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ADAPTATION AND IMMUNITY

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It is shown that adaptive reaction to stress effect is non-specific and short-lived, and the immune response is specific and prolonged to 21 days.

Key words: *adaptation, stress, immunity.*

Introduction. Since the inception of the human society and along its development, there is a constant human desire to live a long, biologically and socially active life.

Human health is defined as the inner and outer harmony, which depends upon a huge variety of factors. Any factor determined separately, can not cover the diversity of the processes occurring in the human body as a result of its interaction with nature, social environment and all that defines the livelihoods and health causes. The solving of health problems requires an integrated approach. There are indicators that reflect the integral functional state of the whole organism. Qualitative and quantitative characteristics of these indicators can objectively assess the level of health. Method of determining the level of health allows not only to evaluate the overall human condition, but also determines the ways to strengthen it, directs high school teachers to use different means of recovery, compliance and lead a healthy lifestyle and implementing comprehensive individual health program [5, 19, 25, 26, 28].

It was found out that the body can be defined as physical-chemical system that exists in the environment in the steady state. This is the ability of living systems to maintain a steady state in the conditions of ever-changing environment and determines their survival. To ensure a steady state in all organisms – from morphologically simplest to the most complex – various anatomical, physiological and behavioral adaptations were elaborated that serve one purpose – maintaining a constant internal environment

It is known that a living cell is energetic, self-regulating system. Its internal organization is supported by active processes aimed at restricting, preventing or eliminating deviations caused by various influences of external and internal environments. The ability to return to its original state after the rejection of a mid-level caused by any factor is the main feature of the cell.

Multicellular organisms is the organization, cell elements of which are specialized at performing different functions. Interaction within the body carried out by complex regulatory, coordinating mechanisms involving neural, humoral, metabolic and other factors. Many individual mechanisms that regulate internal and intercellular interactions, provides mutually opposing actions that balance each other. This leads to the establishment of a body moving physiological background (balance) and allows a living system to maintain relative dynamic constancy, despite changes in the environment and the changes that occur during the life of the organism. Risk factors for premature aging include lack of exercise, frequent and prolonged stress, presence of chronic diseases, bad habits, poor nutrition, genetic factors (short lifespan of parents) [5, 19, 21, 28]. The list of these factors determines the main ways to prevent premature aging and increase life expectancy.

Adaptation – non-specific reaction the body. Adaptation is the ability of a living organism to adapt to changing environmental conditions that develop in the process of evolution. Without adaptation it would be impossible to maintain normal functioning of the body, its adaptation to changes in various environmental factors – abiotic, biotic and anthropogenic.

Through adaptation there is a support of constancy of internal environment and if some parameters of environmental factors go beyond the optimum. The problem of adaptation is of great practical importance now when a human develops new spaces, works in mines, underwater, in space when there is intensive denaturation of environment, its pollution by products of human activity that requires the tension of adaptive forces of the body [3, 16, 22].

Types of adaptation. Adaptations may be structural, physiological or adaptations of behavior.

Structural adaptations – are specific parts of the body that help it survive in the ambient environment. For instance, such adaptations may be skin color, body shape, or modification of skin cover.

Adaptations of behavior – are modification of behavioral reactions in response to changes in the environment. For instance, it may be conditional or unconditional reflexes.

Physiological adaptations – are systems within the body that allow to carry out certain biochemical or physiological processes – the secretion of poison, maintaining body temperature, neutralize toxins during digestion, etc. [11, 16].

The phases of the adaptation process. *First phase or "emergency"* – is developing at the start of both physiological and pathogenic factors or changes in environmental conditions. In this case all central systems react: circulatory, respiratory, and central nervous system which controls hormones of adrenal medulla (kahealaminy), accompanied by raising the tone of the sympathetic system. The result of the activation of sympathetic-adrenal system is changes of vegetative functions that have catabolic nature and provide an organism with the necessary energy, foreseeing the need in the near future expenses. These warnings are striking manifestation of "outstripping" excitation.

In the emergency phase the hyperactivity of auxiliary systems proceeds without coordination, with elements of randomness. Reactions are generalized and not economic and often exceed the required level for these conditions. The number of modified parameters in different systems is very high [3, 6, 29].

Emergency phase of adaptation takes place against the background of emotionality (negative modality).

The second phase – the transition to a sustainable adaptation. It is characterized by a decrease in the overall excitability of the central nervous system, the formation of functional systems that provide management of adaptation to new conditions which have arisen. There is a decrease of intensity of hormonal shifts. During this phase adaptive response of the body switch to a deep tissue level. Hormones level is

changed, there is an enhance of the action of the adrenal cortex hormones – "hormones of adaptation" [8–10, 18, 29].

The third phase – the phase of a sustainable adaptation (resistance). Auxiliary systems are functioning at baseline. Tissue processes are being activated, providing a new level of homeostasis, adequate to the new conditions of existence [14, 24, 25].

Peculiarities of this phase:

- mobilization of energy resources;
- increased synthesis of structural and enzymatic proteins;
- mobilization of the immune system.

In the 3rd phase the organism acquires non-specific and specific resistance. Control mechanisms are coordinated. Their expression is minimized. But as a whole the phase requires stress management, which is caused by the inability of constant occurrence. Tension of this phase is called price of adaptation. The phase is not completely stable. During the life of the body there may be reject fluctuations (decrease of stability) and rehabilitation (establishing of stability) [4, 6, 17].

Should be remembered that health depends on many factors, which are combined into one integrated concept – healthy lifestyle. Its purpose is to teach a person reasonably take care of their health, physical and mental culture, harden your body, skillfully organize work and leisure.

Mechanisms of adaptation. There are three mechanisms of adaptation:

- passive way of adaptation – the type of tolerance, endurance;
- adaptive way acts at the cellular level;
- resistant way – saves the relative constancy of the internal environment.

Adaptation to any factor associated with energy use. In the area of optimum active mechanisms are not needed and energy is spent on basic life processes, the body is in balance with the environment. With increasing load and its output beyond the optimum there is induce of adequate mechanisms.

Mechanisms that provide adaptive character of overall stabilization of certain functional systems (ie, increased consumption of oxygen, increasing the intensity of metabolic processes. This happens on the organ level, there is an increase of the

speed of blood flow, blood pressure, respiratory volume of the lungs, breathing becomes more frequent, and deeper) and the organism as a whole. General adaptive response of the body is nonspecific, ie the body reacts similarly in response to the actions of different quality and strength of stimuli [18, 24, 25, 29].

Immunity is a specific reaction of the body. The immune system provides interaction of organisms with the internal and external environment and takes genetically alien signals. The ultimate goal of the immune system of a constant internal environment, conservation and preservation of homeostasis his chances of survival. Implementation of this feature is implemented by 10^{12} immune cells. The system and its components have the ability to perceive information, process it and form for this situation and response. The immune system can store the information and use it in the future, which means the immune system has a memory [8–10, 20, 26].

The trigger for immunological reactions influence antigen – genetically foreign matter. The final stage of the reaction – the formation of sensitized lymphocytes, antibodies and many broad spectrum of interleukins. At its beginning and end of the process-specific, but in its implementation plays a significant role nonspecific reactions in the body that are closely related to the specific protection mechanisms [20, 26, 30–34].

According to modern concepts the immune protection is implemented through the joint work of the immune system – bone marrow, thymus, spleen, lymph nodes, different populations of lymphocytes, phagocytes and their cooperation. Lymphoid cells and organs are affected by many endogenous factors that change the intensity of the immune response, immune cells and the degree of involvement dynamics of their activation. Qualitative characteristics of immune response caused by the properties of the antigen, and the intensity is not only the quality and quantity, but a number of other factors. Factors of regulation of the immune system of their origin are divided into intra-immune that occur within the immune system and extra-immune – nervous, hormonal, neurohormonal [12, 20, 22, 26, 31, 32].

Adrenalin, noradrenalin and acetylcholine receptors affect immunocompetent cells. Neurotransmitters exhibit regulatory effects on cellular processes of

cooperation and the formation of clones of effector cells of the immune response. Activation of adrenergic mechanisms in the induction period of the immune response and cholinergic mechanisms in the productive period – a process of optimization reactions to antigenic stimulus [8–10, 18, 20, 26].

Problems of stress and the immune system have been widely studied due to the presence of positive and negative effects of stress on the actions defenses. Weak stress stimulates the humoral immune response and strongly suppressed [8–10, 18].

The most susceptible to stress condition is T-cell immune system link. The reasons for this are less resistance to T lymphocytes glucocorticoids compared with B-lymphocytes.

In the early period of stress – "anxiety reaction" redistribution of lymphocytes, resulting in spoiled thymus, spleen, lymph nodes [8, 9, 18, 20, 26]. At this stage, there is an increase in functional activity of lymphoid cell number, activation of cooperative interactions, increase in the content of stem cells in the bone marrow. Perhaps the early stages of development of stress T-suppressor function is reduced and therefore at this stage may increase in autoimmune diseases.

If the stress factor by its power is not damaging to the given organism , then comes the "stage of resistance", which an organism, "turned its spare capacity", able to resist these actions. If stress is then repeated it causes depletion of the body [3, 14, 27, 29].

Researches of many authors have shown the reduction of T cells, disruption relationship between T-, B lymphocytes and phagocytes [3, 8, 10, 18, 20, 26]. Further changes occur nonspecific protective reactions, decreased functional activity of macrophages, but the level of antibodies remained at normal values.

Prolonged stress causes depression action that covers all major subpopulations of T lymphocytes (T-killer cells, T-suppressor regulators, T helper cells and B cells.

There is a reduce in functional activity of B-lymphocyte proliferation decreases, the amount of i B cells in lymphoid organs are reduced as well as i immunoglobulin levels down to the disappearance of [18, 27].

Violation of cooperative processes of immune cells during stress can result from both inhibition of functional activity of these cells and the effect of reducing the synthesis of secretion of cytokines (interleukins, interferons, etc.). As indicated by the work of many researchers [8–10, 12, 18, 20,]. It is known that the level of IL-1 in the conditions of the stress is being increased, which is natural. Increase of IL-1 in blood and its synthesis by monocytes during stress may stimulate or suppress the intensity of the humoral immune response. The reaction of lymphocytes to IL-1 in low stress results in increase of proliferation, while strong in a decrease. This is the number of modified enzyme sphingomyelinase. So with a strong stress the transduction of this enzyme is dramatically reduced, and in low is increased.

The immune system is one of the first to include the effect of internal or external stress – factors and receptors on immune cells are many mediators of stress, catecholamines, serotonin, endorphins, corticosteroids and others [8–10, 12, 18, 20].

Grinevich Y. A. and other researchers [7], when studying lipid peroxidation in the membranes of lymphocytes after exposure to immunostimulants of different nature – PHA, splenin, timostimulin and microbial antigens nature, have come to a conclusion that the mechanisms of the immune response activation LPO cells plays an essential role in the early stages of development of the immune response. The maximum accumulation of malondialdehyde, the end product of lipid peroxidation occurs at 2–3 days after antigenic stimulation, and the peak of spontaneous chemiluminescence was recorded already next day after immunization, while antibody titers in mice peaked on 5–7 days, and in rats on 9–11 days of experiment [13].

Activation of free radical processes and lipid peroxidation are a mandatory component of response of the body to the action of any stress agent [1–4, 6].

The immune response to the effect of stress goes through several phases. Inductive phase occurs within 1 day, proliferative phase reaches a maximum of 3 days, productive phase starts on 5th day and to release the body from foreign agent immune system it requires 21 days [6, 18, 20, 26].

Thus adaptive response of the body is nonspecific and short temporal and immunity is specific and prolonged response to the stress agent

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АДАПТАЦІЯ І ІМУНІТЕТ

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Показано, що адаптаційна реакція організму на дію стресових факторів є неспецифічною і короткочасовою, а імунна реакція – специфічною та тривалою до 21 доби.

Ключові слова: *адаптація, стрес, імунітет.*

АДАПТАЦИЯ И ИММУНИТЕТ

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Показано, что адаптационная реакция организма на действие стрессорных факторов есть неспецифической и краткой, а иммунная реакция – специфической и длительной до 21 дня.

Ключевые слова: *адаптация, стресс, иммунитет.*