Clusters of active nanocompartments as efficient nanotheranostics

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Abstract

There is a tremendous need to find new properly functional mimics of natural organelles or cells to address both early diagnostics and efficient therapeutics or to understand in more details cell behavior, if they can be made sufficiently flexible and capable. In particular, soft synthetic nanocompartments can be combined with biomolecules in order to develop artificial organelles. Here we present how DNA-directed arrangement of soft synthetic nanocompartments serves to generate super-assemblies with emergent properties, which can be loaded with biomolecules and/or imaging agents in order to develop medical applications [1]. The size and stability of the resulting DNA-linked compartment clusters have been controlled by manipulating molecular factors such as compartment membrane composition and DNA surface density [2]. These clusters can interact selectively with different cell lines, opening a new strategy to modify and expand cellular functions by attaching them on cell surfaces. To display the breadth of therapeutic applications attainable with our system, we encapsulated medically established enzymes within the inner compartment and demonstrated their activity within the clustered compartments. A step forward has been achieved when such DNA-zipped compartments were able to serve as segregated nanospaces containing therapeutic enzymes (Dopa decarboxylase, DDC) and fluorescent probes for development of nanotheranostics [3]. The diagnostic compartment provides a twofold function: tractability via dye-loading as the imaging component and the ability to attach the cluster construct to the surface of cells. The therapeutic compartment, loaded with active DDC, triggers the cellular expression of a secreted reporter enzyme via production of dopamine implicated in atherosclerosis. The architecture of the DNA-zipped clusters of nanocompartments equipped with biomolecules can be expanded by integrating Janus nanoparticles as core components to induce a specific location of the nanocompartments[4]. Such DNA-mediated clusters of soft or soft-hard components allow a large variety of medical applications by diversifying the types of utilizable active molecules.

References

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