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Endocrine System

Richard A. Dienstbier

University of Nebraska-Lincoln, rdienstbier2@unl.edu

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Endocrine System

In complex animals the two principal systems of regulation are the endocrine system and the nervous systems. The endocrine system consists of the ductless endocrine glands, which secrete hormones directly into the bloodstream. The endocrine system and the autonomic nervous system both regulate most of the involuntary functions of the body, including circulatory functions (e.g., blood pressure and heart rate), energy and arousal levels, reproductive functions, and the immune system.

Another major function of endocrine hormones is to regulate tissue growth in young, developing organisms. For example, whether the brain of a developing human male fetus becomes masculinized depends on levels of circulating androgen hormones (e.g., testosterone) that are secreted by the testes of the fetus. One of the developing brain structures most affected by such circulating sex hormones is the hypothalamus, a brain structure that then becomes the major regulator of the entire endocrine system. Thus in many ways the endocrine system and the nervous systems regulate each other.

The cells of the body have receptors for some of the many kinds of endocrine hormones and/or for some of the many kinds of neural transmitters secreted by neurons. The receptors are structures on the cell membrane that are often compared to locks; the hormones (or neural transmitters) represent the keys. In contrast to neural transmitters, which are concentrated in tiny synapses between neurons, even minute concentrations of hormones must be able to affect target cells because hormones become extremely diluted after being secreted directly into the rich blood supply of the endocrine gland. However, distinctions between neural transmitters and endocrine hormones break down; several of the neural transmitters eventually enter the circulatory system and act as hormones. On the other hand, the sensitivity of neurons and of other target tissues to neural transmitters is affected by hormonal concentrations. Whether a hormone greatly affects several major organ systems or has very precise and limited effects depends on the distribution and density of the receptors for that hormone.

Whereas hormonal control of the endocrine glands is achieved through hormones secreted by the “master” pituitary gland, the pituitary itself is regulated by the hypothalamus. The hypothalamus is a nearby brain structure that plays a vital role in many kinds of motivation and in regulation of the body through its control of both the autonomic nervous system and the endocrine system. For endocrine control, in response to neural messages from other brain areas, the hypothalamus secretes hormones which flow into a closed (portal) circulatory system connecting the hypothalamus with the pituitary gland. The pituitary in turn secretes hormones directly into the blood; those pituitary hormones mainly regulate the hormonal output of the various endocrine glands.

This abbreviated summary of endocrine system responses to challenge and threat illustrates some of the ways that mind and body interact. When a situation is appraised as challenging (i.e., important and taxing, but likely to lead to success) energy is required. To meet that need the sympathetic-adrenal-medullary arousal system is activated when the hypothalamus causes the sympathetic branch of the autonomic nervous system to stimulate the medulla of the adrenal gland to secrete the hormone epinephrine (also called adrenaline) With other hormones, epinephrine causes increased blood circulation to vital areas (e.g., major muscles) and increases in blood

sugar for energy for use by muscles and brain. The resultant feeling of energy is likely to affirm the appraisal that success is likely. Sympathetic-adrenal-medullary arousal can dissipate within minutes after the need for energy and arousal ceases.

On the other hand, if the same situation is appraised as threatening (i.e., important and taxing, but potentially disastrous), then besides the arousal of the sympathetic—adrenal-medullary system, the pituitary—adrenal—cortical arousal system is activated. The hypothalamus signals the pituitary by secreting a hormone, corticotropin-releasing hormone (CRH), into the portal system. Then CRH stimulates the pituitary to release adrenocorticotrophic hormone (ACTH) into the blood system and ACTH signals the cortex of the adrenal gland to eventually release cortisol (typically at least 15 min after the crisis began). Although cortisol causes many positive changes in arousal, disadvantages of pituitary-adrenal-cortical arousal are that it dissipates in hours rather than minutes, long-term activation interferes with immune system and even brain (hippocampal) function, and feelings of energy are accompanied by feelings of tensions. The associated feelings of tension are likely to affirm the appraisal that disaster is likely.

Related Entry: Cortisol

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RICHARD A. DIENSTBIER

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