Researchers discover 'switch' that allows microbes to recognize kin

27 March 2017

Associate Professor Daniel Wall of UW's Department of Molecular Biology is one of the researchers whose paper was published in the *Proceedings of the National Academy of Sciences*. Credit: UW Photo

How one-celled microbes recognize their kin is described in a paper by University of Wyoming scientists and published online this week in the *Proceedings of the National Academy of Sciences*.

Molecular biologist Daniel Wall and Ph.D. student Pengbo Cao solved a piece of the mystery surrounding how bacteria recognize family members, helping them band together for protection and even unite to become true multicellular organisms for survival.

"Self-identity reprogrammed by a single residue switch in a cell surface receptor of a social bacterium" describes how a lone amino-acid switch they found can govern how the soil bacterium Myxococcus xanthus recognizes its kin.

Microbes have a bad rap for being socially inept, but actually many of them live quite social lives.

"If they really want to thrive, they need to come together, recognize each other and assemble into multicellular structures to form something that's beyond the ability of the individual," Cao says. "I was pretty amazed how such a small, single-cell microbe could exhibit such sophisticated social behaviors."

These efforts build on an earlier discovery by Wall and colleagues in the College of Agriculture and Natural Resources that found a particular cell receptor called TraA facilitated recognition among M. xanthus cells and allowed them to come together and exchange proteins and other components, a process called outer membrane exchange.

Cao noted different strains have different TraA sequences.

"The TraA receptors ensure when cells come in contact the sharing of cellular resources only occurs with close relatives that have identical or very similar TraA receptors," Cao says.

Wall and Cao asked if different TraA receptors allow cells to selectively bind one another. They put different receptors into the same parent strain that were labeled with different color markers and showed that cells with different receptors formed distinct kin groups.

They then questioned how one receptor could create such diversity in recognition among natural populations so, using molecular scalpels and wrenches, they assembled parts of different TraA receptors and tested if cell recognition could be reprogrammed.

"Cao took the simplest case of two receptors very similar in sequence that only had 11 amino-acid differences yet did not recognize each other," Wall says.

Cao made a series of chimeras, using half of one receptor and half of another, and observed what the bacteria recognized. They found that a single amino acid within the receptor plays an important role in the recognition.

"This was a surprising result—that changing one amino acid had such a dramatic impact on specificity," Wall says.

By changing this residue, they even engineered a TraA receptor with unique specificity that only recognized itself.

They hypothesize the malleability of TraA has allowed it to evolve and create social barriers between myxobacterial populations which, in turn, avoids nasty interactions with exploitive relatives.

Recognition is an important process, because misrecognition of a neighboring cell could be lethal. Hundreds of different proteins are transferred during outer membrane exchange, Wall says. Included in the mix are toxins and, if the other cell is not a true clonemate or self, it won't have the antidote and will die. Wall and Cao speculate that such adverse interactions may drive and maintain diversification of TraA sequences in nature.

M. xanthus' predatory nature has drawn agricultural interest.

"They kill and consume other bacteria," Wall says. "That's how they make their living, by eating their microbial neighbors."

Scientists want to use that predatory behavior for biocontrol.

"Myxobacteria themselves do not harm plants, but they can kill pathogens of crops," Wall says. "M. xanthus, along with other types of microbes, are organisms of interest to use as a natural way to control and protect crops from disease."

More information: Pengbo Cao et al. Self-identity reprogrammed by a single residue switch in a cell surface receptor of a social bacterium, *Proceedings of the National Academy of Sciences* (2017). DOI: 10.1073/pnas.1700315114

Provided by University of Wyoming