

Biology in space and on Earth: Studies on the ISS



What happens on the return to the Earth after the trip?

SPEAKING OF SCIENCE

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“Around the World in Eighty Days” was the famous 1873 novel by the French writer Jules Verne. It was a challenge then. A century and half later, anyone can do this within 80 hours, on an airplane. We can now go around half the world (say, from India to California) in 20 hours. That of course upsets our body clock. What is daytime here is night time there, and it takes a day or two to adjust our daily rhythm. The biological mechanism behind such daily rhythms (not just of people but even of plants) has been understood, and this fetched this year’s Nobel Prize for three scientists.

“Fly me to the moon, let me play among the stars, let me see what spring is like, on Jupiter and Mars” sang Frank Sinatra sixty years ago. The Verne challenge has moved from Earth to the sky and the stars. And it appears, soon enough, it will be possible for anyone to be an astronaut. There are already companies that offer space trips to people. And when that becomes commonplace, what are all the biological changes that occur to life

forms, how they adapt to the altered environment and recover once they return to Earth - these are issues that are being actively studied today.

Two sets of projects are going on in this connection. One set is to keep humans in space for extended periods of time (months or years), study them there and again after they return home to earth. The International Space Station (ISS) was launched in 1998 at an altitude of 408 km above the Earth, and its residents experience near zero gravity. What happens to their bodies, organs, blood flow and other biological features is the major study here.

Space microbiology

The other set of experiments going on involves launching cells (single cell organisms such as bacteria) into space and studying their properties there, and comparing them with ‘controls’ on earth. This branch is now termed as *space microbiology*. Studying cells gives us a fundamental idea about what happens at the molecular level, and this will help in extending it further to tissues, organs and the whole organism it-



Pioneer: International Space Station (ISS) crew member Scott Kelly of the U.S. is part of the famous twin experiment. ■ AP

self - from the micro to the macro.

The latest report in space microbiology comes from the group of Dr Luis Zea of the University of Colorado in the US (Zea et al, *Frontiers in Microbiology* 2017; 8: 1598 doi:10.3389/fmicb.2017.01598). They sent one set

of the bacterium *E. coli* samples to the ISS and had an astronaut there study its size, shape, response to the killer drug gentamycin, and other properties. The control set of *E. coli* was studied at Colorado on earth, and the properties of the two sets compared. Such comparison ought to throw light on the effects of gravity on various aspects of cell biology.

The comparison is informative. First, the cells in ISS changed their shape, shrunk in size, the cell walls became thicker, coated with a film (called biofilm), and produced more spherical buds on their outer membranes than the

controls on earth. These buds, called the outer membrane vesicles, enable bacterial survival during stress conditions. *E. coli* in ISS were more drug-resistant than the controls on earth. It appears that the absence of gravity, which helps in transporting and pushing fluids ‘downstream’, the major mechanism of fluid movement appears to be just diffusion, which is less efficient.

Experiments needed

Two other points also came out of this study. First, there may be a greater risk of infection in astronauts (or greater doses of the drug), and second, the endogenous microbes that live in the guts of astronauts, helping their metabolic activities, might become less efficient. More experiments are needed to ascertain these possibilities.

Turning now to real humans

circling the earth on ISS. Experiments reveal that the viscosity of their blood increases, circulation decreases and the cardiovascular system becomes “lazy”, or slows down a bit. The eyeballs become a bit oblong. Bones become thinner and organs like the liver ‘shift’ a bit. All these have been explained as due to the near-absence of gravity. These results are of value when we send manned space ships to other planets. What happens when they return to Mother Earth after such space trips - do they recover? The answer appears to be “yes”, since astronauts who returned home after a long stay at ISS, recover well with time. This is gratifying to note; recall the astronaut Sunita Williams actually ran a marathon back on earth, after a period of stay in space.

What about the biochemistry, cell biology and gene biology of astronauts? Do they differ from those of their earthbound brothers? The answer will come soon, once the ongoing, exciting identical twin study is over. Scott Kelly is a spaceman at ISS, while his identical twin Mark Kelly (a retired officer) stayed back on earth. Researchers have taken biological samples from each twin, before, during and after Scott’s space mission (lasting 340 days at ISS). Is there a “space gene” that operates while in space, and goes silent back on earth? The study is ongoing and we await the results with excitement.

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