



**PHYSIOLOGICAL MECHANISMS OF
MAINTAINING HOMEOSTASIS IN THE BODY AND
THEIR DISRUPTION**

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ABSTRACT

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There are physiological mechanisms of homeostasis in the human body that ensure the stability of the internal environment, and the role of the nervous and endocrine systems in maintaining homeostasis throughout our lives, the principles of feedback, and the processes of controlling vital signs depend on them. Also, pathological conditions resulting from disruption of homeostatic balance and their significance in modern medicine are a topical topic today.

Introduction: The great French physiologist of the 19th century, Claude Bernard, who studied the concept of homeostasis, although he did not use the term "homeostasis", created its theoretical basis. [6, P. 12-15] The American physiologist Walter Cannon, who worked at the beginning of the 20th century, first introduced the term "homeostasis" into science in 1926. [6, P. 24] He expanded on Claude Bernard's ideas and explained how the body "actively" controls this



balance through nerves and hormones. Norbert Wiener, despite being a mathematician and engineer, made a huge contribution to the mechanical understanding of homeostasis. Wiener showed that biological homeostasis and technical systems operate on the basis of the same mathematical laws. This paved the way for the study of homeostasis in physiology as an "automatic control system".

Main part: Ivan Pavlov, a representative of the Russian and Russian school of physiology, showed the role of the central nervous system (conditioned reflexes) in the adaptation of the organism to the external environment. Leon Orbeli created the theory of adaptive trophic function, that is, proved how the sympathetic nervous system controls tissue metabolism and homeostasis. Hans Selye called the disruption of homeostasis and the general response of the organism to it "Stress" (General Adaptation Syndrome). [5, P. 24-38] Michael Brown and Joseph Goldstein were awarded the Nobel Prize for the discovery of cholesterol homeostasis. In Uzbekistan, in the field of physiology, scientists such as A.S. Almatov, U.Z. Kadyrov and B.A. Magrupov have deeply studied changes in homeostasis in various pathological conditions (hypoxia, toxic poisoning). Homeostasis (derived from the Greek word "homoios" meaning similar, same, "stasis" meaning state, immobility) is the property of a living organism to maintain the balance (constancy) of its internal environment, despite changing external environmental conditions. [3, P. 4-9] The main parameters of homeostasis that must be maintained in our body are the following: body temperature is usually around 36.6°C (thermoregulation). The pH of the blood is approximately 7.35 - 7.45 (acid-base balance). The amount of glucose (sugar) in the blood is 3.3 - 5.5 mmol / l, arterial blood pressure is normally 120/80 mm Hg. Water-salt balance is the amount of fluid and electrolytes in the tissues [1, P. 9-11] Homeostasis is a system of "self-regulation" of the organism. It involves three main parts: receptors that sense changes in the external or internal environment (for example, baroreceptors that sense a drop in blood pressure), [3, P. 211-214] the central control analyzes the information received (mainly the hypothalamus and the brain), [1, P. 254] effectors carry out the command from the center (for example, generating heat through muscle tremors or cooling through sweating). Homeostasis mainly works on the basis of negative feedback. Negative feedback means that if an indicator increases, the system tries to lower it. For example, if the blood sugar level increases, the hormone insulin is released and lowers the sugar level. Positive feedback further enhances the process (this is rarely the case for homeostasis, but mainly works in emergency situations such as childbirth or blood clotting. The physiological mechanisms of homeostasis have three main stages: reception of information (reception), the body must perceive even the slightest changes in the internal environment. Special "sensors" - receptors serve for this. Chemoreceptors monitor the chemical composition of the blood, for example, the amount of CO₂ (carbon dioxide) or glucose. Baroreceptors are located in the neck and aorta and sense changes in blood pressure (tension of the vascular wall). Thermoreceptors record changes in body and blood temperature. Osmoreceptors respond to changes in the osmotic pressure



(concentration of salts) of the blood. Central Control and Integration Signals from the receptors go to the "control panel" hypothalamus (base of the brain). The hypothalamus compares the information received with the "standard" (norm) indicators. If there is a difference, it immediately sends a signal to the executive organs. Neuroendocrine connection is where nerve impulses are converted into hormonal signals (for example, by activating the pituitary gland) and an effector response (execution mechanism) occurs. At this stage, the body takes specific measures to restore balance. This can be seen in two main directions. Humoral (Hormonal) mechanism, this mechanism lasts a long time. For example, when the body loses water, the hypothalamus senses this and begins to secrete antidiuretic hormone (ADH). The kidneys reabsorb water into the blood (reabsorption), as a result of which urine output decreases and the body is protected from dehydration. The nerve-reflex mechanism is a very fast mechanism, when a person is cold, a signal is sent to the skeletal muscles. The muscles contract rapidly and shivering occurs. As a result of muscle contraction, heat energy is released and body temperature rises.[11, 14] The process of adaptation, in which an organism responds to changes in its external environment in order to maintain homeostasis, is called adaptation. Adaptation (from Latin, "adaptation" means adaptation), is a set of physiological, morphological and behavioral characteristics of an organism that ensure its survival and reproduction in changing external environmental conditions. Homeostasis and adaptation are closely related: while homeostasis maintains a stable internal environment, adaptation expands the organism's capabilities to maintain this stability. The stages of adaptation formation occur when an organism encounters new conditions (for example, climbing a high mountain or doing sports). Urgent adaptation occurs immediately with the onset of this external influence. The organism uses all its capabilities. For example, during physical activity, the heart rate and breathing rate increase. This stage consumes a lot of energy and quickly tires the body. Cumulative adaptation is formed when an external factor is exposed to it for a long time. In this case, structural changes occur in the body. For example, as a result of regular training, muscle growth or an increase in heart volume. [5, P. 40] Physiological adaptation The body adapts in the following areas to maintain homeostasis. This is climate adaptation, i.e. increased sweating in a hot environment or accelerated metabolism in the cold (to produce heat). Altitude adaptation is when the oxygen in the air decreases, the amount of red blood cells and hemoglobin in the blood increases. This increases the oxygen-carrying capacity of the blood. [1, P. 312]

Sensory adaptation is a change in the sensitivity of receptors, such as the adaptation of the eye when entering a dark room or getting used to constant noise. Adaptation is a "strategic way" to maintain homeostasis. If the external environment changes dramatically and the homeostasis mechanisms cannot cope with this, the organism raises its working functions to a new level through adaptation. The adaptive capacity of each organism is limited. If an external factor (stress, cold, poisoning) is stronger than the organism's ability to adapt, a violation of adaptation (disadaptation) occurs. As a result, pathological diseases arise. As a result of a violation of



homeostasis (dyshomeostasis), various pathological diseases develop in the body. In physiology, this condition is considered "the inability of the organism to restore the stability of the internal environment." The most common violation of homeostasis is associated with a loss of chemical balance, for example: diabetes mellitus is associated with a violation of glucose homeostasis. Energy balance (energy intake and expenditure) disorders lead to excessive accumulation of adipose tissue and obesity. Uric acid metabolism disorders lead to salt accumulation in the joints and gout. Arterial hypertension develops as a result of the failure of baroreceptors and renal mechanisms that regulate blood pressure. Disturbances in the stability of lipids in the blood plasma and the formation of plaques in the vascular wall lead to narrowing of the vascular wall with the formation of atherosclerosis. [4, P. 386-392] When the osmotic pressure balance between tissue fluid and blood is disturbed, edema occurs due to the release of fluid into the tissue. Acidosis and alkalosis occur when the pH of the blood shifts to the acidic or alkaline side (as a result of lung or kidney failure).[7, 8,] A change in the "thermostat" in the hypothalamus to a higher temperature due to infection or inflammation leads to fever (hyperthermia).[12] Hypothermia occurs when the body temperature drops below a critical level (depletion of energy reserves). A sharp acceleration of metabolism due to excessive production of thyroid hormones leads to a condition called Graves' disease (hyperthyroidism), in which the eyes become abnormally large in adults. Conversely, a slowdown in all physiological processes due to a lack of hormones leads to the development of hypothyroidism: The cause of clinical diseases of homeostasis: diabetes mellitus and atherosclerosis are the most striking examples of how the disruption of homeostasis reinforces each other. From a physiological point of view, a violation of the balance of glucose in the blood (diabetes) initiates a process that ends with the destruction of the structural integrity of the vascular wall (atherosclerosis).[10] The main problem in diabetes is the long-term high concentration of glucose in the blood (hyperglycemia), which is formed as a result of a violation of the balance. [4, P. 338-342] Excess sugar in the blood, combining with proteins (collagen and elastin) in the vessel wall, makes them brittle, and further exacerbates the symptoms of glycosylation. The inner layer of the vessels must secrete vasodilators to maintain homeostasis. Hyperglycemia "poisons" this endothelium, which is unable to perform its function, and as a result, it provokes endothelial dysfunction. Disturbance of lipid homeostasis leads to the rapid development of atherosclerotic plaques, which are formed by the accumulation of cholesterol and other fats in the walls of blood vessels. Normally, the exchange of cholesterol between the liver and tissues is in balance, which develops due to the balance of lipids. Cholesterol deposited on the vessel wall creates a focus of inflammation there, as a result of which the vessel narrows and, as a result of loss of elasticity, provokes the formation of inflammation. The stage of the pathological process of homeostasis is the occurrence of a pathology characterized by the disruption of homeostasis by an external (microbe, virus, trauma) or internal (genetic change) factor. The period when the body still looks healthy, but internal systems begin to fight stress, determines the clinical picture of



adaptation. The body uses its reserve capabilities and forms a pathological chain leading to compensation. For example, if one kidney fails, the second one works twice as hard, maintaining the stability of the internal environment. We hardly notice any signs of this. Disadaptation is an intermediate period between compensation and decompensation. Protective mechanisms begin to wear out, homeostasis parameters (pressure, pH, temperature) change. During the decompensation period, reserve forces are exhausted. The body can no longer maintain homeostasis. It is at this stage that all clinical signs of the disease (pain, swelling, fever) appear. [9,13,14]

Conclusion: The conducted analyses show that homeostasis is not just a static state of the organism, but a complex dynamic process based on the integral cooperation of the nervous and endocrine systems. Based on the above evidence, the idea of the constancy of the internal environment, founded by Claude Bernard and Walter Cannon, remains the foundation of modern medicine today. These analyses show that in maintaining homeostasis, rapid nervous mechanisms such as baroreceptors and adaptation processes play the role of the main shield that ensures the organism's resistance to the external environment. However, a violation of this balance, dyshomeostasis, negatively affects not only the work of individual organs, but also the metabolic system of the entire organism. It is worth noting that the hyperglycemic state, considered in the example of diabetes mellitus, has been proven to accelerate the process of atherosclerosis by disrupting the function of the vascular endothelium. A noteworthy feature is that the disruption of one chain of homeostasis causes chain-like pathological reactions. It should also be noted that maintaining the physiological balance of the body and preserving its adaptive reserves has been found to be the most effective way to prevent many chronic pathological diseases.

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