Samples from experiments performed on the International Space Station may soon have a return route to Earth aboard the Dragon capsule developed by SpaceX.

SPACE SCIENCE

Space-station rendezvous set to spur research push

Upcoming docking of commercial supply craft heralds easier access to orbiting laboratory.

BY ERIC HAND

When it comes to doing science on the International Space Station (ISS), the laws of gravity have been flipped: what goes up mostly stays up. A case in point are two freezers packed with more than 2,000 *Arabidopsis* seedlings awaiting return to Earth, where they can be analysed for changes in gene expression.

The samples cannot fly home aboard the unmanned European, Japanese and Russian cargo capsules that regularly deliver equipment and experiments to the station, because these capsules burn up on re-entry. Even the Russian Soyuz capsules that are the only route back to

Earth since the space shuttle was retired last year are not ideal, because they lack freezers to store the seedlings during the plunge home, says the experiment's lead investigator Imara Perera, a plant biologist at North Carolina State University in Raleigh. "If they thaw out, then the RNA will be degraded."

Now science is about to get a new way home from the ISS. It marks a first step in what NASA hopes will be the space station's transformation from an orbiting construction site into a thriving research laboratory (see 'Making space for science').

Next month, SpaceX of Hawthorne, California, is scheduled to launch Dragon, a pressurized capsule that can make a round trip

to the station. Lofted by the company's Falcon 9 rocket, it should dock with the space station four days later. As a demonstration mission, it will carry low-priority cargo. But if all goes well, several aluminium-alloy rods, melted and solidified under microgravity in a special furnace, will be returned to Earth, where researchers will study their recrystallization patterns.

Eventually, NASA will pay for four resupply missions a year — which could come from both SpaceX and Orbital Sciences, based in Dulles, Virginia, which is planning to test its Antares rocket and Cygnus capsule later this year (see 'Planned missions').

NASA is betting that scientific interest will match the increased tempo of the upcoming

NASA

MAKING SPACE FOR SCIENCE

The viability of the International Space Station (ISS) as a research platform depends on transport to and from it and on having a full (six-person) crew available.

NOVEMBER 1998 First ISS module deployed

NOVEMBER 2000 First station crew dock

FEBRUARY 2003 Loss of *Columbia* grounds shuttle fleet for more than 2 years

MARCH 2008 European Space Agency launches its first resupply vehicle

MAY 2009 First six-person crew arrives at ISS

SEPTEMBER 2009 Japanese space agency JAXA launches its first resupply vehicle

MARCH 2011 ISS completed

JULY 2011 Space-shuttle fleet retired

launches. Last year, NASA picked the non-profit Center for the Advancement of Science in Space (CASIS), based at Cape Canaveral in Florida, to manage half of the US research area on the station, which the US Congress deemed a national laboratory in 2005. CASIS will get US\$15 million in annual funding from NASA, and 50% of the cargo space on rides to and from the station, including Dragon. By holding researchers' hands and helping them through the thicket of NASA rules and regulations, the centre aims to reduce bureaucratic hassle. "What sometimes took years, we want to be able to do in months," says CASIS's interim director, Jim Royston.

For months, CASIS staff have been attending scientific conferences and visiting pharmaceutical labs, trying to drum up interest among researchers outside NASA. They have also begun to put together a panel of external scientists to review and prioritize experiments. Solicitations for research, planned for June, will offer \$3 million of CASIS's own seed money to researchers, although the centre hopes that the attraction of free flights and free space on the station, along with the free labour of station crew members, will be so enticing that proposers will bring their own grant money to the table. That money could come from other US science agencies, such as the National Institutes of Health in Bethesda, Maryland, or from private sources.

The panel will judge proposals not only on their scientific merit, but also on their potential for commercialization. The emphasis on applied research is motivated in part by the limited lifetime of the space station, which is currently scheduled to operate until 2020, says Timothy Yeatman, who on 5 April was named interim chief scientist for CASIS and head of the review panel. "We know that funding for the ISS can't go on in perpetuity," says Yeatman, a surgical oncologist at the Moffitt Cancer Center in Tampa, Florida.

CASIS also has the challenge of wooing back researchers — particularly those in biomedicine, physics and materials science — who were involved in experiments on the ISS but were sidelined in the mid-2000s when the station's

crew was reduced following the loss of the space shuttle *Columbia*. Moreover, ISS-based research shifted towards medical research related to a manned Moon mission — a plan that has since been dropped. "You really have to coax people back now," says Jeffrey Manber, managing director of NanoRacks in Houston, Texas, which built small cubic experimental modules, installed them on the space station and now rents the modules to researchers.

Some of CASIS's first solicitations will be for research in materials science and remote Earth observations. Yeatman says that biomedical

"What sometimes took years, we want to be able to do in months."

research is also ripe for renewal, especially in areas such as osteoporosis and protein crystallography. The osteoporosis-like disorders that develop

in mice after just a few months in space may be a more natural model on which to test drugs than mice that acquire osteoporosis through gene experiments, he says. Previous ISS research also suggested that proteins form higher-quality crystals in space than on Earth, Yeatman adds. That may help biologists to deduce currently unknown protein structures — if they can get the specialized crystals back from space to an X-ray light source before they degrade.

Paul Reichert, a structural chemist at Merck Research Laboratories in Kenilworth, New Jersey, is keen to see success. He is a veteran of experiments on six space-shuttle missions, and tried to crystallize one particular kinase, a signalling protein, aboard the ISS. He obtained some crystals, but by the time he brought the samples back three months later, they were so degraded that it was impossible to get a clean X-ray diffraction signal. "I only had one shot," he says. He is eager for another chance to do research in space. "It gets in your blood."

Perera is similarly eager to see her experiment through — but has been waiting since July last year, when her *Arabidopsis* seedlings were taken up on the last shuttle mission. Her plants are currently on the return manifest for the first official Dragon resupply mission, which could launch later this year. "There's some kind of history here," she says. "You go up on the last shuttle and come back on the first SpaceX. It's very exciting, but it's kind of nerve-racking." ■

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PLANNED MISSIONS

SPACEX

Artist's impression of the Dragon capsule.

MAY 2012 First docking of SpaceX's Dragon capsule

AUGUST 2012 First Dragon resupply mission

2012 (4TH QUARTER) Test flight of Orbital Science's Cygnus capsule

2013 First Cygnus resupply mission