Posterior Pituitary hormones

ADH and oxytocin

The neurohypophysial hormones ADH and oxytocin are synthesized as preprohormones in the cell bodies of magnocellular neurons located in the supraoptic and paraventricular nuclei. They are then transported in secretion granules down axons to nerve terminals in the posterior pituitary gland.

ADH is synthesized largely in the supraoptic nucleus, and oxytocin is synthesized largely in the paraventricular nucleus, although each hormone is synthesized in the alternate site. The secretion granules containing either ADH or oxytocin also contain an additional protein, or neurophysin, that is part of the preprohormone. When a nerve impulse travels from the cell body of the magnocellular neurons down the axon to the nerve terminal, both the neurohormone and the corresponding neurophysin are released from secretion granules into the capillary blood as separate polypeptides.

ADH and oxytocin are nonpeptides with a similar chemical structure; only the amino acids in positions 3 and 8 differ.

Physiological Functions of Antidiuretic

Hormone ADH Regulates the Osmolality of Body Fluids by Altering Renal Excretion of Water. ADH plays an important role in the regulation of plasma osmolality. As discussed in Chapter 28, in the absence of ADH the collecting tubules and collecting ducts are largely impermeable to water, which prevents significant reabsorption of water in this portion of the nephron. This results in a large volume of dilute urine and a net loss of water; consequently, the osmolality of body fluids rises. In comparison, when increased ADH activates V2-receptors on the basolateral side of the tubules via a cAMP second messenger system, cytoplasmic vesicles containing water channels (aquaphorin) are inserted in the apical membrane. This increases the permeability of the tubules to water; therefore water moves by osmosis from the tubular to the peritubular capillary fluid. In the collecting ducts, the urine becomes concentrated, and its volume decreases. As a result, there is retention of water in excess of solute, and the osmolality of body fluids decreases. In accordance with its role in the regulation of the osmotic pressure of plasma, ADH secretion is sensitive to small changes in plasma osmolality (approximately 1%). When plasma osmolality increases above normal,

the rate of discharge of ADH-secreting neurons in the supraoptic and paraventricular nuclei increases, and ADH is secreted from the posterior pituitary gland into the systemic circulation. Circulating ADH increases the permeability of the collecting ducts to water, which ultimately decreases plasma osmolality to normal levels. The opposite changes in neuronal discharge and ADH secretion occur when plasma osmolality declines. ADH secretion is regulated by osmoreceptors in the anterior hypothalamus that send nervous signals to the supraoptic and paraventricular nuclei. Osmoreceptors are outside the blood-brain barrier and appear to be located in the circumventricular organs, primarily the organum vasculosum of the lateral terminalis. These same osmoreceptors may also mediate the thirst response to increased plasma osmolality.

ADH Secretion Is Influenced by Multiple Factors. Other than increased plasma osmolality, stimuli that increase ADH secretion include hypovolemia, hypotension, nausea, pain, stress, and a number of drugs, including morphine, nicotine, and barbiturates. Factors that decrease ADH secretion include hypervolemia, hypertension, and alcohol. The influence of these factors on the neurons in the supraoptic and paraventricular nuclei that secrete ADH may have an impact on the regulation of body fluid osmolality. For example, in hypovolemic states, elevated plasma levels of ADH may decrease plasma osmolality. ADH Contributes to the Maintenance of Blood Pressure During Hypovolemia. Stimulation of ADH secretion by hypovolemia and/or hypotension is achieved by reflexes initiated from receptors in both the highand low-pressure regions of the circulation. The highpressure receptors are those in the carotid sinus and aortic arch; the low-pressure receptors are those in the cardiopulmonary circulation, especially in the atria. At least a 5% decrease in blood volume is necessary to increase ADH secretion appreciably by this reflex mechanism. Greater degrees of hypovolemia and hypotension can result in very large increases in plasma osmolality.

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ADH concentration to levels much higher than those required to achieve maximal antidiuresis. When these unusually high plasma levels of ADH occur, such as during hypotensive hemorrhage, ADH constricts vascular smooth muscle and helps restore blood pressure to normal levels. This action of ADH is a result of the peptide binding to vascular V1-receptors on arteriolar smooth muscle. The vasoconstriction induced by ADH is mediated by calcium- and phospholipase C generated second messengers.

Physiological Functions of Oxytocin Hormone

Oxytocin Plays an Important Role in Lactation by Causing Milk Ejection. Oxytocin causes contraction of the myoepithelial cells of the alveoli of the mammary glands; this forces milk from the alveoli into the ducts so the baby can obtain it by suckling. The milk ejection reflex is initiated by receptors on the nipples of the breast. Suckling causes reflex stimulation of oxytocin-containing neuroendocrine cells in the supraoptic and paraventricular nuclei and secretion of oxytocin from the posterior pituitary gland. The circulating oxytocin then causes the myoepithelial cells to contract, initiating milk ejection.

Oxytocin Contributes to Parturition.

Oxytocin also causes contraction of the smooth muscle of the uterus; the sensitivity of this response is enhanced by plasma levels of estrogen, which increase during pregnancy. During labor, the descent of the fetus through the birth canal stimulates receptors on the cervix, which send signals to the supraoptic and paraventricular nuclei and cause secretion of oxytocin. Secretion of oxytocin in turn contributes to labor by causing contraction of the uterus.