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THE EMERGING FUTURE AT THE NEXUS OF NANOTECHNOLOGY AND BIOMEDICINE: AN INTRODUCTION TO *NANO LIFE*

Today, great challenges abound in both biomedical research and healthcare delivery in many critical areas. Some of these challenges can and will be best addressed by application of principles and techniques of nanoscience and nanotechnology. At the nanoscale, versatile and multifunctional systems can now be designed and assembled for specific biomedical applications. For instance, it is now possible to deliver gene-based molecules and drugs via nanocarriers that target precise structures on the cell membrane. Great challenges lie in the further development of these systems by endowing them with multimodal capabilities for sensing, actuating, regulating, and signaling the biological responses in order to precisely control outcomes at the cellular and molecular levels. Many of the critical issues deal with increasing our understanding of how to create life-friendly nanosystems that interact seamlessly with biological systems.

One very active research area involves the development of functional nanoparticles for cancer diagnosis and treatment. A variety of nanomaterials have been developed for these biomedical applications, including colloid gold, silica nanoparticles, quantum dots, magnetic nanoparticles, and functional polymers. In the vast majority of cases, however, the nanomaterials are exploited on a very limited basis based on singular intrinsic properties, be it magnetic, fluorescent, or thermal. Yet, the complexity of biological systems demands more sophisticated tools that can function in a controlled, adaptable, and predictable manner. Design and development of these futuristic multifunctional "intelligent" nanodevices will no doubt usher in a new wave of biological system manipulation and medical diagnosis. This multifunctionality will be based on the structural integration of several nanospecies with unique properties including quantum dots for *in vivo* imaging, magnetic nanocomposites for hyperthermia and separation, nanotube capsules for drug storage, and reversible surface functional groups for biochemical conjugation and release. These combined components begin to provide some of the additional functionalities needed for better biological system manipulation and medical diagnosis. The "intelligent" nanosystem integrates functionalities and performs controlled actions such as time-controlled drug release, signaling to sensing device, recognizing a specific cell, and monitoring the concentration level of a particular biological species. The development of multifunctional nanoparticles requires advances in engineering design of nanostructures and systems and biochemical tuning of the intelligent responses-capabilities that can only be provided by true interdisciplinary teams expert in materials synthesis, nanostructure architecture, surface engineering, biochemical manipulation, and biomedical system integration.

Furthermore, many critical issues involved with regeneration or repair of tissues must be addressed before medical applications see the light of day. These include bioactivity, compatibility, toxicity, and chemo-mechanical properties of all types of nanoscale materials. We are still in our infant years when it comes to designing synthetic and biohybrid materials that can interface and replace natural structures in directing developmental biology processes. Although many investigators have attempted to build bone, liver, arteries, bladder, pancreas, nerves, cartilage, heart valves, cornea, and various soft tissues, the vast majority of techniques have involved macroscopic bulk fabrication strategies rather than the "brick-by-brick" approach. A major challenge for the future of tissue engineering and regenerative medicine involves how subcellular structures and materials dictate cell function, growth, and development. For very complex tissues,

we need to understand how to fabricate organ-scale structures with at least microscale resolution.

With this inaugural issue, we are pleased to introduce a new peer-reviewed journal, *Nano LIFE*, that aims to publish the most cutting-edge and original research results in both the nanotechnology and biomedical sciences. *Nano LIFE* will begin as a quarterly international journal and rapidly grow to publish bimonthly and monthly editions. The journal will emphasize contributions that feature originality, societal significance, and the interdisciplinary aspects of nanotechnology and the life sciences. *Nano LIFE* will also provide news features and commentaries on critical issues in nanomedicine that impact both the scientific community and the general public. This journal will speak to researchers in a broad spectrum disciplines including materials, chemical, biological and medical sciences, and engineering. It will also highlight breaking trends in these fields, and hopefully cultivate a new integrated community with shared interests in frontier research and higher education.

The inaugural issue of *Nano LIFE* includes review articles authored by authorities in both the nano and biomedical sciences, and original research results that address critical challenges in nanoscience and biomedicine. *Nano LIFE* will be divided into two major thrusts: (1) basic nanoscience and nanoengineering and (2) application of nanoscience and nanoengineering to biomedical systems. We aim to publish frontier research results covering but not limited to the following basic and applied topics:

Nanoscience and Nanoengineering

- Nanostructures and their unique properties
- Fluorescent nanomaterials
- Magnetic nanomaterials
- Smart nanomaterials for sensors and transducers
- Quantum dots
- Novel nanodevices
- Integrated multifunctional nanoparticles
- Understanding biological responses to implanted or injected materials
- Computer simulation of nanostructures
- Nanomechanics
- Nanosurface and interface structures
- Nanosurface modifications
- Nanosurface chemistry
- Intelligent nanobehaviors
- Nanogenerators
- Nanoself-assembly
- Modeling of microscale and nanoscale transport phenomena and processes
- Engineering and design of microfluidic and nanofluidic lab-on-a-chip devices

Nanobiomedicine

- Scintillation crystal materials for medical PET imaging devices
- Multimodal imaging
- Intelligent nanoscale contrast agents for imaging and treatment
- Early cancer diagnosis and treatment
- Molecular diagnostics and disease pathology
- Drug, gene, and protein targeting and delivery
- Nanopharmaceuticals
- Pharmacology and toxicology of nanoparticles
- Using biomolecular building blocks to create novel materials and devices
- Mechanics of biological and bioinspired nanomaterials
- Using nanomaterials to probe, alter, and control biological responses
- Understanding biological responses to nanomaterials
- Biosurfaces, biointerfaces, and biosensors
- Nanopatterning of biomolecules on surfaces
- Nanostructures and novel devices for biological and chemical detection
- Integrated nanosensors
- Nanoscale magnetic nanoparticles
- Mechanics of biological and bioinspired nanomaterials
- Luminescent nanomaterials
- Magnetic nanomaterials for hyperthermia applications
- Smart nanomaterials for sensors and transducers
- Quantum dots/nanocrystals in biolabeling and marking
- Scintillation crystal materials for medical PET imaging devices
- Cellular and molecular dynamics
- Modeling and simulation of molecular biological systems
- Cellular transport
- Protein–protein interactions
- Molecular and supramolecular hybrid biostructures
- Genomics and proteomics applications

- Miniaturized devices for biology, chemistry, and medicine
- Point-of-care and global health applications
- Pharmaceutical and environmental toxicological applications
- Biological fuel cells and bionics
- Nanobiomaterials for information processing and information storage

Paper contributions in the following categories will be considered for publication

- Research papers: Reports of original scientific research, techniques and applications.
- Brief communications: Urgent announcements of important advances or preliminary accounts of new work, with the most important criteria for acceptance being novelty, significance, and timeliness.
- Topical reviews: Compositions summarizing accepted practice and reporting recent progress in selected areas; generally commissioned by the Editorial Board.

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