

## Division 8

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### SPACE MEDICINE («Biomedcontrol» Project)

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**Introduction.** The long-term flights in outer space and the further interplanetary missions pose the problems of space medicine as the principal issues. Some of these problems are:

- to elaborate telemetric methods allowing evaluation of the organism functional state and its adaptation to the influence of space flight factors;
- to study the peculiarities of development of regulatory deviations and pathological states in microgravity using test models and members of a crew;
- to study the peculiarities of pharmacological drugs under space flight conditions;
- to work out prophylactic countermeasures and treatment of a pathological state caused by long-term stay in space;
- to perform long-term research for evaluation of the biological age and dynamics of health state of

space mission participants.

- to study the influence of space flight on aging tempos and development of age pathology;

- to provide the psycho-physiological monitoring of the astronauts' working capacity and to create an onboard system for performance of such a monitoring in a space flight. Special attention will be given to study of the influence of micro- and hypergravity, as well as hypodynamism on the state of microcirculatory system and rheological properties of astronauts' blood, regulation of thrombus formation and thrombolysis, as well as to elaboration of measures to correct the possible disturbances in the studied systems, which cause the pathological processes and, as a result, a faster ageing of the astronauts.

The current system includes individual adaptive models of astronaut's working capacity and evaluation of astronaut's pre-flight state.

### «Biominerals» Experiment

### MECHANISMS OF PROPERTY CHANGES OF BIOMINERALS IN MICROGRAVITY AND METHODS FOR REDUCTION OF BONE DEMINERALISATION IN A SPACE FLIGHT

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Solution of bone demineralization problem is impossible without development of new methods and emergence of new scientific ideas.

We propose new methods for reduction of bone demineralization processes and decrease of bone mass loss in a space flight. To study biominerals, we

have introduced a notion of the «mineral-organic nano-associated» (MONA) systems. These systems have some special features. The important feature of the MONA systems is their capability of creating the nano-dimensional piezoelectric effect (NPE). Due to NPE, mechanical stress causes a gradient of electric charges in biominerals. The electric forces, induced by mechanical pressure, control the ion diffusion in the mineral component of biominerals. The efficiency of mechanical-electrical mechanism of diffusion is decreased under microgravity that leads to bone demineralization.

Human and rat bones will be used in the ground-

based experiments. We will apply the methods of electron paramagnetic resonance, nuclear magnetic resonance, electron nuclear double resonance, as well as other methods. The intent is to implant special paramagnetic markers in the rat bones and to expose these animals to various external influence, including the immobilization, centrifugation, electric and acoustic fields. We will also control rats with paramagnetic markers in their bones during the flight experiments. Study of the markers after returning the rats to Earth should provide new data about bone demineralization processes in microgravity.

**«Osteoprotection» Experiment**  
**SKELETAL EFFECTS OF MICROGRAVITY**  
**AND PROTECTOR EFFECTS OF INTERMITTENT GASEOUS MIXTURES**  
**WITH LOW OXYGEN CONTENT ON OSTOPENIA**  
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The aim of experiment is to evaluate skeletal effects of weightlessness and to study preventive and corrective effects of gaseous mixtures with low oxygen content on weightlessness-induced osteopenia;

The principal objectives are the following:

- to carry out the structure analysis of crystalline framework of animal bones (both trabecular and compact ones) before and after mechanical unloading and weightlessness;
- to study the influence of weightlessness on strength of the trabecular and compact bone (by microstrength measurement);
- to study the influence of weightlessness on electric and dielectric properties of long tubular bones of animals;
- to study the influence of weightlessness on

mineral and organic components of animal bones (both trabecular and compact bone tissues);

- to assess preventive and corrective effects of intermittent gaseous mixtures on osteopenia generated by exposure to natural weightlessness.

Objects of this study are the tubular and trabecular bones of adult Wistar rats. Biochemical determination of bone remodelling, calorimetric determination of calcium and phosphorus in bone and blood will be performed. A gas-mixtures generator will be used, which is based on «molecular sieves» principle, i. e., on physical-chemical separation of ambient air components by passing them through polymer capillary gas-separation modules.

It is assumed that application of gaseous mixtures with low oxygen content in weightlessness may prevent weightlessness-induced osteopenia.