Study finds molecular recognition mechanism that assists outer membrane fusion in myxobacteria

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(Phys.org) —Molecular biologists at the University of Wyoming have found a molecular mechanism that allows myxobacteria to recognize related strains that lead to the transient fusion of their outer membranes to exchange lipids and proteins.

Results of the study, led by Associate Professor Daniel Wall in the College of Agriculture and Natural Resources, were published in the November issue of *PLOS Genetics*. Wall's group found that Myxococcus xanthus exchanges cellular components to help single cells transition into multicellular life. Further, the mechanism may play a role in how the bacteria adapt to stresses, perhaps including antibiotic resistance.

Myxococcus xanthus are soil bacteria and are unusual – they are social, says Wall. They interact with one another and form units of cells that exhibit behaviors such as group movement over solid surfaces. Related bacteria also will assemble multicellular structures in response to starvation.

"They live in soil, which is a cosmopolitan environment made up of thousands of different kinds of microbial species, and myxobacteria have the ability to recognize each other and can aggregate in response to starvation and build spectacular fruiting structures that can be seen with the naked eye," says Wall, in the Department of Molecular Biology.

Some of these structures resemble trees with a stalk and branches. The aggregation of bacteria raises them off a surface and enables them to be dispersed by wind, water or animals to a more sustaining environment.

Wall wanted to determine the molecular mechanism for recognition between cells.

The researchers determined that traA, a gene necessary for the transfer of outer membrane material, acts as a cell surface receptor. They also found that myxobacteria exhibit discriminatory behavior in what they partner with for outer membrane exchange, and those selective interactions correlate with hyper-variable sequence variations found in the TraA receptor among environmental isolates.

To test if TraA polymorphisms governed cell-cell recognition, they swapped traA alleles from one strain to another and found the resulting strain would recognize the group belonging to the new traA allele and not its old recognition group.

"That experiment demonstrated that traA is the molecular specificity determinant," he notes.

Why do they exchange?

"We don't have the full answer," says Wall. "We think they share cellular goods to build a cooperative team of cells that can function in multicellular activities. To date, we know of no other bacterial system that does this behavior where cells have a receptor involved in recognition that leads to membrane fusion and exchanging of components."

Wall speculates that exchange is one way for bacteria to repair damaged cells.

Partnering cells share exchangeable components to approximately equal levels. If one cell lacks a particular protein, after outer membrane exchange, both cells will have the same amount of this protein, he says.

"When you think about bacteria living in their environment, the cells are of various ages, are exposed to all sorts of environmental insults and predators, so populations become heterogeneous – some cells are healthy, some are damaged, and others might be starving," Wall says. "Outer membrane exchange allows the cells to mix cellular factors, and we hypothesize this makes the population more homogenous and fit."

Bacteria of the same species, but which are different strains or isolates, are commonly antagonistic toward one another, says Wall. "Frequently, one can find that one strain will kill another strain of the same species."

These components typically are called bacteriocins – specific peptides or proteins that recognize another closely related bacterium and kills them unless it encodes an immunity protein, says Wall. The cell that produces the bacteriocin also has to make an immunity factor to protect itself from the toxin. Any related neighboring cell that doesn't have the immunity factor is killed.

"Swapping the traA gene between two strains that did not belong to a recognition group allowed them to exchange outer membrane components and, in the cases tested, provided protection from killing," he says. "We've interpreted this result to mean there is an immunity factor that can be transferred between cells."

By extension, the exchange process also could play a role in antibiotic resistance, he says.

This work describes a new paradigm for how bacterial cells interact, which may also provide insight into how microbes interact within our

own bodies, he says.

"Cells can use this mechanism to communicate, and new functions can be transferred between cells," he says.

The research also can apply to processes that occur in the bacteria's home turf – soil.

"Our lab species of myxobacteria are commonly found in soil," says Wall. "They prey on other bacterial and fungal organisms, including crop pathogens. And myxobacteria importantly do not harm crops so, in a separate project, we are exploring the utility of myxobacteria as a biological control agent to protect crops."

More information: Pathak DT, Wei X, Dey A, Wall D (2013) Molecular Recognition by a Polymorphic Cell Surface Receptor Governs Cooperative Behaviors in Bacteria. *PLoS Genet* 9(11): e1003891. DOI: 10.1371/journal.pgen.1003891

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