Structure and Function of Blood Vessels

Peter Takizawa
Department of Cell Biology

What we'll talk about…

- Structure of blood vessels and their appearance in histological samples

- Endothelium and structures that control permeability

- Increasing endothelial permeability and leukocyte transmigration

- Smooth muscle and vascular repair

- Angiogenesis

Blood vessels comprise three functional layers.
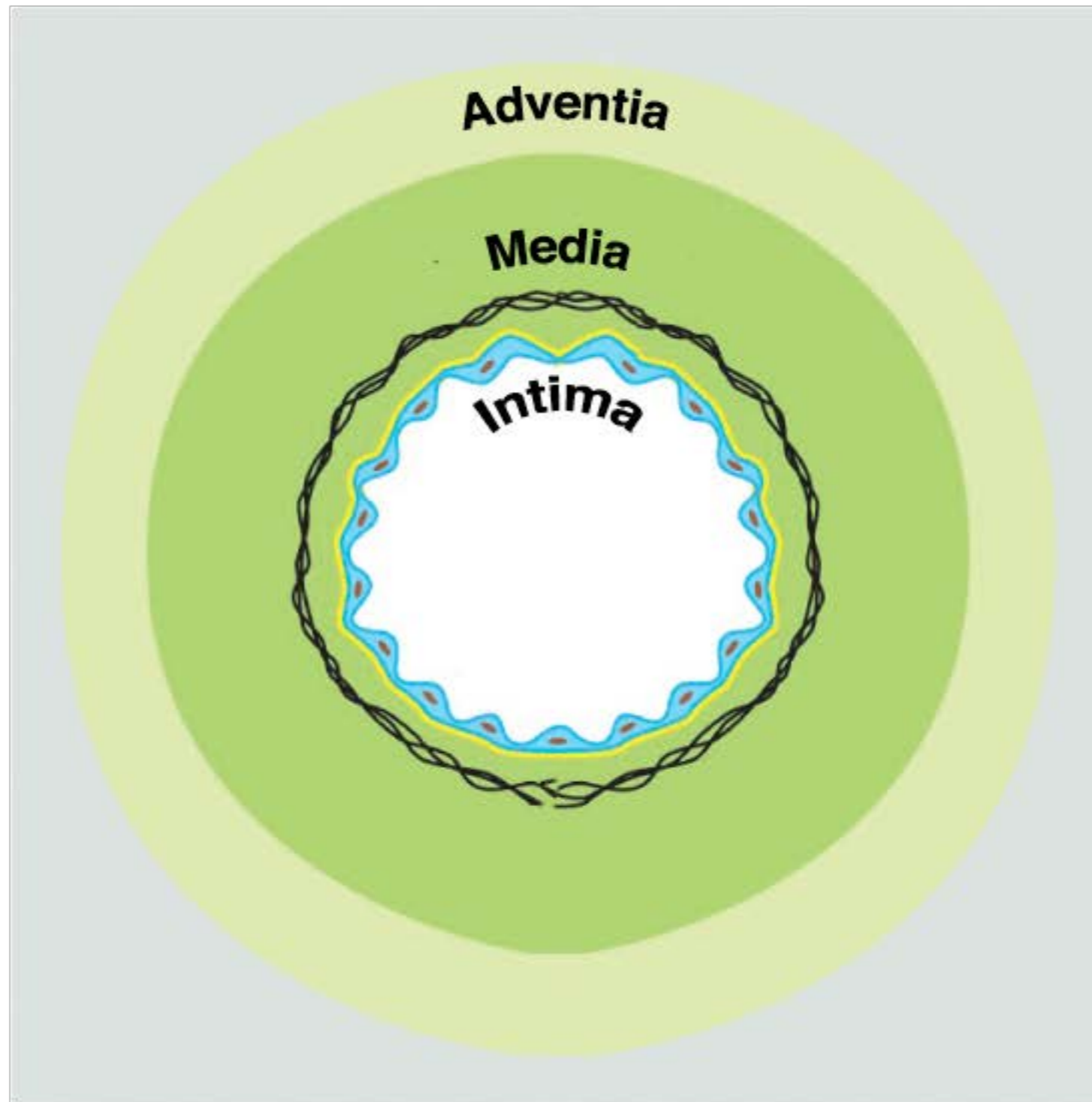
Endothelial cells perform a variety of structural and biochemical functions.

- Permeability

- Immune response

- Angiogenesis

- Modulate vascular resistance

- Antihaemostatic and haemostatic control
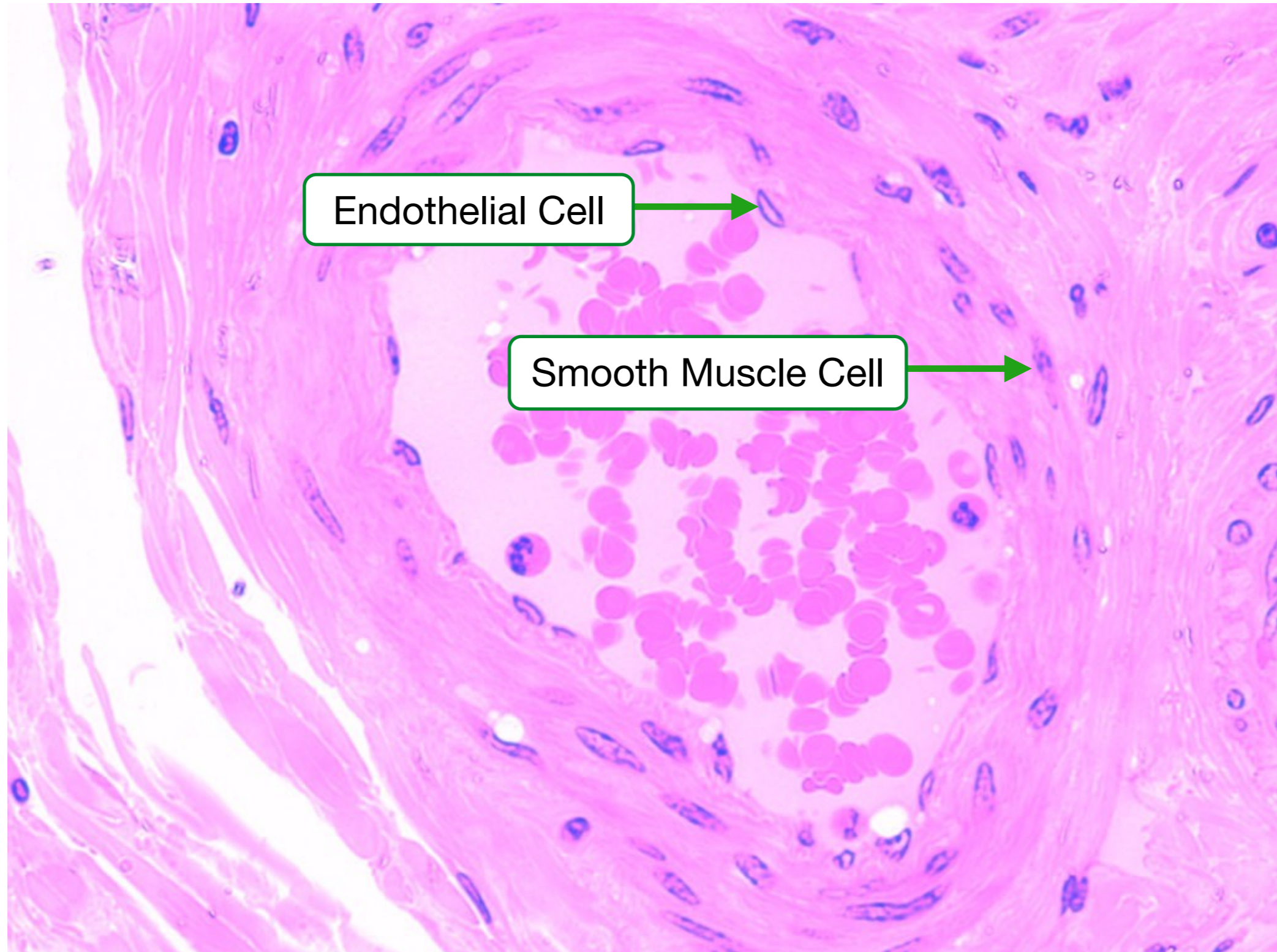
- Enzymatic action on plasma proteins

The aorta is an elastic artery that contains numerous elastic fibers in the media.
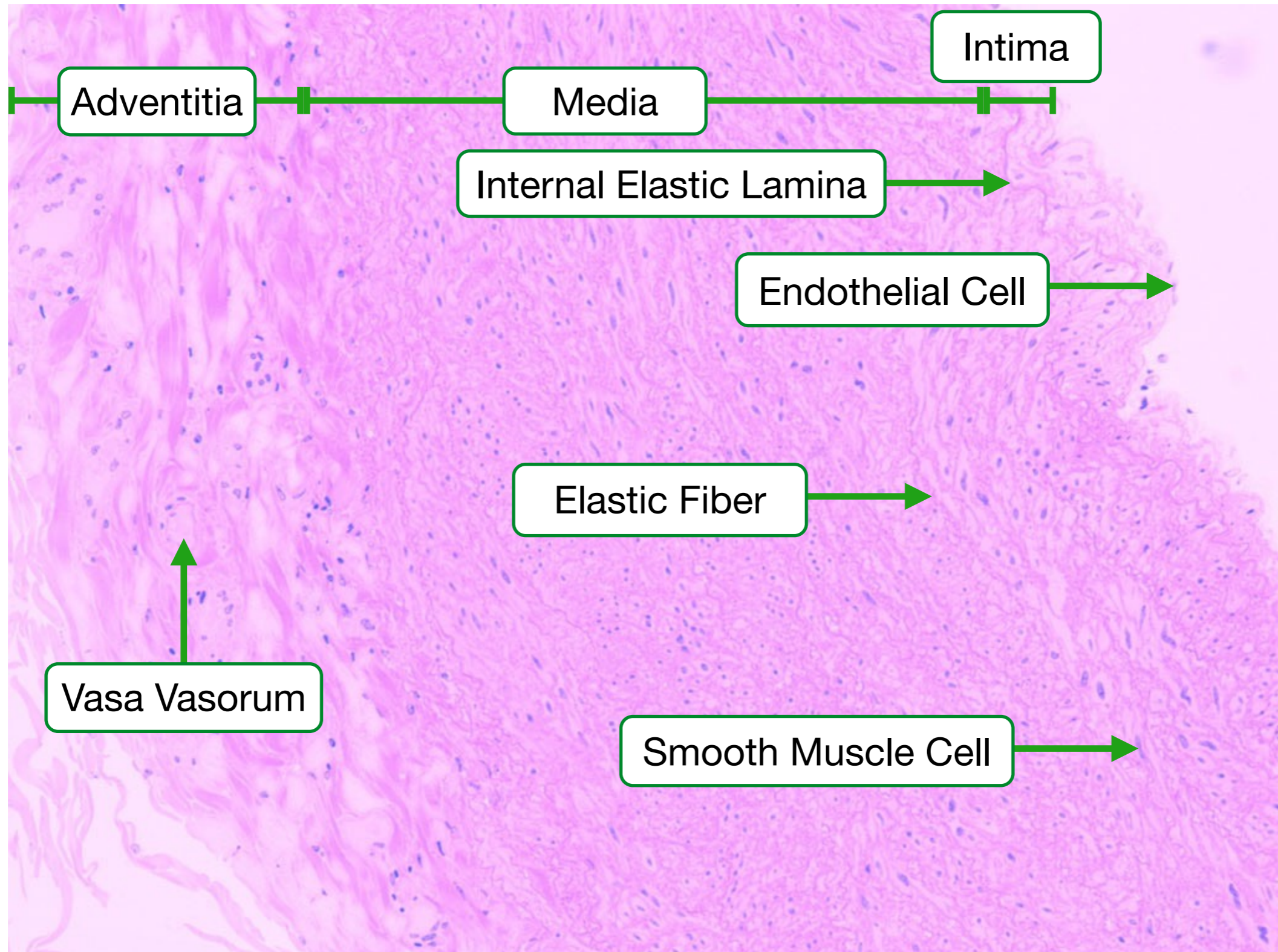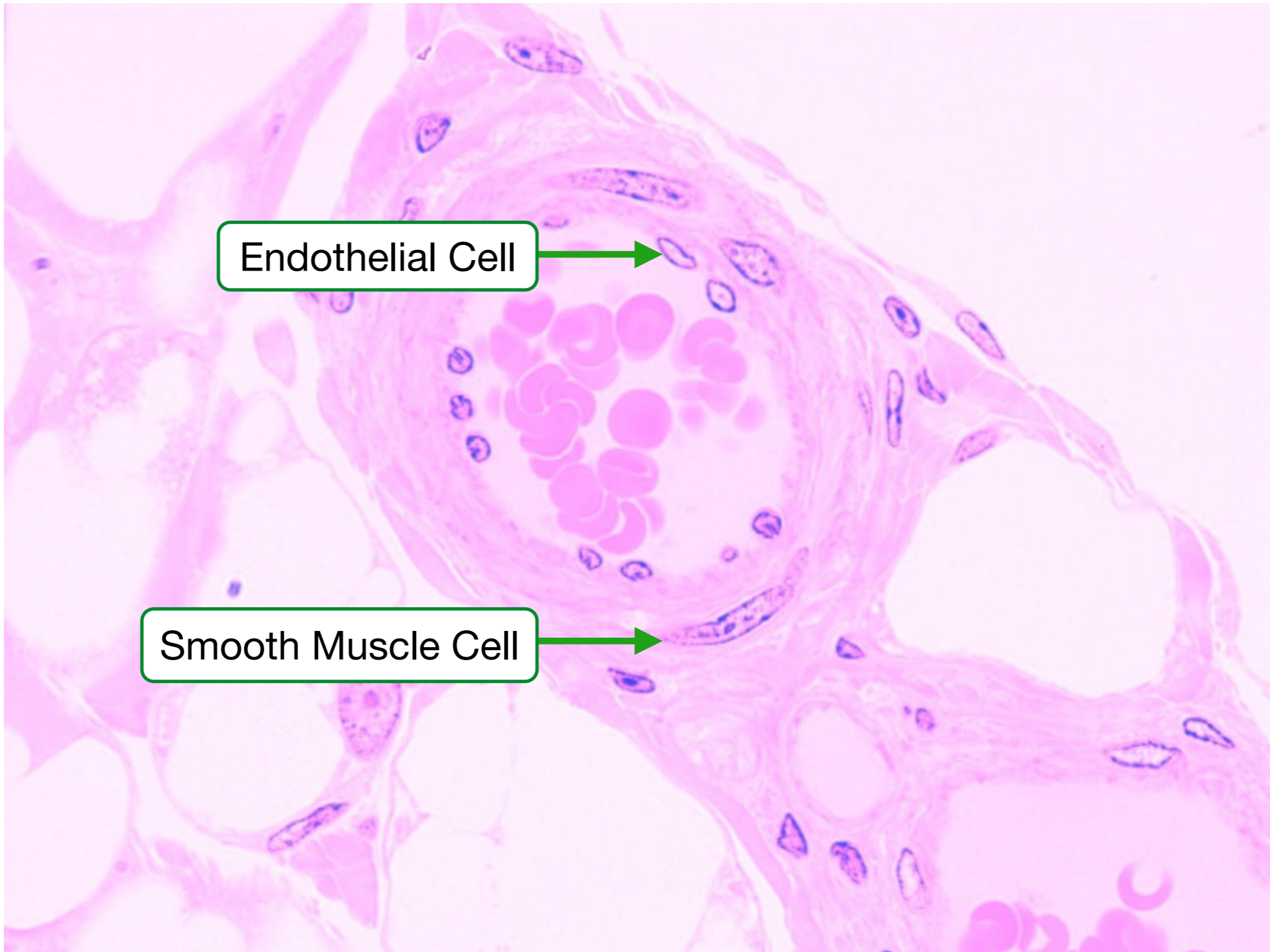
Muscular arteries contain more smooth muscle and fewer elastic fibers in the media layer.
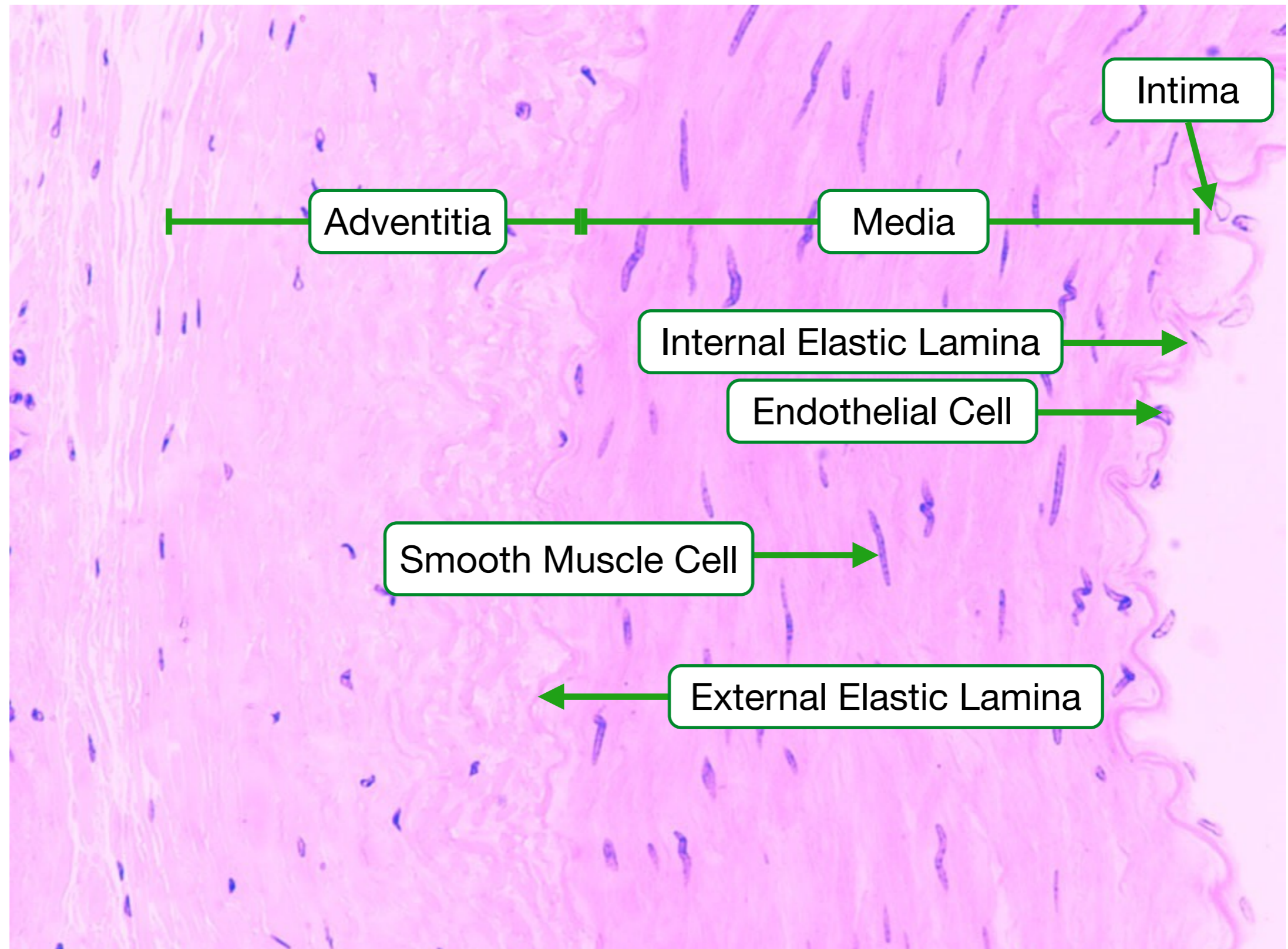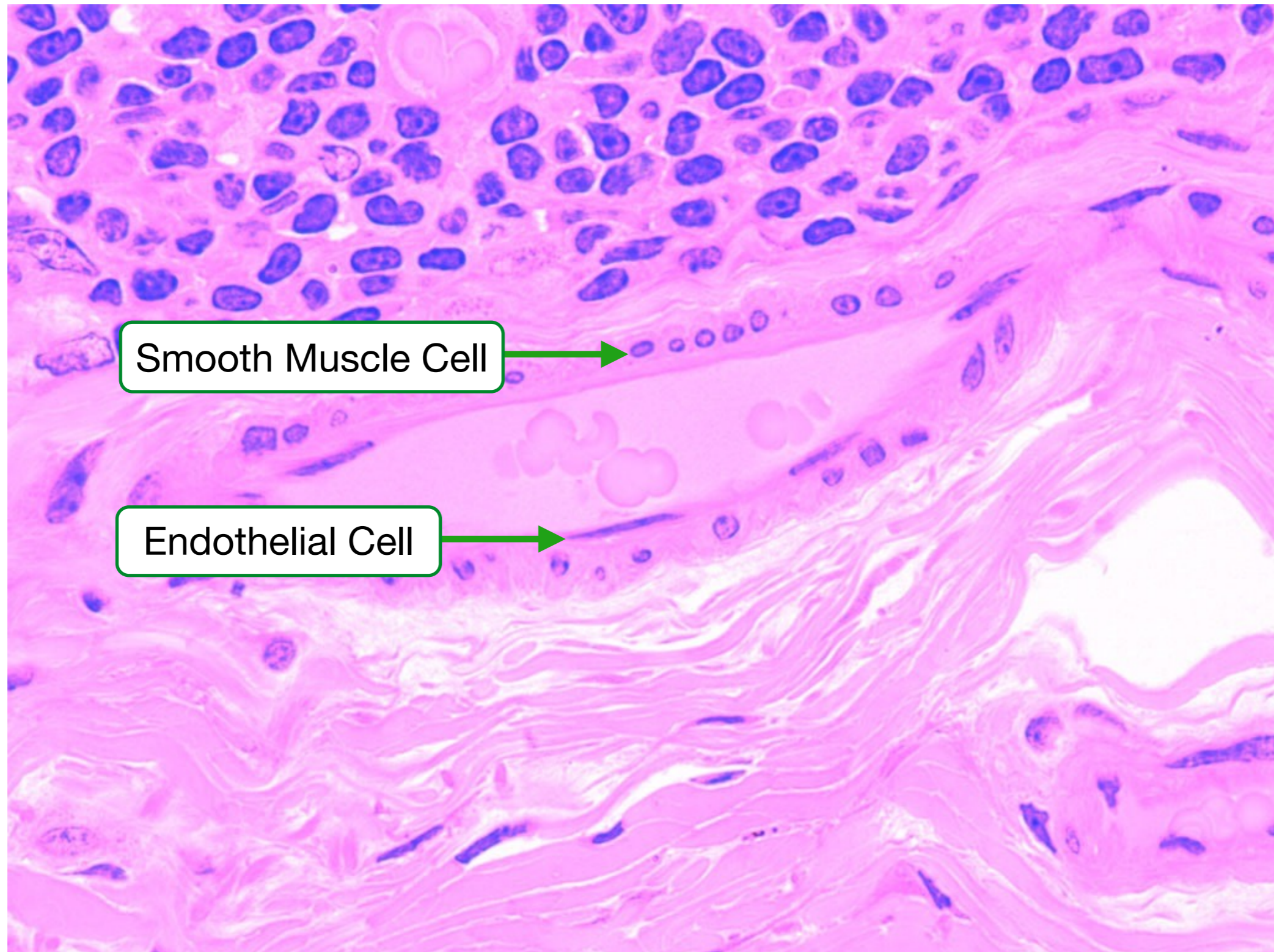
# Small muscular arteries contain fewer layers of smooth muscle.

Arterioles control blood flow into capillaries and create the highest resistance in the circulatory system.

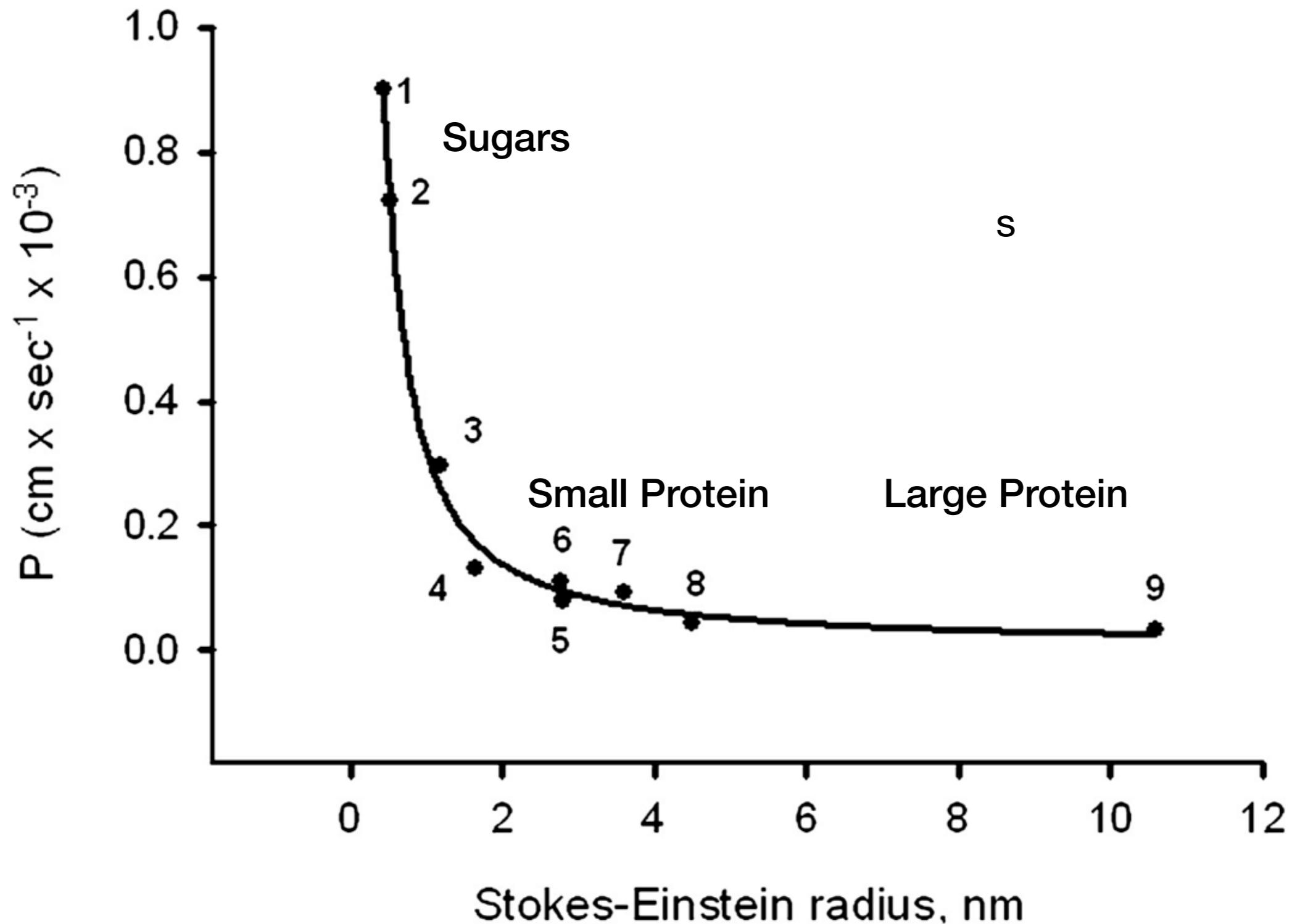# Arterioles have one or two layers of smooth muscle cells.

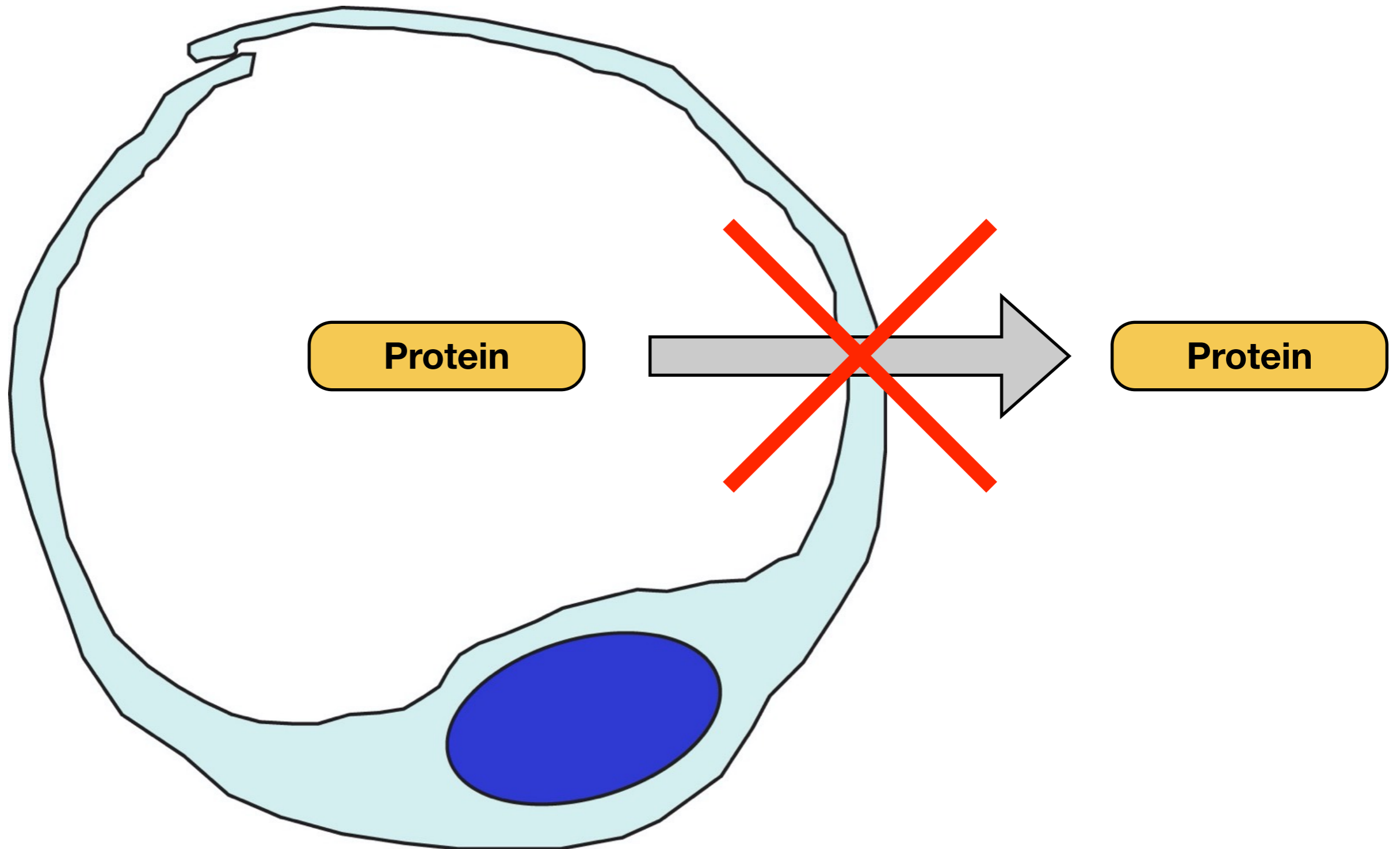# Capillaries contain a single layer of endothelial cells and the occasional pericyte.

Pericyte

Endothelial Cell

Capillary Lumen
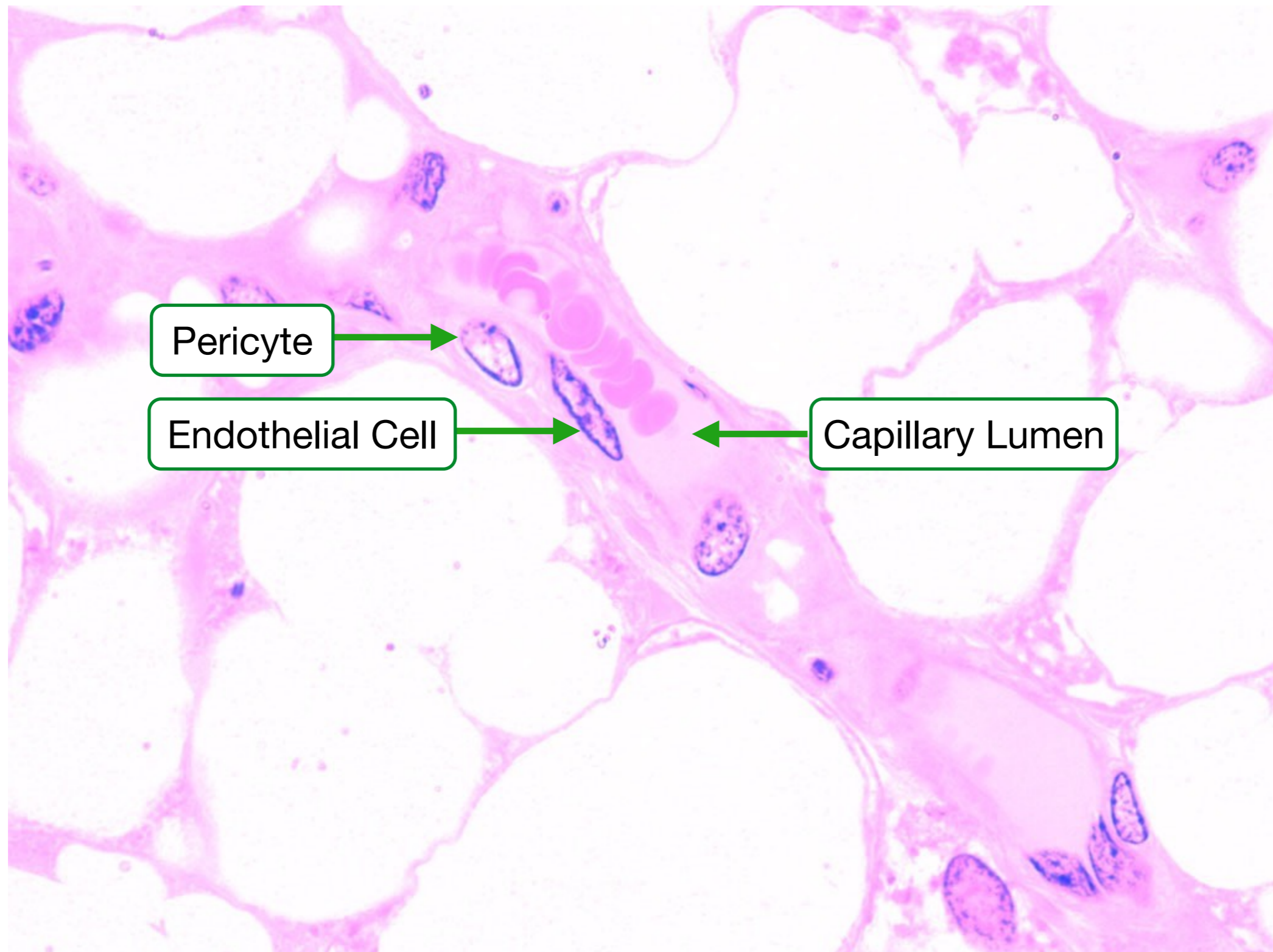
Permeability of capillaries

Small molecules and ions diffuse across capillaries but proteins are restricted in most capillaries.

# Capillaries restrict the diffusion of protein to maintain oncotic pressure.

Primary components that regulate permeability of capillaries.
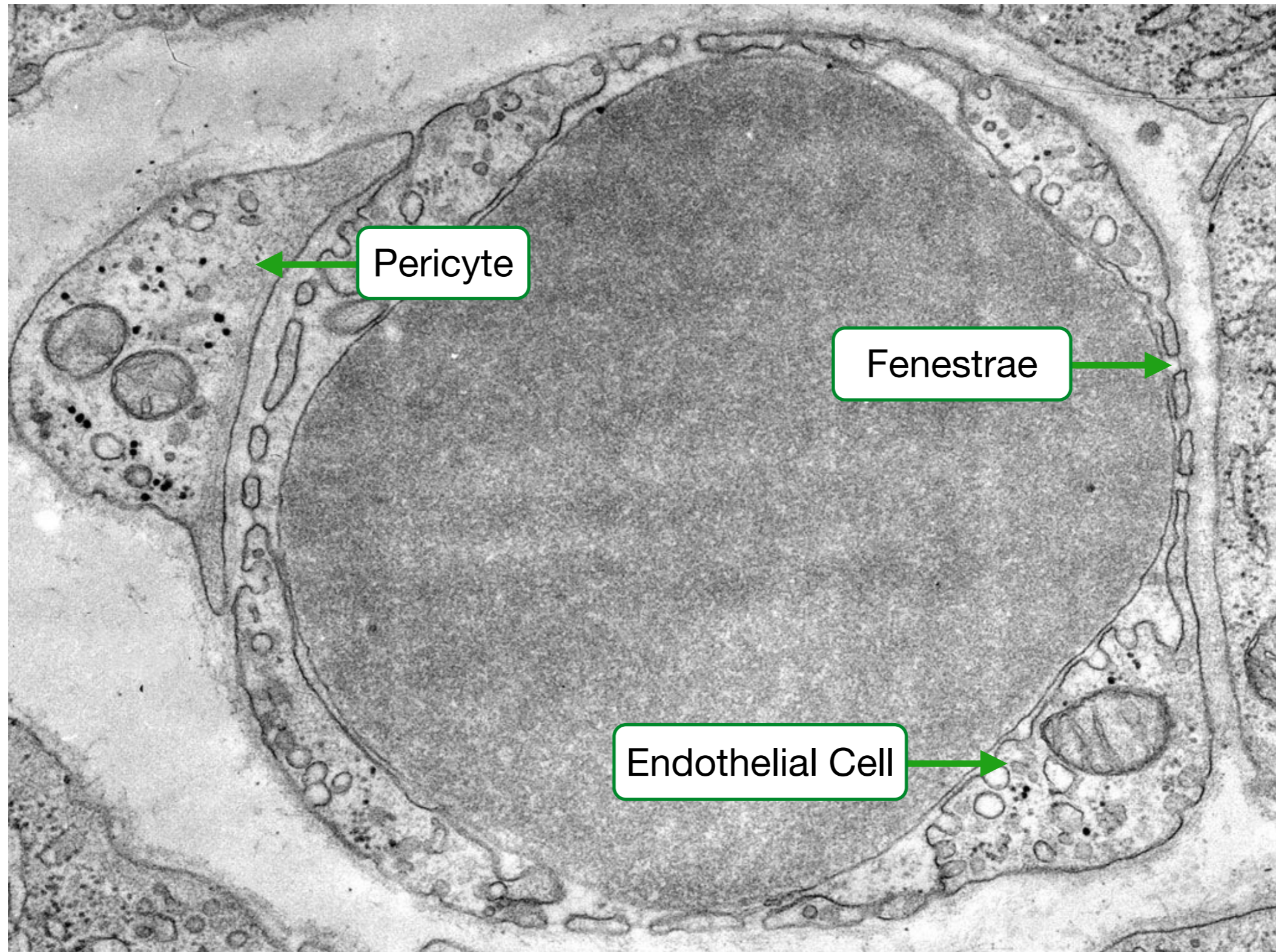
- Structure of endothelial cells

- Basement membrane

- Intercellular junctions between endothelial cells
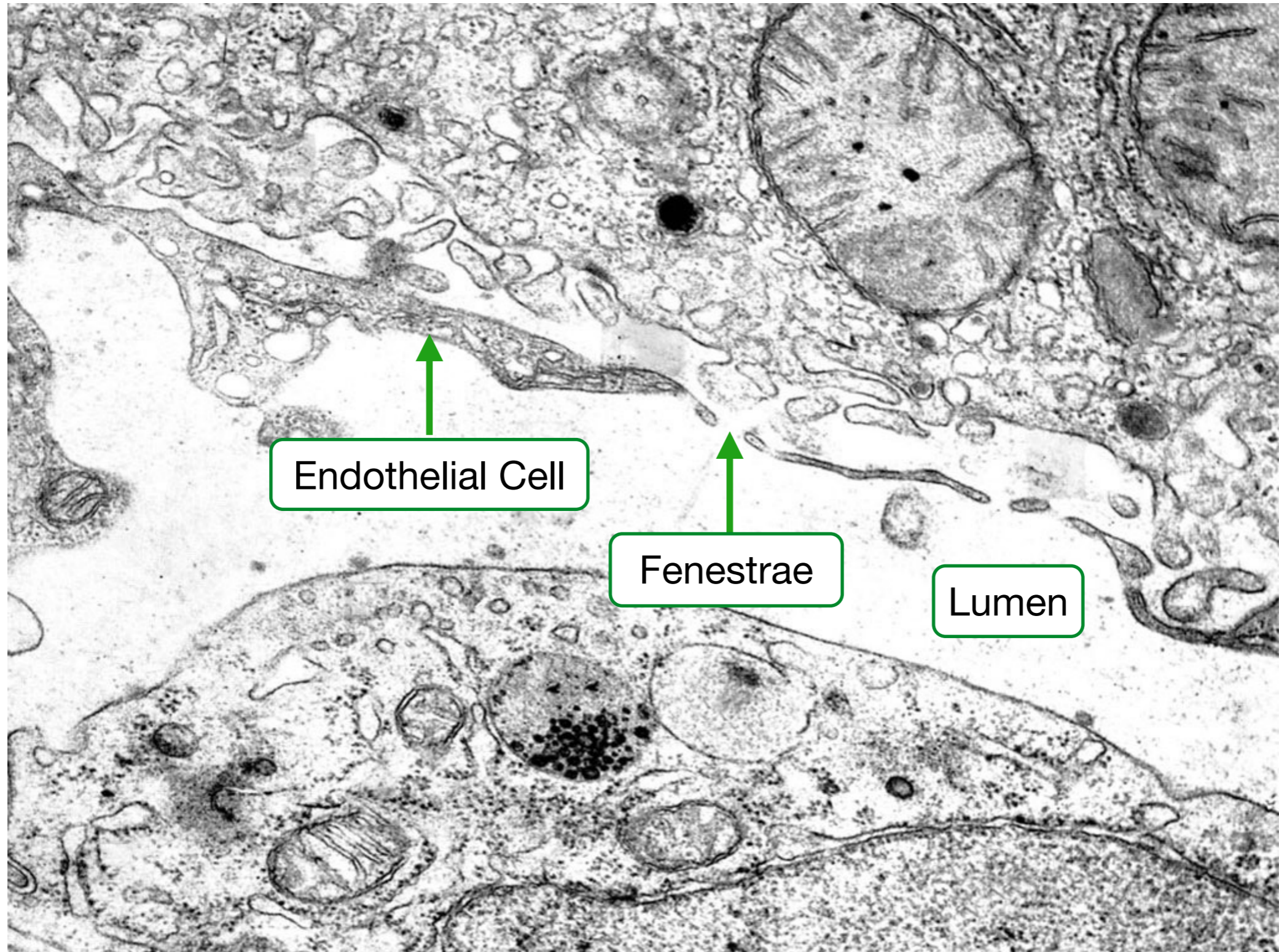
- Glycocalyx

Structure of Endothelial Cells

# Continuous capillaries contain endothelial cells that only allow passage through intercellular junctions.
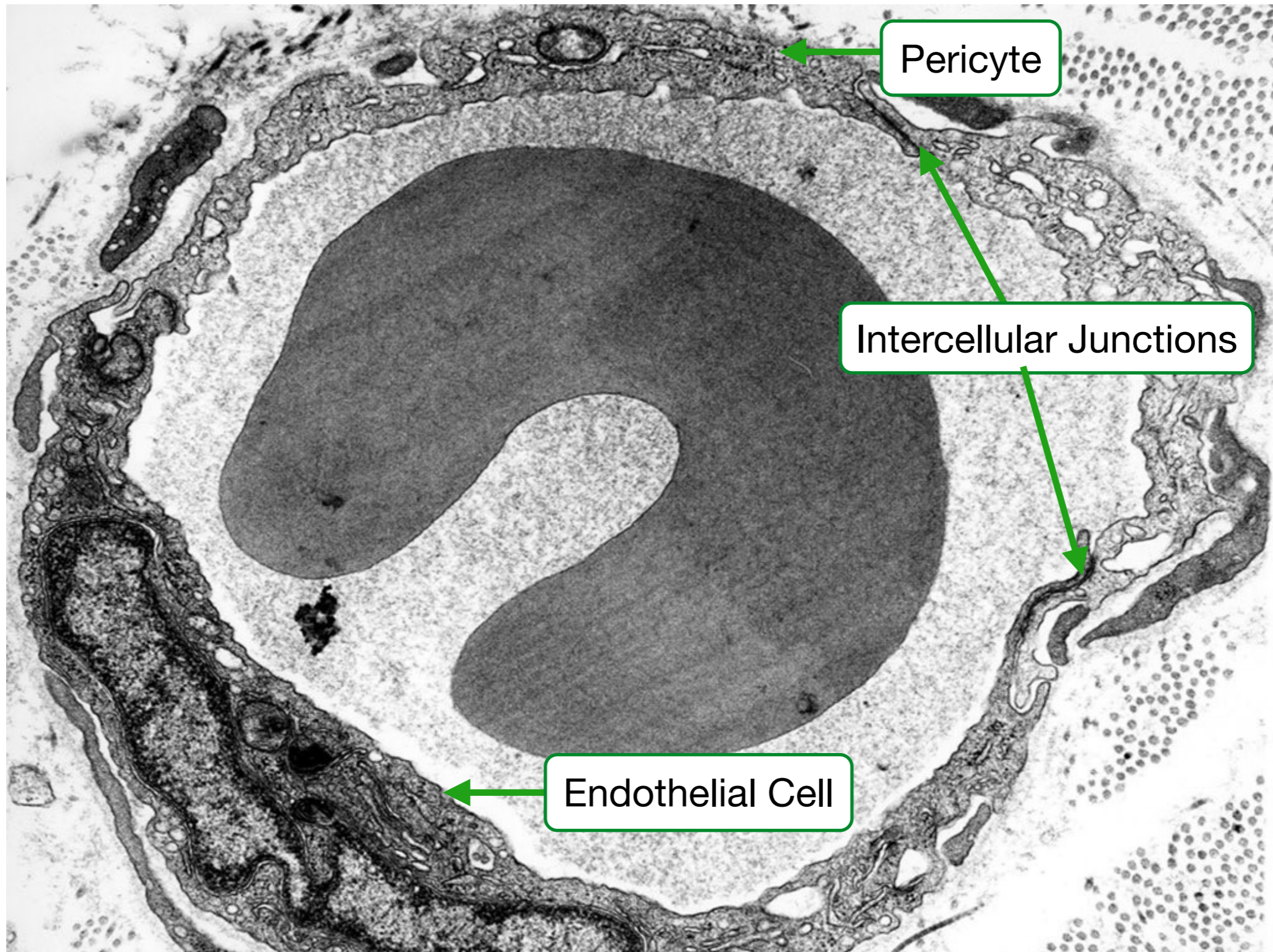
Fenestrated capillaries have endothelial cells with several gaps for diffusion of solutes.
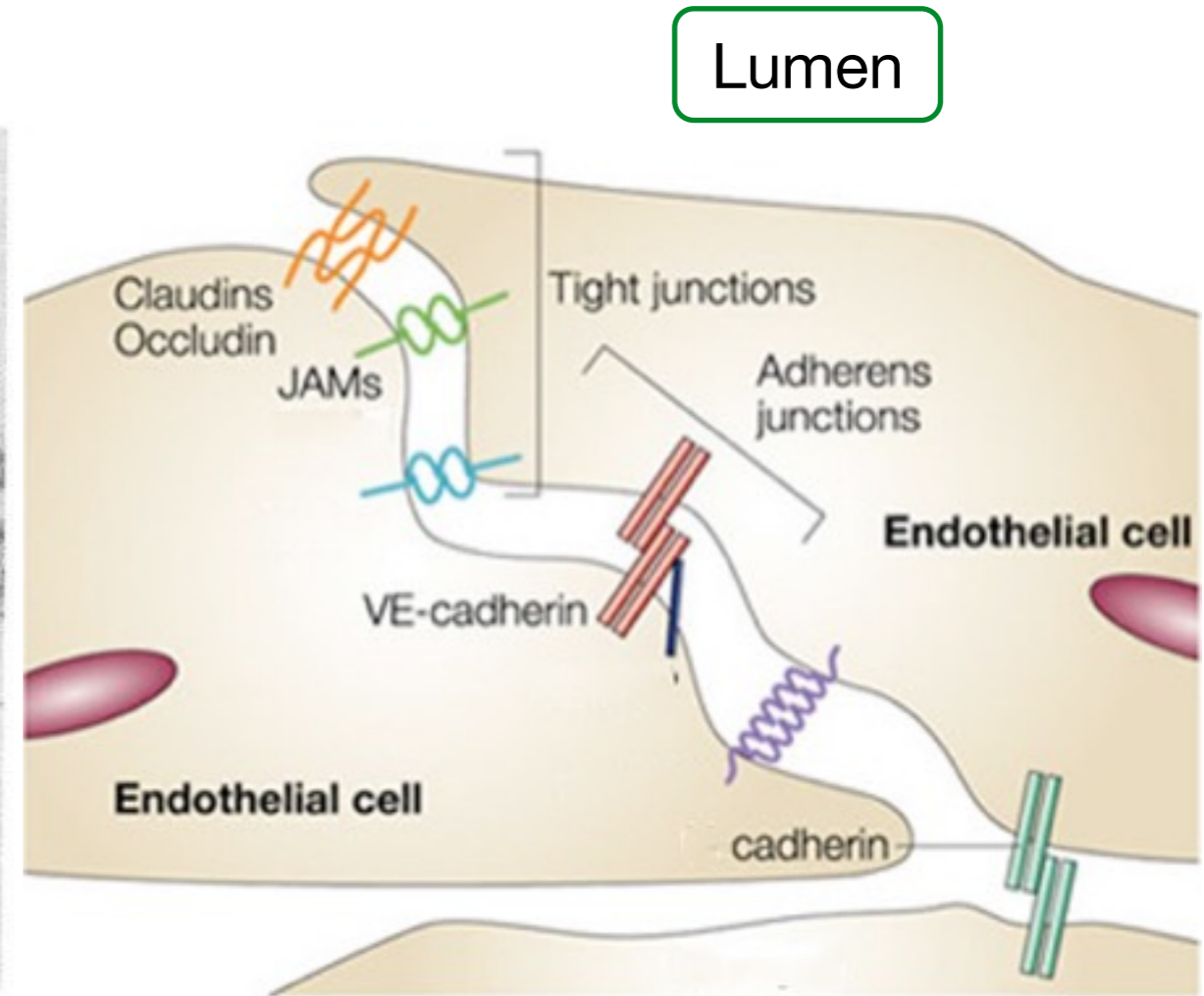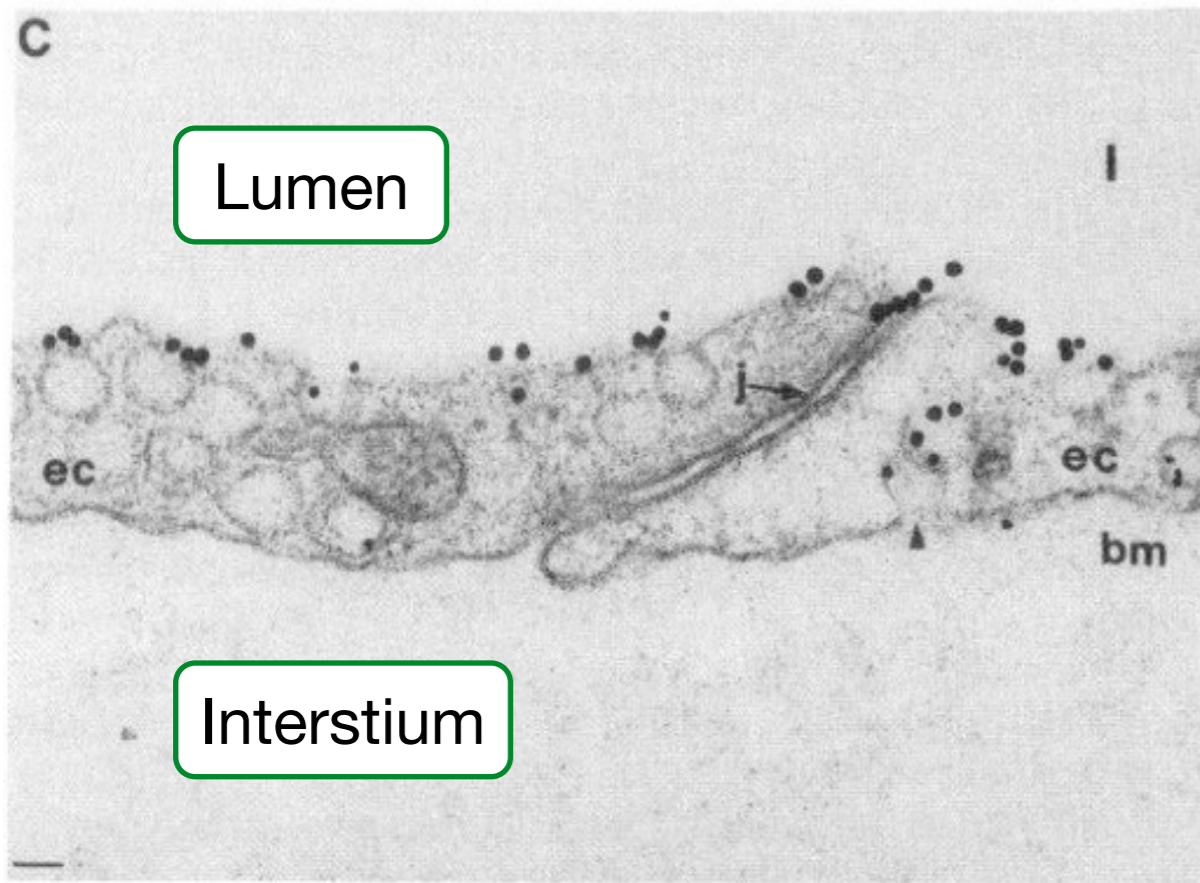
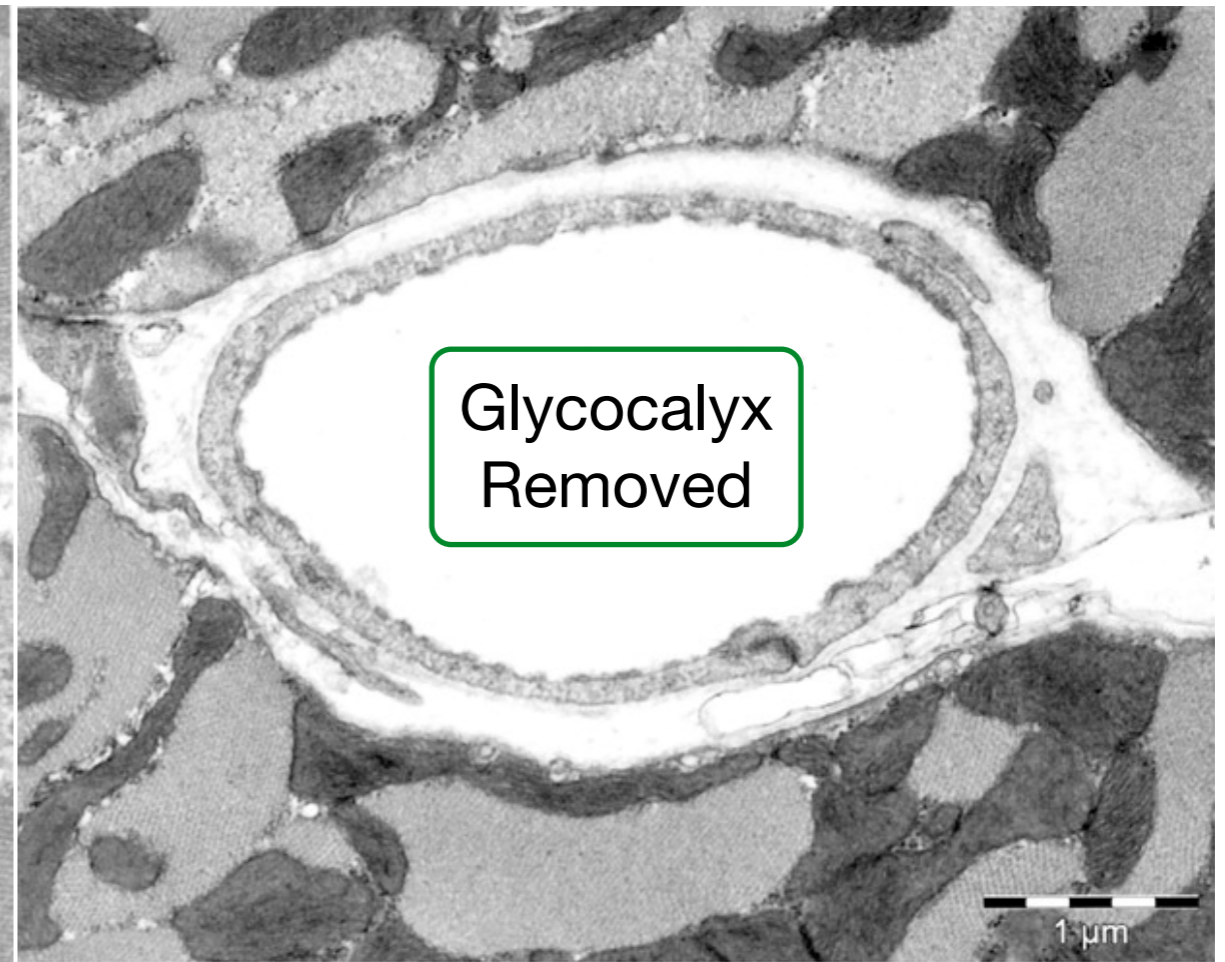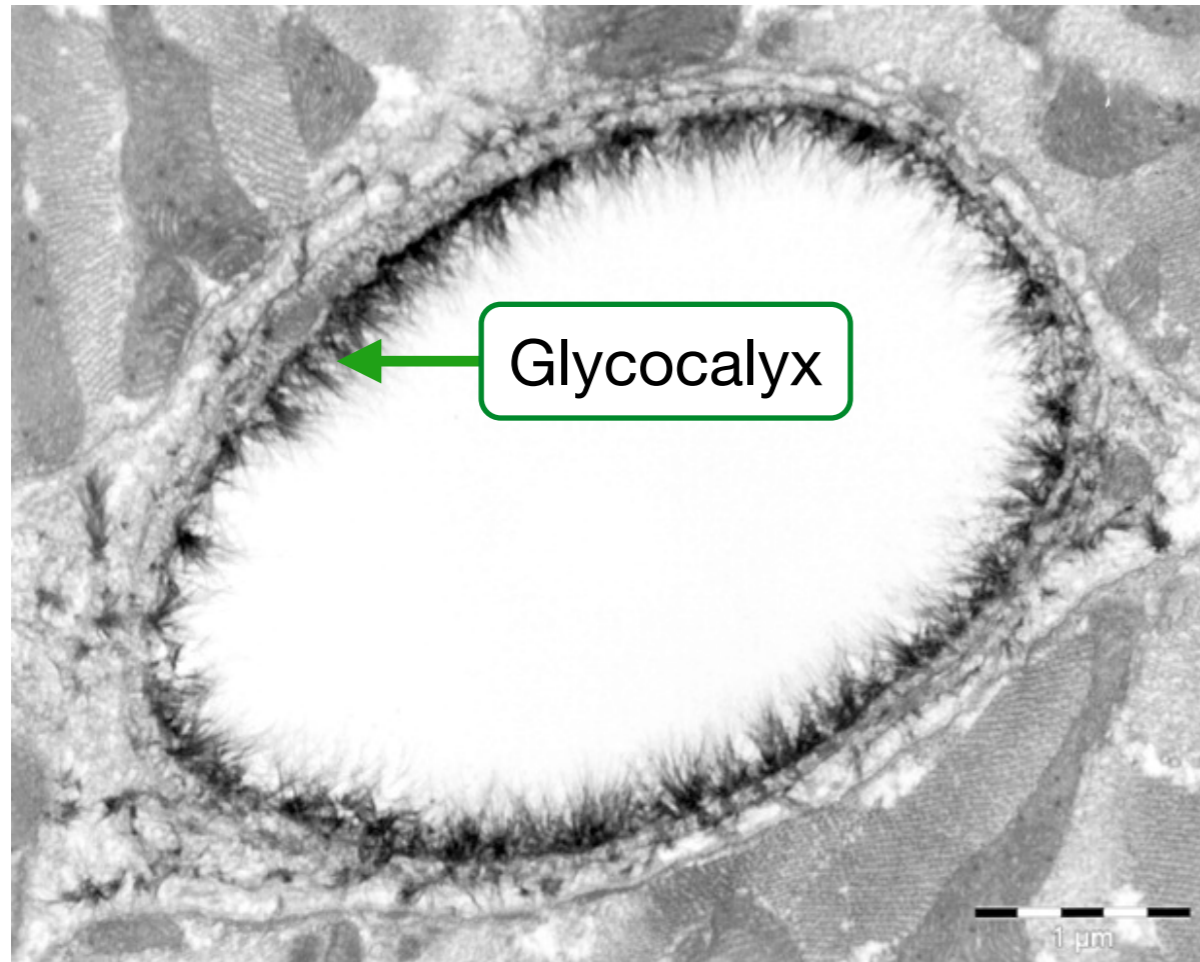# Discontinuous capillaries contain large pores and lack a basement membrane.

Basement membrane is a negatively-charged barrier on the basal surface of endothelial cells.
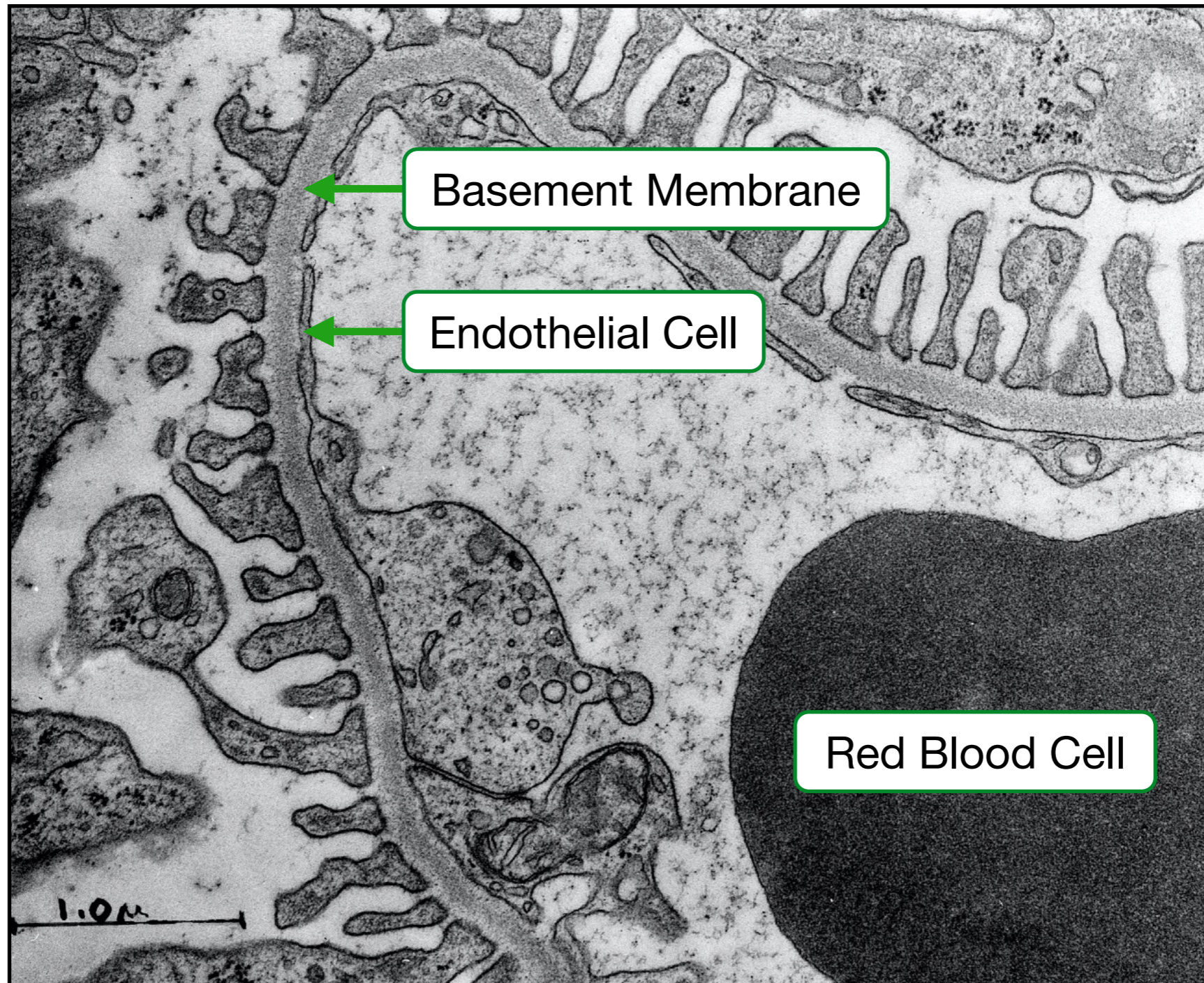
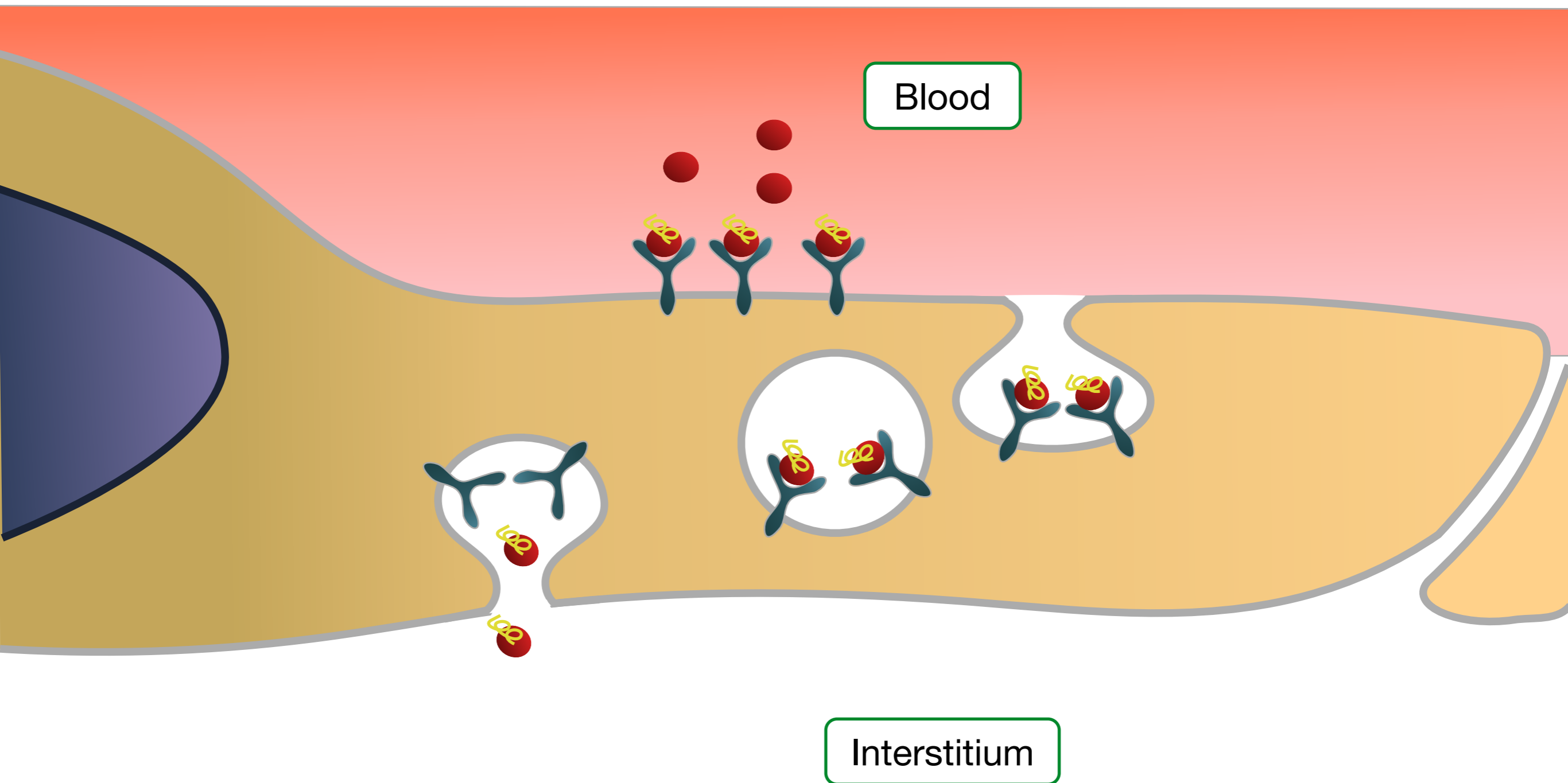# Junctional complexes restrict paracellular diffusion between endothelial cells.

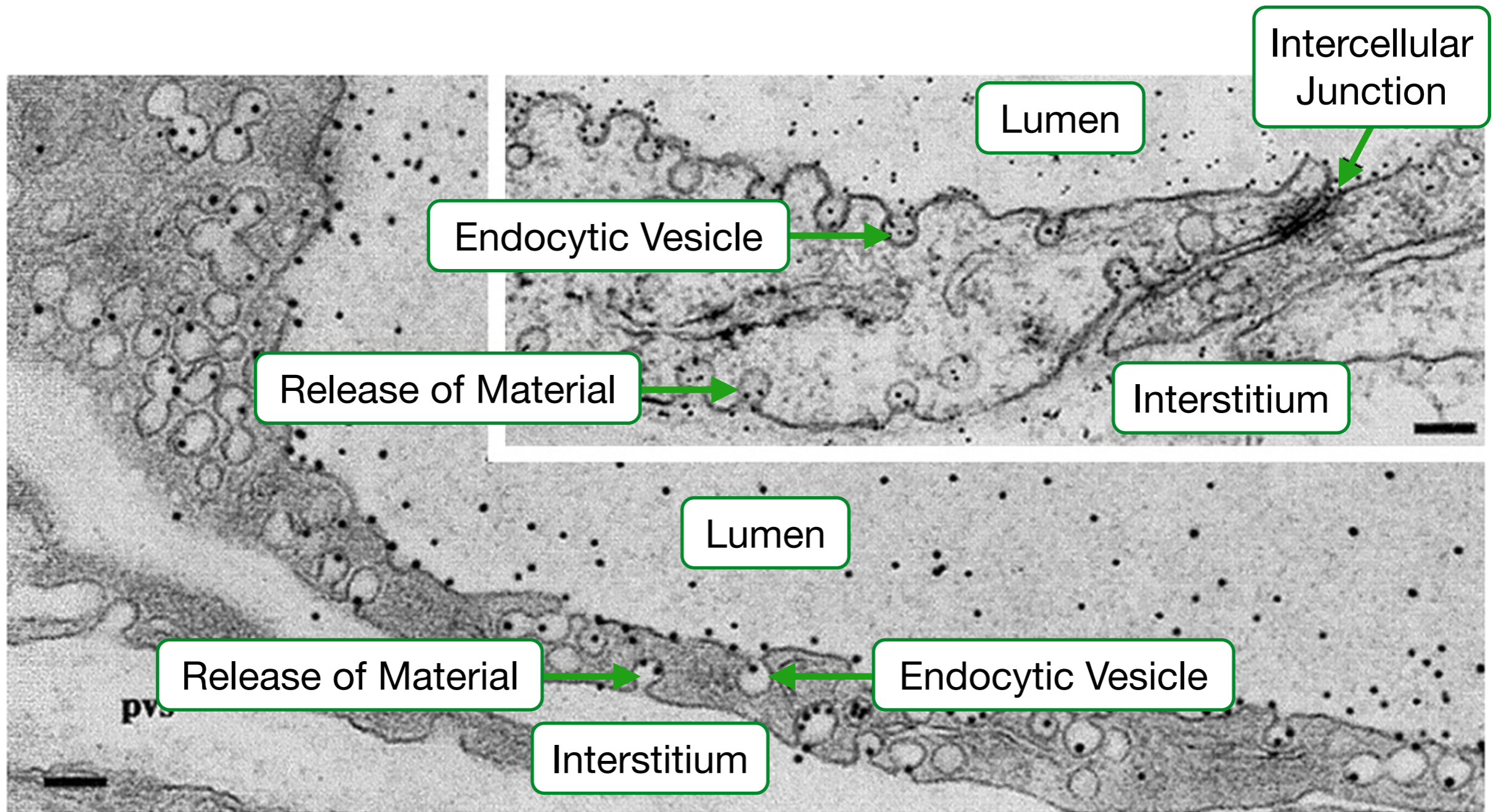# Glycocalyx restricts diffusion of large, negatively charged molecules.

Transcytosis of Proteins

Receptor-mediated endocytosis transports specific proteins across endothelium via transcytosis.
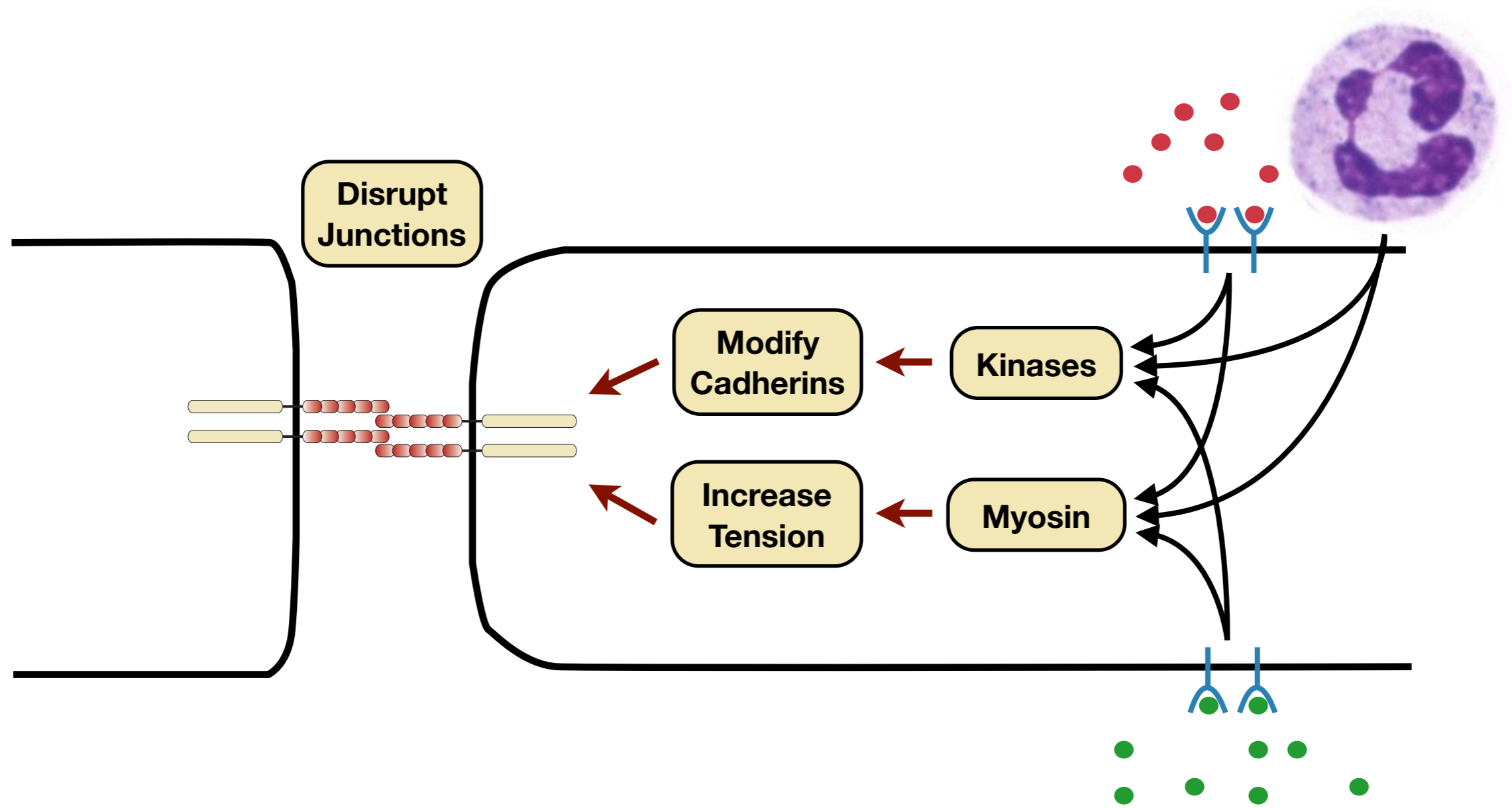

Blood

Interstitium

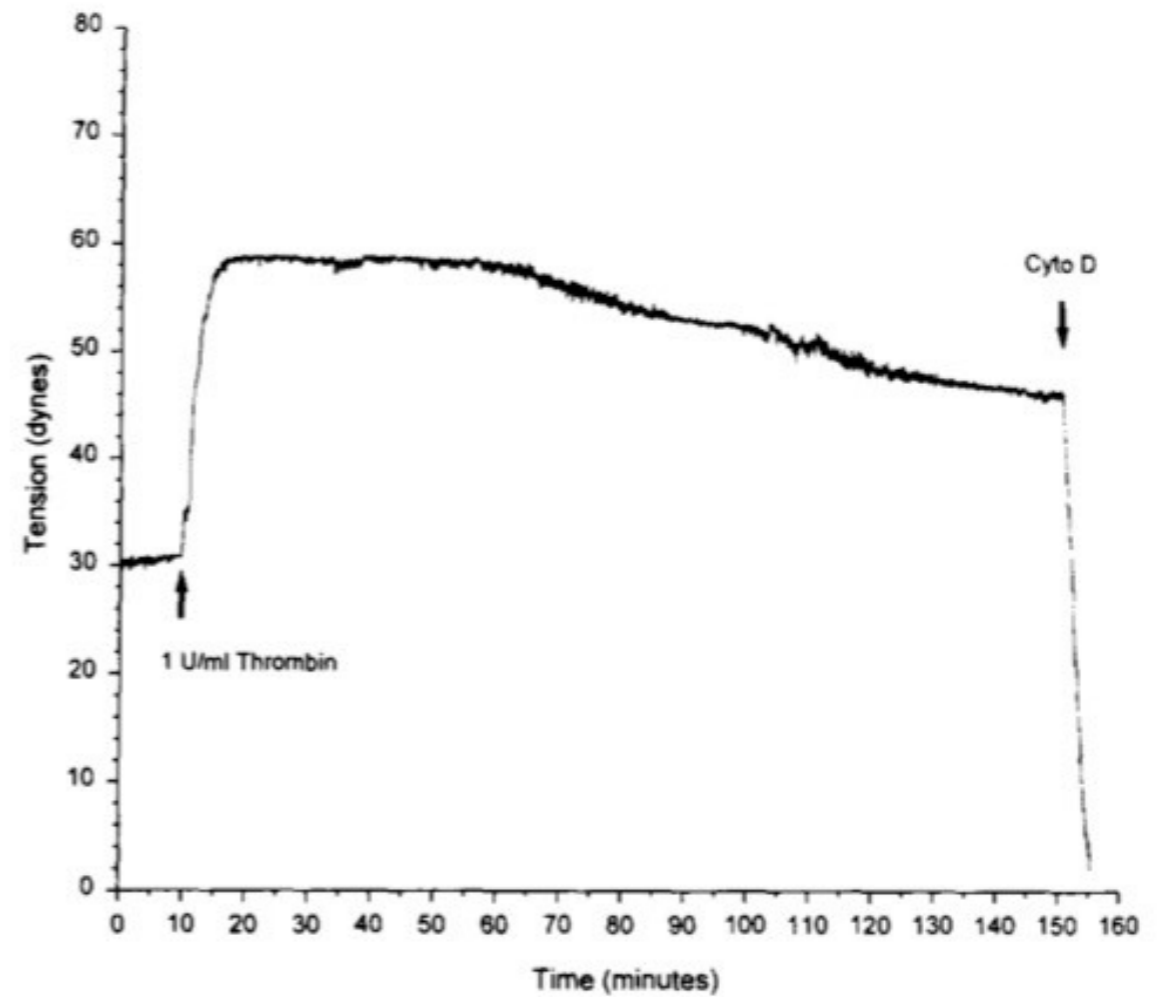# Transcytosis mediates movement of proteins across endothelial cells.
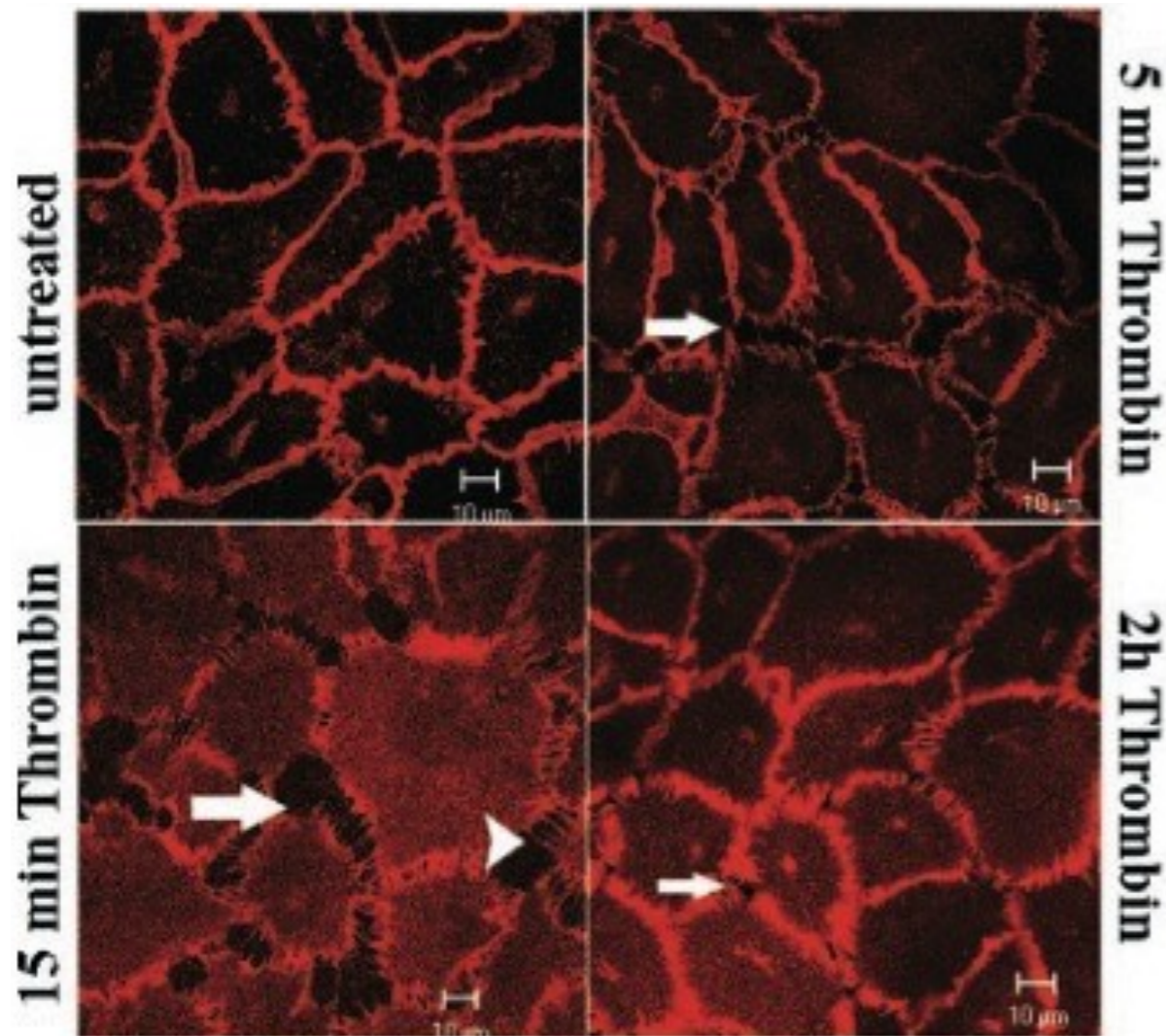
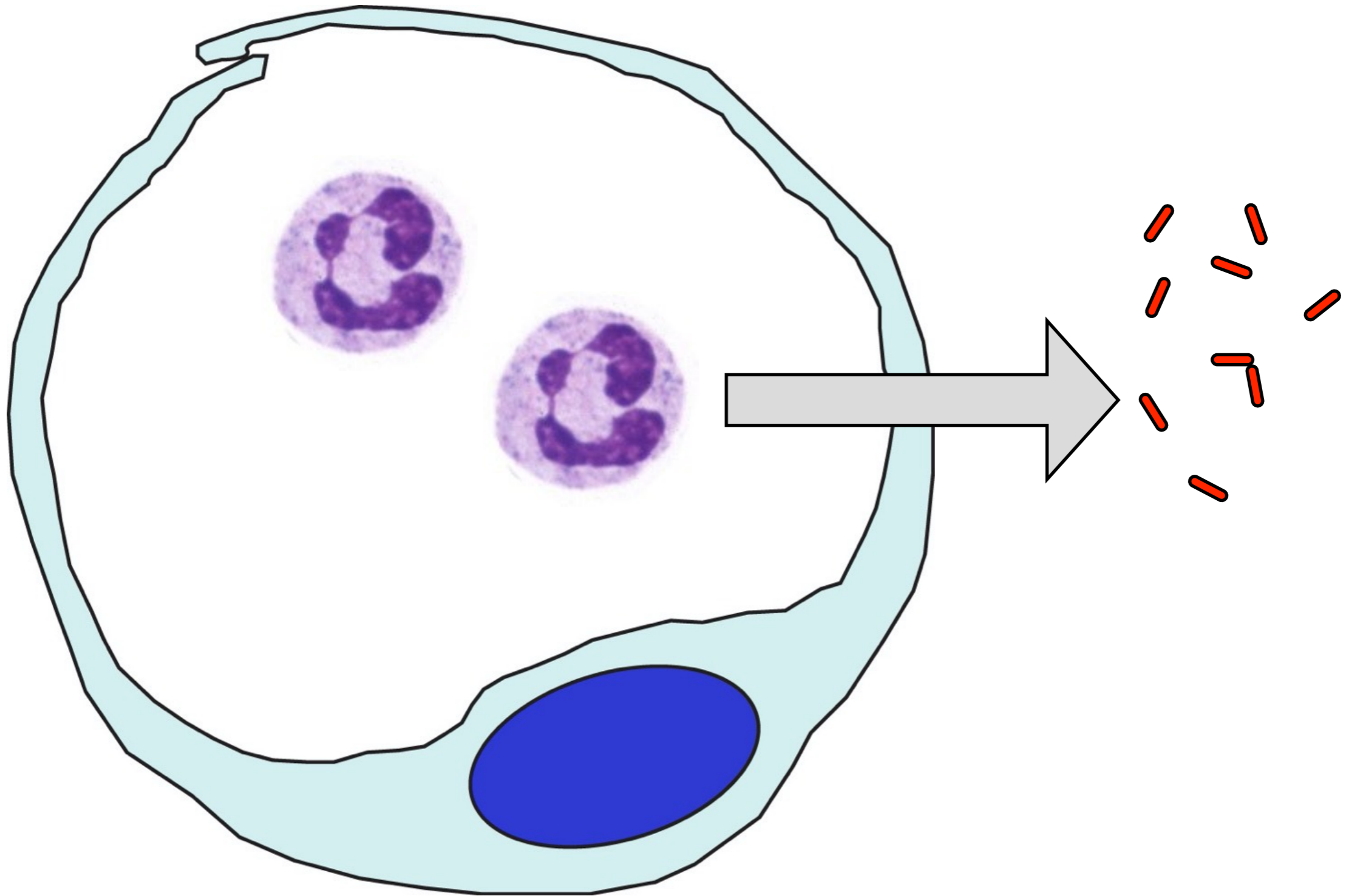# Increasing the Permeability of Blood Vessels

Inflammatory molecules and immune cells activate signaling pathways that disrupt junctions.

Thrombin increase vascular permeability through tension on adhesion junctions.
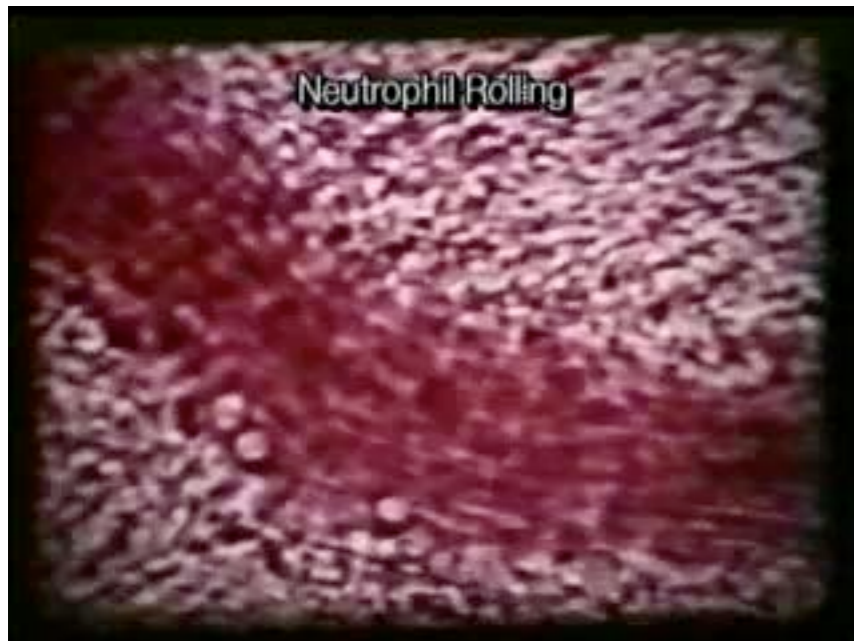
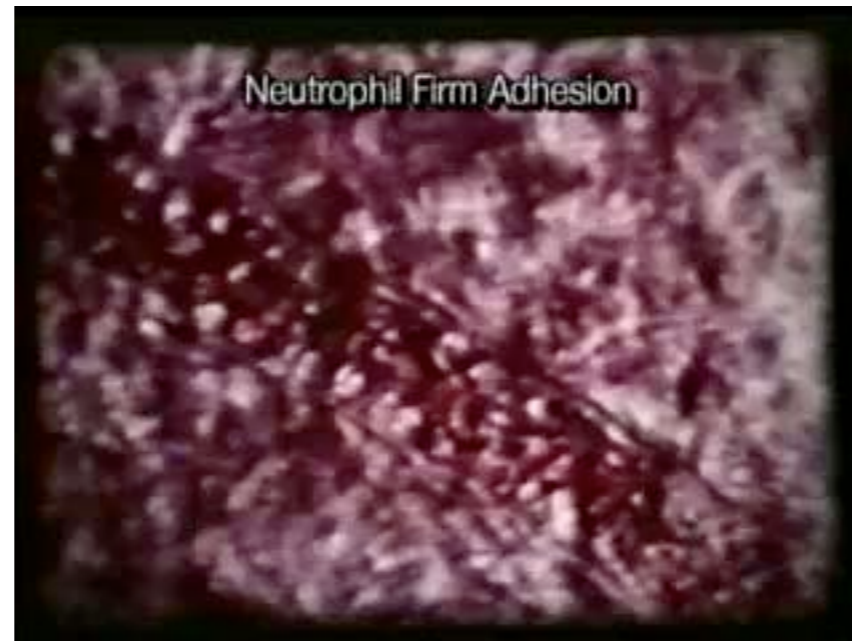# Immune cells must pass across endothelial cells to reach sites of infection.

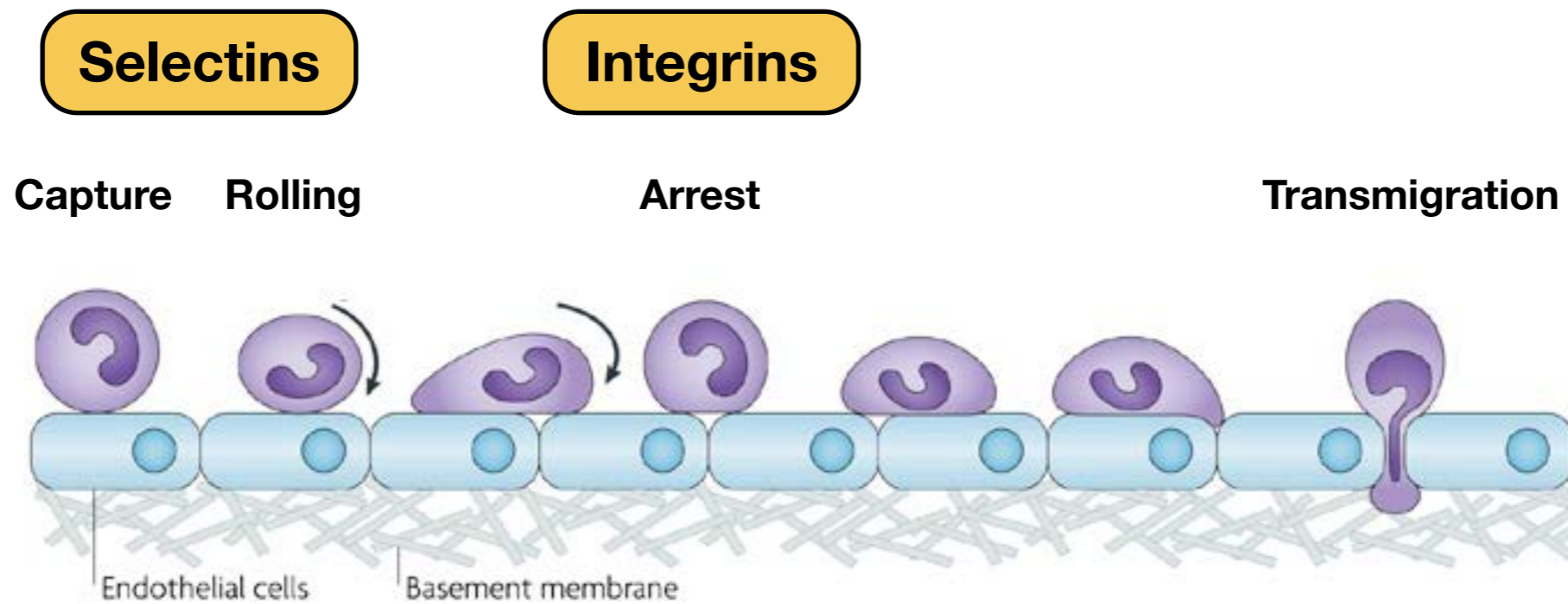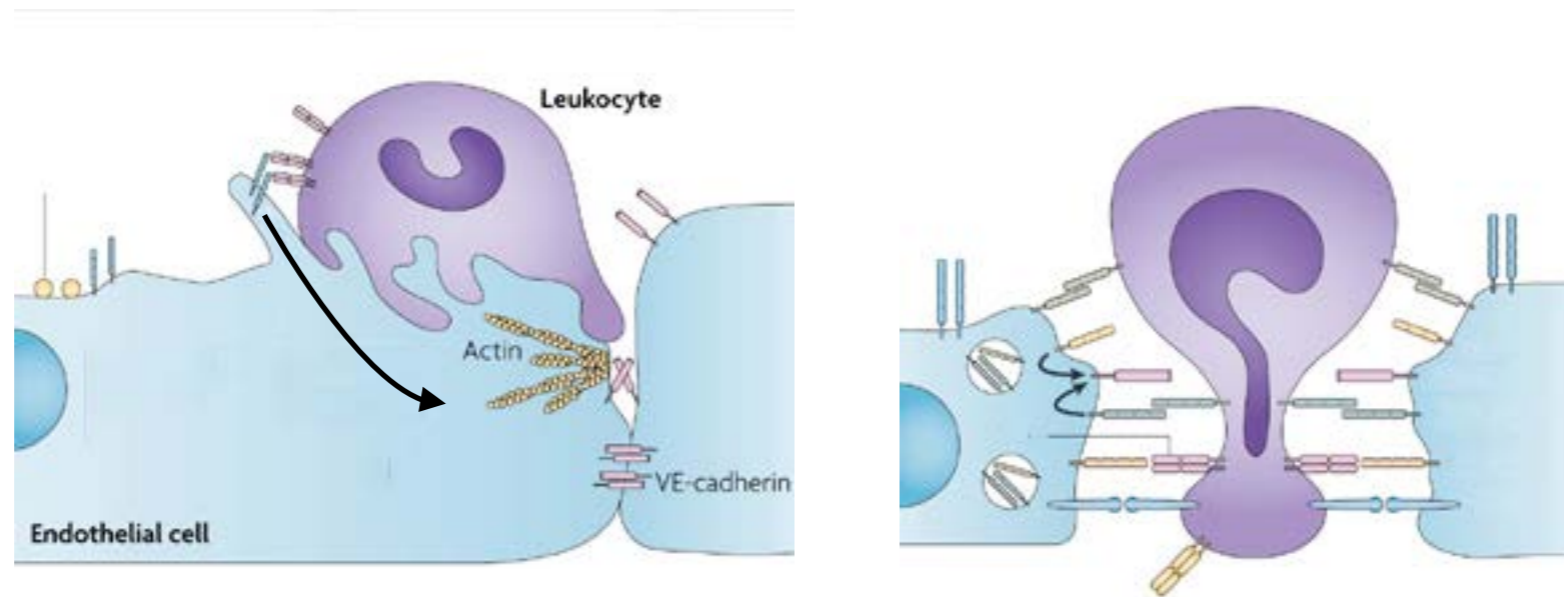# Leukocyte transmigration consist of three distinct steps.

Rolling **Adhesion** **Emigration**

Selectins and integrins mediate rolling and adhesion of immune cells.
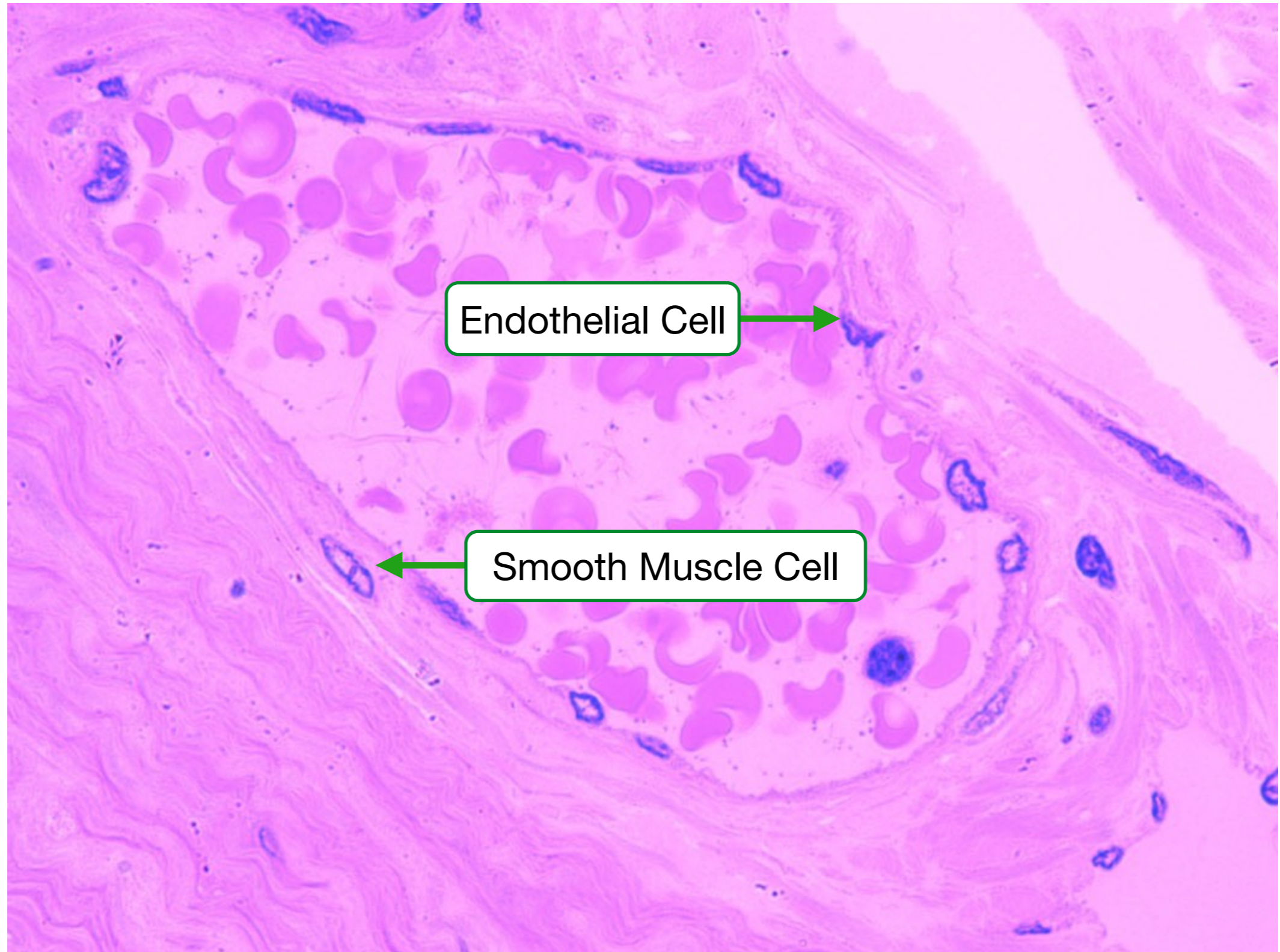
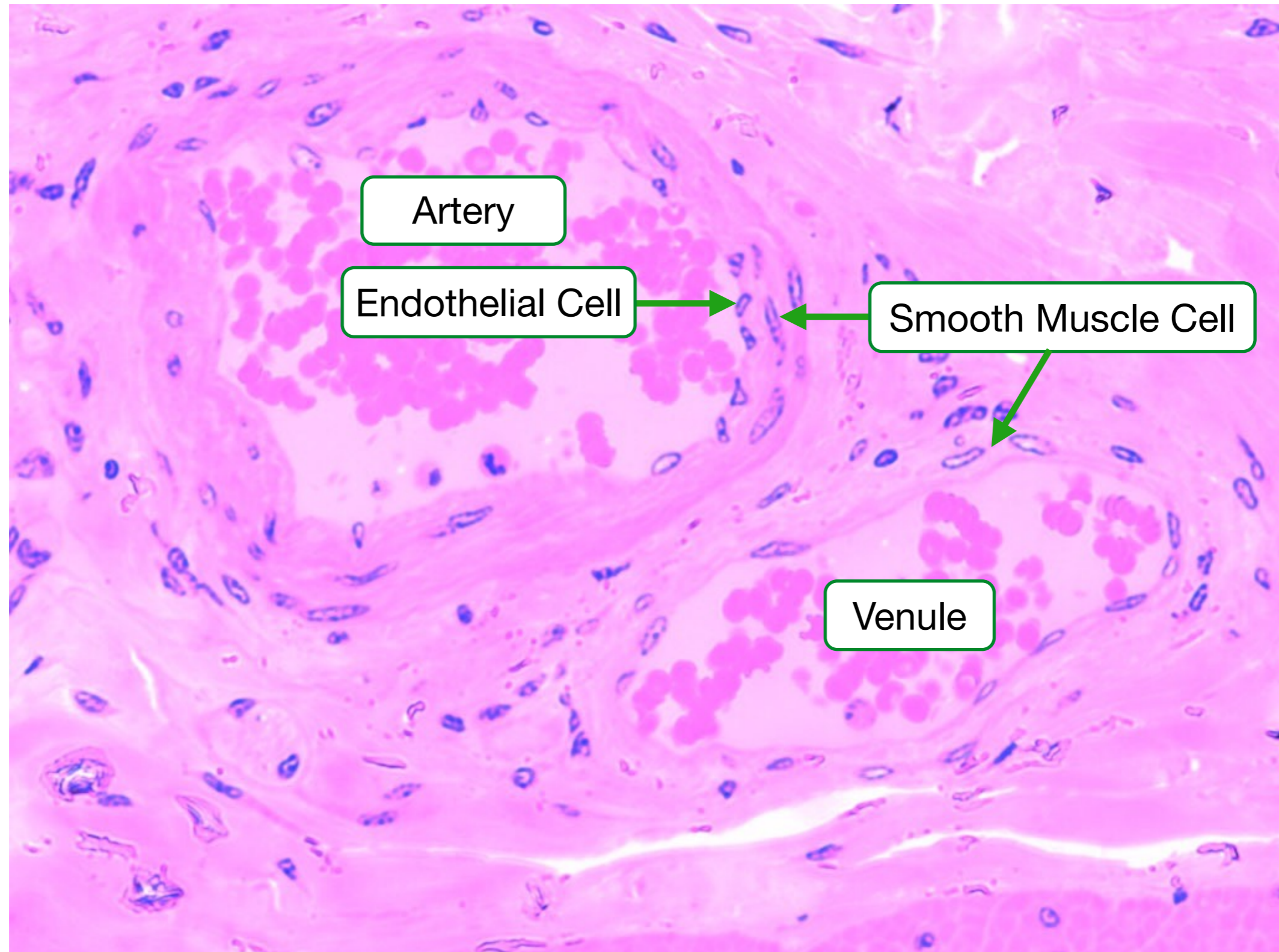# Leukocytes disrupt adhesion junctions to migrate across endothelium.
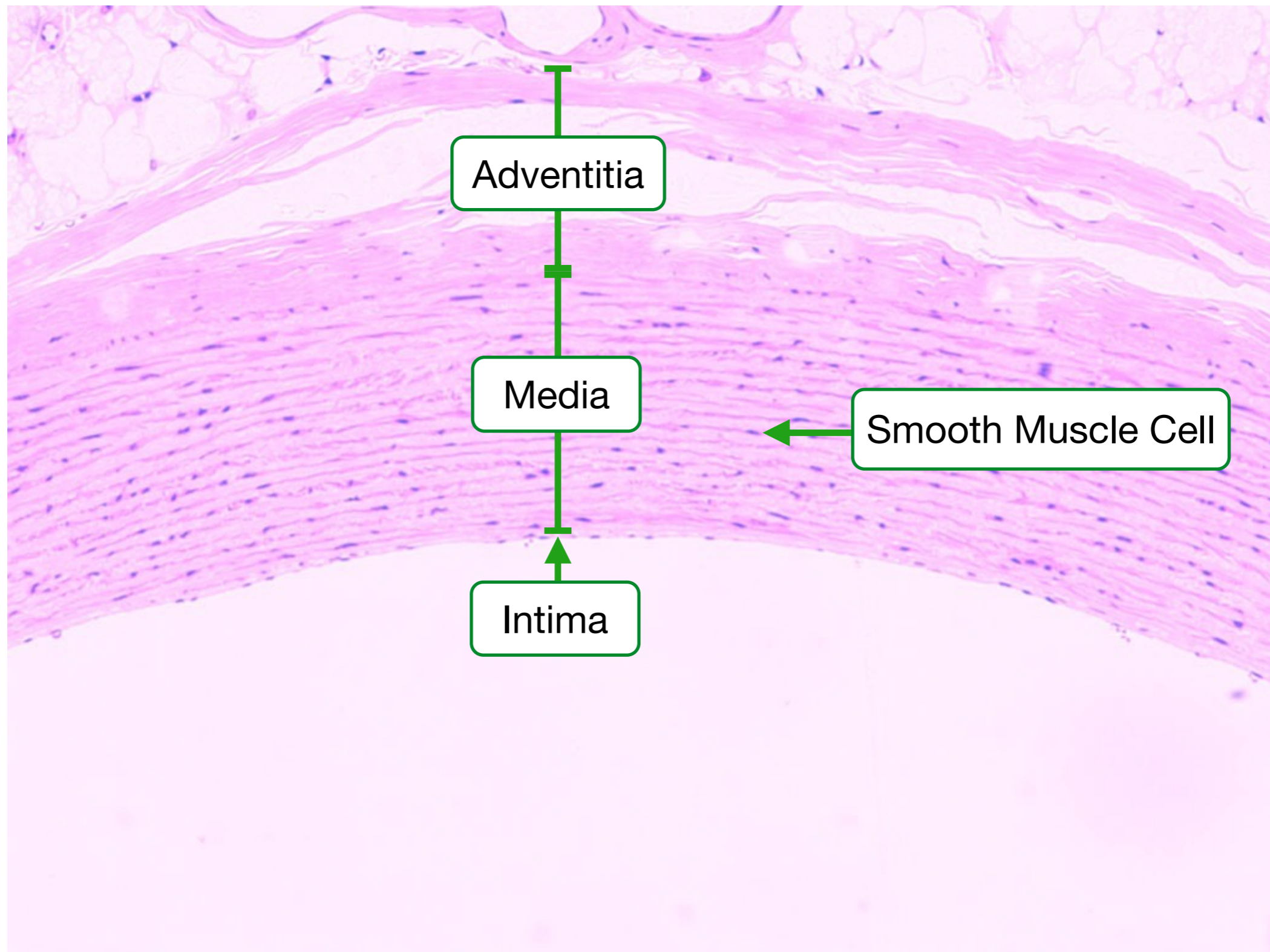
Venules and Veins

Venules have an endothelium and relatively thin layer of smooth muscle.

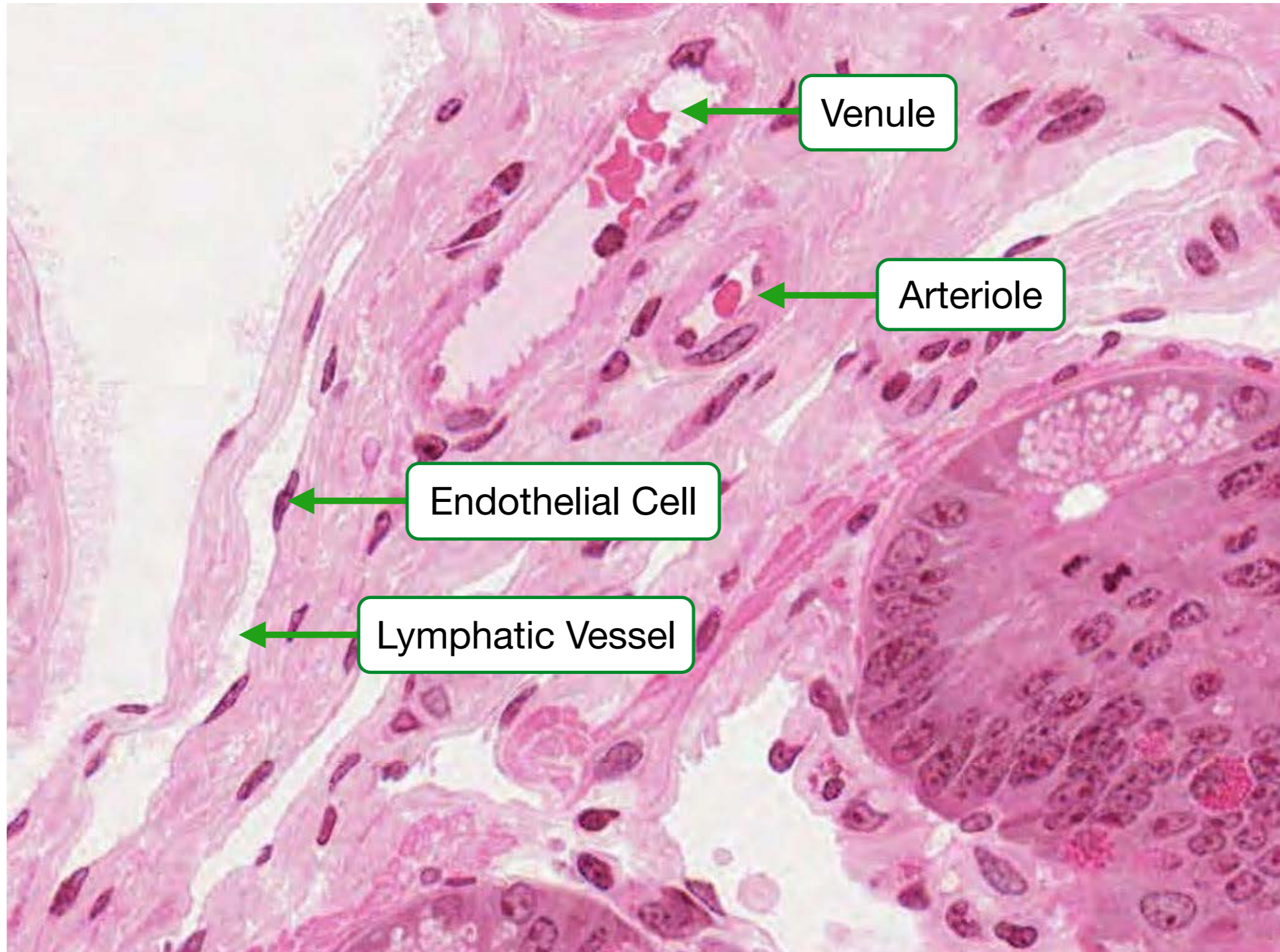Endothelial Cell

Smooth Muscle Cell

Venules have thinner medial layers than arteries and tend to lose their shape.

The vena cava has a thinner media than the aorta with mostly smooth muscle cells and collagen.
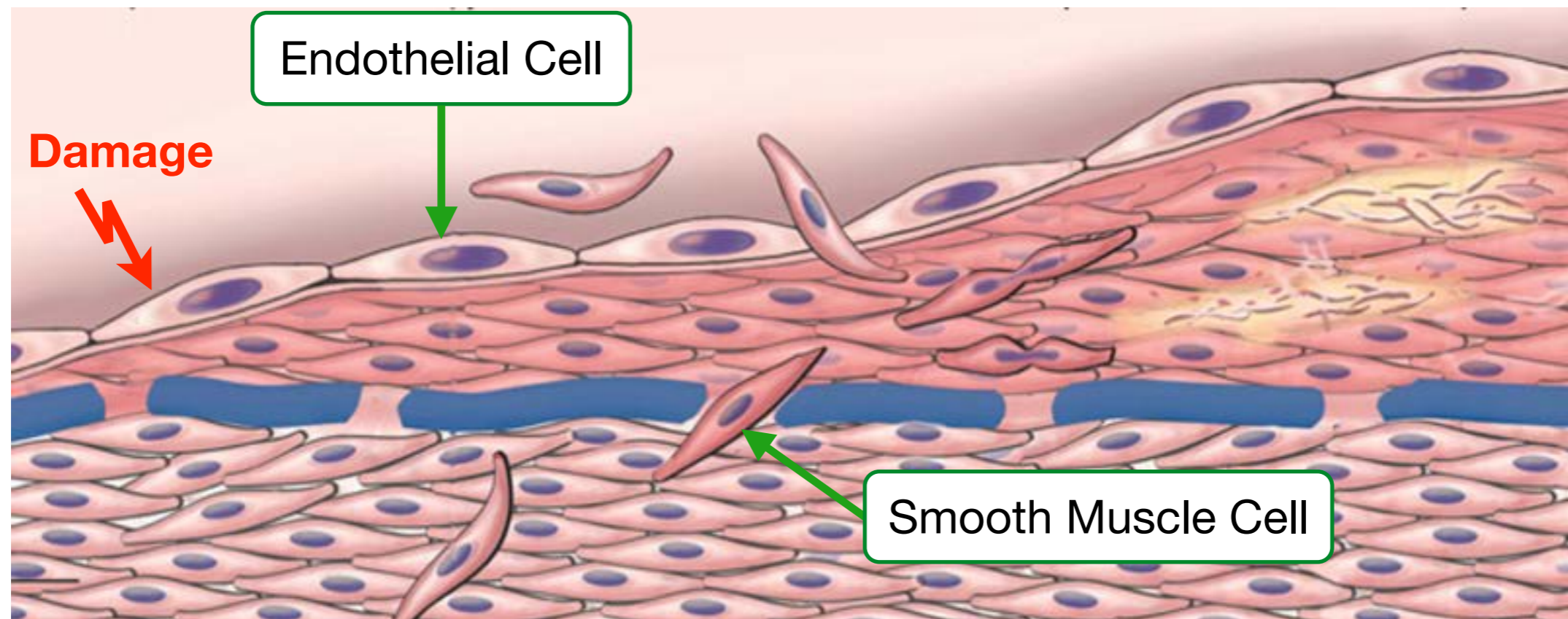
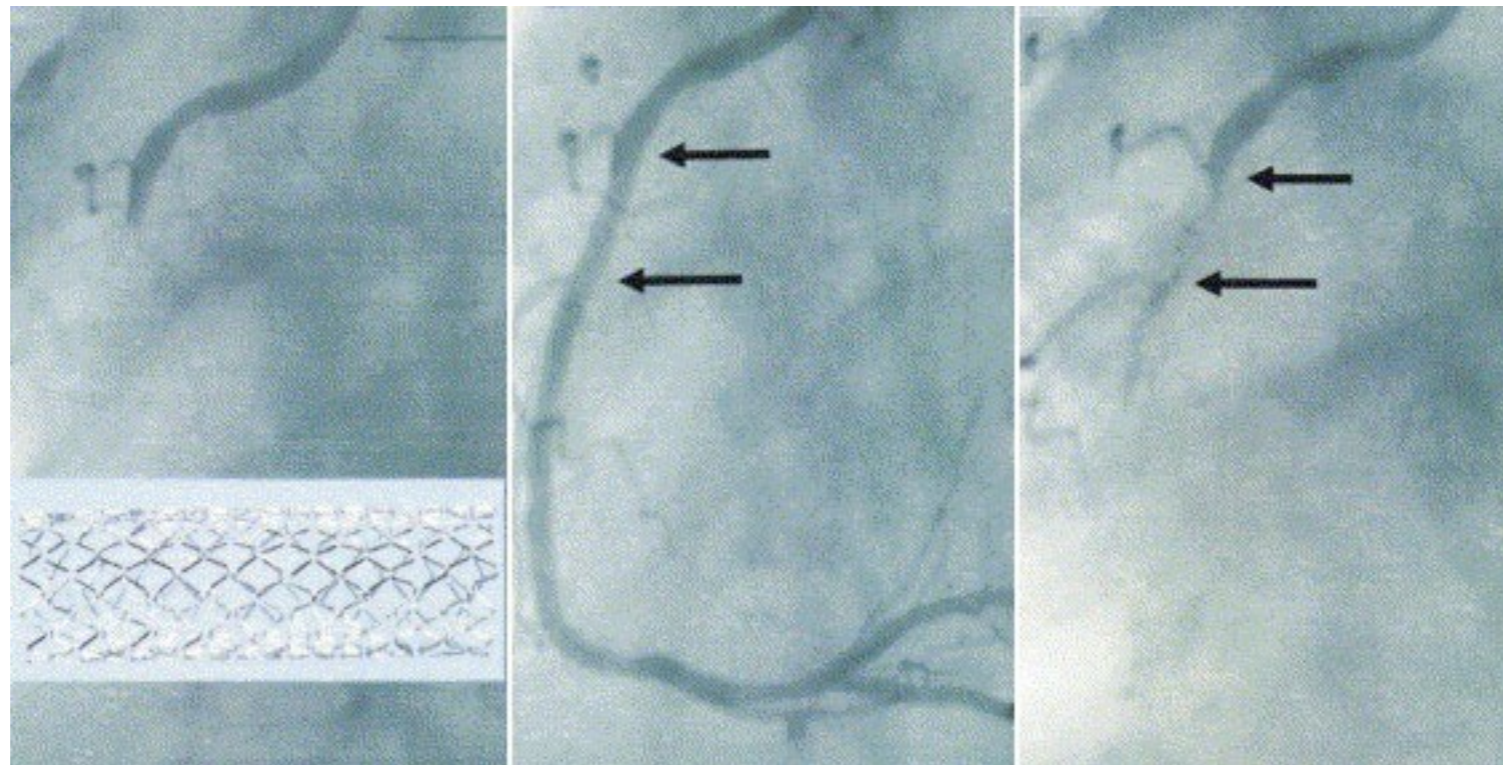# Lymphatic vessels have thin walls and lack red blood cells.

Vascular Repair

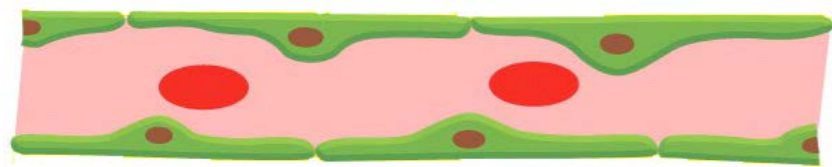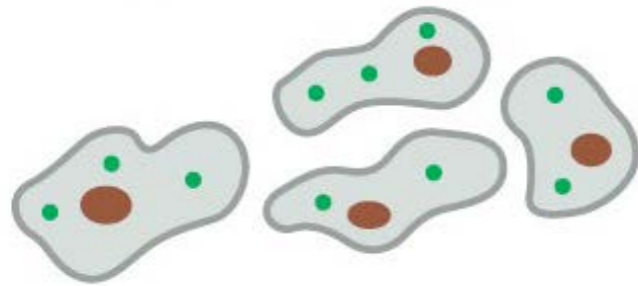# Damage recruits smooth muscle cell progenitors to the intima.

Smooth muscle proliferation can lead to occlusion of arteries after insertion of stents.
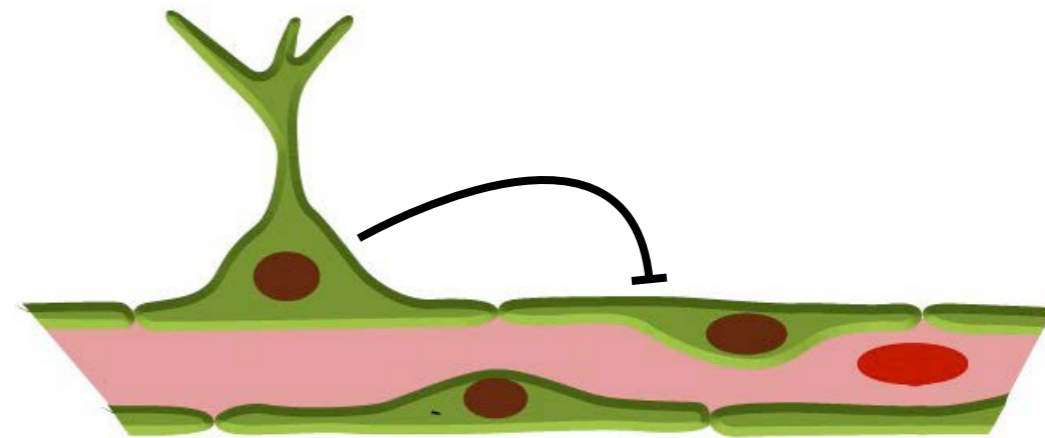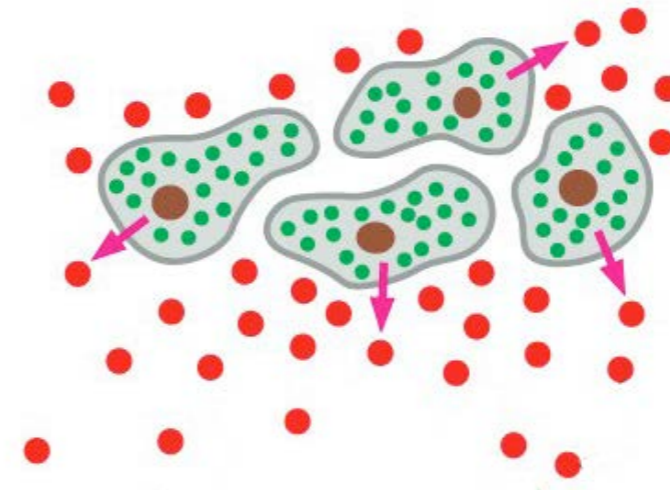
Angiogenesis

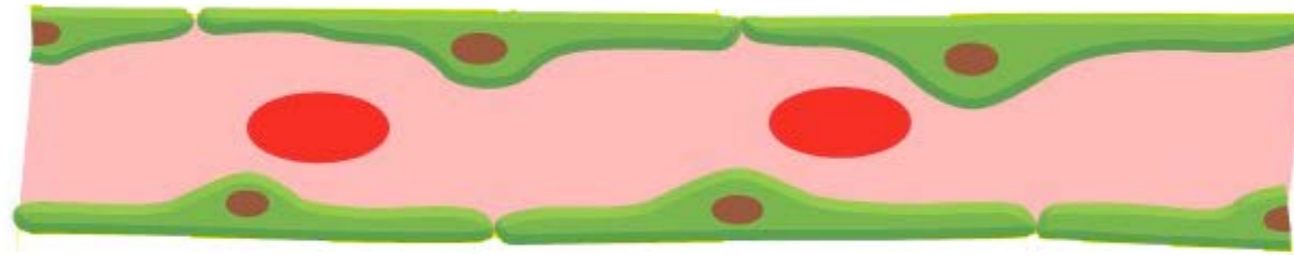# VEGF triggers morphological changes in endothelial tip cells.
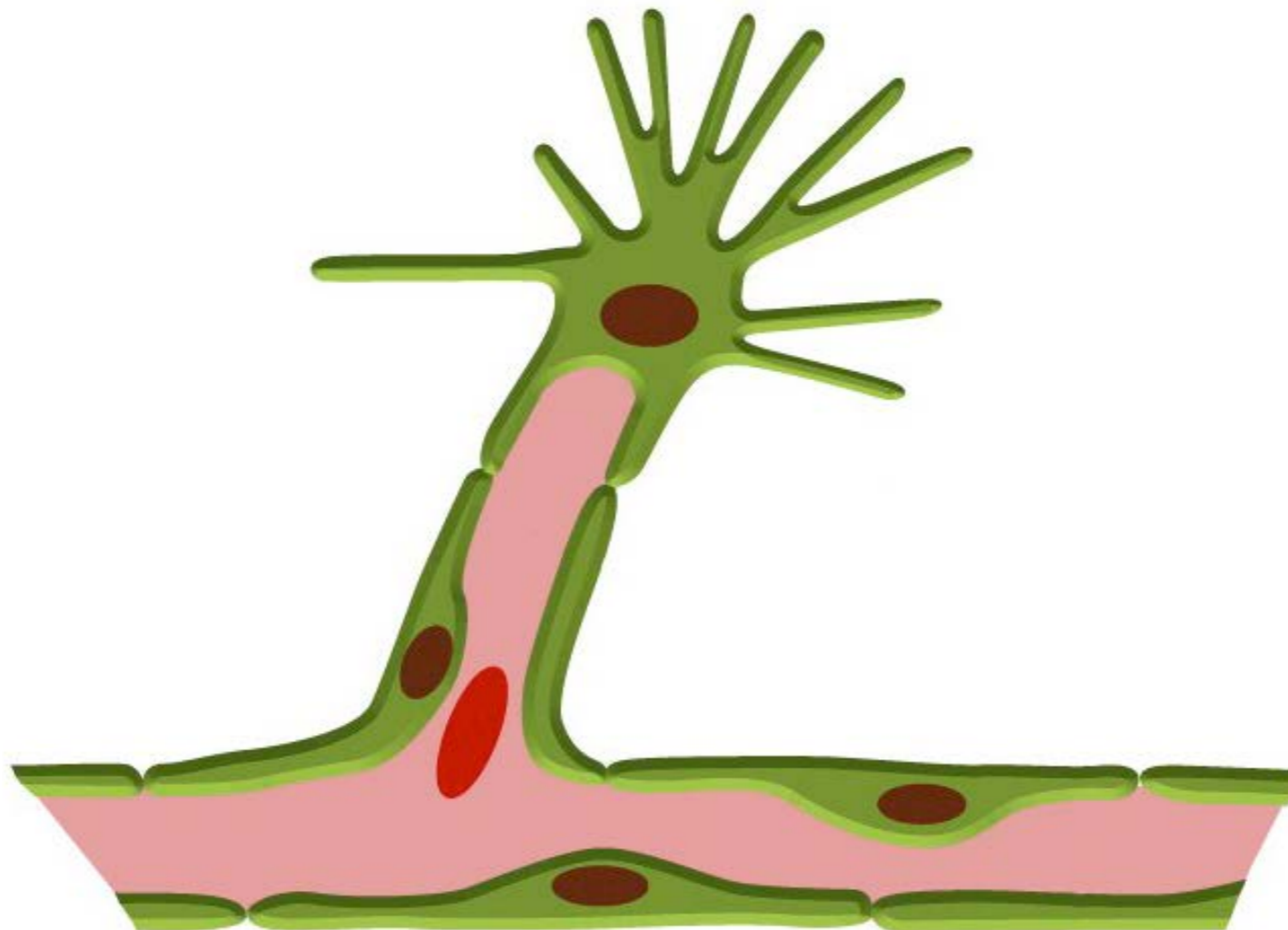

High O₂

Low O₂

Tip cells follow guidance cues to connect to existing vessels.

Semaphorins

Tumor cells initiate angiogenesis to increase their blood supply.