Researchers design artificial cells that could power medical implants

October 9 2008

Researchers at Yale University have created a blueprint for artificial cells that are more powerful and efficient than the natural cells they mimic and could one day be used to power tiny medical implants.

The scientists began with the question of whether an artificial version of the electrocyte – the energy-generating cells in electric eels – could be designed as a potential power source. "The electric eel is very efficient at generating electricity," said Jian Xu, a postdoctoral associate in Yale's Department of Chemical Engineering. "It can generate more electricity than a lot of electrical devices."

Xu came up with the first blueprint that shows how the electrocyte's different ion channels work together to produce the fish's electricity while he was a graduate student under former Yale assistant professor of mechanical engineering David LaVan, now at the National Institute of Standards and Technology.

But the scientists didn't stop there. "We're still trying to understand how the mechanisms in these cells work," said LaVan. "But we asked ourselves: 'Do we know enough to sit down and start thinking about how to build these things?' Nobody had really done that before."

Using the new blueprint as a guide, LaVan and Xu set about designing an artificial cell that could replicate the electrocyte's energy production. "We wanted to see if nature had already optimized the power output and energy conversion efficiency of this cell," said Xu. "And we found that

an artificial cell could actually outperform a natural cell, which was a very surprising result."

The artificial cell LaVan and Xu modeled is capable of producing 28 percent more electricity than the eel's own electrocyte, with 31 percent more efficiency in converting the cell's chemical energy – derived from the eel's food – into electricity.

While eels use thousands of electrocytes to produce charges of up to 600 volts, LaVan and Xu show it would be possible to create a smaller "bio-battery" using several dozen artificial cells. The tiny bio-batteries would only need to be about ¼-inch thick to produce the small voltages needed to power tiny electrical devices such as retinal implants or other prostheses.

Although the engineers came up with a design, it will still be some time before the artificial cells are actually built. For one thing, they still need a power source before they could start producing electricity. LaVan speculates the cells could be powered in a way similar to their natural counterparts. It's possible, he said, that bacteria could be employed to recycle ATP – responsible for transferring energy within the cell – using glucose, a common source of chemical energy derived from food.

With an energy source in place, the artificial cells could one day power medical implants and would provide a big advantage over battery-operated devices. "If it breaks, there are no toxins released into your system," said Xu. "It would be just like any other cell in your body."

Citation: *Nature Nanotechnology* advanced online publication, 10.1038/nnano.2008.274

Source: Yale University