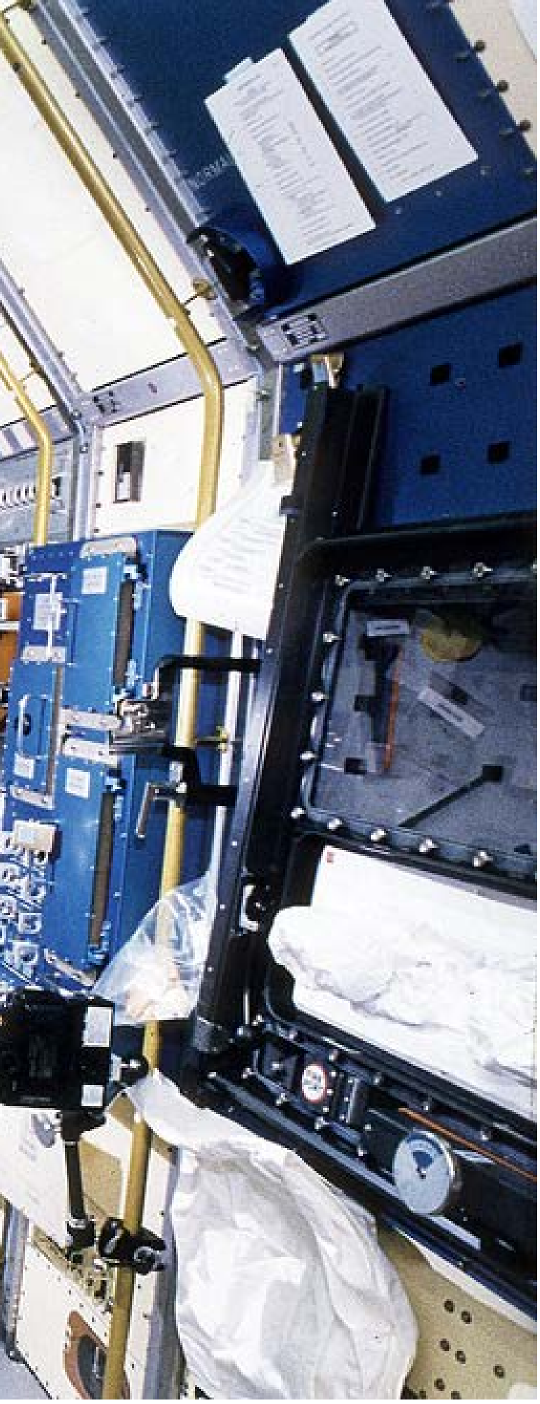
Space travel and the human immune system

Are we ready to travel to Mars? A new study, called INVEST, funded by the National Research Foundation (NRF) and Belgian Federal Science Policy Office (BELSPO) examines if humans could survive long-duration space travel.

At the moment, space radiation is a potential showstopper for future manned space missions, since an astronaut on a mission to Mars would receive radiation doses up to 700 times higher than on Earth. A new study investigates the effects of space radiation on the human immune system. Dr Randall Fisher, a postdoctoral researcher in Space Radiobiology working in the Radiation Biophysics division at NRF-iThemba LABS, is leading a team of scientists who are studying how the human immune system, which is highly sensitive to both psychological and physical stressors, would react to extended space travel-related neutron radiation, an important secondary component produced by space radiation.

Comprised mainly of galactic cosmic rays and solar energetic particles, space radiation differs from the radiation types (e.g. X-rays) we normally encounter on Earth. It has a greater ionising effect that can cause



considerable damage to human DNA. In addition, its potent ability to disrupt atoms enables it to produce secondary particles when it impacts spacecraft shielding or astronauts' bodies. This phenomenon, called 'spallation', produces a more-dangerous neutron radiation field inside the spacecraft.

It is challenging and costly to study the health effects of space radiation in space, and ground-based experimental analogues are an achievable alternative for researchers with access to a particle accelerator. This requirement paints NRF-iThemba LABS as a niche facility to conduct space life sciences experiments in Africa and forms the rationale behind the INVEST collaborative, whose aim is to establish a ground-based *in vitro* model to study space health effects. Dr Fisher's pilot study in the INVEST collaborative examined the immune effects of low doses and dose rates of spaceflight-related high-energy neutrons.

What did they do?

The effect of neutron dose rate on immune alterations was studied using the *in vitro* cytokine release assay. Blood samples from healthy adult volunteers were exposed to 0.125Gy or 1Gy of neutron radiation, administered at a 0.015Gy/min (lower dose rate or LDR) or a 0.4Gy/min dose rate (higher dose rate or HDR). The unit Gray (Gy) refers to the absorbed radiation dose that's typically 0.7 mGy for an abdominal X-ray and as high as 80 Gy in radiotherapy applications. After irradiation, immune cells in the blood were stimulated with Pokeweed Mitogen (PWM) or bacterial antigens before being incubated for 24 hours.

Interleukin-2 (IL-2), interferon-gamma (IFN-γ), tumour necrosis factor-alpha (TNF-α), and interleukin-10 (IL-10) are soluble signalling molecules or cytokines, secreted by immune cells to coordinate immune system functioning. Plasma concentrations of these cytokines were measured and correlated to the neutron dose rate and stimulant treatment administered. Stimulants generally increased all plasma cytokine levels except IL-2, where only PWM induced a significant increase.

What did they find?

In general, no statistically significant changes were observed in IL-2, IFN-γ, and TNF-α concentrations at different neutron doses and dose rates when compared to their controls. After PWM-stimulation, IL-10 levels were significantly increased after 0.125Gy HDR and 1Gy LDR neutron treatments. Pooled-per-dose rate data showed that the HDR significantly increased IL-2 titres (under PWM-stimulation) and IFN-γ titres (with all stimulants), but significantly decreased TNF-α secretion in unstimulated samples.

Their findings suggest that neutron irradiation on a deep space mission may suppress the astronaut's immune system through the over-secretion of IL-10 (an anti-inflammatory cytokine) and that the dose rate plays an important role in IL-2 and TNF-α suppression, which may prevent efficient immune response to viral infections. Dr Fisher and his team are continuing this research and plan to incorporate simulated stress and simulated microgravity as spaceflight stressors into future experiments.

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Sesikulungele ukuya emkhathini ku Mars? Ibizwa nge INVEST, ixhaswe I National Research Foundation (NRF) and Belgian Federal Science Policy Office (BELSPO) ihlola ukuthi abantu banga phila emkhathini isikhathi eside.

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