41.5A: Epinephrine and Norepinephrine

Epinephrine and norepinephrine are released during the flight/fight response, causing vasoconstriction of blood vessels in the kidney.

Learning Objectives

• Describe hormonal control by epinephrine and norepinephrine of osmoregulatory functions

Key Points

• Epinephrine, produced by the adrenal medulla, causes either smooth muscle relaxation in the airways or contraction of the smooth muscle in arterioles, which results in blood vessel constriction in the kidneys, decreasing or inhibiting blood flow to the nephrons.

• Norepinephrine, produced by the adrenal medulla, is a stress hormone that increases blood pressure, heart rate, and glucose from energy stores; in the kidneys, it will cause constriction of the smooth muscles, resulting in decreased or inhibited flow to the nephrons.

• Together, epinephrine and norepinephrine cause constriction of the blood vessels associated with the kidneys to inhibit flow to the nephrons.

Key Terms

• epinephrine: (adrenaline) an amino acid-derived hormone secreted by the adrenal gland in response to stress

• norepinephrine: a neurotransmitter found in the locus coeruleus which is synthesized from dopamine

• catecholamine: any of a class of aromatic amines derived from pyrocatechol that are hormones produced by the
Epinephrine and Norepinephrine

Epinephrine

As a hormone and neurotransmitter, epinephrine acts on nearly all body tissues. Its actions vary by tissue type and tissue expression of adrenergic receptors. For example, high levels of epinephrine cause smooth muscle relaxation in the airways, but cause contraction of the smooth muscle that lines most arterioles. Epinephrine acts by binding to a variety of adrenergic receptors. Epinephrine is a nonselective agonist of all adrenergic receptors, including the major subtypes α1, α2, β1, β2, and β3. Epinephrine’s binding to these receptors triggers a number of metabolic changes. Binding to α-adrenergic receptors inhibits insulin secretion by the pancreas, stimulates glycogenolysis (the breakdown of glycogen) in the liver and muscle, and stimulates glycolysis (the metabolic pathway that converts glucose into pyruvate) in muscle. β-Adrenergic receptor binding triggers glucagon secretion in the pancreas, increased adrenocorticotropic hormone (ACTH) secretion by the pituitary gland, and increased lipolysis by adipose tissue. Together, these effects lead to increased blood glucose and fatty acids, providing substrates for energy production within cells throughout the body.
Norepinephrine

Figure \(\PageIndex{1}\): Adrenal gland: The adrenal medulla, located toward the bottom of this image, is responsible for the release of epinephrine and norepinephrine.

Norepinephrine is a catecholamine with multiple roles. It is the hormone and neurotransmitter most responsible for vigilant concentration in contrast to its most-chemically-similar hormone, dopamine, which is most responsible for cognitive alertness. Areas of the body that produce or are affected by norepinephrine are described as noradrenergic. One of the most important functions of norepinephrine is its role as the neurotransmitter released from the sympathetic neurons to affect the heart. An increase in norepinephrine from the sympathetic nervous system increases the rate of contractions in the heart. Norepinephrine also underlies the fight-or-flight response, along with epinephrine, directly increasing heart rate, triggering the release of glucose from energy stores, and increasing blood flow to skeletal muscle. When norepinephrine acts as a drug, it increases blood pressure by increasing vascular tone through α-adrenergic receptor activation. Norepinephrine is synthesized from dopamine by dopamine β-hydroxylase in the secretory granules of the medullary chromaffin cells and is released from the adrenal medulla into the blood as a hormone. It is also a neurotransmitter in the central nervous system and sympathetic nervous system, where it is released from noradrenergic neurons in the locus coeruleus. The actions of norepinephrine are carried out via the binding to adrenergic receptors.

Role of Epinephrine and Norepinephrine in Kidney Function

Epinephrine and norepinephrine are released by the adrenal medulla and nervous system respectively. They are the
flight/fight hormones that are released when the body is under extreme stress. During stress, much of the body’s energy is used to combat imminent danger. Kidney function is halted temporarily by epinephrine and norepinephrine. These hormones function by acting directly on the smooth muscles of blood vessels to constrict them. Once the afferent arterioles are constricted, blood flow into the nephrons of the kidneys stops. These hormones go one step further and trigger the renin-angiotensin-aldosterone system, the hormone system that regulates blood pressure and water (fluid) imbalance.