

Background information

German Mars 500 experiments

Bone metabolism, Nathalie Bäcker, DLR Institute of Aerospace Medicine, Cologne:

Human bone mass adapts itself to mechanical loads. Generally, a lack of physical activity results in a loss of bone mass. Strictly controlled environmental and nutritional conditions during the study have made it possible to carry out detailed investigations into bone metabolism and bone mass when physical activity is restricted.

Blood pressure regulation, Luis Beck, DLR Institute of Aerospace Medicine, Cologne:

Long-term regulation of blood pressure is generally provided by a fluid and electrolyte balance, which is effected by the kidneys under the control of the various hormonal systems and the autonomic nervous system. Blood pressure levels and diurnal patterns in blood pressure are influenced by other factors, such as daily activity, exercise, eating habits and, not less important, psychological and social factors such as stress or relaxation. The key question to be answered by this experiment is how the combination of all these influences affects the blood pressure of individual members of a small, isolated group.

Stress and the immune system, Prof. Alexander Choukèr, Ludwig-Maximilian University, Munich:

The complex link between stress and the immune system plays a crucial role in the health and performance of people in extreme environments. A better understanding of the interaction between the psyche and the immune system could lead to the development of new preventive and therapeutic strategies. Neurobiological stress systems, scarcely researched until now, are being studied using innovative, non-invasive techniques and advanced blood analyses. The knowledge obtained will eventually be beneficial for patients who find themselves in stressful situations due to surgery or treatment in an intensive care unit, and who are therefore experiencing considerable immunological changes.

Physical fitness through vibration training, Ulf Gast, Center for Space Medicine, Charité Berlin:

A training programme to investigate the effectiveness of vibration training on physical fitness has been developed especially for use during long-term isolation. The analysis focuses on investigations into bone and muscle functionality.

Circadian rhythms of humans in long-term isolation, Hanns-Christian Gunga, Center for Space Medicine, Charité Berlin:

Research has shown that the circadian timing system (CTS) plays a part in the coordination of almost all circadian fluctuations in physiological and psychological systems. Maintaining synchronised circadian rhythms is extremely important for human health and wellbeing. The hypothesis is that long-duration spaceflights will significantly alter the synchronisation of human circadian rhythms. The following are considered to be the causes: changes in the 24-hour light-dark cycle, reduced physical activity, confinement, changes in body composition and/or changes in heat transportation and temperature regulation. For this reason, circadian variations in the core temperature of the participants in the Mars 500 study are being examined. Data is being collected with the dual sensor ThermoLab System, already tested on the International Space Station (ISS) and in the Antarctic.

Computer-based training for complex control tasks, Bernd Johannes, DLR Institute of Space Medicine, Hamburg:

This project tested a new approach to teaching and practicing the skills needed to manually control a space vehicle using a self-study programme on a computer. Simultaneously controlling six degrees of freedom – for example, a spaceship docking with a space station or the capture of free-floating objects in space using a robotic arm – is a very difficult task that greatly demands spatial perception and situational awareness. During long-term travel (for example, to Mars) it is more reasonable to wait to complete the training on the last few weeks before the actual docking has to take place. A computer programme that takes on the role of an instructor by analysing errors is of great importance. The ‘6df’ tutor, a prototype for exactly this kind of training program, was successfully tested during the previous 105-day phase of Mars 500, when it was compared with the ‘real-life’ Russian docking trainer to assess its technical and functional capabilities and effectiveness.

Group dynamics, Bernd Johannes, DLR Institute of Space Medicine, Hamburg:

This international socio-psychological experiment is testing a completely new and innovative approach to assessing the dynamics of group structures under confined conditions and comparing it with more traditional methods. The cohesion of the crew, the relationships between the individual crewmembers, and how both change over time plays a key role in the success of long-term missions. A wireless measuring system that records the duration and distance when two crewmembers spend time with one another was commissioned by DLR from the company Koralewski Industrie-Elektronik oHG in partnership with SpaceBit GmbH, for testing during the Mars 500 study. The study provides a unique opportunity to analyse psychological factors while living in extreme environmental conditions, as well as psychosocial situations in group dynamics, especially decision making.

Autonomous emergency medical care, Wolf Mann, Johannes-Gutenberg University, Mainz:

During the simulated journey to Mars, six people have to learn to live with one another in a confined space for one and a half years – relatively isolated from ‘Earth’.

They have to treat illnesses and injuries themselves; the probability of anyone on Earth assisting a sick or injured person is very low. Therefore, the crew must learn how to survive completely self-sufficiently. Based on this need, the Johannes-Gutenberg University has developed a specialised training scheme for astronauts embarking on long-term missions, to enable them to provide autonomous emergency medical care.

Microbiology and health in enclosed systems, Petra Rettberg, DLR Institute of Space Medicine, Cologne:

Microorganisms originating from humans or the surroundings have a tendency to breed in enclosed environments inhabited by people over prolonged periods of time. Studies on astronauts and cosmonauts on the International Space Station have shown that, in this environment, the number of opportunistic pathogenic organisms increases, whereas the number of protective microorganisms on the skin and in the gastrointestinal tract decreases. Bio-films were found to be growing and breeding on structural elements within the space station (metals, polymers) and on components of the life support systems (water tanks, air filters). This can pose a risk to the crew, both in terms of possible infection and damage to materials, which can lead to the malfunction of important equipment. As part of the Mars 500 experiment MICHA, the team is recording the microbial population on the surfaces and in the air inside the habitat, as well as on the occupants, and will track their growth over the 520 days of the isolation study. The knowledge the researchers gain from the MICHA experiment is essential for future manned space missions, helping to combat the potential risks posed by microorganisms by prevention, monitoring and prompt implementation of countermeasures.

Long-term salt and fluid balance, Jens Titze, Friedrich-Alexander University, Erlangen-Nuremberg:

For the entire duration of the Mars 500 study, the volunteers are in a hermetic system with an artificial atmosphere, normal air pressure and an uninfluenced gravitational field in a space of around 600 cubic metres. The combination of an exceptionally long observation period and a continuously regulated thermally constant environment offers unique experimental conditions in which to study human metabolism. This simulation study focusses on analysing the volunteers' salt and fluid balances, and their influence on the regulation of blood pressure.

Psycho-physiological performance, Stefan Schneider, German Sport University, Cologne:

The effect that physical activity during long-term isolation has on the interaction of key physiological and psychological parameters is being recorded on a large scale for the first time. It is generally assumed that regular cardio-vascular exercise contributes to improved mental performance and mood. The obtained results will be of major significance, not just for manned space missions, but also for boosting sports therapy as well as leisure and sport activities for the elderly.