A modular self-assembling platform for multicomponent nanobiodevices based on viral nucleoproteins

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Área temática: B. Autoensamblado

Bionanotechnology is a rapidly expanding field that aims to harness the potential of biological molecules to generate functional nanostructures capable of addressing various technological challenges. Numerous examples of structured functional supramolecular assemblies can be found in Nature. Spatial proximity of their components is essential for processes like enzymatic cascades, signal transduction and molecular recognition, highlighting the importance of precise structural arrangements in biology. Many of these examples encompass self-assembling proteins that are particularly attractive candidates for nanotechnological applications. Their inherent ability to self-organize into defined architectures renders them as suitable scaffolds to engineer nanoscale devices. However, to exploit these properties it is first necessary to understand and control the self-assembly process, ensuring reproducibility and functional integration. In this context, viral nucleoproteins from the order Mononegavirales constitute excellent candidates as building blocks for synthetic bionanodevices: multiple studies have shown that when recombinantly expressed in E. coli, these proteins assemble into ring-like nanostructures.

In this work, we present the proof of concept for a versatile self-assembling platform based on the Ebola virus nucleoprotein. The constructs, designed as ChM-NEbV-X consist of a double fusion protein involving the N-terminal chaperone fragment of Ébola's phosphoprotein (ChM), the nucleoprotein, and a cargo of interest (X). These chaperoned constructs are expressed in E. coli as soluble monomers. Upon proteolytic removal of the chaperone and addition of RNA, the monomers assemble into multivalent, multicomponent cargo-displaying ring-like particles (RLPs). Furthermore, we demonstrate the incorporation of functional binding modules such as SpyCatcher as cargoes (X), enabling covalent attachment of Spy-tagged proteins. This strategy expands the range of expression systems beyond bacterial hosts, accommodating cargos that may require alternative production platforms.

Overall, our results establish a modular and adaptable framework for generating multifunctional bionanodevices. By varying the fused cargos, this platform can be tailored for diverse applications in health, bioremediation, and detection, paving the way toward innovative solutions in nanotechnology.