Cell membranes capture electrical energy to amplify sound

Baylor College of Medicine
HOUSTON -- (August 12, 2010) -- Lightning, with its bright flash and deadly force, has nothing on the electrical energy generated by human cells. Now researchers at Baylor College of Medicine [1] have found that cell membranes, the thin outer layer of cells, act alone to convert that electrical energy into mechanical force, helping us hear. The findings are in the current edition of the Biophysical Journal [2].
"It has long been known that there is a very large electrical gradient across cell membranes. Relative to its size, the cell membrane has about 20 megavolts per meter of electrical energy, while lightning generates only three," said Dr. William Brownell [3], professor of otolaryngology - head and neck surgery at BCM. "These new findings demonstrate how membranes can capture this important energy store that is created from the positive and negative charges found inside and outside of the cells."

Increasing tether force

Brownell's research team created a tether, a technique that pulls the membrane from the cell's cytoskeleton, creating a "tube" consisting of only the membrane, from a variety of cell types.

By adding a predetermined voltage to the cell through an electrode, researchers were able to control the difference in voltage between the interior and exterior cell (called the potential difference) and measure the force required to form and maintain the tethers.

"The electrical field across the membrane affected the mechanical force required to pull the tether, hyperpolarizing potentials (an increase in the potential difference) resulted in greater tether force." said Brownell. "Since the tether is made up of only the cell membrane, this shows us that there is a direct conversion of electrical to mechanical energy without any intermediate processes going on."

Membrane response

Changes in the potential difference of cells occur naturally as ions flow through specialized channels in the cell membrane. Once converted, the mechanical energy acts as a motor of sorts to add power and amplification to sound, allowing us to hear. Researchers manipulated the membrane's ability to respond to the potential differences to further understand how electrical energy converted to mechanical energy affects hearing.

This transduction of energy is found in all cell membranes. Exactly how other cell

membranes in the body use this energy source is not clear.

Others who took part in the study include Feng Qian and Bahman Anvari, both currently in the department of bioengineering the University of California at Riverside. The research took place while both were with the department of bioengineering at Rice University [4].

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SOURCE [5]

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