MEMORANDUM

on the results of the experiments conducted on mice after 30-day flight of the BION-M №1 spacecraft

With regard to orbital flights and future flights to the Moon and Mars, it becomes necessary to understand more deeply biological effects of long-term stay in zero-gravity combined with ionizing radiation and to develop prospective measures to prevent unfavorable effects of these factors on different body functional systems. Although a great body of data from research into the effects of a space flight on physiological systems has been obtained in the course of 2-3-week flights of biological satellites and Space Shuttles, the variability of individual characteristics of crew members makes it difficult, to put it mildly, to carry out proper analysis of statistical data obtained in the course of long-term flights even now, when the ISS flights are carried out.

The main way of dealing with that kind of problems and other important biomedical problems is to study structural and functional reactions of animals to the factors of a space flight using methods on the cellular, molecular and system levels. Such approach formed the basis for the scientific program of the BION-M №1 flight.

The flight of BION-M №1 was the longest (30-day) flight of an unmanned spacecraft with bioobjects on board. The main objective of all experiments conducted on board BION-M №1 was to make a significant contribution to our present view of how different physiological systems adapt to operation in zero-gravity state. Particular importance was attached to the experiments on animals (mice) which purpose was to study and develop new technologies of life support during a space flight.

Assessing the findings of the BION-M №1 scientific program it should be noted that scientists managed to obtain an adequate and high-quality biomaterial to

conduct a comprehensive research into the response of animals to space flight conditions. Although analysis of the biomaterial has not yet completed, it may be said now that Russian and American specialists (the main executors of animal experiments) have obtained unique data that, in a spirit of an international scientific cooperation, will contribute significantly to space biology. Specifically, we can point out some preliminary conclusions:

- Data on changes in tone regulation of vessels in different vascular areas has been obtained for the first time. These changes are the evidence of specific effect of flight factors on blood flow in different tissues. In addition, the revealed changes in cerebral arteries may account for the increase of blood circulation in brain vessels that was observed among cosmonauts, and the rise of intracranial pressure that may be the reason of visual acuity decrement among astronauts.
- Considerable changes in gene expression of speed-limiting enzymes of the main proteolysis system (ubiquitous-proteasome mechanism) in skeletal muscles as well as changes in gene expression of isoforms heavy myosin chains have been discovered for the first time.
- It has been first shown that rehabilitation of postural-tonic muscles requires considerably longer period of time than rehabilitation of locomotor muscles.
- The experiment on spine functions and spine structure after 30-day flight have been first conducted. In addition, the biomaterial obtained from mice of the flight group will make it possible to study growth of non-load-bearing bones under zero-gravity by the example of cranial bones.
- Synapse of animal utricle epithelium exposed under zero gravity during 30 days has been first visualized that makes it possible to obtain the most significant information about the ability of an inner ear to adapt under conditions of a long-term flight.

- Data on effect of 30-day zero-gravity on tendon-bond joint has been first obtained. In particular, structural, biomechanical and molecular changes of rotatory cuffs and ankles have been studied.
- Data on effect of 30-day zero-gravity on gene expression and content of proteins in cartilaginous tissues.
- The experiment on sperm motility under space flight conditions has been first conducted. It was also the first experiment to establish whether instability of male cell genome would increase in the course of a space flight.
- It has been shown that stay of animals in zero-gravity state results in changing expression of catecholamines controlling adrenergic receptors which mediate production of secretory proteins in salivary glands, which indicates the appearance of organismic stress reactions in saliva. Identification of biomarkers of such reactions forms the basis for biochemical analysis in a clinic and under space flight conditions.
- Preliminary data of the comparative analysis of flight and control bioassays show more pronounced formation of nodules among flight animals. The results agree with the hypothesis that precursor cells of bone marrow accumulate in a zero-gravity state, apparently because of the inhibition of cell differentiation.

Only preliminary results have been obtained to date; comprehensive analysis and detailed studies are just being launched. However, even available data show how experiments on animals are important for better insight into the effect of space flight conditions on health. Unfortunately, complexity of space flights limits their operation and underlines the need for utilizing collaborative efforts and knowledge of the grand scientific community. Close cooperation of Russian and American researchers in the BION-M №1 project facilitated its successful implementation and is fundamental to success of future flights. Russian and American researchers are certain that animal experiments conducted on both unmanned and manned spacecraft are indispensable to identification, analysis and reduction of risks, and finally to successful space exploration. Experimenting on animals on board the

International Space Station has a great number of limitations. On this basis, Russian and American researches strongly recommend to continue with experiments on animals on board unmanned spacecraft which will furnish insights into mechanisms of space flight effect on living organisms, including human. In addition, running experiments on board different spacecraft makes it possible to investigate fundamental issues of biology that will broaden knowledge and allow independent verification of experimental results, which is a key factor of scientific progress. On this basis, participants of the BION-M №1 research program appeal to all departments and organizations dealing with space programs for active support and continuation of researches started on board BION-M №1.

Subscription list

of Memorandum on the results of the experiments conducted on mice of C57B1 after 30-day flight of the BION-M №1 spacecraft

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