Researchers study radiation risks for astronauts journeying to Mars

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A new research facility at Colorado State University – the only one of its kind in the world – will be established with a $9 million grant from NASA to help reveal the effects of long-term exposure to space radiation as the nation prepares for a manned mission to Mars.

The multimillion-dollar grant from America's space agency will provide a unique neutron radiation facility at CSU, which is one of three new NASA Specialized Centers of Research for the study. The Colorado State facility will mimic the long-term, low-dose-rate exposures to highly energetic radiation that astronauts would encounter on a multiyear mission to the Red Planet.

"NASA is asking, 'Are the cognitive effects of space radiation exposure going to jeopardize the mission?'" said Michael Weil, a professor in CSU's Department of Environmental and Radiological Health Sciences and the project's lead scientist. "Safety guidelines ensure that astronauts are not exposed to radiation that will increase their risk of developing a fatal cancer by more than 3 percent, but a three-year Mars mission will exceed this limit. Plus, CSU investigators and others have recently found that cancers caused by space radiation may be more lethal."

The five-year project will renovate an existing gamma ray facility at CSU, allowing researchers to assess the impact of low doses of neutron radiation over long periods. A mission to Mars is expected to last about three years, and astronauts already are staying in space longer than they used to on the International Space Station.

In fact, Weil's colleague Susan Bailey is one of 10 researchers chosen by NASA to study the effects that a full year on the space station has on the body of astronaut Scott Kelly, whose mission began March 27. She'll also be studying astronaut Kjell Lindgren, a CSU alumnus whose mission begins May 26.

The exposure to radiation increases as the duration of the mission increases. And astronauts encounter radiation composed of energetic cosmic rays that no current spacecraft or spacesuit can shield, Weil said. The Earth's magnetic field and atmosphere protect people on terra firma from these energetic cosmic rays.

NASA must first understand the health effects of this space radiation, such as increased cancer risk, then must determine how to mitigate risks for astronauts on extended missions.

To gain insights, CSU researchers will modify an existing gamma ray facility in the basement level of the Molecular and Radiological Biosciences Building. Central to the modified facility will be an irradiator that emits low doses of neutrons. Inside this secured and well-shielded room, mice will be exposed to low levels of neutron radiation for up to 400 days, receiving doses comparable to what astronauts experience on long missions.

The design will closely approximate conditions astronauts would face traveling to Mars, said Thomas Borak, another CSU investigator on the project who is an expert in neutron radiation.

"Neutrons are not identical to space radiation, but they're a close approximation," Borak said. "They are an excellent surrogate for the complex radiations that would be encountered in deep space."

The CSU team will study the effects of neutron radiation on the central

nervous system and will identify biomarkers that could predict the chances of developing cancer after an astronaut returns to Earth.

Weil and his colleagues have conducted radiation research funded by NASA for more than a decade. Previous studies have examined the effects of acute exposures to high-energy radiation using a Department of Energy particle accelerator at the Brookhaven National Laboratory in New York.

The new NASA-funded project marks the first time the CSU group has analyzed long-duration, low-dose-rate exposures that cannot be replicated at the Brookhaven facility.

Weil said it will be fascinating to learn the differences between acute and chronic exposures.

"It may be like taking 365 baby aspirin in one day instead of one each day for a year," he explained. "Something that might be extremely hazardous in one shot might not be hazardous at all when spread over time. Of course, with cosmic rays, the opposite could be true. At this point we just don't know."

The CSU team has been part of two previous NASA Specialized Centers of Research, which likely helped the researchers in competing for the current project, Weil said.

In these studies, Weil's team found that space radiation is no more likely to cause leukemia than terrestrial radiation.

"However, we found quite by accident that space radiation is 50-fold more effective than typical radiation on Earth at causing a type of liver cancer called hepatocellular carcinoma," he said.

Collaborators in the new project include Dr. Douglas Thamm, a CSU veterinarian and cancer researcher who holds the Barbara Cox Anthony Chair in Oncology; he will study why simulated space radiation causes certain tumors to spread, or metastasize, more readily.

Scientists know that liver tumors resulting from space radiation are more likely to metastasize than those that develop without such exposure, Thamm said. The question is whether space radiation makes the tumor cells more aggressive or whether it makes the body's tissues more susceptible to spread.

"Is it something about the tumor, or something about the host?" Thamm asked. "It may be a bigger deal if it's related to the host, because then any tumor that an astronaut gets could behave more aggressively, no matter what kind it is."

Although the primary focus is related to radiation effects in astronauts during manned space missions, the scientists believe that many of the discoveries could have a broader impact in understanding the initiation and development of cancers in humans.

Provided by Colorado State University