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Hormonal Regulation

Nuraliev Ahrorbek– student of group 432 of the Faculty of General Medicine
Lee Myungjae – student of group 432 of the Faculty of General Medicine
Lee Jungjae – student of group 432 of the Faculty of General Medicine
Jae Hanbin – student of group 432 of the Faculty of General Medicine
Lee Seungjun – student of group 432 of the Faculty of General Medicine
Lee Seungmin – student of group 432 of the Faculty of General Medicine
Salimova Dildora Erkinovna – scientific supervisor, assistant at the Department of Endocrinology
Samarkand State Medical University, Samarkand, Uzbekistan

Abstract: All of the biologically active compounds and substrates involved in the regulation of biochemical processes and functions, hormones play a special role. Hormones are organic substances that are formed in tissues of one type (endocrine glands, or endocrine glands), enter the blood, are transported along the bloodstream to tissues of another type (target tissue), where they exert their biological effect (regulate metabolism, behavior and physiological functions of the body, as well as cell growth, division and differentiation).
Hormonal regulation is a general term for the regulatory effects of various hormones on body functions. Hormonal regulation arose at a certain stage of evolution, earlier than neuromodulation, and serves as a link between the central nervous system and body tissues. Hormonal regulation plays an important role in maintaining homeostasis and in adapting the body to changes in the external and internal environment.

Keywords:

Results. Since hormonal regulation in general is the result of the influence of various hormones, individual physiological actions are determined by the action of these hormones; hormonal regulation affects all levels of organization of a living system; hormonal regulation is a physiologically active hormone responsible for the development of the body. Depending on the specificity of the hormonal action, it can be relatively specific, for example, the selective regulation by aldosterone of the transport of sodium and potassium through the renal epithelial structures, or it can be extensive, for example, the regulation of oxidative processes, differentiation processes, growth and development. In any case, however, the specific objects of hormonal regulation are the chemical reactions of living organisms, and this is of primary theoretical and practical interest.
The most studied mechanism of hormonal regulation is the influence of hormones on protein biosynthesis. Hormonal influences on the rate of protein biosynthesis underlie the control of processes such as growth, development, tissue differentiation, tissue protein synthesis, and follicular maturation.
Since all chemical reactions in the body are catalyzed by enzymes, hormonal regulation is most clearly represented by the influence of hormones on the synthesis of enzymes. The most studied hormonal regulation is the synthesis of two amino acid metabolism enzymes - tryptophan (tryptophan oxygenase or tryptophan pyrrolase) and tyrosine (tyrosine aminotransferase). Glucocorticoids have been found to significantly increase the rate of synthesis of these enzymes in animals and humans. Similar evidence has been obtained for the effects of other hormones on enzymes, and there is often an antagonistic relationship between the hormones. For example, there is evidence that glucocorticoids and insulin have opposite effects, with glucocorticoids suppressing the breakdown of glucose in tissues, and insulin increasing the breakdown of glucose. This fact is explained by the opposite action of these hormones, where evidence shows that hormones increase the activity of certain enzymes without changing the amount of the enzyme itself. In such cases, this may be due to the fact that Hg maintains the optimal conformation of the enzyme for catalysis. It should also be taken into account that hormonal regulation throughout the body occurs in interaction with other control mechanisms that regulate the rate of enzyme reactions. Cyclic 3',5'-AMP, as an intermediate product for the action of many hormones, is of great importance in the implementation of hormonal regulation. This compound is formed

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from ATP in the body by the enzyme adenylate cyclase, and the breakdown of 3',5'-AMP is catalyzed by phosphodiesterase; 3',5'-AMP-mediated influence on steroidogenesis under the influence of ACTH and luteinizing hormone. Influence on lipolysis glycogenolysis of catecholamines, glucagon and insulin, release of pituitary convexital hormones by hypothalamic releasing factors, etc. The intracellular effects of 3',5'-AMP are to affect enzyme activity. Cyclo-AMP binds to the inactive protein kinase unit, the catalytic subunit is released and an activated protein kinase is formed. Cyclo-AMP has been shown to not only mediate the effects of hormones, particularly aldosterone and calcitonin. A very important aspect of hormonal regulation is the influence of hormones on the permeability of cell membranes. Components of the internal environment, such as ions, water, carbohydrates, amino acids and fats, pass through membranes, which largely determine the physicochemical state of the internal environment of the cell. The cell membrane is about 8 nm thick and consists of a lipid bilayer covered on both sides by a protein membrane. The cell membrane is not uniform throughout the cell and consists of different functional units. Insulin changes the membrane from laminar to micelle (sphere), with a concomitant rearrangement of polar lipid groups and the appearance of "channels" that change permeability. The influence of hormones on the functional state of cell membranes is a very important part of hormonal regulation for three main reasons: 1) because permeability can be controlled in this way; 2) because hormones act on the activity of adenylate cyclase, which is included in the membrane in many tissues; 3) because metabolic membranes are the target for hormones in the blood because they are the first point of contact with the organ. According to their chemical nature, hormones are divided into the following groups:
1) peptide – hormones of the hypothalamus, pituitary gland, insulin, glucagon, parathyroid hormones;
2) amino acid derivatives – adrenaline, thyroxine;
3) steroids – glucocorticoids, mineralocorticoids, male and female sex hormones;
4) eicosanoids – hormone-like substances that have a local effect; they are derivatives of arachidonic acid (polyunsaturated fatty acid).
According to the place of formation, hormones are divided into hormones of the hypothalamus, pituitary gland, thyroid gland, parathyroid glands, adrenal glands (cortical and medulla), female sex hormones, male sex hormones, local or tissue hormones.
Based on their effect on biochemical processes and functions, hormones are divided into:
1) hormones that regulate metabolism (insulin, glucagon, adrenaline, cortisol);
2) hormones that regulate calcium and phosphorus metabolism (parathyroid hormone, calcitonin, calcitriol);
3) hormones that regulate water-salt metabolism (aldosterone, vasopressin); 4) hormones that regulate reproductive function (female and male sex hormones);
5) hormones that regulate the functions of the endocrine glands (adrenocorticotropic hormone, thyroid-stimulating hormone, luteinizing hormone, follicle-stimulating hormone, somatotropic hormone);
6) stress hormones (adrenaline, glucocorticoids, etc.);
7) hormones affecting GNI (memory, attention, thinking, behavior, mood): glucocorticoids, parathyroid hormone, thyroxine, adrenocorticotropic hormone).

Properties of hormones. 1) High biological activity. The concentration of hormones in the blood is very small, but their effect is very pronounced, so even a slight increase or decrease in the level of a hormone in the blood causes various, often significant, deviations in metabolism and the functioning of organs and can lead to pathology.
2) A short lifespan, usually from a few minutes to half an hour, after which the hormone is inactivated or destroyed. But with the destruction of the hormone, its effect does not stop, but can continue for hours or even days.
3) Distance of action. Hormones are produced in some organs (endocrine glands) and act in others (target tissues).
4) High specificity of action.
The hormone exerts its effect only after binding to the receptor. The receptor is a complex protein-glycoprotein consisting of protein and carbohydrate parts. The hormone binds specifically to the carbohydrate part of the receptor. Moreover, the structure of the carbohydrate part has a unique chemical structure and corresponds to the spatial structure of the hormone. Therefore, the hormone accurately, accurately, and specifically binds

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only to its receptor, despite the low concentration of the hormone in the blood. Not all tissues respond equally to the action of the hormone. Those tissues that have receptors for this hormone are highly sensitive to the hormone. In such tissues, the hormone causes the most pronounced changes in metabolism and functions. If there are receptors for a hormone in many or almost all tissues, then such a hormone has a general effect (thyroxine, glucocorticoids, somatotropic hormone, insulin). If receptors for a hormone are present in a very limited number of tissues, then such a hormone has a selective effect. Tissues that have receptors for this hormone are called target tissues. In target tissues, hormones can affect the genetic apparatus, membranes, and enzymes. Types of biological action of hormones.

1) Metabolic - the effect of the hormone on the body is manifested by the regulation of metabolism (for example, insulin, glucocorticoids, glucagon).
2) Morphogenetic - the hormone acts on the growth, division and differentiation of cells in ontogenesis (for example, somatotropic hormone, sex hormones, thyroxine).
3) Kinetic or triggering - hormones are capable of triggering functions (for example, prolactin - lactation, sex hormones - the function of the gonads).
4) Corrective. Hormones play a vital role in human adaptation to various environmental factors.

Hormones change metabolism, behavior and organ functions in such a way as to adapt the body to changed living conditions, i.e. carry out metabolic, behavioral and functional adaptation, thereby maintaining the constancy of the internal environment of the body. Mechanism of action of peptide hormones and adrenaline Receptors for these hormones are located on the outer surface of the cell membrane, and the hormone does not penetrate into the cell. The action of the hormone into the cell is transmitted through the so-called second messengers, which include cyclic AMP (cAMP), cyclic GMP (cGMP), calcium, inositol triphosphate, diacylglycerol (diglyceride) and some others. In the regulatory signal transduction system, they are called 7' second messengers because the first messenger is the hormone itself.

Each of the second messengers activates a specific protein kinase. Protein kinases phosphorylate enzymes, and this changes the activity of the enzymes. The main second messenger is cAMP. Most hormones act through it. Other intermediaries, acting through their protein kinases, can change the cAMP content in the cell by increasing or decreasing the activity of enzymes that synthesize or destroy cAMP. cAMP Cyclic AMP is formed in the cell from ATP under the action of the adenylate cyclase system. The adenylate cyclase system includes: a receptor, a G protein and the enzyme adenylate cyclase. The G protein is so named because it is capable of binding guanyl nucleotides (GTP or GDP). There are 2 types of G protein: Gs - stimulates adenylate cyclase and increases the formation of cAMP and Gi - inhibits adenylate cyclase and reduces the formation of cAMP. The Gs and Gi proteins exert their activating or inhibitory effects only when they are in an active state. G-protein ATP AMP +H2O Phosphodiesterase Adenylate cyclase FFn Cyclic-3', 5'-AMP. The metabolism of cAMP 8 is active when it is bound to GTP, and vice versa, when bound to GDP, G protein is inactive. While the hormone does not act on the cell, the adenylate cyclase system is inactive; all its components are separated and GDP is associated with the G protein. However, after the hormone binds to the receptor, a sequential change in the conformation of all components of the adenylate cyclase system occurs, the G protein exchanges GDP for GTP, enters an active state and activates adenylate cyclase, which synthesizes cAMP from ATP. Cyclic AMP, in turn, activates a specific cAMP-dependent protein kinase (protein kinase A), which phosphorylates intracellular enzymes, resulting in changes in enzyme activity. Adenylate cyclase system Protein kinase consists of 4 subunits (tetramers), two of which are regulatory and two are catalytic. In this form, the protein kinase is inactive. When protein kinase 4 binds cAMP molecules, detachment (dissociation) of catalytic subunits occurs, which phosphorylate proteins (enzymes), changing their activity. 9 Destroyed by cAMP phosphodiesterase. Activation of protein kinase A under the influence of cAMP K - catalytic subunits, P - regulatory subunits of cGMP Cyclic GMP is formed from GTP under the action of guanylate cyclase by analogy with the synthesis of cAMP. Cyclic GMP activates a specific cGMP-dependent protein kinase or protein kinase G, which phosphorylates enzymes, which is accompanied by a change in their activity. CGMP, like cAMP, is destroyed by phosphodiesterase.

Conclusions. The action of the hormone on the membrane can be considered as part of the first interaction between the hormone and the tissue, i.e. specific hormone reception. Although the question of the penetration of protein hormones into the cell has not yet been unambiguously resolved, it is believed that it is on the

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membrane that the “trigger” response occurs, unleashing a series of actions of these hormones. For steroid hormones, it has been established that they penetrate cells and bind mainly to specialized receptor proteins. This issue has been studied most thoroughly for estrogens. In the case of feminizing tumors, found in estrogen-sensitive tissues, this is similar to the mercury abnormalities found in male genitalia that can occur with overexposure to estrogen. However, even in diseases not related to the endocrine system, changes in hormonal regulation are usually observed, although not always pronounced, since the endocrine system is abnormally sensitive to all influences. The line between permanent and pathological changes in hormonal regulation is often very difficult to draw. There are specific properties of changes in hormonal regulation in tumors (for example, in the tissue of experimental hepatomas in animals, the ability of some enzymes to change activity in response to the administration of corticosteroids is lost, while in the liver tissue adjacent to the tumor, this ability is preserved). In addition, when prescribing hormonal therapy, one should be aware of the possibility of serious metabolic disorders, especially with long-term use of hormones.

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