Scientists first to mimic nature's vital potassium ion channel

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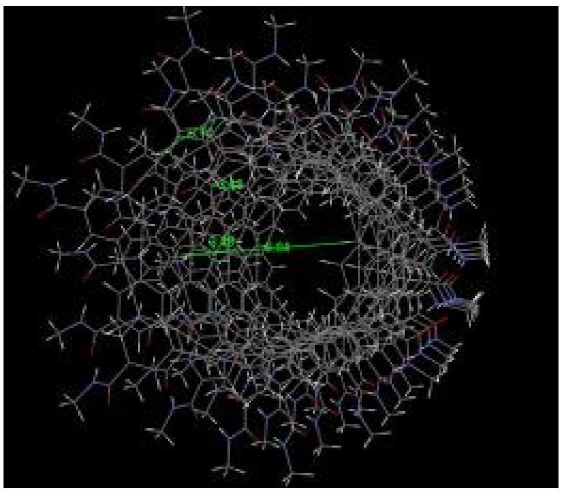

Computer-generated image of the artificial potassium ion channel

(Phys.org) -- An international team of scientists, including chemist Xiao Cheng Zeng of the University of Nebraska-Lincoln, has created what is in effect a nanoscale sieve that is very selective in what it will allow to pass through -- and performs in much the same way as the potassium ion channels that are vital components of virtually all living cells.

It's also the first synthetic nanotube that possesses a uniform diameter, as well as being self-assembling and hydrophobic, characteristics that could lead to industrial and medical breakthroughs.

"This nanotube can be viewed as a stack of many, many rings," said

Zeng, Ameritas University Professor of chemistry. "The rings come together through a process called self-assembly, and it's very precise. It's the first synthetic nanotube that has a very uniform diameter. It's actually a sub-nanometer tube. It's about 8.8 angstrom."

In living cells, ion channels allow potassium ions to pass through cell membranes, but don't allow sodium ions through, even though the potassium ion (atomic weight 39) is nearly 70 percent larger than sodium (atomic weight 23).

"We found a totally different potassium channel," Zeng said. "It's the same function, but it's totally different from Mother Nature. We, possibly for the first time, mimicked Mother Nature's potassium pore by using a uniform subnanometer pore, but why the bigger ion can go through and the smaller one can't is still under study."

Zeng's research group at UNL used UNL's Holland Computing Center with funding from the National Science Foundation and the Nebraska Research Initiative to perform computations investigating the structure of the tubes. His group determined the size of the rings and the distance between them to find the structure of the devices, and found eight possible ways to stack the molecules. Crucially, computations also showed that the structures are stable at room temperature.

Bing Gong, professor of chemistry at the University at Buffalo and Beijing Normal University, a long-time collaborator of Zeng's, and Zhifeng Shao, executive dean of the Center for System Biomedicine at Shanghai Jiao Tong University and a former long-time faculty member at the University of Virginia School of Medicine, and their teams, synthesized the nanotubes and measured the ion flow, completing a three-year project funded in large part by the NSF. X-ray work was done at the Advanced Photon Source at Argonne National Laboratory in Argonne, Ill. Zeng's research group at UNL includes postdoctoral fellows Hui Li and Yi Gao.

The success of the experiments, Zeng said, will lead to continuing research and development.

"One thing people are interested in in this field is desalination. Another is drug delivery," he said. "In the future, our direction, also supported by NSF, is to functionalize the inner wall of the tube.

"For now, at least, it's a very intriguing nanotube because it has what we call selective ion transport, which is very special. Only potassium can go in. It goes through and the sodium can not. But, hopefully, if we can add a different function inside, and then sometimes we can allow only water to go through, or some other ions to go through, we can add more selectivities."

The findings were reported in the July 17 issue of *Nature Communications*, the Nature Publishing Group's online-only multidisciplinary journal of research in all areas of the biological, physical and chemical sciences.

Provided by University of Nebraska-Lincoln

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