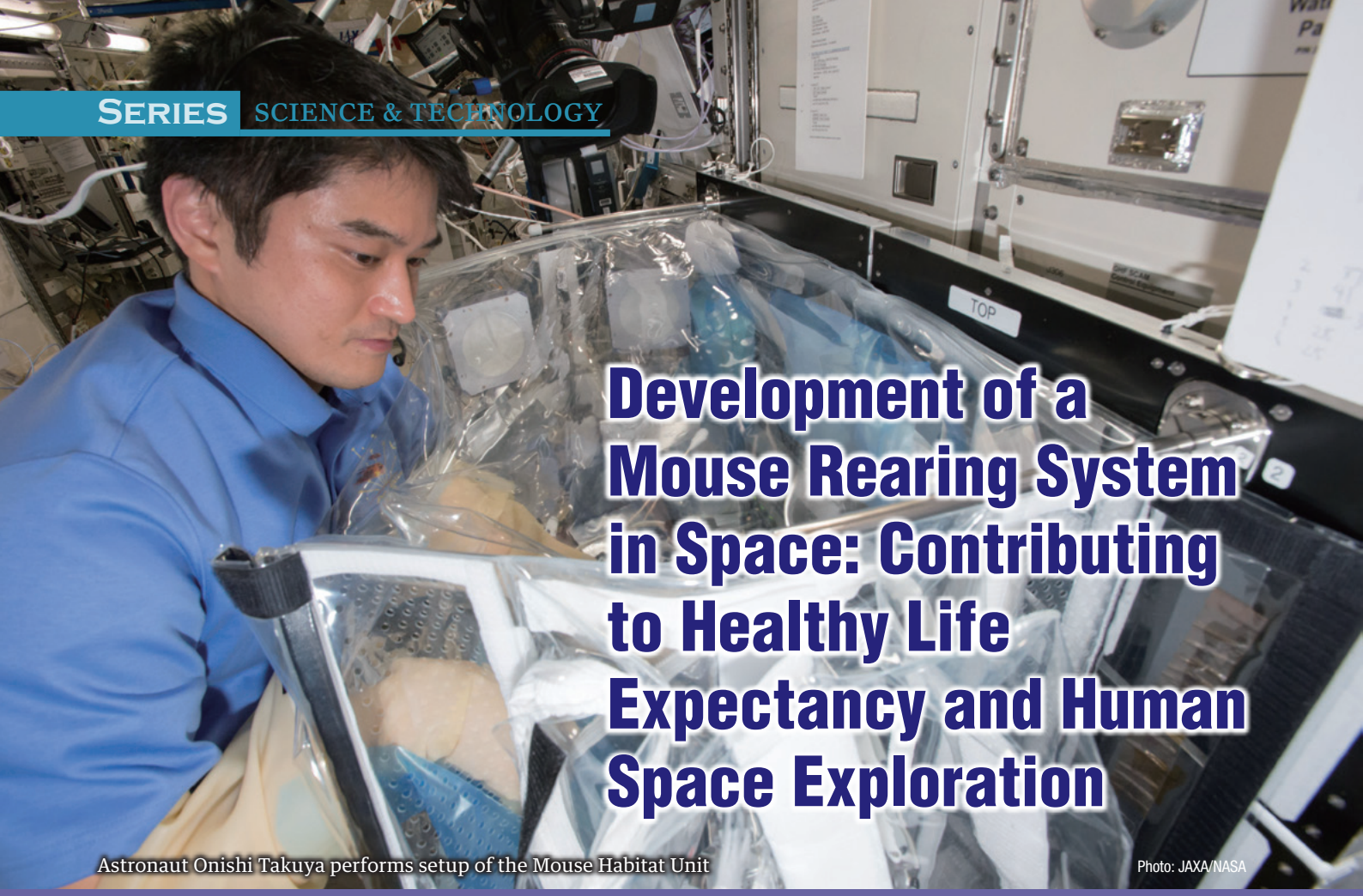


Development of a Mouse Rearing System in Space: Contributing to Healthy Life Expectancy and Human Space Exploration

Astronaut Onishi Takuya performs setup of the Mouse Habitat Unit

Photo: JAXA/NASA

The International Space Station (ISS) is a massive, crewed research facility orbiting approximately 400 kilometers above the Earth. It is home to the Japanese Experiment Module Kibo, where scientists conduct experiments and measurements that take advantage of the specific environment (microgravity), in which the effect of gravity is much weaker than on Earth. The Japan Aerospace Exploration Agency (JAXA), which is responsible for the projects conducted on Kibo, has been engaged in joint research with various research institutions since 2016. In the fiscal year 2020, JAXA and the University of Tsukuba, one of the collaborative research institutions, received an award from the Minister of Education, Culture, Sports, Science and Technology for their contribution to extended healthy life expectancy and human space exploration through the development of a Mouse Rearing System in Space.

Fukuda Mitsuhiro

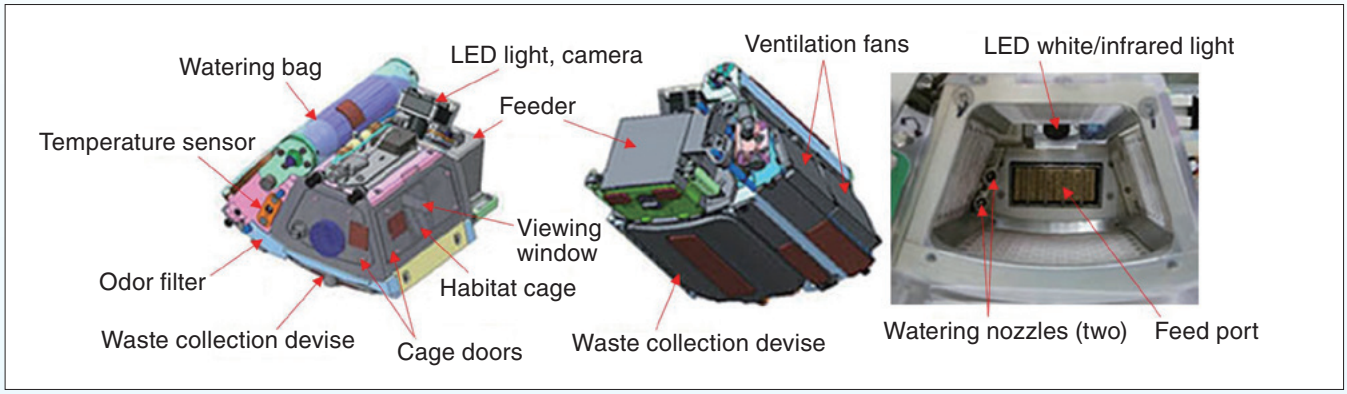
After long periods in space, even healthy astronauts experience symptoms such as weakened bones and muscles, worsened sense of balance, and decreased immune function. Research shows that these symptoms are very similar to those experienced by the elderly and bedridden here on Earth.

Clarifying the mechanisms of these symptoms, which occur during extended stays in space, can contribute solutions to various issues, such as extending healthy life expectancy (the period during which people can live without being restricted by health problems) in the super-aging society of Japan and many other countries, and maintaining health during future human space exploration. This idea gave rise to the Mouse Rearing System in Space study. By installing small habitat units, in which mice can be bred separately, in a centrifuge, this system can be used to artificially create gravity even in a space environment and rear mice (see diagrams, interior photo, and installation diagram below).

It was already known that when mice are bred in the environment of outer space, they undergo changes similar to those that occur in humans. However, it has been difficult to accurately assess the mechanism of change in space mice compared to ground mice because the effects of the large gravitational load experienced during rocket launch and landing on experimental results could not be ignored.

In the Mouse Rearing System in Space study, one group of mice was raised in microgravity in space and another group of mice was raised in gravity equivalent to that on Earth (1G) for about a month without changing other conditions. The results showed no difference between the mice raised in the 1G environment and those raised back on earth, but there were clear changes in muscle and bone density in the mice raised in microgravity. This is a step forward in understanding the mechanism of change at the molecular level in the future.

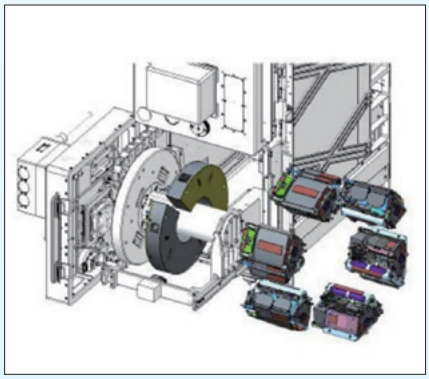
Overall view of the Japanese Experiment Module (JEM) Kibo, photographed during a spacewalk by US astronauts Photo: JAXA/NASA



Diagrams and interior photo of the Habitat Cage Unit (HCU) Photo: JAXA

Furthermore, in anticipation of future space development such as human exploration of the Moon and Mars, the Mouse Rearing System in Space study compared mice reared in a 1G environment with mice reared in an environment with 1/6G gravity, the same as on the lunar surface. The results showed that the quantitative changes in muscles that occur in microgravity were not observed in the case of lunar gravity. However, there was a qualitative transformation in the muscle fibers from slow muscles, which are necessary for endurance, to fast muscles, which are essential for instantaneous force, demonstrating that the effect of gravity on muscle quantity is different from its effect on muscle quality. Elderly people are generally characterized by weakened muscles and slower movements, and one of the factors behind this deterioration is linked to the age-related decrease in fast muscles. Analysis of the results of this series of experiments may provide a possible key to extending healthy life expectancy.

The physiological changes observed during stays in space are said to progress at an accelerated rate compared to those observed on the ground. Research using the Mouse Rearing System in Space is expected to continue to provide insights that cannot be obtained from experiments on the ground, and many clues that will contribute to extended healthy life expectancy and human space exploration.



Installation of the HCU in a centrifuge

Photo: JAXA