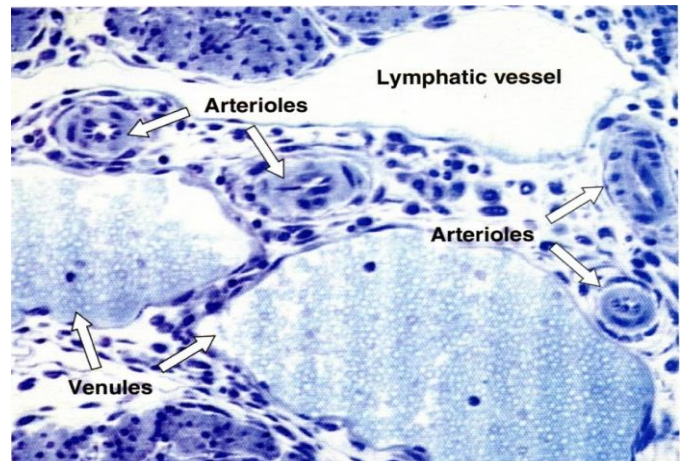


The circulatory system

2. Venous system

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.

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.

o 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.

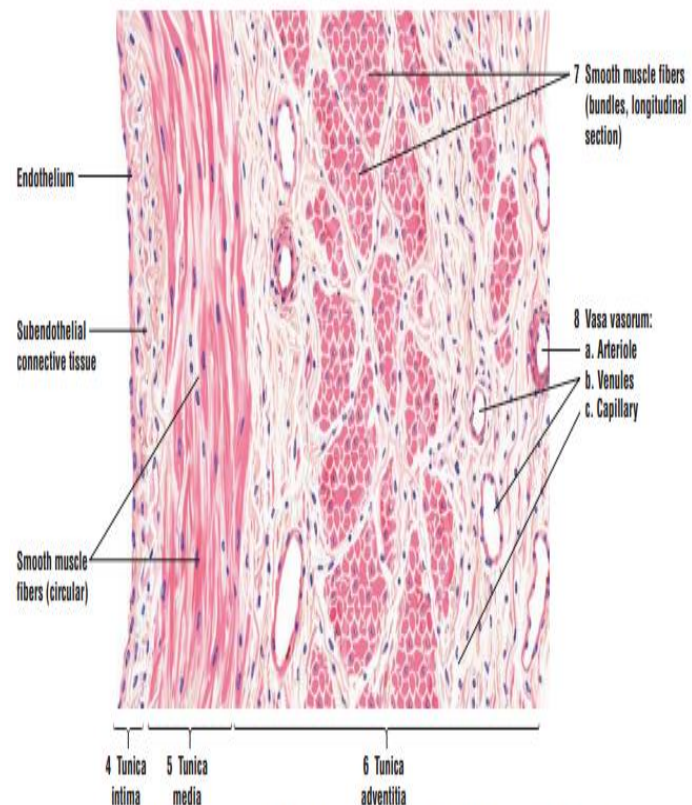
o Veins

The thickness of the walls of the veins is much less, compared to the lumen, and the lumen is often collapsed.

- **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

Three layers can be identified, tunica intima (thin flattened endothelial cells), the thick muscular wall (tunica media) and the adventitia layer, which has vasa vasorum which 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.



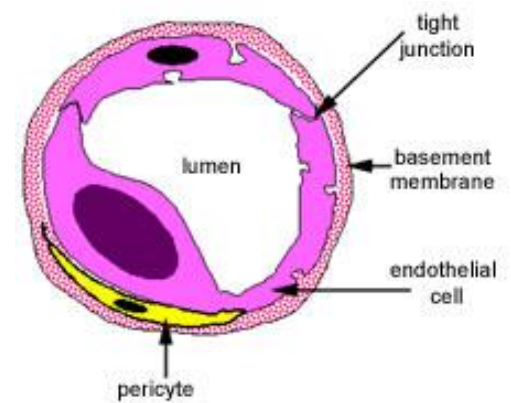
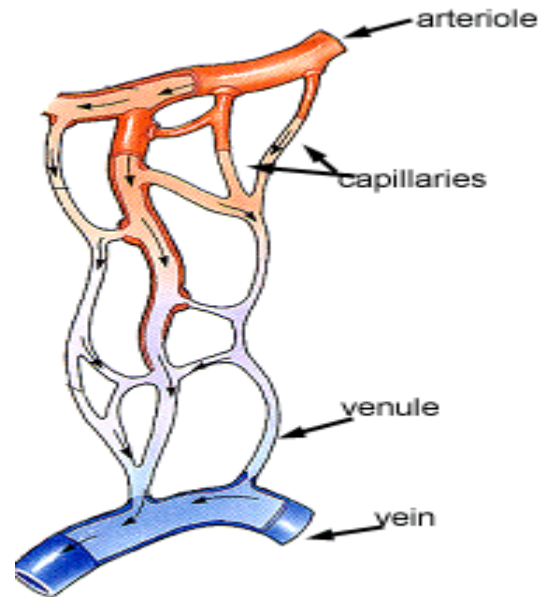
* Wall of a large vein: portal vein (transverse section). Stain: hematoxylin and eosin.

3-Capillaries

Capillaries are small blood vessels. The largest capillaries are found in the liver. (*capillar* comes from the Greek for hair like).

Capillaries connect arterioles to venules. They allow the exchange of nutrients and wastes between the blood and the tissue cells, together with the interstitial fluid. White blood cells can move through intercellular junctions, into the surrounding tissue to repair damage, and fight infections. This route is also used by metastasizing cancerous cells.

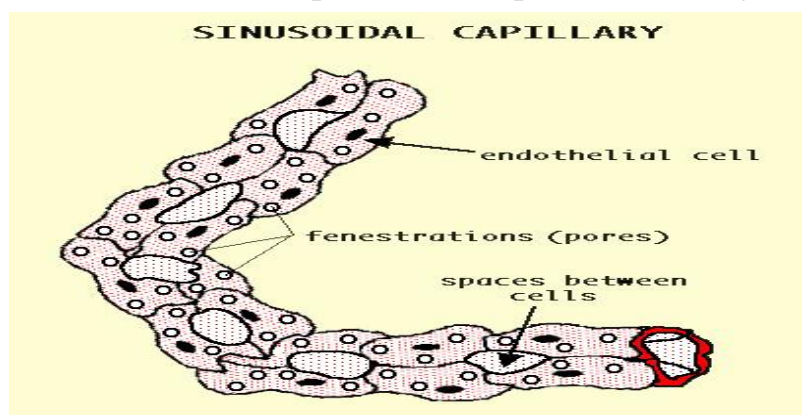
Capillaries have a single layer of flattened endothelial cells. **There are no muscular or adventitial layers.** The thinness of the capillaries helps efficient exchange between the lumen of the capillary and the surrounding tissue. Continuous capillaries often have pericytes associated with them. (perivascular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



There are 3 types of capillaries.

1. **Continuous:** no pores or spaces between cells in walls; most capillaries are of this type.
2. **Fenestrated or perforated capillaries:** there are pores penetrate the endothelial cells; found in tissues where rapid exchange of substances occurs (e.g., in the villi of the intestinal wall and glomeruli of the kidney).
3. **Sinusoidal:** are special types of open-pore capillary also known as a discontinuous capillary that have larger openings in the endothelium. These types of blood vessels allow red and white blood cells and various serum proteins to pass, aided by a discontinuous basal lamina.

Sinusoid blood vessels are primarily located in the bone marrow, lymph nodes, and adrenal glands. A capillary wall is only 1 cell thick and is simple squamous epithelium.



4-The heart :

The heart is a muscular pump that propels blood at high pressure round the body through the blood vessels.

As with the rest of the circulatory system, the heart has three layers:

o **Tunica adventitia (Epicardium)**

This layer contains fibroelastic connective tissue, blood vessels, lymphatics and adipose tissue. The simple squamous epithelium of the tunica adventitia layer is called the mesothelium.

o **Tunica media (Myocardium)**

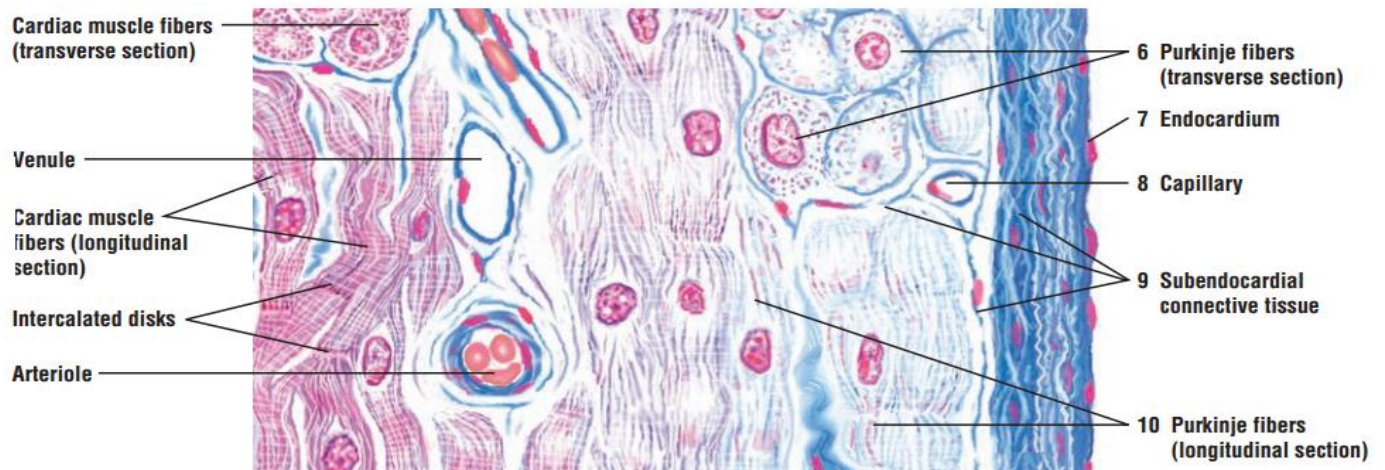
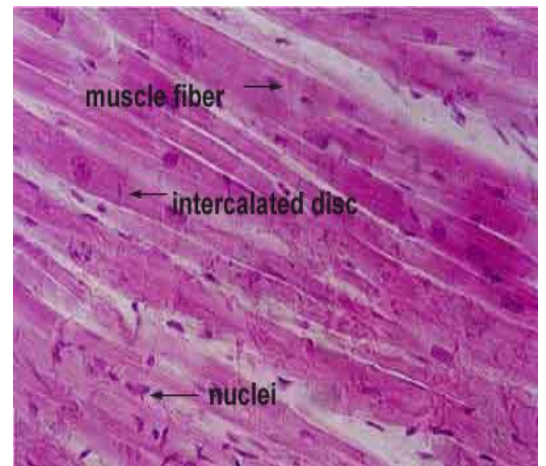
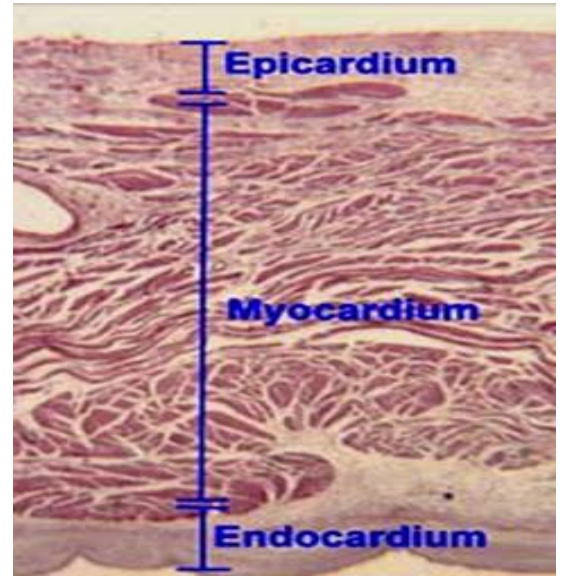
The myocardium is the largest of the three layers, and contains cardiac muscle fibers, and loose endomysial connective tissue that contains lots of capillaries.

o **Tunica intima (Endocardium)**

The endocardium lines the atria and ventricles and covers the heart valves. As well as the endothelium and underlying basement membrane, there is a small layer of loose connective tissue and some adipose tissue.

o **Purkinje fibers**

The purkinje fibers are found in the sub-endocardium. They are larger than cardiac muscle cells, but have fewer myofibrils, lots of glycogen and mitochondria. These cells are connected together by desmosomes and gap junctions, but not by intercalated discs. They are specialized conducting fibers, which extend from the interventricular septum, to the papillary muscles, and up the lateral walls of the ventricles.



Heart: contracting cardiac muscle fibers and impulse-conducting Purkinje fibers.

Reference:

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2- diFIORE'S Atlas of histology with Functional Correlations, twelfth edition, 2013.

3- Jonquiere's basic histology text and atlas 13th edition (2013) by Anthony L. Mescher ; Di Fiore's Atlas of Histology 12th ed. (2013) Victor P. Eroschenko