Shuttle's end could spell a bumpy ride for biomedicine in space

NASA's Space Shuttle program is officially over. The final flight of the US National Aeronautics and Space Administration's program—a 13-day jaunt by the Shuttle Atlantis to the International Space Station (ISS) and back—touched down last month, marking the end of an era for space exploration.

It also marks the end of an era for the small group of life sciences researchers whose mice, bacteria and plants have flown on the orbital spacecrafts. Without any US government–run manned spaceflights planned for the foreseeable future, those in the field of space biomedicine have fewer options for getting their research samples into orbit and back home again. But some scientists are optimistic that the recent completion of the ISS will mark the beginning of a new golden age for biology *ex terra*.

"I don't think space biomedicine is going to go away," says Jeffrey Sutton, director of the National Space Biomedical Research Institute, a Houston-based consortium of NASA's extramural biomedical research partners. "I think it can only really go one way, and that is we need to advance."

Lingering too long in the weightlessness of space can cause bones to weaken, hearts to shrink and muscles to atrophy. So, most space-based biomedical research has tested ways to keep astronauts healthy, especially over longer missions. But more basic experiments that have looked at the effects of microgravity on genes, cells and whole organisms have also flown to the final frontier.

To date, though, both kinds of investigation have been largely afterthoughts—small experiments squeezed onto shuttles and conducted in a few scraps of the astronauts' spare time. Similarly, NASA officials have placed funding for life sciences research low on the priority list, particularly after former President George W. Bush asked the agency to refocus on exploration in 2004.

An exciting development came in 2007 when the US National Institutes of Health (NIH) signed a memorandum of understanding with the space agency wherein projects funded by the NIH could get room in the ISS laboratories and transport from NASA (see *Nat. Med.* **13**, 1123, 2007). But according to Joan McGowan, director of the musculoskeletal diseases division at the NIH, only three awards have been given out so far, and none of them is close to flying.

For the long haul

Now, without NASA's taxi service, biomedical researchers will need to find new ways for their samples to reach orbit. US astronauts will continue to reach the space station aboard Russian Soyuz space capsules, but these are designed to move people, not cargo. Another option is to use commercial space cargo services, such as Space Exploration Technologies' Dragon or Orbital Sciences' Cygnus spacecrafts, both of which are running demo flights this year. However, Cygnus can only take cargo up, not down, while Dragon splashes down in the Pacific Ocean when it comes back to Earth.


NASA

Center of microgravity: Vaccine research in space.

Neither is a great option for returning samples, so scientists will need to adapt their research protocols, says Louis Stodieck, director of BioServe Space Technologies, a NASA-sponsored center focused on space life science research based at the University of Colorado–Boulder. "Because we will have less ability to bring things back, we will be doing analyses in space and sending the data down, not the samples," he says.

Cheryl Nickerson, a microbiologist at Arizona State University's Biodesign Institute in Tempe who has sent five experiments to space over the years, puts the situation more bluntly. "Losing the vehicle that has the amazing up and down mass capability is a hit," she says. "Anyone who tells you that it is not a hit either doesn't understand the program or is playing games."

Nevertheless, Nickerson counts herself as one of the optimists. She's been working with *Salmonella* bacteria, which show an increased virulence in microgravity. Her team's new flu vaccine, which relies on disabled *Salmonella* as a vehicle, flew on the final Atlantis flight (see 'One giant leap for biomedical research'). She hopes to use the gene expression patterns from the outer-space sample to design a more potent vaccine back on Earth.

NASA has made much of the ISS's completion, promising that more space on board and crew time will now be available for research. After all, the US portion of the space station was turned into a national laboratory in 2005. Nickerson says there are now opportunities waiting for researchers with stars in their eyes. "The ISS is equipped, it is open for business and there's plenty of space," she says.

Emma Marris

One giant leap for biomedical research

Getting a biomedical experiment into orbit takes years, but there's nothing like watching your organisms head for the stars. "I teared up at the launch," says Mary Bouxsein, a bone biomechanics researcher at the Beth Israel Deaconess Medical Center in Boston who led one of the research projects sent into space last month. "You are quite excited for the launch, and then you take a step back and say, 'We put mice into orbit.'" Here we describe some of the health-related studies that hitched a ride to the International Space Station and back last month aboard Shuttle Atlantis.

Boning up, up and away: US and Belgian researchers, in partnership with the California biotech Amgen, launched 30 mice into orbit, half of which were injected with a sclerotin-targeted antibody designed to boost bone formation.

All sys-stems are go: California scientists sent mouse embryonic stem cells in culture to study the effects of space flight on cell differentiation.

Filming in space: A team from the Rensselaer Polytechnic Institute in Troy, New York grew *Pseudomonas aeruginosa* and *Staphylococcus aureus* in flight to see how biofilms form in microgravity.

Flu shot at the sun: Researchers from Arizona State University in Tempe dispatched a *Salmonella*-based vaccine against pneumococcal pneumonia that they plan to test in mice back on Earth. —*EM*