

Devouring *Salmonella*

Food microbiologist Dr. Xiuping Jiang (pronounced “shoo-ping jong”), a member of the Clemson University Animal Co-Products Research and Education Center (ACREC) team, is working to find new ways to reduce or eliminate *Salmonella* populations within rendering plant environments. Jiang, an associate professor in the Department of Food Science and Human Nutrition, is a native of the city of Qingdao in Shandong province, China, and has a strong background in food, aquatic, pathogenic, and composting microbiology. She earned her bachelor of science and master of science degrees in food science/food microbiology from the Ocean University of China and her doctor of philosophy in food microbiology from the University of Maryland. After graduation, Jiang worked as a postdoctoral research fellow at the Center for Food Safety at the University of Georgia. Her work centers on a variety of cutting edge issues in pathogenic microbiology, food safety, and antibiotic resistance. In Jiang’s current ACREC research project, she is exploring a unique approach for reducing pathogenic bacterial populations using microbial entities known as bacteriophages.

As the winter cold and flu season approaches, it is easy to envision malevolent virus particles floating through the air and lurking on surfaces ready to pounce on unsuspecting victims. Not only are humans subject to viral illnesses, but animals and plants can also be infected by specific viruses. However, most people do not realize that even the lowly bacterium is susceptible to viral attack.

The word “bacteriophage,” which means “to devour bacteria,” describes a class of viruses that are specific to bacteria. Bacteriophages cannot affect any species of animal or plant as they are capable of infecting only particular strains of bacteria. In order to be susceptible, the bacterium must have a

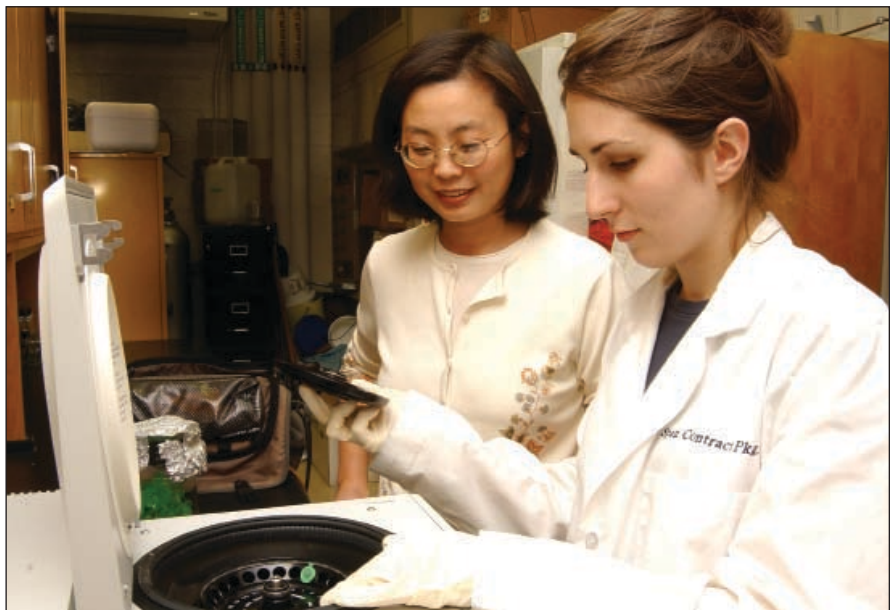
receptor site for that bacteriophage on its outer cell wall. If the receptor is not present, the bacteriophage cannot affect that bacterium.

Also known by the term “phage(s),” there are an estimated 10 million trillion trillion (approximately 10^{31}) bacteriophages on earth. They hold the distinction of being the most plentiful entity on the planet with an estimated 10 bacteriophages for every single bacterium on earth (<http://pbi.bio.pitt.edu/>). These small viruses are ubiquitous, which means that they may exist almost everywhere on the planet. They are present in locations ranging from soils to aquatic environments to even the air between you and the pages of this magazine.

There are several different types of bacteriophages. In her studies, Jiang is interested in certain types of bacteriophages that can reduce bacterial populations by (1) infecting a host cell, (2) taking over the cell machinery to make copies of the bacteriophage, and then (3) lysing (breaking open) the cell to release new bacteriophage particles (Figure 1).

During natural infection of a bac-

terium, a bacteriophage floats through the environment until it randomly encounters a susceptible bacterium (i.e., a bacterium with a matching receptor site). The bacteriophage will tightly bind to the bacterial cell receptor and once bound, the bacteriophage will inject its genetic material into the bacterium. This initiates a cascade of events in which the bacterium becomes a slave to the virus. The bacteriophage will order the bacterial cell to make multiple copies of the bacteriophage. Upon completing assembly of the new bacteriophages, the bacterium will burst and new bacteriophage virus particles will be released into the environment. The bacterial cell is killed during this process. The newly formed and released bacteriophages are available to infect additional susceptible bacteria. Through the infection process, bacteriophages can create an epidemic and quickly destroy populations of similar bacteria. In fact, the entire process from infection of a single bacterial cell to release of new bacteriophages can often occur in less than 30 minutes. With each successive infection cycle, the number of bacteriophages increases exponentially.



Dr. Xiuping Jiang, left, and student Adrienne Wimbrow.

Photograph by Patrick Wright.

Bacteriophage destruction of bacterial populations was used as a therapeutic treatment as far back as the 1930s. Upon the discovery and commercialization of antibiotics in the 1940s, bacteriophage research was suspended. However, as antibiotic resistance issues continue to emerge as a critical health problem, medical researchers are returning to study bacteriophages as an antimicrobial treatment therapy. Bacteriophages have also been used to preserve food products and to reduce or eliminate foodborne pathogens. On August 18, 2006, the U.S. Food and Drug Administration announced approval of a mixture of six bacteriophages as an antimicrobial agent to prevent growth of the foodborne pathogen *Listeria monocytogenes* in ready-to-eat meat and poultry products (<http://www.cfsan.fda.gov/~dms/opabacqa.html>).

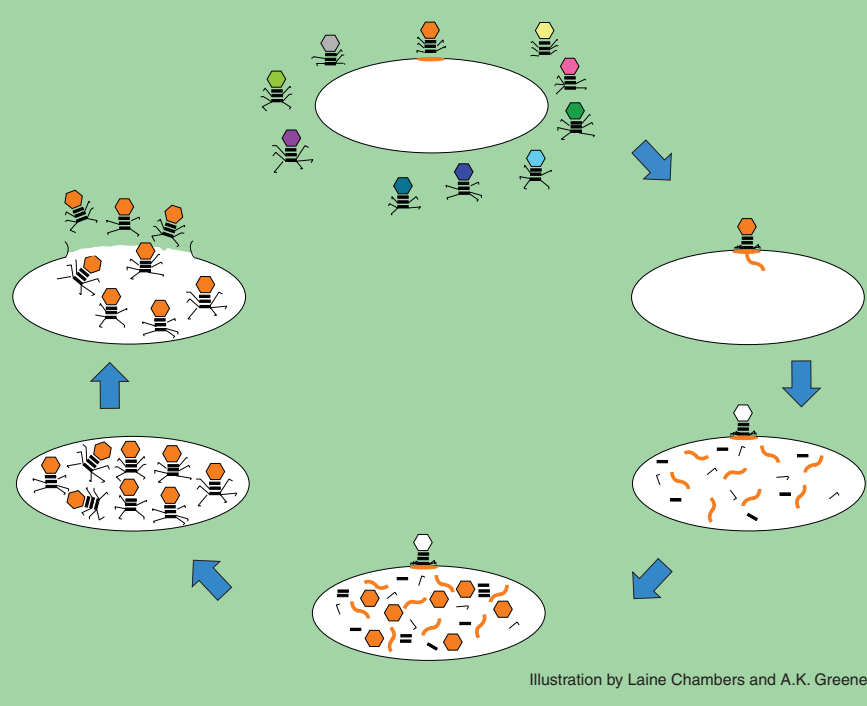
Previously, the only bacterial control methods used within the rendering environment have been heat and chemical preservatives such as acids, alcohols, or formaldehyde. Bacteriophages offer a unique biological control method that allows the control agent to replicate and increase in effectiveness as long as it encounters bacteria with the appropriate receptor sites.

Jiang's project will be directed toward isolating bacteriophages against *Salmonella*. This is an exploratory project and, as such, a great number of difficulties must be overcome. First, bacteriophages can sometimes be too specific to be useful as a bacterial control agent. For instance, there are hundreds to even thousands of different strains of *Salmonella*. Currently, there is no one bacteriophage known that can destroy all strains of *Salmonella*. Jiang and her team hope to find a group of bacteriophages that have the ability to target multiple strains of *Salmonella* associated with rendered products. She hopes to create a "cocktail" of bacteriophages that can be used to destroy significant numbers of a mixed population of *Salmonella*.

This two-year study was initiated on November 1, 2007, and will be labor intensive. As with any research project, results are not always predictable. However, if successful, this study could

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Figure 1. Bacteriophages seek a host bacterium that carries a suitable receptor site. Upon binding to the receptor site, the bacteriophage inserts its genetic material into the bacterium and orders the bacterium to begin producing multiple copies of the bacteriophage. The process kills the bacterium as the cell bursts to release new bacteriophage particles. Each bacteriophage particle can infect another suitable bacterium. Depending on the bacteriophage and its host bacterium, the time elapsed for this process can be as short as 30 minutes.



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