Design of artificial organelles by combining proteins with synthetic nanocompartments

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Abstract. New concepts that combine multifunctional compounds with stable, safe carriers or membranes are on focus in a variety of domains, such as medicine, catalysis, environmental science, and technology. Suitable amphiphilic block copolymers are ideal candidates for applications because they can self-assemble into supramolecular assemblies, such as compartments, or planar membranes with a superior stability, and robustness compared to the lipid based membranes.[1] By combining these polymeric membranes with suitable biological entities, e.g., by incorporating integral membrane proteins or by enzyme encapsulation in polymer compartments it is possible to provide well-defined functions, such as molecular recognition, cooperation, and catalytic activity.[1]

Here, we present distinct spaces for desired reactions at the nanometer scale based on protein-polymer assemblies as compartments with triggered activity that are able to function as mimics of natural organelles inside cells (Figure 1).[2] Such artificial orgenelles are generated by simultaneous insertion of biopores/membrane proteins inside the membrane of compartments, and encapsulation of active compounds (enzymes, proteins, mimics) inside. Biopores/channel proteins selectively control the exchange of substrates and products with the environment of nanocompartments, resulting in development of stimuli-responsive compartments, which preserve their architecture, while allowing specific *in situ* reactions. Upon up-take by cells, these artificial organelles preserve their integrity and start to function in the presence of the specific stimulus (pH, reductive conditions). Such artificial organelles open new avenues in various domains, as for example protein therapy or biosensing approaches.

References

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Figures

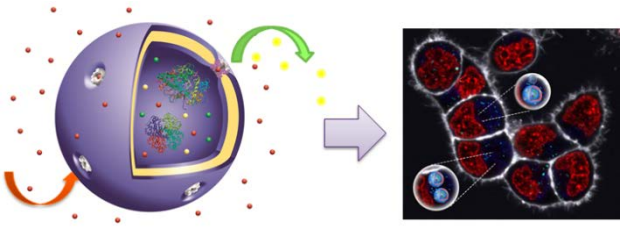

Figure 1. Concept of an artificial organelle with triggered activity inside cells based on encapsulation of a specific enzyme, and insertion in the membrane of the nanocompartment of a chemically engineered protein "gate".