WORKING OUT SPACE CELL BIOTECHNOLOGY, THE METHODS OF SPACE PLANTING, WASTE UTILIZATION, AND EQUIPMENT MONITORING («Biolaboratory», «Biomedcontrol» Projects)

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Introduction. Space biotechnology is one of the promising fields of space technology. The unique conditions of microgravity open up a prospect for obtaining a better separation of cell and biologically active substances, as well as growing protein crystals and other biopolymers. However, manufacturing biopolymer crystals in orbit is the only short-term practical benefit, which may be derived from space biotechnology. All the other areas require profound basic research carried out in close cooperation of biologists, mathematicians and designers.

Having an experience of performance of biotechnological experiments at Salyut and Mir orbital stations, Ukrainian scientists propose new basic and applied research for experiments on board the URM.

In order to meet some priority objectives of CELSS creation, Ukrainian scientists propose the following:

— working out space technologies for alga cultivation on orbit;

— selection and testing of inert organic and mineral materials with different additives of bioactive compounds and fertilizers with a prolonged effect, as substrates for plant growing in space;

— use of oligochaetae (Californian worm) for food waste utilization;

— use of daphnia as a biotest for control of general toxicity and mutageneity of the environment, in particular, water and air in a cabin of space vehicles.

«Daphnia» Experiment

DAPHNIA AS BIOTEST ON GENERAL TOXITY AND MUTAGENEITY OF ENVIRONMENT IN SPACE VEHICLES

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The purpose of the experiment is to create a system for biological control over total toxicity and mutageneity of the environment in space vehicles. The main objective is to develop a semi-automatic device for daphnia-biotest. The device output will be connected to a computer for estimation of the total toxicity and mutageneity of the environment inside space vehicles under the influence of microgravity and high-energy radiation.

Drinking and service water, aero- and gaseous

mixtures, food-stuffs, beverages, bioactive substances reproduced and manufactured under microgravity and cosmic radiation, and unknown compounds will be tested in the experiment.

An express method of instrumentation application for estimation of the total toxicity of the samples and the environment will be worked out. The essence of our approach lies in the use of daphnia metabolism changes in response to the influence of deleterious substances dissolved in water. The basic idea of the method is to register the chemiluminescence of exometabolites in daphnia's habitat, which is altered under the influence of the above changes. The mutagenic changes of daphnia (changes of eggs, hereditary traits transmitted to offspring) will be estimated visually.

The obtained results will allow identifying the presence and nature of toxicants in the tested objects, as well as their activity compared to the standard.

«Utilization» Experiment

INFLUENCE OF MICROGRAVITY ON THE PHYSIOLOGICAL STATE AND REPRODUCTIVE ABILITY OF OLIGOCHETAE

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The main objectives of the experiment are as follows:

— to study the nature of metabolism in invertebrates (hybrid red californian worm) in microgravity;
— to study reproductive ability of oligochetae in microgravity,
— to evaluate the influence of space flight factors on the resistance of oligochetae and efficiency of food utilization.

The level of plastic metabolism is evaluated by the contents of total proteins, lipids, carbohydrates (glycogen), nucleic acids (DNA and RNA) and their ratio in worm tissues. Contents of adenine nucleotides and activity of appropriate enzymes in worm tissues will allow determining the level of energy-related metabolic processes. The mineral exchange will be evaluated by studying the accumulation of macro- and microelements in worm tissues. The adaptation and resistance of worms will be assessed during investigation of the free radical processes, dienic conjugate concentration, lipid hydroperoxides, and malonic dialdehyde in mitochondrial fractions of worm tissues. Reproductive ability will be estimated by counting the quantity of adults, young specimens and cocoons. Changes in the chemical structure of a substratum will be studied by recording the concentrations of protein, crude fat, cellulose, ash, macro- and microelements.

Data obtained will allow a physiological state of worms to be evaluated. This, in its turn, will provide new theoretical knowledge of the mechanisms of biological influence of microgravity on invertebrates, as well as on the adaptability and reproductive ability of invertebrates for CELSS.