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. But is it safe to make the journey? How do you protect the astronaut’s health in the hostile environment of interplanetary space? The crew will face cancer-inducing radiation and maybe massive deep-space solar storms. In-spacecraft air pollution, such as skin particles from other crew members, may cause problems. And, of course, the body will change as a result of the long-term weightlessness, the body does not need this amount of water inside our body. Finally, we would lose the outer dead cells as horny dead material (e.g. by mechanical friction) and it drops to the ground due to gravity. The turnover of the epidermis takes one month - at least on Earth. On the ISS, skin physiology is different. Bioparticles from the stratum corneum are ‘floating’ in the air and may easily be inhaled. Mechanical friction is reduced. Microgravity impacts cellular metabolism, cell migration and reproduction.

Interestingly, MPT provides clear evidence the epidermis of the two male astronauts became thinner by more than 50 per cent, the mean epidermis thickness decreased from 57 to 49 µm (54 per cent) on the thinnest area, and from 67 to 57µm (15 per cent) on the thickest investigated site. The decrease was observed within the living cell layers of the epidermis and not within the dead-cell layer stratum corneum. The observed thinning of the epidermis did not correspond to other significant signs of skin aging such as flattening of the epidermal-dermal junction. Also the lower part of the skin, the dermis, changed. In particular, the extracellular matrix components elastin and collagen underwent modifications. Interestingly, there was a strong increase in the amount of collagen and in the ratio of collagen to elastin compared with pre-flight conditions. This observation is in contrast to age effects on Earth. In fact, the monitored collagen-elastin ratio increase results in an ‘anti-ageing’ effect, as observed with certain cosmetic products on Earth.

However, thinning of the viable epidermis is no disadvantage. Dangerous radiation, such as low-wavelength ultraviolet - and cosmic radiation can reach the basal cell layer easily at the epidermis-dermis junction. That most important skin layer contains the stem cells and is also the location where black skin cancer starts. If an astronaut’s viable epidermis is only thin, after a six-month expedition, his viable skin cell layer can likely shrivelt to less than two cell layers during a one-year Mars expedition.

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 readjusting 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 thinning of the viable epidermis, modifications of the dermis, and allergic reactions, before starting the trip to the red planet.

Skin problems IN OUTER SPACE

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.

Skin impairments are one of the number of long-term effects on humans in space is obtained by Russian cosmonaut and space medicine expert Valeri Polyakov, who spent 438 days in space. The record for the longest spaceflight is held by the astronaut who performed in-flight and post-flight skin measurements. Modifications of the skin after spaceflight could pose to the health of an astronaut’s skin.

Skin problems included 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 E’ project, which covers pre-flight, in-flight on the ISS, 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 Saurbrücken. 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 Shizindo to evaluate pharmaceutics and cosmetics, including nanoparticle-based sunscreens.

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 lowest skin cell layer, the stratum basale, migrate to the skin surface. On the way, they die and form the outermost layer, the stratum corneum. That dead cell layer acts as a barrier and keeps, for example, the water inside our body. Finally, we lose the outer dead cells as horny dead material (e.g. by mechanical friction) and it drops to the ground due to gravity. The turnover of the epidermis takes one month - at least on Earth.

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15% decrease in skin thickness among some astronauts

Above: Alexander Gerst, here shown performing a spacewalk, was one of the astronauts studied in the project. Left: An astronaut during a spaceflight. The gravitation is reduced by a number of long-term effects on the health of human skin.