A first manned mission to Mars, which could start in about 20 years, must ensure that the astronauts remain healthy during the more than 500-day journey and that their health is not adversely affected by microorganisms. Likewise, microbes must not exert any harmful influence on the technology on board. Scientists from the Astrobiology Working Group of the DLR Institute of Aerospace Medicine, in collaboration with the Medical University of Graz and the UK Center for Astrobiology, have examined samples from the International Space Station ISS and found that the microbiome poses no direct danger to the crew of a spacecraft. Nevertheless, quality standards must be developed to ensure the stability of the nuclear microbiome and thus prevent epidemics or technical difficulties. The research results have now been published in "Nature Communications" (https://doi.org/10.1038/s41467-019-11682-z).

Manned Mars mission: focus on astronauts' health

Humans carry about $10^{14}$ - i.e. 100 trillion - microorganisms with them. Most of them are found in the intestines and on the skin. This "microbiome" takes over important tasks in the body and travels with the astronauts into space. Since 2000, the hermetically sealed International Space Station ISS has been permanently inhabited by a crew, making it home to countless microorganisms. This may lead to various problems: Microorganisms can attack surfaces in the space station. In addition, the astronauts' immune system is reduced in space, making them more susceptible to microbial infections. For these reasons, the microbiome on board a spacecraft must be precisely controlled.

Habitat Space Station: Insights into the "Silent Place"

Within the framework of the research project "Archaeal and bacterial extremophiles on board the International Space Station - ARBEX" funded by the Austrian Research Promotion Agency FFG, the effects of ISS conditions on the diversity and function of microorganisms on board were investigated and compared with the "normal" microbiome of buildings and environments on earth. In 2017, samples were taken on the ISS in the Columbus module as well as at the sleeping places and the waste and hygiene compartment, including the toilet area. The wipe samples from the ISS were analysed using next-generation sequencing and cultivation-based approaches and the results were now published in Nature Communications. After careful analysis, the international team (Germany, Great Britain, Austria, the Netherlands, Russia) gave the all-clear: the ISS microbiome does not differ from the microbiome of an indoor environment on earth in terms of antibiotic resistance and other potentially health-damaging properties and corresponds roughly to a classic bathroom microbiome consisting of a mixture of skin, intestinal and ambient microorganisms.

Quality standards and monitoring for crew and spacecraft safety

What the microbes on the ISS are particularly good at is "sleeping", surviving dehydration and interacting with surfaces. Especially the metallic surfaces seem to put the microbes under stress. Metal- and surface-associated functions were significantly increased on the genomic level. The project isolated several hundred microorganisms from the ISS, including bacteria and fungi, which are now available for further experiments.

Although the microbiome within a spacecraft does not pose an obvious "danger" to humans, quality standards and monitoring for manned space flights must be developed in order to ensure the stability of the core microbiome during long-term missions, e.g. to Mars.

Link to "Nature Communications":
https://doi.org/10.1038/s41467-019-11682-z