Spacebound bacteria inspire earthbound remedies

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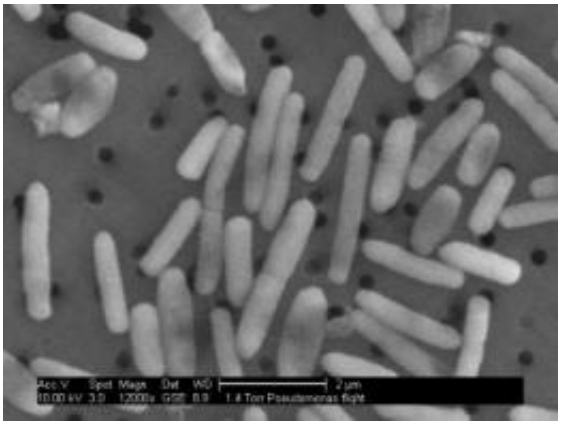

Scanning electron micrograph of *Pseudomonas aeruginosa* cultured on board Shuttle mission STS-115, as part of the MICROBE experiment (magnification 12,000x) Credit: Image courtesy of Mayra Nelman-Gonzalez

Recent research aboard the Space Shuttle is giving scientists a better understanding of how infectious disease occurs in space and could someday improve astronaut health and provide novel treatments for people on Earth.

The research involves an opportunistic pathogen known as *Pseudomonas aeruginosa*, the same bacterium that caused astronaut Fred Haise to become sick during the Apollo 13 mission to the moon in 1970.

Scientists studying the bacterium aboard the Shuttle hope to unlock the

mysteries of how disease-causing agents work. They believe the research can lead to advanced vaccines and therapies to better fight infections. The findings are based on flight experiments with microbial pathogens on NASA space shuttle missions to the station and appear in a recent edition of the journal Applied and Environmental Microbiology.

"For the first time, we're able to see that two very different species of bacteria - *Salmonella* and *Pseudomonas* - share the same basic regulating mechanism, or master control switch, that micro-manages many of the microbes' responses to the spaceflight environment," said Cheryl Nickerson, associate professor at the Center for Infectious Diseases and Vaccinology, the Biodesign Institute at Arizona State University (ASU) in Tempe. "We have shown that spaceflight affects common regulators in both bacteria that invariably cause disease in healthy individuals [*Salmonella*] and those that cause disease only in people with compromised immune systems [*Pseudomonas*]."

By studying the global gene expression patterns in bacterial pathogens like *Pseudomonas* and *Salmonella*, Nickerson's team learned more about how they react to reduced gravity.

Pseudomonas aeruginosa can coexist as a benign microbe in healthy individuals, but poses a serious threat to people with compromised immune systems. It is the leading cause of death for those suffering from cystic fibrosis and is a serious risk to burn victims. However, a high enough dosage of *Salmonella typhimurium* always will cause disease, even in healthy individuals.

During the initial study in 2006, two bacterial pathogens, *Salmonella typhimurium* and *Pseudomonas aeruginosa*, and one fungal pathogen, *Candida albicans*, were launched to the station aboard space shuttles. They were allowed to grow in appropriately contained vessels for several days. Nickerson's team was the first to evaluate global gene and protein

expression (how the bacteria react at the molecular level) and virulence changes in microbes in response to reduced gravity.

"We discovered that aspects of the environment that microbes encountered during spaceflight appeared to mimic key conditions that pathogens normally encounter in our bodies during the natural course of infection, particularly in the respiratory system, gastrointestinal system and urogenital tract," Nickerson said. NASA's Advanced Capabilities Division Director, Benjamin Neumann added that, "This means that in addition to safeguarding future space travelers, such research may aid the quest for better therapeutics against pathogens here on Earth."

The initial study and follow-on space experiments show that spaceflight creates a low fluid shear environment, where liquids exert little force as they flow over the surface of cells. The low fluid shear environment of spaceflight affects the molecular genetic regulators that can make microbes more infectious. These same regulators might function in a similar way to regulate microbial virulence during the course of infection in the human body.

"We have now shown that spaceflight conditions modified molecular pathways that are known to be involved in the virulence of Pseudomonas aeruginosa," said Aurélie Crabbé, a researcher in Dr. Nickerson's lab at ASU and the lead author of the paper. "Future work will establish whether Pseudomonas also exhibits increased virulence following spaceflight as did Salmonella."

More information: www.ncbi.nlm.nih.gov/pubmed/21169425

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