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Protein Nanotechnology

Protocols, Instrumentation, and Applications

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Preface

Protein Nanotechnology: Protocols, Instrumentation, and Applications is intended to serve as an authoritative reference for a broad audience involved in nanotechnology research and in the teaching, learning, and practice of nano-technology for genomics, proteomics, bioengineering, and medicine. Recently, nanotechnology—which involves research on and the development of materials and species at the length scales of 1 to 100 nm—has been revolutionizing many important scientific fields, ranging from biology to medicine. This is technology on the scale of molecules, and it has the potential of developing devices smaller and more efficient than anything currently available. To understand complex biological nanosystems at the cellular level, we urgently need to develop a next-generation nanotechnology tool kit. It is believed that the new advances in genetic engineering, genomics, proteomics, medicine, and biotechnology will depend on our mastering nanotechnology in the coming decades. The combination of nanotechnology, materials sciences, and molecular biology opens the possibility of detecting and manipulating atoms and molecules using nanodevices, which have many potential applications across a wide variety of biological research topics, as well as medical uses at the cellular level.

Today, the amount of research in biomedical sciences and engineering at the molecular level is growing exponentially because of the availability of these new investigative nanotools. They are capable of probing the nanometer world and will make it possible to characterize the chemical and mechanical properties of cells, discover novel phenomena and processes, and provide researchers with a wide range of tools, materials, devices, and systems with unique characteristics.

With the completion of the sequencing of the human genome, one of the greatest impacts of proteomics is the establishment of an entirely new approach to biological and medical research. Proteins are major cellular components that play an essential role in maintaining the proper functioning of the cell. Nanotechnology promises to provide the tools for studying how the tens of thousands of proteins in a cell (the so-called proteome) work together in networks to orchestrate the chemistry of life. Specific genes and proteins have been linked to numerous diseases and disorders, including breast cancer, muscle disease, deafness, and blindness. Protein misfolding processes are believed to cause such diseases as Alzheimer's, cystic fibrosis, "mad cow" disease, an inherited form of emphysema, and even many cancers. Nanotech-

nology also has the potential to dramatically change the field of diagnostics, therapy, and drug discovery in the postgenomic area. The combination of nanotechnology and optical molecular probes are being developed to identify the molecular alterations that distinguish a diseased cell from a normal cell. Such technologies will ultimately aid in characterizing and predicting the pathologic behavior of diseased cells, as well as the responsiveness of cells to drug treatment.

The combination of biology and nanotechnology has already led to a new generation of devices for probing the cell machinery and elucidating molecular-level life processes heretofore invisible to human inquiry. Tracking biochemical processes within intracellular environments can now be performed in vivo with the use of fluorescent molecular probes and nanosensors. With powerful microscopic tools using near-field optics, scientists are now able to explore the biochemical processes and submicroscopic structures of living cells at unprecedented resolutions. It is now possible to develop nanocarriers for targeted delivery of drugs that have their outer surfaces conjugated with antibodies for targeting antigens and fluorescent chromophores for in vivo, intracellular tracking.

This volume presents the most recent scientific and technological advances of nanobiotechnology, as well as practical methods and applications, in a single source. Included are a wide variety of important topics related to protein nanotechnology. Each chapter provides introductory material with an overview of the topic of interest; a description of methods, protocols, instrumentation, and applications; and a collection of published data with an extensive list of references for further details.

The goal of *Protein Nanotechnology: Protocols, Instrumentation, and Applications* is to provide a comprehensive overview of the most recent advances in instrumentation, methods, and applications in areas of nanotechnology related to genomics and proteomics, integrating interdisciplinary research and development of interest to scientists, engineers, manufacturers, teachers, and students.

Tuan Vo-Dinh

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