Food safety in unlimited space may

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Tales chronicling this small force attacking a larger foe while sailing amidst the stars probably isn't fodder for Hollywood. One might title it "Phage Wars," and future astronauts would agree it will be good for what ails them.

Animal science Assistant Professor Lawrence Goodridge and doctoral student John Willford are developing a simple test for food-borne bacterial pathogens using bacteriophages – viruses that infect larger bacteria – to seek out and attack specific bacteria. If successful, travelers on long-duration space flights will be easily able to use the test to avoid nasty intestinal ailments.

John Willford introduces bacteriophages to the Phast Swab. The tubes are incubated for an hour and a half then the tops snapped, which releases a substrate into the bottom of the tube to react with an enzyme.

An army marches on its stomach and astronauts on long-duration flights will travel on theirs. "To get to Mars, you can never transport enough food from the Earth," says Goodridge. "You have to grow your own food on Mars and en route. That opens the door to bacteria. Anything that goes up in space is sterilized, but all you need is one bacterial pathogen, and it could multiply. What is needed is a rapid method of bacterial detection."

Astronauts face psychological challenges on long-duration flights, and something as simple as eating fresh food goes a long way to help astronauts with that, he notes. Sterilized food is tasteless, and there can be a disagreeable odor. "Safe food that is fresh is the issue. Astronauts on a trip to Mars are 18 months out and back plus their time on Mars. They could be out four years."

A Wyoming NASA Experimental Program to Stimulate Competitive Research (EPSCoR) grant is funding their research titled "Development of a Luminescent Biosensor for Rapid Detection of *Escherichia coli* O157:H7."

Goodridge and Willford launched their project and filed a preliminary patent on their biosensor, termed the Phast Swab, this fall. "Our interest is food-borne pathogens, and our test is designed to be used to detect different bacterial pathogens without expensive instruments," says Goodridge. Their method is of interest to both the food industry and NASA.

Weight and space considerations force equipment on spacecraft to be designed for multiple purposes. Currently, many food pathogen tests are not practical, Goodridge says. Some have too many steps, are long, and can be expensive to perform. Or they are complex, and personnel need extensive training.

"We wanted to make sure the tests are robust, easy, and repeatable," he notes.

Goodridge and Willford harness the ambitions of phages to infect bacteria to create a test that only requires a person identify colors.

A phage looks somewhat like a NASA lunar module as it settles upon the larger bacteria. Certain phages attack specific kinds of bacteria. Sitting "upright" with its six tail fibers attached to the bacteria, the phage inject their DNA into the bacterium and use the bacteria to reproduce. The phage reproduce in enough numbers that the bacteria eventually burst.

Goodridge and Willford take advantage of this phage reproduction, by genetically modifying the phage to produce an enzyme. The phage produces the enzyme in such amounts during reproduction that it can be identified through a simple mixing of a solution.

Goodridge and Willford combined known bacteriophage research with tubes used for hygienic purposes to produce their Phast Swab system.

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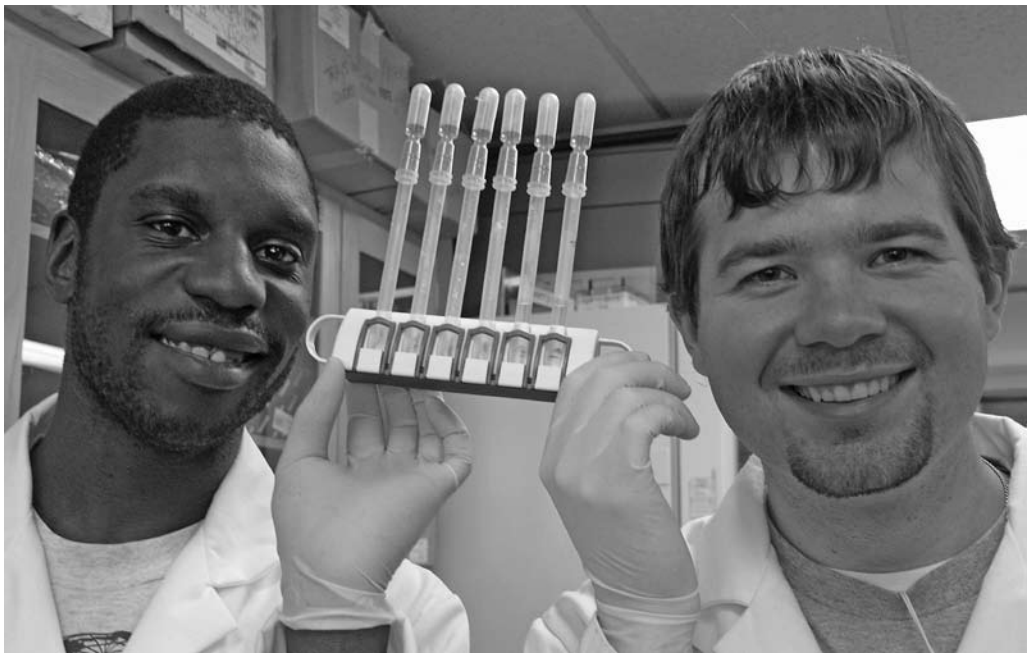
Their invention, the Phast Swab, looks like an eyedropper with a long cotton swab attached on a tube. The bottom of the tube contains a growth media and immunomagnetic beads specific for the bacteria to be tested. The swab is removed; the surface to be tested is swabbed, and the swab is returned to the tube. The sample is enriched for eight hours to allow the bacteria to grow. The immunomagnetic beads trap the growing bacteria, and the bacteriophage is added. The Phast Swab is incubated at 37 degrees Celsius for one and one-half hours. The cap of the Phast Swab is then broken, which releases a substrate into the bottom of the device, where it reacts with an enzyme that is produced as the bacteriophages are reproducing. A positive test is red, and a negative test is yellow.

Willford wants to reduce the test time to six hours.

The end system will be fast, simple, and portable. "We will make it very applied for people with no training or expertise," says Goodridge.

There are complex details yet to be worked out.

The duo wants to develop ways the phages can be specific, for example, to *E. coli* O157:H7, *Salmonella,* or *Listeria*, and methods to make the test more sensitive.



Lawrence Goodridge (left), assistant professor in the Department of Animal Science, and John Willford, doctoral candidate, display their Phast Swab equipment designed to test for food-borne pathogens.

Willford is beginning research that will lead to switching tail fibers of phages so only one type of genetically modified phage need be used, and aren't required to genetically modify a bacteriophage for each type of bacteria to be tested.

The project builds upon Goodridge's doctoral work, but success was not possible until technology had advanced, and he figured out how to modify swab tubes being used for hygienic purposes for their invention. "That was a major 'Aha' moment," says Goodridge. Phage research they could utilize has existed for two decades. They were able to combine inventions to create a new one.

"People in science are very creative, especially in applied science, but they don't have much patience," he notes. "Someone in science may invent something, which at that moment is not useful. Five years later, there is another invention and maybe, through combining the two methods, somebody creates something special."

Scientists may also work without an end product in mind. "Scientists don't always begin with the end in mind," adds Goodridge. "For example, who is going to be using the test? We have a method that will be used by people with minimal training. Tests have to be simple. There are a lot of tests out there that work well but only if the tester has extensive training. After a five-minute discussion, the person should be able to do our test."