Are sacrificial bacteria altruistic or just unlucky?

April 15 2008

An investigation of the genes that govern spore formation in the bacteria B. subtilis shows that chance plays a significant role in determining which of the microbes sacrifice themselves for the colony and which go on to form spores.

B. subtilis, a common soil bacteria, is a well-known survivor. When running short of food, it can alternatively band together in colonies or encase itself in a tough, protective spore to wait for better times. In fact, B. subtilis is so good at making spores that it's often used as a model organism by biologists who study bacterial spore formation.

"It's too early to say whether B. subtilis is truly altruistic," said co-author Oleg Igoshin, assistant professor of bioengineering at Rice University. "What is clear from this is that not all bacteria are going to look and act the same, and that's something that can be overlooked when people either study or attempt to control bacteria with population-wide approaches."

For example, Igoshin said doctors and food safety engineers might need to amend general approaches aimed at controlling bacteria with more targeted methods that also account for the uncharacteristic individual.

The new results appear in the April 15 issue of *Molecular Systems Biology*. The experimental work, which was done by Jan-Willem Veening, currently at Newcastle University, and by other members of Oscar Kuipers' research group at the University of Groningen in the

Netherlands, focused on the B. subtilis genes that regulate both spore formation and the production cycles of two proteins -- subtilisin and bacillopeptidase. These two proteins help break apart dead cells and convert them into food. They are produced and released into the surrounding environment by B. subtilis cells that are running low on food.

From previous studies, scientists know there is some overlap between genes that control the production of the two proteins and those that control spore formation.

"Only a portion of the bacteria in a colony will form spores and only portion of the bacteria produce subtilisin, and we were interested in probing the genetic basis for this," Igoshin said. "How is it decided which cells become spores and which don't?"

Igoshin, a computational biologist, used computer simulations to help decipher and interpret the team's experimental results. He said the team found that fewer than 30 percent of individuals in a colony produce large quantities of the food-converting proteins. Even though the proteins benefit all members of the colony and help some cells to become spores, the cells that produce the proteins in bulk do not form spores themselves.

"There's a feedback loop, so that cells that start producing the proteins early get a reinforced signal to keep making them," Igoshin said. "We found that it's probabilistic events -- chance, if you will -- that dictates who is early and who is late. The early ones start working for the benefit of everyone while the later ones save valuable resources to ensure successful completion of sporulation program. Many cells will end up committing to sporulation before they had a chance to contribute to protease production"

Igoshin said a key piece of evidence confirming modeling predictions came in experiments that tracked genetically identical sister cells, some of which became protein producers and some of which didn't.

Source: Rice University