Universität Basel

Research Project

BIOINSPIRED FUNCTIONAL PROTEIN-POLYMER SUPRAMOLECULAR NANOASSEMBLIES

Third-party funded project

Project title BIOINSPIRED FUNCTIONAL PROTEIN-POLYMER SUPRAMOLECULAR NANOASSEMBLIES
Principal Investigator(s) Palivan, Cornelia ;
Project Members Zartner, Luisa ;
Organisation / Research unit
Departement Chemie / Physikalische Chemie (Palivan)
Department
Project start 01.07.2017
Probable end 30.06.2021
Status Completed

The development of new functional materials by bottom-up approaches that combine different building blocks at the nanoscale in a novel architecture with improved or new properties and functionality is currently in focus for applications in various domains. One of the most promising strategies is to interface biomolecules (enzymes, proteins, DNA, biomimics) with synthetic assemblies that have a variety of architectures (micelles, vesicles, tubes, particles) in order to mimic natural structures and functions. Such biohybrid materials have the advantages of combining the activity and specificity of biomolecules with the stability and precise topology of a synthetic matrix, and thus underscore conventional systems in terms of efficacy and functionality. This project aims to develop functional protein-polymer assemblies, which will serve as new types of catalytic nanocompartments providing efficient and controlled reaction space for biomolecules by combining physical chemistry, nanoscience and enzyme biochemistry. In a biomimetic approach inspired by natural organelles in living cells, we will encapsulate/insert biomolecules (proteins, enzymes) in synthetic nanocompartments to create catalytic reaction spaces with different topology and functionality. We will produce catalytic nanocompartments with “triggered activity” so that in situ reactions inside compartments are activated by opening “protein gates” inserted inside the membrane. A complementary objective is based on producing catalytic nanocompartments acting “in tandem” to support cascade reactions involving a combination of different nanocompartments. Catalytic nanocompartments, producing desired molecules “on demand” serve as simple mimics of natural organelles, whereas those acting “in tandem” mimic chemical communication between organelles. The development of enzymatic reactions in the confined spaces of supramolecular assemblies with nanometer sizes represents a response to the increasing evidence of low bioavailability and stability of directly administrated biopharmaceuticals, and the necessity to produce/detect compounds by controlled cascade reactions between different spatial assemblies in new materials with complex functionality (electronics, medicine, catalysis, food science). The understanding at the molecular level of the relationships between the factors that support successful reactions in confined spaces with different topologies represents a major benefit of this project, which aims to combine model enzymatic reactions with complementary properties resulting from different architectures of the reaction spaces (single-, and in tandem- nanocompartments) Systematic variation of the nanocompartment properties (size, thickness of the membrane, concentration of compartments), and characteristics of the biomolecules (concentration, modification with specific molecular entities, ratio between different biomolecules) will produce efficient interfacing and result in new functional hybrid assemblies. The project combines a fundamental study of the structural changes and interactions that occur when a functional bio-hybrid assembly is generated with applied investigations of the relevant factors and conditions that characterise “model” enzymatic reactions for extension

to other reactions necessary for translational applications. This will support the development of a rational design for an efficient platform of catalytic nanocompartments by optimizing the structural and functional details for each type of reaction space (single-, and in tandem- nanocompartments), and straightforward changes of biomolecule or the overall polymer assembly.

Keywords Nano-compartiments polymériques; organelles artificielles; réactions en cascade; enzymes; protéines membranaires
Financed by
Swiss National Science Foundation (SNSF)

Add publication

Published results

4634566, Zartner, Luisa; Maffeis, Viviana; Schoenenberger, Cora-Ann; Dinu, Ionel Adrian; Palivan, Cornelia G., Membrane protein channels equipped with a cleavable linker for inducing catalysis inside nanocompartments, 2050-750X ; 2050-7518, Journal of Materials Chemistry B, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4607687, Zartner, Luisa; Garni, Martina; Craciun, Ioana; Einfalt, Tomaz; Palivan, Cornelia G., How Can Giant Plasma Membrane Vesicles Serve as a Cellular Model for Controlled Transfer of Nanoparticles?, 1525-7797 ; 1526-4602, Biomacromolecules, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4600045, Zartner, Luisa; Muthwill, Moritz S.; Dinu, Ionel Adrian; Schoenenberger, Cora-Ann; Palivan, Cornelia G., The rise of bio-inspired polymer compartments responding to pathology-related signals, 2050-750X ; 2050-7518, Journal of Materials Chemistry B, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4527274, Einfalt, Tomaz; Garni, Martina; Witzigmann, Dominik; Sieber, Sandro; Baltisberger, Niklaus; Huwyler, Jörg; Meier, Wolfgang; Palivan, Cornelia, Bioinspired Molecular Factories with Architecture and In Vivo Functionalities as Cell Mimics, 2198-3844, Advanced Science, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4599261, Meyer, Claire E.; Abram, Sarah-Luise; Craciun, Ioana; Palivan, Cornelia G., Biomolecule-polymer hybrid compartments: combining the best of both worlds, 1463-9076 ; 1463-9084, Physical chemistry chemical physics, JournalItem (Kommentare, Editorials, Rezensionen, Urteilsanmerk., etc. in einer wissensch. Zeitschr.

4527299, Belluati, Andrea; Mikhalevich, Viktoria; Yorulmaz Avsar, Saziye; Daubian, Davy; Craciun, Ioana; Chami, Mohamed; Meier, Wolfgang P.; Palivan, Cornelia G., How Do the Properties of Amphiphilic Polymer Membranes Influence the Functional Insertion of Peptide Pores?, 1525-7797 ; 1526-4602, Biomacromolecules, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4527286, Yorulmaz Avsar, Saziye; Kyropoulou, Myrto; Di Leone, Stefano; Schoenenberger, Cora-Ann; Meier, Wolfgang P.; Palivan, Cornelia G., Biomolecules Turn Self-Assembling Amphiphilic Block Copolymer Platforms Into Biomimetic Interfaces, 2296-2646, Frontiers in Chemistry, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4527281, Garni, M.; Wehr, R.; Yorulmaz Avsar, S.; John, C.; Palivan, C.G.; Meier, W., Polymer membranes as templates for bio-applications ranging from artificial cells to active surfaces, 0014-3057, European polymer journal, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

4527248, Thamboo, Sagana; Najer, Adrian; Belluati, Andrea; von Planta, Claudio; Wu, Dalin; Craciun, Ioana; Meier, Wolfgang; Palivan, Cornelia G., Mimicking Cellular Signaling Pathways within Synthetic Multicompartment Vesicles with Triggered Enzyme Activity and Induced Ion Channel Recruitment,

Advanced Functional Materials, Publication: JournalArticle (Originalarbeit in einer wissenschaftlichen Zeitschrift)

Add documents

Specify cooperation partners