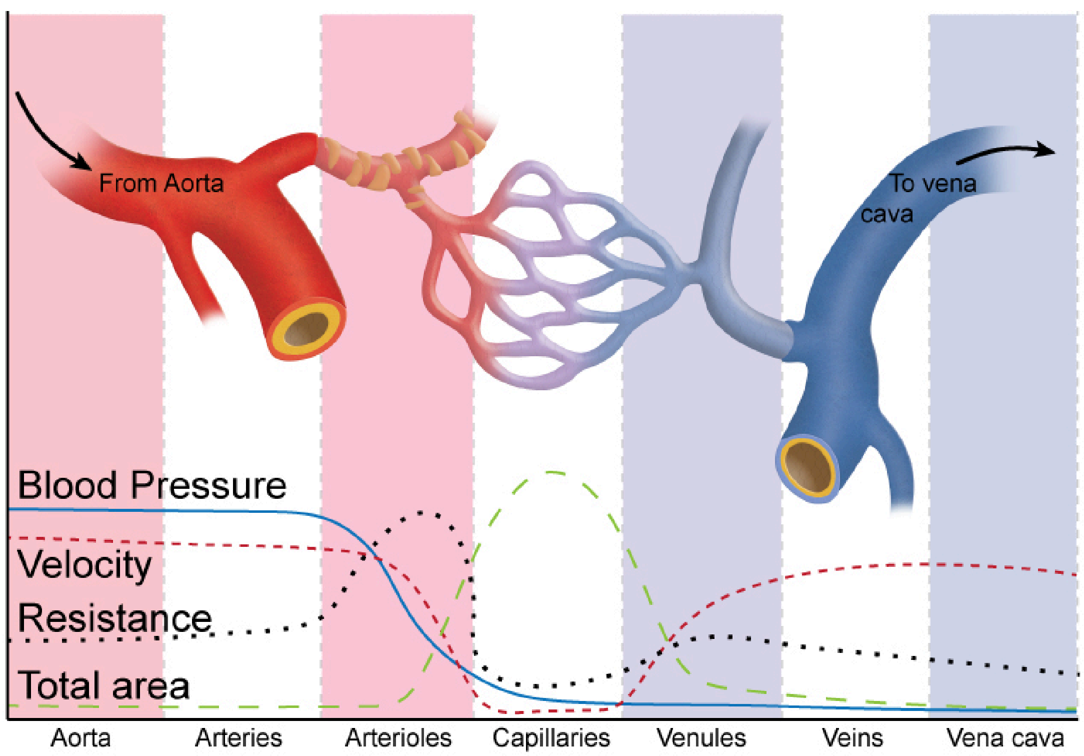
3.5.2

Capillaries

As mentioned above, capillaries are the smallest vessels in the human body, with an interior diameter roughly equivalent to the width of a single erythrocyte at 5-10 µm. Widespread branching creates a capillary network capable of carrying blood to within 1 mm of almost every human cell. There are estimated 10 billion capillaries in the body, each 1.1-millimeter-long which if stretch end to end would equal 25,000 miles. Accordingly, capillaries lie very close to one another arranged in complexes throughout the body known as **capillary beds**.

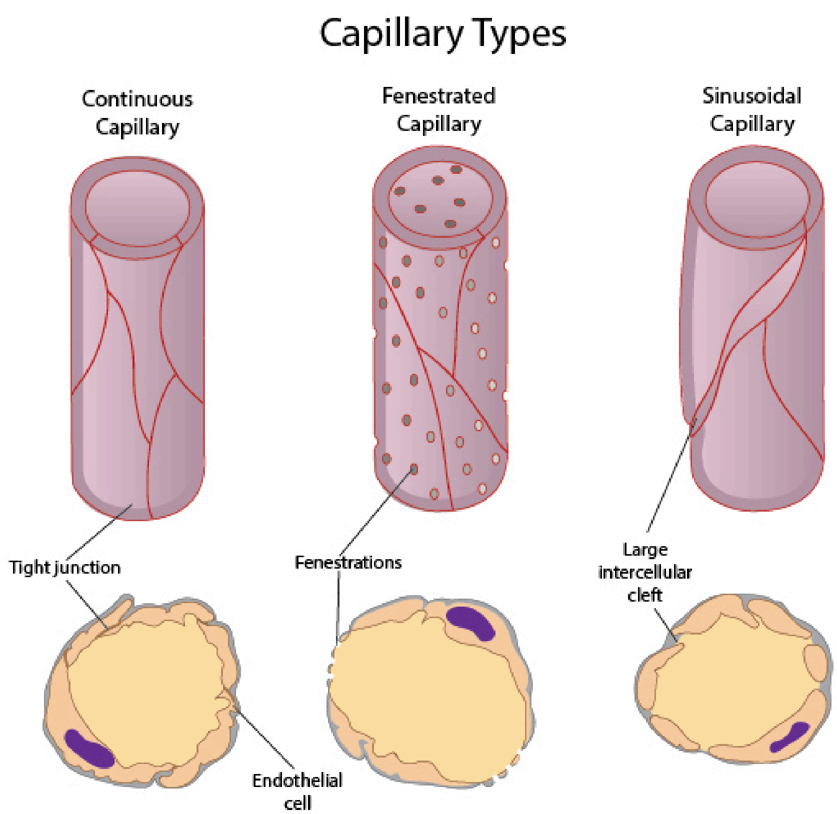


Blood Pressure Changes From Arteries to Veins

Image created at BYU-Idaho by Nate Shoemaker Spring 2016

Owing to this widespread branching, the total area of vasculature within the capillary network greatly exceeds that of the arterial network that supplies them. Consequently, as the total area of vasculature increases, the velocity and pressure of the blood decreases. This decreased velocity allows more time for the diffusion of oxygen, nutrients, and waste products to occur between capillaries and the tissues they support.

Three main types of capillaries exist within the human body based on their permeability to substances departing and entering the blood stream. These three types are known as continuous, fenestrated, and sinusoidal capillaries.



Continuous, Fenestrated and Sinusoidal Capillaries

Image created at BYU-I Fall 2013

Continuous Capillaries

The endothelial tissue of continuous capillaries is arranged with virtually no gaps between individual cells. This allows continuous capillaries to be impermeable to polar molecules and in some cases even water. Continuous capillaries ar the most common type in the body and are located in kidneys, nervous system, muscle, fat, heart and a number of oth tissues throughout the body.

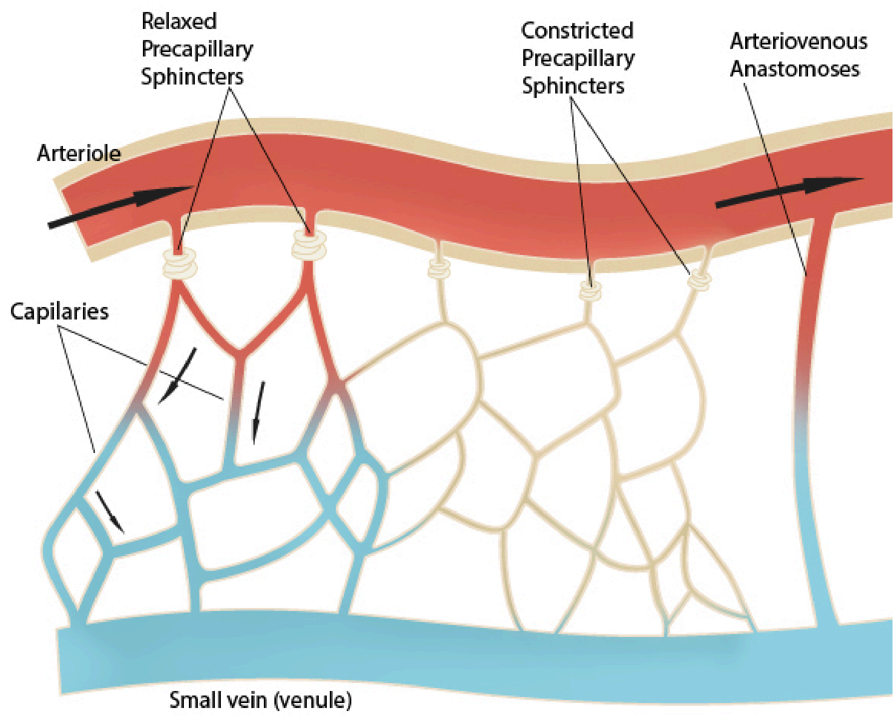
Fenestrated Capillaries

The endothelial tissue of fenestrated capillaries is also arranged in a tight weave, but comparatively large pores known as **fenestrae** occur within the individual cells. Fenestrated capillaries primarily supply tissues which require a high leve of permeability for accelerated diffusion such as the intestines, and kidney glomeruli. Fenestrae size varies depending upon tissue type. The size of the fenestrae determines the size of the substances that can pass in and out of the bloodstream.

Sinusoidal Capillaries

Sinusoidal capillaries are similar to fenestrated capillaries but are larger in diameter and are arranged in a looser weav to allow the presence of gaps between individual cells. These capillaries are found in tissues such as endocrine glands which require permeability to large molecules.

A **Sinusoid** is a special type of capillary bed, found in the bone marrow, spleen and liver. These capillaries possess very large gaps between individual cells. The gaps are large enough that all the components of blood freely pass.



Pre-capillary Sphincters
Image created at BYU-Idaho Fall 2013

As blood flows from an arteriole into a capillary bed, it passes by a concentration of smooth muscle cells known as the **precapillary sphincter**, located at the arteriole end of each arteriole. This sphincter controls the amount of blood that enters the capillary bed. In this way, the precapillary sphincters control the local blood flow in the tissues.

When the sympathetic nervous system is activated during times of "fight and flight" responses, muscular arteries and arterioles constrict. This greatly decreases the amount of blood flow to an area of capillary beds. However, the sympathetic nervous system does not constrict precapillary sphincters. This is because pre-capillary sphincters are no innervated by sympathetic nerves but instead rely on products of increased metabolism like CO2, acid, and adenosine to stimulate sphincter relaxation. In fact, through mechanisms not completely understood it can be shown that when precapillary sphincters are stimulated by waste products to relax, vessels upstream from these metabolically active tissues also dilate. The effects of metabolic waste products on precapillary sphincters overrides the sympathetic response to constrict arterioles in the area. This is advantageous during exercise because the circulation will increase blood flow to the metabolically active tissue while decreasing blood flow almost everywhere else. This ability for tissu to regulate their blood flow based off of metabolic need is called **autoregulation**.

Capillaries and Temperature Regulation

Capillaries play an important role in temperature regulation as well as in capillary exchange. There is a structure of special vessels known as **arteriovenous anastomoses** that shunts blood flow directly from arterioles into small veins, avoiding capillaries entirely. This becomes especially important in the skin, when the body needs to shunt a lot of bloo away from the skin quickly to control heat loss. Arteriovenous anastomoses may also develop pathologically due to genetic or developmental errors or from tissue damage or as a result of tumor growth. These vessels allow large quantities of blood to flow directly from arteries into veins, greatly increasing venous return and thereby, the workload the heart. Heart failure may result if these vessels are allowed to grow to extremely large sizes. Also, these malformed anastomoses can break and cause unwanted bleeds, especially if they are in the brain.