



Why do astronauts' immune systems become weakened?

18 April 2014

DLR sends two biomedical experiments from the University of Magdeburg to the ISS. Also on board – NASA cameras for Columbus Eye, the DLR student experiment.

Everything is different in space. Every cell in our body seems to be aware of the lack of gravity and our bodily functions change. Spending time in space also weakens astronauts' immune systems. Researchers at the University of Magdeburg want to find out why with two experiments organised by DLR Space Administration that will be conducted on the International Space Station (ISS). Two cell cultures were launched to the ISS on board a Dragon spacecraft operated by US company SpaceX from the Cape Canaveral Air Force Station in Florida, at 21:25 CEST (15:25 local time) on 18 April 2014.

Also on board the spacecraft was another piece of important cargo for DLR – the NASA High Definition Earth Viewing (HDEV) experiment. "This is a box containing four HD video cameras that will be installed on the European ISS module, Columbus," says Johannes Weppler from DLR Space Administration. The cameras will act as Columbus' 'eyes', acquiring images of Earth that will be used by the Columbus Eye student project as part of Alexander Gerst's mission to the ISS. On May 28 2014, the next German ESA astronaut will embark on his journey to the ISS, where he will live and work for six months.

The two biological experiments from the University of Magdeburg "investigate how human phagocytes and thyroid cancer cells behave in zero gravity. After 30 days on the ISS, the small experiment chambers containing the cell cultures will be sent back to Earth on board the Dragon capsule. The scientists will then analyse the samples in their home labs," explains DLR project leader Markus Braun.

This is the first time that a commercial provider has been commissioned for transporting and carrying out the experiments. NanoRacks – the company involved – was founded in 2008 to commercialise the usage of the ISS and make it accessible to more users in the United States. Today, around one quarter of its revenues come from NASA, and the overwhelming majority from customers worldwide. Through the CellBox mission, and in addition to its use of the ISS via ESA and bilateral collaborations, DLR is trying out new ways of offering German scientists additional cost-effective options for carrying out experiments in space. Two different cell types are being used in the CellBox experiment; macrophages – the immune system's 'scavenger cells' – and human thyroid cancer cells. The cells were prepared in a laboratory and placed in the sample chambers prior to launch. The scientists are supported by a team from Airbus Defence & Space.

"Macrophages circulate around the body and 'eat' intruder microorganisms and other harmful substances. In this experiment, certain surface molecules responsible for the detection of cellular debris and pathogens and for communication between the cells will be specifically analysed both in zero gravity and under Earth-like conditions. In addition, the cytoskeleton and certain secretion products such as cytokines, which regulate cell growth and differentiation – among other things – will be studied," Braun summarises. This can be used to determine the condition of the cells and to precisely measure any changes. Countermeasures in the form of therapy or medication can only be developed if the cellular causes for immunodeficiency in zero gravity are understood.

Preliminary tests conducted during DLR parabolic flights have indicated that macrophage activity is influenced by changes in gravity. This could possibly explain the immune function deficiency experienced by humans in space.

The second CellBox purpose focuses on thyroid cancer cells. "This involves studying changes in cellular and molecular function as a result of the absence of gravity. Cellular biologists at the University of Magdeburg want to use this knowledge to find new therapeutic methods for combatting tumours," Braun explains. In microgravity, cancer cells form three-dimensional spherical agglomerations consisting of thousands of tumour cells that are similar to the original tumour.

Following experiments in space such as the German-Chinese SIMBOX Project, the researchers know that, in zero gravity, thyroid cancer cells change the way they produce a wide range of proteins as a result of various physiological processes. Cancer cell reproduction and metastasis is influenced in precisely the same way as cell death, cellular movement and stimulus processing. These results are now expected to be confirmed and expanded upon in the CellBox experiment.

The tendency of cells to grow in spherical agglomerations in zero gravity is also of interest in another context: "Tissue engineering involves generating three-dimensional tissues," states Braun. Scientists had previously managed to cultivate vessel-like structures in zero gravity – now the researchers intend to continue this work as part of the CellBox experiment.

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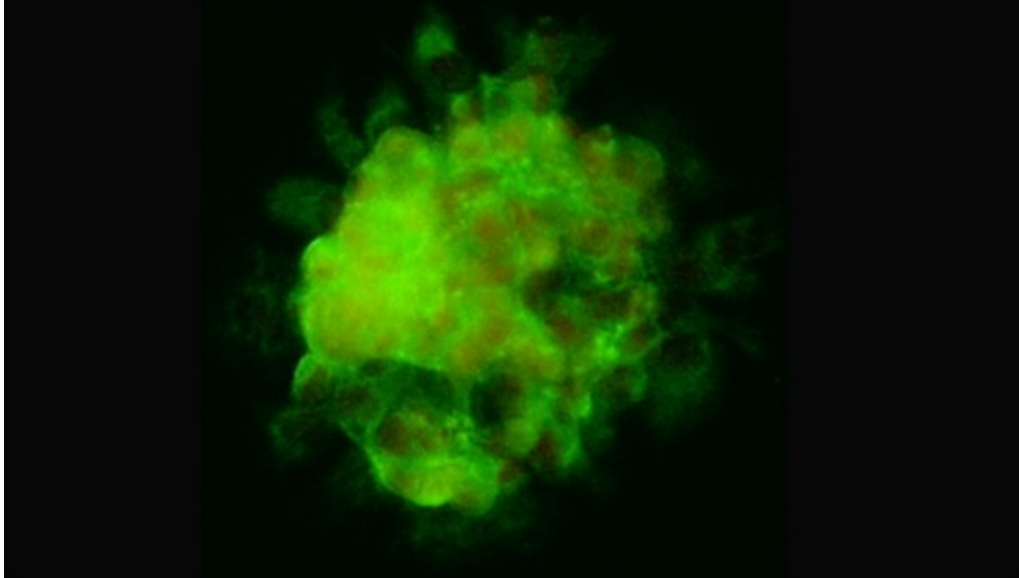
Falcon 9 launcher lifts off from Cape Canaveral



On 18 April 2014 at 21:25 CEST (15.25 local time), a Falcon 9 launcher lifted off from Cape Canaveral. On board the Dragon capsule were two biological experiments from the University of Magdeburg.

Credit: NASA.

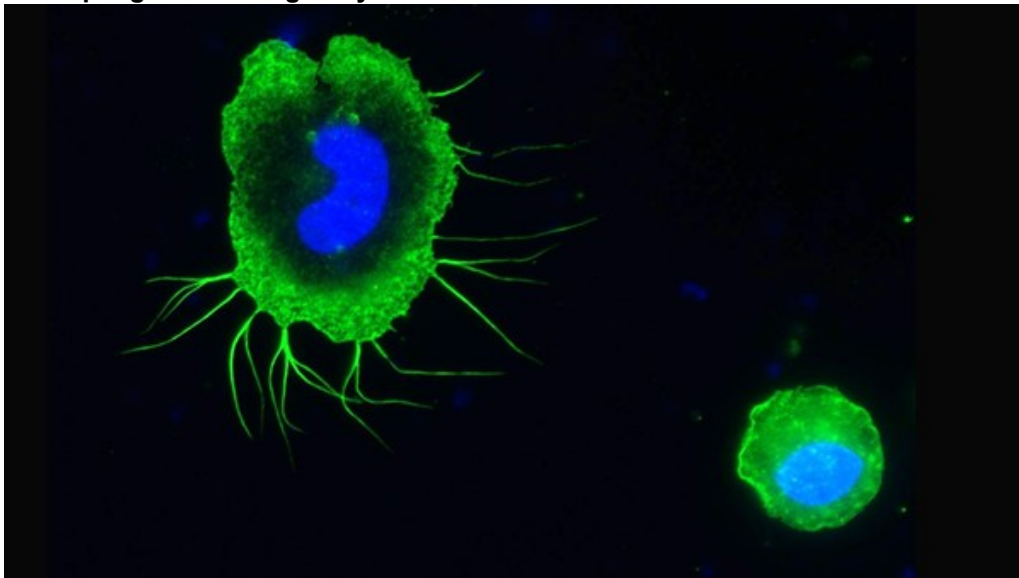
Multicellular spheroids consisting of human thyroid cancer cells



One of the two German CellBox experiments focuses on thyroid cancer cells. This involves studying cellular and molecular changes in these cells that occur as a result of the absence of gravity. Doctors at the University of Magdeburg want to use this knowledge to find new therapeutic methods for combatting tumours. In zero gravity, the cancer cells form three-dimensional spherical agglomerations (spheroids) consisting of thousands of tumour cells that resemble the original tumour.

Credit: AG Grimm/University of Magdeburg.

Macrophages in microgravity

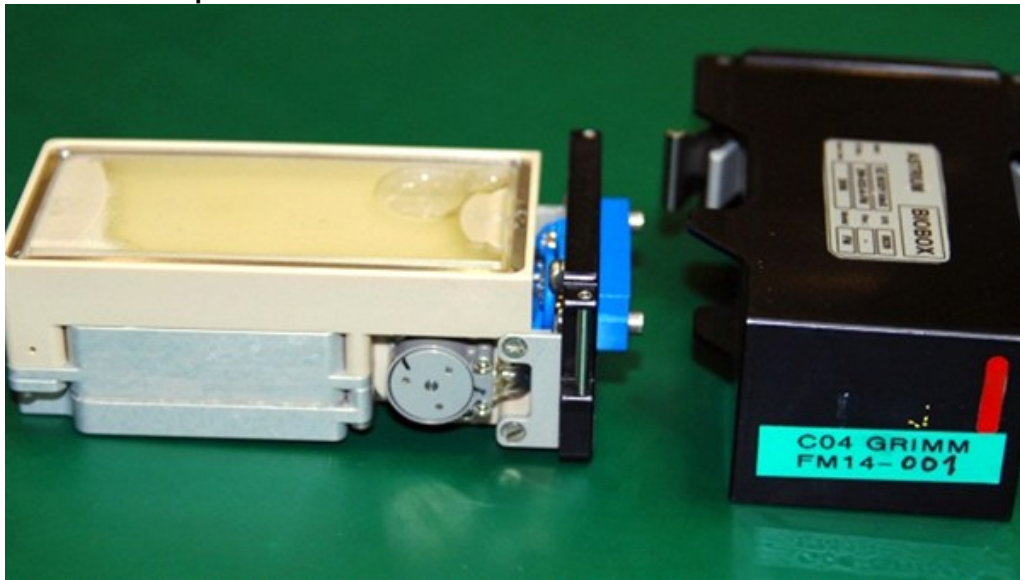


In the second CellBox experiment, millions of macrophages will be exposed to microgravity on the ISS. The immune system's 'scavenger cells' circulate around the body and 'eat' intruder microorganisms and other harmful substances. In this experiment, certain surface molecules that are responsible for the detection of foreign bodies and for communication between the cells will be analysed in microgravity and under Earth-like conditions. In addition, the cytoskeleton and certain secretion products such as cytokines, which regulate cell growth and differentiation will be studied. This can be used to determine the condition of the cells and to precisely measure any changes. Countermeasures in the form of therapy or medication can only be

developed if the cellular causes for immunodeficiency in zero gravity are understood. Preliminary tests conducted during DLR parabolic flights have indicated that macrophage activity is influenced by changes in gravity. This could possibly explain the immune function deficiency experienced by humans in space.

Credit: Svantje Tauber/AG Ullrich/University of Magdeburg.

The CellBox experiment chamber



The two cell cultures developed by German scientists at the University of Magdeburg will be subjected to microgravity conditions on the ISS – their 'habitat' is the smartphone-sized CellBox experiment chamber. The chamber with the pumps and tanks for nutrient and fixer solutions for the cells is visible in the image. After 30 days in space, the cell cultures are due to be brought back to Earth aboard the Dragon capsule; scientists will then analyse the samples in their home labs.

Credit: DLR (CC-BY 3.0).

Experiment preparation for cell research



Two different cell types are being used in the CellBox experiment; macrophages and human thyroid cancer cells. The cells were prepared in a laboratory and placed in the sample chambers prior to their launch to the ISS.

Credit: DLR (CC-BY 3.0).

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