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Lab Notes

Research from the College of Engineering, University of California, Berkeley

OPEN SESAME FOR CELLS

by David Pescovitz

This month, Boris Rubinsky, professor of bioengineering and mechanical engineering, and his former graduate student Yong Huang are receiving what the Chicago Tribune calls an "Oscar of invention" and others refer to as a "Nobel Prize of applied research." The 2002 R&D 100 Award from R&D Magazine is for the pair's "bionic chip," a device that may help revolutionize medicine by merging electronic circuitry with living tissue.

First unveiled at UC Berkeley two years ago, the microelectromechanical chip acts as an electronic doorknob that opens up the pores in fragile, living cells at the touch of a button so genes or drugs, for example, can be introduced. The bionic chip's operation is based on electroporation, a technique for forming pores in a cell's membrane by applying a specific voltage. While electroporation is a standard method of introducing macromolecules into cells, it's traditionally done by zapping batches of cells with very little control. Rubinsky and Huang's chip treats each biological cell like a diode, or switch, that allows current to flow through it only at a certain voltage that varies from cell to cell.

manufactured. Inside the three-layered device, a cell is captured between two electrodes. The circuit is only completed when the electrical potential is high enough to induce electroporation, enabling a measurable current to flow between the electrodes through the newly opened pores. Once the proper voltage is known, Rubinsky says, "it's like having a remote control to the door."



Professor Boris Rubinsky (seen here) and Yong Huang receive their 2002 R&D 100 Award at an October ceremony in Chicago. Photo courtesy Boris Rubinsky



The new flow-through bionic chip enables cell membranes to be opened en masse.

Photo courtesy Boris Rubinsky

Patented by UC Berkeley, the technology was licensed for commercialization to Bioelectronic Micro Systems, a start-up founded by Rubinsky and Huang and funded by the Florida Hospital in Orlando. Huang serves as the president of the company while Rubinsky sits on the board of directors. Recently, the company created a new version of the chip that employs microfluidics "plumbing" to automatically induce electroporation in millions of cells en masse.

"There is a free flow of information between my laboratory at Berkeley and the company," Rubinsky says. "The chip is an ideal lab tool for us to study fundamental biophysics and develop applications."

The development of new electroporation approaches to gene therapy is one of Rubinsky's primary research thrusts. He and his graduate students recently used the bionic chip to introduce a test gene for flourescence into a cell and study how the cell expresses that gene.

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"It's the most promising engineering alternative to viral gene therapy" where desired genes are introduced into the body by piggybacking them on viruses, Rubinsky says.

Another project involves engineering stem cells using electroporation to produce heart tissue that can be grown on scaffolds as biocompatible "band-aids" for damaged heart muscle. Meanwhile, other laboratories around the world are conducting research into other applications for the electroporation technology. However, Rubinsky says, UC Berkeley remains the bionic chip's alpha test site.

"Our feeling is that the future of biotechnology rests with the electroporation process," he says.

SOURCE: http://www.coe.berkeley.edu/labnotes/0902/bionic.html

The chip is manufactured using processes similar to the way integrated circuits are