40.3B: Arteries, Veins, and Capillaries

Blood vessels include arteries, capillaries, and veins which are responsible for transporting blood throughout the body.

Learning Objectives

- Explain the structure of arteries, veins, and capillaries and how blood flows through the body

Key Points

- Arteries carry blood away from the heart; the main artery is the aorta.
- Smaller arteries called arterioles diverge into capillary beds, which contain 10-100 capillaries that branch among the cells and tissues of the body.
- Capillaries carry blood away from the body and exchange nutrients, waste, and oxygen with tissues at the cellular level.
- Veins are blood vessels that bring blood back to the heart and drain blood from organs and limbs.
- Capillaries have one layer of cells (the endothelial tunic or tunica intima) where diffusion and exchange of materials takes place.
- Veins and arteries have two more tunics that surround the endothelium: the middle tunica media is composed of smooth muscle that regulates blood flow, while the outer tunica externa is connective tissue that supports blood vessels.

Key Terms

- vasodilation: dilation of the blood vessels
• **vasoconstriction**: constriction of a blood vessel
• **venule**: small vein, especially one that connects capillaries to a larger vein

## Arteries, Veins, and Capillaries

The blood from the heart is carried through the body by a complex network of blood vessels. Arteries take blood away from the heart. The main artery is the aorta that branches into other major arteries, which take blood to different limbs and organs. These major arteries include the carotid artery, which takes blood to the brain; the brachial arteries, which take blood to the arms; and the thoracic artery, which takes blood to the thorax and then into the hepatic, renal, and gastric arteries for the liver, kidneys, and stomach, respectively. The iliac artery takes blood to the lower limbs. The major arteries diverge into minor arteries, and then into smaller vessels called arterioles, to reach more deeply into the muscles and organs of the body.

**Major arteries and veins**: The blood from the heart is carried through the body by a complex network of blood vessels. This diagram illustrates the major human arteries and veins of the human body.
Arterioles diverge into capillary beds. Capillary beds contain a large number (10 to 100) of capillaries that branch among the cells and tissues of the body. Capillaries are narrow-diameter tubes that can fit red blood cells in single-file lines and are the sites for the exchange of nutrients, waste, and oxygen with tissues at the cellular level. Fluid also crosses into the interstitial space from the capillaries. The capillaries converge again into venules that connect to minor veins, which connect to major veins that take blood high in carbon dioxide back to the heart. The major veins drain blood from the same organs and limbs that the major arteries supply. Fluid is also brought back to the heart via the lymphatic system.

The structure of the different types of blood vessels reflects their function or layers. There are three distinct layers, or tunics, that form the walls of blood vessels. The inner, tunica intima is a smooth, inner lining of endothelial cells that are in contact with the red blood cells. This tunic is continuous with the endocardium of the heart. Unlike veins and arteries, capillaries have only one tunic; this single layer of cells is the location of diffusion of oxygen and carbon dioxide between the endothelial cells and red blood cells, as well as the exchange site via endocytosis and exocytosis. The movement of materials at the site of capillaries is regulated by vasoconstriction, narrowing of the blood vessels, and vasodilation, widening of the blood vessels; this is important in the overall regulation of blood pressure.

Blood vessel layers: Arteries and veins consist of three layers: an outer tunica externa, a middle tunica media, and an inner tunica intima. Capillaries consist of a single layer of epithelial cells, the endothelium tunic (tunica intima).

Veins and arteries both have two further tunics that surround the endothelium: the middle, tunica media is composed of smooth muscle, while the outer tunica externa is connective tissue (collagen and elastic fibers). The elastic, connective tissue stretches and supports the blood vessels, while the smooth muscle layer helps regulate blood flow by altering vascular resistance through vasoconstriction and vasodilation. The arteries have thicker smooth muscle and connective tissue than the veins to accommodate the higher pressure and speed of freshly-pumped blood. The veins are thinner walled as the pressure and rate of flow are much lower. In addition, veins are structurally different from arteries in that veins have valves to prevent the backflow of blood. Because veins have to work against gravity to get blood back to the heart, contraction of skeletal muscle assists with the flow of blood back to the heart.