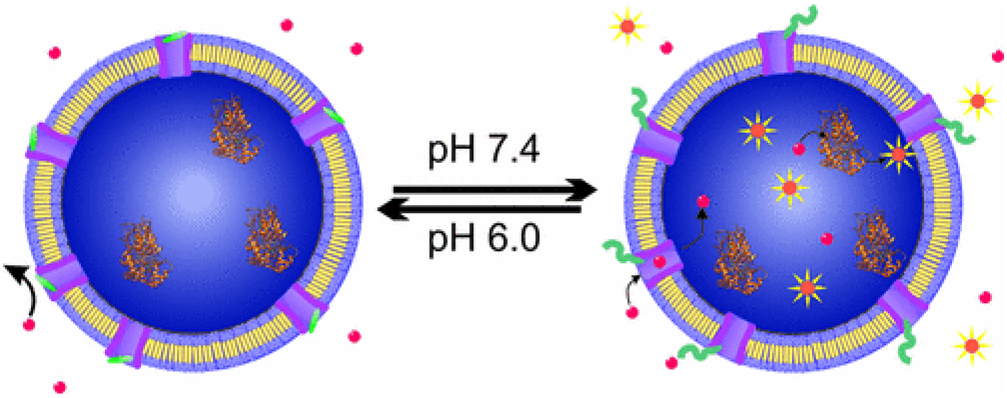
Artificial Molecular Doors Controlling Nanofactories

Press release | Basel, 03 October 2017

Researchers at the NCCR Molecular Systems Engineering succeeded in modifying membrane proteins to switch catalytic nano-compartments on and off depending on the pH. The results have been published in the scientific journal ACS Nano Letters.



Without compartmentalisation, there would be no life. Compartmentalisation is the generation of defined spaces and controlling what enters and leaves them. Nature uses cell membranes and a plethora of different membrane proteins, which act as tunnels allowing and controlling molecular flow across the membrane. Scientists introduced artificial cells as simplified models for better understanding specific parts of cells. Our knowledge allows us today to go a step further, using existing enzymes and membrane proteins to create artificial cells to create nanofactories that could find their use in nano-medicine, analytics and advanced functional materials.

Thus far, most artificial assemblies have no control over when molecules enter or leave these nanofactories, since they rely on permanently open pores. More advanced designs allow a plug to be cleaved off allowing a single stimuli-response.

Now, the groups of Prof. W. Meier and Palivan have achieved a system that can be switched on and off, theoretically endlessly. It was achieved by taking a permanently open pore and attaching two identical peptides which change their conformation with the pH creating a molecular sliding-door. This new module was tested by inserting it in an artificial membrane which in turn encapsulates an enzyme.

At physiological pH, the enzyme substrate is able to diffuse through the membrane and meet the enzyme where it is converted into a fluorescent dye, whereas at low pH the pores close blocking off causing the enzyme to shut down the production of dye. The small drop in pH changes the pore from a completely open state into a completely closed state. This effect overrides the pH-dependency of the enzyme activity and protects the enzyme from degradation, thus allowing longer storage times and more pH-changes. Lastly, the attachment of the peptides to the pore is a simple reaction. By creating similar peptides, it would be possible to select the trigger; thus, enabling the choice, if the pores open at high or low pH.

Reference

Christoph Edlinger, Tomaz Einfalt, Mariana Spulber, Anja Car, Wolfgang Meier, and Cornelia G. Palivan, Biomimetic Strategy To Reversibly Trigger Functionality of Catalytic Nanocompartments by the Insertion of pH-Responsive Biovalves. Nano Letters, 2017, 17(9), 5790-5798, doi: 10.1021/acs.nanolett.7b02886.

Contact

Prof. Cornelia G. Palivan, Department of Chemistry, University of Basel, Mattenstrasse 24a, BPR 1096, CH-4058 Basel; cornelia.palivan@unibas.ch

Prof. Wolfgang Meier, Department of Chemistry, University of Basel, Mattenstrasse 24a, BPR 1096, CH-4058 Basel; wolfgang.meier@unibas.ch

About the NCCR Molecular Systems Engineering

Molecular Systems Engineering is a National Centre of Competence in Research (NCCR) funded by the Swiss National Science Foundation (SNSF), and headed by the University of Basel and ETH Zürich. Molecular systems engineering attempts to capture the complexity and emergent properties prevalent in biology. The uniqueness of this initiative relies on the combination of both chemical- and biological modules. In this approach, complex dynamic phenomena emerge as the result of the integration of molecular modules (molecular- or biological prosthetics) designed to interact in a programmed way with their complex environment. In this manner, it should be possible to create molecular factories and cellular systems whose properties are more than sum of the attributes of the individual modules. These new system-level properties emerge through the interactions of chemical- and biological networks assembled from the individual modules.

Links

NCCR Molecular Systems Engineering

Palivan Group

Meier Group