Post-doc vacancy

Consequences of space flight stressors on human health: Study of the impact of cosmic radiation, microgravity and psychological stress on different model systems

Introduction:

Space travel comprises a unique and complex stress model composed of physical and psychological stressors. Physical stressors include the presence of cosmic radiation in combination with microgravity conditions. Furthermore, astronauts experience psychological stress due to confinement and isolation, disrupted circadian rhythms, high expectations of performance, and risks of equipment failure or fatal accidents. These extreme conditions can induce specific stress responses within the astronauts body that will affect several organ systems. The precise nature of these health effects are not completely understood and multiple underlying causes might be involved. In view of future interplanetary travel, studies onboard the International Space station (ISS) will help to answer many critical questions. Next to flight studies, the European Space Agency (ESA) offers a number of ground-based programmes for researchers to test theories without launching experiments into space.

The **immune system** is one of the organ systems that is affected during spaceflight. Previous studies in which SCK•CEN was actively collaborating (long-term stay on the ISS) and in the Antarctic environment at the Concordia Station demonstrated the negative impact of space stressors on the adaptive immune system (including both humoral immunity components and cell-mediated immunity components). Because the immune system is crucial for the human body homeostasis and the capability to cope with infectious challenges, immune dysfunction may endanger successful mission accomplishment. SCK•CEN is participating in six ESA studies that further investigate the impact of space stressors on the immune system. The studies include four ISS studies and two studies using ground-based platforms. Blood samples from astronauts will be collected pre, in- and post-flight to analyse changes in cellular immunity. The humoral immune system (antibody production) will be further investigated by using respectively X. *Laevis* embryos and the *in vitro* Ramos cell line as model systems.

Next to changes in the immune system, many space missions have shown that long-term space flight may also increase the risk of **cardiovascular** diseases. Dysfunction of endothelial cells which line the interior surface of blood vessels) at microcirculatory sites might contribute to cardiovascular deconditioning induced by space stressors. Therefore, it is of great interest to further investigate how endothelial cells respond to altered gravity and cosmic radiation conditions and which signaling molecules are involved. SCK•CEN is involved in a flight study where the main focus is placed on the impact of real microgravity conditions on human endothelial cells cultured onboard the ISS.

Finally, the model species Adineta vaga will be send to space and used to study the effect of microgravity and cosmic radiation on their survival and DNA repair capacities, and to sequence their transcriptome after different stress conditions.

Objectives:

A first goal of this project is to study changes in **cellular and humoral immunity** in combination with several stress factors on humans or alternative model systems (animals, cells) exposed to (simulated) space conditions. Research platforms include the ISS, the hypobaric and hypoxic environment with exposure to low dose chronic radiation at Antarctica, and a study simulating microgravity on Earth.

A second important goal will be the analysis of cellular and molecular changes in endothelial cells in order to gain more insight into space-flight induced **cardiovascular changes**.

Within the third goal, bdelloid rotifers will be used to further understand the molecular mechanisms of living beings that face extreme conditions (radiation resistance and DNA repair).

A final goal of the project is to perform **ground-based experiments** for the different ESA studies. These include procedure and hardware testing, as well as parallel studies on Earth. The latter will serve as a control for the results obtained from the pre-, in-, and post-flight samples.

Methodology

Various cellular and humoral **immune parameters** (in blood cells, plasma or cell supernatants) will be analyzed using high-throughput technologies available within the genomic and Luminex platform at SCK•CEN: whole genome analysis of immune cells, standardized monitoring of the cellular immune status using the *in vitro* delayed-type hypersensitivity test, and high-throughput quantitative analysis of inflammatory proteins (cytokines) using the Luminex Technology.

In preparation of the different ISS experiments, **ground-based optimization and feasibility studies** will be executed. In this context, SCK•CEN will perform a number of ground-based experiments using space simulating devices. The Random Positioning Machine (RPM) is a 3D device that allows to simulate microgravity on cell cultures. Two RPMs are available at the Radiobiology Unit of SCK•CEN. In order to simulate cosmic radiation, experiments with low-LET photons or high-LET neutrons can be performed at the irradiation facility of SCK•CEN. Psychological stress can be mimicked by adding stress hormones (e.g. cortisol) to cell cultures. These ground-based tests are essential for the final outcome of the flight study and will allow a careful preparation of the many steps composing the final flight experiment. Moreover, ground-based experiments are much more flexible in set-up and can be repeated when needed. They also have the advantage that larger sample volumes can be obtained, and many more experimental conditions can be analyzed.

Application deadline:
March 25 2016

Application website:
General: http://academy.sckcen.be/en/Your_thesis_internship/
Post-doc topic: http://academy.sckcen.be/en/Your_thesis_internship/AllTopics/Consequences-of-space-flight-stressors-on-human-health--Study-of-the-impact-of-cosmic-radiation-microgravity-and-psychological-stress-on-different-model-systems-1334

Required education level of candidates:
PhD in (bio)medical sciences with experience in immunology and bio-informatics

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