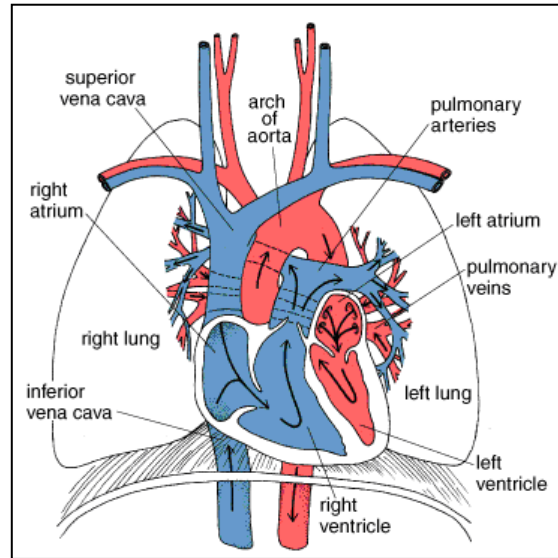


## Vascular system

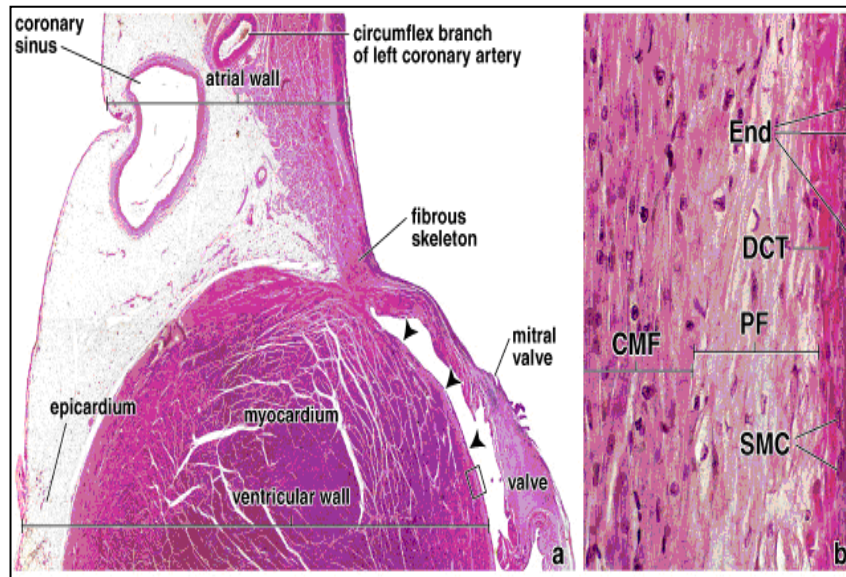
### Wall of the heart

- The wall of the heart contains:
  - \* A musculature of cardiac muscle
  - \* A fibrous skeleton
  - \* Impulse conducting system



### Musculature of the heart

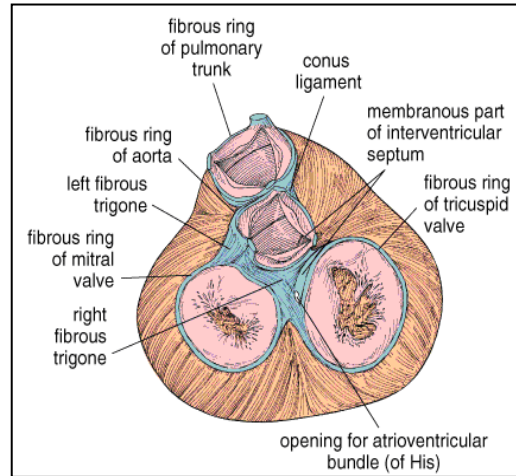
- Epicardium: endothelial cells and its underlying CT, BV, and nerve fibers.
- Myocardium: cardiac muscle fibers.
- Endocardium: formed of endothelium and sub-endothelial CT.



*Diagram showing the structure of the heart wall*

### Fibrous skeleton of the heart

- It Consists of 4 fibrous rings around the valve openings, and 2 fibrous trigones connecting the rings, and the membranous parts of the interventricular and interatrial septa. The fibers rings composed of dense irregular CT.

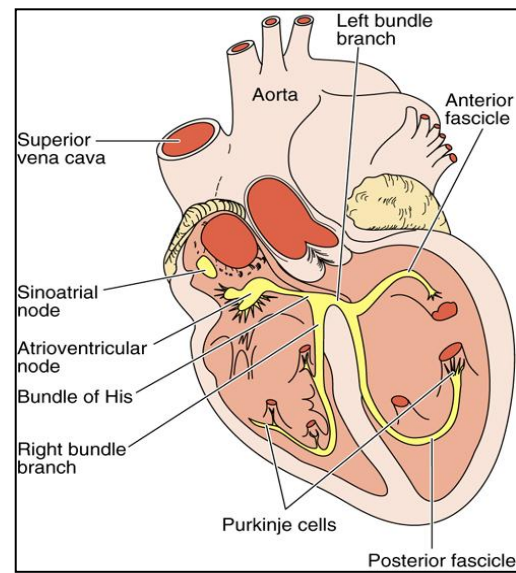


### Impulse conducting system

- SAN
- AVN
- Bundle of Hiss
- Rt bundle branch
- Lt bundle branch
- Purkinje fibers

### Receptors within the cardio-vascular system

- Baro-receptors: High pressure receptors, sense arterial blood pressure (carotid sinus, aortic arch)
- Volume receptors: Low pressure receptors, sense cardiac distention).
- Chemo-receptors: pH and blood gases (carotid and aortic bodies).



### General features of the vascular wall

#### 1- Tunica Intima

Endothelium: single layer of S. Sq. Ep.

Basal lamina:

Subendothelial layer: loose CT, occasionally; contains some smooth muscle fibers.

Sometimes; the subendothelial layer of arteries and arterioles contain a sheet of elastic fibers (internal elastic membrane).

## 2- Tunica Media

Circumferentially arranged layers of smooth muscle fibers, with collagen, elastic fibers and proteoglycans in between.

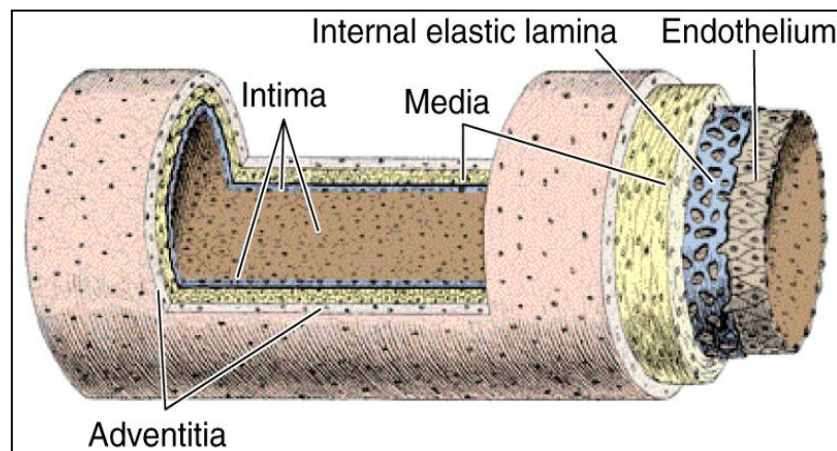
Smooth muscle f. secrete the fibers, and matrix.

Contraction of smooth muscles regulate and/or affect the blood pressure and blood flow.

Sometimes; a dense layer of fenestrated sheet of elastic fibers (external elastic membrane) separate tunica media from tunica adventitia.

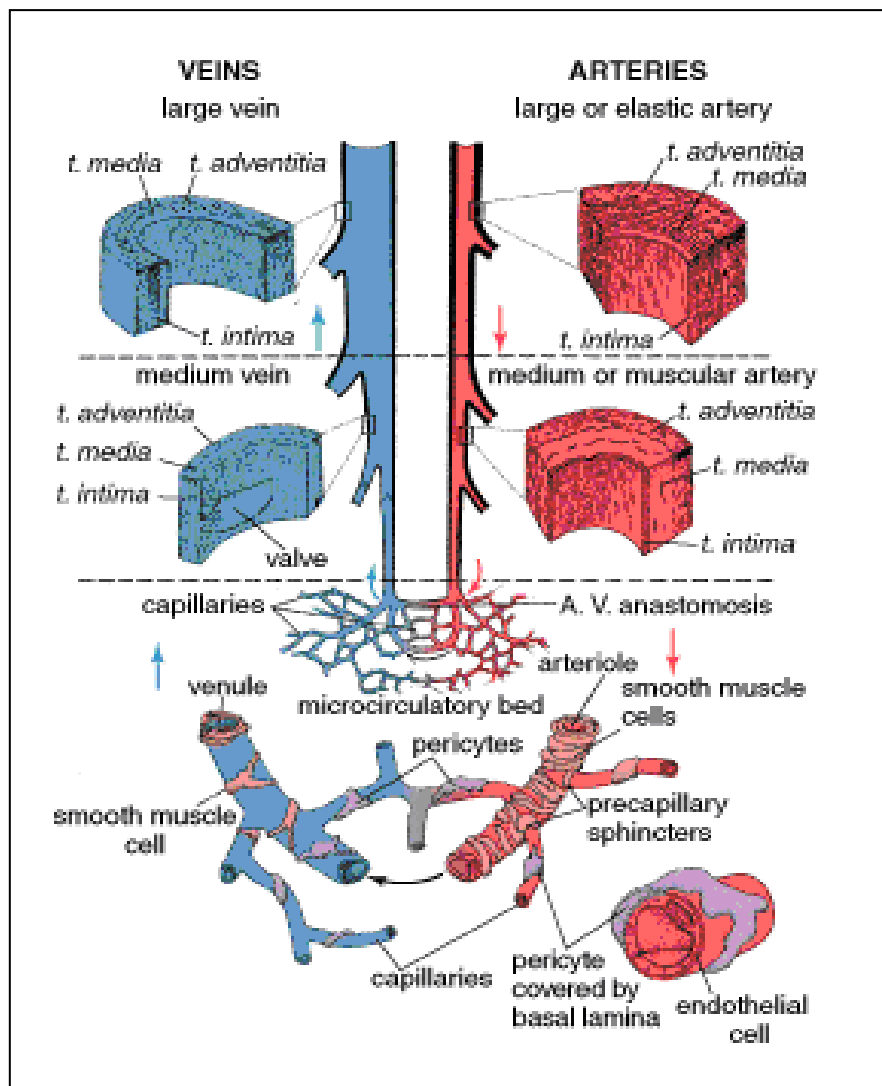
## 3- Tunica Adventitia

The outer most CT layer composed of longitudinal bundles of collagen and elastic fibers; BV, lymphatics, and nerve supply.



## Types of BV

- Large or elastic arteries
- Small arteries
- Capillaries
- Muscular venules
- Medium sized veins
- Atypical veins
- Medium sized or muscular arteries
- Arteriole
- Postcapillary venules
- Small veins
- Large veins



### Elastic or Large Arteries

- Includes aorta, pulmonary arteries, and their main branches.
- They serve as conductor tubes

#### 1- Tunica intima

- \* It is relatively thick.
- \* Endothelium lining and its basal lamina.
- \* The cells are joined together by tight, and gap junctions.
- \* The endothelial cells contain cytoplasmic rod-like bodies called Weibel-Palade Bodies.

- \* These bodies are electron dense structures contain coagulating factor 8 (Von-Willebrand) that are secreted mainly by arterial endothelium into blood stream.
- \* Subendothelial layer; CT contain collagen, elastic fibers, and smooth muscle fibers; and occasionally macrophages.
- \* Internal elastic membrane not well developed.

## **2- Tunica Media**

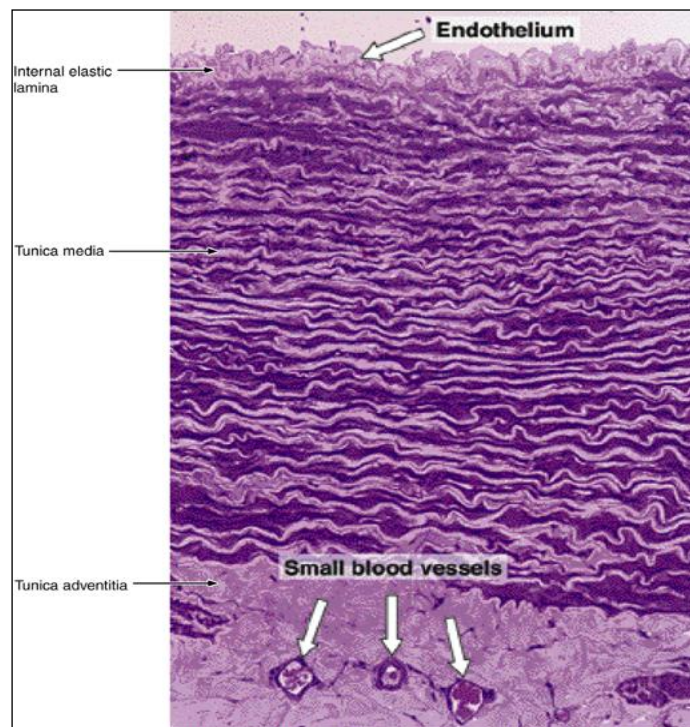
- \* It the thickest layer of the wall.
- \* Formed of multiple layers of smooth muscle fibers separated by elastic lamellae.
- \* Elastic lamellae are formed of fenestrated sheets arranged in concentric layers, their number and thickness related directly to the age and blood pressure.
- \* Smooth muscle fibers arranged in layers in between the elastic lamellae. They secrete collagen, elastic fibers, and proteoglycans

## **3- Tunica adventitia**

- It is formed of loose network of elastic and collage fibers.
- It contain Fibroblasts, macrophages, blood vessels (vasa vasorum), and nerves (nervi vascularis).

## **Endothelial cells**

- Endothelial cells play an important role in blood homeostasis.
- Participate in the structural and functional integrity of the vascular wall, a process called endothelial activation.
- Maintenance of selective permeability barrier
  - Simple diffusion: O<sub>2</sub>, CO<sub>2</sub>, lipid soluble molecules.
  - Trans-cellular pathways ..endocytosis
  - Small pinocytotic vesicles.....
  - Receptor mediated endocytosis

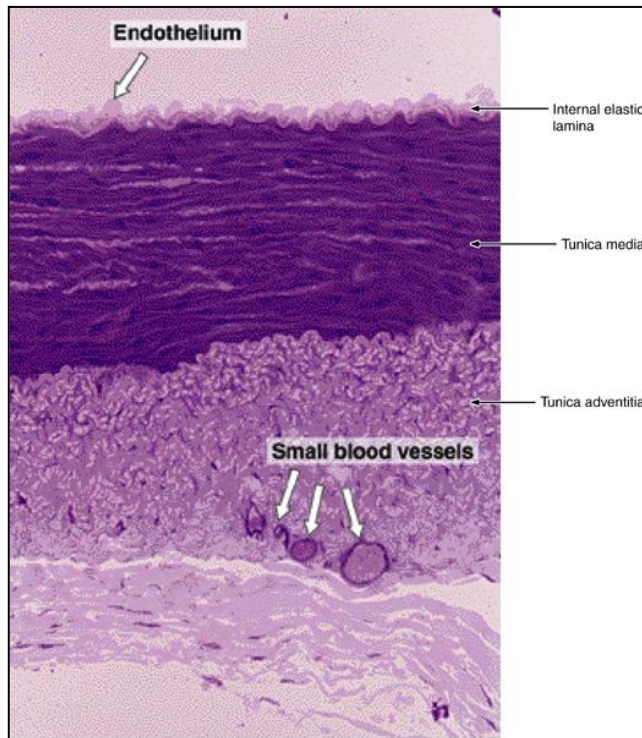


- Maintenance of non-thrombogenic barrier between blood platelets and subendothelial tissues by producing anticoagulants (thrombomodulin) and thrombogenic substances as prostacyclin, and tissue plasminogen activator factors.
- Modulation of blood flow and vascular resistance by secreting vasoconstrictors and vasodilators substances.
- Regulation and modulation of the immune response by controlling interaction of lymphocytes with endothelial surface.
- Regulation of cell growth by secreting growth stimulating factors (Platelet derived growth factor, hemopoietic colony stimulating factors, and others).
- Maintenance of extracellular matrix---- synthesis basal lamina, glycocalyx, and proteoglycans.
- Modification of lipoproteins by oxidation via production of free radicals.
- Modified LDL are endocytosed by macrophages to form foam cells, which are characteristic feature in the formation of atherosclerotic plaques.



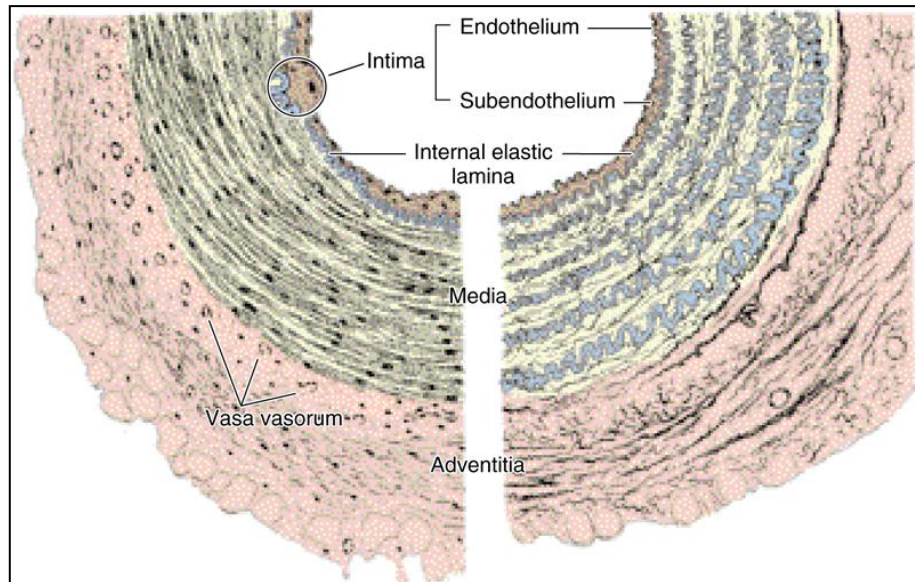
### **Muscular, Medium Sized Arteries**

- Have more smooth muscle fibers and less elastic fibers in the tunica media
- Tunica Intima: relatively thin, with well prominent Internal Elastic Membrane.
- Tunica Media: Formed mainly of smooth muscle fibers, and few collagen and elastic fibers.
- Tunica Adventitia: Formed of CT, collagen and elastic fibers, blood vessels, and nerves.
- Separated from tunica media by well prominent External Elastic Membrane.



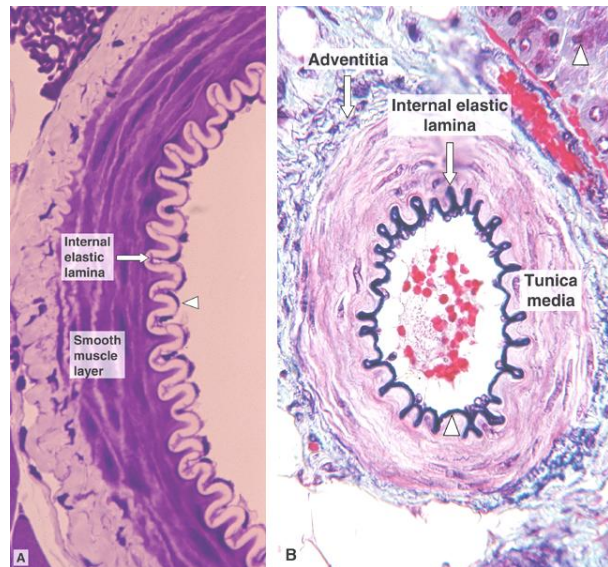
### **Small arteries & arterioles**

- They are differentiated from each other by the number of smooth muscle fibers layers in tunica media.
- Arterioles have one or two layers, but small arteries have up to 8 layers of SMF in tunica media.
- Internal Elastic Membrane is well defined in small arteries, but could or could not be present in arterioles.



### Specialized arteries

- **Cerebral (basilar) artery**; has thin wall and prominent internal elastic membrane.
- **Coronary arteries**; have thick wall, and well developed internal and external; and sometimes middle elastic membranes.
- **Umbilical arteries**; have two thick muscle layers in the media, and not well developed internal elastic membrane, with mucoid in adventitia.
- **Arteries of lung**; have thin wall with reduced muscles and elastic fibers.



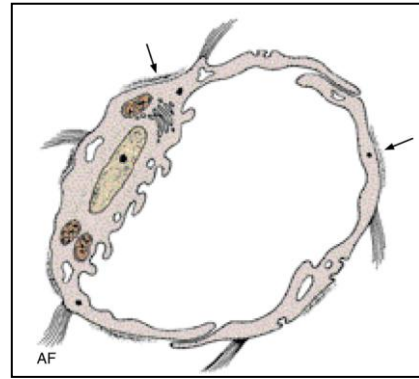
### Capillaries

- Have small diameter, less than the diameter of RBCs.
- Have thin wall through it fluid containing gases, metabolites, and waste product can move.
- Formed of single layer of endothelium, and their basal lamina, and sometimes the Pericytes.



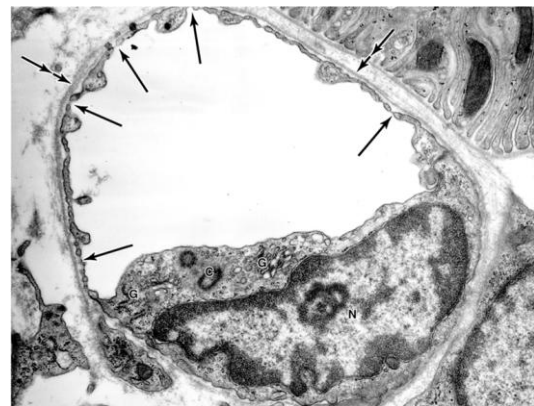
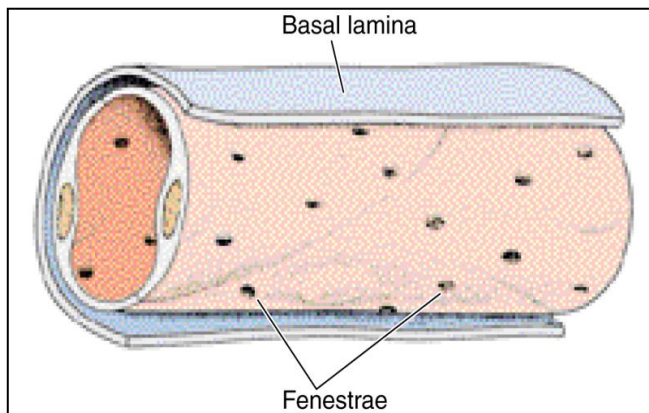
### Continuous Capillaries

- Found in the muscles, lung, and CNS.
- Tight junctions appear to joint cells.
- Several pinocytotic vesicles (luminal and basal lamina) that function in transport material between CT and capillary lumen.



### Fenestrated capillaries

- Found in the endocrine glands, site of absorption as in intestine.
- Contain fenestrations provide channels (with non-membranous diaphragm) across the wall.

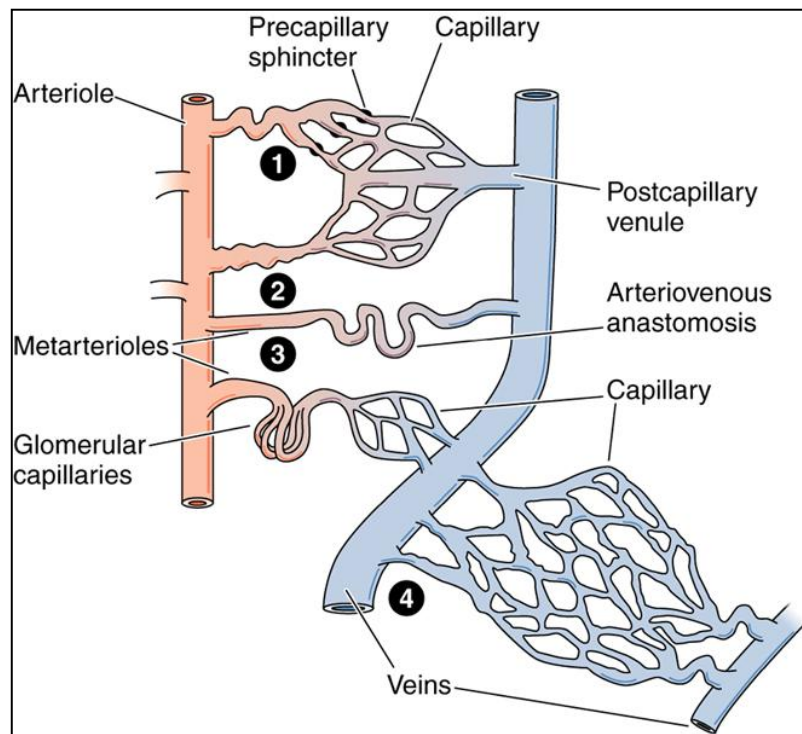


### Discontinuous capillaries

- Sometimes called blood sinusoids.
- Found in the liver, spleen and bone marrow.
- They are large in diameter, and more irregular in shape.
- Their structure varies between organs; but macrophages are associated with endothelial cells.

### Arterio-venous anastomoses / shunt

- Allow blood to bypass capillaries between arteries and veins.
- They are found in the skin of fingertips, nose, lips, and in erectile tissues.
- A-V shunt serves in thermoregulation; i.e. in hotness the shunt of skin closed, makes blood pass in capillaries, so lead to loss of heat.



## **Veins**

- The tunics of veins are not well developed as those of arteries.
- Veins have thinner wall than arteries.
- The lumen of vein is large and collapsed.
- Some veins contain valves, specially those of the lower limbs.

## **Classification of veins**

- Small veins or venules:
  - \* Postcapillary venules.
  - \* Muscular venules.
- Medium sized veins.
- Large veins.

## **Postcapillary venules**

- They receive blood from capillaries.

- Diameter ~ 0.2 mm
- Formed of endothelial lining cells, basal lamina, and pericytes.
- There is no tunica media.
- The endothelial cells are the site of action of vaso-active agents like histamine, and serotonin.
- The postcapillary venules in lymph nodes are called high endothelial venules

### **Muscular venules**

- Located distal to postcapillary venules.
- Their diameter ~ 1mm.
- Have one or two layers of smooth muscle fibers in their tunica media, and thin tunica adventitia.

### **Medium sized veins**

#### **- Tunica Intima:**

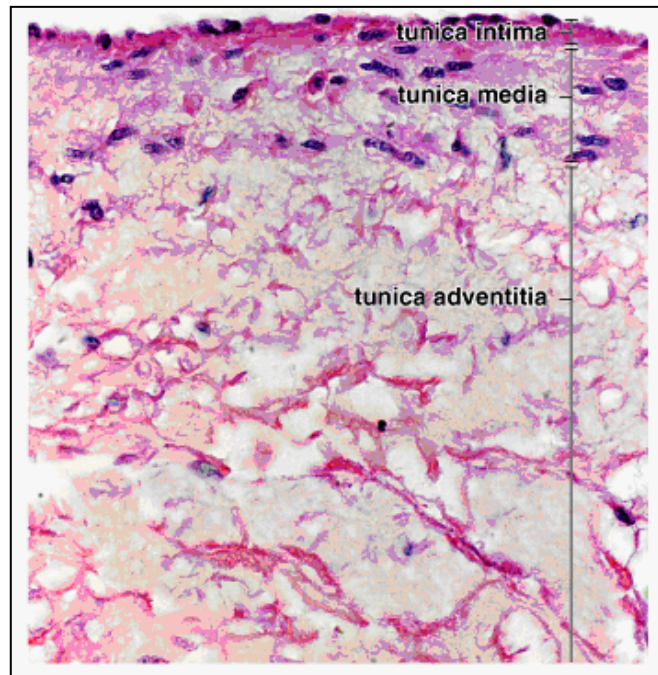
- \* Endothelial cells and basal lamina
- \* Subendothelial CT tissue, with some smooth muscle fibers.
- \* Sometimes, a thin internal elastic membrane found in some veins.

#### **- Tunica media:**

- \* Thinner than tunica adventitia.
- \* Many layers of smooth fibers, with collagen and elastic fibers in between.
- \* Longitudinal arranged smooth muscles fibers.

#### **-Tunica Adventitia:**

- \* Thicker than tunica media
- \* Contain collagen fibers, and a network of elastic fibers.



### **Large veins**

- Diameter more than 1cm.
- Tunica intima: no clear boundary between it and tunica media

- Tunica media: is relatively thin.
- Tunica adventitia: the thickest layer.

\* Longitudinal smooth muscle fibers, collagen, and elastic fibers.

### Atypical veins

- In several locations veins with special structure are present such as;
  - \* Venous channels in the cranial cavity, venous or dural sinuses.
  - \* Veins of the retina, placenta, and trabeculae of spleen

### Lymphatic vessels

- Convey fluids from the tissues to the bloodstream.
- Lymphatic capillaries are blind ended, and more permeable, formed of continuous tube of endothelial cells with incomplete basal lamina.

