Experiment aboard Russian satellite “Foton M2” in 2005: new approaches for study on stimulating effect of space flight on cell proliferation and regeneration in Urodela

E. Grigoryan (1), E. Almeida (2), E. Domaratskaya (1), V. Poplinskaya (1), M. Tairbekov (3), K. Aleinikova (1), V. Mitashov (1)

(1) Koltsov Institute of Developmental Biology, Russian Academy of Sciences, Moscow, Russia; (2) NASA Ames Research Center, Moffett Field, California, USA, (3) Institute for Biomedical Problems, Russian Academy of Sciences, Moscow, Russia

(nora@proxima.idb.ac.ru / Phone: +7-495-1350052)

A study on space flight effect upon processes of regeneration is due to the necessity to know their characteristics in animals and human exposed to space and earth conditions shortly after flight. Several experiments on the newts performed earlier aboard Russian biosatellites showed that the rate of organ and tissue regeneration in space was greater than that on the ground. Space flight effect stimulating regeneration was enduring and apparent not only just after flight but long time later as well. This observation found support in studies simulated physiological weightlessness by means of fast-rotating clinostat. It was shown also that the higher rate of regeneration was associated with enhanced cell proliferation. For instance, we found that the number of cells in S-phase in regenerating tissues was significantly greater in space-flown animals than in the ground controls. However, it was unclear whether cell proliferation stimulation was induced by micro-“g” per se or by conditions of hyper-“g” during launching and re-adaptation on the earth. Molecular mechanisms underlying the change also remained obscure. These issues were addressed by the joint Russian-USA experiment “Regeneration” performed on Foton-M2 in 2005. In 16- day flight we used two well-known models of regeneration: lens regeneration after lensectomy and tail regeneration after amputation in adult newts Pleurodeles walt (Urodela). In order to evaluate cell proliferative activity in time limits of microgravity influence the original method for in-flight delivering DNA precursor BrdU was developed for the first time. Our preliminary results showed that during the flight the number of DNA synthesizing cells in the regenerating eyes and tails significantly increased. These data together with those obtained earlier suggest that the cell proliferation and, consequently, the regeneration rates increase in response to the accumulated effect of all changes of gravity during and after flight. For better understanding of molecular mechanisms of stimulating effect of space flight upon regeneration we studied an expression of bFGF in regenerated tissues of flown and control animals. It was found earlier that bFGF is one

of the important proteins regulating cell proliferation and differentiation during regeneration in vertebrates. Using immuno-histochemical methods after flight we observed bFGF expression higher and steadier in tail and lens regenerates of flown animals than in control ones. In particular, cells of tail spinal cord, chord, skin, muscles and cells of new formed lens epithelium demonstrated the maintenance of bFGF expression in newts exposed to space while those cells of control animals lost it. In addition, the expression of two proteins of generalized stress (HS70, HS90) in regenerating tissues of space-flown newts and ground controls was examined. It was found that studied stress proteins had the different pattern of expression in flown animals in comparison with the control. Therefore, the data obtained in experiment aboard Foton M2 is the part of the reason for the accelerating effect of space flight upon regeneration in lower vertebrates.