Introduction

The therapeutic bionanoscience interface

Juan Andres Melendez

SUNY Polytechnic Institute, Albany, NY 12203, USA
Corresponding author: Juan Andres Melendez. Email: jmelendez@sunypoly.edu

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The National Nanotechnology Initiative (NNI) in 2000 led to unprecedented advances in the development of nanomaterials, nanodevices, nanoparticles, and nanotherapeutics that have impacted the lives of individuals worldwide. Twenty years have passed and the investment in nanotechnology has proven to be a wise strategy as the success of the COVID-19 vaccines was reliant on the use of nanoparticles to preserve the RNA information that the immune system would use to combat the pandemic virus. In terms of economic development, "The global Healthcare Nanotechnology market size was USD 194 billion, and it is expected to reach USD 372 billion by the end of 2026, with a CAGR of 9.6% during 2021-2026" (*Market Watch*, 15 October 2022, Healthcare Nanotechnology Market Size and In-Depth Research Report During 2022-2026 | Business Growth, Trend, Segmentation, Top Key Players, Revenue and Industry Expansion Strategies).

In this thematic issue, there are six mini-reviews and two original research articles targeting, toxicology,[1] pathogen and exosome detection,[2,3] spinal cord injury,[4] tissue scaffolds,[5] molecular barcoding,[6] RNA biology,[7] and bio-hybrid electronic devices[8] that bridge biology with nanotechnology and the bionanoscience interface.

In the area of nanotoxicology, Huber and Cerreta[1] demonstrate how inhaled nanoparticles exert their toxicological effect using a well-established model for lung diseases, Golden Syrian Hamsters. Exposure to molybdenum oxide nanoparticles that are commonly used as additives in a variety of industrial applications damages the lung by interfering with autophagy, activating inflammasome leading to lung inflammation, damage, and toxicity.

For pathogen detection, Taubner *et al.*[2] have developed a nano-enabled biosensor using grating-coupled fluorescent plasmonic-based (GC-FP) detection of SARS-CoV-2 antigens and antibodies. GC-FP can detect a diverse set of SARS-CoV-2 antigens and circulating antibodies from minute (finger prick) quantities of dried patient blood samples. This assay system is capable of co-detecting antigens and antibodies in 1 h in a combined test and can provide additional clinical information in a single test.

Hsu and Wu[3] review nano-enabled biosensors for the detection of cancer exosomes from liquid biopsies. Recent advances in nano-enabled biosensors that can detect cancer-specific exosomal RNAs and proteins will aid in cancer screening, diagnosis, and prognosis. The manuscript discusses the latest advances in exosome detection and the challenges when using complex liquid biopsy samples.

In the field of spinal cord injury (SCI), Paredes-Espinosa and Paluh[4] highlight advances and challenges at the forefront of neuronal circuitry restoration. The authors describe the complexity of the SCI microenvironment and discuss stem cell–based restorative therapeutics, transplantable materials, and electro-stimulated scaffolds that will drive advances in stem cell–based SCI therapeutics in the next decade. Xie *et al.*[5] review the use of alginate microfibers for therapeutic use and as tissue scaffolds. This timely review discusses current state-of-the-art systems for the development and use of alginate microfibers in three-dimensional cell culture, cell delivery, and tissue engineering systems.

The review by Lee *et al.*[7] introduces the idea of epitranscriptomic control of the senescence program and details not only the many factors that drive senescence but also how nanoscale RNA modifications control this process. The manuscript is focused on how the transfer RNA (tRNA) methylating enzyme, Alkbh8, regulates selenocysteine utilization and selenoprotein synthesis to limit senescence. The role of other RNA-modifying enzymes and their potential impact on senescence and the aging process are discussed.

Fasullo and Dolan[6] describe advances in molecular barcoding for use in taxonomy and species identification, signature-tagged mutagenesis, cancer lineage studies, developmental studies, and viral genome sequencing. Of particular interest to the authors is the use of barcoding to identify tolerance genes that confer toxicant resistance. This technology opens the horizon for mapping the fate of individual cells in complex organisms and for identifying mutations driving cancer in a heterogeneous mixture of cells.

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The thematic issue is anchored by a discussion of the challenges and advances in developing bio-hybrid devices that combine electronic and photonics with cells, tissue, and organs.[8] The review captures the many nuances in coupling inorganic devices to organic living systems. The development of bio-hybrid electronic and photonic devices is crucial for improving health outcomes and health monitoring, and the implementation of real-time sensor technologies that detect early interventional disease markers is critically needed.

This exciting thematic issue coincides with the presidential signing of the $52 billion CHIPS and Science Act which will "quickly increase production of semiconductors, strengthen research and design leadership, and grow a diverse semiconductor workforce to give the country a competitive edge on the world stage" (The White House FACT SHEET: President Biden Signs Executive Order to Implement the CHIPS and Science Act of 2022). The nanotechnological advances that place billions of transistors on a postage stamp size substrate are key to advances in bionanoscience. The CHIPS act will facilitate expansion in many areas of semiconductor research and also lead to advances that bridge the bionanoscience interface.

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ORCID ID

Juan Andres Melendez https://orcid.org/0000-0001-8021-3097

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