Research hopes to shed light on link between space travel, sickness

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This is the flu in microgravity. Astronauts tend to get sick -- 15 of the 29 astronauts who flew on Apollo missions in the 1960s and '70s came down with infections during flight or immediately after -- and Millie Hughes-Fulford has been on a mission to find out why.

The UC San Francisco molecular biologist and former astronaut anxiously awaits the imminent return of 16 mice from a two-week stay aboard the space shuttle Discovery, as part of an experiment she designed to study how their immune cells handle spaceflight. The scheduled landing: 8:48 a.m. Monday at Florida's Kennedy Space Center.

NASA Ames researcher Eduardo Almeida also sent millions of mouse stem cells on the same shuttle flight, hoping to find clues about a constellation of space-travelers' maladies: weakened bones and muscles, and compromised immune systems.

Both projects aim to help humans survive years-long journeys to Mars and beyond. The work might also have implications for health problems on Earth.

The astronauts' maladies are similar to muscular-skeletal diseases in paralyzed or comatose patients on Earth, Almeida said, and to the weakening of the immune system with aging, according to Hughes-Fulford. She has seen young astronauts come down with shingles, which commonly occur in people past the age of 60.

"Over the years I've been able to do several experiments on the shuttle," Hughes-Fulford said. "We've found that the immune system is suppressed when it doesn't have gravity."

The research is set up differently than when Hughes-Fulford traveled to space herself, on a 1991 shuttle mission devoted to science.

"We had a dedicated lab where all four people on the payload side were doing experiments, even our pilot and flight engineer," she said.

These days, researchers automate experiments as much as possible to conserve the crew's valuable time. They prepare rigorously in the months and weeks before take-off.

"You have this one opportunity," said Natalya Dvorochkin, a research associate on Almeida's team. "When the shuttle is ready you have to be ready."

The team poured millions of the cells in culture into 12 six-inch-long reactors, to fly in the comfort of a mid-deck locker. Over time, the cells grow into various tissues -- muscle, liver, neurons. Under the microscope, the researchers can even see tiny glimmers of twitching heart tissue.

When the cells return, the team will track the genes and biochemical pathways that were active during flight, and compare those to the activity in stem cells that remained on Earth. Dvorochkin said completing the analysis will take roughly a year.

During the George W. Bush administration, after the space shuttle Columbia disintegrated on re-entry in 2003, the work lost funding. Hughes-Fulford, Almeida, and other United States scientists were able to get access to space only due to personal and institutional partnerships.

Hughes-Fulford hopes the Obama Administration will make it easier to conduct such spaceflight experiments.

This time, Hughes-Fulford was able to send 16 mice in climate-controlled containers along with Discovery. Her team will analyze how mouse white blood cells respond to a simulated infection during flight and upon return, and compare that to how white blood cells behave in 16 Earth-bound mice.

"Her results from previous flight experiments are pretty compelling," said Daniel Bikle, professor of medicine and dermatology at UC San Francisco.

Bikle also said studying how stem cells turn into various tissues has implications for astronauts' health.

"If there's any failure of these stem cells to differentiate into normal tissues that could cause problems," he said. "If we ever do get around to sending somebody to Mars and somebody gets pregnant, if stem cells fail to differentiate you wouldn't get a normal baby."

By looking at how different biochemical pathways are regulated in spaceflight, both experiments might shed light on how things work naturally on Earth, said immunologist Gerald Sonnenfeld of Binghamton University in New York. Sonnenfeld himself has done nine spaceflight experiments since 1976; he was not involved in Hughes-Fulford's or Almeida's studies.

In previous studies, Hughes-Fulford found T-cells, a type of white blood cell, were malfunctioning during spaceflight.

"We found that the T-cell is dependent on gravity," she said. After the mice return, "we'll know exactly where the change is occurring. We'll be

able to map out which genes are not being activated."