Microgravity and radiation exposure add up to serious health risks for astronauts

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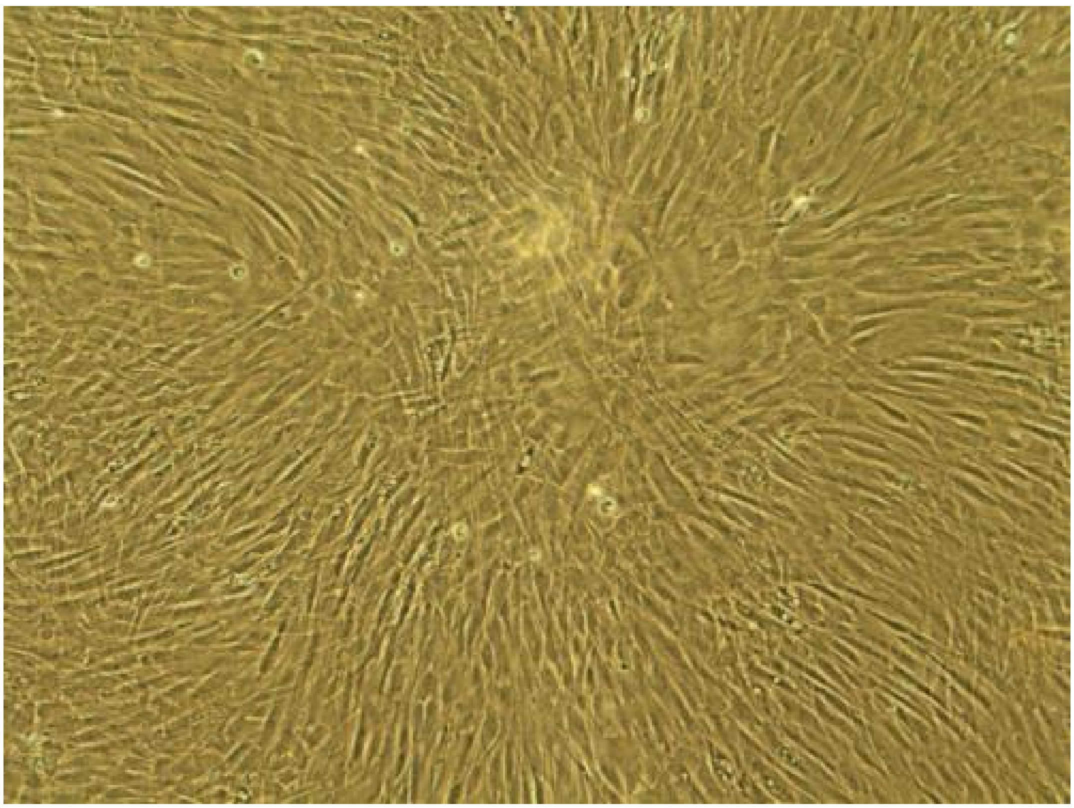


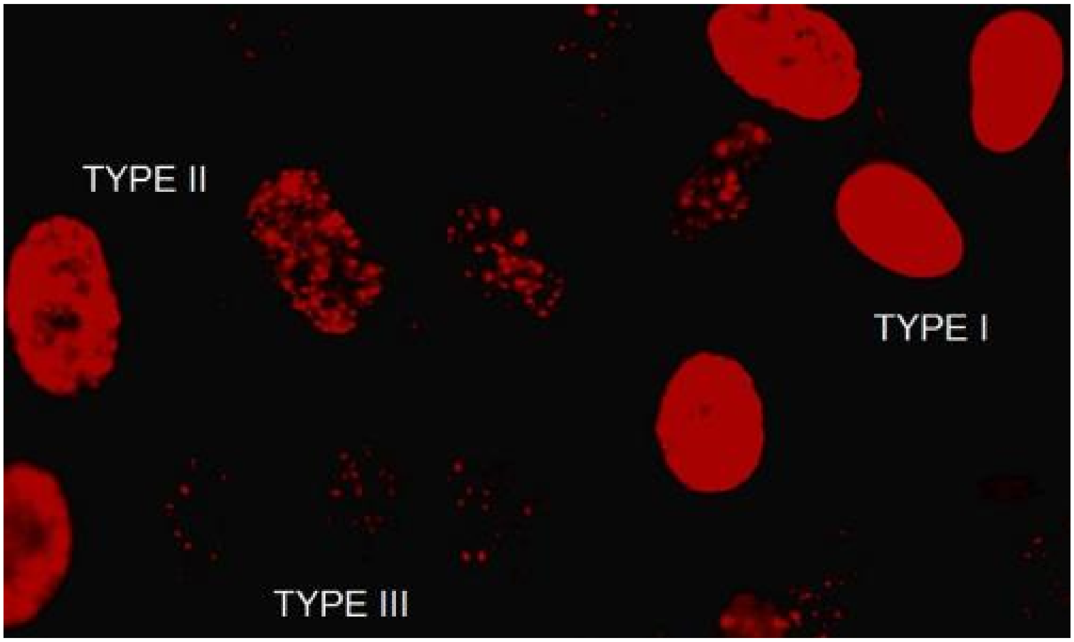
Human fibroblasts will be grown in the BioServe's cell culture system. Credit: Bioanalytical Core Laboratory

Astronauts floating weightlessly in the International Space Station may appear carefree, but years of research have shown that microgravity causes changes to the human body. Spaceflight also means exposure to more radiation. Together, microgravity and radiation exposure add up to pose serious health risks. But research is not only making space safer for astronauts, it's helping to improve health care for the Earth-bound as well.

One of the effects of space radiation is damage to DNA, or deoxyribonucleic acid, the genetic material in nearly every cell of our bodies. When damaged DNA repairs itself, errors can occur that increase the risk of developing cancer. A new study, MicroRNA Expression Profiles in Cultured Human Fibroblast in Space – Micro-7 for short – will examine the effect of gravity on DNA damage and repair. Because there is no controlled radiation source aboard the space station, the cells will be treated with bleomycin, a chemotherapy drug, to induce DNA damage.

"When a cell in the human body is exposed to radiation, DNA will be broken and repaired, which is considered the initiation stage of tumor development," explains principal investigator Honglu Wu, Ph.D., at NASA's Johnson Space Center in Houston. "Cells damaged from radiation exposure in space also experience microgravity, which we know changes gene expressions even without radiation exposure." That equals the space double-whammy for the human body.

Previous studies have exposed cells or organisms on Earth to high-energy charged particles to simulate space radiation, using the resulting cell damage or induction of tumors to predict the risk of cancer for astronauts from radiation. But those predictions don't include the effects of microgravity, making them potentially less accurate than the space based Micro-7 study. This investigation will address that by examining the effects of bleomycin-induced DNA damage aboard the orbiting laboratory.



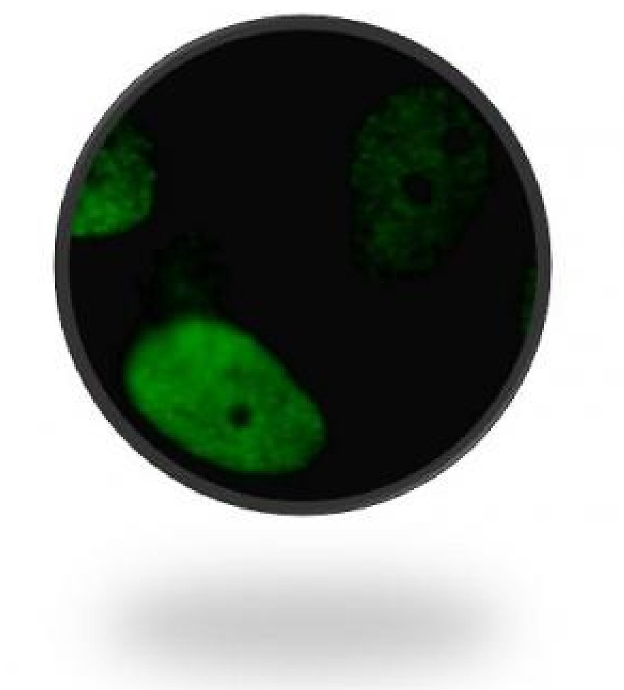
Damage in human fibroblasts will be measured by the phosphorylation of a histone protein H2AX after bleomycin treatment. Credit: Bioanalytical Core Laboratory

The study will be the first in space to use cultured human fibroblasts, the non-dividing cells that make up most of the human body. Fibroblasts form the framework for organs and tissues and play a critical role in wound healing and other bodily functions.

The investigation is scheduled to launch to the orbital complex aboard SpaceX-3 March 16, 2014. Micro-7 is managed by NASA's Ames Research Center, Moffett Field, Calif., and is funded by NASA's Space Biology Program. Bioserve Space Technologies at the University of Colorado, Boulder, Colo. is providing the experiment hardware and implementing the science payload aboard the space station.

Wu will focus on how these cells respond to DNA damage in space by examining changes in a small, non-coding form of RNA known as microRNA, which is known to affect how genes are expressed in cells. The investigation will compare the cells in spaceflight with those on the ground to identify unknown functions of microRNA and the functions they regulate in our bodies. Similarities and differences in the space and Earth data will also improve our knowledge of fundamental biological processes critical for maintaining normal cell function.

In the future, Wu would like to have a controlled radiation source, such as a portable X-ray machine, on the space station to expose cultured cells or small animals to specific doses of radiation in space. Cells or organisms on the ground would be exposed to the same dose, and the DNA repair in both compared. Wu says that may be possible in the near future, perhaps by modifying a bone density scanner or other equipment aboard the space station.



TYPE IV damage to human fibroblasts after bleomycin treatment, shown in a 53BP1 stain. Credit: Bioanalytical Core Laboratory

Researchers can use data from Micro-7 in future Earth-based studies to examine whether the cell changes observed during spaceflight are seen in disease states of tissues and organs as well. Ultimately, this may help scientists better understand disease and this type of research could even lead to development of new treatment drugs.

"If we learn more about how cells repair DNA damage more efficiently or less efficiently in space, that knowledge also will be helpful for cancer radiotherapy or treatment with radiation," Wu adds. "A challenge in medical treatment is that certain tumors are highly resistant to radiation. But there could be various ways to make them more radiosensitive, or less resistant to radiation. That would help provide more effective treatment." And also make those weightless astronauts a bit more carefree.

Provided by NASA

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