DEVELOPMENTAL BIOLOGY IN MICROGRAVITY («Greenhouse», «Biolaboratory» Projects)

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Introduction. The currently available experimental evidence concerning the generative development of higher plants in microgravity does not provide an answer to the problem of obtaining the second and next generations of fertile plants in orbit. This issue is of paramount importance, because higher plants are an indispensable component of CELSS. The attempts to obtain the second generation of fertile higher plants in orbit, i. e., fruiting and forming viable seeds, were futile. The causes of failure could be the following: 1) disturbance of hormonal balance in plants in space flight, especially at the stage of transition to generative development; 2) lack of the optimal conditions for plant growth, first of all, aeration and water regime for the root system growth.

Therefore, development and creation of a space green-house of a new generation is absolutely necessary for growing higher plants and selection of other species of dicotyledons and monocotyledons for long-term space flight experiments. All this will enable studying the peculiarities of seed reproduction of higher plants in microgravity. The higher plants (wild and cultivates) have a different ecology and diverse types of the root system. They differ by the peculiarities of generative development, in particular, by the types of embryo- and endospermogenesis. Due to these features, the various species of higher plants will adapt to microgravity in different ways. The chief objective of experiments proposed below is to realize all the stages of generative development (budding, flowering and fruiting) for formation of viable seeds of the second and next generations in orbit.

«Seed» Experiment

INFLUENCE OF MICROGRAVITY ON VEGETATIVE AND GENERATIVE STAGES OF ONTOGENESIS AND PLANT SEED REPRODUCTION

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The purposes of this experiment are to study the reproductive development of annual higher plants in microgravity and to obtain a full plant cycle from seed to seed as the basis for working out the technologies of space planting for CELLS. The main objectives are as follows:

— to obtain an «embryological diagram» of annual plants in microgravity (characteristics of anther and

ovule formation, micro- and macrosporogenesis, male and female gametophyte development, processes of pollination and fertilization, embryo- and endospermogenesis, the peculiarities of reserve substance accumulation during seed formation);

— to try to obtain the second generation of higher plants in microgravity. The methods of light microscopy, transmission and scanning electron microscopy, cytochemistry, and morphometric analysis will be used.

The obtained data will be important for understanding the role of gravity in plant seed reproduction system formation and for revealing the stages in plant generative development, which are the most sensitive to the influence of microgravity.

«Orchids» Experiment

INFLUENCE OF MICROGRAVITY ON GROWTH AND DEVELOPMENT OF ORCHID PLANTS

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The purpose of the experiment is to define a sensitivity of different orchid species to the microgravity effect, depending on their anatomical and morphological features and development phases to devise methods of plant cultivation in a space flight.

The main objectives are as follows:

— to study the effect of clinostating and microgravity on physiological and biological processes in plants;

— to make a comparative analysis of the anatomical structure of the leaf surface in epiphyte and terrestrial orchid species in microgravity.

— to work out the technology of plant growing in the artificial soil substitutes using the mineral nutrition balance system.

Epiphyte and terrestrial orchid species with monopodial and sympodial types of shoot system broaching and various photosynthetic types of metabolism were chosen as the experimental samples. Use of the callus cultures in the solid nutrient medium is also planned.

The integral parameters of morphological, anatomical and physiological changes in orchid species will be studied, to define the functional state of plants under clinostating and microgravity. The amino acid analyser will determine the content and composition of free aminoacids. Photosynthetic pigment content and activity of oxidising, as well as respiration enzymes will be evaluated by the methods of spectrophotometry. Biogenous element level in plant organs will be assessed by the atomic-absorptive gas analyser. Phytohormone compounds will be evaluated by the chromatography method and biotests.

Results obtained will promote development of the cultivation technology of plants with different morphological and ecological types in microgravity. The structural model for the microgravity conditions will be elaborated.