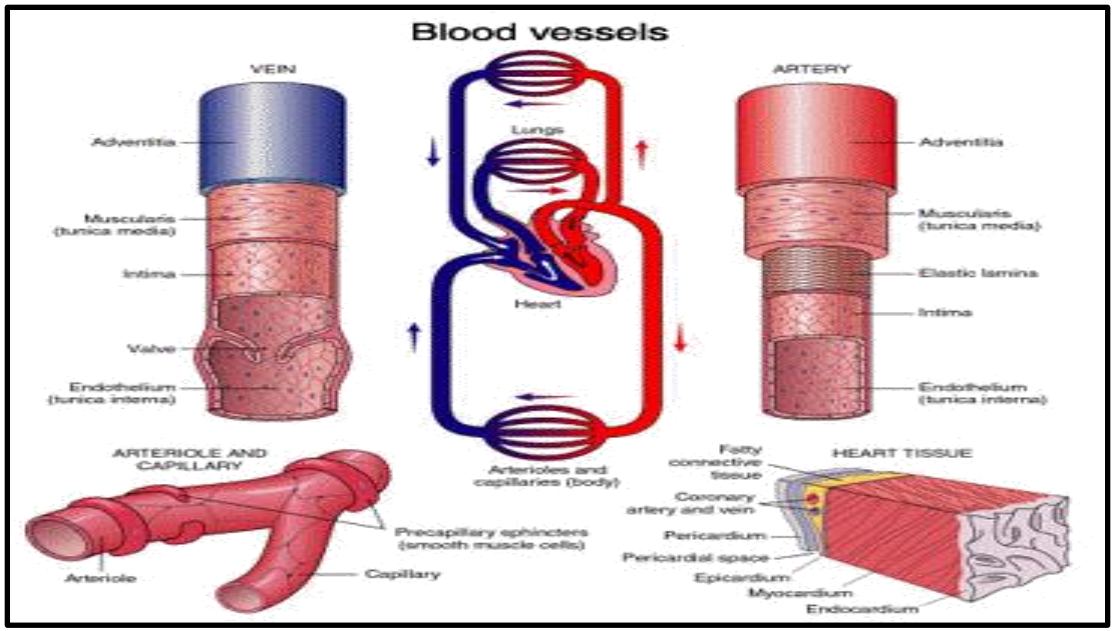
# THE BLOOD VASCULAR SYSTEM

## (cardiovascular system)





By

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# LEARNING OBJECTIVES

- ✓ Recognize the structural characteristics of the circulatory system.
- ✓ Define and describe the structure of different parts of the circulatory.
- ✓ Differentiate between different parts of the circulatory system.
- ✓ Predict the special type of blood vessels from its components.

**The Blood vascular system is formed of:**

- **Heart** that pumps blood.
- **Arteries** that carry the blood from the heart to tissues.
- **Veins** that carry the blood from tissues to the heart.
- **Arterio-venous connections** in the form of: in the form of:

1. *Capillaries.*
2. *Arterio-Venous anastomosis*

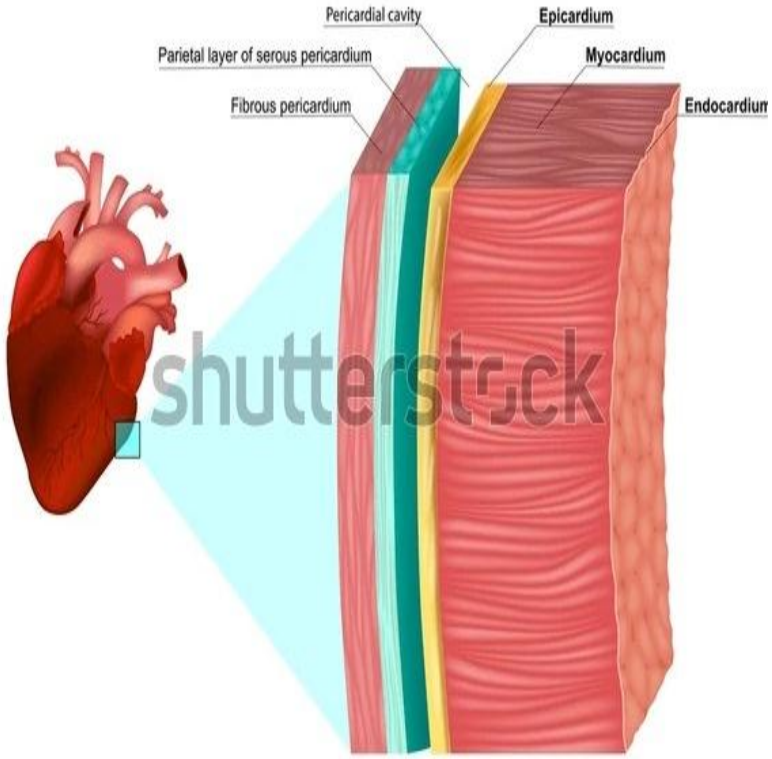
# THE HEART

The wall of the heart consists of 3 *layers or tunics:*

**1-The endocardium** (the inner layer).

**2- The myocardium** (the middle and thickest muscular layer):

**3- The epicardium:** It is outer protective layer of the heart.



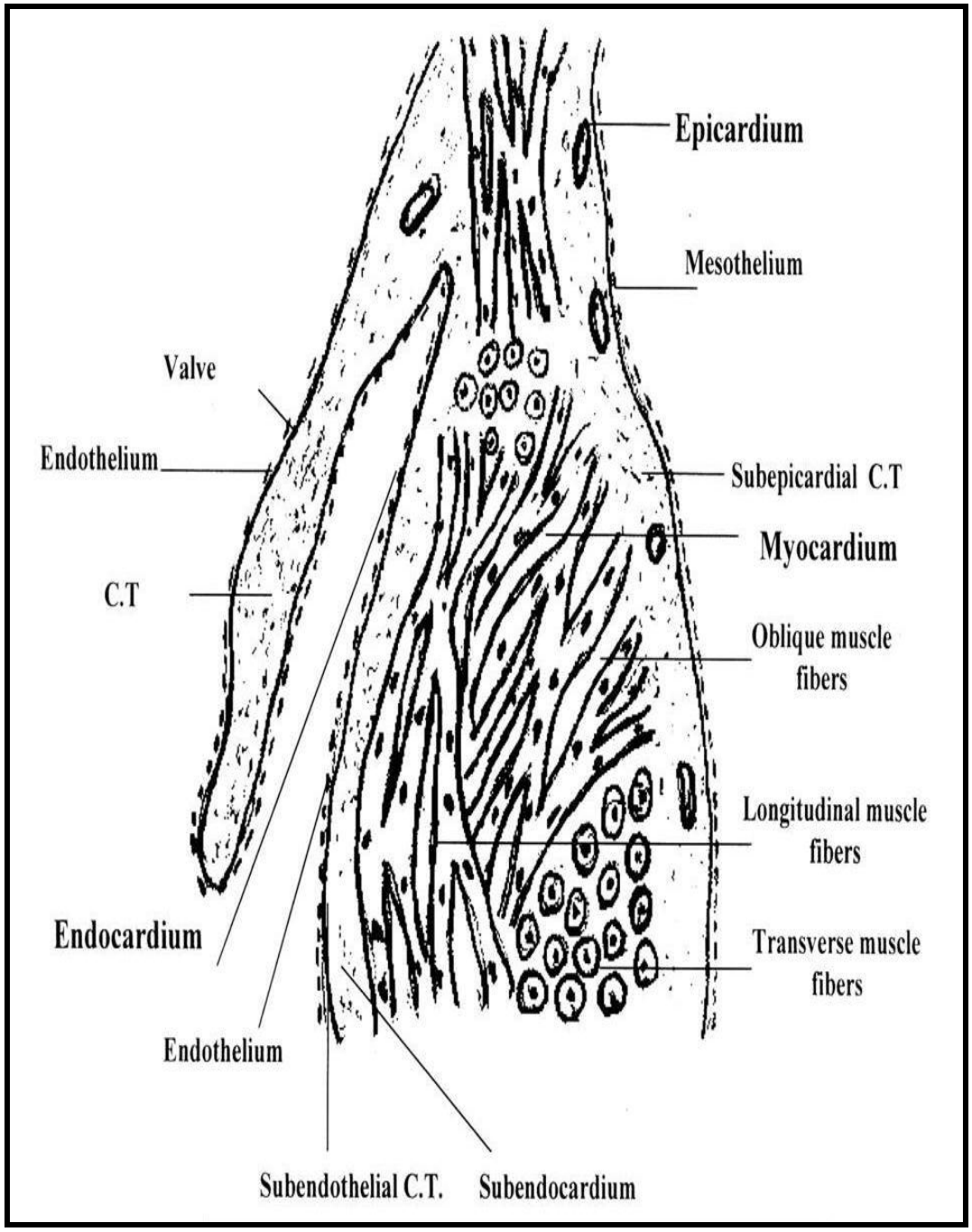
**The endocardium** consists of:

***a) Endothelium:*** single layer of simple squamous epithelial cells.

***b) Subendothelium:*** thin layer of loose connective tissue.

***c) Subendocardium:*** layer of C.T. between endocardium and myocardium rich in veins, nerves and impulse conducting fibers.

**The heart valves** are folds of endocardium formed of dense connective tissue lined on both sides by endothelial cells.



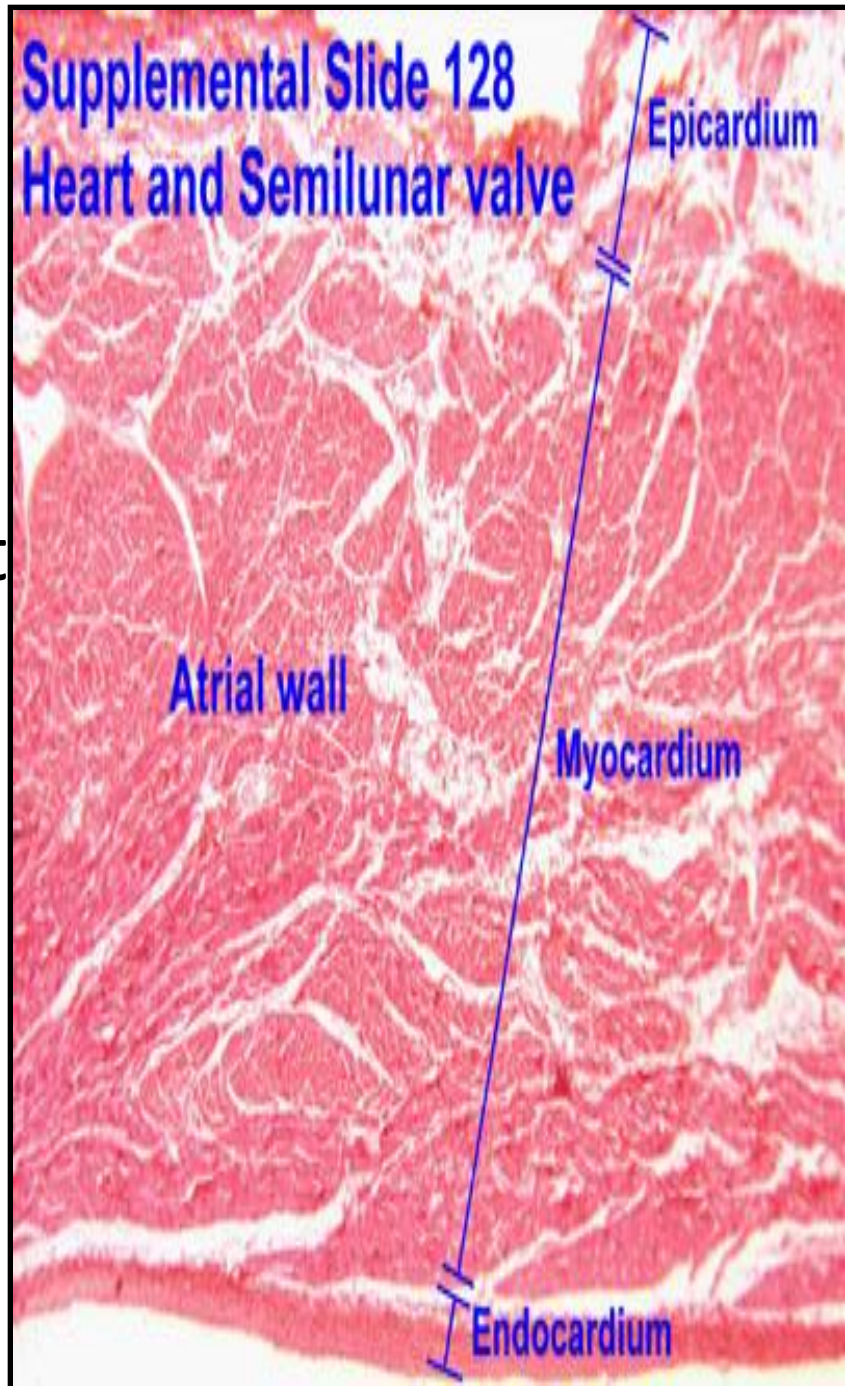
# The myocardium

thickest layer:

-Consists of cardiac muscle fibers arranged in many different directions.

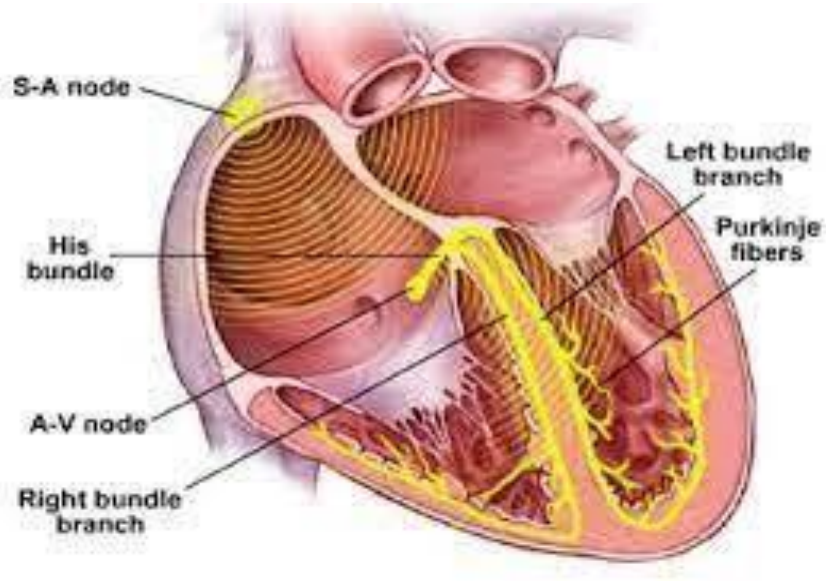
-The muscle fibers of the heart are grouped into three populations:

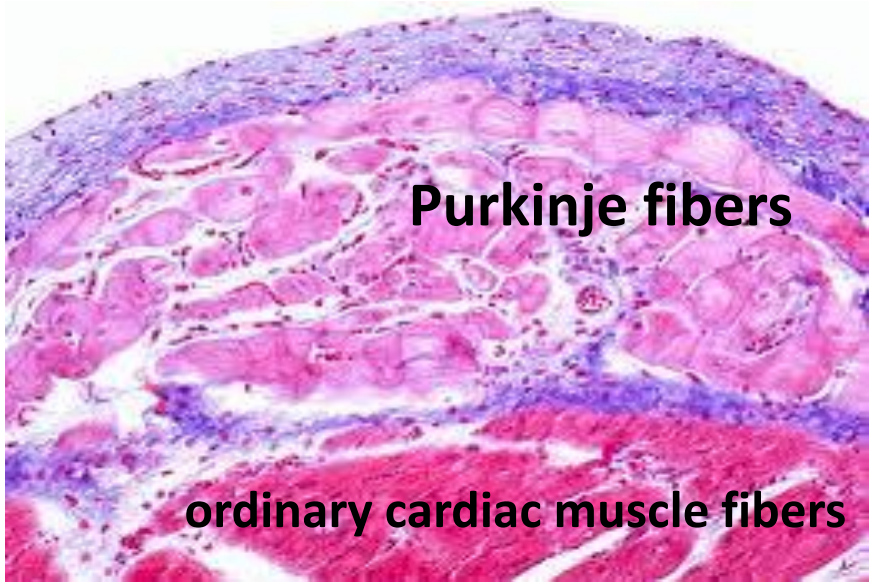
- Contractile fibers.
- Specialized fibers for endocrine secretions
- Impulse generating and conducting fibers.



# Purkinje fibers

- They are specialized cardiac muscle cells for **conduction** of impulse to the ordinary muscle cells.
- They travel in **subendocardial layer** of the ventricles.
- **The cells contain** fewer myofibrils, **larger** and paler than ordinary cardiac muscle fibers.



**The epicardium:** It is outer protective layer of the heart and consists of:

a) ***Mesothelium*** formed of simple squamous epithelial cells resting on thin layer of loose connective tissue.

b) ***Subepicardium*** connective tissue layer, containing coronary arteries, veins, nerves.

# **General Structure**: The wall of a blood vessel consists of 3 coats (tunica):

All blood vessels have nearly the same structure with some differences depending on:

1- The size of the vessel.

2- The physiologic requirements (e.g. blood pressure inside the lumen).

Generally the wall of blood vessels is composed of 3 tunics:

**1- Tunica Intima**

**2- Tunica Media**

**3- Tunica Adventitia**

# The wall of a blood vessel consists of 3 coats (tunica):

**1- Tunica Intima** The innermost layer close to the lumen formed of:

**i) Endothelium:**

- It is formed of a **single layer of simple squamous cells.**

-It lines the blood vessel from inside.

**ii) Subendothelial:**

-It consists of loose connective tissue

**iii) Internal elastic lamina:**

-Composed of fenestrated layer of elastin

-It appears as a wavy pink line in empty vessels.

**2- Tunica Media** (The middle layer) formed of:

-*Circularly arranged* smooth muscle cells

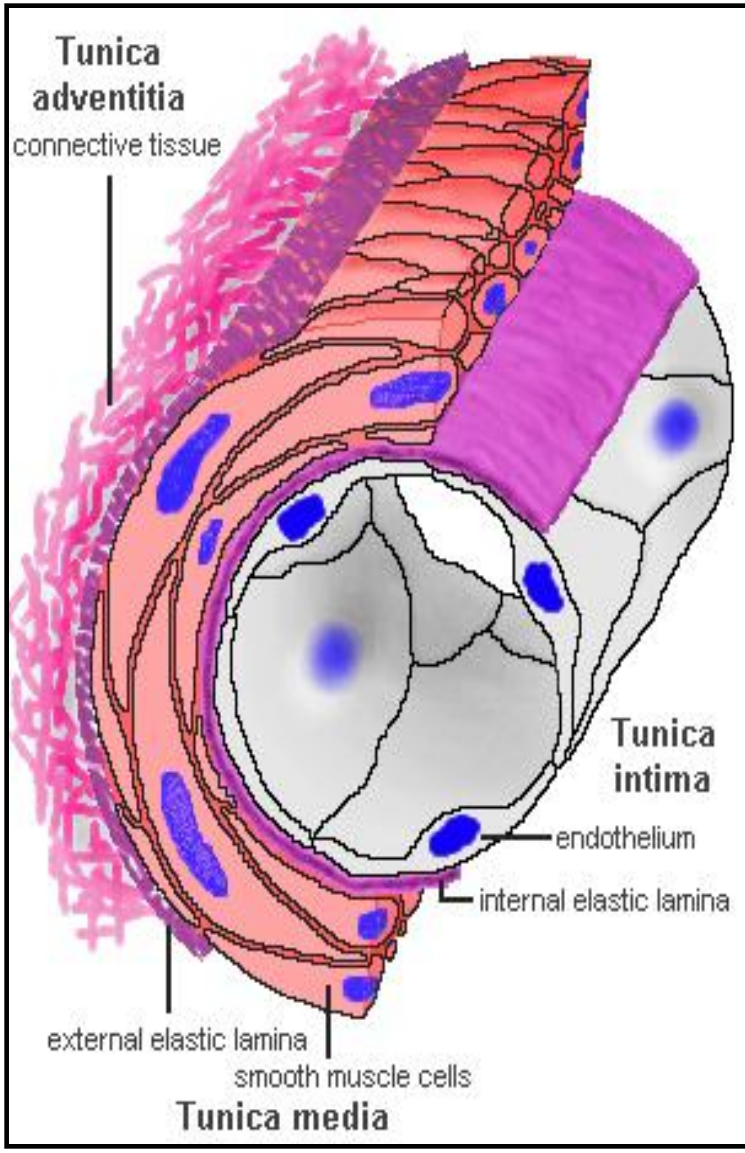
-Variable amounts of elastic fibers in between the muscle cells.

**-An external elastic lamina** may be present.

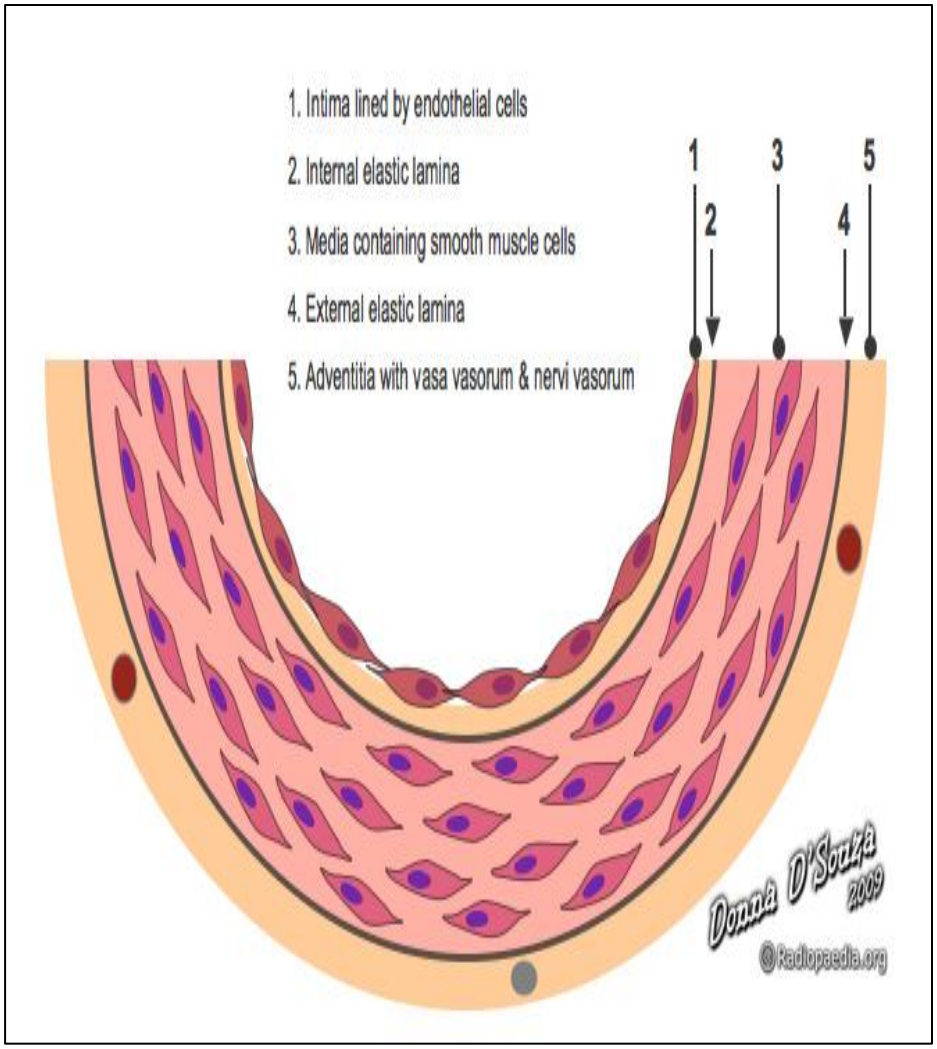
**3- Tunica Adventitia:**(The outermost layer).

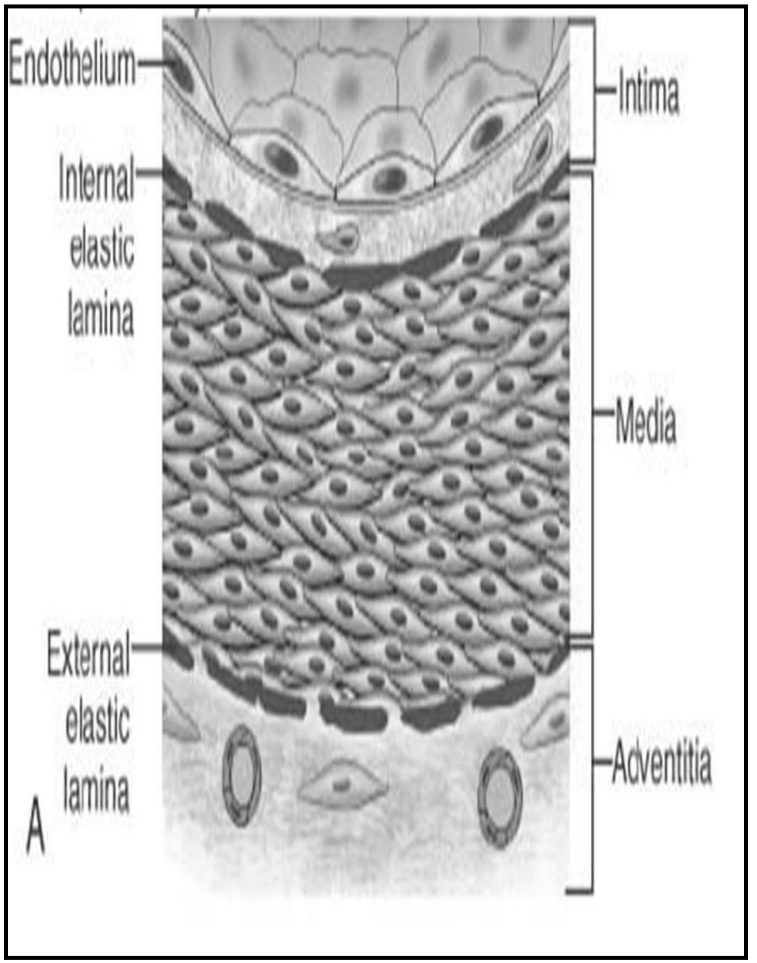
-It is formed of loose connective tissue

-It contains small blood vessels (vasa vasorum) to supply the outer layer of the blood vessel and vasomotor nerves.



# The wall of a blood vessel



# Arteries

They are classified according to the diameter into:

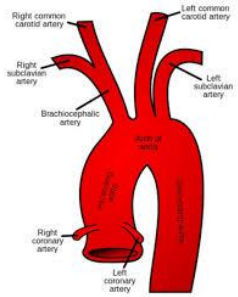
1- Large (elastic) arteries.

2- Medium sized (muscular) arteries.

3- Arterioles.

# Structure of large elastic artery (Aorta):

It has a **very thick elastic wall** and a **wide lumen**.



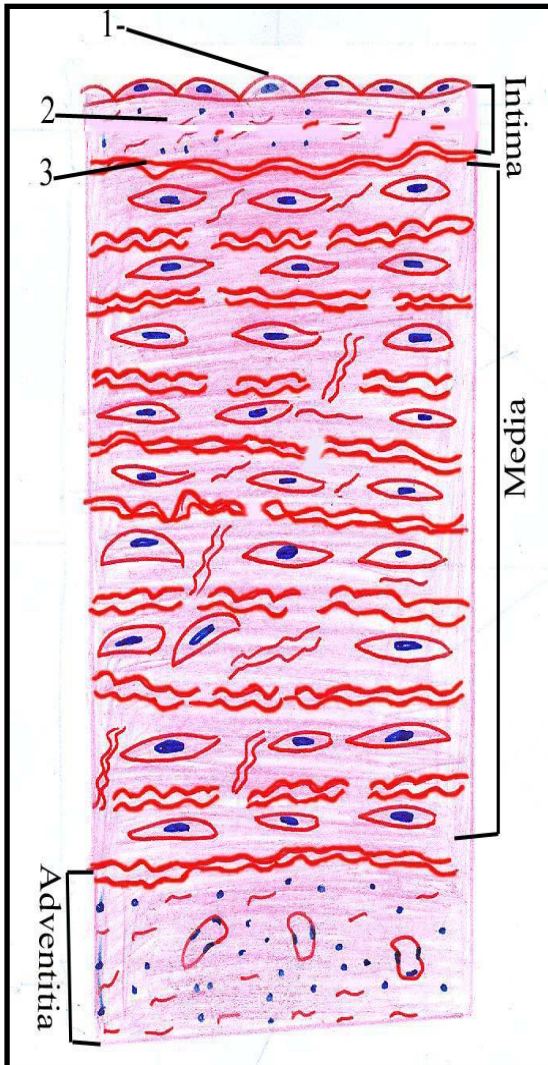

**Tunica intima:** it is formed of:

- Endothelium.
- Subendothelium.
- Internal elastic lamina (indistinct).

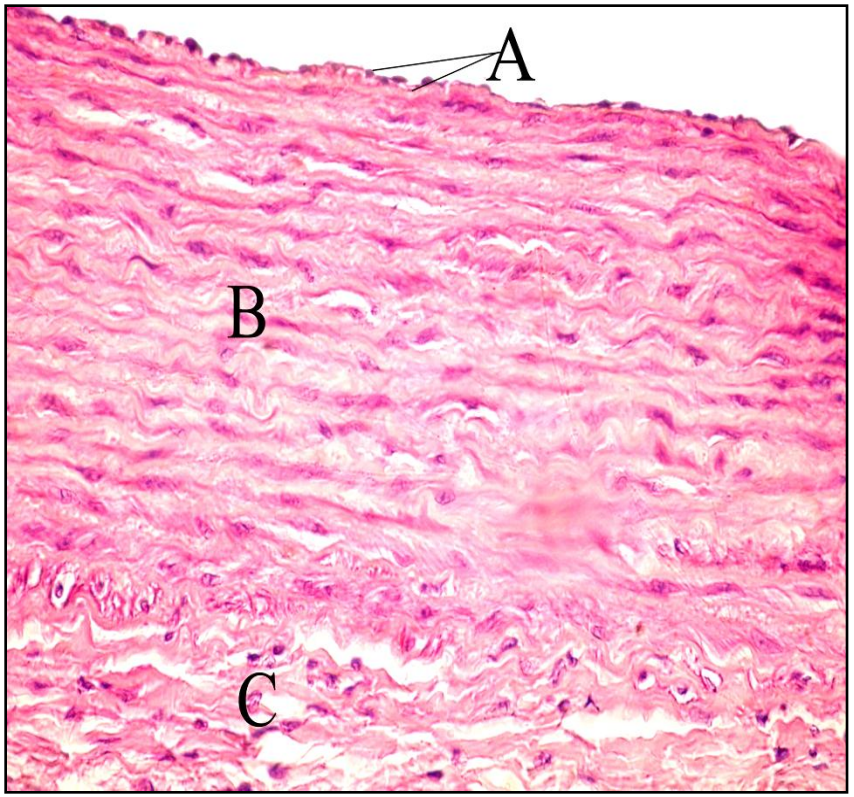
**Tunica media:**

- It is very thick .
- formed mainly of **fenestrated laminae of elastic fibers** separated by circularly arranged smooth muscles &collagen fibers.
- Internal and external elastic laminae although present, are **not distinct** as they emerge with that of tunica media.

**Tunica adventitia:** It is relatively thin.



# Aorta




**Orcein**

**A- Tunica Intima**

**B- Tunica Media**

C-**Tunica Adventitia**

# Structure of medium sized (muscular) artery:

It has a thick wall with narrow lumen.

## Tunica intima:

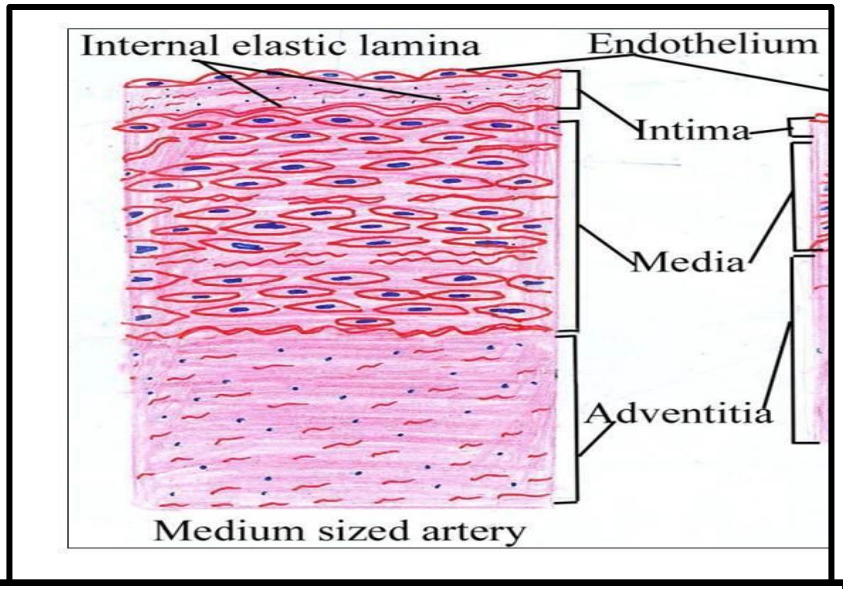
- Endothelium
- subendothelium
- prominent internal elastic lamina.

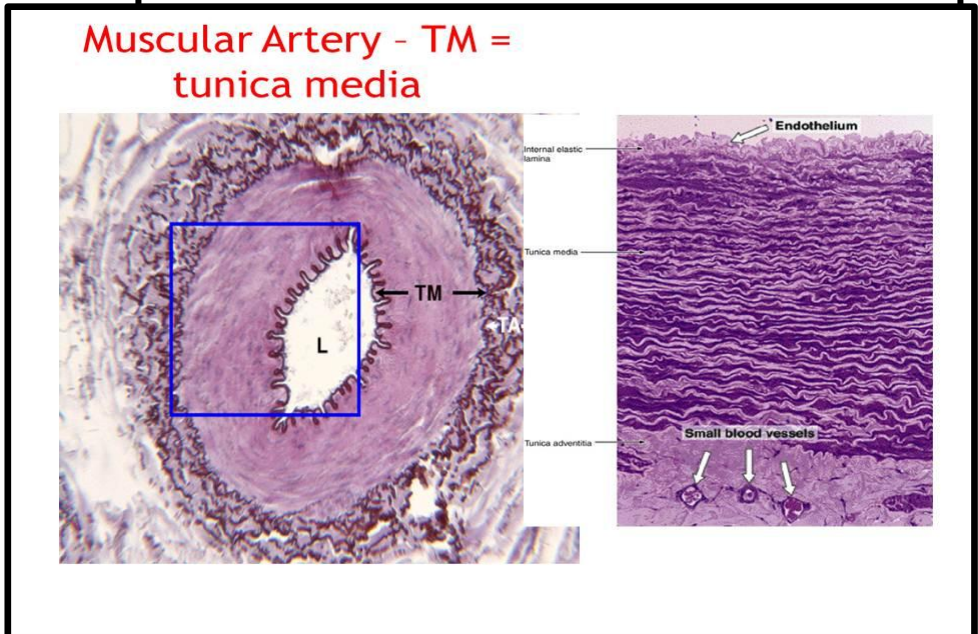
## Tunica media:

- It is formed mainly of circularly arranged smooth muscle cells separated by few elastic fibers and collagenous fibers.
- External elastic lamina is present between media and adventitia.

## Tunica adventitia:

- It is as thick as the media.



# Metarterioles

- They are vessels intermediate between arterioles and capillaries.

**Structure:**

- ✓ They have thin walls.
- ✓ They are lined by endothelial cells with basal laminae.
- ✓ They are surrounded by a discontinuous layer of smooth muscle.
- ✓ At the junction of a metarteriole with a capillary, there is a ring of smooth muscle fibers called the precapillary sphincter.

# Veins

## large veins (inferior vena cava):

- **Tunica intima:** Well developed

-endothelium

-subendothelial

-poorly defined internal elastic lamina.

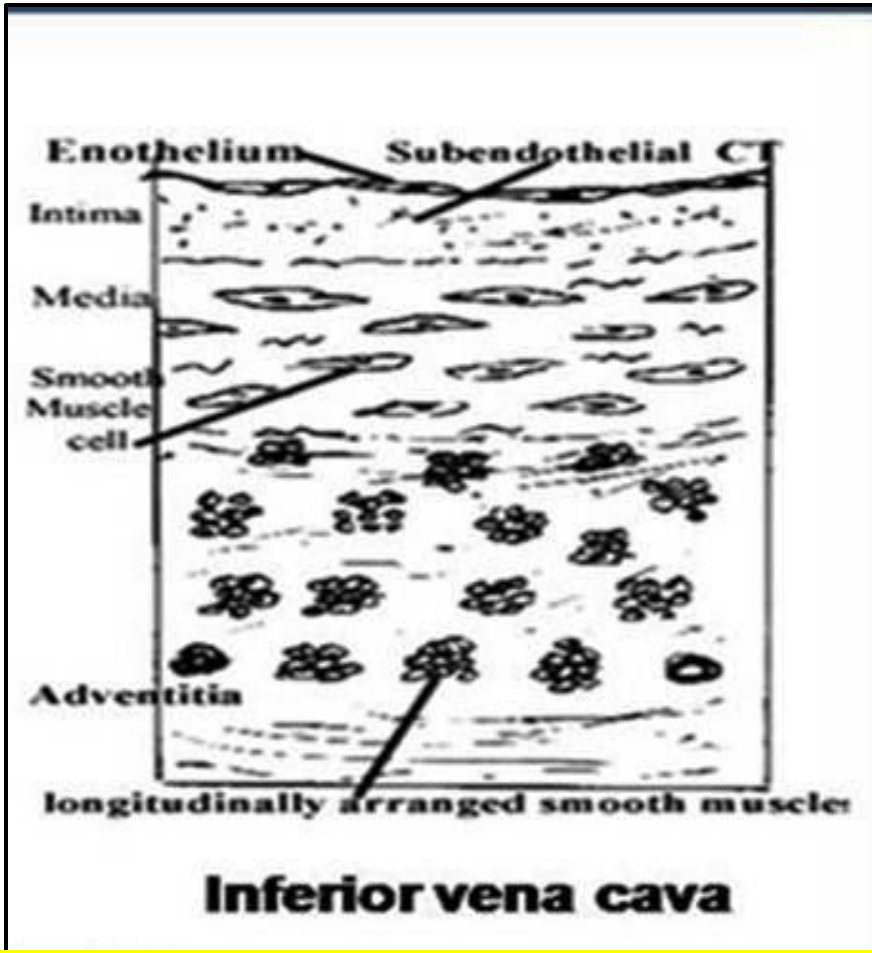
-Valves are present

- **Tunica media:**

is thin & formed mainly of few smooth muscle cells.

- **Tunica adventitia:**

It is thick and contains longitudinal bundles of smooth muscle.




**Inferior vena cava**

***Valves:***

-Numerous in veins of the limbs.

-They direct the blood towards the heart.

-They consist of two semilunar folds of the intima , covered on both sides by endothelium.

# Veins

## Medium sized vein:

- They accompany the medium sized arteries, carry their names.
- It has a and wide lumenthin wall .

***Structure of the wall:***

**Tunica intima:**

-endothelium

-subendothelium v.thin

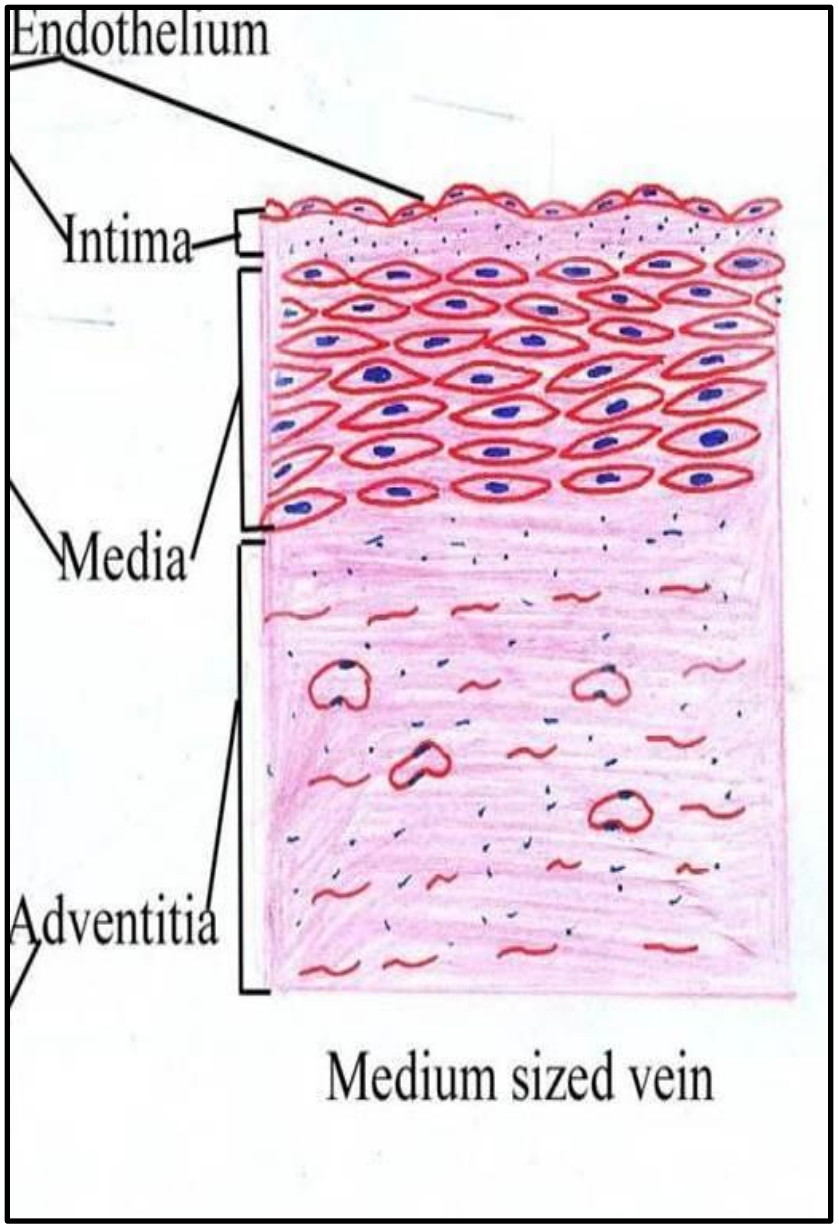
-no internal elastic lamina.

**Tunica media:**

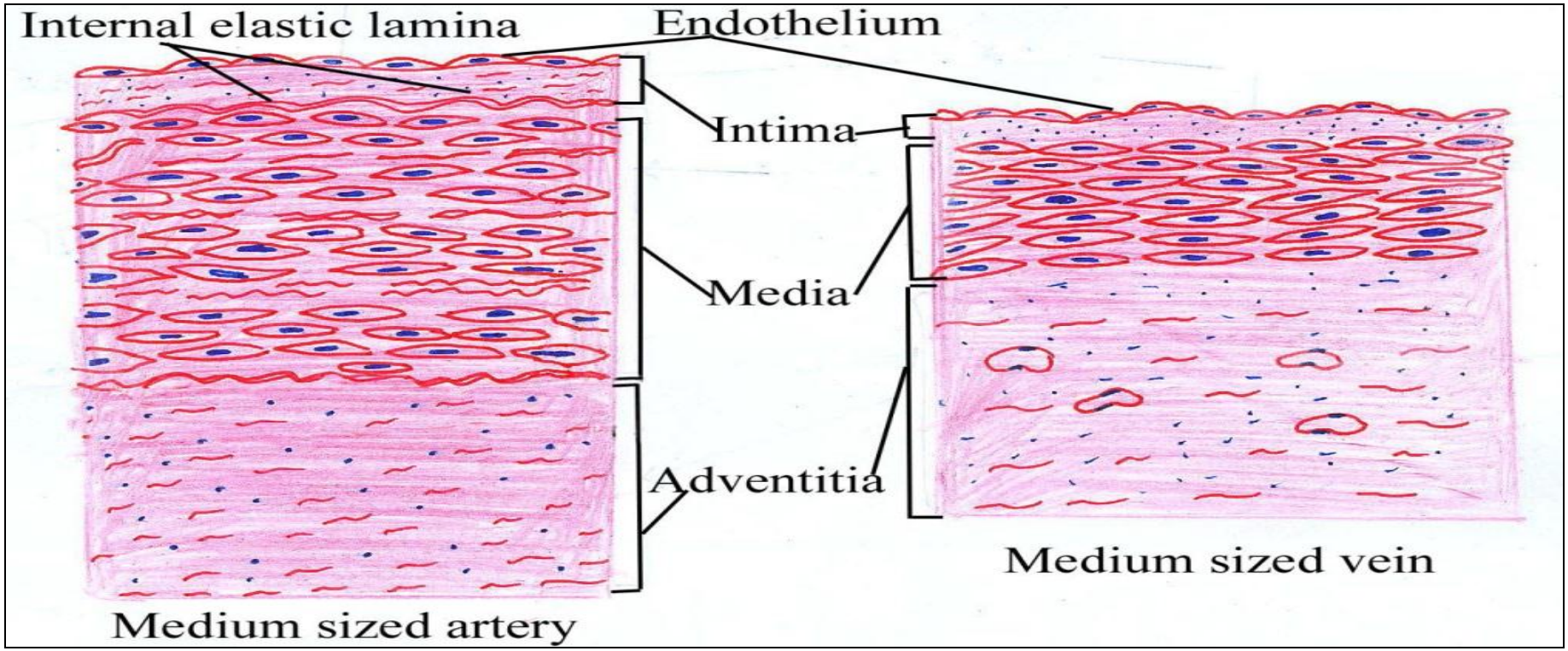
- It is thin.
- formed of few smooth muscle cells with few elastic &collagen fibers.
- no external elastic lamina.

**Tunica adventitia:**

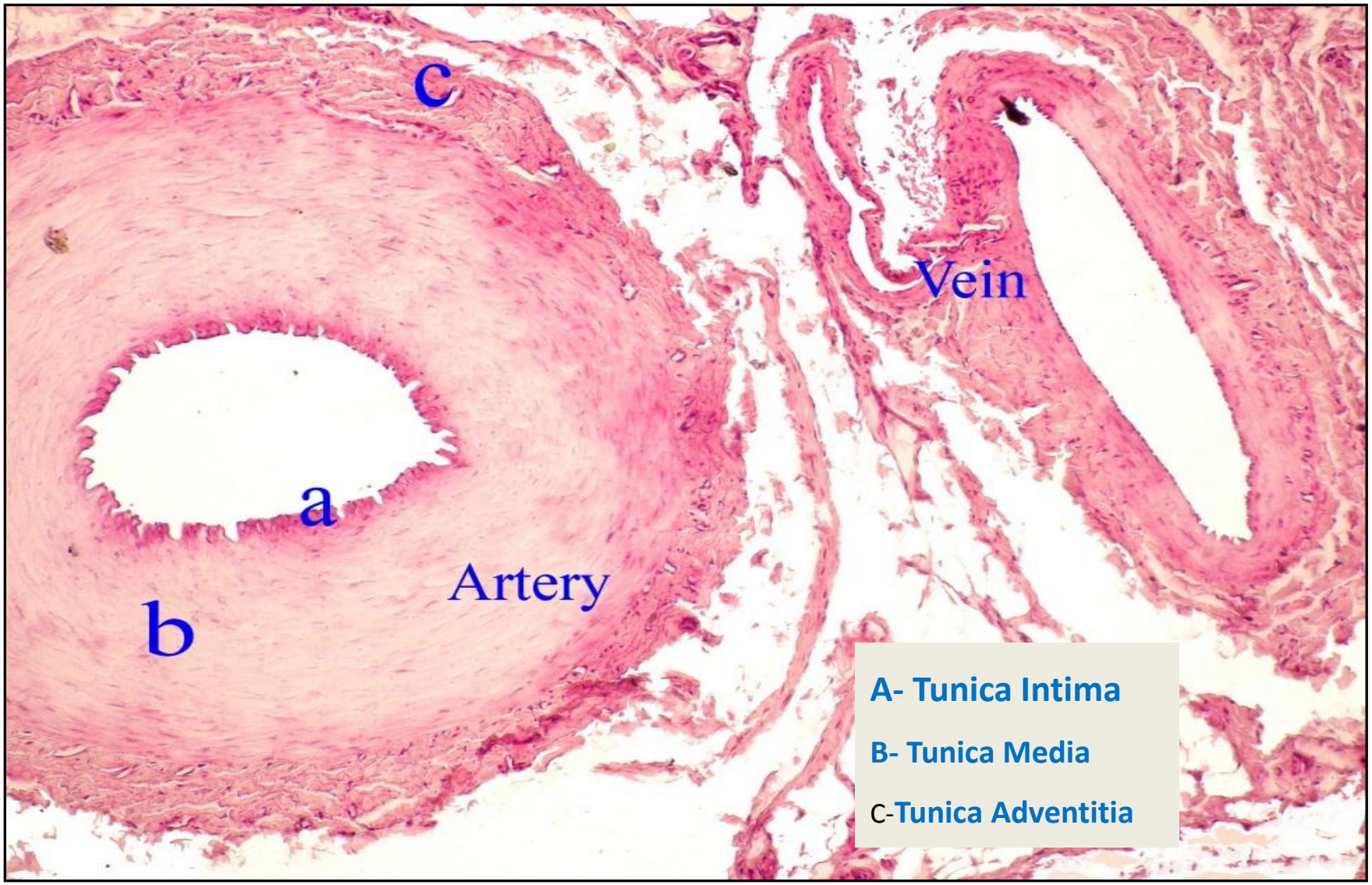
It forms the **main thickness** of the wall.



| | Medium sized artery | Medium sized vein |
|---|---|---|
| wall | Thick | Thin |
| lumen | Narrow | Wide |
| Intima | Thick folded | Thin not. folded |
| Media | Thick formed of smooth muscle | Thin |
| adventitia | Is almost thick as media | Thicker<br>Form the main thickness of the wall |



# Medium sized artery & vein

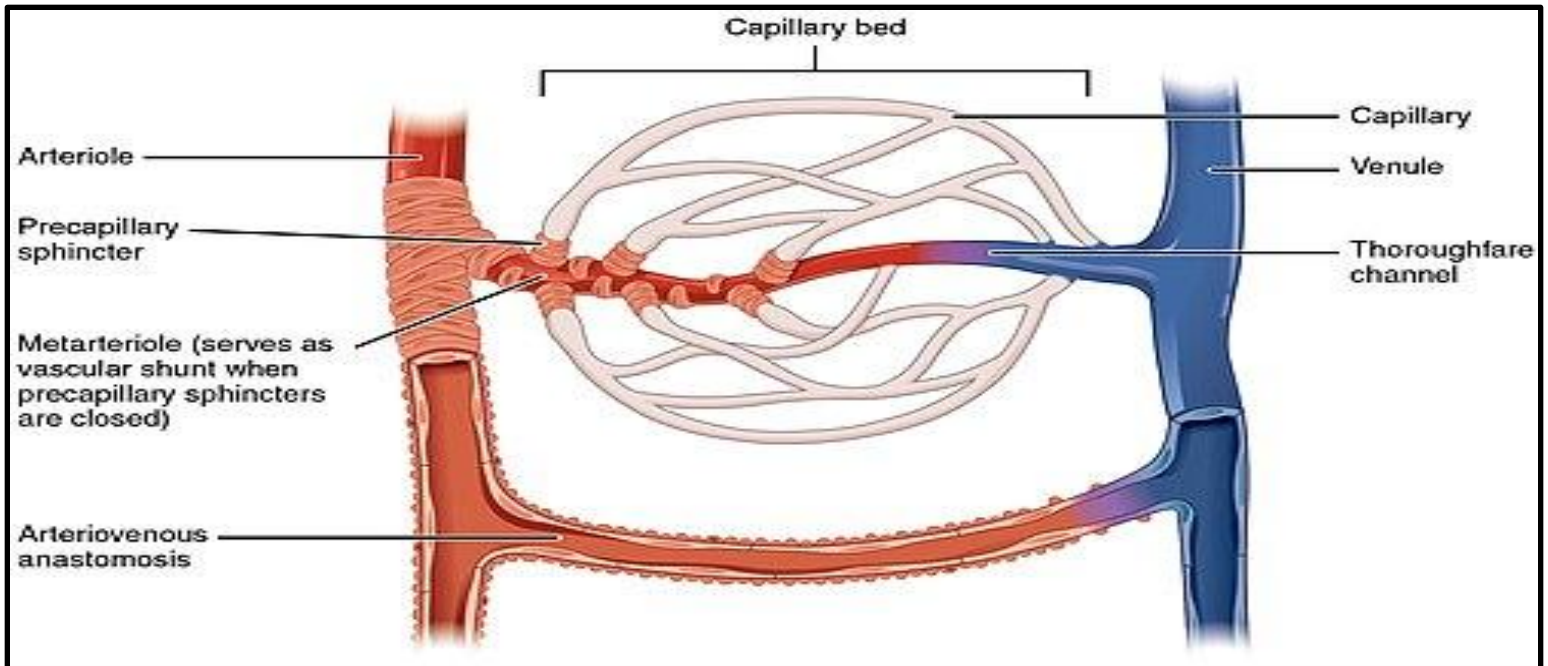


# Connections between Arteries and Veins:

## 1- Capillaries.

## 2- Arterio-venous anastomosis(A-V shunts).

These are direct communication between arterial and venous circulation.



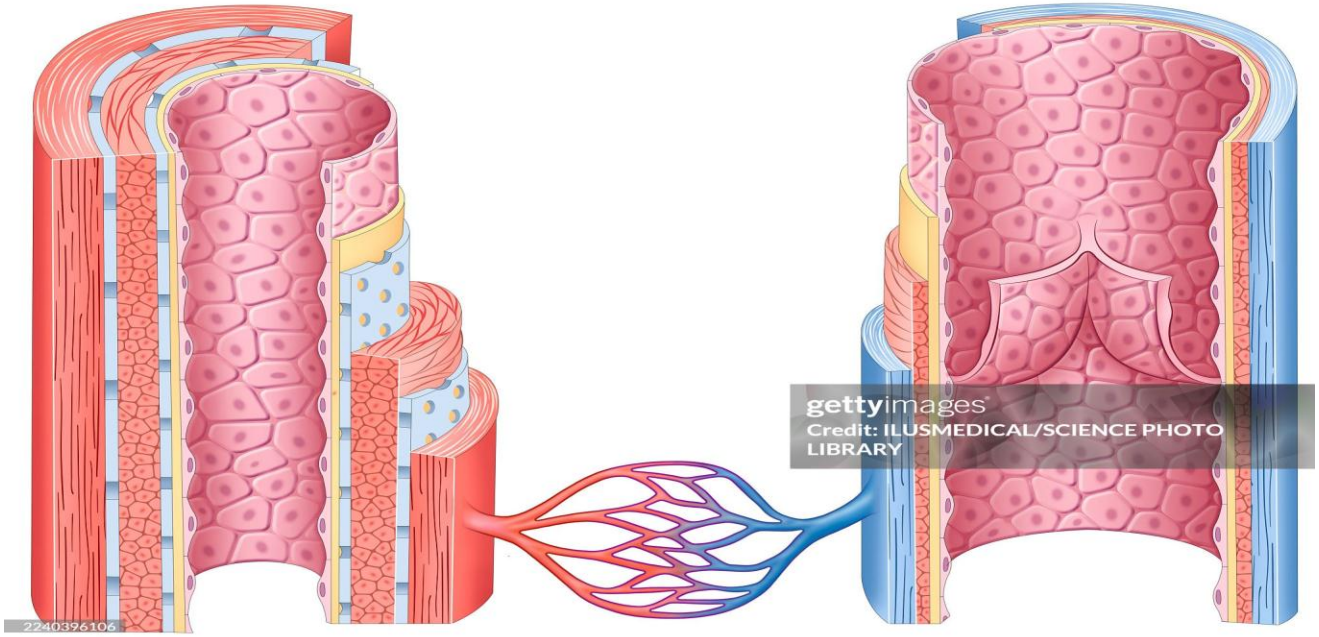
# Capillaries

-They are the smallest and thinnest channels in the circulatory system.

-They anastomose freely forming a network called capillary bed that interconnects the arterial and venous sides of the circulation.

-Capillaries arise from metarterioles or directly from arterioles.

-They recollect forming venules.



# ***The blood capillary consists of :***

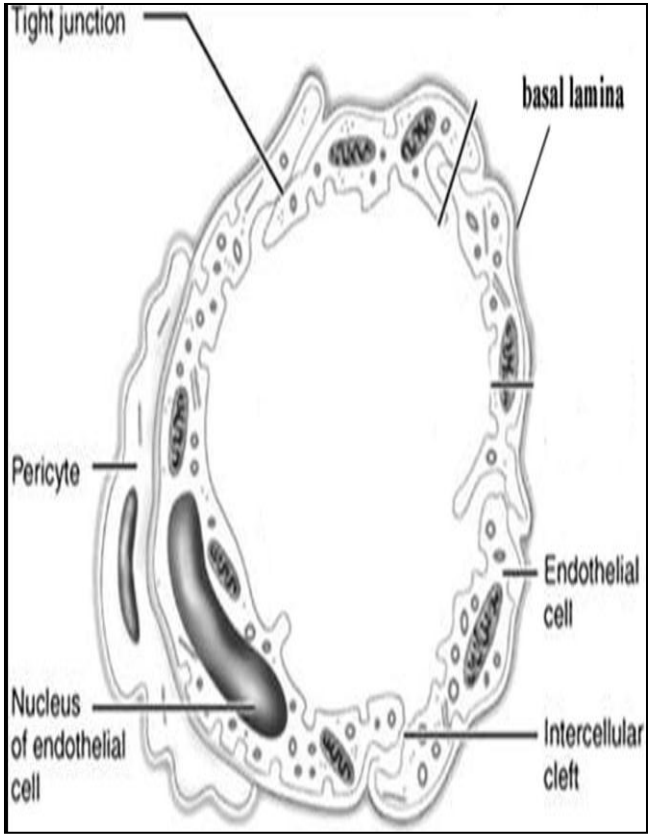
**In cross section the wall consists of:**

- 1-2 endothelial cells only rest on basal lamina. ***(represent the intima).***
- They are elongated flat cells
- **Nuclei:** central oval bulging in the lumen of the capillary.
- **Cytoplasm:**

-***The perinuclear region*** contains the usual organelles

-***The rest of cytoplasm*** contains abundant microfilaments and many pinocytotic vesicles.

-The cells are held together by **tight junctions** with occasional desmosomes and gap junctions.




**Pericytes:**

- They surround the endothelial cells partly.
- They have long cytoplasmic processes.
- They have their own basal lamina.
- They constitute **the tunica media** for capillaries.
- **Cytoplasm:** actin, myosin, and tropomyosin in which help them to contract.

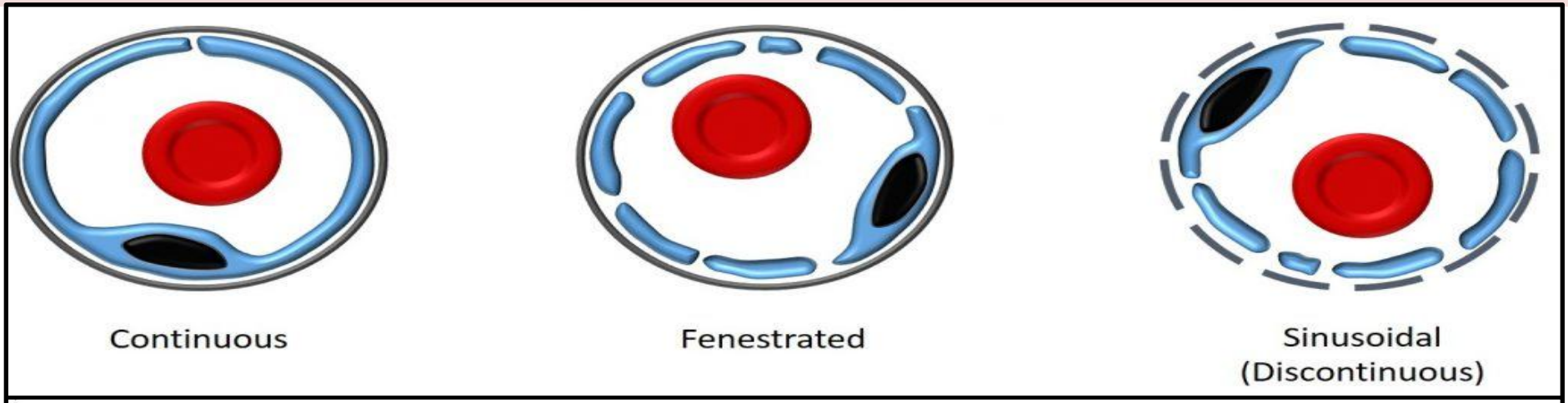
***A thin layer of reticular fibers represents the adventitia.***

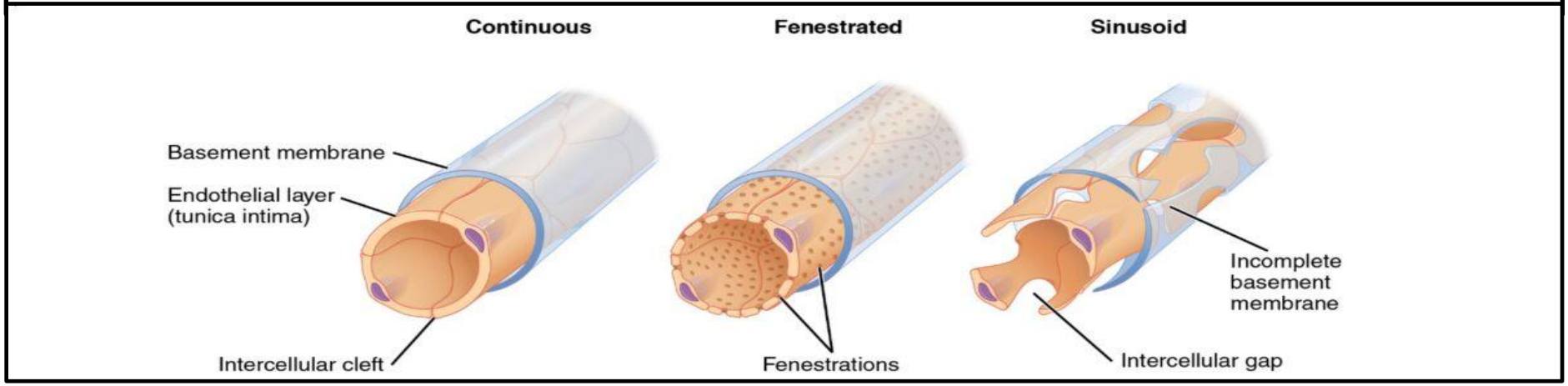
# Types of capillaries:

## 1-Continuous capillaries

## 2-Fenestrated capillaries

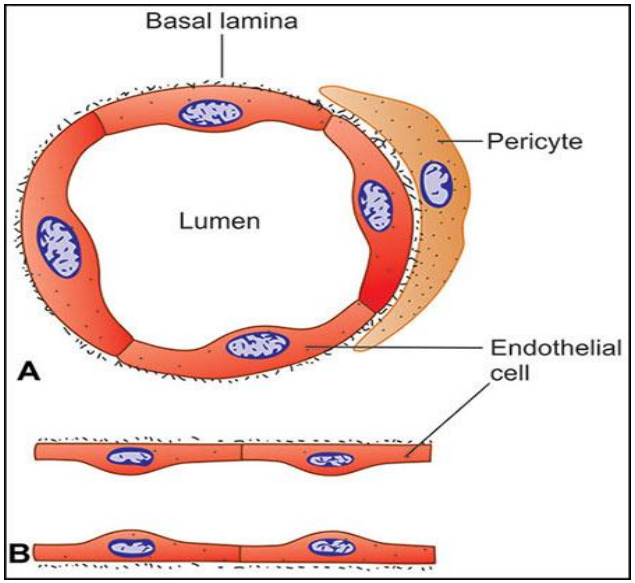
## 3-Sinusoidal capillaries

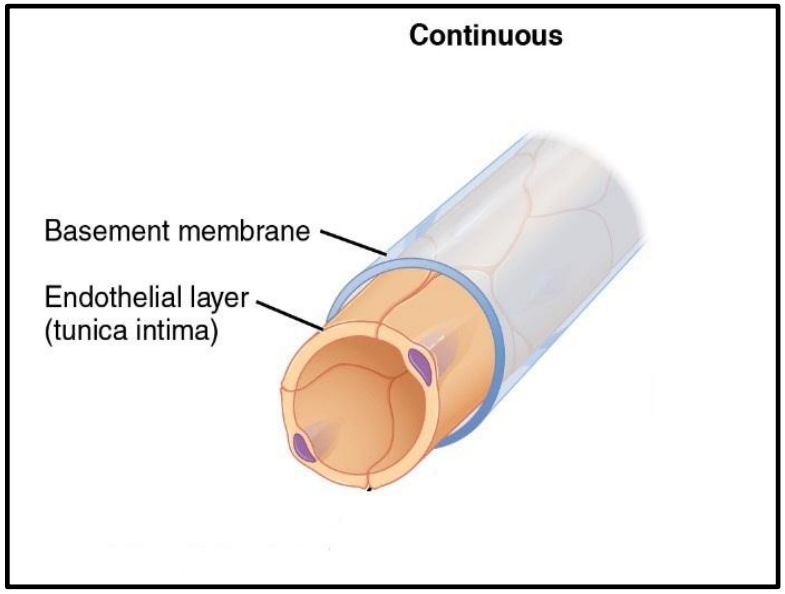


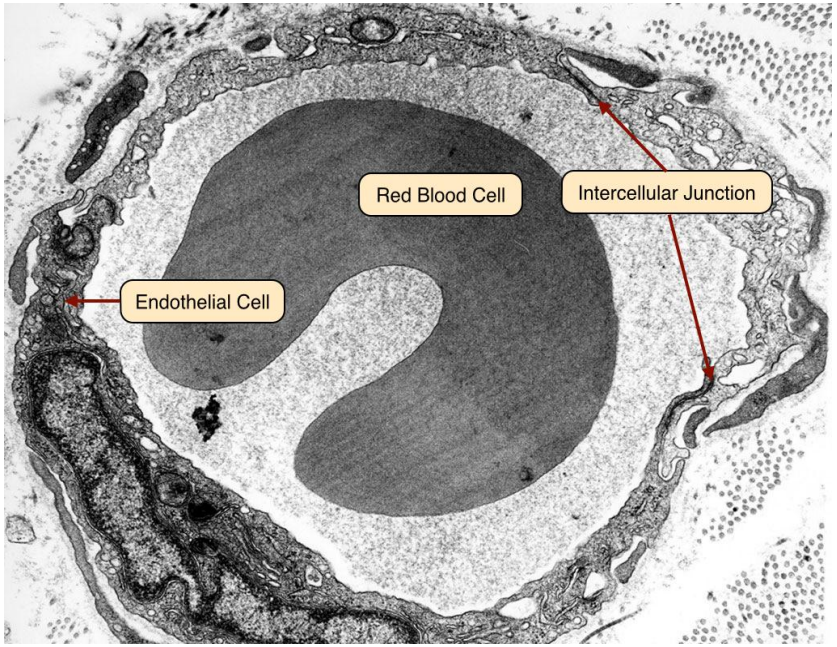



# I) *Continuous capillaries*

- In **brain** and muscles.
- The endothelial cells have no fenestrae (pores) in their walls.
- The basal lamina is continuous, thick and strong.

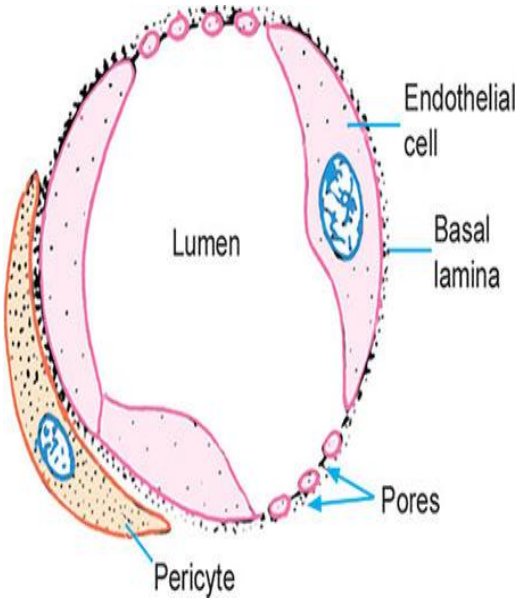


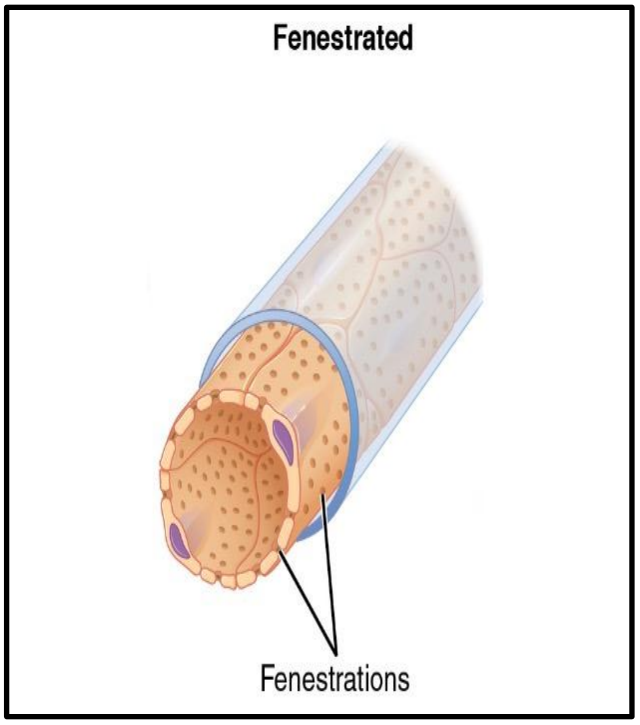



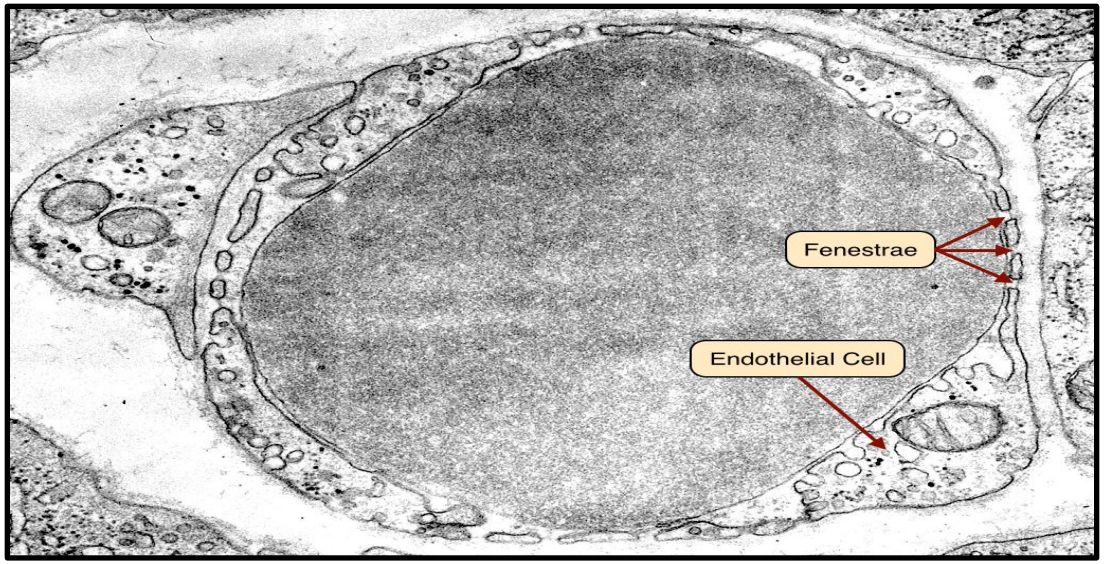



# II) *Fenestrated capillaries*

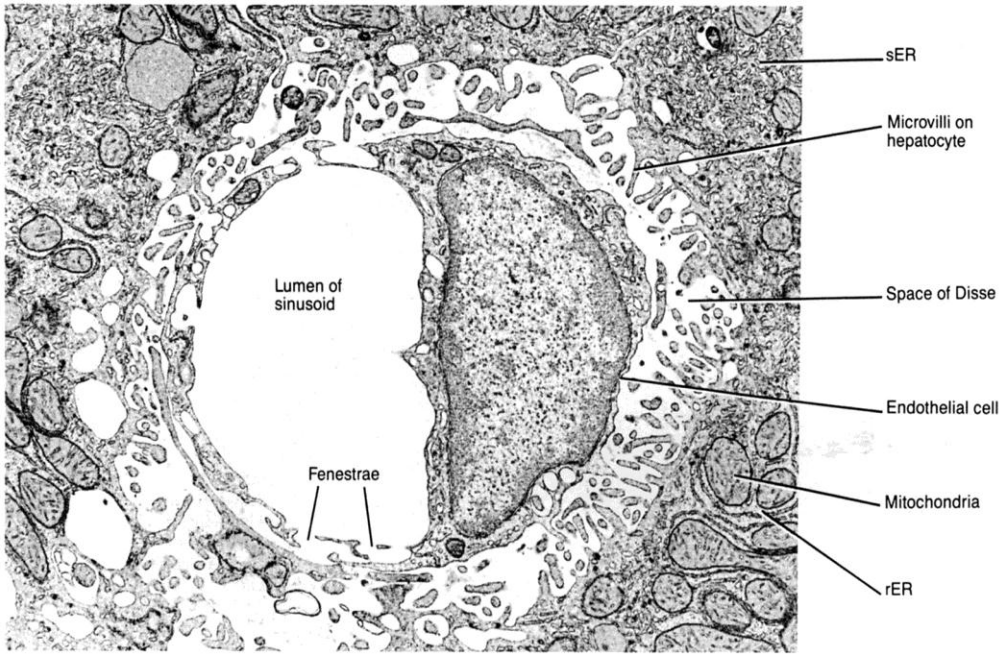
- In Kidney and endocrine glands.
- The endothelial cells have large fenestrae in their walls.
- The basal lamina is continuous

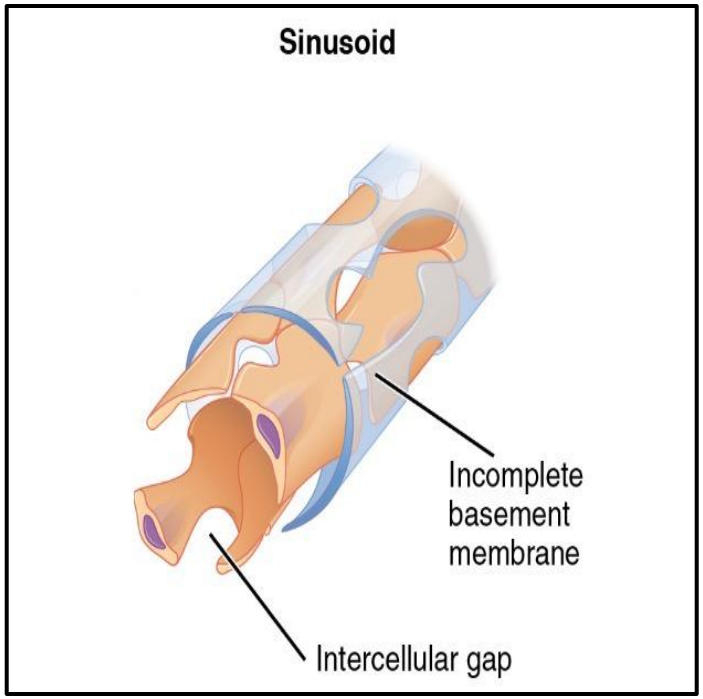


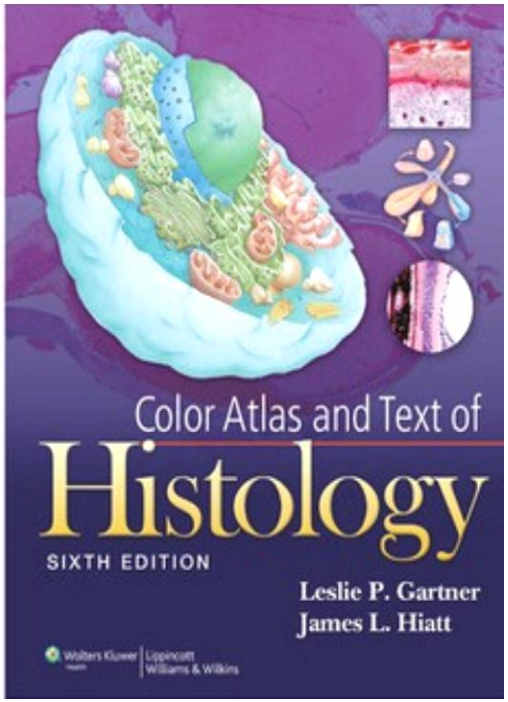



- **IV) *Sinusoidal capillaries***
- It has a tortuous path and wide lumen
- **In** bone marrow, spleen and liver.
- The endothelial cells are fenestrated
- The basal lamina is discontinuous
- Usually associated with macrophage.



# References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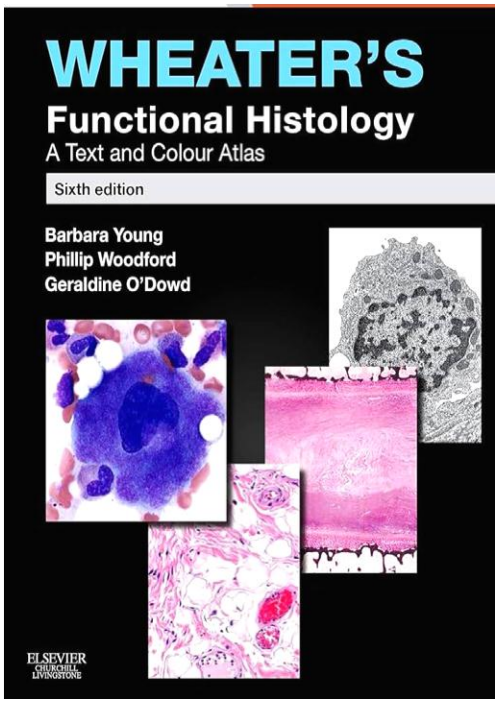
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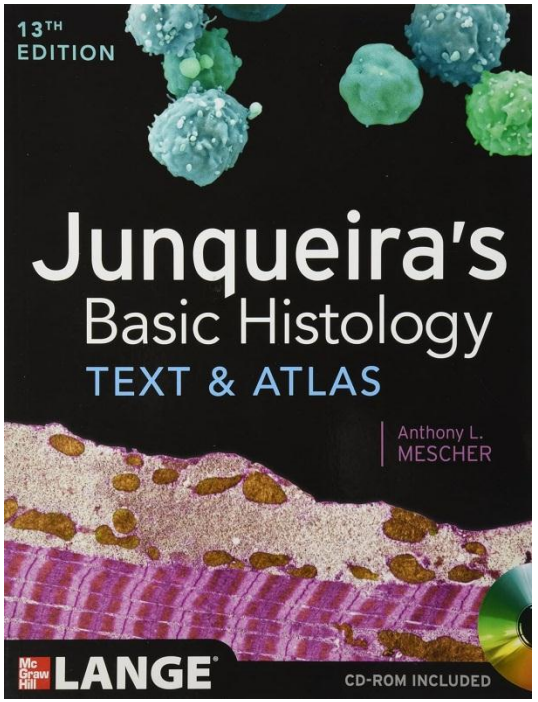
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