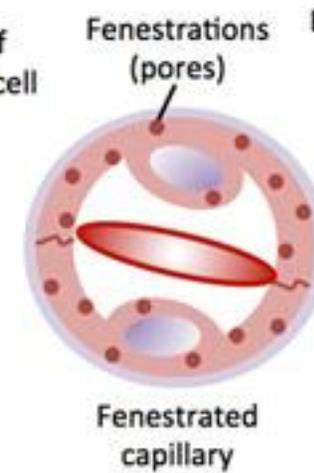
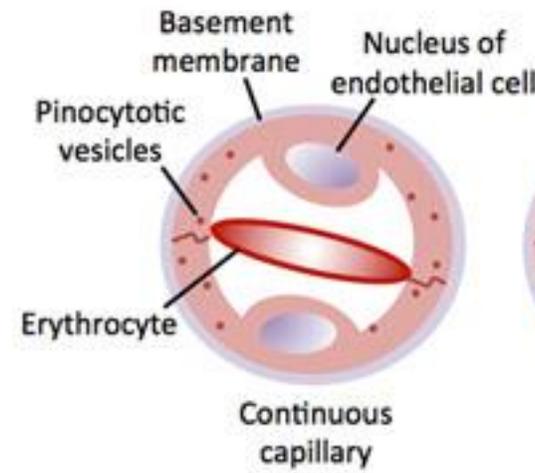
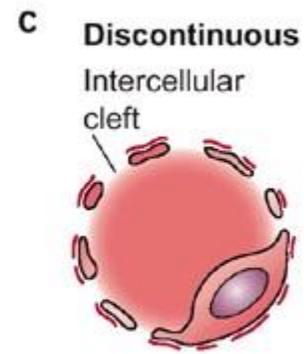
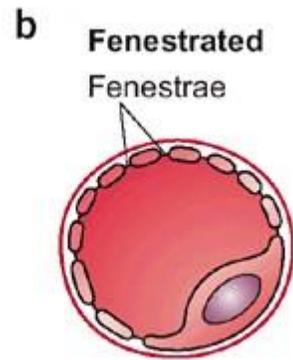
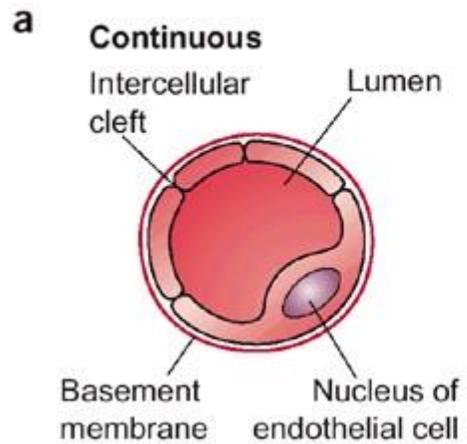
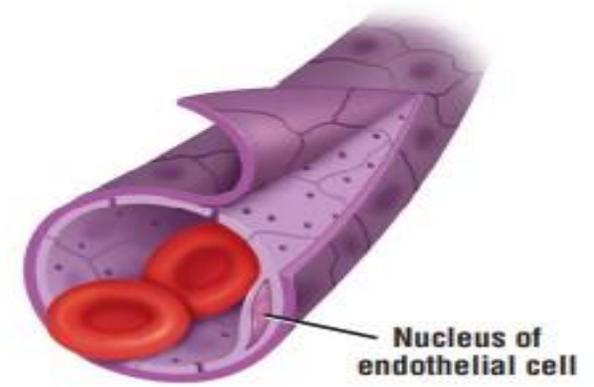
**Sinusoidal (discontinuous) capillary**



**Fenestrated capillary**



**Continuous capillary**



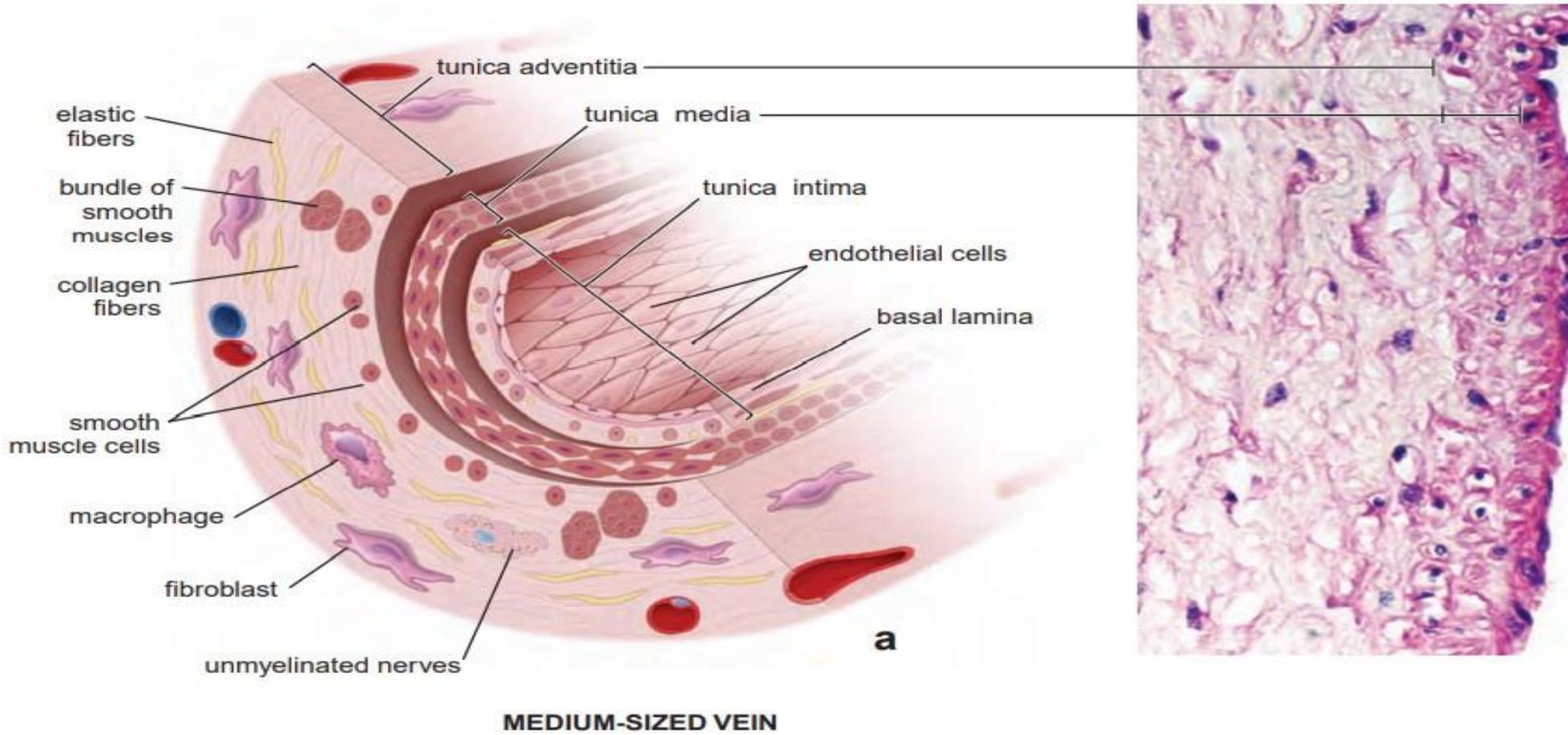
# Venules

- **Structure** - larger diameter than capillaries consist of endothelium surrounded by pericytes.
- **Functions:-**
- **(1)** Collect blood from capillaries.
- **(2)** Respond to vasoactive agents (e.g., histamine, serotonin) by altering permeability.
- **(3)** Also a site of exchange of materials between tissue fluid and blood.
- **(4)** Site of exit of WBCs from blood into tissue.

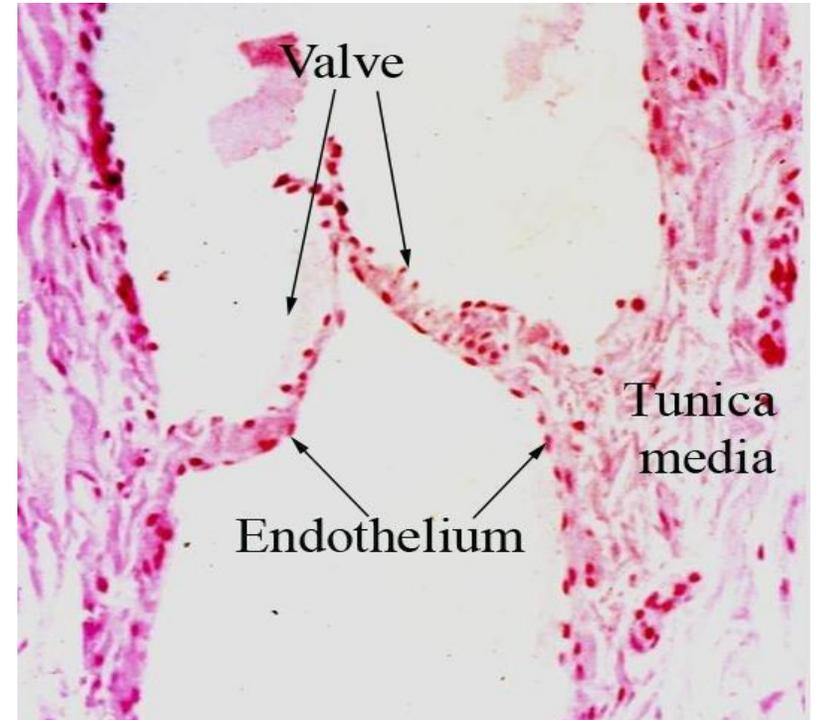
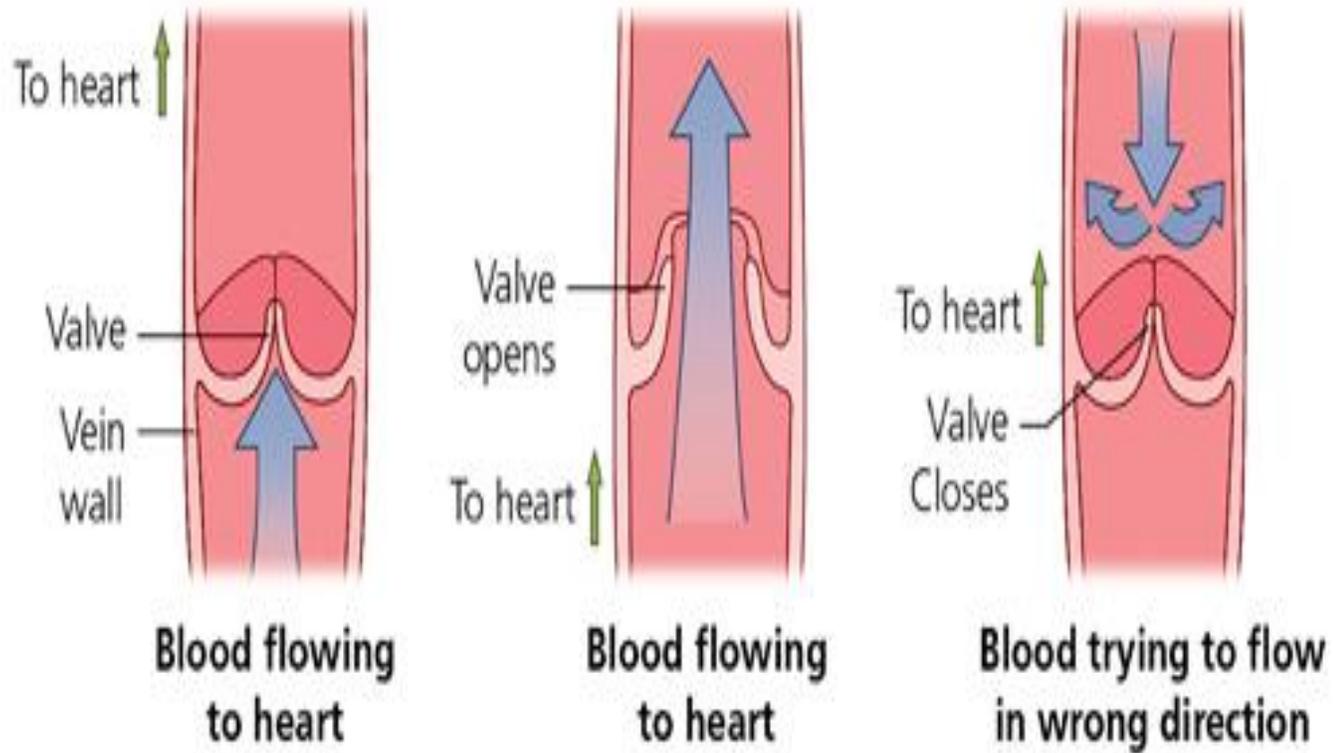
# Small to medium veins

- Structure
- **A. Tunica intima** – thin.
- (1) Endothelium.
- (2) Valves are thin folds of tunica intima projecting well into the lumen, they are rich in elastic fibers and are lined on both sides by endothelium.
- The veins contain valves that maintain the direction of blood-flow. This is important where blood must flow against the force of gravity.
- (3) Thin subendothelial layer.
- **B. Tunica media** - thin circular smooth muscle, collagen fibers, some elastic fibers.
- **C. Tunica adventita** - well developed loose Connective Tissue with longitudinally arranged collagen and elastic fibers, bundles of longitudinal smooth muscle.
- **Function:-** to collect blood from smaller venous vessels.

# Medium vein



# Valves



# Large veins - vena cavae and its larger branches

- Structure
- **A. Tunica intima** – thin.
  - (1) Endothelium.
  - (2) Thin subendothelial layer.
  - (3) Internal elastic lamina are not present.
- **B. Tunica media** - thin, poorly developed mostly Connective Tissue little smooth muscle.
- **C. Tunica adventita** - very thick dense Connective Tissue with spirally arranged collagen fibers, elastic laminae, longitudinal smooth muscle.
- **Function :-** to collect blood from medium sized veins and return it to heart.

# Large vein - vena cavae

