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Brain stem cells sensitive to space radiation

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Cold Spring Harbor Laboratory (CSHL) scientists recently led a team of researchers to study potential effects of space radiation on astronauts. The results of their study are revealing and will provide the foundation for ensuring the safety of crew members participating in long distance space travel. Measures to protect astronauts from health risks caused by space radiation will be important during extended missions to the moon or Mars, say researchers in a paper currently online in *Experimental Neurology*.

Using a mouse model designed to reveal even slight changes in brain cell populations, scientists found radiation appeared to target a type of stem cell in an area of the brain believed to be important for learning and mood control.

The findings — from a team of researchers from The Cold Spring Harbor Laboratory, Brookhaven National Laboratory, NASA's Kennedy Space Center and the McKnight Brain Institute of the University of Florida (UF) — suggest that identifying medications or physical shielding to protect astronauts from cosmic and solar radiation will be important for the success of human space missions beyond low Earth orbit.

"Our discovery does not present any adverse issues for the astronaut program because the ground-based dose and application of radiation we used were not comparable to that seen for existing space travel," said Dennis A. Steindler, Ph.D., executive director of UF's McKnight Brain Institute and co-investigator in the study. "But the exceptional sensitivity

of these neural stem cells suggests that we are going to have to rethink our understanding of stem cell susceptibility to radiation, including cosmic radiation encountered during space travel, as well as radiation doses that accompany different medical procedures."

Stem cells are important because they have the remarkable ability to renew themselves and produce many different cell types.

In this study, Cold Spring Harbor Laboratory scientists developed mice that were genetically engineered with easily identifiable, florescent stem cells. The stem cells lose their florescence when they transform into neurons, which makes it easier to account for them. Scientists from the NASA Space Radiation Laboratory located at the Brookhaven National Laboratory in Upton, NY, then administered a single dose of radiation to the mice about equal to the amount astronauts would receive after a three-year space voyage to Mars.

A CSHL team of scientists led by neurobiologist Grigori Enikolopov, Ph.D., then examined the mice and unexpectedly found that a special type of stem cell is selectively killed in the hippocampus. The cell is described as quiescent — or quiet — because even though it is the wellspring that repopulates the brain with new cells, it exists in relative repose while its daughter cells divide and reproduce in great numbers.

"Our findings are surprising because it is assumed that dividing cells are the most vulnerable to radiation — that is why radiation is used in cancer therapy," said Enikolopov, who served as co-investigator and corresponding author for the project. "These stem cells divide quite rarely and it was unexpected that they would be the most vulnerable to this type of radiation. But at least two thirds of these quiescent cells died. The challenge now is to find something to protect those cells."

Whether certain brain cells are at risk more than others is vital

information for scientists planning lengthy lunar expeditions or deep space missions. The President's Commission on Implementation of United States Space Exploration Policy outlined plans to send a human expedition to the moon by 2020. NASA led the mission to land the first unmanned spacecraft on Mars in 1975. More recently, NASA's unmanned Phoenix Mars Lander was launched on Aug. 4 and is expected to land on the red planet on May 25, 2008.

"Space radiation has not been a serious problem for NASA human missions because they have been short in duration or have occurred in low Earth orbit, within the protective magnetic field of the Earth," said Philip Scarpa, M.D., a NASA flight surgeon at NASA's Kennedy Space Center in Florida and co-investigator in the study. "However, if we plan to leave low Earth orbit to go back to the moon for long durations or on to Mars, we need to better investigate this issue and assess the risk to the astronauts in order to know whether we need to develop countermeasures such as medications or improved shielding. We currently know very little about the effects of space radiation, especially heavy element cosmic radiation, which is expected on future space missions and was the type of radiation used in this study.

"In addition, we should expect that within each critical organ system, there may be different cell sensitivities that need to be considered when defining space radiation dose limits." Scarpa said.

The finding raises questions about the cognitive and emotional risks associated with radiation exposure during human space exploration missions.

"There is a growing body of evidence that the death of these types of cells is a potential adverse effect of radiation during cancer treatment, but it's not been discussed in terms of space travel," said Jack M. Parent, M.D., a neurologist at the University of Michigan who was not involved

in the research. “Radiation has been associated with adverse cognitive effects, which is a potential hazard during space missions. Shielding and other measures to block the effects of radiation have to be strongly considered. The subject certainly deserves more study.”

Source: Cold Spring Harbor Laboratory