Mimicking nature at the nanoscale: Selective transport across a biomimetic nanopore

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Researchers at Delft University of Technology and the University of Basel have established a biomimetic nanopore that provides a unique test and measurement platform for the way that proteins move into a cell's nucleus. In the journal *Nature Nanotechnology*, they report an artificial nanopore that is functionalized with key proteins which mimicks the natural nuclear pore. Upon testing the transport of individual proteins through the biomimetic pore, they found that most proteins cannot move through, but some specific ones can indeed pass. This is the hallmark of the intriguing selectivity that is also found in natural pores. The biomimetic pore is fully functional and can be used as a testing platform for studies of drug delivery into a cell's nucleus.

The nuclear pore complex

"Human cells have a nucleus, and proteins and RNA need to get in and out. This is regulated by small holes, called nuclear pore complexes. These are essential biological pores that act as gatekeepers of the cell nucleus. They transport proteins and RNA in and out of the nucleus in a highly selective manner, which means that some go through but others are blocked from passing. There is much debate on how this intriguing selectivity is achieved. Given the fact that it is very difficult to perform high-resolution measurements in the complex environment of the living cell, the exact mechanism is hard to resolve." Professor Cees Dekker, director of the Kavli Institute of Nanoscience at Delft and leader of this research, explains.

In the new research by Dekker's group in collaboration with the group of dr. Roderick Lim of the University of Basel, they were able to make a biomimetic nanopore - a synthetic pore that imitates the nuclear pore - which acts as a new, powerful platform to monitor transport of individual proteins across.

Biomimetic nanopore

Dekker: "One promising approach to study this nuclear transport is biomimetics - the development of synthetic systems that imitate biological structures and processes. Advances in nanotechnology now make it possible to study and shape matter at the nanometer scale, opening the way to imitate biological structures at the molecular level to both study and harness their ingenuity." The group of dr. Roderick Lim at the University of Basel purified the nuclear pore proteins and Dekkers group made the biomimetic nanopores of these by attaching these proteins to small holes in a solid-state support.

Selectivity

The new research, performed chiefly by lead author Stefan Kowalczyk, a graduate student in Dekkers lab, demonstrates that it is possible to establish a biomimetic nuclear pore and to monitor transport of individual proteins across the pore. Importantly, the biomimetic pore exhibits strong selectivity, just like the natural nuclear pore complex: ImpB proteins do pass the pores, whereas BSA proteins do not (as illustrated by the attached image). A differing degree of selectivity was found, depending on which exact nuclear pore proteins were used to functionalize the pore. The researchers have shown that the biomimetic pore is fully functional and can be used as a testing platform for studies of drug delivery into a cell's nucleus.

Provided by Delft University of Technology