**Endocrine Physiology**

The science that studies glands and secreting organs is called **Endocrinology**. This science began to emerge in the 19th century, specifically in 1838, when Barthold removed the testes from male chickens and observed the effects resulting from the removal of these structures. Later, he re-implanted these structures and noticed the disappearance of the effects caused by the removal of the testes. Although Barthold did not identify the chemical compound responsible for these changes or give it a name, his studies were a catalyst for many scientists who followed and laid the foundations of endocrinology.

The term "hormone" was first used by William Bayliss and Ernest Starling in 1905 to describe the hormone **secretin** secreted by the duodenum, which affects the digestive system. The person known as the "father of endocrinology" is Charles Sequard, who injected himself in 1889 with extracts from the testes of dogs and guinea pigs to restore his physical and mental activity, believing in the importance of testosterone in this field.

**Hormonal Regulation**

When multicellular organisms appeared, two simultaneous developments were necessary for them to adapt to their environments: the first was the emergence of a system for distributing labor among cells, meaning that each group of cells specializes in performing specific functions that other cells cannot perform, such as muscle cells for contraction, nerve cells for responding to the environment, and ectoderm cells for protection. The second development was the emergence of a means of communication among cells. This communication is essential for the various activities and functions of organs and tissues to be coordinated in a way that achieves the goals of the living organism in survival and reproduction.

There are two methods of communication among cells in vertebrates: the first is **neural regulation** based on the nervous system, and the second is **hormonal regulation**. These two methods are not independent of each other, as there is interaction between them, which can be highly complex at times. Scientists have dedicated a special field to this interaction called **neuroendocrinology**.

Despite the fact that hormonal and neural regulation perform the same essential function of stimulating the body's organs and tissues to carry out their activities and functions in a coordinated manner to achieve the goal of survival, there are three fundamental differences between them in how they perform this essential function:

1. **Speed of Response**: Hormonal regulation is slower in response to stimuli. Nerve impulses travel through nerves quickly when stimulated, and the release of neurotransmitters at each synapse does not take long to transmit the nerve impulse to the adjacent cell. In contrast, hormonal regulation involves the secretion of hormones in response to a stimulus, which then travel through the bloodstream to the target organ at the speed of blood circulation, which is relatively slow compared to nerve impulses. Additionally, many hormones exert their effects by building new proteins, which can take hours or even days.
2. **Duration of Effect**: Hormonal regulation usually has a longer-lasting effect than neural regulation. Nerve impulses cause the release of neurotransmitters that lead to immediate or indirect responses in the affected organ, which quickly degrade and stop the response. In contrast, hormones travel through the blood to the affected cells, where they bind to specific receptors either on or inside the target cell. This binding can lead to the internalization of the hormone and its receptor, resulting in a prolonged effect.
3. **Scope of Effect**: Hormonal regulation has a broader impact than neural regulation. Nerve impulses affect specific post-synaptic cells, which can be nerve, muscle, or gland cells, leading to a localized response. Hormones, however, are carried by the blood to all tissues of the body, theoretically affecting all cells that have receptors for the hormone.

**Hormonal Secretions**

The presence of receptors for a hormone on a specific cell gives hormones specificity in their action. This means that despite the general action of hormones, they only affect cells that contain receptors for them, making the hormone's effect specific.

**Types of Hormonal Secretions**

The word "hormone" is derived from the Greek word "hormaein," which means "to excite or stimulate." However, some hormonal secretions do not cause excitation or stimulation but rather inhibition. Therefore, researchers differ in providing a comprehensive definition of a hormone, as no definition can apply to all the increasing numbers of hormonal secretions being continuously discovered. Hence, hormonal secretions have been classified, and a specific definition has been provided for each type to facilitate dealing with these secretions by researchers, as follows:

1. **Classic Hormone**: This term refers to any chemical substance secreted by specialized cells or glands in very small quantities, towards the blood, and transported to other parts of the body (often far from the secretion site) called target tissues, causing a biological effect in those tissues. A large group of hormones falls under the category of classic hormones, such as insulin. The glands that secrete hormones are called endocrine glands or ductless glands.
2. **Neurohormone**: A chemical substance produced and secreted by neurons whose axons form synapses with blood capillaries. Neurohormones are produced in the bodies of neurons and then transported through their axons to be stored in vesicles at their synaptic ends. When the neuron is stimulated, it secretes these substances directly into the blood, which then transports them to other parts of the body, affecting them just like classic hormones. Examples of neurohormones include oxytocin and antidiuretic hormone (ADH), which are produced in the hypothalamus.
3. **Paracrine Secretions**: These hormones are secreted by specialized cells to varying degrees but do not enter the blood. Instead, they reach the interstitial fluid surrounding the cells that secreted them through diffusion. In this case, the hormone does not affect cells far from its secretion site but rather the neighboring cells. An example of this is somatostatin, which is secreted by delta cells in the islets of Langerhans in the pancreas and affects beta and alpha cells in the same islets.
4. **Autocrine Secretions**: These compounds are secreted by non-specialized cells and can be released into the interstitial fluid through diffusion, but they only affect the secreting cell itself (they can also affect the cell directly without reaching the interstitial fluid). Examples of these compounds include prostaglandins and leukotrienes.

**Control of Hormone Release**

In this section, we will attempt to answer the following two questions:

What causes the secretion of a specific hormone? How is the secretion of a specific hormone stopped? The general answer to these two questions lies in the fact that the control of hormone secretion is managed through a mechanism known as negative feedback. In this system, an increase in the concentration of a particular hormone negatively affects the gland that secretes it, leading to a cessation of secretion. This system helps us understand how hormone release can be halted.

But how does this mechanism contribute to the initiation of hormone secretion? This mechanism functions like a gate that prevents additional individuals from entering a building. If the number of people inside decreases, the gate opens to allow more in. In the context of endocrine glands, negative feedback prevents further hormone secretion because it counteracts or cancels out the effects of the factors that cause hormone release.

The factors that stimulate hormone secretion can be summarized as follows:

A. Hormonal Factors Certain concentrations of substances in the blood encourage the secretion of specific hormones. For instance, a decrease in calcium ion (Ca²⁺) concentration in the blood stimulates the parathyroid glands to secrete parathyroid hormone (PTH), which acts on bones, kidneys, and the digestive tract, causing an increase in blood calcium levels. Conversely, an increase in blood calcium concentration above normal levels (20% increase) leads to the secretion of calcitonin from the thyroid gland, which attempts to restore calcium levels to normal by inhibiting bone resorption and increasing calcium excretion through urine.

Similarly, an increase in blood glucose concentration is the primary stimulus for the secretion of insulin from the pancreas. Insulin promotes the storage of glucose in cells, thereby reducing its blood level to normal. Glucagon secretion is also regulated by metabolic factors; a decrease in blood glucose levels and an increase in amino acids cause the secretion of this hormone.

The negative feedback mechanism is evident in all these cases. When blood Ca²⁺ levels rise, this mechanism halts the secretion of PTH. When blood calcium levels drop, it stops the secretion of calcitonin. The same applies to insulin and glucagon. In the case of these four hormones, it can be said that their secreting glands operate independently and utilize the negative feedback mechanism without interference from other endocrine glands.

B. Hormonal Factors The secretion of many hormones is regulated by hormones secreted by other endocrine glands. Some anterior pituitary hormones control the secretions of other endocrine glands. The anterior pituitary releases four hormones known as tropic hormones, which significantly affect the secretions of four other glands, prompting them to release their hormones. For example, the anterior pituitary hormone adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex to secrete glucocorticoids such as cortisol and male sex hormones. If the pituitary stops secreting this hormone, the adrenal cortex gradually atrophies and may reduce its secretion of cortisol and aldosterone.

Reference:

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