Mortal chemical combat typifies the world of bacteria

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Like all organisms, bacteria must compete for resources to survive, even if it means a fight to the death.

New research led by scientists from the University of North Carolina at Chapel Hill School of Medicine and the University of California, Santa Barbara, describes new complexities in the close chemical combat waged among bacteria.

And the findings from this microscopic war zone may have implications for human health and survival.

"It has been known for a long time that bacteria can produce toxins that they release into their surroundings that can kill other bacteria, sort of like throwing hand grenades at enemies," said Peggy A. Cotter, PhD, associate professor in the microbiology and immunology department at UNC. "Our data suggests that the situation is far more complex that we thought."

Cotter points out that it was in David A. Low's lab at U.C. Santa Barbara, where the discovery was made that bacteria can also produce proteins on their surface that inhibit the growth and end the life of other bacteria upon contact.

"So it appears that some bacteria participate in 'man to man' (or 'bacteria to bacteria') combat using poison-tipped swords," Cotter said. "What we have discovered is that each bacterium can have a different poison at the

tip of their sword. For each poison, there is a specific protective (immunity) protein that the bacteria also make so that they don't kill themselves and are not killed by other members of their same 'family'."

The new research by senior co-authors Cotter and Low and others appear on-line November 18, 2010 in the journal *Nature*.

As to "swords," the metaphor lives close to reality. Bacteria use proteins to interact with a host, including disease-causing bacteria, such as Bordetella pertussis, the cause of whooping cough and Burkholderia pseudomallei, found in soil throughout Southeast Asia and a cause of a frequently fatal tropic disease.

In these and other gram-negative bacteria, large proteins appear as rods on the surface of cells. "In the soil or in humans, different bacteria bump into each other all the time and bump into their own 'family,' too. They have to touch each other and recognize each other and then one can inhibit the growth of the other, non-family, bacteria." Cotter said.

According to the UNC scientist, this system may represent a primitive form of kin selection, whereby organisms kill organisms that are genetically different but not those that are closely related.

"As an additional twist, we have found that some bacteria can have two or three (or possibly more) systems. Our data suggest that these bacteria will be protected from killing by bacteria that produce any of three types of poison swords and they will be able to kill other bacteria that lack at least one of those types of immunity proteins."

Moreover, there's evidence here that these bacteria acquire these additional systems by horizontal gene transfer from other bacteria. "In other words, it seems that they may be able to kill their enemy and then steal the poison-tipped sword and protective (immunity) protein from

the dead enemy, increasing their own repertoire of weapons."

By teasing out the genetics of these bacterial close combat mysteries, it may someday be possible to "engineer an organism, a non-pathogenic variant, and by putting it out in the environment, such as soil, you can potentially get rid of other pathogens, "Cotter said. "Or you could decontaminate an area, if the new knowledge is applied to biodefense."

Provided by University of North Carolina School of Medicine