

Components of the human body environmental preparedness for adaptation. Literature review

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Abstract. Health completeness is the adaptation completeness, a human body's property of being "inscribed" into the living environment. Homeostasis, a good adaptation at high trophic and neurohumoral interaction of all organs. Cells functioning environment is blood and lymph. Lymph flows into the bloodstream, so the quality of the internal environment is determined by the quality of the blood. Modern living conditions alter the internal environment: exogenous toxins accumulate in the intercellular space, in lymphatic and later in the circulatory system, causing intoxication. Qualitative organism functioning is provided by removing endotoxins. They can be rejected and excreted only by the organs having excretory ducts. Natural blood filters, having excretory ducts, indirectly related to the environment are the liver, kidneys, and pancreas. Their self-cleaning property solves the problem of natural recovery of human body functions, strengthen environmental preparedness of the human body for adaptation.

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Introduction

Back in the mid-twentieth century, academician Davydovskiy I.V. referred the most important reason for the transformation of physiological processes into pathological ones to the lack of adaptive reserves, ecological failure of human body's property of being "inscribed" into the living environment [1]. This reduces the level of health, labor, social significance and duration of life. The quality of adjustment to the future, but not yet occurred event, is simultaneously the principle of ensuring natural selection [2, 3]. In the context of demographic aging of the population, it is especially important to preserve individual health, the extension of labor and social activity of people. Therefore, it is necessary to find ways of increasing adaptation to changing environmental conditions, natural recovery of body functions, increase of functional reserve capacity and environmental fitness involved in the process of system adaptation. Many scientists have been and are currently engaged in solving these tasks, including [4-15]. We propose the concept of human body's elements functioning, enhancing its environmental readiness for adaptation.

Main part. Health completeness is a completeness of adaptation to the changing environmental factors [16]. In the condition of external environment changes, the body maintains homeostasis and high quality of functioning in the presence of adaptation reserves [16-18]. Provision of adaptation and homeostasis at the control level is performed by means of neuroendocrine regulation, which represents systems of reception and passing regulatory signal to the executive cell system of functioning organs. About 20% of the human

functioning genome is aimed at this action [19]. At the investigated level, adaptation and homeostasis are possible when the *internal environment of the human body* provides the high quality trophism and neurohumoral interaction. Optimal medium for transportation of organic, inorganic substances and metabolic reactions is an aqueous medium of a human body [20]. So as an adult person consists for more than 55% of water [21], the maximum interest is focused on the *quality* of the human body's fluid mediums – *blood* and *lymph*.

At rest, the heart pumps 4.6 liters of blood per minute, per day it is 8-10 thousand liters [20]. The circulatory system serves: lungs (blood oxygenation); liver (processing the primary quantity of nutrients and neutralization of toxins coming from the blood); blood-forming organs (supplementing of the blood work-out cells); endocrine glands (in blood releasing of hormones for humoral regulation of body's vital activity) [22]; and kidney (from blood extraction of the substances which are to be removed from the body) [23]. From the gastrointestinal tract organs, the nutrients carrying blood outflows to the portal vein, which is sequentially branching in the liver up to the capillaries. The volume of blood flowing into the liver via the portal vein reaches 2/3 of the circulating blood volume [24]. From liver the blood flows into the inferior vena cava, further into the heart, lungs, and then feeds the whole body.

The human body contains 1-2 liters of lymph [25]; 3/4 of its volume gathers in the thoracic duct coming from the abdominal cavity and the lower half of the body [21]. 2/3 of this volume [20], i.e. half of the total lymph amount [26] comes from the liver. The lymphatic system provides the lymph formation

and its diversion into the venous system; resorption from tissues of the interstitial fluid, which is the external environment for most cells of the body [22]; performs the return of proteins, water, salts, metabolites and toxins from the tissues into the blood; participates in immunity establishing, in protection against disease-causing microbes and viruses [25]. The volume of liquid, returning through the lymphatic system into the blood, constitutes 2-3 liters per day [20]. Since lymph flows into the bloodstream, namely blood nourishes all organs, tissues and cells of the body; the quality of the internal environment is determined, above all, by the quality of the blood. A human living within the modern conditions dramatically changes the quality of the internal environment: exogenous toxins caused by poor living environment and ecology addictions, impaired cellular metabolism products accumulating in the intercellular space, and then in the lymphatic and circulatory systems. So, intoxication is growing. The quality of cell habitat is disrupted, impaired are their functioning and responses, which ensure the maintenance of homeostasis under the external changing conditions. Currently, this problem has the character of the broadest epidemic. Normalization of the internal environment, environmental preparedness capacity of the human body to adaptation is a priority for the preservation of health and the survival of humanity. The accumulated endotoxins circulate through the blood and lymph in the body. The investigations performed by Levin Y.M. demonstrate how toxic the lymph [27] and then the blood may become. The organ cells, having excretory ducts (stomach, intestines, liver, gallbladder, pancreas, kidney, bladder) may reject the endotoxins accumulated into the lumen of ducts and cavities, and then remove them from the body. Purification from the endotoxins of organ cells, not having the excretory ducts, is possible only through the lymphatic and then bloodstream. At the same time the blood cleaning from toxins is possible only in the presence of *natural filtration systems capable of performing this work* within the human body.

Let us consider the organs having excretory ducts and determine which ones are able to effectively carry out a blood self-cleaning from endotoxin. Stomach and intestines provide processing and absorption of food components into the blood and lymph, and gall bladder provides a transient accumulation of ingredients, secreted by the liver and kidneys. Stomach, intestines, pancreas and bladder are the hollow organs, with the muscular wall, able to conduct through themselves components, excreted outside by the liver, pancreas and kidneys, but do not have the mechanisms of blood filtration. Liver, kidneys and pancreas have some analogy structural

features and functioning. All of them are parenchymal, blood filling; have internal excretory ducts, which open into the other organ cavity and intercommunicate with the surrounding environment.

Let us compare the function features of the liver, kidneys and pancreas. The liver is involved in the metabolism of carbohydrates, lipids, proteins, enzymes, vitamins; ensures the formation and secretion of bile [28] needed for the absorption of the lipid components of the food, performs the bactericidal role, stimulation of microflora in the large intestine, epithelial renewal in the small intestine, the regulation of motor function of the gastrointestinal tract [29]. The liver performs the antitoxic function with neutralization of intestinal poisons, toxic metabolites, and exogenous poisons. A liver disorder is an important pathogenetic link to intoxication, which is caused by the in blood buildup of substance levels that have a general toxic and cerebrotoxic action. Bile enzymes also contribute to the toxicity: unconjugated bilirubin provides a pathogenic effect on cell membranes of tissues and organs. In connection with the general intoxication, there is impaired a systemic hemodynamics [28]. The most important functions of the *kidneys* include: maintaining the qualitative condition of water-salt metabolism of human body and environment, a constant concentration of salts in the internal environment of the body [25] and, accordingly, the osmotic pressure of the blood, the level of arterial blood pressure [28]. The kidneys are responsible for filtering, reabsorption and excretion of urine into the environment, and slags along with the urine. Together with the urine there are secreted both end products resulting from the metabolism and some not fully oxidized decomposition products (water, salt, ammonia, urea, uric acid, etc.). The kidneys remove from the body toxic substances detoxified by the liver; also derive some poisons, such as taken in the form of drugs [19]. Additionally, it should be noted that the urinary and genital organs are combined by the commonality of development, have close anatomical and functional relationships [30]; their excretory ducts open into the urogenital sinus separated from the cloaca [22]. It should be noted that Chinese medicine classifies the reproductive system disorders to the diseases associated with impaired renal function [31]. Thus, the system of the kidneys and the bladder is associated with genital function [22]. Let us note the common features: both the liver and kidneys can detoxicate and excrete toxic substances. *The pancreas* daily secretes and excrete through its ducts to the small intestine about 1 liter of pancreatic juice (exocrine function) containing enzymes for the digestion of carbohydrates, proteins and fats, as well as bicarbonate to neutralize the

acidic chyme coming from the stomach [17]; by the islets of Langerhans secretes insulin and glucagon hormone regulating blood glucose levels (Endocrine Function) [21]. The secreted pancreatic juice may be excessively dense and even cause pancreolithiasis [32]. Usage of increased amounts of toxins (eg., alcoholism, smoking) is one of the reasons for the pancreatic juice thickening and stone formation in the pancreas [33]. Thus, the pancreas can filter the blood and remove toxins into its ducts, the same as liver and kidney do.

Let us compare the performance of the liver, kidneys and pancreas as organs capable of filtering the blood in the human body. The main indicators of the organ abilities are its weight, the amount of blood flow, oxygen consumption and the level of its utilization (arteriovenous oxygen difference) (see Table 1) [34-45].

Table 1. Evaluation of the organ performance according to their weight, volume of blood flow, oxygen consumption and utilization

Organ	Weight, gr	Amount of blood passing through the organ (l/day)	Oxygen consumption (ml/100 gr of organ mass/min)	Arteriovenous oxygen difference (ml/100g of blood mass/min)
Liver	1200-2000	2000-7200	$5 \cdot 10^{-2} - 6 \cdot 10^{-2}$	Portal vein – hepatic vein: $4 \cdot 10^{-2} - 5 \cdot 10^{-2}$; hepatic artery – hepatic vein: $8 \cdot 10^{-2} - 10 \cdot 10^{-2}$
Kidneys (300 both)	120-150	1500-1800	$5.5 \cdot 10^{-2} - 6.5 \cdot 10^{-2}$ (the inner layer of the medulla – $0.3 \cdot 10^{-2} - 0.5 \cdot 10^{-2}$)	$1.5 \cdot 10^{-2} - 2 \cdot 10^{-2}$
Pancreas	70-90	70-250	$1 \cdot 10^{-2}$	$1 \cdot 10^{-2}$

Liver, performing more than 500 metabolic functions [46], adjusts the chemical composition of blood. This is a sort of a "chemical factory" of the human body where blood is cleaned and toxins are excreted. The second in its abilities organ, cleansing blood and excreting slags, is the kidneys. The filter with minimal abilities is pancreas.

Let us compare the structural features of the liver, kidneys and pancreas. All are parenchymal. Into them there is secreted a capsule, intraorganic stroma (connective tissue) and parenchyma. Parenchyma is the determining element providing for the main specific functions of the organ [47]. In each of the given organs, parenchyma forms the specialized spatial structures. In the liver and pancreas these are slices, in the kidney these are nephrons, organized in a pyramid. The lobules of the liver and pancreas are also of a pyramidal shape. All of them are qualitatively perfused, have a system of excretory ducts draining into the main excretory duct [48]. It is known that the secrets produced by the liver, kidney and pancreas are capable of stone formation. Moreover, the more toxic substances are consumed by the person, the more of them are in the blood, and the higher is the stone formation. Therefore, we can conclude that the main blood filtering systems that support the purity of the

internal environment are the liver, kidneys and pancreas.

Conclusion. In the nature there is no mechanism, which would have the efficiency of 100%. Our body is no exception. Excreted substances partially remain in the ducts of the blood filtering organs, making it difficult for their full operation. With age and depending on the ecological tense of the living environment, these processes are worsening, the quality of blood filtering from toxins weakens – intoxication increases. To solve the problem of the natural recovery of human body functions and to improve its environmental readiness for adaptation, it is necessary to find ways for "maintaining the purity of" the excretory organ ducts – the filters, *naturally cleansing* the blood of toxins (liver, kidney, pancreas).

Summary

1. Modern living conditions alter the internal environment: exogenous toxins cause intoxication, health weakening and diseases.
2. Health completeness is a completeness of adaptation to the changing environmental factors. Adaptation is provided by the increased reserves of the human body adaptive abilities.
3. Adaptation reserves are provided by increasing purity of the internal environment (endoecology) and, above all, purity of body fluids (blood and lymph).
4. Lymph flows into the bloodstream. Blood nourishes all organs, tissues and cells of the body, so the quality of the internal environment is determined primarily by the qualitative composition of the blood.
5. For the good body functioning, the toxins must be removed. These actions can be performed by the organs that filter the blood and have excretory ducts.
6. Natural blood filters, having excretory ducts and indirectly related to the environment, are the liver, kidneys and pancreas.
7. Since there is no mechanism in nature, which would have efficiency of 100%, the toxins being excreted remain partially in the ducts of the blood filtering organs, preventing them from full-rate functioning.
8. To solve the problem of the natural recovery of human body functions and to improve its environmental readiness for adaptation, it is necessary to find ways for "maintaining the purity of" the excretory organ ducts – the filters, *naturally cleansing* the blood of toxins (liver, kidney, pancreas).

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