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NUTRITION DURING LONG FLIGHT

A. S. Ushakov

Translation of "Pitaniye v dlitel'nom polete," Zdorov'ye, No. 4 (304), 1980, pp. 4-5.

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Translation

Leo Kanner Associates
Redwood City, California 94063

National Aeronautics and Space Administration, Washington, D.C. 20546

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The nutrition of astronauts during long flights is discussed, especially with respect to the changes brought about in the body by the condition of weightlessness.

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A short time, in the historical sense, separates us from the first /4* human flight to space, but during this period about 100 astronauts have completed flights, and the total time man has been in space has been about 6 years. The appearance of permanent orbital stations and reusable space systems will significantly expand the opening up of space in the near future.

Life in space is impossible without the creation of conditions that are similar to those on earth. In spacecrafts this is achieved by means of life-support systems that supply the person with oxygen, water and food, and create an inhabitable environment.

When sending man on the first flight, the scientists did not know how the physiologic processes of taking and using food (mastication, deglutition, digestion) would be accomplished in conditions of weightlessness. Therefore the astronauts were provided with homogenized (ground to uniform mass) products in tubes. Later their nourishment became more and more like that on earth.

The crews of the "Salyut" orbital station already had a varied menu; the collection of products was repeated only every six days. Included in the ration were dishes in tubes and in dehydrated form in packets, meat and fish conserves, garnishes, different kinds of bread, various dairy products and confections, fruit and vegetable juices, tea and coffee. Thanks to the efforts of the specialist-technologists, the astronauts' food could be kept long enough and did not lose taste and external appeal. With transport ships the astronauts received fresh fruits, vegetables and greens, as well as products according to the as-

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* Numbers in the margin indicate pagination in the foreign text.

tronauts' taste and desire, for example, black bread, sauces and garlic.

New methods of changing the food's structure were developed by the joint efforts of the engineers and technologists. Now the astronauts can eat and drink even the first dishes and drinks from open containers. However, these successes do not solve the problem of the astronauts' nutrition.

With food a person receives a complex collection of food substances (nutrients). They are intended to supply the body with material for the formation of energy, [illegible] of the body and synthesis of a huge quantity of biologic substances--hormones, enzymes and other active compounds that regulate metabolism and the entire activity of the body and create the stability of its internal environment.

In the process of evolution certain interrelations were established between the body and the environment. Thanks to the biologic regulating mechanisms the body obtains that quantity of food substances that satisfies its requirement in energy and material for the processes of synthesis. Such interrelations designate the balance between need and nutrition, and adequate nutrition.

A person's need for food substances depends primarily on his energy expenditure, for the most part from muscle activity, the intensity of functioning of organs and systems, the features of psychic activity and other processes. The fundamental regulating mechanisms

On board the piloted orbital complex "Salyut-6"-"Soyuz", astronaut V. Ryumin opens a packet with food.
TASS photograph.

are such physiologic functions as thirst, appetite, digestion and metabolism. One of the most powerful evolution-produced regulators is motor activity, that is, physical work.

The formation of these processes began millions of years ago and took place in the conditions of earth's gravitation.

In space there is practically no gravitation. Man is not adapted to a condition of weightlessness.

A typical result of the effect of weightlessness is redistribution of the blood circulating in the vessels: astronauts clearly sense increased flow of blood to the upper part of the body, and puffiness of the face and a feeling of heaviness in the head occur. The increase in the blood volume in the upper half of the body leads to stimulation of the receptors that regulate the fluid volume in the circulatory system. Impulses from these receptors go to the medulla oblongata and hypothalamus and inhibit the secretion of antidiuretic hormone. Reduction of its concentration in the blood leads to a decrease of the return [illegible--line cut off], as a result of which the body loses fluid. /5
As a result of these changes all astronauts lose body weight (after return to Earth it is quickly restored).

Along with fluid, sodium, chlorine, potassium, phosphorus, calcium and other electrolytes are removed from the body. Because of the reduction of activity, muscle mass is also decreased, and the body loses protein nitrogen. In the adaptation process, metabolism in the astronauts is altered: there is a restructuring of lipid, carbohydrate and protein metabolism, and the digestive processes occur differently. But all these changes do not have a pathologic character; to the contrary, they are directed at adaptation to weightlessness.

The adaptation process has a phase character. The initial acute period of adaptation is replaced by a phase of adjustment, although the body does not completely return to the earth level of functioning. During the entire flight, regardless of its duration, it works as if in a

new physiologic regimen. This causes a change in the need for nutrients.

Life in weightlessness, just as on Earth, requires an energy supply in accordance with its expenditure. The total energy expenditures of the astronauts compose slightly more than 3000 kilocalories. And their food ration corresponds in calories with these expenditures. The quantitative ratio of the basic nutrients in the ration is similar to the normal--earth--ratio.

The qualitative aspect of nutrition is different. In the course of a flight, metabolic processes occur intensively in the astronauts, in particular in the nerve cells; this is related to the great nervous, emotional stress. This involves an increased consumption of a number of biologically active substances--hormones, mediators and enzymes. Necessary for their synthesis are such nutrient components as amino acids, vitamins and minerals. Therefore during the flight, and especially in its final stage prior to the "meeting" with earth's gravitation, the astronauts receive a complex of vitamins (more than ten of them, and the doses exceed the normal by two to three times), amino acids and minerals. They increase the body's resistance to adverse effects and promote the retainment of water and, consequently, electrolytes in the astronauts' body. All this is necessary for the best endurance of the last stages of the flight and the readaptation process after return to Earth. To normalize mineral metabolism, complexes containing unsaturated fatty acids are included as a supplement in the ration. Such supplements are prepared on the basis of sea buckthorn juice and oil.

The absence of a gravitational load on the structural-motor apparatus results in release of calcium from the body, including from the bones, and it is very important that vitamin D_3, which regulates calcium exchange, be actively synthesized in it. For this purpose the astronauts receive mineral supplements, and a certain ratio of calcium and phosphorus in them is necessarily accounted for.

Under the influence of weightlessness, the blood also undergoes a

change. Not only is the volume of its liquid portion reduced, but the mass of erythrocytes is decreased disproportionately as well. The physiologic role of erythrocytes is extremely important: hemoglobin, one of their components, transports oxygen to the cells and thus promotes their respiration. There are data that in long flights the reserves of iron, which is necessary for hemoglobin synthesis, in the blood are reduced. Therefore saturation of the astronauts' body with assimilable iron even in the preflight period and during the course of the flight is an important factor of nutrition.

Thus, the principles of nutrition in space expeditions are formed on the basis of physiologic and biochemical investigations, with consideration of the peculiarities of the functioning of all systems and organs in conditions of weightlessness. Balanced, rational nutrition meets the needs of the body and maintains the work capability and health of the astronauts.