Human Histology session
1st stage
2020-2021
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Histology of cardiovascular system (Part 2)

Arteries

There are 3 main types of arteries:

* Elastic arteries
* Muscular arteries
* Arterioles

Elastic Arteries

These arteries that receive blood directly from the heart (the aorta and the pulmonary artery). These need to be elastic because they are relatively thin compared to their diameter. When the heart contracts, and ejects blood into these arteries, the walls need to stretch to accommodate the blood surge.

The arterial hydrostatic pressure that results from ventricular contraction is the 'systolic blood pressure' (systole is greek for contract).

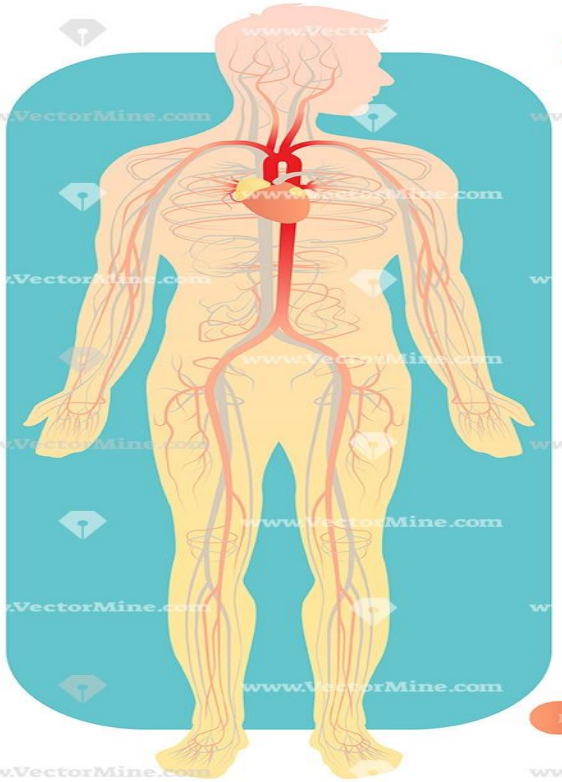
Between heart contractions, the elastic walls turn back, to maintain blood pressure, continuing to move blood even when ventricles are relaxed.

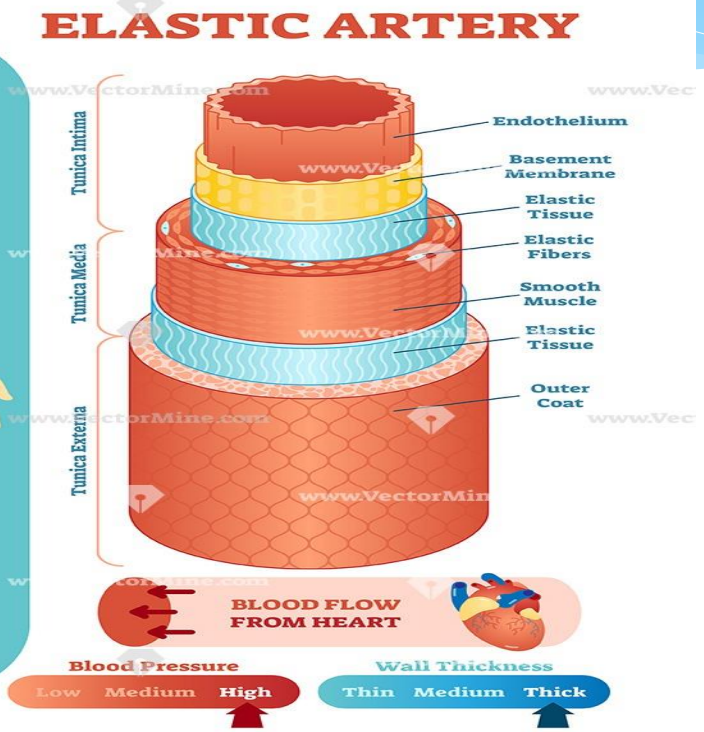
The arterial hydrostatic pressure between contractions is the 'diastolic blood pressure' (diastole is greek for dilatation).The walls of these arteries have lots of elastin and collagen.

Elastic arteries wall layers

* **Tunica adventitia** - has small 'vasa vasorum' (is a network of small blood vessels that supply the walls of large blood vessels, such as elastic arteries (e.g., the aorta) and large veins (e.g., the venae cavae) as the large arteries need their own blood supply.
* **Tunica media** is broad and elastic with concentric fenestrated sheets of elastin, and collagen and only relatively few smooth muscle fibers.
* **Tunica intima** is made up of an epithelium, which is a single layer of flattened endothelial cells, together with a supporting layer of elastin rich collagen. This layer also has fibroblasts and 'myointimal cells' that accumulate lipid with ageing, and the intima layer thickens, one of the first signs of atherosclerosis.

Elastic arteries wall layers





Muscular artery

* These arteries distribute blood to various parts of the body.
* These include arteries such as the femoral and coronary arteries.
* The walls of these arteries have lots of smooth muscle, which means that they are able to contract or relax (dilate) to change the amount of blood delivered, as needed.

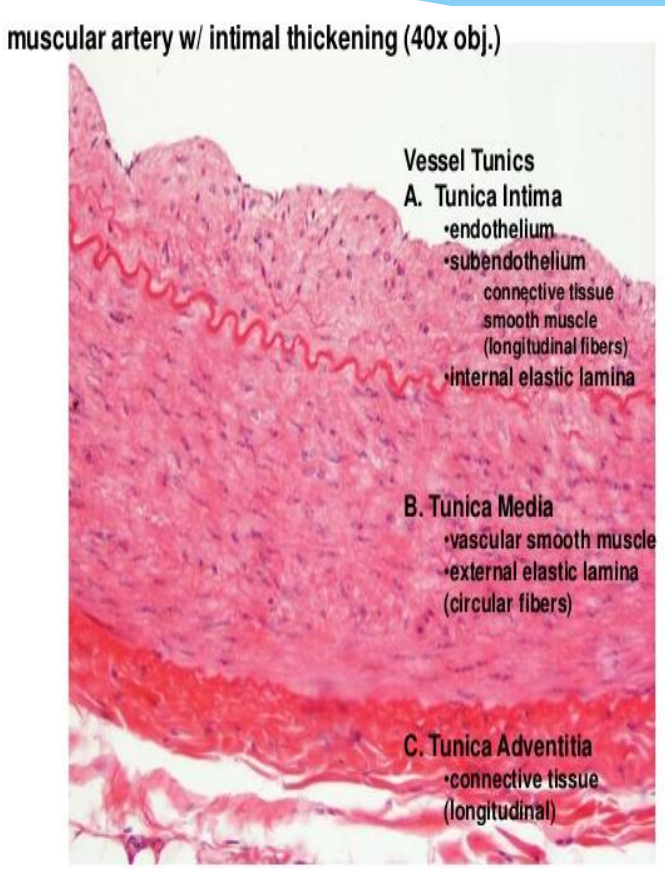
Muscular artery

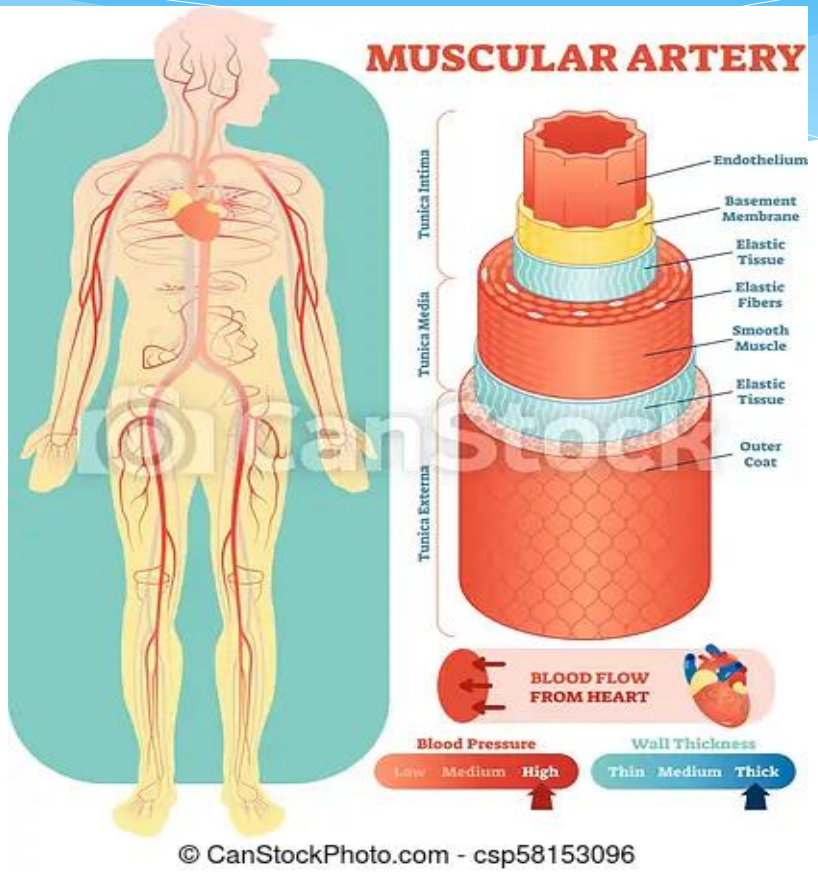
* Comparing these arteries to the elastic arteries, the sheet of elastin is now much reduced, and found at the border between the **tunica intima** and **tunica media** in a layer called the **internal elastic layer** (IEL) which can be seen very clearly. Less well defined is the **external elastic layer** (EEL), between the **tunica media** and tunica **adventitia.** There is a well defined circular layer of smooth muscle in the tunica media.

Muscular arteries wall layers

* The **tunica intima** has an endothelium of flattened endothelial cells**.**
* The **tunica media** is primarily a layer of smooth muscle, with some elastin and collagen. muscle layer, and is sandwiched between the IEL and EEL.
* The **Tunica Adventitia** is very broad, and mostly contains collagen and elastin**.**

Muscular arteries wall layers





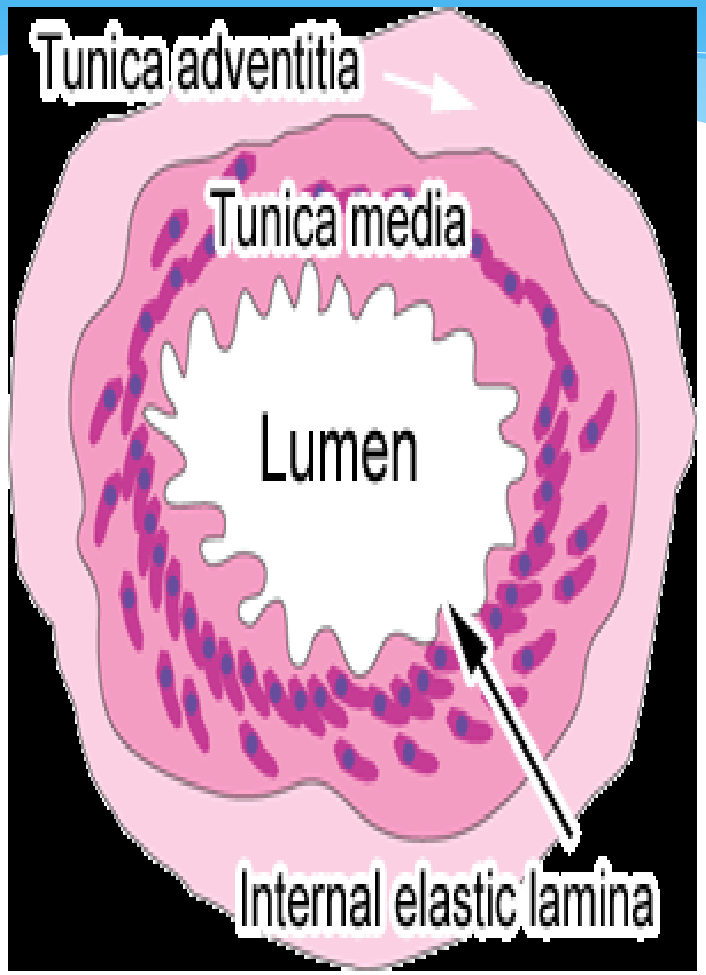
Arterioles

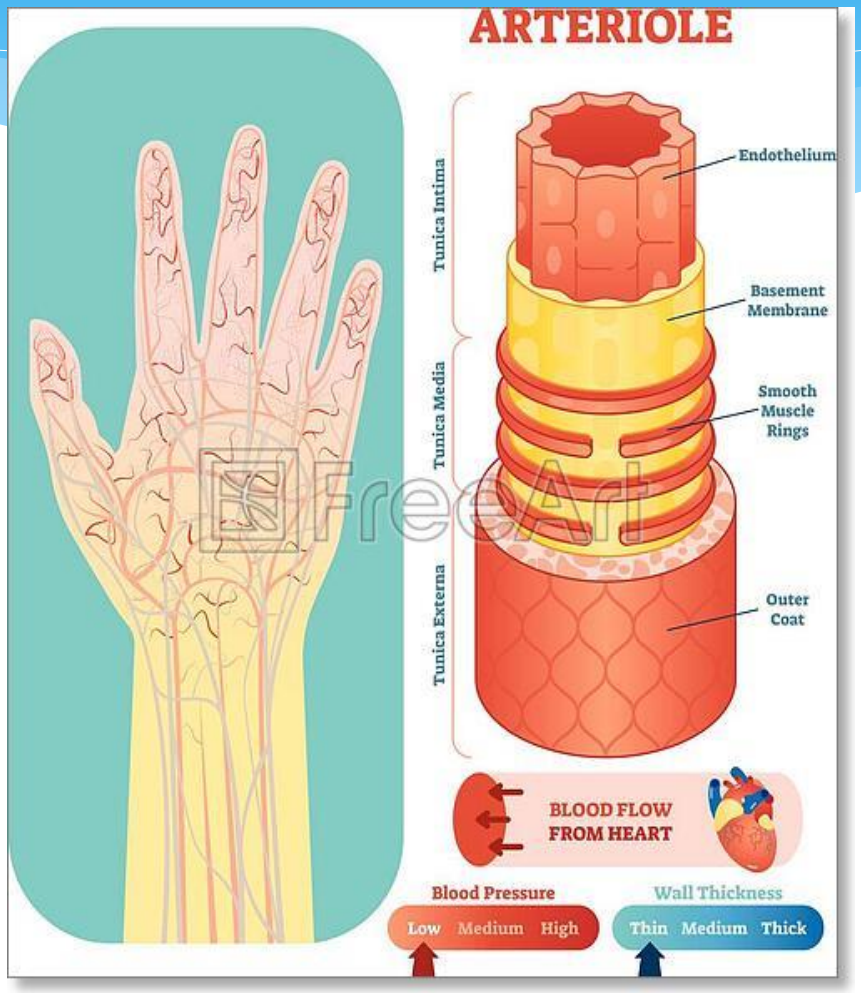
Larger arterioles have a lumen less than 100 to 300 μm in diameter. Arterioles are small arteries that deliver blood to capillaries. Arterioles control blood flow through capillary beds by contracting or dilating the the size of the lumen, and therefore the **tunica media** layer contains concentric rings of smooth muscle to do this. This compartment is important in determining your blood pressure as the narrow diameter of these blood vessels resists blood flow

Arterioles wall layers

* **Tunica intima** is very thin, and mostly consists of a single layer of squamous epithelium.
* **Tunica media** consists almost entirely of a single layer up to six layers of smooth muscle cells, and there is no EEL.
* **Tunica adventitia** is about the same size as the **tunica media** layer, merges in with surrounding tissue.

Arterioles wall layers





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Arteries and Arterioles

Artery

- thick strong wall
- endothelial lining
- middle layer of smooth muscle and elastic tissue
- outer layer of connective tissue
- carries blood under relatively high pressure

Arterioles

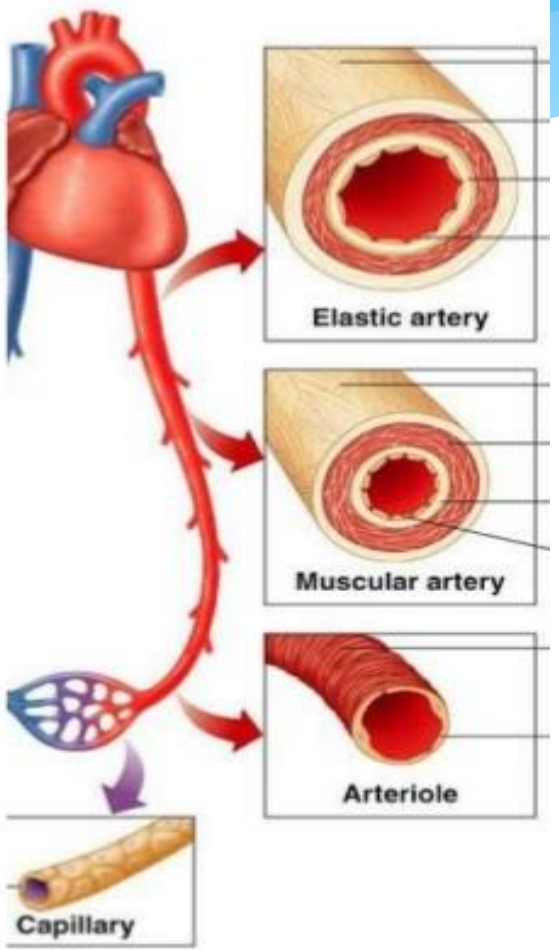
- thinner wall than artery
- endothelial lining
- some smooth muscle tissue
- small amount of connective tissue
- helps control blood flow into a capillary

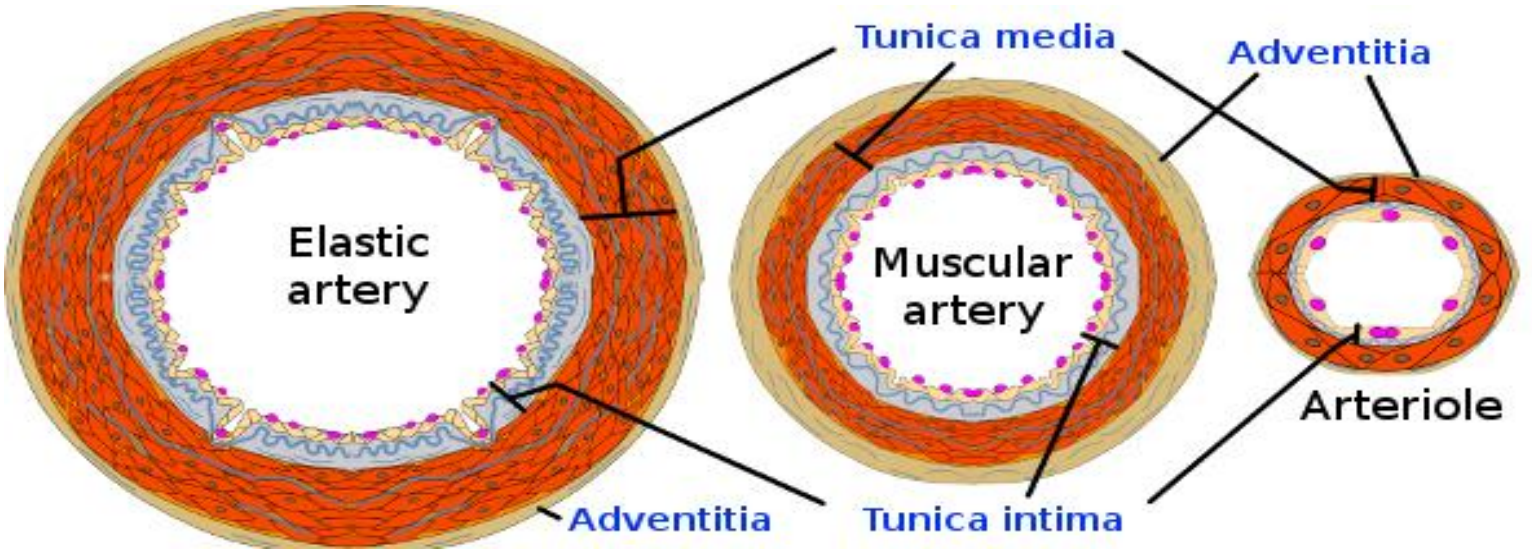
Elastic VS. muscular artery

Arteries

The arterial system consists of:

1. **Elastic arteries:**
   - Lager arteries
   - **More elastic fibres** and **less smooth muscles** in TM
2. **Muscular arteries:**
   - Medium-sized arteries (0.5–10 mm in diameters)
   - **More smooth muscles** and **less elastic fibres** in TM




Tunica media
Adventitia
Elastic artery
Muscular artery
Arteriole
Adventitia
Tunica intima

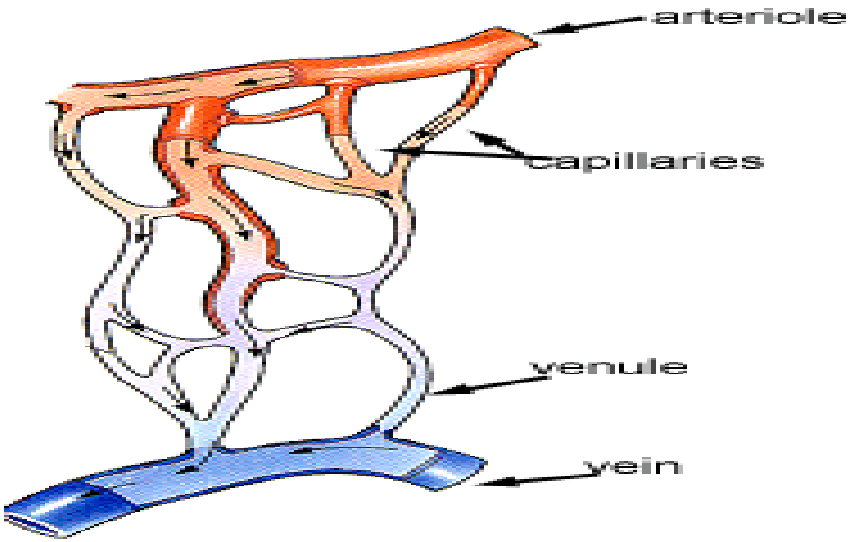
Venules and Veins

To return blood to the heart, there is a series of venules, veins, and muscular veins. Venules have much larger lumina and thinner walls than corresponding arterioles. Similarly, the veins are distinguishable from arteries and arterioles, because their walls are much thinner, compared to the diameter of their lumen.

The venous return from the legs is aided by contraction of skeletal muscle, which compresses the veins inside them, and the veins of medium size also have valves in them, to overcome the problem of reverse flow.

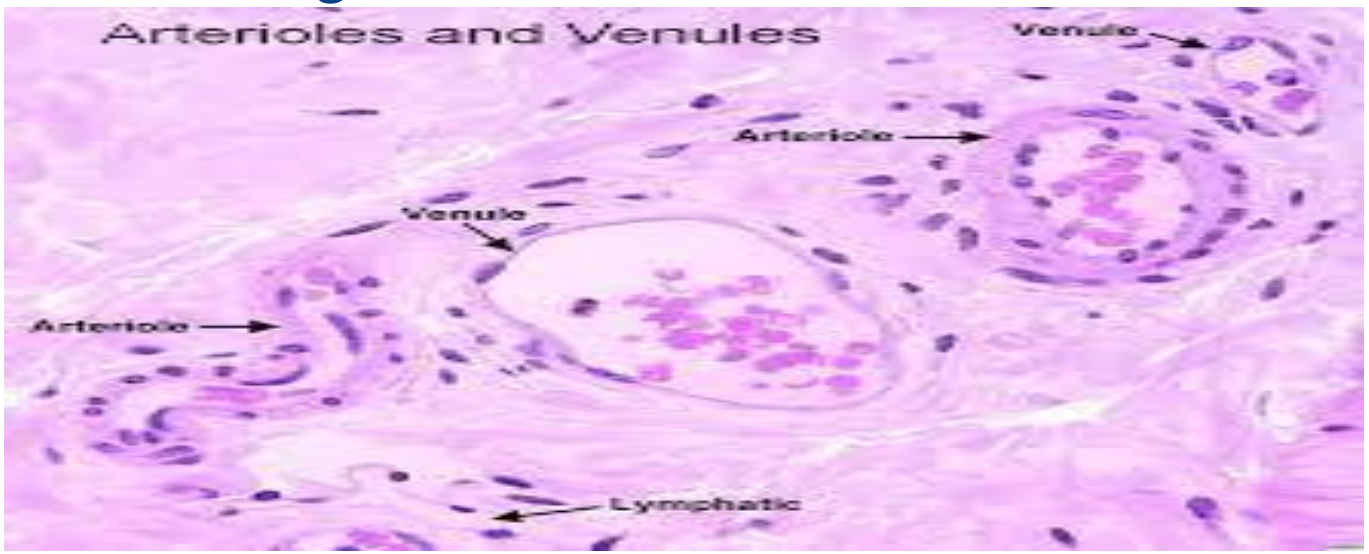
Venules and Veins

* The veins still have the three basic layers (tunica adventitia, tunica media and tunica intima), but the elastic and muscular components are less prominent. The smooth muscle layers are used to contract or dilate the veins, to accommodate changes in blood volume.



Venules

* These have a clear **tunica intima** layer, without any elastic fibers, and a **tunica media** with one or two layers of muscle fibers. The **tunica adventitia** fuses with surrounding tissue.



Veins

In a section that has both arteries and veins, the artery and veins are very easy to tell apart. The thickness of the walls of the veins is much less, compared to the lumen, and the lumen is often collapsed.

The 3 layers of the vein:

* **Tunica Intima:** A thin endothelial lining, (in some veins, you may be able to see the valves).
* **Tunica Media**: This layer contains 2-3 layers of muscle cells.
* **Tunica Adventitia:** This is the broadest layer. It contains longitudinal collagen fibers, and vasa vasorum.

Muscular veins

The three layers, **tunica intima** (thin flattened endothelial cells), the thick muscular wall (**tunica media**) and the **adventitia** layer, which has vasa vasorum. These blood vessels are much more numerous than in arteries of a similar size.

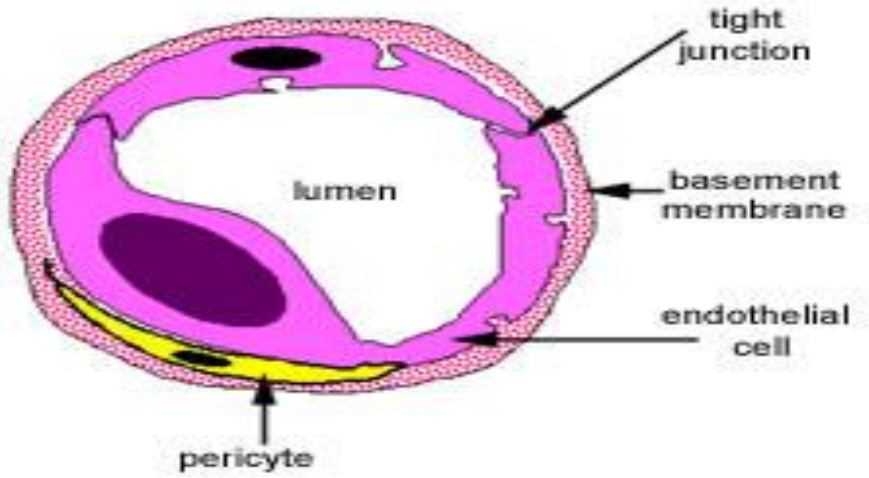
Unlike muscular arteries, there is no internal or external elastic layer surrounding the muscle layer (why do you think this is?).H.W

Capillaries

* **Capillaries** are small, normally around 3-4µm, but some capillaries can be 30-40 µm in diameter. The largest capillaries are found in the liver. (*capillar* comes from the greek for hairlike).
* **Capillaries** connect **arterioles** to **venules**. They allow the exchange of nutrients and wastes between the blood and the tissue cells, together with the interstitital fluid. This exchange occurs by passive diffusion and by pinocytosis which means 'cell drinking'. Pinocytosis is used for proteins, and some lipids. Also, importantly, white blood cells can move through intercellular junctions, into the surrounding tissue to repair damage, and fight infections. This route is also used by metastasising cancerous cells.

Capillaries

* Capillaries have a single layer of flattened endothelial cells, as shown here in the diagram. There are no muscular or adventitial layers. The thinness of the capillaries helps efficient exchange between the lumen of the capillary and the surrounding tissue.
* **Continuous** capillaries often have pericytes associated with them. (perivascular cells - peri is greek for 'around') lie just underneath the endothelium of blood capillaries, and are a source of new fibroblasts.



Types of capillary

There are three types of capillary:

* **continuous**
* **fenestrated**
* **discontinuous**

Continuous capillaries

* **Continuous capillaries: located in skeletal muscle ,only water and certain ions can leave.**

Fenestrated capillaries

* These are found in some tissues where there is extensive molecular exchange with the blood such as the small intestine, endocrine glands and the kidney. The 'fenestrations' are pores that will allow larger molecules leave.
* These capillaries are more permeable than continuous capillaries.

Fenestrated capillaries

* The transmission and scanning electron microscopes below show pores (fenestrae) in the capillary wall of the kidney glomeruli that are not resolved by the light microscope.
* At high magnification, the fenestrations of the endothelial cell can be seen as 'gaps' next the the basement membrane (F) in the picture below.

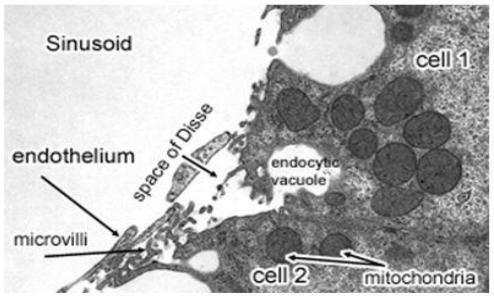
Discontinuous Capillaries

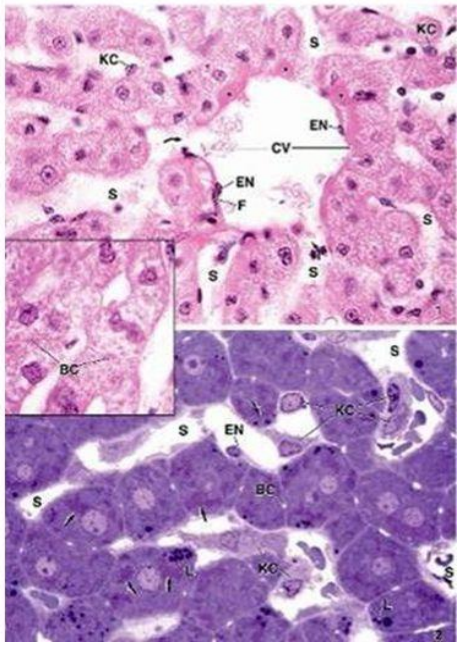
* Sinusoidal capillaries or discontinuous capillaries are a special type of open-pore capillary, also known as a sinusoid, that have wider 30–40 μm diameters, and wider openings in the endothelium. Fenestrated capillaries have diaphragms that cover the pores whereas sinusoids lack a diaphragm and just have an open pore. These types of blood vessels allow red and white blood cells (7.5 μm – 25 μm diameter) and various serum proteins to pass, aided by a discontinuous basal lamina. These capillaries lack pinocytotic vesicles, and therefore utilize gaps present in cell junctions to permit transfer between endothelial cells, and hence across the membrane.

Discontinuous Capillaries

Sinusoidal capillaries or discontinuous capillaries

- Such type of capillaries have wide diameter.
- These are found in the liver, spleen, lymph nodes, bone marrow and some endocrine glands.





End

* Thanks a lot for attention

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* 2021