

Control & Coordination



Lecture Notes on Hormonal System

Hormonal System

The hormonal system, also known as the endocrine system, consists of glands that secrete hormones directly into the bloodstream. These hormones regulate various physiological processes and maintain homeostasis in the body.

Endocrine Glands and Hormones

- **Endocrine Glands:** These are ductless glands that release hormones directly into the blood. Major endocrine glands include:
 - **Pituitary Gland:** Often referred to as the "master gland," it controls other endocrine glands and secretes various hormones such as growth hormone (GH), prolactin, and adrenocorticotrophic hormone (ACTH).
 - **Thyroid Gland:** Produces thyroid hormones (T3 and T4) that regulate metabolism, and calcitonin, which lowers blood calcium levels.
 - **Parathyroid Glands:** Secrete parathyroid hormone (PTH), which increases blood calcium levels.
 - **Adrenal Glands:** Consist of the adrenal cortex and adrenal medulla.
 - **Adrenal Cortex:** Produces corticosteroids (e.g., cortisol) that regulate metabolism and immune response, and aldosterone, which regulates sodium and potassium balance.
 - **Adrenal Medulla:** Secretes adrenaline and noradrenaline, which prepare the body for 'fight or flight' responses.
 - **Pancreas:** Contains islets of Langerhans, which secrete insulin and glucagon to regulate blood glucose levels.
 - **Gonads (Ovaries and Testes):** Produce sex hormones. Ovaries secrete estrogen and progesterone, while testes produce testosterone.
 - **Pineal Gland:** Produces melatonin, which regulates sleep-wake cycles.
 - **Hypothalamus:** Produces releasing and inhibiting hormones that control the pituitary gland.

Mechanism of Hormone Action

- **Hormone-Receptor Binding:** Hormones exert their effects by binding to specific receptors on the target cells. These receptors can be located on the cell surface or inside the cell.
 - **Cell Surface Receptors:** For hormones that are not lipid-soluble (e.g., peptide hormones), the receptors are located on the plasma membrane. The binding of the hormone to the receptor triggers a series of intracellular events, often involving second messengers like cyclic AMP (cAMP).
 - **Intracellular Receptors:** For lipid-soluble hormones (e.g., steroid hormones), the receptors are located inside the cell. The hormone-receptor complex directly influences gene expression by binding to specific DNA sequences.

- **Signal Transduction Pathways:** The binding of a hormone to its receptor activates signal transduction pathways that result in physiological responses. These pathways can involve:
 - **Second Messengers:** Molecules like cAMP, inositol triphosphate (IP3), and calcium ions that amplify the signal inside the cell.
 - **Gene Expression:** Activation or repression of specific genes leading to changes in protein synthesis.
 - **Metabolic Changes:** Alterations in enzyme activity that affect metabolic pathways.

Feedback Mechanisms in Hormone Regulation

- **Negative Feedback:** The most common mechanism for hormone regulation. It involves the inhibition of hormone release when levels reach an optimal point, maintaining homeostasis.
 - **Example:** Regulation of thyroid hormones. When blood levels of T3 and T4 are high, they inhibit the release of Thyroid Stimulating Hormone (TSH) from the pituitary gland and Thyrotropin-Releasing Hormone (TRH) from the hypothalamus, reducing further production of thyroid hormones.
- **Positive Feedback:** Less common, it involves the enhancement of hormone release in response to a stimulus, leading to an increased physiological response.
 - **Example:** Oxytocin release during childbirth. The stretching of the cervix triggers the release of oxytocin, which increases uterine contractions, leading to further stretching and more oxytocin release until delivery occurs.

Key Points

- The endocrine system consists of glands that secrete hormones into the bloodstream to regulate various body functions.
- Hormones exert their effects by binding to specific receptors, either on the cell surface or inside the cell, triggering signal transduction pathways.
- Hormone levels are regulated through feedback mechanisms, primarily negative feedback, to maintain homeostasis.

Summary

Understanding the hormonal system involves knowing the major endocrine glands and the hormones they produce, the mechanisms by which hormones act on target cells, and the feedback mechanisms that regulate hormone levels. This knowledge is crucial for comprehending how the body maintains internal balance and responds to changes in the environment.