Weightlessness affects health of cosmonauts at molecular level

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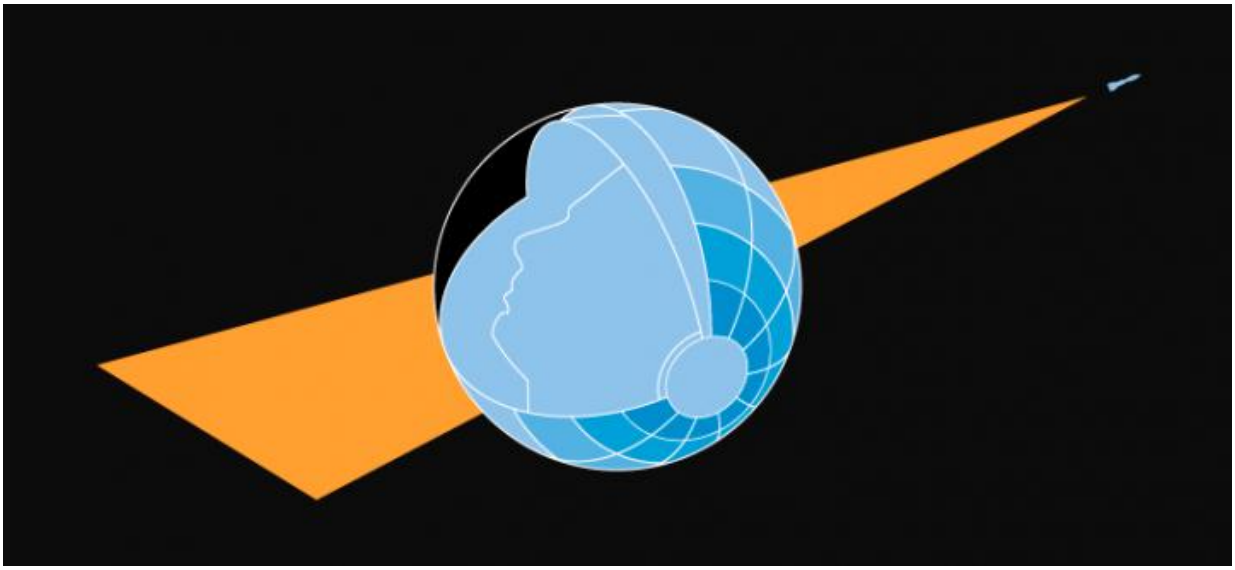

Space abstraction. Credit: MIPT's Press Office

A team of scientists from Russia and Canada has analyzed the effect of space conditions on the protein composition in blood samples of 18 Russian cosmonauts. The results indicate many significant changes in the human body are caused by space flight. These changes are intended to help the body adapt and take place in all major types of human cells, tissues and organs. The results of the research have been published in the prestigious scientific journal *Scientific Reports*. Skoltech and MIPT Professor Evgeny Nikolaev led the study and is a corresponding author.

The effects of spaceflight on the human body have been studied actively since the mid-20th century. It is widely known that space conditions influence metabolism, thermoregulation, heart biorhythms, muscle tone, the respiratory system and other physiological aspects of the human body. However, the molecular mechanisms driving these physiological changes remain unknown.

The scientists focused on proteins, key players in the adaptive processes in an organism. To gain a deeper understanding of the changes in human physiology during space travel, the research team quantified concentrations of 125 proteins in the blood plasma of 18 Russian cosmonauts who had been on long-duration missions to the International Space Station. The blood was drawn 30 days prior to their flights, and again immediately after their return to Earth, and a final sample seven days after that. This timing was chosen to identify trends in protein concentration changes and see how fast the protein concentrations returned to their normal levels prior to the flight.

Protein concentrations were measured using a mass spectrometer. This technology makes it possible to identify a particular molecule and perform a quantitative analysis of a mixture of substances. The scientists found proteins whose concentrations remained unchanged, as well as those whose concentrations did change, but recovered rapidly to their pre-flight levels, and those whose levels recovered very slowly after the cosmonaut's return to Earth.

"For the research, we took a set of proteins—non-infectious disease biomarkers. The results showed that in weightlessness, the immune system acts like it does when the body is infected, because the human body doesn't know what to do and tries to turn on all possible defense systems. For this study, we began by using quantitative proteomics to study the cosmonauts' blood indicators, so we detected not only the presence of a protein but its amount, as well. We plan to use a targeted

approach in the future to detect more specific proteins responsible for the human response to space conditions. To do this, the cosmonauts will have to take blood tests while in orbit," said Professor Nikolaev.

The factors that affect the human body during spaceflight are different from those that influence human evolution on Earth. It is not known if the human body has mechanisms responsible for rapidly adapting to such major changes. The results of the study indicate that such mechanisms probably do not exist, because during space flight, these adaptations take place in all the major types of human cells, tissues, and organs. This indicates that the human body does not know what to do and is trying to do everything in its power.

More information: Irina M. Larina et al. Protein expression changes caused by spaceflight as measured for 18 Russian cosmonauts, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-08432-w

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