Managing Microbes in Space

Background (HS)

You've probably experienced it before: that miserable feeling of *something* making your intestines cramp and making you very ill. Fortunately, that misery usually only lasts a relatively short time because our bodies have a great immune system that is very good at defending us from pathogens. But, what if a pathogen were to become stronger, or if our immune systems were to become weaker, or if both were to happen? That is exactly what Dr. Cheryl Nickerson and her team at Arizona State University are trying to figure out in their newest experiment launching on SpaceX-5 to the International Space Station.

Officially named Micro-5 by NASA, Dr. Nickerson and her team call their experiment the PHOENIX - Pathogen Host ENteric Interactions EXperiment. A pathogen is an organism that causes disease. A host is an organism on/in which a pathogen lives. Enteric is a term referring to the intestines. So, PHOENIX is an experiment that looks at the interactions of a pathogen on the intestines of a host. Specifically, this experiment looks at the interactions of *Salmonella* bacteria with a small nematode worm called *Caenorhabditis elegans* or *C. elegans*. This worm has an intestinal track similar to humans and is a good model to study how *Salmonella* infections might happen in humans.

C. elegans roundworm

Previous studies have shown that when *Salmonella* spends time in space, the bacteria become more virulent as compared to when they are grown on Earth under otherwise identical conditions (a control). This means that when they infect a host, they are able to cause more severe damage (disease) to the host. This has been demonstrated in a number of ways. *Salmonella* cultured (grown) in space on Shuttle missions STS-115 and STS-123 were brought back to Earth and then used to infect mice. The mice had greater mortality rates than those infected with *Salmonella* grown on Earth. On STS-131, human intestinal cells were infected with *Salmonella* during spaceflight and early results also suggest that the intestinal cells infected in spaceflight are behaving differently to the infection as compared to ground control samples.

Salmonella bacterium (red)

In other studies, researchers have found that astronauts become immunocompromised, or have a weakened immune system, which suggests that they may have higher risks of getting sick from infections.

PHOENIX will be the first experiment to infect and monitor in real-time the infection of a whole organism, not just cells, in space to assess the effect of the pathogen on a host. In other words, based on their previous findings, Nickerson and her team predict that the *Salmonella* bacteria will become more virulent and will be better able to infect and cause disease in an organism that is less able to fight it.

There are two main goals of PHOENIX. The first is to prevent or counteract illness in astronauts. The second is to make applications of this research back on Earth. For example, this research will help us to learn more about how *Salmonella* causes disease, which might help in the development of vaccines. It may also help prevent infection of bacteria found in food sources.

Previous studies by Nickerson's team have also shown that the increased virulence of *Salmonella* can be turned down by the addition of five different ions (including phosphate) in the growth medium (the liquid nutrients that the bacteria grow in). In follow-up ground-based studies, they found evidence that it was the addition of phosphate in the growth medium that may be responsible for this decreased virulence. In this current spaceflight experiment, prior to infecting the *C. elegans* worm, the bacteria will be grown in media containing varying concentrations of phosphate. Two different bacteria will be cultured – the same strain of *Salmonella Typhimurium* used in Dr. Nickerson's previous studies, and also a harmless control strain of bacteria called *Escherichia coli* OP50, which is the normal laboratory food source for *C. elegans.* These two bacteria will be cultured in four different media types.

The basic growth medium is called LB (Lennox Broth) media and is a liquid filled with nutrients that allow the bacteria to grow. A different media, called LB-M9 (the media containing phosphate and the four other ions which was previously shown to turn down the increased virulence of *Salmonella* in spaceflight), will also be used. Two other media types focusing only on phosphate ion will be used: and LB-phosphate media and a LB and Pi-PEG media (a different type of delivery system for phosphate).

The bacteria from each of the samples will be added to cultures of *C. elegans* during spaceflight. The worms will be kept in a hibernation-like state until they are ready to be used. After the bacteria are added to each culture, videos will be taken of the worms to determine how long it takes for 50% of the worms to die under each condition. This is known as the time-to-death 50, or TD50. The same experiment will be conducted here on Earth and used for comparison (a control). Dr. Nickerson's hypothesis is that the TD50 will be sooner in the flight worms than the ground-based worms.

Dr. Nickerson and her team will have a lot of work to do once the videos are sent back from space and from the ground-based experiments to determine if their hypothesis is supported. That's where you come in! Dr. Nickerson has asked you to help her count the worms in the videos to determine what percentage of the worms are living or dead. Your work will help her determine TD50 and, more importantly, may lead to protecting future astronauts in space and protecting people from getting sick from food poisoning here on Earth!

ADDITIONAL REFERENCES:

PHOENIX	http://youtu.be/df1ck6RjdYc
C. elegans	http://wormclassroom.org/meet-worm-caenorhabditis-elegans
C. elegans	https://www.youtube.com/watch?v=zjqLwPgLnV0
Salmonella	http://www.cdc.gov/salmonella/
Salmonella	http://science.nasa.gov/science-news/science-at-nasa/2009/06may_salmonella/
Microgravity	http://www.nasa.gov/audience/forstudents/5-8/features/what-is-microgravity-58.html#.VGzP__nF_uK
	http://www.dvidshub.net/video/172345/nasa-connect-watmtg-microgravity#.VGzP5fnF_uK