CityU
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Cellular Nanoinjection for Biomedical Applications

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Yeung Kin Man Academic Building

Abstract

Programmable vertically configured nanostructures are spurring scientific and technological advances in engineered nanobio cellular interfaces [1–2]. In particular, diverse, tuneable, vertically configured nanoneedle (NN) in the form of nanowire (NW), nanostraw (NS), and nanotube (NT) arrays are now providing major advantages in precisely manipulating increasingly complex cellular processes—such as intracellular delivery, biomolecular extraction/sampling, intracellular probing of action potential, ex vivo gene editing, immunomodulation, and biosensing [3–5]. Intracellular access and bioactive cargo transport are tightly constrained to ensure healthy cell function and behaviour. Many different approaches have been developed to breach the cell plasma membrane to gain intracellular access. Intracellular delivery can be achieved by viral, chemical, and physical methods; these delivery routes typically achieve less-than-satisfactory delivery efficiency, and their functionality is often limited to specific cargo and cell types. Existing delivery technologies focus mainly on addressing a certain subset of combinations, specifically nucleic acid delivery (transfection) to certain classes of cells; this has hampered progress and versatility toward next-generation ex vivo cell-based therapies. For example, cellular immunotherapy (CAR-T cells), and stem cell technologies, require delivery of genome-editing systems into diverse cell types with minimal invasiveness and perturbation, and function in diverse scenarios, from fundamental to biomedical (a major limitation). The talk will cover the development of engineering novel NN designs and fabrication paradigms—a transformative shift, allowing precise control of ex-vivo cellular processes, in particular the ability to deliver gene-editing tools via cellular nanoinjection, bringing deep understanding of the fundamental mechanisms at the interface of nanoscale engineering and cellular interrogation.

REFERENCES: [1] Chiappini C*., et al., Elnathan R*., Nature Protocol 2021, 16, 4539; [2] Elnathan R*. et al., , Chiappini C* Nature Nanotechnology, 2022, 17, 807; [3] Hao Zhe Yoh., N.H. Voelcker*, R. Elnathan* Advanced Functional Materials, 2022, 32, 2104828; [3] Elnathan R*., et al., Chiappini C*., Nature Reviews Materials 2022, 7, 953 [4] Chen Y., N.H. Voelcker*, Elnathan R*., Advanced Materials 2023, 35 (44), 2304122; [5] Chen Y., et al., Elnathan R*., N.H. Voelcker*, Materials Today, 2023, 63,8.

Biography

A/Prof Roey Elnathan received his PhD in chemistry from the Centre for Nanoscience and Nanotechnology and the School of Chemistry at Tel Aviv University in 2012. He was a Research Fellow in the University of South Australia (2012–2015) and a Foundation Fellow in nanobiotechnology (2015–2017). In 2017, he moved to Monash University in Melbourne and won the Australian Research Council DECRA Fellowship. In 2022, he moved to Deakin University (Melbourne) and won the Australian Research Council Future Fellowship.