Scientists find soil bacteria require two-layer security, just like digital world

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Credit: Mick Lissone/public domain

Those people at Google think they're sooooo smart. So, too, the Apple and Microsoft wunderkinds.

Their software (and many others) use two-factor authentication in the digital world to verify identity, but they're a little behind. A one-celled soil bacterium beat them to it by who knows how many millions of years.

University of Wyoming Ph.D. student Chris Vassallo in molecular biologist Dan Wall's laboratory found the bacterium Myxococcus xanthus performs its equivalent of a secret handshake after an initial meet-and-greet encounter in its social world. The second level of verification is important. They die if not recognized.

Their results are described in "Infectious polymorphic toxins delivered by outer membrane exchange discriminate kin in myxobacteria," published last week in the open-access journal *eLife*.

Earlier research in Wall's lab found these bacteria recognize kin through the cell surface receptor called TraA and transfer cellular goods to each other when touching via a process the lab calls outer membrane exchange (OME). This current research is about the cargo that's exchanged.

M. xanthus's social lifestyle requires them to cooperate with their kin or close family members.

"It's very important these cells know who they are cooperating with," says Vassallo, from Cheyenne. "They don't want to give beneficial treatment to another cell they are competing with if it's not their self. One way they do this is through toxin exchange."

The cells exchange potentially toxic proteins during OME. The process takes a couple of minutes.

"If their identities don't match, they'll kill each other with the toxins," Vassallo says.

The toxic cocktail of proteins moves from cell to cell, chewing up DNA or RNA if the cell is not immune. Vassallo says these bacteria don't die immediately. Although sick, they are able to infect other cells, similar to humans with a transmittable disease.

Wall's laboratory found the bacteria use a receptor that is unique to M. xanthus. In the wild, underfoot outdoors, there are hundreds of different recognition receptors within the myxobacteria group.

Just using the TraA receptor for identity verification is not enough. A few grams of soil might contain a hundred distinct M. xanthus social groups, all living together but not necessarily wanting to cooperate with one another, Wall says.

Vassallo discovered the second layer of specificity, he says.

"The first layer is, 'Do you have a compatible TraA receptor?' If you do, you exchange components," Wall says. "Then the next layer is, 'Do you have immunity to the collection of toxins I'm going to give you using this exchange process?'"

The bacterial decimation, where kin kill nonkin as packs of cells converge, results in a kill zone. Not all exchanges result in death and destruction. Vassallo found in previous research healthy bacteria repair damaged kin. He designed an experiment where cells had defective membranes and left on their own would die. But, if mixed with healthy kin, the clonemates would give them healthy material, and the sick cells become rejuvenated.

Wall's research is part of a $1.2 million grant from the National

Institutes of Health. It follows a previous $1.6 million, five-year grant. The research helps address how multicellular animals and plants came into existence.

The evolutionary transition from single cell to multicell life is apparently very difficult, Wall says. The event is thought to have occurred only once for animals and perhaps twice for plants.

"In the microscopic world, it might have happened separately a couple dozen of times," Wall says. "In the case of myxobacteria, they appear to have made this transition to multicellularity, a fairly primitive transition that's based on an aggregation strategy, and OME plays a role in this process."

More information: Christopher N Vassallo et al. Infectious polymorphic toxins delivered by outer membrane exchange discriminate kin in myxobacteria, *eLife* (2017). DOI: 10.7554/eLife.29397

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