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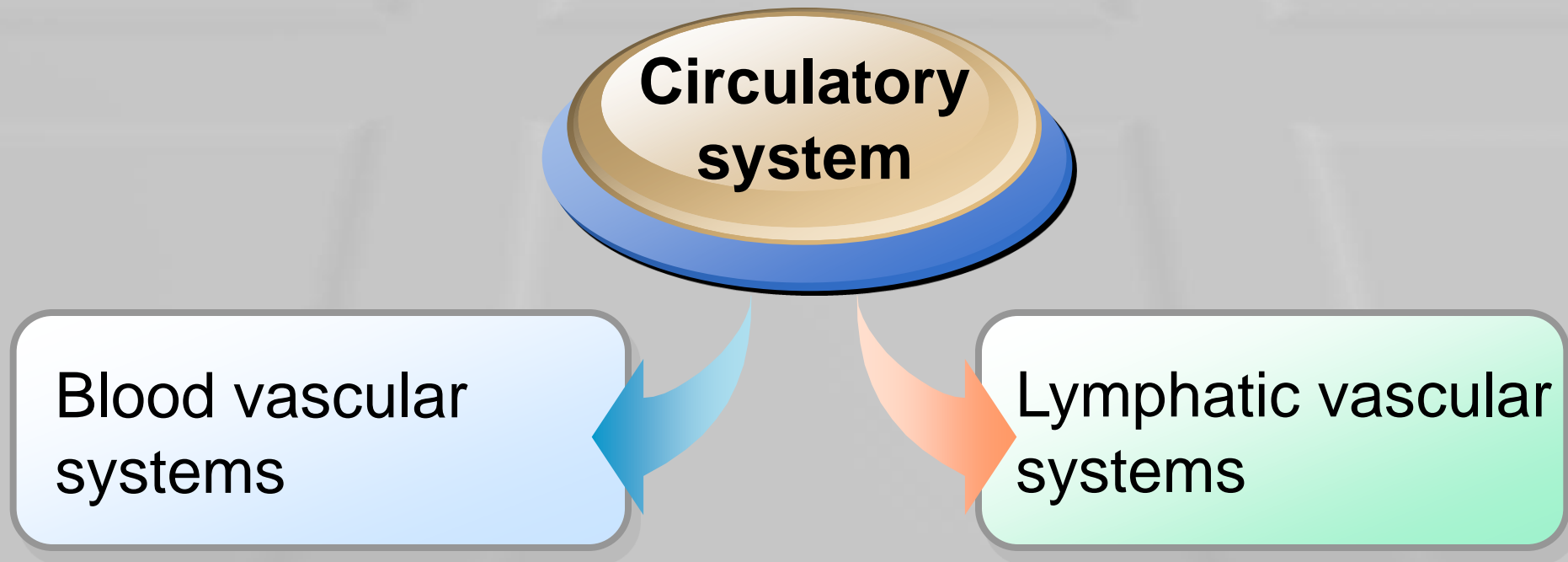
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# The Circulatory System

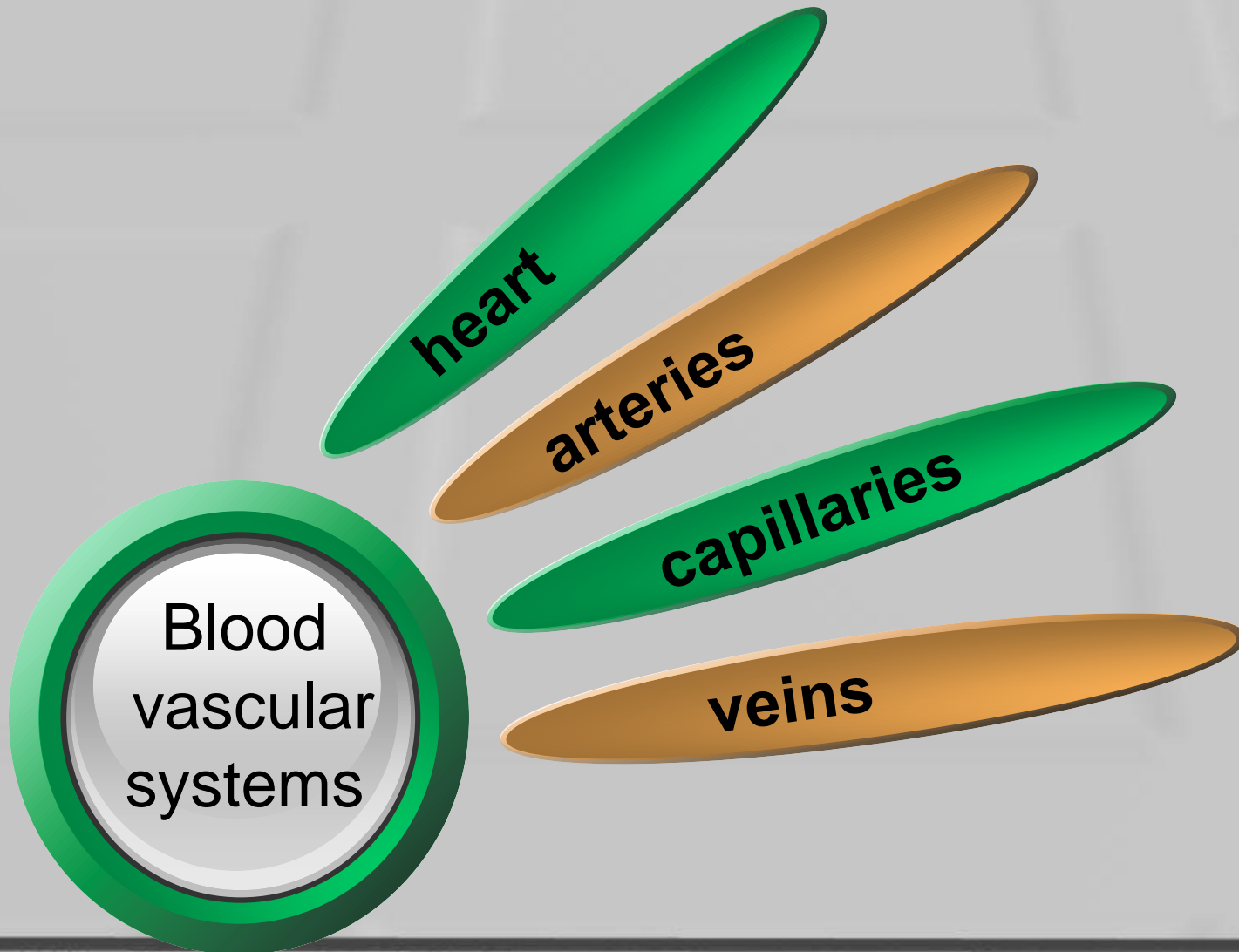
Dr. Sami Zaqout

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# The circulatory system

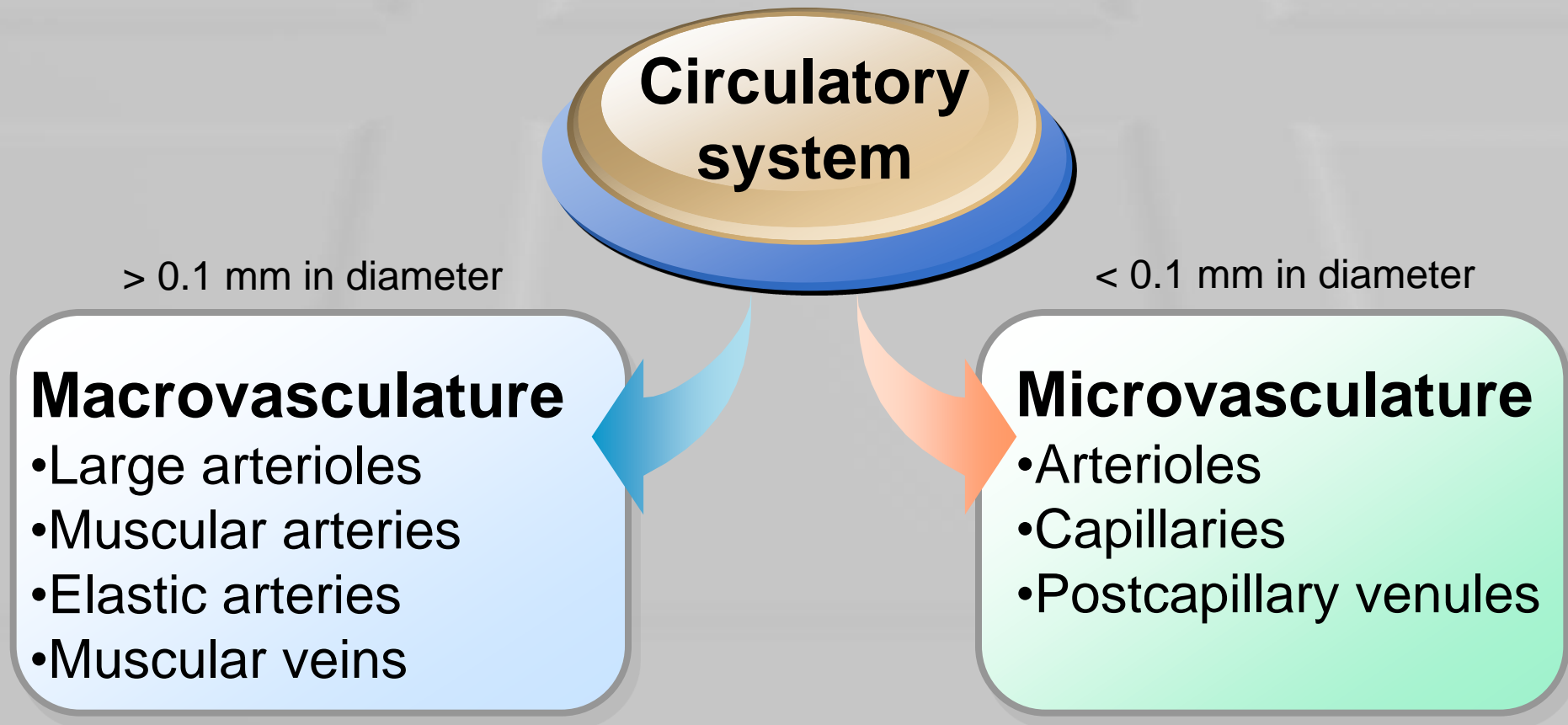


# Blood vascular systems





# The circulatory system



# Tissue Components of the Vascular Wall

**Endothelium**



The diagram illustrates the three tissue components of the vascular wall. Three labels are arranged around a central point, with arrows pointing towards it. The 'Endothelium' label is at the top, 'Muscular tissue' is on the left, and 'Connective tissue' is at the bottom. A pink arrow points from the 'Endothelium' label towards the center, a teal arrow points from the 'Muscular tissue' label towards the center, and a white arrow points from the 'Connective tissue' label towards the center.

**Muscular tissue**

**Connective tissue**

# Endothelium

Single layer of a squamous epithelium

## Functions of Endothelium

Interchanges between blood and surrounding tissues

Lipolysis of lipoproteins

Production of vasoactive factors

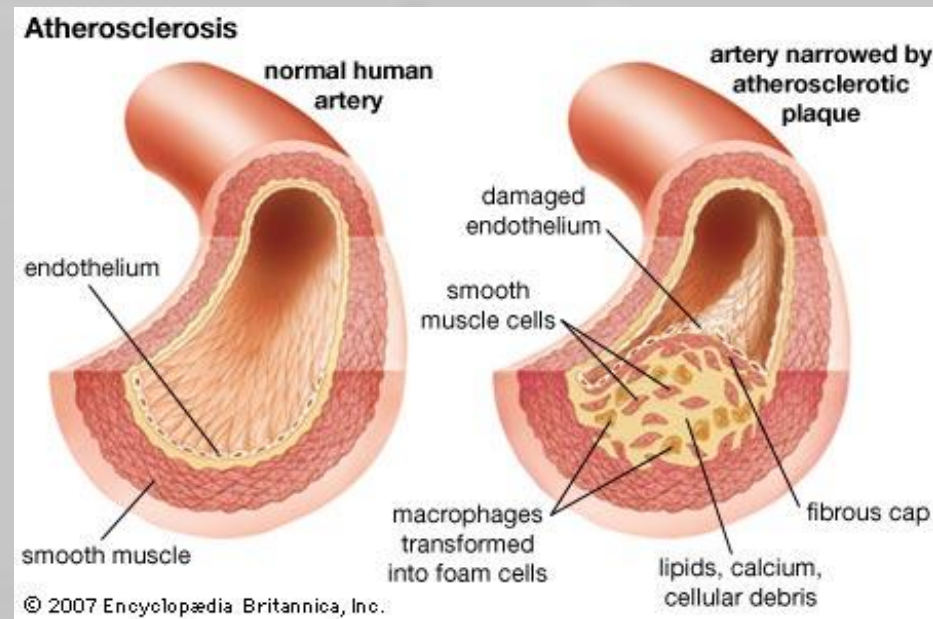
Conversion of angiotensin I to angiotensin II

Conversion of bradykinin, serotonin, prostaglandins, thrombin to biologically inert compounds

Antithrombogenic action

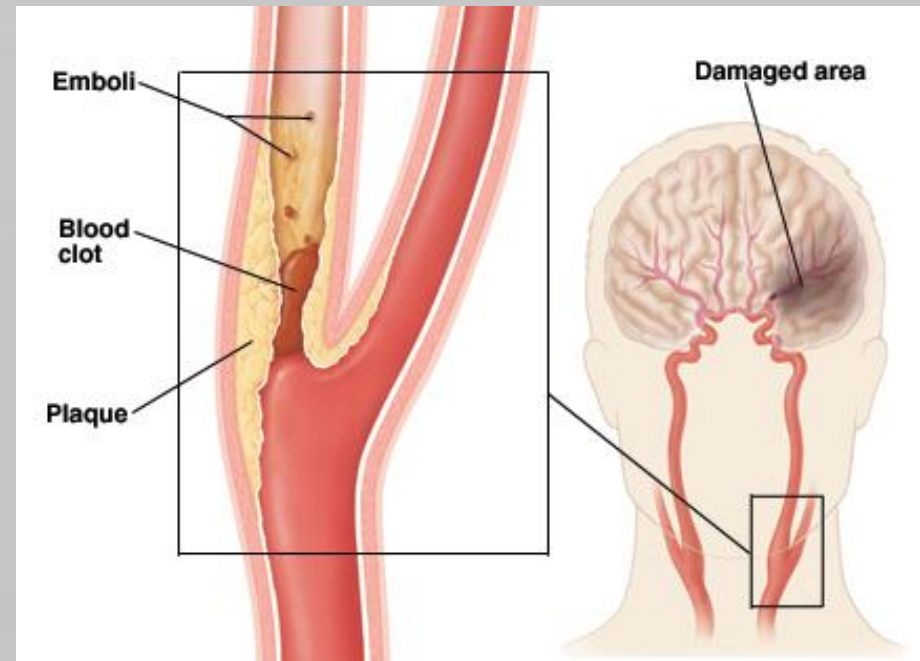
# Endothelium - Antithrombogenic action

- When endothelial cells are damaged by atherosclerotic lesions, for example, the uncovered subendothelial connective tissue induces the aggregation of blood platelets.
- This aggregation initiates a cascade of events that produces fibrin from blood fibrinogen.



# Endothelium - Antithrombogenic action

- An intravascular coagulum, or **thrombus** is formed that may grow until there is complete obstruction of the local blood flow.
- From this thrombus, solid masses called **emboli** may detach and be carried by the blood to obstruct distant blood vessels.





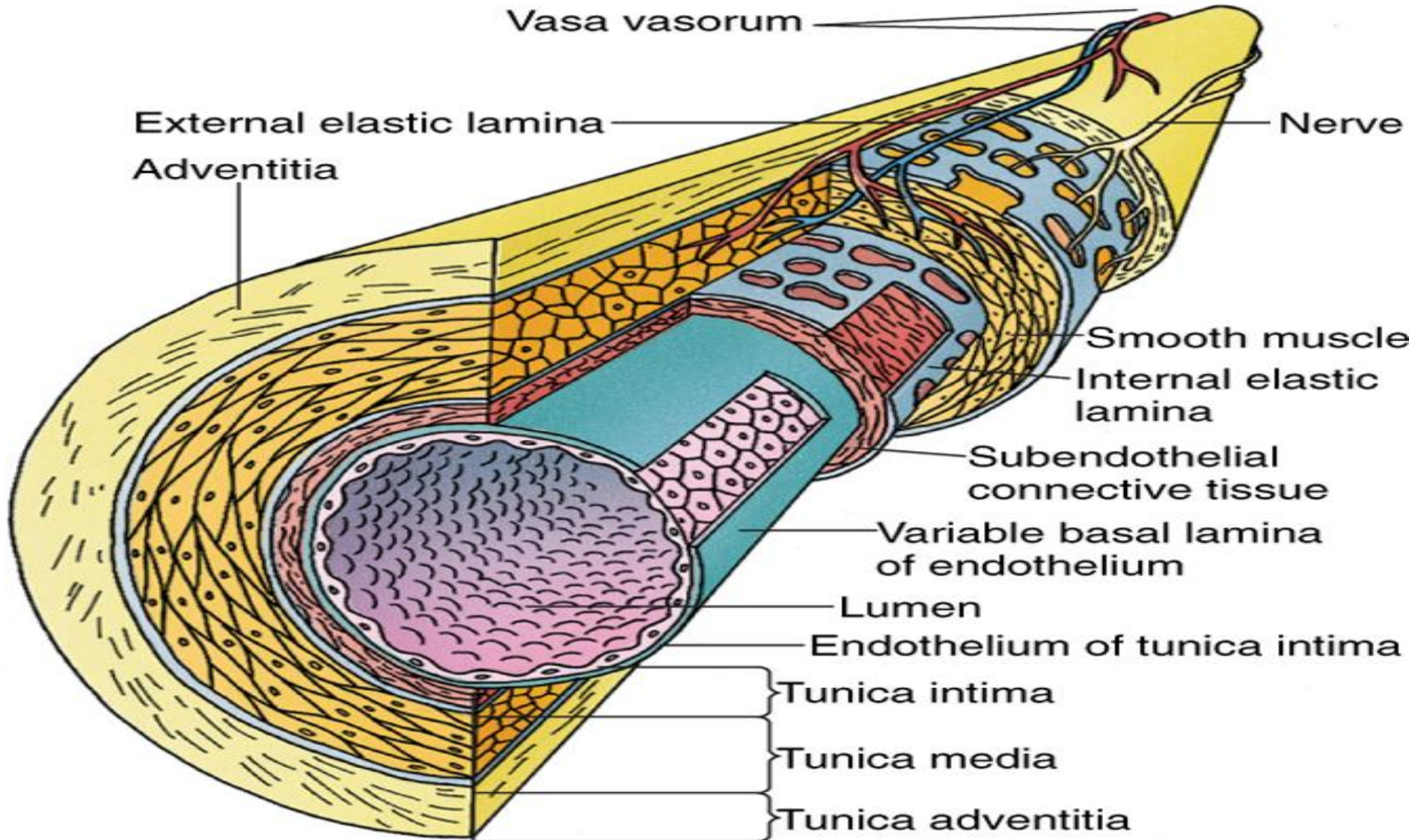
# Vascular Smooth Muscle

- Present in all vessels **except capillaries and pericytic venules.**
- Arranged in helical layers in the **tunica media** of the blood vessels.
- Each muscle cell is enclosed by a basal lamina and by variable amounts of connective tissue.
- Frequently connected by communicating (gap) junctions .

# Vascular Connective Tissue

- **Collagen fiber:**
  - Collagen IV → basement membranes
  - Collagen III → tunica media
  - Collagen I → adventitia
- **Elastic fibers**
  - Predominate in large arteries
- **Ground substance**
  - Contributes to the physical properties of the walls of the vessels
  - The concentration of glycosaminoglycans is higher in arterial than in venous tissue.

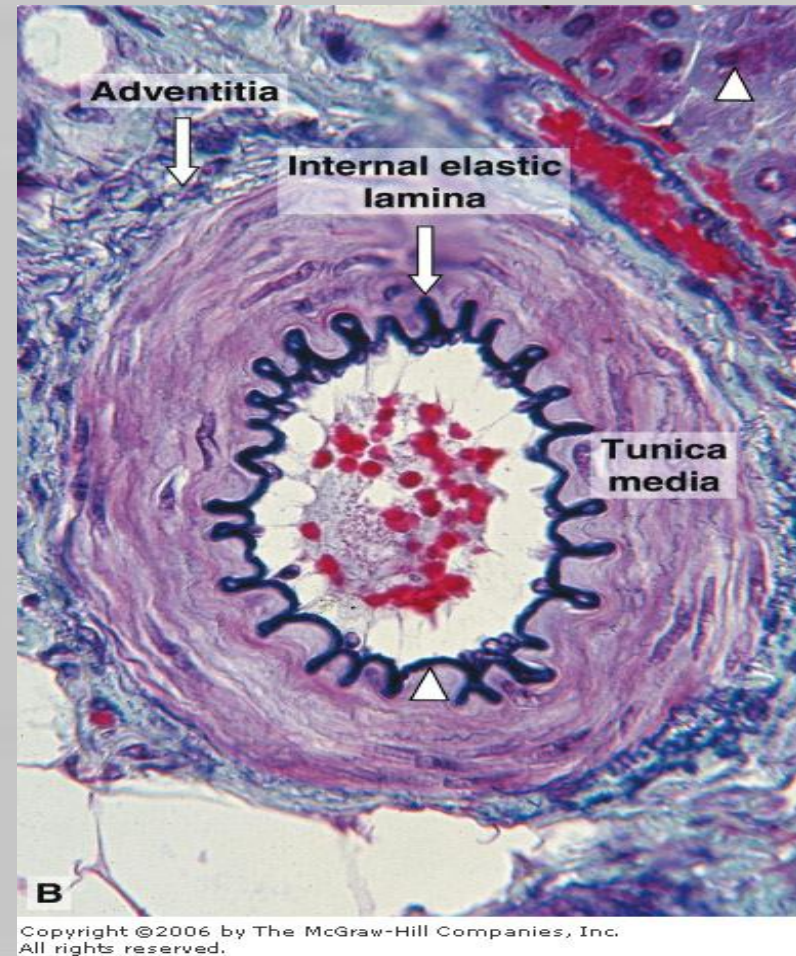
# Structural Plan of Blood Vessels





# Structural Plan of Blood Vessels

- As a result of the absence of blood pressure and the contraction of the vessel at death, the tunica intima of the arteries generally has an **undulating appearance** in tissue sections.

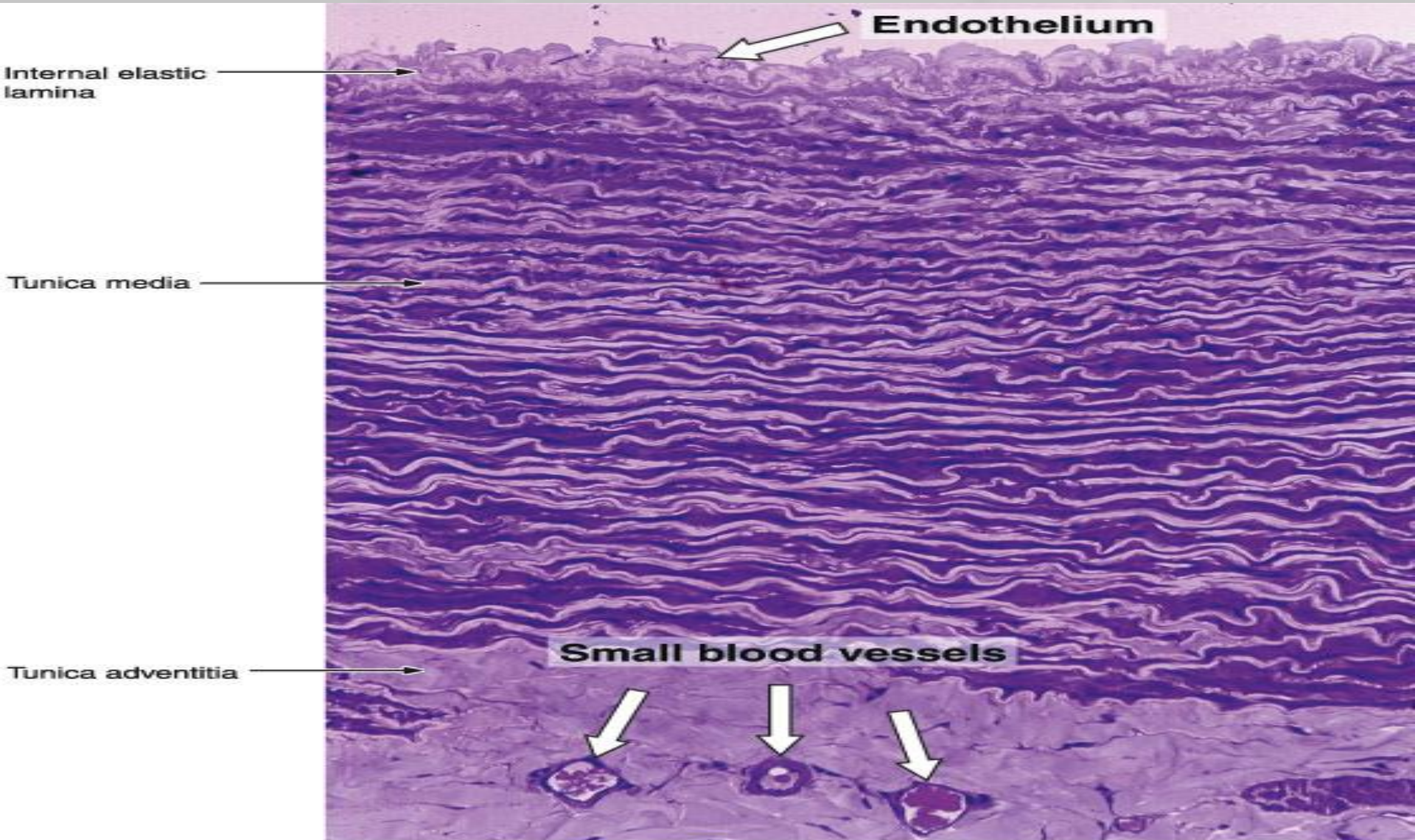




# Arterial blood vessels

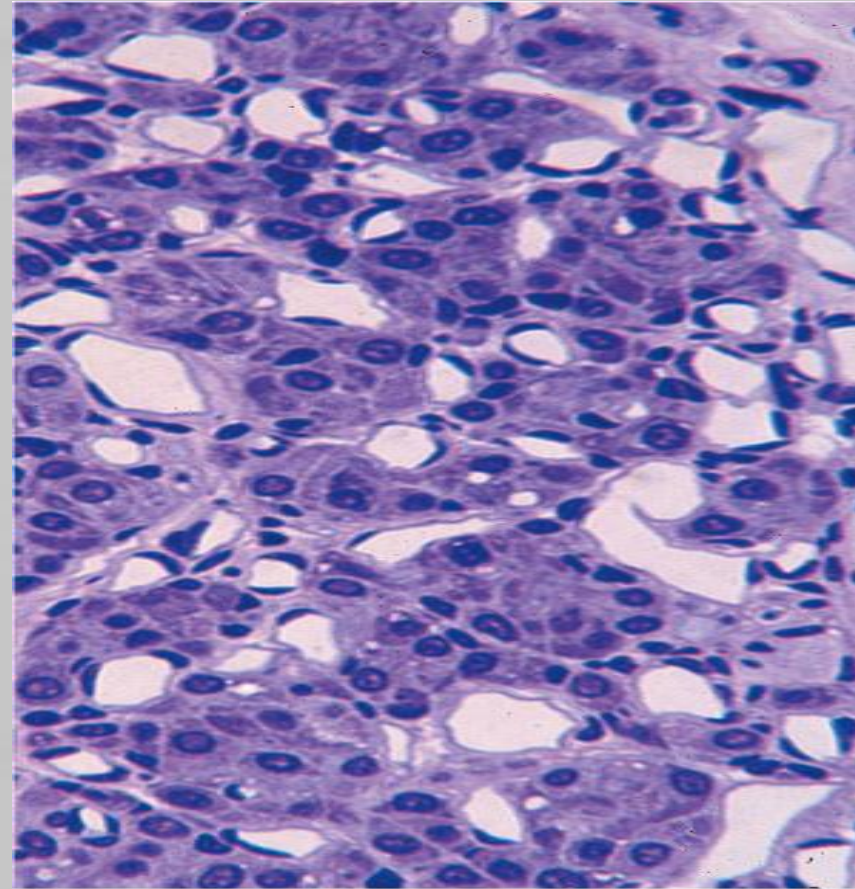
- the arterial blood vessels are classified, based on their diameter into:
  - **Larger (elastic) arteries**
  - **Arteries of medium diameter (muscular arteries)**
  - **Arterioles**

# Large Elastic Arteries



# Carotid Bodies

- **Chemoreceptors** sensitive to carbon dioxide and oxygen concentrations in the blood.
- These structures are richly irrigated by **fenestrated capillaries** that surround type I and type II cells.
- The type II cells are supporting cells
- Type I cells contain numerous dense-core vesicles that store dopamine, serotonin, and adrenaline

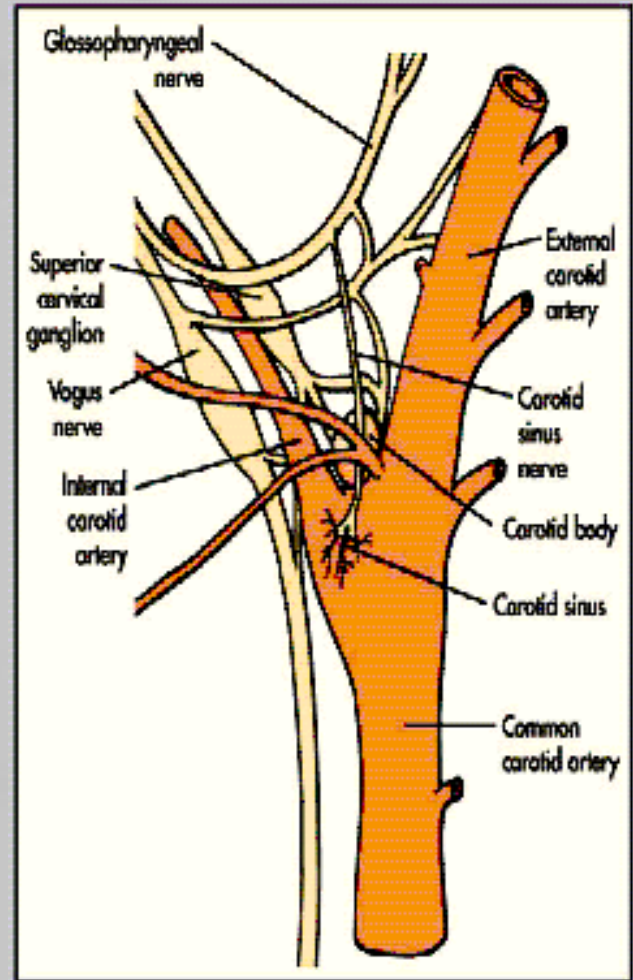


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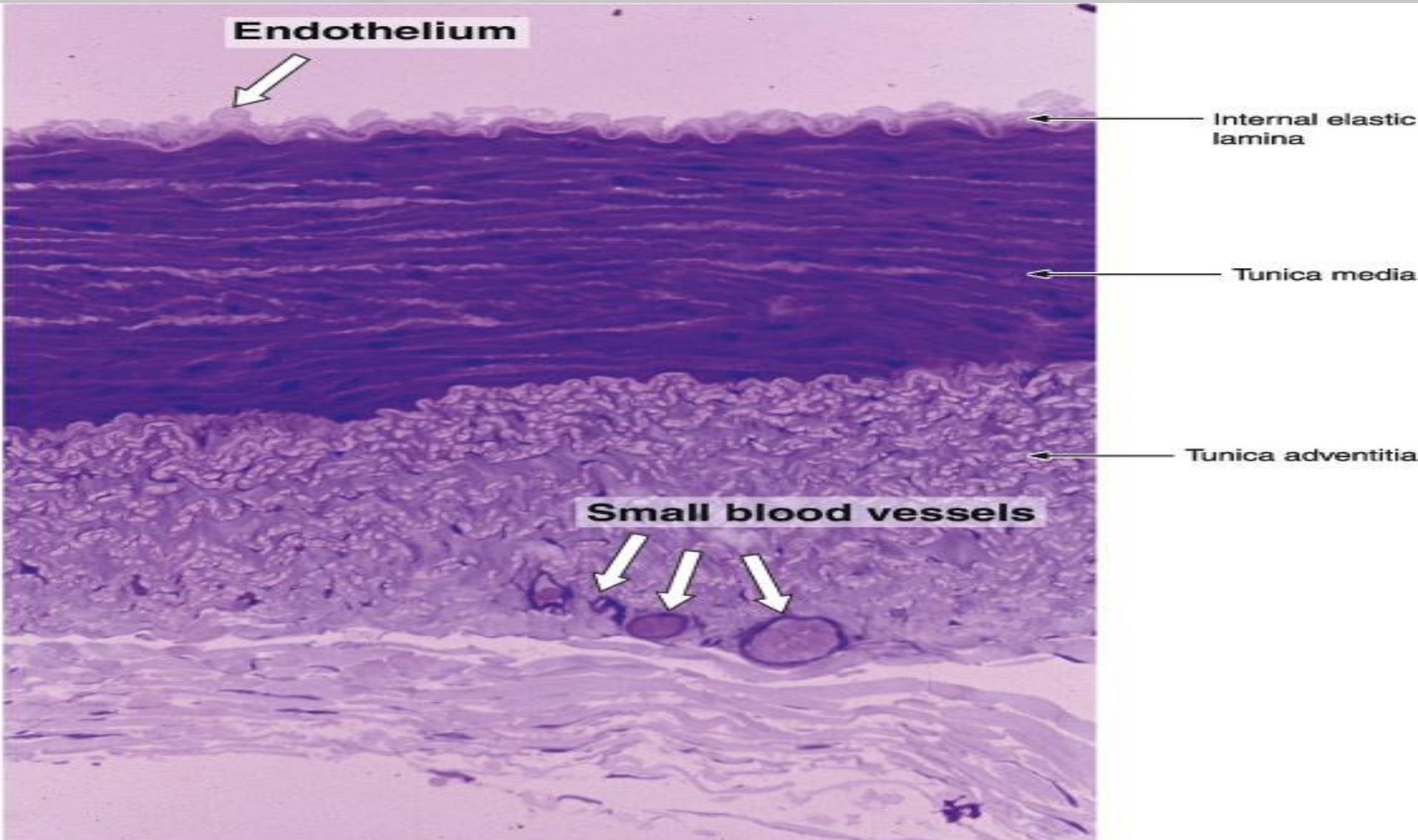
# Carotid Sinuses

- Carotid sinuses are slight dilatations of the internal carotid arteries.
- These sinuses contain **baroreceptors** that detect changes in blood pressure and relay the information to the central nervous system.
- The arterial media layer of the sinus is thinner to allow it to respond to changes in blood pressure.
- The intima and the adventitia are very rich in nerve endings.

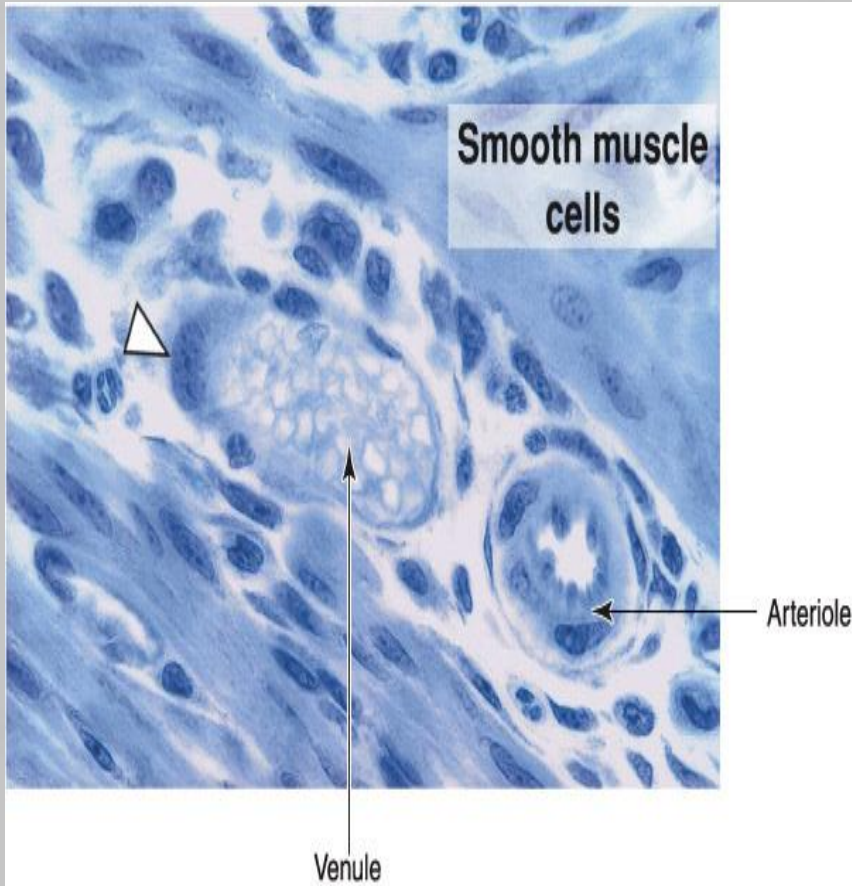




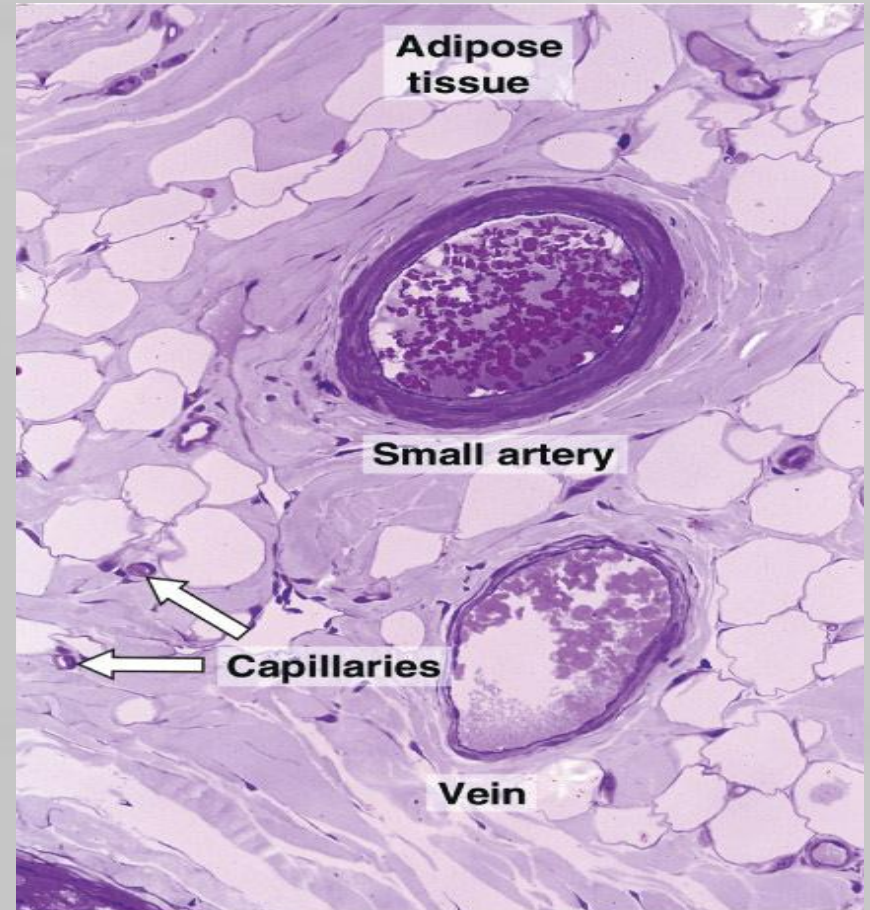
# Medium Muscular Arteries



# Arterioles + Small arteries



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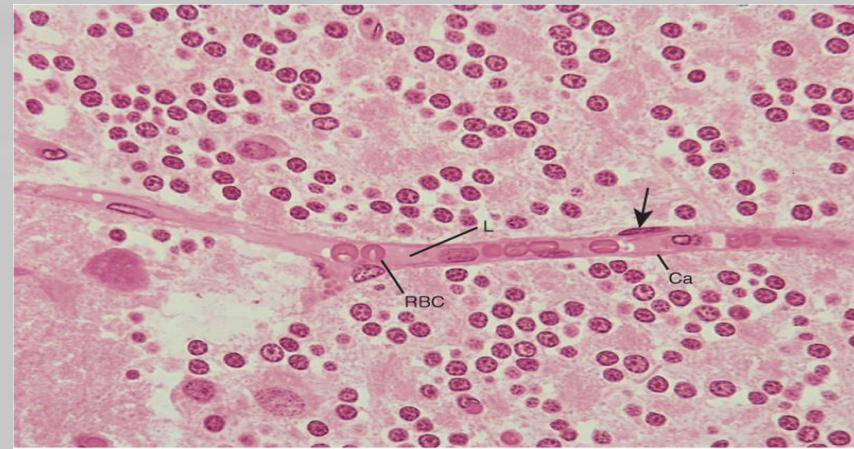


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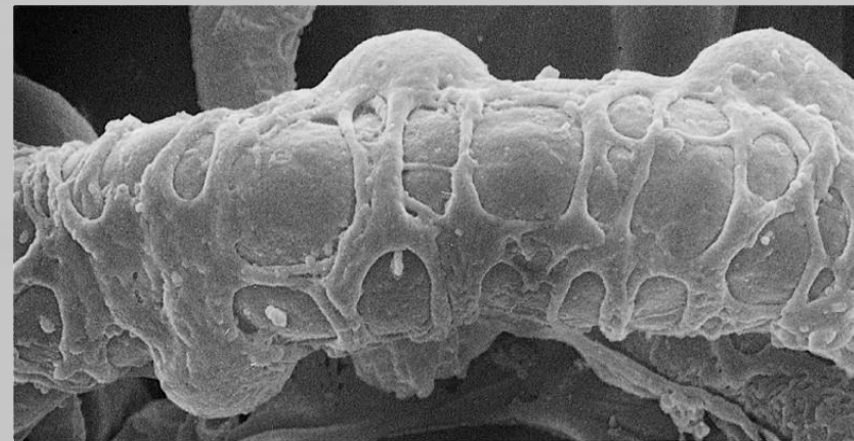


# Capillaries

- Capillaries have structural variations to permit different levels of metabolic exchange between blood and surrounding tissues.
- They are composed of a **single layer of endothelial cells** rolled up in the form of a tube.
- The external surfaces of these cells usually rest on a **basal lamina**.
- **Pericytes** are cells of mesenchymal origin with long cytoplasmic processes that partly surround the endothelial cells at various locations along capillaries.

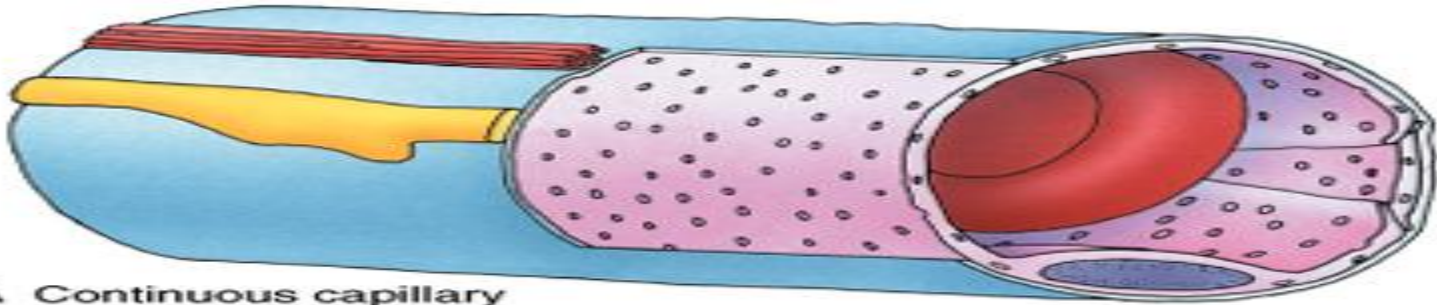


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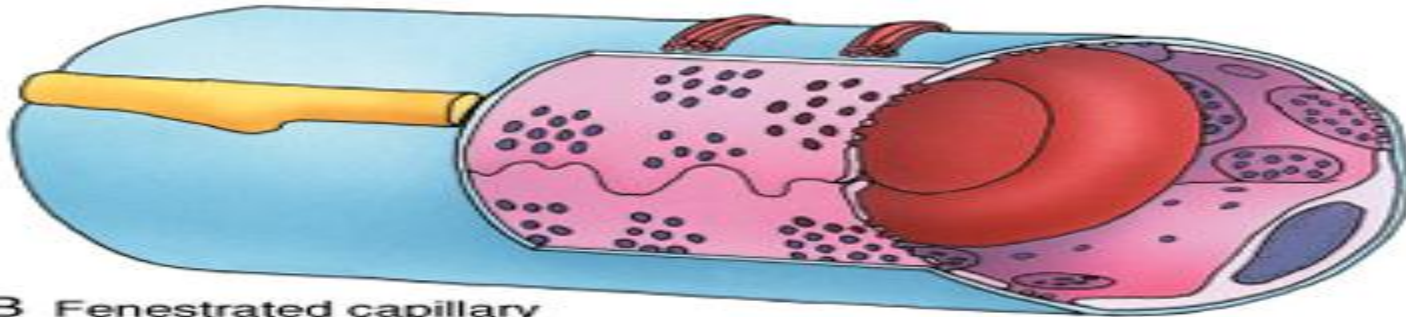


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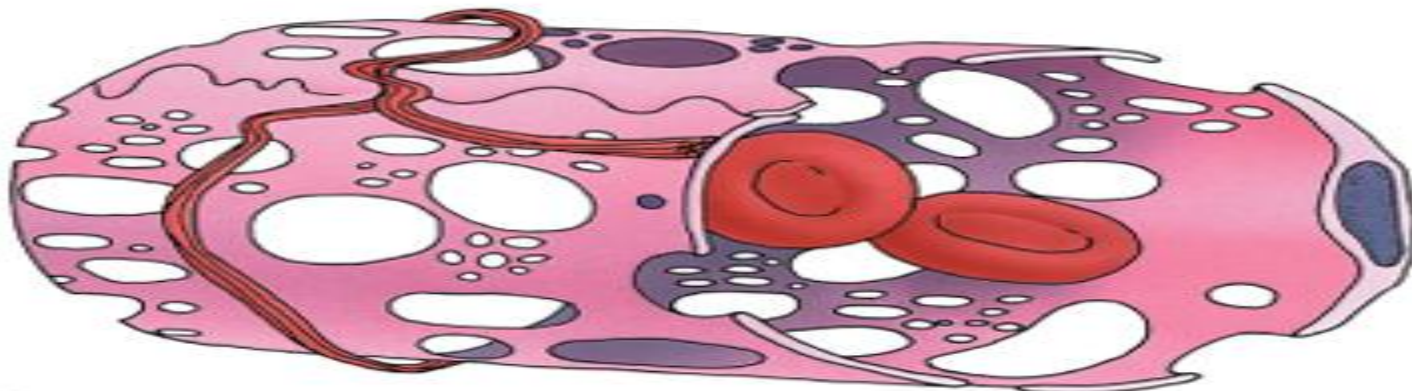
# Capillaries types



A Continuous capillary



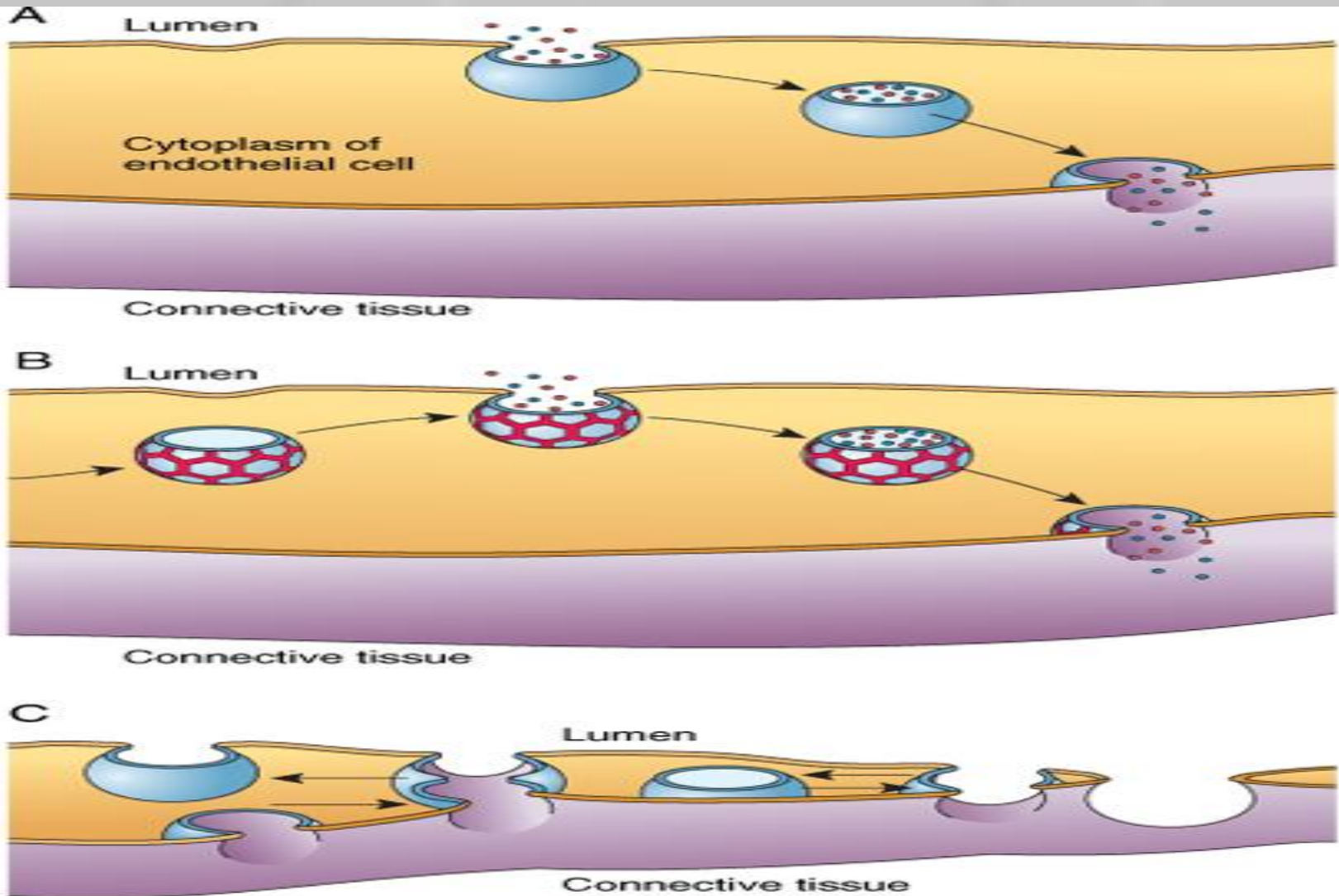
B Fenestrated capillary



C Sinusoidal (discontinuous) capillary

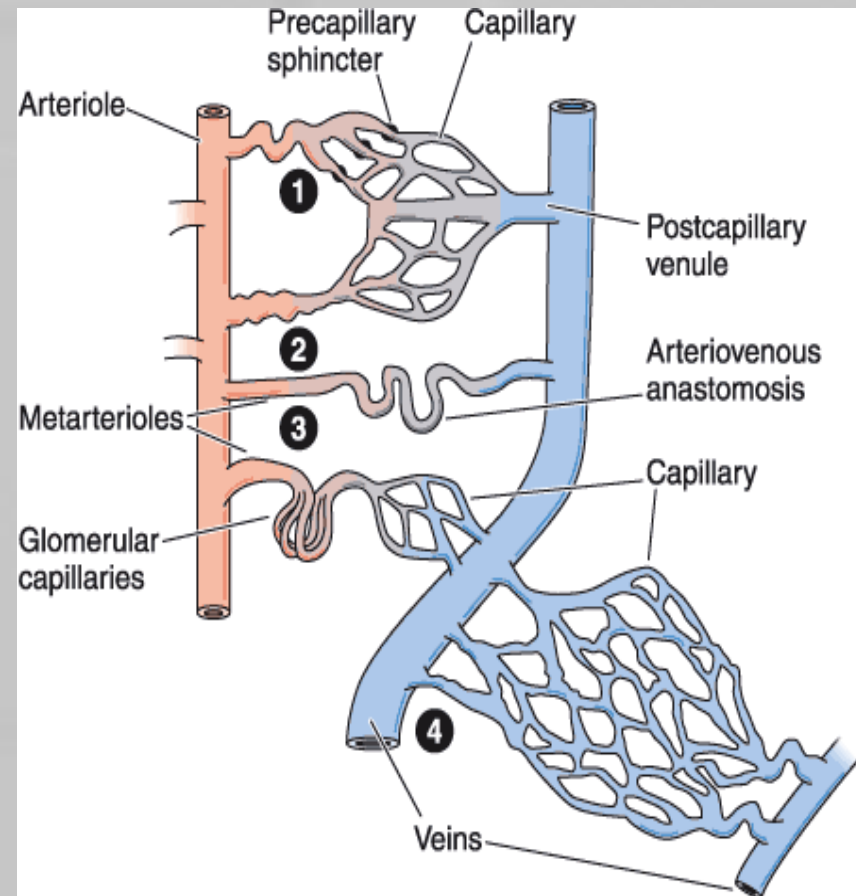


# The various methods of transport across capillary endothelia



# Types of microcirculation formed by small blood vessels

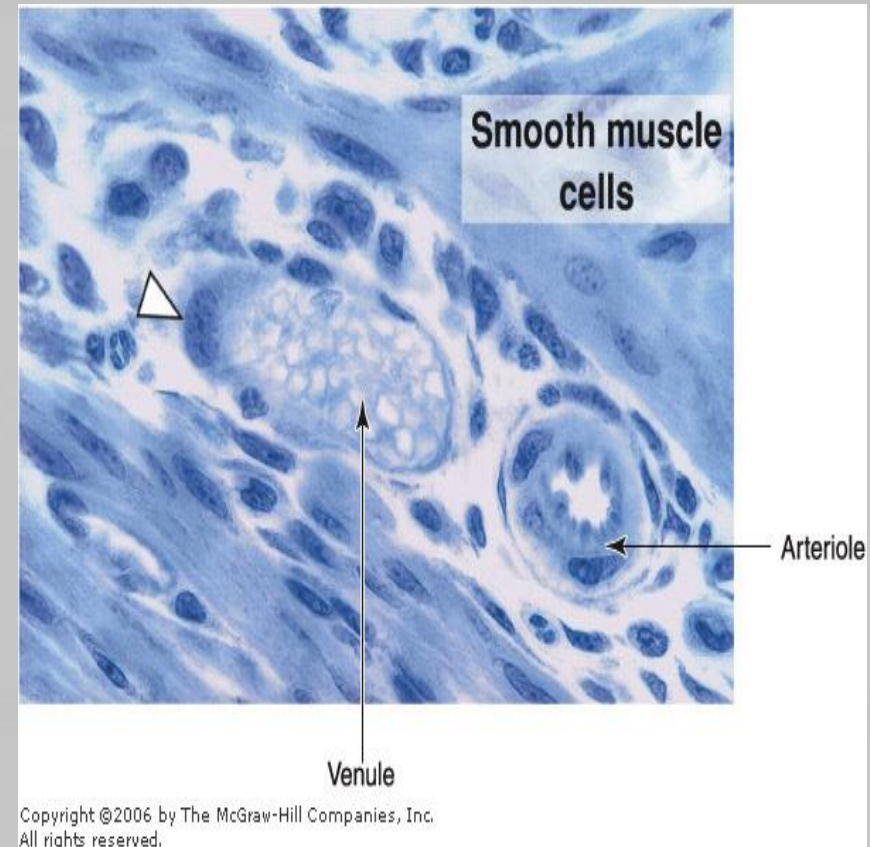
- 1) The usual sequence of arteriole → metarteriole → capillary → venule and vein.
- 2) An arteriovenous anastomosis
- 3) An arterial portal system, as is present in the kidney glomerulus
- 4) A venous portal system, as is present in the liver.



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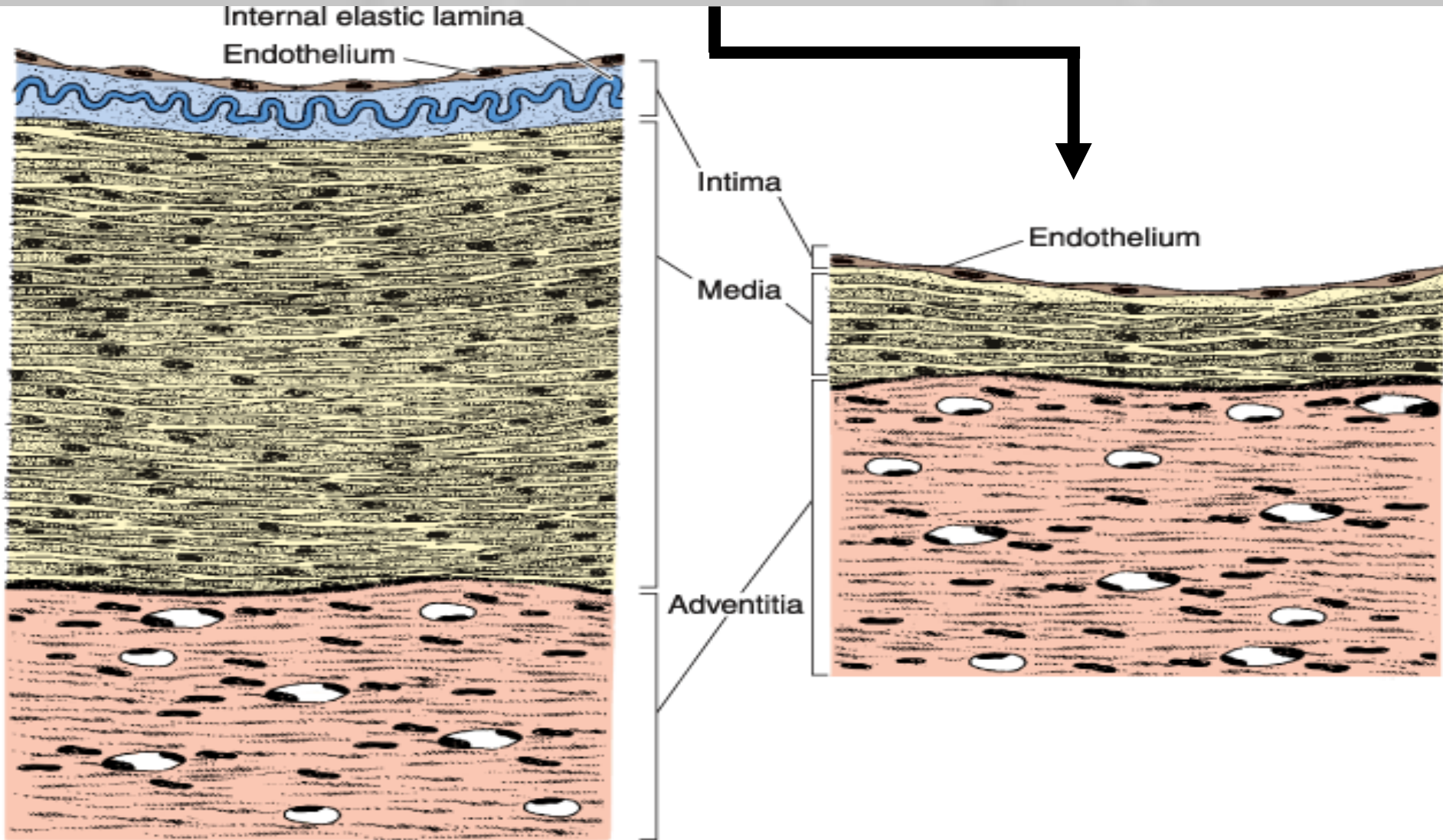
# Postcapillary Venules

- The tunica intima of these vessels is composed of endothelium and a very thin subendothelial layer.
- It has the loosest endothelial junctions along the entire vascular system.
- The media of these venules may contain only contractile pericytes

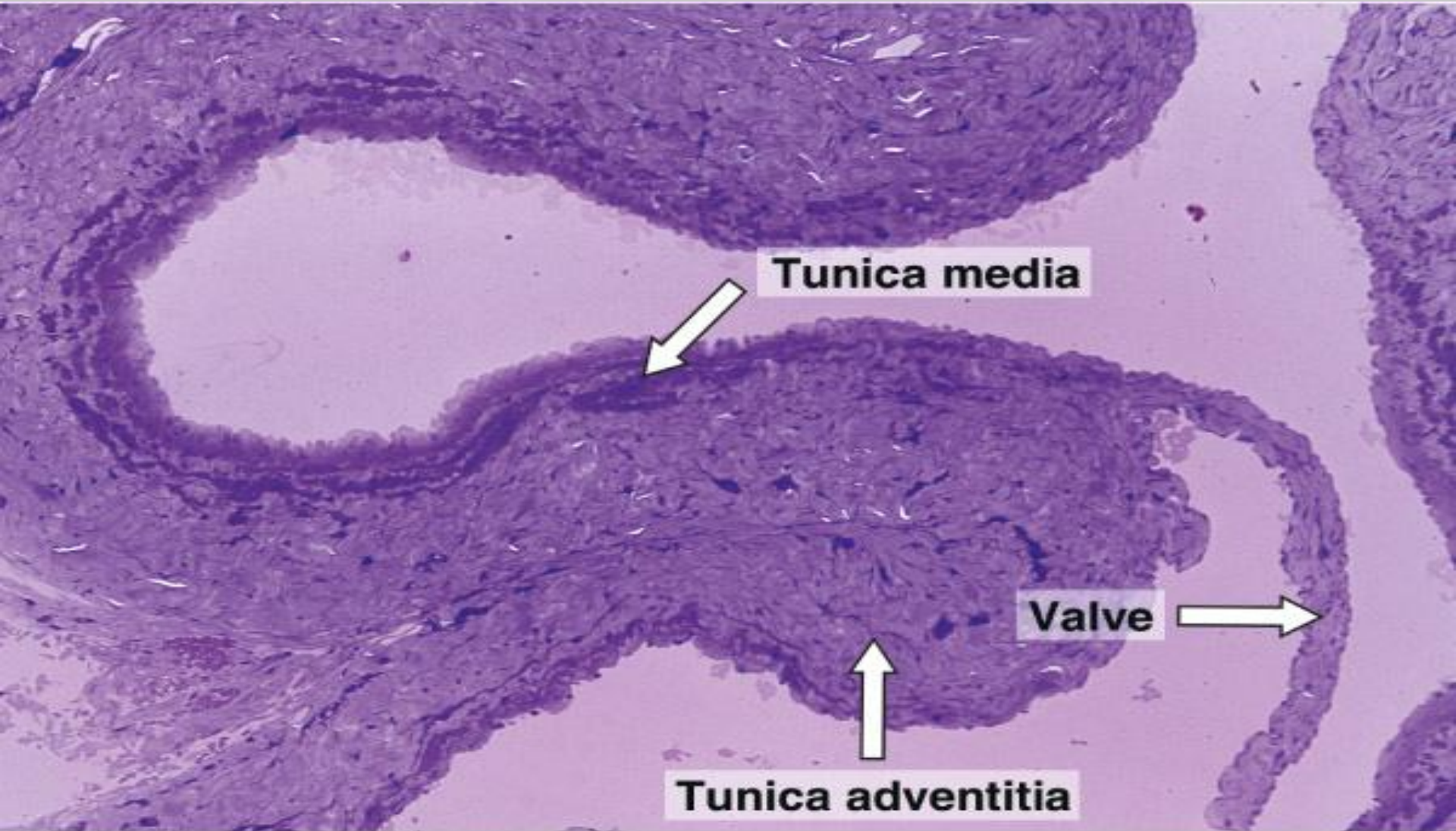




# Muscular Veins



# Valves in large veins



# Medium Sized artery vs. Medium Sized Vein

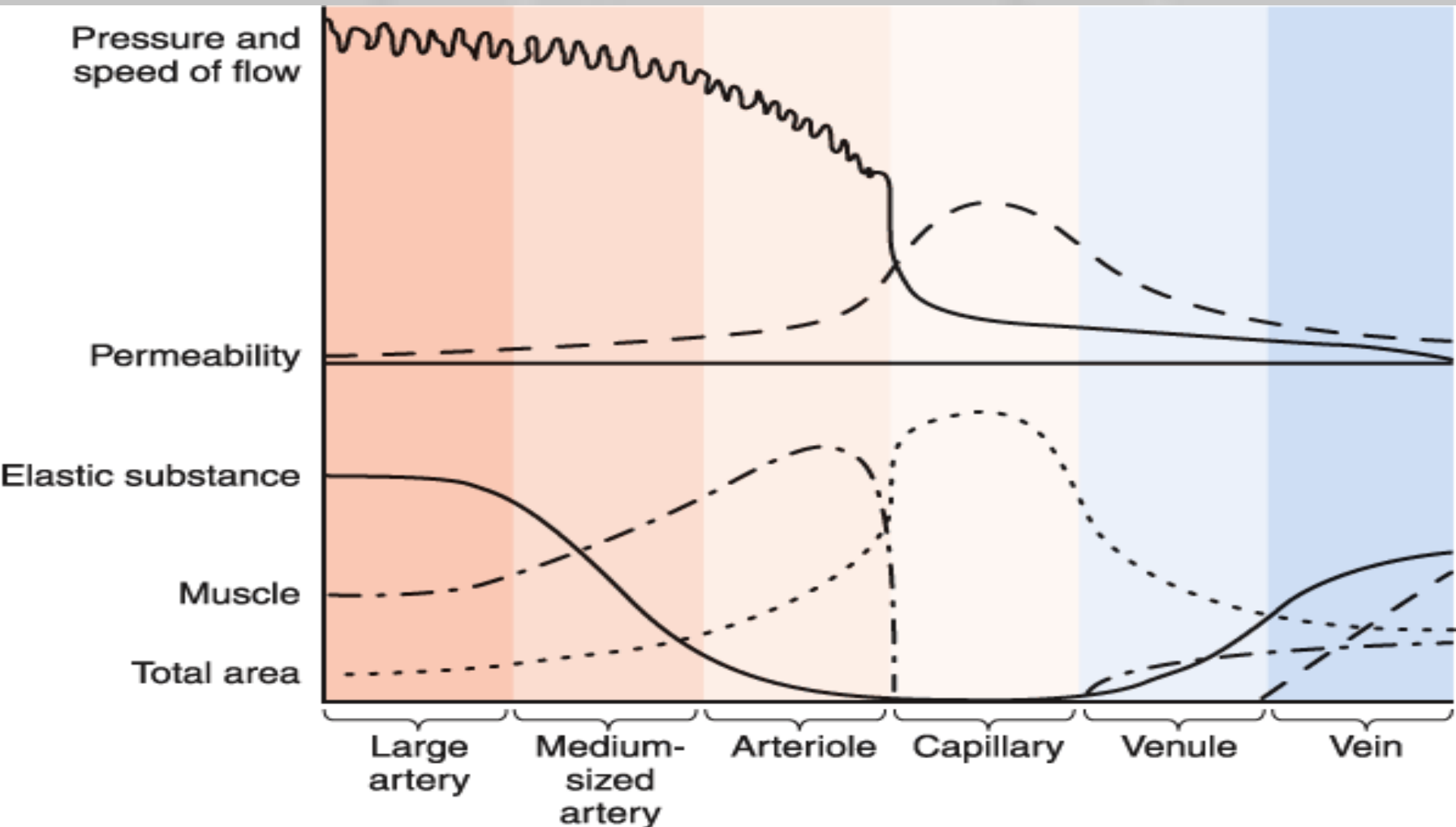
<b>Medium Sized artery</b>	<b>Medium Sized Vein</b>
<ol style="list-style-type: none"><li>1.The lumen appears rounded.</li><li>2.The lumen contains no blood after death.</li><li>3.It has a thick wall but narrow lumen.</li><li>4.There are no valves.</li><li>5.The intima is thick, folded and has a well-developed internal elastic lamina.</li></ol>	<ol style="list-style-type: none"><li>1.The lumen appears collapsed.</li><li>2.Its lumen usually contains blood.</li><li>3.It has a thin wall but wide lumen.</li><li>4.They often have valves.</li><li>5.The intima is thin, not folded and has no elastic lamina.</li></ol>



# Medium Sized artery vs. Medium Sized Vein

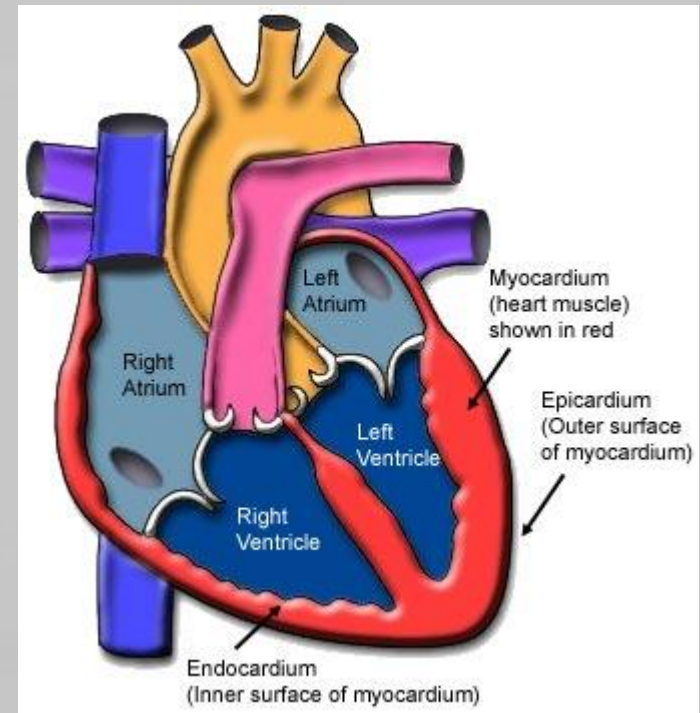
<b>Medium — Sized artery</b>	<b>Medium — Sized Vein</b>
<p>6.The media is thick and contains elastic fibers.</p> <p>7.External elastic lamina may be present between the media and adventitia.</p> <p>8.The adventitia is thin and contains some elastic fibers.</p> <p>9.No lymphatic capillaries in its wall.</p> <p>10. It has a rapid flow of arterial blood.</p>	<p>6.The media is thin with very few elastic fibers.</p> <p>7.No external elastic lamina.</p> <p>8.The adventitia is thick and is very rich in collagenous fibers.</p> <p>9.Lymphatic capillaries may be present in its adventitia.</p> <p>10. It has a slow flow of venous blood.</p>

# Relationship between the characteristics of blood circulation and the structure of the blood vessels



# The heart

- **The heart** is formed of two thin atria and two thick ventricles.
- **The wall of the heart is formed of 3 layers :**
  - **1. Epicardium**
  - **2. Myocardium**
  - **3. Endocardium**



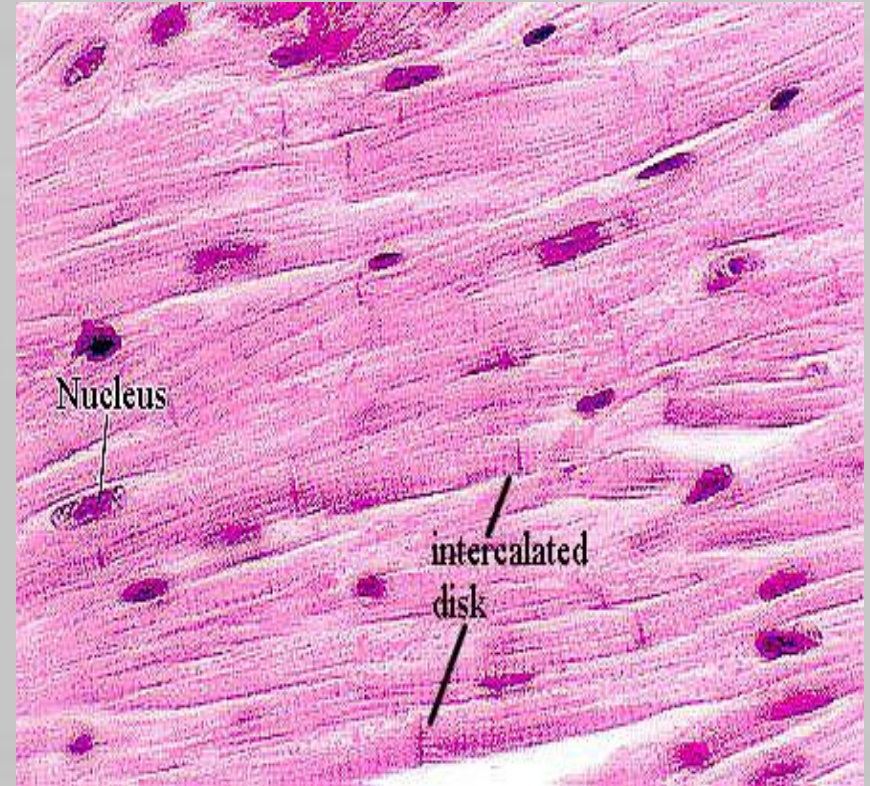


# Epicardium

- It is the visceral layer of the pericardium.
- **Simple squamous epithelium** (mesothelium) supported by a thin layer of connective tissue.
- **A subepicardial layer** of loose connective tissue contains veins, nerves, and nerve ganglia.
- The adipose tissue that generally surrounds the heart accumulates in this layer.

# Myocardium

- Forms the main substance of the heart.
- It is formed of groups of cardiac muscle fibers.



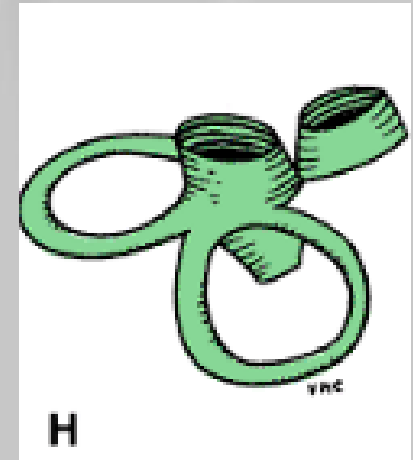
# Endocardium

- Homologous with the intima of blood vessels.
  - **Single layer of squamous endothelial cells**
  - **Thin subendothelial layer** of loose connective tissue that contains elastic and collagen fibers as well as some smooth muscle cells.
- **Subendocardial layer** contains veins, nerves, and branches of the impulse-conducting system of the heart (Purkinje cells).



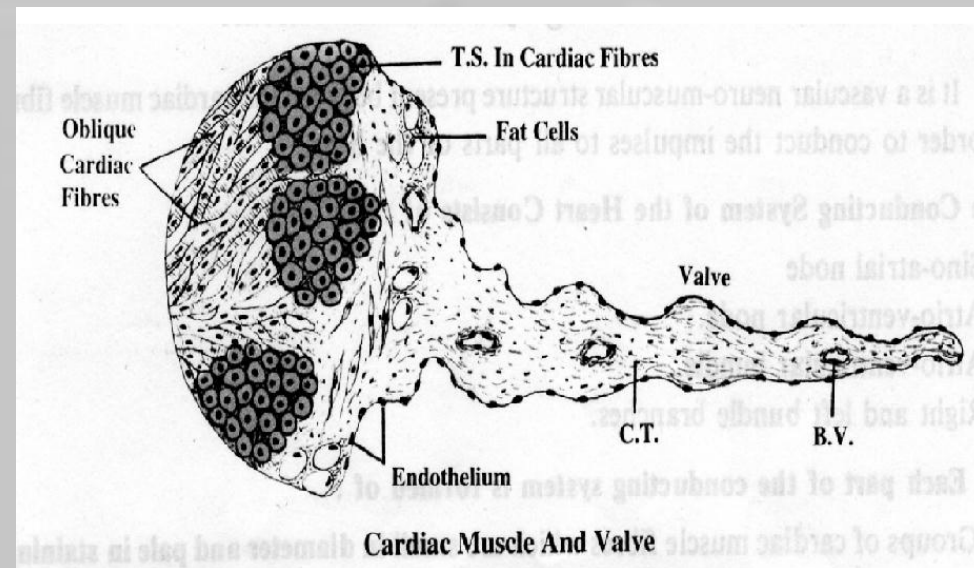
# The fibrous skeleton of the heart

- The cardiac fibrous skeleton is composed of dense connective tissue with thick collagen fibers oriented in various directions.
  - **Septum membranaceum**
  - **Trigona fibrosa**
  - **Annuli fibrosi.**



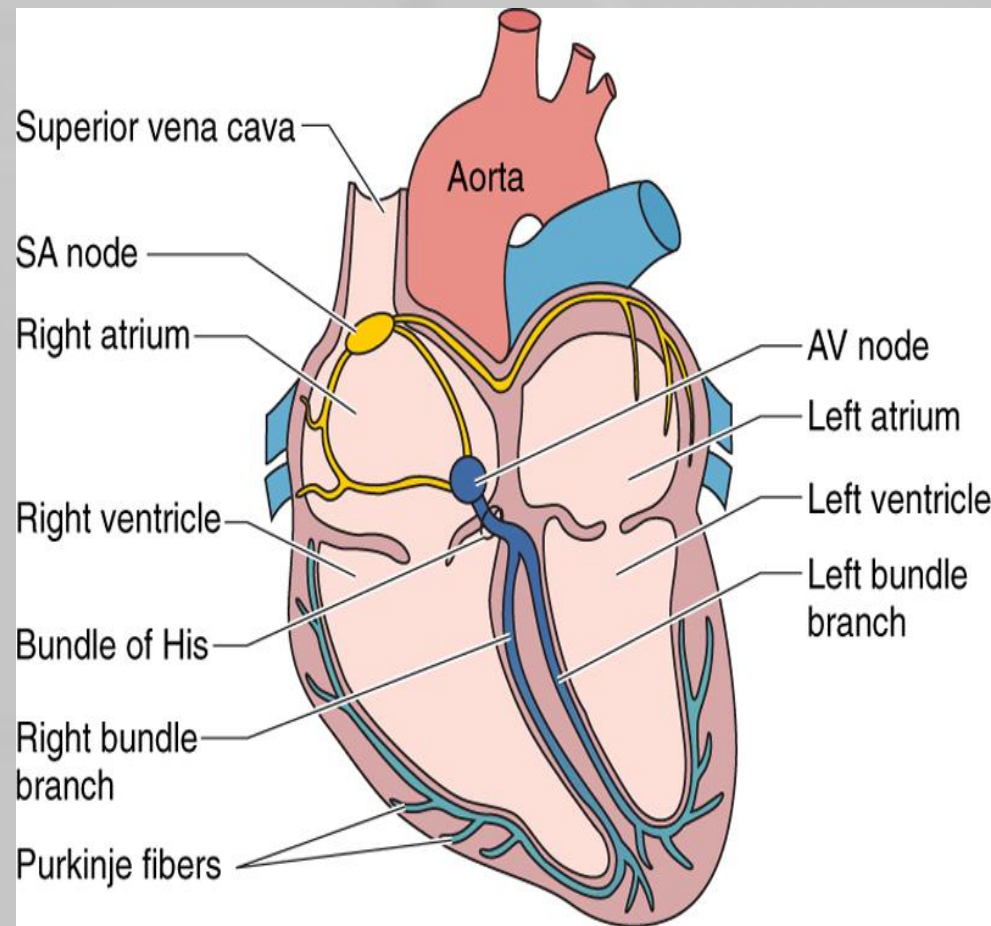
# Valves of the heart

- The cardiac valves consist of a central core of dense fibrous connective tissue containing both collagen and elastic fibers
- Lined on both sides by endothelial layers.
- The bases of the valves are attached to the annuli fibrosi of the fibrous skeleton.



# The conducting system of the heart

- A specialized system to generate a rhythmic stimulus that is spread to the entire myocardium.
- 1. Sino-atrial node.
- 2. Atrio-ventricular node.
- 3. Atrio-ventricular bundle.
- 4. Right and left bundle branches.



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# The conducting system of the heart

- 1. The sinoatrial node** is a mass of modified cardiac muscle cells that is fusiform, is smaller than atrial muscle cells, and has fewer myofibrils.
- 2. The atrioventricular node** cells are similar to those of the sinoatrial node, but their cytoplasmic projections branch in various directions, forming a network.
- 3. The atrioventricular bundle** is formed by cells similar to those of the atrioventricular node.

# The conducting system of the heart

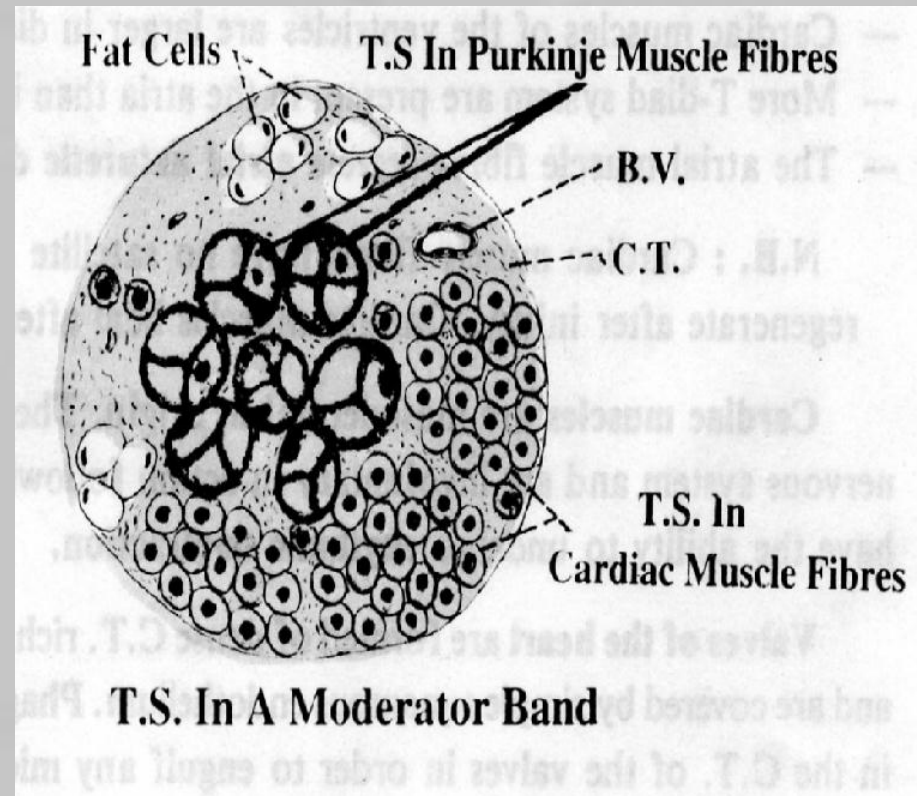
4. **Purkinje cells** larger than ordinary cardiac muscle cells and acquire a distinctive appearance.
- Have one or two central nuclei
  - Their cytoplasm is rich in mitochondria and glycogen.
  - The myofibrils are sparse and are restricted to the periphery of the cytoplasm



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# The Moderator Band

- Cardiac muscle bundles
- Some fat cells
- Blood capillaries
- Purkinje muscle fibers
- Bundles of nerve fibers

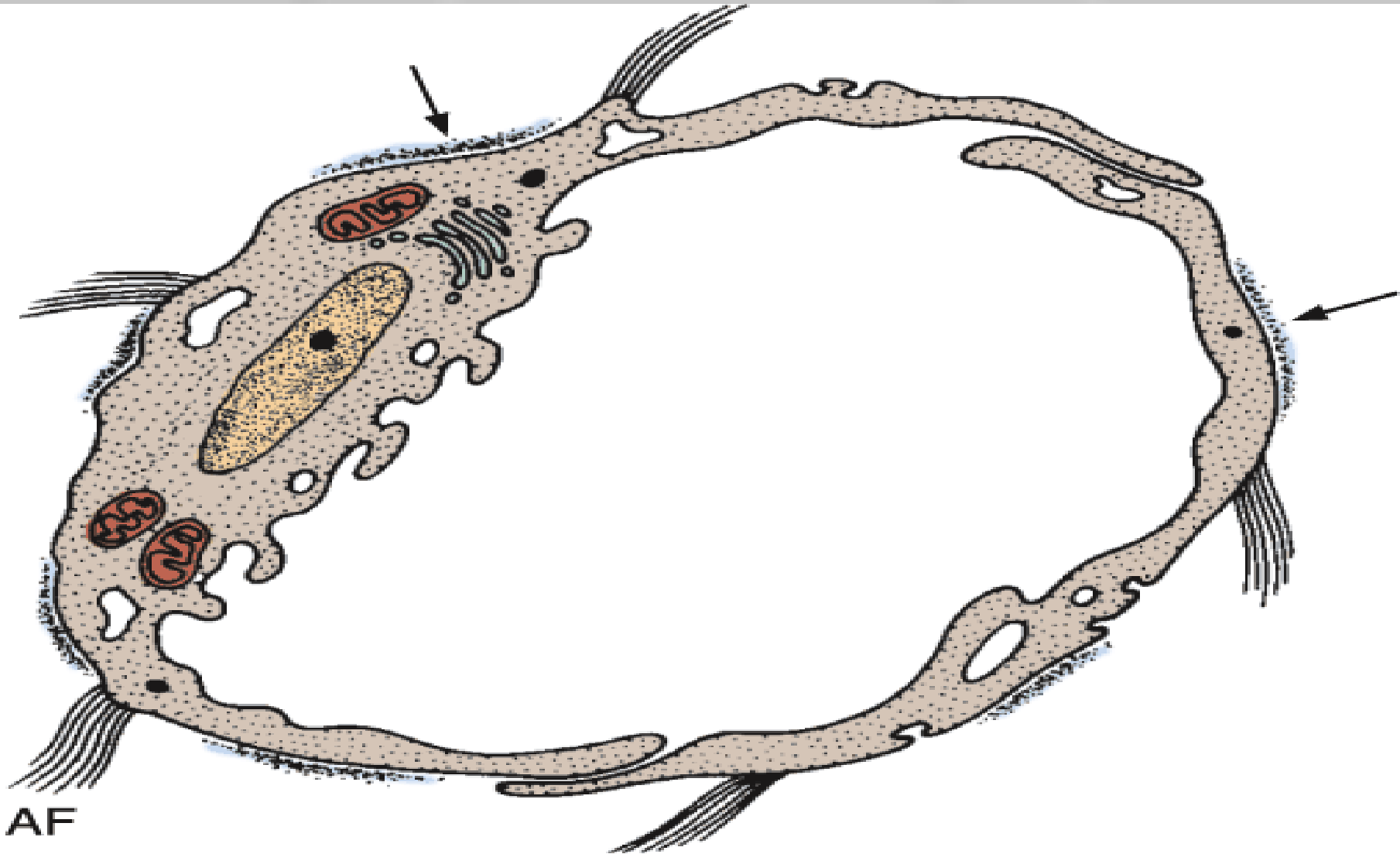




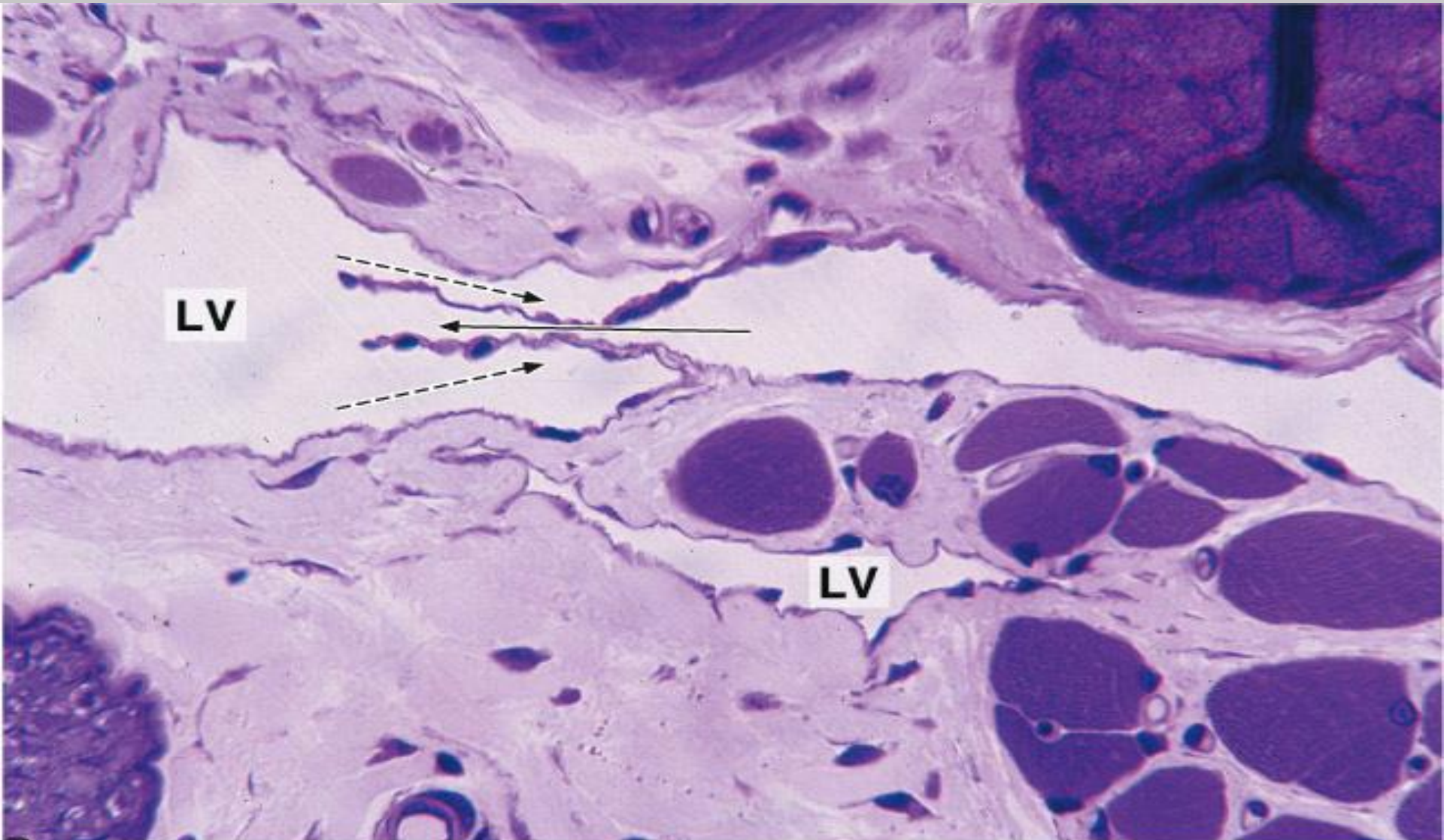
# Lymphatic Vascular System

- A system of endothelium-lined thin-walled channels that collects fluid from the tissue spaces and returns it to the blood.
- **Lymph** circulates in only one direction, toward the heart.
- The **lymphatic capillaries** originate in the various tissues as thin, closed-ended vessels that consist of a single layer of endothelium and an incomplete basal lamina.
- Lymphatic capillaries are held open by numerous microfibrils of the elastic fiber system, which also bind them firmly to the surrounding connective tissue.

# Structure of a lymphatic capillary



# Valves in lymphatic vessels





Thank You!

Dr. Sami Zagari

