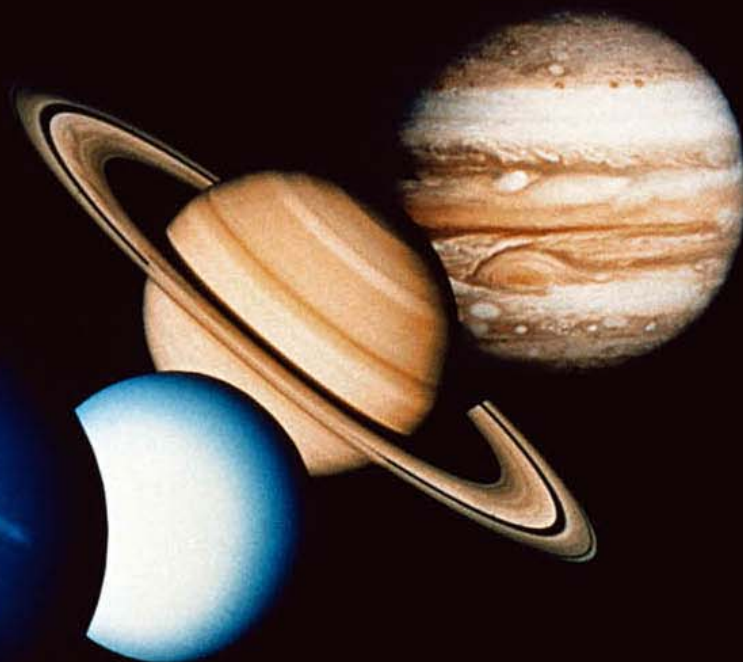




ADVANCES OF SPACE MEDICINE AND BIOLOGY RESEARCH IN RUSSIA



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of Outer Space
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Space Medicine and Biology are the Contemporary areas of Life Sciences

Accomplishments:

- Large volume of scientific information related to the effects of space flights and space environment upon different living systems was accumulated
- Complex of means, methods and operational procedures for medical support of human in space was developed. The effectiveness of it was proved by a good health and high level of working capacity of crew members in prolonged flights up to 14 month



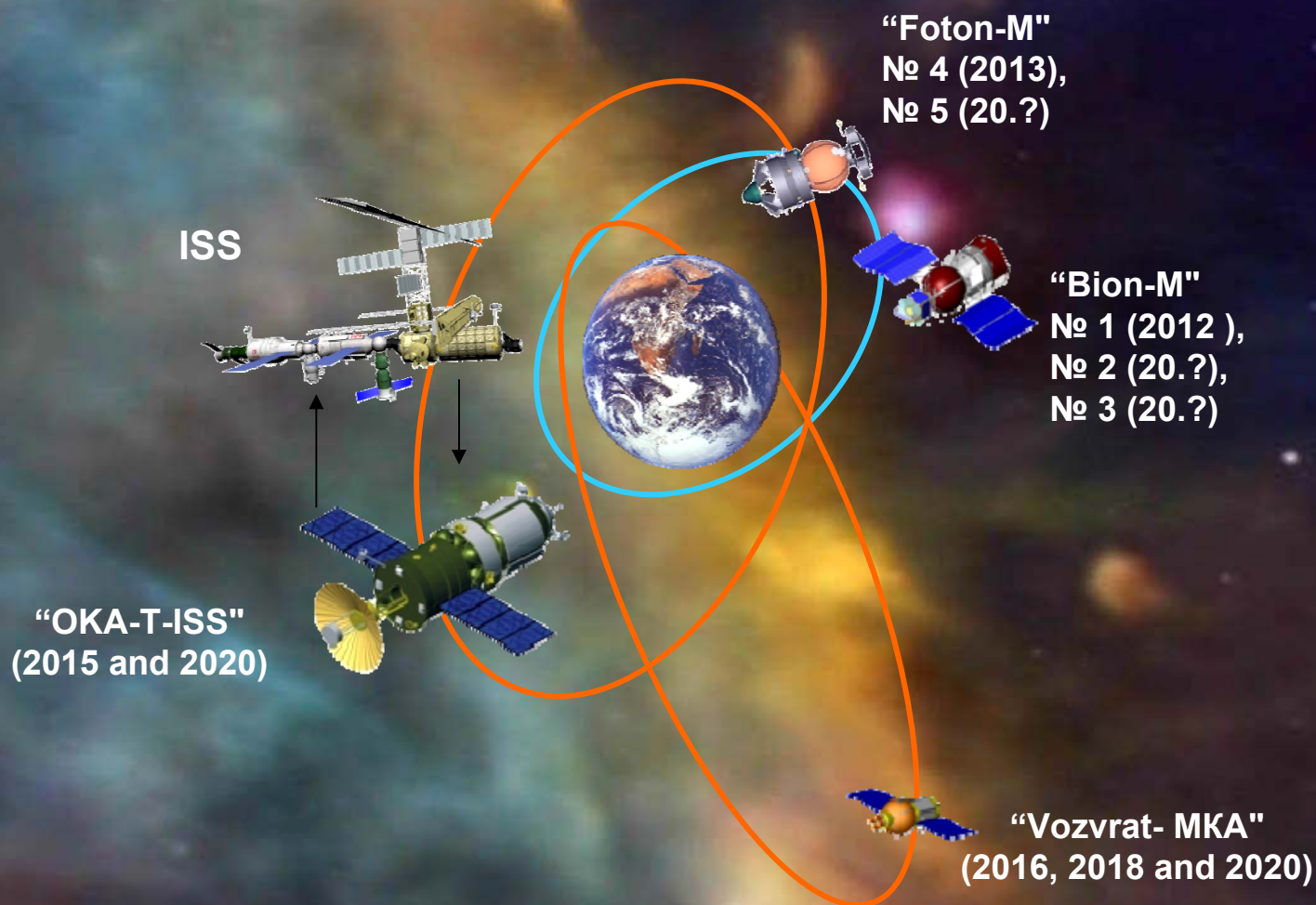
“Foundations of Russian Federation Policy in the field of Space Activity up to 2020 and for the future”, approved by the President of Russia in April 24th, 2008

Main goals of Space Policy

- **scientific, engineering and technological research and development for realization of full-scale space program**
- **profound research and exploration of the Universe**
- **further development of the International cooperation in advanced manned space missions for mutual benefits**



Space vehicles for fundamental and applied research in orbital flights



OKA-T-ISS - automatic spacecraft for 5 years of flight with periodical docking with ISS;
Foton-M, Bion-M – automatic spacecrafts for biomedical and technological research in flights up to 60 days and more;
Vozvrat-MKA – small sized automatic spacecraft for flights on low and high elliptic orbits with recovery of space capsule to the Earth.



STRATEGY OF SPACE LIFE SCIENCES IN RUSSIA AT NEXT DECADE

- Continue the fundamental and applied physiological and biological research aboard ISS, space transportation systems and unmanned spacecrafts including research on international basis
- Accumulate the new biomedical data related to the extra prolonged orbital manned flights and future flights of crews to the Moon and Mars
- Provide the medico-engineering and ergonomic support of new manned space systems development
- Improve system for the medical support of human in space



Unpredictable accidents

- trauma and damage
- psychological stress
- consciousness loss
- death

Microgravity, 1/6 and 1/3 g

- kidneys stone
- osteoporosis and lowering of mechanical properties
- muscles atrophy and lowering of contraction force

MEDICAL RISKS IN SPACE FLIGHTS

Isolation and sensory deprivation

- psychoneurological disturbances
- sleep disorders
- desinchronosis

Artificial environment

- hypo- and hyperoxia
- intoxication
- hypo- and hyperthermia
- bacterial or fungi infections

Space Radiation

- radiation induced tumors
- acute or chronic radiation sickness



THE MAIN AREA OF FUNDAMENTAL AND APPLIED BIOMEDICAL RESEARCH ABROAD RUSSIAN SEGMENT OF ISS AND RUSSIAN MODULES FOR SCIENTIFIC EXPERIMENTS

- Study the mechanisms of physiological adaptation to the specific factors of space flight and space environment
- Development and testing of new means and methods for prophylaxis of unfavorable changes in organism and protection against adverse effects of space radiation
- Research for lowering of potential medical risks in current orbital and future manned flights to the Moon and Mars with the use of contemporary technology and new achievements in general science



AREAS OF PLANNED BIOMEDICAL EXPERIMENTS ABOARD ISS AND RESEARCH MODULS PERFORMED BY COSMONAUT- BIOLOGIST

Central Nervous System - 8
Psychophysiology - 3
Cardiovascular System -4
Muscular System -1
Bone System -1
Digestive System -2
Pulmonary Function -1
Hormonal Regulation - 1
Erythropoiesis - 1
Body Composition - 2
Metabolism - 2

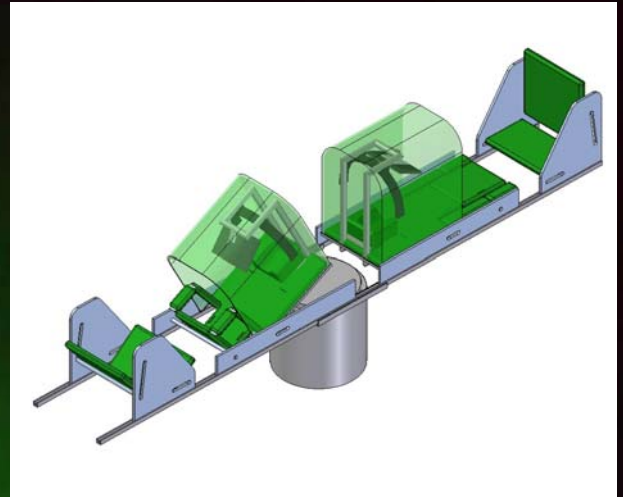
Genetical Status - 2
Immunological Status -1
Pharmacokinetics -1
Physiology and Biochemistry of
microorganisms -2
Physiology of Plants - 3
Ontogenesis of Birds - 1
Radiobiology and Dosimetry – 2
Cell Biology – 5
Exobiology (Astrobiology) - 2
Biotechnology - 1

Total: 46 experiments



MEDICAL AND PHYSIOLOGICAL RESEARCH IN GROUND BASED SIMULATED EXPERIMENTS

- Water immersion experiments for study of physiological effects of microgravity
- Head-down (6°) anti-orthostatic hypokinesia experiments for study of physiological effects of microgravity
- Short radius centrifuge experiments for study of artificial gravity biomedical effects
- Long-duration experiment in fully hermetical medico-engineering complex to study biomedical effects of some simulated peculiarities of manned mission to Mars (Mars-500 project) and radiation experiment with monkeys (Gamma-Breez-550 project)





MARS-500 PROJECT



Goals: • study the human adaptation to simulated peculiarities of future manned mission to Mars.

• study the biomedical requirements for support of extra prolonged orbital manned and interplanetary missions

Duration of experiment: 520 days

Crew: 6 males in age 25-50 years old from different countries

Provided conditions: • isolation in fully hermetical medico-engineering complex consisting of 5 segments with total volume 550 cub.m

• autonomous function of complex and crew



Start of experiment: 2010

Expected results:

- physical and psychic state of health, working capacity and behavior
- dynamics of environmental parameters and life support system function
- effectiveness of diagnostic procedures, treatment and prophylaxis of unfavorable changes in organism
- grounds for procedures of medical and psychological selection and training of test subjects



SIMULATED EXPERIMENT “MARS-105”

Goals:

- test of environmental conditions inside medico-engineering fully hermetical complex before start of Mars-500 project
- work out the program of biomedical research in reference to Mars-500 project

Duration of experiment: 105 days (March 31 – July 14, 2009)

Crew: 6 males in age 25-50 years old from different countries

Results:

- more than 70 biomedical experiments were conducted and new data related to physiology, psychophysiology and psychology of humans in isolation and autonomous function were received
- significant individual variations in adaptive reactions to simulated environment of space flight were revealed
- criteria for medical and psychological selection and training of crewmembers for Mars-500 project were verified
- Recommendations to improve facilities for medico-engineering complex



“GAMMA-BREEZ” PROJECT

Goal: Study of biomedical effects of radiation exposure in dose close to real flight to Mars

Biospecies: Macaca Mulatta monkeys, males, initial weight 3-3,5 kg

Start of experiment: 2010

Duration of experiment: 550 days

Source of radiation: gamma rays
The total dose for experiment - 2,75 Sv

Area of research: physiology, behavior, mental capacity, hematology, biochemistry, immunology





BIOLOGY IN SPACE: FUNDAMENTAL RESEARCH

Nature of living in space from molecules to organism in whole. Mechanisms of adaptation and readaptation

Specifics of ontogenic and phylogenic development of living systems in microgravity

Biorhythms in space

Gravity, radiation and magnetic field are the ambient factors for life on Earth, their role in structure and function of different living systems

Combined biological effects of main space flight factors

Ways of forming and distribution of life in Universe



BIOLOGY IN SPACE: APPLIED RESEARCH

Potential biological damage inhibited by flights beyond the Earth radiation belts and magnetosphere

Experimental modeling of pathology and trauma in space. Means and methods of treatment

Biological effects of artificial gravity and prolonged living in low gravity ($1/6$ and $1/3g$)

Pharmacodynamics and pharmacokinetics of drugs in Space. Biotechnology Research

Biodosimetry methods for radiation safety control in space flights

Perspective methods and means of prophylaxis for manned flights beyond the Earth



“BION-M1” PROJECT

Date of launch – 2012

Duration of flight – 30 days

Main goals:

molecular- physiological mechanisms of adaptation to microgravity

effects of open Space factors upon capable of life and vital functions

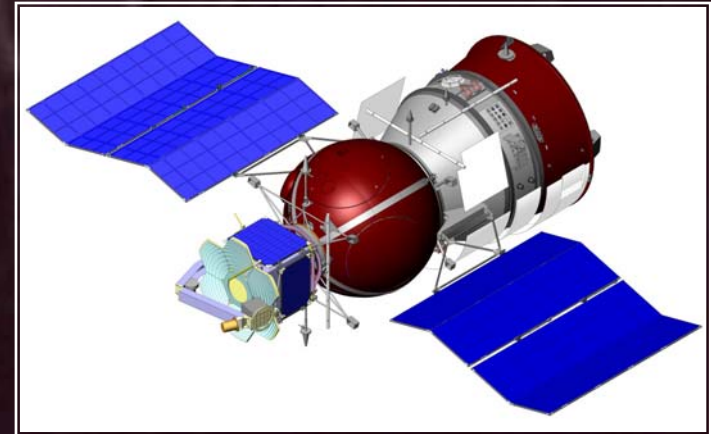
growing of protein crystals in microgravity

biodegradation of wastes in microgravity

Radiation dosimetry and spectrometry

Biospecies:

mice C57 bl, Mongolian gerbils, snails, lizards, seeds, seedlings, microorganisms, biosamples





“FOTON-M4” PROJECT

Date of launch– 2013

Duration of flight– 60 days

Main goals :

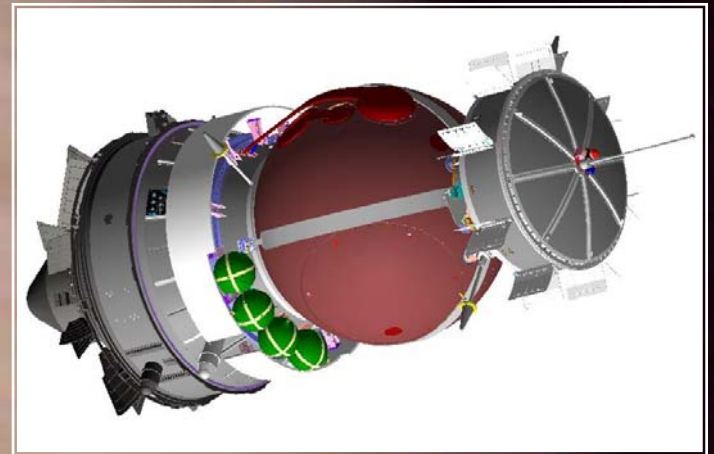
growth and development of low vertebrates in microgravity

cell physiology and biotechnology studies

effects of open space factors upon capability of life and vital functions

Biospecies :

snails, lizard's eggs, seeds, seedlings, microorganisms





“VOZVRAT-MKA” PROJECT

Dates of launch: Tree in the period of 2016-2020

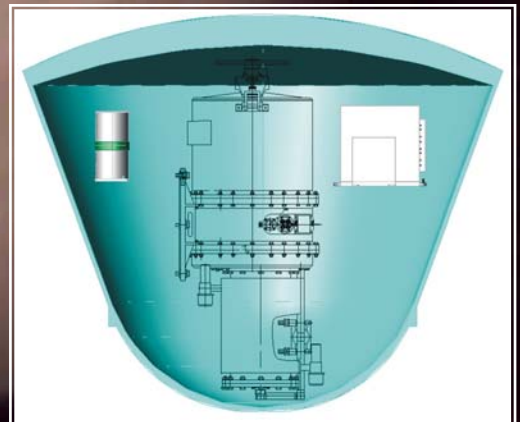
Duration of flights: Up to 1 year

Orbit parameters:

- Circular, apogee 500 km and 1000 km
- High elliptical, apogee - 200 000 km
perigee - 500 km

Main goals:

- Combined biological effects of microgravity, ionizing radiation and hypomagnetic fields
- Biological effects of open space factors
- Biotechnology processes in microgravity





“ОКА-Т-МКС” PROJECT

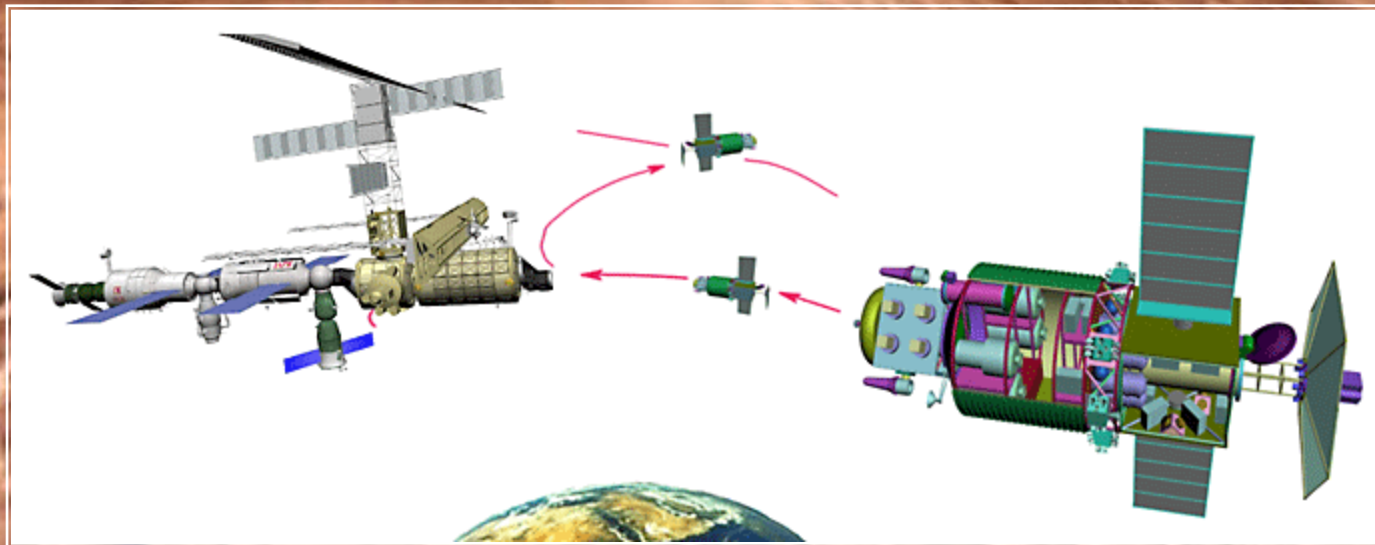
Dates of launch: 2015 and 2020

Duration of flight: up to 5 years

Main goals of biological research:

- Survival and functioning of biospecies in flight duration for several years.
- Dependence of structural and physiological changes in organism upon duration of flight

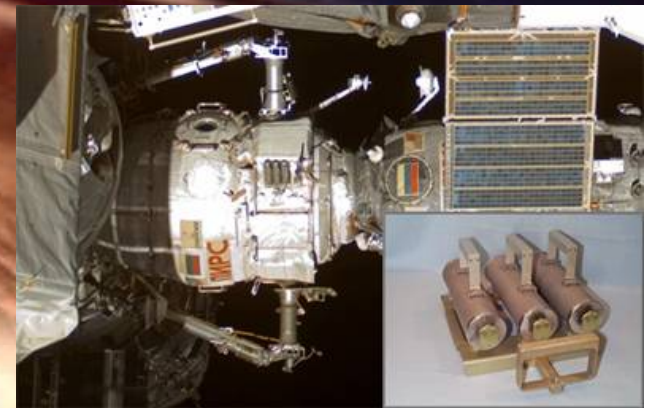
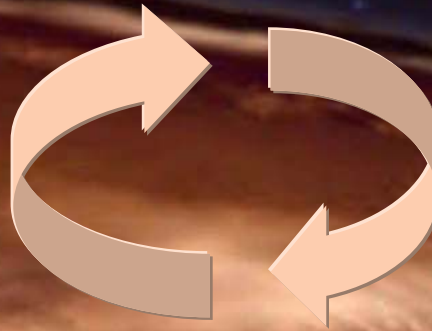
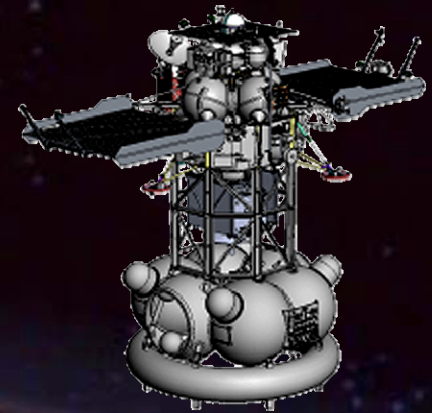
Biospecies: lizards, microorganisms, seeds





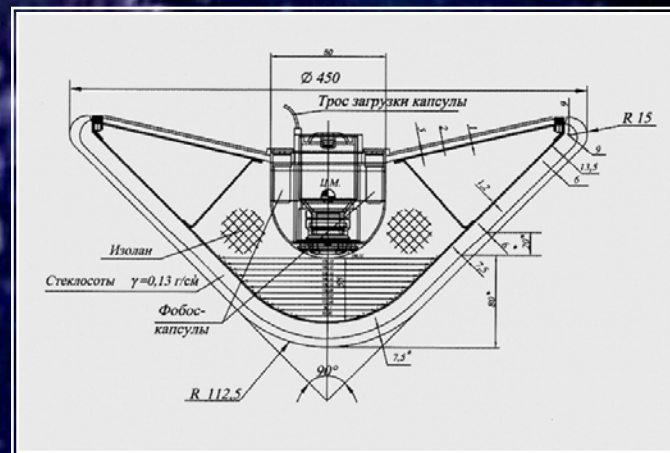
EXO BIOLOGY (ASTROBIOLOGY) AND PLANETARY CARANTIN RESEARCH IN ORBITAL AND INTERPLANETARY MISSIONS

Fobos-Grunt Project



Long duration program of research aboard service module of ISS, “Bion-M1” and “Foton-M4”







CONCLUSION

Space medicine and biology in Russia are ready to accept any future scenario of national activity in space, but it requires to continue uninterrupted first priority fundamental and applied research in manned and automatic space missions

Certain theoretical and experimental basis for medical support of manned missions to Moon and Mars is developed in Russia. New scientific technologies will be used for more active study of biomedical problems of interplanetary manned missions



Thank you for attention!