Humans could reach Mars in the next 20 years. Professor Karsten Koenig of JenLab explains the dangers such a spaceflight could pose to the health of an astronaut’s skin.

NASA plans to send humans to Mars within the next 20 years. The Red Planet is more than 55 million kilometres away and it would take at least half a year to get there. How safe is such a trip? How do you protect the astronaut’s health in the hostile environment of interplanetary space?

Human spaceflights have been performed since 1961. 545 astronauts and cosmonauts have been to space, corresponding to about 123 man-years. The record for the longest spaceflight is held by Russian cosmonaut and space medicine technology revealed astonishing long-term effects on the health of human skin.

NASA has conducted research on the skin physiology of astronauts. Two European space shuttles, Columbus and Alexander Gerst, were involved in the experiments. Alexander Gerst, here pictured during a spacewalk on June 16, has a long number of long-term effects on the health of human skin.

The good news is the skin effects are reversible. When back on Earth, the epidermis of the two astronauts became thicker again. Studies are currently being conducted to monitor the repair process and to evaluate memory effects. We will gain knowledge of the process of re-adaptation to gravity.

Skin can be employed as an early recognition system for physical and mental health status. Further studies are recommended to understand why some astronauts show severe skin reactions, such as impaired wound healing in space and cosmonauts underwent modifications.

Skin problems have been performed since 1961. 545 astronauts and cosmonauts have been to space, corresponding to about 123 man-years. The record for the longest spaceflight is held by Russian cosmonaut and space medicine expert Valeri Polyakov, who spent 838 days non-stop in space.

At the moment, most health information on humans in space is obtained from scientific projects performed during six-month stays at the International Space Station (ISS), in a low Earth orbit at an altitude of 435km. A series of physiological modifications have been observed, but not everybody is a responder. The question arises: why do some astronauts develop health problems, such as impaired eyesight, and others do not?

**Getting under the skin**

On Earth, the body is attuned to gravity, with the heart pumping fluids upwards. In weightlessness, the body does not need this function. This can result in modifications of fluidics in the body. The Radiology journal reported that during the spaceflight, the astronauts had high fluid pressure in their skull, according to MRI data. Many astronauts suffered from space headaches (0.5 events/astonaut). In general, astronauts face the problem of bone loss similar (0.56 events/astronaut). In general, astronaut had high fluid pressure in their skull.

Skin problems including impaired wound healing in space need further research activities to protect astronauts’ health during long-term flights and to better understand ageing and wound-healing processes. Therefore, NASA and the European Space Agency (ESA) launched the ‘Skin in F’ project, which covers pre-flight, in-flight and post-flight skin measurements on five astronauts. For the first time in space research, medical femtosecond lasers are being employed to obtain label-free optical biopsies with superior intracellular resolution on astronauts. Physically taken biopsies are not required to get a precise look inside the skin and to monitor modifications of the tissue architecture and the cellular metabolism.

The novel imaging technology is called multiphoton tomography (MPT). MPT was introduced by the German company JenLab, with facilities in Jena and Saarbrücken. So far, MPT is mainly used in major hospitals in Australia, California, Russia and Western Europe for early detection of skin cancer and to monitor tumour borders during neurosurgery. Furthermore, it became an important tool for major companies such as P&G, Chanel, L’Oreal, Beiersdorf and Shiseido to evaluate pharmacologies and cosmetics, including nanoparticle-based sunscreens. In 2014, JenLab was awarded a New Economy Award in London and an IAB Award in Milan for the development of the certified multiphoton tomography MPTex. The Skin B project is ongoing. The in-flight measurements take place aboard Columbus (the ISS space lab module) to obtain information on skin hydration, the function of the skin barrier and the skin surface. Pre- and post-flight multiphoton measurements are performed at the European Astronaut Centre in Cologne. So far, ESA astronauts Luca Parmitaone, Alexander Gerst and Samantha Cristoforetti have been studied. Parmitaone launched on March 28, 2013 from the Baikonur Cosmodrome in Kazakhstan, Gerst on May 28, 2014 and Cristoforetti on November 23, 2014. Their journeys to the ISS were performed with the novel ‘express space-craft’ and took less than six hours. Parmitaone and Gerst spent almost half a year on the ISS. Cristoforetti is still working there.

**Dangerous thinning**

The novel, high-resolution, MPT imaging technology revealed astonishing long-term space effects on the skin.

Normally our skin thickness stays relatively constant. Cells produced in the lowermost skin cell layer, the stratum basale, migrate to the skin’s surface. On the way, they die and form the outermost skin layer. It seemed the astronaut underwent an accelerated skin aging process in space.

Skin impairments are one of the most frequent health problems that occur during space missions. For example, skin rashes are common on spaceflights. However, so far no major studies on the effects of extended space travel on human skin have been performed. There was one pilot study conducted in 2004 with a European astronaut who performed in-flight and post-flight skin measurements. Modifications of the dermis, the skin surface, and the hydration level were observed. Furthermore, the measured increase in the transdermal water loss reflected an impairment of the barrier function of the outermost skin layer. It seemed the astronaut underwent an accelerated skin aging process in space.

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**IN OUTER SPACE**

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