Threat to Health of the Nation - Food Pyramid

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***Abstract*—Activity is provided with receipt of exogenous food connections ("a food pyramid") and use of endogenous sources ("a power pyramid"). On the basis of the analysis of relationship of absorptive and post absorptive food periods the generalized metabolic model of metabolism is offered and certain algorithm of use of separate food unions for ensuring processes of rehabilitation and work. For the modern person insufficiency of endogenous power materials for maintenance of intellectual and operator kinds of activity that is the main reason for development of chronic noninfectious diseases–diabetes and obesity is characteristic. Such insufficiency approaches of correction are offered.**

***Index Terms*—theories of food, noninfectious diseases, prevention**

I. Introduction

Now consider that because of improper feeding of people dies in 70-80 years of old age diseases, which are on a third before allocated for it by the nature and genes of 110-120 years. The role of food is an ensuring all processes of growth and development by necessary power, structural and regulatory factors. In 1992 the Ministry of Agriculture of the USA offered the model of food of the population presented in the form of a pyramid which gave representations what products and in what quantity it is necessary to use for preservation of good health and longevity. However norms of needs of an organism for feedstuffs and energy, representation in the form of a food pyramid are developed on the basis of average sizes while it is more expedient to develop food model which would consider both specific features of the person, and a biorhythm of physiological processes [1].

The existing models of balanced nutrition are based on determining of average requirements in the main nutrients and energy derived from experiments on animals and observations of human beings. They are mostly based on energy expenses of various groups of population, and are in the form of requirement tables in macro- and micronutrients dependent on gender, age, occupation and other variable.

Carbohydrates are the principal source of energy for body because glucose is the only source of energy for such vital tissues and systems like brain and blood cells, and the decline of its blood level below some critical point blocks the vitality [2], therefore all types of metabolism and all regulatory systems must participate in the maintaining of glucose homeostasis.

Carbohydrates enter the body at varying rates, thus one could conventionally identify two opposite states: feeding and fasting. From the energy supply standpoint these states can be defined as the state of "Surplus energy", or glucose (absorptive period), and the state of "Energy deficiency" (postabsorptive period) when the glucose supply is made on the account of glycogenolysis and gluconeogenesis.

Glucose homeostasis may be maintained on the account of auto-regulation of enzymes involved in its utilization and synthesis [3]. However, such a regulation has limited potential, and one can observe considerable fluctuations of glucose levels at excessive or deficient intake of carbohydrates with food, as well as at various physiological and pathological conditions that determine the existence of more powerful systems for maintaining glucose homeostasis of the body.

Even though carbohydrates usually constitute over half of energy value of daily ration, however, the body is forced to balance on the edge of their deficit and to save glucose molecule from complete oxidation, for instance, by recycling it via lactate (Cori cycle). Later Feling [4] proposed a model of recycling of glucose via amino acid alanine (glucose-alanine cycle). This model considers the involvement of protein metabolism in maintaining glucose homeostasis.

These models do not take into account the fluctuating character of food intake (they are stationary models), and they disregard the interrelationship between the metabolisms of every nutrient (proteins, lipids and carbohydrates). Moreover, generation of lactate and alanine occurs during the period of "Surplus energy", but gluconeogenesis is blocked at this stage while there is no depot of neither lactate, nor alanine in body. Glucose synthesis from lactate and alanine is activated during the "Energy deficiency", but there is no nutrient inflow which would energize the generation of lactate and alanine, thus these stages occur actually in different time.

II. Methods

The method of division of food streams according to metabolic characteristics in various phases of activity of

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the person was used. So, after meal (the absorptive period) there is an activation of a parasympathetic part of the nervous system and secretion of a hormone of insulin that promotes activation of processes of updating of protein aceous and cellular structures and storage of an excess stream of energy, but thus there is a decrease in physical and intellectual working capacity therefore it is conditionally possible to call this period a phase of "rest".

When the person performs work (phase "works"), its power providing happens at the expense of internal (endogenous) sources (the post-absorptive period).

III. Results

Taking into consideration the routes of transportation of carbon skeleton and stages of interrelation between the processes of generation and utilization of ATP energy dependent on supply of the body with food energy, we have developed a model of glucose homeostasis of the body which takes into account the metabolism of all nutrients (Fig. 1).

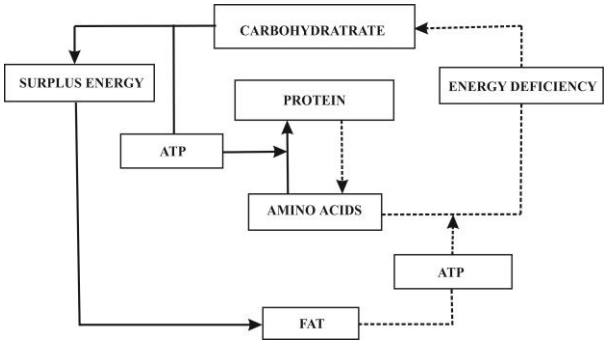

Figure 1. A conceptual model of interrelation between metabolism of protein, fat and carbohydrates for utilization exogenous (⟶) and endogenous (⇢) nutrition flows.

During the "Surplus energy" (for utilization exogenous nutrition flow) glucose utilization (dissimilation) is accomplished via storing it as glycogen and oxidation. If glucose inflow exceeds its dissimilation rate, then the excess carbon skeleton is utilized for the synthesis of lipids, that is, a combined anabolic lipogenesis is switched on.

Glucose oxidation results in the generation of ATP energy, therefore, there should exist routes to utilize this energy, since the excess ATP automatically block glycolysis. From the dietetic standpoint the process of protein synthesis is of interest. In other words, the rate of amino acids intake with food is an important regulator of glucose utilization.

Thus, during the "Surplus energy" the process of glucose dissimilation is associated with the two assimilation processes: with lipogenesis in regard of carbon skeleton, and with protein synthesis in regard of generation and utilization of ATP energy.

Even though glycolysis and protein synthesis are interconnected via generation and utilization of ATP energy, however, these metabolic flows are closely interrelated since no protein synthesis occurs without energy supply while reduced utilization of ATP energy blocks ATP generation or glycolysis. In such case an excess carbon skeleton will be redirected to lipid synthesis resulting in obesity.

During the "Energy deficiency" (for utilization endogenous nutrition flow) glucose homeostasis is maintained on the account of its endogenic synthesis from amino acids, those results in protein catabolism to supply the required substrates while lipolysis and lipid oxidation get activated to supply the energy for gluconeogenesis. This stage is characterized with combination of two dissimilation processes (protein catabolism and lipid oxidation) and one assimilation process (gluconeogenesis). Glucose synthesis is associated with lipid oxidation through the generation and utilization of ATP energy, while with protein catabolism - via routes of transportation of carbon skeleton.

Though gluconeogenesis and lipid oxidation are associated with each other through the generation and utilization of ATP energy, these metabolic flows are inter-dependent. For example, blockade of lipolysis [3] or lipid oxidation [4] automatically causes the decline of gluconeogenesis resulting in hypoglycemia, and on the contrary, the reduction of concentration of the substrate for gluconeogenesis blocks ATP synthesis from acetyl-CoA and results in condensing of excess acetyl groups in acetoacetate and oxybutyrate, leading to ketosis, for instance, in diabetes or fasting [5].

Thus, glucose homeostasis in the body depends to considerable extent on interrelations between the metabolism of proteins, lipids and carbohydrates. This dependence is determined by the capacity of any component of the food to affect individual steps of conversion of other nutrients with involvement of regulatory function of hormones. This model may serve as a theoretical basis to develop a dynamic model of balanced nutrition.

Models of glucose recycling via lactate or alanine are circular, that is, carbon skeleton of glucose is used to synthesize lactate or alanine while glucose synthesis requires the return of carbon skeleton. In our model during the "Surplus energy" the carbon skeleton of glucose is used for lipid synthesis while at the "Energy deficiency" there occurs a loss of that carbon skeleton (elimination in the form of carbon dioxide at lipid oxidation). On the contrary, ATP energy generated at glucose oxidation is spent for protein synthesis, and we again get back the carbon skeleton.

Hence, our model can be defined as a cross-like one, since there is no direct route of transportation of carbon skeleton or energy because of opposite direction of assimilation and dissimilation of proteins, lipids and carbohydrates during the "Surplus energy" and the "Energy deficiency". If during the "Surplus energy" one observes activation of protein and lipid assimilation and carbohydrate dissimilation, then during the "Energy deficiency" protein and lipid dissimilation and carbohydrate assimilation occur, thus glucose homeostasis in the body is maintained on account of utilization its excess flow to include the carbon skeleton in lipid synthesis, while ATP energy is directed to

protein synthesis, and during the endogenic glucose synthesis lipids provide ATP energy while proteins supply the carbon skeleton.

Extensive studies on the specifics of metabolism in fasting or intake of individual nutrients are available; therefore these states are a convenient model to assess the intensity of metabolic flows from the position of the proposed model.

Hepatic glycogen stores almost completely disappear after a 24-48 hour fasting [6], therefore the body is supplied with glucose due to protein catabolism [7] and lipid oxidation. Introduction of the key gluconeogenic amino acid - alanine - causes an increased glucose production in the liver [8] while oleic acid (energy substrate for gluconeogenesis) increases hepatic glucose production almost two-fold [9], and on the contrary, the inhibition of lipolysis [10] or fatty acid oxidation [11] result in hypoglycemia.

Muscular alanine synthesis in fasting is completely dependent on the levels of branched amino acids produced in protein catabolism, and their levels are elevated during the first week of starvation [7]. A two-week feeding of rats with low-protein chow did not affect blood glucose level [8], but the starvation caused more expressed hypoglycemia.

Obesity is the most prevalent metabolic disorder. Among the causes of obesity the most often is over-eating, especially carbohydrates [12]. This correlates well with the considerations on the character of metabolic flows during the "Surplus energy" when the surplus flow of under-oxidized glucose (lactate) is directed to lipid synthesis. There are available data evidencing to the development of lactate-acidosis in obesity [13] and high correlation between blood lactate concentration and size of adipocyte [14].

Obesity causes activation of metabolic flows during the "Surplus energy", therefore obese patients have an increased blood concentration of insulin [15] while on the contrary glucagon levels are lower [16].

Thus, metabolic changes arising at various physiological states of the body and metabolic disorders are determined to a considerable extent by inadequacies between nutrient flows that stipulate the possibility of correcting them with nutritional factors.

A certain balance between individual nutrient flows should be maintained. During the "Surplus energy" such balance should be met between the flows of glucose and amino acids. Excess glucose flow induces hyperglycemia and lipidemia while inadequate glucose intake with food leads to a lower inclusion of amino acids in proteins resulting in hyperaminoacidemia. Therefore, adequacy between these nutrient flows is the most important principle of balanced nutrition.

During the "Energy deficiency" depot flows are utilized. The balance between the flows of amino acids (pool of free amino acids) and lipids is of key importance at this stage. It is well known, that lipid reserves (in the form of triglycerides) are much higher than protein reserves (in the form of muscular protein), and therefore the prevalence of lipid flow is the most often seen phenomenon. This inadequacy becomes more evident in low-protein rations when there are no enough amino acids or energy for protein synthesis. In such cases there occurs the reduction of the pool of free amino acids and more pronounced hypoglycemia and ketosis in fasting. Hence, there take place dynamic changes of metabolic indices which depend on the ratio of individual nutrients in food; therefore, the proposed model is a theoretical basis for the dynamic model of balanced nutrition.

The general endogenous stocks in an organism are quite considerable and for the healthy young man weighing 65kg make 136.000kcal. 93% of stocks, on a protein share - 6%, and on a share of carbohydrates – only the fifth part of percent (0.2%) fall to the share of fats. If to consider that fact that at starvation at rest we spend about 1.000kcal a day, this amount of energy would be enough for 136 days of a complete starvation. Actually these calories are enough for smaller term. It is connected with that power providing one kinds of activity is carried out due to oxidation of fats whereas others – glucose. The main problem is a deficiency of glucose. Free glucose (blood glucose) only 5g (20kcal) contain, i.e. this quantity will be enough only for one hour of work of a brain at rest (a night dream). The glycogen of a liver can ensure functioning of a brain within 4-8 hours, i.e. at the expense of these sources it isn't possible to live also one day. Providing a brain with glucose at its insufficient receipt with food is carried out mainly at the expense of a gluconeogenesis, as a substratum for which amino acids that conducts to disintegration of proteins are used. Utilization of fabric proteins leads to development of various functional violations which are well studied at starvation (Fig. 2).

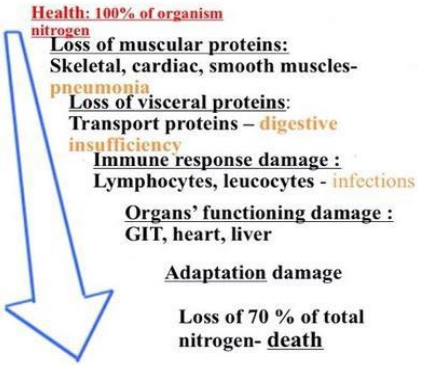

Figure 2. Dynamics of loss of fabric proteins and health at starvation [17]

Use of muscle proteins promotes development of muscular weakness, deterioration of activity of respiratory muscles and development of pneumonia. Utilization of visceral proteins (proteins of blood) leads to deterioration of transport function of blood and development of endogenous food insufficiency. Expenditure of blood cells (lymphocytes, leukocytes) causes violation of the immune answer and promotes development of infectious process. Development of these manifestations is especially characteristic for the persons who are engaged in intellectual and operator kinds of activity when the need for energy of glucose sharply

increases. Therefore at this category of the population incidence is higher and life expectancy is lower.

IV. Discussion

The first food which the person faces is a milk of mother which on composition of macronutrients can be carried to the Highly Fats (HF). When the child passes to natural feeding, he already receives Highly Carbohydrates (HC) a diet, but HF the principle of food remains in breaks between feedings. Now and further ensuring processes of activity is carried out already at the expense of two food streams: an exogenous food stream (ExoFS) of the being HC and an endogenous food stream (EndoFS) of the being HF. Actually in food of the person have to consider two food streams: it is ExoFS for ensuring processes of growth and development and EndoFS for provision of energy of physical and mental work. If to keep alternation of nutrients in ExoFS and EndoFS and to present them in the form of pyramids, they will be multidirectional (Fig. 3).

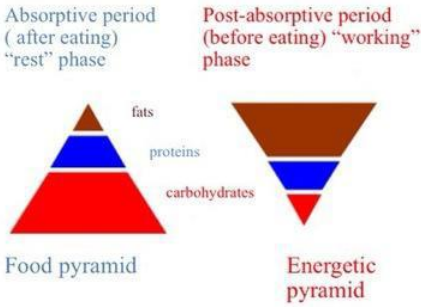

Figure 3. Ratios of nutrients in food and in power pyramids

Here such turned pyramid (during the post-absorptive period) illustrates energy needs of work of the person. Earlier the food should be "caught up" or "grown up" that was carried out mainly due to energy of fats. Fats are also necessary for heat production maintenance. Now we are warmed at the expense of clothes and heaters, we buy food in shop therefore consumption of fats was sharply reduced by these purposes that reduces their use and leads to accumulation. Glucose expenditure, on the contrary, sharply increased as in our activity operator and intellectual kinds of activity prevail. In other words for the modern person the condition of "abundance" of fats against "deficiency" of glucose is characteristic. Development of such power imbalance is the main reason for increase in patients with diabetes and obesity and decrease in life expectancy of the person.

For substrate ensuring metabolic processes in phases of work and rest various food connections are required. So, if in ExoFS fats are required: animal as basic, vegetable and fish for creation of membranes of cages and synthesis of biologically active molecules, in EndoFS as fats it is necessary to use shortly and the middle chained triglycerides which are taking part in power providing. As a source of protein or amino acids in ExoFS amino acids whereas in EndoFS such replaceable amino acids as alanine, serine, glycine are required are important anabolic (leucine, valine, an isoleucine), irreplaceable (a lysine, methionine, threonin) and media even (tryptophan, phenylalanine). From carbohydrates: at ExoFS there has to be a polysaccharide starch, maltose disaccharide, monosaccharide glucose whereas in EndoFS from polysaccharides inulin, disaccharides aren't present, and as monosaccharaides - galactose and fructose.

It means need of intake of these feedstuffs in a certain phase of activity or to adhere to a certain algorithm of food [18]. We will take, for example, a monosaccharide fructose. On sweet it is one and a half times sweeter than sugar therefore, proceeding from a postulate that it is necessary to reduce intake of digestible carbohydrates, it was decided to replace in drinks sugar with fructose. However now there was a large number of works that consumption of the fructose-containing drinks is the reason of growth of diabetes and obesity [19], [20]. The organism in the power purposes doesn't use fructose. At absorption from intestines in a liver it turns into glucose and already in such look comes to a blood-groove. However during the absorptive period secretion of insulin which blocks a way of transformation of fructose to glucose therefore fructose comes to a blood-groove in not changed look is noted. Both fructose and glucose well gets into cages, but cages use mainly glucose therefore there is an accumulation of fructose to formation of conglomerates that promotes development of a cataract and polyneuritis. Besides, fructose joins in a way of formation of lipids which accumulation in muscles leads to development of an insulin-resistance i.e. to development of diabetes and obesity [21].

Also a lot of talk goes concerning palm-oil. As it is cheaper than animal fats, it had begun to enter into compositions instead of these fats, i.e. to use in ExoFS when palm-oil doesn't participate in processes of growth and development. Therefore there is its accumulation and development of the pathological violations connected with it. But palm-oil will be a good power source in EndoFS.

Life of the city person sharply changed. If earlier work began with sunrise and came to an end at its calling, now the electricity allows prolonging work. Especially it affected faces with intellectual and operator kinds of activity. Labor life became more intensively and more for a long time and endogenous sources for it began not to be enough. As the principle of activity of the person changed, it is necessary to change also the principle of its food. It, first of all, concerns need of power providing EndoFS with food connections which insulin secretions don't promote and by that don't reduce intellectual working capacity. Proceeding from such representation, we developed a specialized product for food of patients with obesity (the English patent GB 2496119 of 22.01.2014). When using such product development of the functional violations presented in Fig. 2 is prevented and working capacity in extreme conditions that is especially important for the modern person is provided.

V. Conclusion

Thus, it is offered to add the theory about the balanced food with the provision on need of observance of receipt

of separate food connections in the corresponding phase of activity. When developing ways of extension of human life need to consider the provision on correction, not only ExoFS, but also EndoFS that, undoubtedly, will promote decrease in chronic noninfectious diseases and extension of human life. Narrow-mindedness of any representation, in particular, of food, only in the form of a food pyramid, unambiguously doesn't solve many problems connected with food. The main problems with health of the person during the modern period of development are caused by discrepancy of EndoFS to energy needs, as is the reason of growth of chronic noninfectious diseases and is direct threat of health of the nation in the advanced countries.

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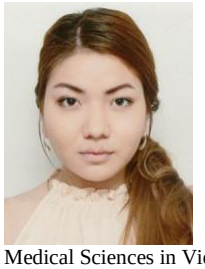

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