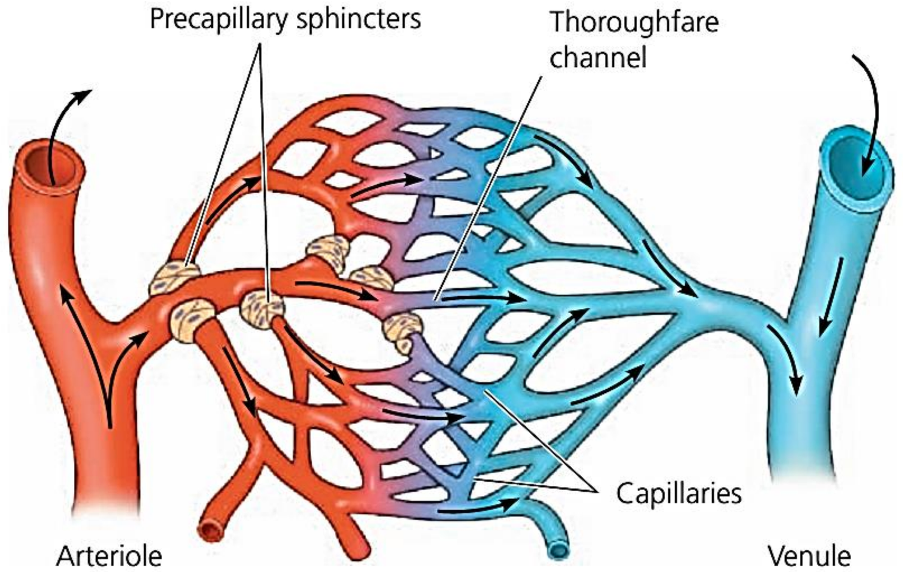
Capillary Function

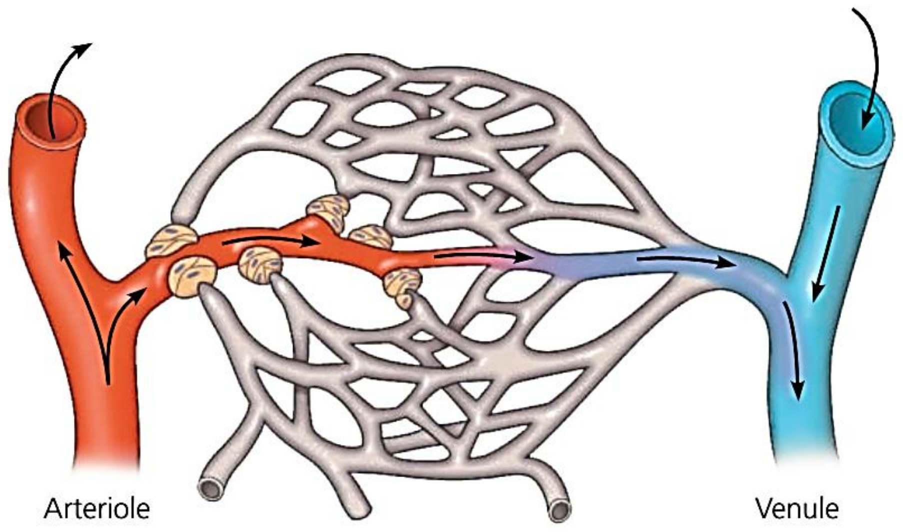
At any given time, blood is flowing through only 5–10% of the body's capillaries. However, each tissue has many capillaries, so every part of the body is supplied with blood at all times. Capillaries in the brain, heart, kidneys, and liver usually remain at capacity, but at many other sites the blood supply varies over time as blood is diverted from one destination to another. For example, blood supply to the digestive tract increases after a meal. In contrast, blood is diverted from the digestive tract and supplied more generously to skeletal muscles during strenuous exercise.

Given that capillaries lack smooth muscle, how is blood flow in capillary beds altered? One mechanism is constriction or dilation of the arterioles that supply capillary beds. A second mechanism involves precapillary sphincters, rings of smooth muscle located at the entrance to capillary beds. The opening and closing of these muscular rings regulate the passage of blood into particular sets of capillaries. The signals regulating blood flow by these mechanisms include nerve impulses, hormones traveling throughout the bloodstream, and chemicals produced locally. For example, the chemical histamine released by cells at a wound site causes vasodilation. The result is increased blood flow and increased access of disease-fighting white blood cells to invading microorganisms.

▼ **Figure 42.13 Blood flow in capillary beds.** Precapillary sphincters regulate the passage of blood into capillary beds. Some blood flows directly from arterioles to venules through capillaries called thoroughfare channels, which are always open.



(a) Sphincters relaxed



(b) Sphincters contracted

The critical exchange of substances between the blood and interstitial fluid takes place across the thin endothelial walls of the capillaries. A few macromolecules are carried across the endothelium in vesicles that form on one side by endocytosis and release their contents on the opposite side by exocytosis. Small molecules, such as O2 and CO2, simply diffuse across the endothelial cells or, in some tissues, through microscopic pores in the capillary wall. These openings also provide the route for transport of small solutes such as sugars, salts, and urea, as well as for bulk flow of fluid into tissues driven by blood pressure within the capillary.

Two opposing forces control the movement of fluid between the capillaries and the surrounding tissues: Blood pressure tends to drive fluid out of the capillaries, and the presence of blood proteins tends to pull fluid back. Many blood proteins (and all blood cells) are too large to pass readily through the endothelium, so they remain in the capillaries. These dissolved proteins are responsible for much of the blood's osmotic pressure (the pressure produced by the difference in solute concentration across a membrane). The difference in osmotic pressure between the blood and the interstitial fluid opposes fluid movement out of the capillaries. On average, blood pressure is greater than the opposing forces, leading to a net loss of fluid from capillaries.

▼ Figure 42.14 Fluid exchange between capillaries and the interstitial fluid. This diagram shows a hypothetical capillary in which blood pressure exceeds osmotic pressure throughout the entire length of the capillary. In other capillaries, blood pressure may be lower than osmotic pressure along all or part of the capillary.