

1. The Circulatory System

It includes:

1. Cardiovascular System
2. Lymphatic System

2. The Blood Vessels

Types of Blood Vessels

- **Arteries:**

Large arteries, medium-sized arteries, and arterioles.

- **Veins:**

Large veins, medium-sized veins, and venules.

- **Arterio-venous connections:**

Blood capillaries, sinusoids, and arterio-venous anastomosis.

3. General Structure of Blood Vessels

1. **Tunica Intima (Innermost layer)**

- In direct contact with blood.

Formed of:

a. **Endothelium:**

- Simple squamous epithelium lying on basal lamina.
- Provides smooth surface for blood flow and easy exchange.

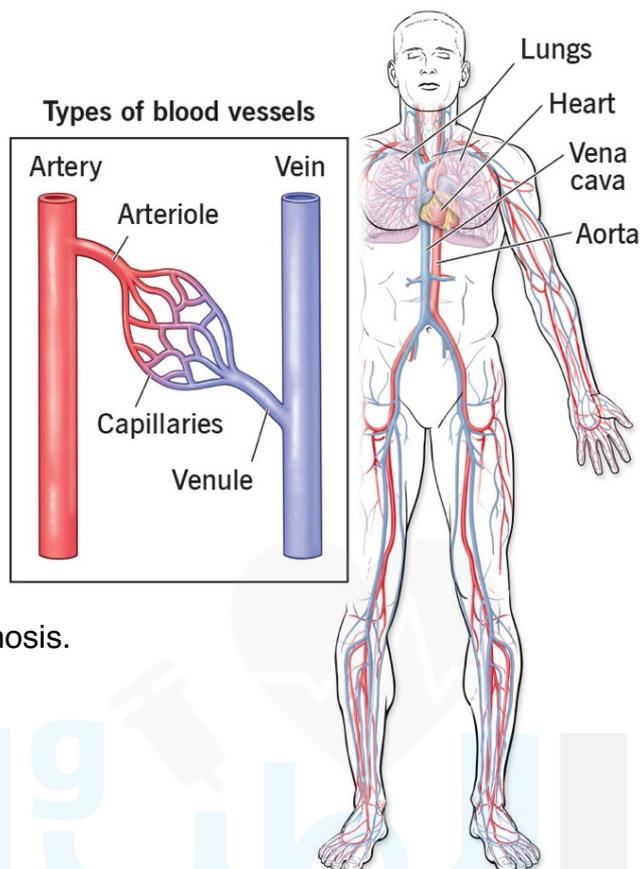
b. **Subendothelium:**

- Loose areolar connective tissue supporting the endothelium.

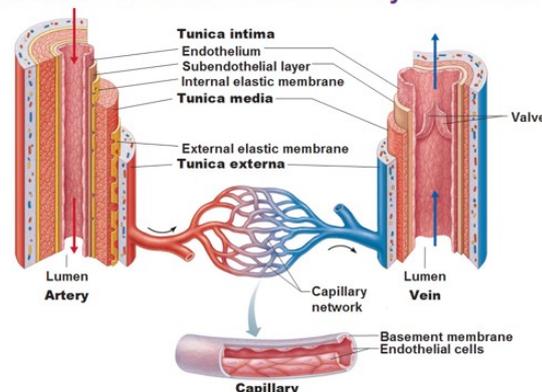
c. **Internal Elastic Lamina (IEL):**

- Present in arteries.
- Made of dense elastic fibers forming a fenestrated membrane.
- Well developed in muscular arteries, absent in small arterioles.
- Function: Prevents occlusion of arteries.

Blood vessels



Structure of Blood Vessels – 3 Layers “Tunics”

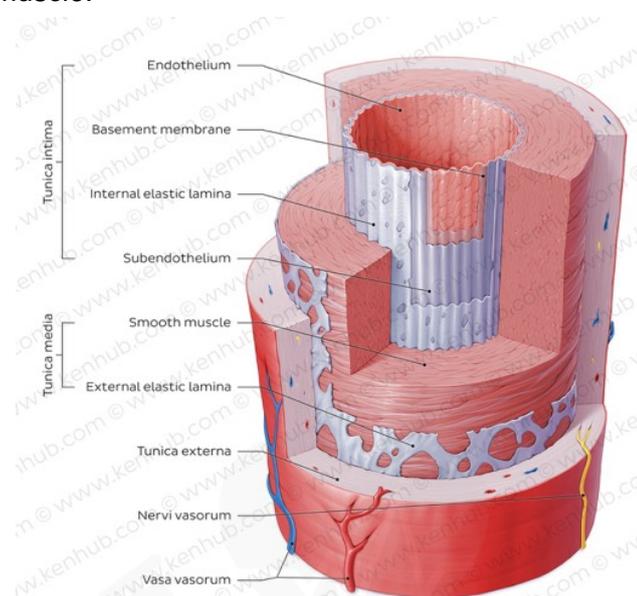


2. Tunica Media (Middle layer)

- Formed of:
- Circularly arranged smooth muscle fibers.
- Variable amounts of elastic and fine collagen fibers.
- Ground substance in between.
- Outer layer: sometimes limited by an External Elastic Lamina (in some arteries).
- Function: Regulates blood flow by contraction of smooth muscle.

3. Tunica Adventitia (Outermost layer)

- Formed of: Loose connective tissue
- Collagen fibers (predominant)
- Some elastic fibers
- Some connective tissue cells
- Contains: Nerves, lymphatics, and vasa vasorum.
- Functions:
- Connects blood vessels to surrounding tissues.
- Prevents over-distension of the vessel.



Vasa Vasorum (“Blood vessel of the blood vessel”)

- Small arteries branching in adventitia and outer part of media in large vessels to nourish them.
- Small blood vessels are nourished by the blood inside their lumina.

4. Arteries

Classification (According to size & main tissue in media):

1. Large Elastic Arteries: Carry blood from the heart.
2. Medium-Sized Muscular Arteries: Distribute blood to organs.
3. Small Arteries (Arterioles): Regulate blood flow to capillaries.

All arteries have the same three concentric layers.

I. Large Elastic Arteries

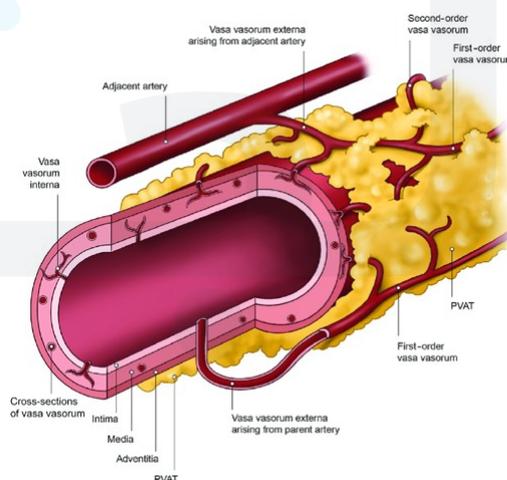
Function:

- Resist changes in blood pressure by elastic recoil.
- Thick yellowish walls (rich in elastic fibers).
- Very wide lumina.

Examples:

- Aorta, Pulmonary arteries, and their large branches.

(Aorta studied as an example.)



The Aorta

1. Tunica Intima

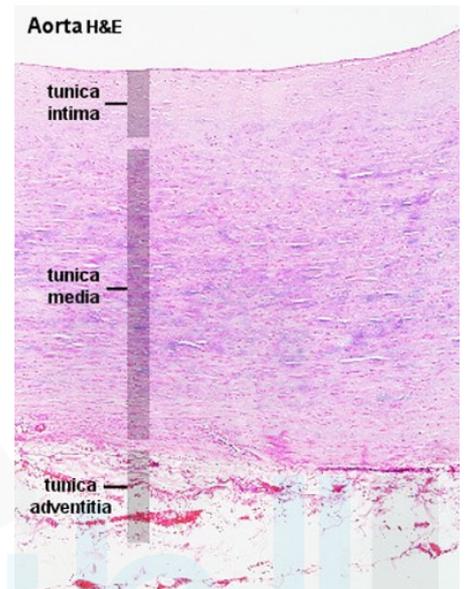
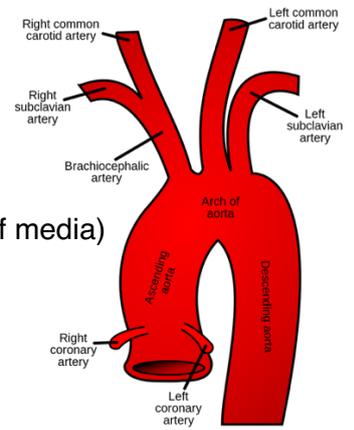
- a. Endothelium: Simple squamous epithelium
- b. Subendothelium: Thick loose C.T. rich in elastic & longitudinal collagen fibers
- c. Internal Elastic Lamina: Not distinct (merges with underlying elastic laminae of media)

2. Tunica Media

- Thickest layer ($\approx 70\%$ of wall)
- Components:
 - Concentrically arranged fenestrated elastic membranes (increase with age)
 - Smooth muscle fibers alternating with elastic membranes (produce elastic fibers & ground substance)
 - Collagen fibers between elastic fibers
- Note: External elastic lamina cannot be differentiated from the media.

3. Tunica Adventitia

- Thin loose C.T., with longitudinal collagen & elastic fibers
- Contains vasa vasorum, lymphatics, and nerves



II. Medium-Sized (Muscular) Arteries

- Most common type
- Wall mainly smooth muscle to regulate blood flow to organs
- Transition from elastic to muscular arteries is gradual (less elastic fibers, more smooth muscle)

1. Tunica Intima

- Thinner than in elastic arteries
- a. Endothelium
- b. Subendothelium: Thin C.T., may contain smooth muscle fibers
- c. Internal Elastic Lamina: Very prominent, appears as wavy pink line in H&E

2. Tunica Media

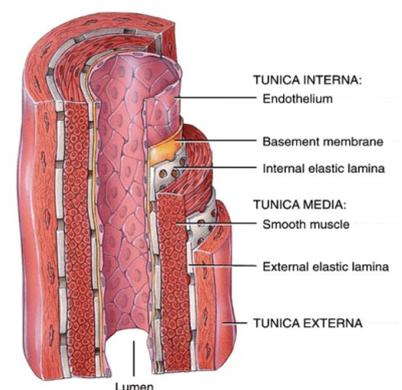
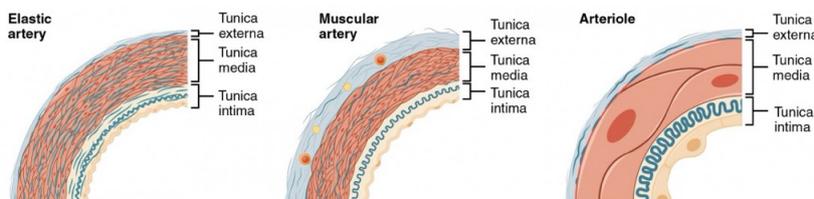
- Thick layer of concentrically arranged smooth muscle fibers

(4 layers in small arteries \rightarrow up to 40 layers in large muscular arteries)

- Elastic & fine collagen (reticular) fibers scattered between muscle fibers
- External Elastic Lamina: Present in large muscular arteries (condensed elastic fibers)

3. Tunica Adventitia

- Thinner than media
- Formed of: Longitudinal collagen & elastic fibers + fibroblasts
- Contains: Nerves, lymphatics, and vasa vasorum (in large ones)



Comparison Table: Large Elastic vs Medium-Sized Muscular Arteries

Medium-Sized Muscular Arteries	Large Elastic Arteries	Feature
Most muscular & organ arteries	Aorta, large branches, pulmonary	Sites
Thinner, prominent IEL	Thicker, IEL not prominent	Tunica Intima
Mainly smooth muscle, defined EEL	Mainly elastic laminae	Tunica Media
No vasa vasorum	Vasa vasorum present	Tunica Adventitia

5. Veins

Function: Carry blood from tissues back to the heart.

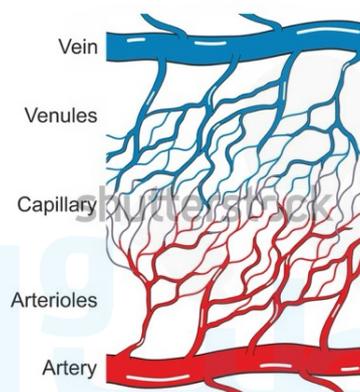
Start as post-capillary venules → muscular veins → large veins.

I. Small Veins (Venules)

- Smallest veins, receive blood from capillaries
- Very thin walls

Layers:

- Tunica Intima:
- Endothelium rich in actin filaments on thin basal lamina
- Tunica Media:
- Contains pericytes and reticular fibers
- Smooth muscle (from pericytes) appears as diameter increases → “muscular venules”
- Tunica Adventitia:
- Relatively thick

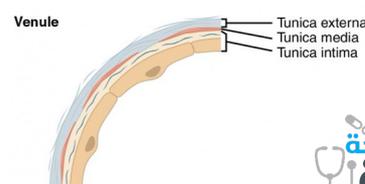
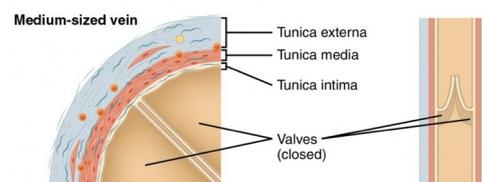
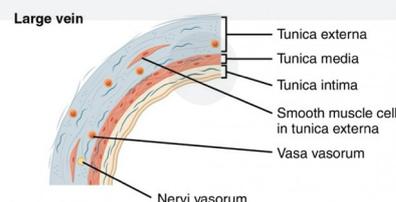


Note: Exchange of materials between blood and tissues occurs in capillaries and postcapillary venules.

II. Medium-Sized (Muscular) Veins

Tunica Intima:

- Endothelium
- Thin subendothelium (C.T. without elastic fibers)
- **No Internal Elastic Lamina**
- **Valves:**
- Semilunar folds projecting into lumen
- Lined on both sides by endothelium
- Core: elastic tissue
- Absent in small & large veins



Tunica Media:

- Thin, small bundles of circular smooth muscle, separated by longitudinal collagen fibers & fibroblasts
- Poor in elastic fibers

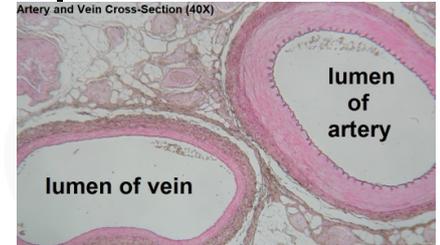
Tunica Adventitia:

- Thickest layer
- Loose C.T. rich in longitudinal collagen fibers
- Contains vasa vasorum in large veins (due to low O₂ tension in venous blood)

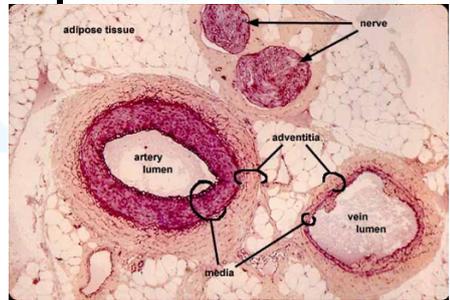


Comparison: Medium-Sized Artery vs Vein

Medium-Sized Vein	Medium-Sized Artery	Feature
Thin, wide lumen	Thick, narrow lumen	Wall
Collapsed, contains blood	Rounded, no blood	Lumen after death
Present	Absent	Valves
Thin, not folded, poor in elastic fibers, no IEL	Thick, folded, rich in elastic fibers, clear IEL	Tunica Intima
Thin, few smooth muscles, poor elastic fibers, no EEL	Thick, smooth muscles + elastic fibers, may have EEL	Tunica Media
Thick, collagen fibers	Thin, elastic fibers	Tunica Adventitia
Slow (venous)	Rapid (arterial)	Blood Flow



Arteries carry high pressure blood away from the heart and veins return low pressure blood back toward the heart. Arteries tend to be round in cross-section with a relatively thick wall compared to veins which usually look like a partially collapsed oval in cross-section with a relatively thin wall.



III. Large Veins

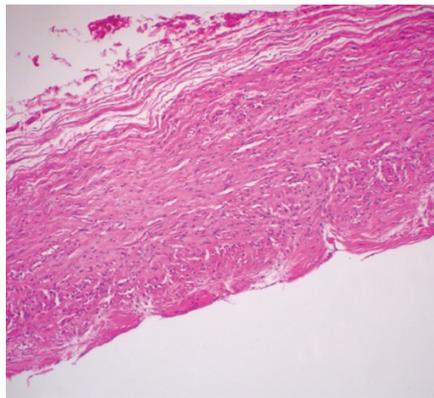
- Thick wall, wide lumen
- Example: Inferior vena cava

Tunica Intima:

- Well developed
- No IEL, no valves

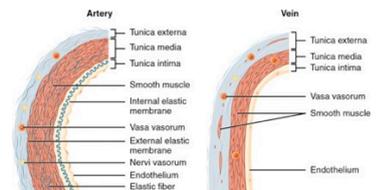
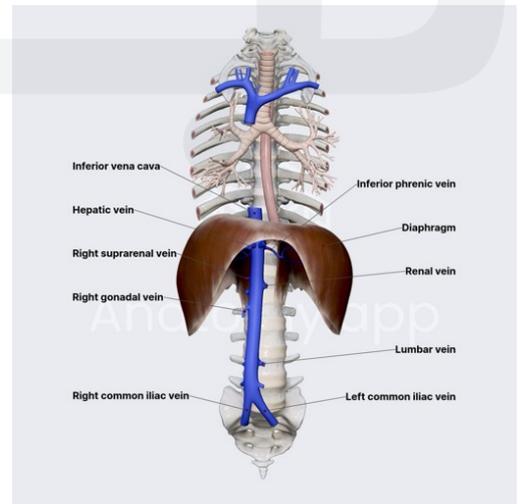
Tunica Media:

- Thinner than arteries
- Few smooth muscle fibers
- Abundant connective tissue
- Poor in elastic fibers



Tunica Adventitia:

- Thickest layer
- Loose C.T. with longitudinal smooth muscle bundles and elastic fibers
- Function: Allows elongation & shortening of vena cava during respiration



DR . AMIRA OSMAN

DONE BY : RAGHAD MRAYAT