Finding the constant in bacterial communication

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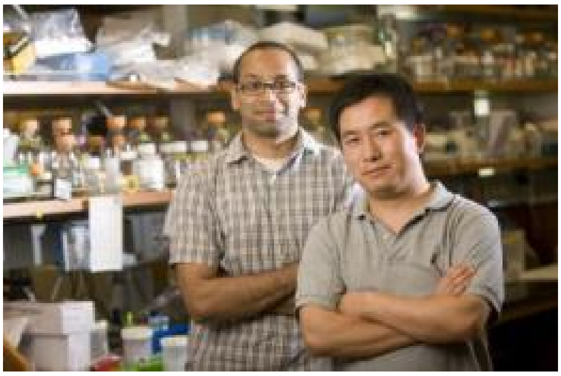

On the left is Anand Pai and on the right is Lingchong You of Duke University. Credit: Duke University Photography

The Rosetta Stone of bacterial communication may have been found.

Although they have no sensory organs, bacteria can get a good idea about what's going on in their neighborhood and communicate with each other, mainly by secreting and taking in chemicals from their surrounding environment. Even though there are millions of different kinds of bacteria with their own ways of sensing the world around them, Duke University bioengineers believe they have found a principle common to all of them.

The researchers said that a more complete understanding of communication between cells and bacteria is essential to the advancement of the new field of synthetic biology, where populations of genetically altered bacteria are "programmed" to do certain things. Such re-programmed bacterial gene circuits could see a wide variety of applications in medicine, environmental cleanup and biocomputing.

It is already known that a process known as "quorum sensing" underlies communication between bacteria. However, each type of bacteria seems to have its own quorum-sensing abilities, with tremendous variations, the researchers said.

"Quorum sensing is a cell-to-cell communication mechanism that enables bacteria to sense and respond to changes in the density of the bacteria in a given environment," said Anand Pai, graduate student in bioengineering at Duke's Pratt School of Engineering. "It regulates a wide variety of biological functions such as bioluminescence, virulence, nutrient foraging and cellular suicide."

The researchers found that the total volume of bacteria in relation to the volume of their environment is a key to quorum sensing, no matter what kind of microbe is involved.

"If there are only a few cells in an area, nothing will happen," Pai said. "If there are a lot of cells, the secreted chemicals are high in concentration, causing the cells to perform a specific action. We wanted to find out how these cells know when they have reached a quorum."

Pai and scientist Lingchong You, assistant professor of biomedical engineering and a member of Duke's Institute for Genome Sciences & Policy and Center for Systems Biology, have discovered what they believe is a common root among the different forms of quorum sensing. In an article in the July 2009 issue of the journal *Molecular Systems Biology*, they term this process "sensing potential."

"Sensing potential is essentially the linking of an action to the number of cells and the size of their environment," You said. "For example, a small number of cells would act differently than the same number of cells in a much larger space. No matter what type of cell or their own quorum sensing abilities, the relationship between the size of a cell and the size of its environment is the common thread we see in all quorum sensing systems.

"This analysis provides novel insights into the fundamental design of quorum sensing systems," You said. "Also, the overall framework we defined can serve as a foundation for studying the dynamics and the evolution of quorum sensing, as well as for engineering synthetic gene circuits based on cell-to-cell communications."

Synthetic gene circuits are carefully designed combinations of genes that can be "loaded" into bacteria or other cells to direct their actions in much the same way that a basic computer program directs a computer. Such re-programmed bacteria would exist as a synthetic ecosystem.

"Each population will synthesize a subset of enzymes that are required for the population as a whole to produce desired proteins or chemicals in a coordinated way," You said. "We may even be able to re-engineer bacteria to deliver different types of drugs or selectively kill cancer cells"

For example, You has already gained insights into the relationship between predators and prey by creating a synthetic circuit involving two genetically altered lines of bacteria. The findings from that work helped define the effects of relative changes in populations.

Source: Duke University (news : web)

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