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editorial

Exploring the microbial universe

From roles in the health, nutrition and performance of humans during spaceflight, through to the question of life on other worlds, microbiology has fundamental contributions to make to our exploration of the cosmos.

The numerous and varied interconnections that microbiology shares with the study and exploration of space may not be readily apparent to many, but these fields have been intertwined ever since the development and adoption of the telescope and compound microscope as scientific instruments at the turn of the seventeenth century. Using a series of lenses to explore physical existence not readily visible to the naked eye — albeit at vastly different scales — has provided inspiration to generations of budding researchers and science enthusiasts over the centuries. Take a straw poll of those working around you and it is likely that the majority of your colleagues will have messed around with a microscope or telescope in their youth; indeed, a poll of the *Nature Microbiology* editorial office gave a unanimous positive outcome. Some individuals take pursuit of the intersection between microbiology and space science to an entirely different level, as revealed in an illuminating interview in this month's issue with Kate Rubins, a virologist and NASA astronaut who recently became the first person to sequence DNA in space (see 'A microbiologist's guide to the galaxy'[1]).

Rubins was part of NASA Expedition 48–49 to the International Space Station (ISS) and spent 115 days in space from July–October 2016. That a terrestrial training in virology helped to prepare her well for the rigors of working on the ISS should not be a surprise. As Rubins notes, time spent working in biosafety level four containment and establishing a field laboratory in the resource-poor setting of the Congo engender challenges almost identical to some of those faced in carrying out research in the extreme environment in orbit. However, it is not only the practical experience gained through working with hazardous pathogens that are of benefit to a space programme; expertise in infectious diseases have been fundamentally important to human spaceflight since the first launch in 1961. Given the scale of investment and time in putting anything into orbit, a great deal of attention must be paid to the nature of all cargo sent up with any launch, and in microbiological terms that initially meant carefully monitoring astronauts and cosmonauts for any signs that they may be carrying an infection. Movie fans may well remember that ahead of the ill-fated Apollo 13 launch in 1970, original command module pilot Ken Mattingly was grounded by the flight surgeon following a possible exposure to rubella virus, and replaced by backup pilot Jack Swigert. The risk of a debilitating infection sweeping through the ISS (or any spacecraft) remains an important concern and so astronauts undertake a quarantine period of about two weeks, during which their diet and contact with other people are strictly controlled to limit the chances of launching someone who is incubating an illness.

In recent decades, increasing attention has also been paid to microbial passengers other than potential pathogens that would cause acute disease. Humans are by no means sterile when they travel into orbit, they carry with them a microbiome teeming with life that, in the case of the ISS, interacts with and contributes to the environmental microbiome that has established and built up over the past 16 years. Early surveys of microbial taxa found on the ISS have revealed, perhaps unsurprisingly, that the collective microbial community on the station is likely to not be dissimilar to built environments found on Earth, although microgravity does alter the growth dynamics and physiological properties of some species[2–4]. However, despite some foundational work, our understanding of the impact of prolonged exposure to microgravity on microbial physiology, and in particular the effects on the human microbiome and how human–microorganism interactions change over time, remains extremely limited. Given the growing appreciation of the importance of the microbiome in human health, a continued focus on microbiological research at the ISS should be encouraged if humans are to travel farther and longer into the solar system.

Another nexus between the field of microbiology and the exploration of the universe has direct links to a question that has stirred the mind of countless stargazers over millennia; are we alone in the universe? A large focus of the search for extra-terrestrial life has been on looking for signs of intelligence, radio signals and physical phenomena that could have originated from an advanced civilization. Yet looking to the microbial world might be more likely to provide the first tentative answer to the question of our universal solitude. We know that there is microbial life in space, we put it there. But is there any truly extra-terrestrial microbial life and if so, what form might it take? Recent evidence has pointed to the possibility that conditions to support microbial life exist not only on Earth but elsewhere in our immediate cosmic vicinity, with liquid water flowing on Mars[5] and hydrothermal activity on Saturn's icy moon Enceladus producing molecular hydrogen and carbon dioxide[6], which could, in theory, sustain methanogenic microbial life. These are highly suggestive observations, especially given that Earth environments once thought to be near sterile, such as the Antarctic Dry Valleys or deep subsurface, are now known to support rich microbial biospheres. However, as Rubins use of the MinION to sequence samples of phage, *Escherichia coli* and mouse genomic DNA aboard the ISS aptly demonstrates, we are only at the preliminary stages of establishing the technology needed to systematically survey for microbial life on other worlds. New tools for remote and direct analyses of chemical, nucleic acid or protein signatures will need to be developed and tested for their utility in environments outside of an Earth laboratory before we should expect to see any definitive results from a search for extra-terrestrial microorganisms.

Even so, with many exciting frontiers to be explored, microbiologists should be encouraged to turn their microscope to the stars. ❐

References

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