18.7B: Local Regulation of Blood Flow

Blood flow is regulated locally in the arterioles and capillaries using smooth muscle contraction, hormones, oxygen, and changes in pH.

Learning Objectives

- Describe local regulation of blood flow

Key Points

- Regulation of blood flow is managed by adjusting the contraction or relaxation of smooth muscle fibers in the walls of arterioles and capillaries.
- This control can be systemic, affecting the whole circulatory system, or localized to specific tissues or organs.
- Arterioles are the primary blood vessel for local control due to their physical location within tissues and ability to vasodilate and vasocontract to influence blood flow.

Key Terms

- **capillary**: Any of the small blood vessels that connect arteries to veins.
- **arteriole**: One of the small branches of an artery, especially one that connects with capillaries.

The flow of blood along arteries, arterioles, and capillaries is not constant, but can be controlled depending upon the requirements of the body. For example, more blood is directed to the skeletal muscles, brain, or digestive system when they are active, and blood flow to the skin can be reduced or increased to aid with thermoregulation. Blood flow is

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regulated by vasoconstriction or vasodilation of smooth muscle fibers in the walls of blood vessels, typically arterioles. This regulation can be systemic, affecting the whole of the circulatory system, or localized to specific tissues or organs.

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**Local Regulation**

The greatest change in blood pressure and velocity of blood flow occurs at the transition of arterioles to capillaries. This reduces the pressure and velocity of flow for gas and nutrient exchange to occur within the capillaries. As such arterioles are the main part of the circulatory system in which local control of blood flow occurs.

Arterioles contain smooth muscle fibers in their tunica media, which allows for fine control of their diameter. They are innervated and so can respond to nervous system stimuli and also various circulating hormones. Local responses to stretch, carbon dioxide, pH, and oxygen also influence smooth muscle tone and thus vasoconstriction and vasodilation.

Generally, norepinephrine and epinephrine (hormones secreted by sympathetic nerves and the adrenal gland medulla) are vasoconstrictive, acting on alpha-1-adrenergic receptors. However, the arterioles of skeletal muscle, cardiac muscle, and the pulmonary circulation vasodilate in response to these hormones acting on beta-adrenergic receptors. Generally, stretch and high oxygen tension increase tone, and carbon dioxide and low pH promote vasodilation.

Pulmonary arterioles are a noteworthy exception as they vasodilate in high oxygen. Brain arterioles are particularly sensitive to pH, with reduced pH promoting vasodilation.

A number of hormones influence arteriole tone such as the vasoconstrictive epinephrine, angiotensin II, and endothelin and the vasodilators bradykinin and prostacyclin.