Scientists uncover mysterious workings of cholera bacteria

July 28 2010

Researchers have found that an enzyme in the bacteria that causes cholera uses a previously unknown mechanism in providing the bacteria with energy. Because the enzyme is not found in most other organisms, including humans, the finding offers insights into how drugs might be created to kill the bacteria without harming humans.

Blanca Barquera, a Rensselaer associate professor of biology, led a team (including research professor Joel Morgan and postdoctoral fellow Oscar Juarez) whose findings were published in the June 28 edition of the Proceedings of the National Academy of Sciences.

The team studied Na+-NQR, an enzyme that is essentially two linked machines to create energy from food and electrically charge the cell membrane of Vibrio cholerae, powering many cellular functions.

Vibrio cholerae causes cholera, a disease transmitted primarily through contaminated drinking water. Cholera, in which severe diarrhea and vomiting lead to rapid dehydration, is a major cause of death in the developing world, and in the aftermath of catastrophes that compromise water systems.

The Rensselaer team found that the way in which the two machines are linked in Na+-NQR is different from other respiratory enzymes and likely involves much more movement of the protein than has been observed in other enzymes.

Their work stems from an interest in cellular respiration. Cellular respiration carries electrons from food to oxygen, in what amounts to a controlled burn. This process releases energy.

"Cellular respiration is remarkable," Barquera said. "It is one of the most efficient energy conversion processes known, and nevertheless, does not require high temperatures. This efficiency has drawn the attention of researchers."

In more complex organisms, like humans, the process of creating energy for a cell - respiration - takes place in specialized organelles within the cell called mitochondria.

But in bacteria, which lack mitochondria, respiration occurs in the cell membrane. Na+-NQR is a respiratory enzyme found on the cell membrane of Vibrio Cholerae.

The enzyme creates energy through respiration and uses that energy to pump ions out of the cell, electrically charging the cell membrane and providing power for all the functions of the cell. Unlike similar enzymes found in many animals and bacteria, Na+-NQR pumps sodium ions out of the cell, rather than protons.

Barquera's paper in PNAS describes the mechanism the enzyme uses to convert energy using sodium ions.

"Na+-NQR plays the same role as human respiratory proteins but it is much smaller," Barquera said. "We want to understand how it works, how it produces energy. If we understand how Na+-NQR works, we can learn the basic principles used by living organisms to convert energy and transport ions."

Researchers studied the enzyme by removing it from the inner cell

membrane and studying it in a solution. Na+-NQR, which prefers an environment of water and oil, flourished in a solution similar to detergent, which mimics the bacterial membrane.

"We have the enzyme off of the membrane with all of its components," Barquera said. Once isolated, the researchers observed the enzyme as it moved sodium from the inside to the outside of the cell.

Their study revealed the protein itself is moving the ions along a path through the cell membrane.

"It works in a very different way from enzymes in other bacteria and mitochondria. The catch and release of ions is done by movement of the protein," Barquera said.

Barquera said that, by modifying the protein in various ways, the researchers had identified the site on the protein where the ions begin and end their travel along the protein.

Next they want to map the route the ion takes along the protein.

"We can see the in and out site. Now we want to know the path," Barquera said.

Provided by Rensselaer Polytechnic Institute