Tackling tumors with space station research

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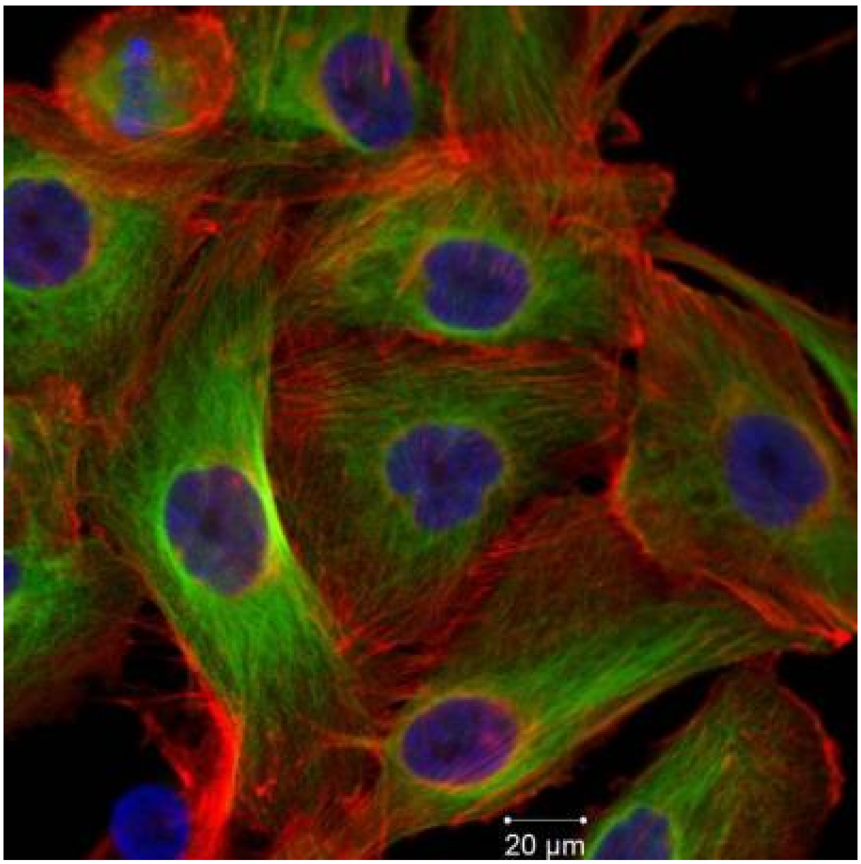


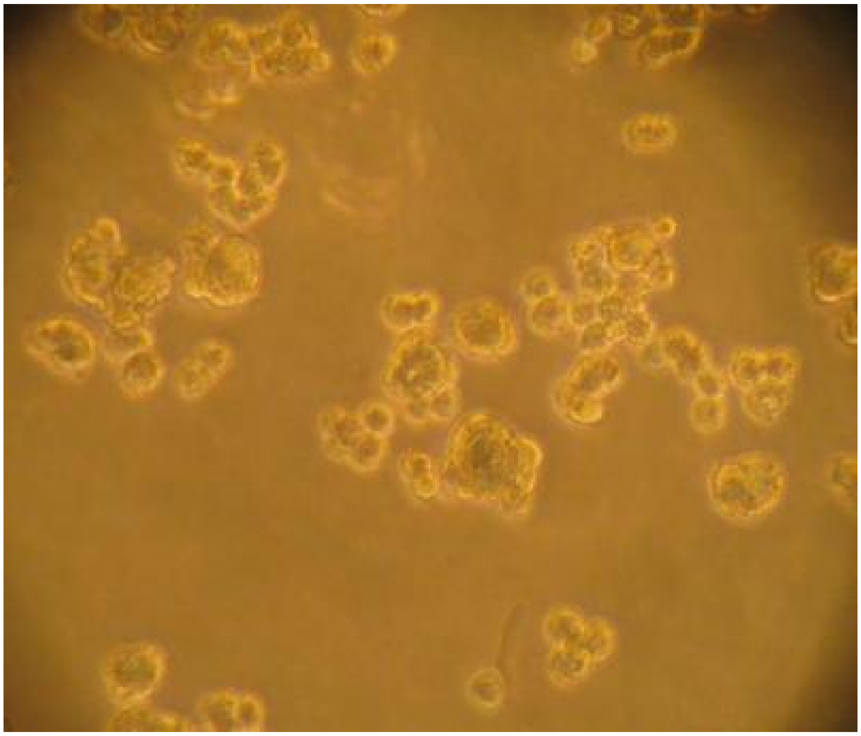
Thyroid cancer cell line FTC-133 after four hours of exposure to simulated microgravity. Nuclei are stained blue, components of the cytoskeleton stained green and red. Credit: Team Daniela Grimm

In space, things don't always behave the way we expect them to. In the case of cancer, researchers have found that this is a good thing: some tumors seem to be much less aggressive in the microgravity environment of space compared to their behavior on Earth. This observation, reported in research published in February by the *FASEB Journal*, could help scientists understand the mechanism involved and develop drugs targeting tumors that don't respond to current treatments. This work is the latest in a large body of evidence on how space exploration benefits those of us on Earth.

Research in the weightlessness of space offers unique insight into genetic and cellular processes that simply can't be duplicated on Earth, even in simulated microgravity. "Microgravity can be approximated on Earth, but we know from the literature that simulated microgravity isn't the same as the real thing," says Daniela Gabriele Grimm, M.D., a researcher with the Department of Biomedicine, Pharmacology at Aarhus University in Aarhus, Denmark, and an author of the FASEB paper.

True weightlessness affects human cells in a number of ways. For one thing, cells grown in space arrange themselves into three-dimensional groupings, or aggregates, that more closely resemble what happens in the body. "Without gravitational pull, cells form three-dimensional aggregates, or spheroids," Grimm explains. "Spheroids from cancer cells share many similarities with metastases, the cancer cells which spread throughout the body." Determining the molecular mechanisms behind spheroid formation might therefore improve our understanding of how cancer spreads.

The FASEB paper resulted from an investigation in the Science in Microgravity Box (SIMBOX) facility aboard Shenzhou-8, launched in 2011. Cells grown in space and in simulated microgravity on the ground were analyzed for changes in gene expression and secretion profiles, with the results suggesting decreased expression of genes that indicate high malignancy in cancer cells.



Three-dimensional, multicellular tumor spheroids begin to form after exposure to real microgravity. Credit: Team Daniela Grimm

The work was funded by a grant from the German Space Life Sciences program, managed by the German space agency, DLR, in collaboration with Chinese partners.

Grimm and her colleagues are following up with additional research, a Nanoracks Cellbox investigation called "Effect of microgravity on human thyroid carcinoma cells," scheduled to launch in March on SpaceX's third commercial resupply mission to the International Space Station. Another follow-up investigation, "Spheroids," is planned in 2015. The overall goal is to find as many genes and proteins as possible that are affected by microgravity and to identify the cellular activities they influence. Researchers can then use this information to develop new strategies for cancer research.

In a recent paper published in *Nature Reviews Cancer*, Jeanne Becker, Ph.D., a cell biologist at Nano3D Biosciences in Houston and principal investigator for the Cellular Biotechnology Operations Support System (CBOSS) 1-Ovarian study, examined nearly 200 papers on cell biology research in microgravity during four decades. This body of work shows that not only does the architecture of cells change in microgravity, but the immune system also is suppressed. Other studies in addition to Grimm's have shown microgravity-induced changes in gene expression. The key variable, Becker concluded, is gravity. And the only way to really mitigate gravity is to go into space.

To maximize use of the space station's unique microgravity platform, in 2011 NASA named the Center for the Advancement of Science in Space (CASIS) as manager of the station's U.S. National Laboratory. By selecting research and funding projects, connecting investors and scientists and improving access to the station, CASIS accelerates new technologies and products with the potential to benefit all humanity.

These are automated Astrium Type-IV experiment chambers that will be used to culture thyroid cancer cells on board the International Space Station. Credit: Team Daniela Grimm

CASIS recently requested proposals for research on the effects of microgravity on fundamental stem cell properties. That request, says Patrick O'Neill, communications manager, generated a terrific response from the research community - larger than any other CASIS proposal to date. That, he says, is because CASIS has become more known within the scientific and research community as a viable option for sending research to the space station. It is also because, now that the station is complete, crew members can increase their focus on research. All in all, this is an ideal time to send research to the station.

Grimm agrees. "The station is an invaluable tool for long-term studies of cells in microgravity. Exposure to real microgravity in space will always be the gold standard for all microgravity research and will therefore always be an important cornerstone of our work."

Thanks to that research in space, scientists continue to learn more about diseases and their possible treatment here on Earth. With this new knowledge, we can turn that unexpected behavior in microgravity to our own advantage.

Provided by NASA