Nanotechnology and Bioinformatics

Nanotechnology in Biology and Medicine: Methods, Devices, and Applications

Edited by *Tuan Vo-Dinh*.

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Nanotechnology is the fascinating and rapidly developing field of the conception, study, manipulation, and use of nanometer-scale entities for the benefit of modern society. By its nature, nanoscience is at the intersection of such fields as biology, physics, chemistry, molecular biology, and engineering; therefore, it is highly interdisciplinary and revolutionary. The impact of nanotechnology is already proving to be widespread, influencing the fields of engineering, electronics, microfluidics, micro-electromechanical systems (MEMS), biomedical sciences, medicine, biotechnology, materials science, optoelectronics, pharmaceuticals, and cosmetics, just to name a few. The fundamental benefits of nanotechnology and nanomanufacturing may be best signified by the choice that nature makes: it opts for construction at the nanometer scale as the platform for the assembly of biological components over either the subatomic or macroscopic scales. This may be due to the inherent energetic and material benefits of fabrication and assembly at the nanometer level. Moreover, all of the essential building blocks, sensing systems, and response tools of biological entities are at the nanoscale. Hence, to interact with, manipulate, and harness the potential benefits of these biological molecules, our tools and devices need to be at the nanoscale as well.

Nanotechnology and nanomedicine, via miniaturization, offer ultra-sensitive, integrated, and rapid bio-detection devices that occupy minimal space and use minimal energy and materials. As predicted by M. Roco of the National Science Foundation, the products of nanotechnology will reach $1 trillion per year within the next 10 years, and about half of the total pharmaceutical production will rely on nanotechnology. Although the biggest initial impacts of nanotechnology will be felt in the fields of materials science, electronics, and chemical processing, eventually nanotechnology and nano-bioscience will be indispensable tools for the realization of personalized medicine through developments in nanomedicine. Firm evidence for these recent forecasts is the latest use of nanotechnology in such fields as biosensors, integrated medical devices, medical diagnostics, high-throughput screening and drug delivery, as well as the emergence of several nanomaterial-based therapies that have been approved for clinical use. Nanotechnology not only holds great potential for the development of novel diagnostic and therapeutic devices and machines at what is currently perceived as a "futuristic" level for biomedical applications, but also promises novel solutions to global issues such as energy generation and use, environmental pollution control, and food and water safety. Nanomaterials also hold great promise for the development of consumer products with very attractive properties, among many other areas that affect daily life.

This book represents one of the best collections of the most recent nanotechnological advances and their applications in biology, medical diagnostics, and therapy. There are currently very few books in which nano-biotechnology or nanomedicine is the topic, and in my opinion this book is a very welcome addition to the field. The editor, who is an authoritative expert in the field of nano-biotechnology, has attempted to cover a wide range of topics in nano-bioscience and nanotechnology, but due to the intrinsically wide-ranging, multidisciplinary nature and fast developmental pace of nanotechnology itself, the book is not an all-inclusive reference book such as Nanomedicine by R. A. Freitas, Jr.,[1] yet it is a very good collection of thought-stimulating recent research topics.

Nanotechnology in Biology and Medicine is structured into two major sections with very clear organization and layout: in the first section, the editor presents examples of the basic building blocks and tools of nano-biotechnology along with their conceptualization methods. In the second section, numerous excellent examples of recent biological and medical applications of the concepts discussed in the first section are given. The contents of the first section include bio-inspired or biomimetic materials, polymers, quantum dots and nanoparticles, electrical nanosensing techniques such as functionalized silicon nanowires, carbon nanotubes, nanopore sensing, optical single-molecule imaging and analysis, and hybrid devices. Some of the topics of the second section involve specific examples of biomedical applications of nano-biosensors from the classes of optical, electrical, and MEMS, single-molecule analysis using atomic force microscopy (AFM), surface-enhanced Raman scattering (SERS) and surface plasmon resonance (SPR), environmentally responsive smart nanostructures, interfacing of nanodevices with cells, nanostructured polymeric materials, and bioconjugated nanoparticles. Examples of medical applications include drug delivery, anticancer drug therapy and its monitoring, detection of infectious disease agents, adult stem cell research, synthetic biology, and magnetic and nonmagnetic nanoparticle-based contrast agents for medical diagnostics. The book is very easy to read, and the technical language

does not obstruct the understanding of the concept under discussion. With its detailed table of contents and index the book makes it easy to locate information. The contributing authors have done a very good job of balancing detail and demonstrating the concepts in a straightforward manner. Each chapter of the major sections is written by authoritative experts in their respective fields contains an introduction to the subject, an experimental design and methods section, followed by results and conclusions. Although the chapters are designed with the outline of a research paper, which makes them easy to follow owing to a layout familiar to scientists, the chapters are not mere replications or aggregations of collected research papers, which is a big plus for the book. Numerous figures and illustrations both in color and grayscale are provided, and the seemingly intended lack of experimental detail is compensated by citations of prior work to obtain further information if the reader desires.

The topics included are comprehensive, timely, and are explained well. The book is one of the best assemblies of information on recent advances in biomedical nanotechnology and its wide-ranging application in biology and medicine. I believe this book is indispensable not only to all those working in nanosciences and engineering, but also for those who are involved in life sciences and medical research and development, and who would like to get an idea about the promises of nanotechnology for their field. This book will also be of great interest to undergraduate and graduate students in such subdisciplines of engineering as biomedical, materials, electrical and optoelectronics, as well as those studying experimental biology, basic and applied medical sciences, and biotechnology. This would therefore be a handy reference book for educators in nanotechnologies.

In conclusion, this book gives a broad overview with specific examples of nano-biotechnology and applied nanomedical research while providing clear scientific and engineering principles of nanotechnology in the areas covered. It can therefore be recommended as a reference book for experts in experimental nano-bioscience and as an excellent introductory book for new recruits into the field of nano-biotechnology.

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[1] R. A. Freitas, *Nanomedicine (Vol. IIA)*, Landes Bioscience, Austin, **2003**..

Bioinformatics—From Genomes to Therapies

Edited by *Thomas Lengauer*.

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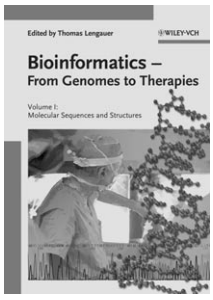

This work is an encyclopedic three-volume set focused on all things bioinformatic. The work is very well edited and compiled by Thomas Lengauer with contributions from distinguished scientists from all over the world who use bioinformatics tools and techniques in their research. An exhaustive review of the work would not do it justice. The three volumes are intuitively organized as follows:

Volume 1 covers the basics of protein and nucleic acid sequence along with sequence analysis, alignment, protein secondary structure prediction and homology modeling.

Volume 2 covers interactions from hormone–receptor to drug–enzyme, as well as DNA microarray techniques (clinical microarray included), molecular docking (structure-based drug design), gene classification, and proteomics.

Volume 3 covers the relation of protein sequence and structure to function. Protein function prediction, genomics, evolution of drug resistance, database integration (biodatabases), and even biological data visualization techniques are covered. Volume 3 has a cumulative index covering content in all three volumes of the set. The reader will find this index to be very helpful.

Each volume is subdivided into "parts" composed of chapters, each with their own bibliography. Each part addresses a specific area of bioinformatics research. For example, Part 4 of Volume 1 addresses the area of structure prediction. This part is composed of two chapters: Predicting Simplified Features of Protein Structure; Homology Modeling in Biology and Medicine. The first chapter provides a smooth introduction to the aspects of predicting protein secondary structure. This chapter gives a history of the techniques, their evolution, and has clear, concise figures describing their accuracy (comparison analysis). In addition, information about online resources is given in a table. An excellent discussion describing the problems with predicting and modeling transmembrane regions of proteins is a nice example of the many challenges in structural bioinformatics today.

The homology modeling chapter has an introduction into the basics of the techniques: template-based, side-chain modeling, and loop prediction, to name a few. The chapter provides a list of online resources and brief descriptions of the currently available homology modeling programs (such as Modeller and MolIDE). However, the author of this chapter spent too much time discussing his own homology modeling software package, and the list of software covered neglects to mention the popular Genemine/Look software package. The Jackal suite of homology modeling tools developed at Columbia University was also absent in this discussion. The author's homology modeling software package is an excellent tool, and the tutorial illustration is appreciated in this context. Nevertheless, a more balanced assessment of the available homology modeling tools would have been a better approach in this reviewer's opinion.

The topics listed above are only a sample of what is available in each volume. Each chapter is a full-blown minireview of the subtopic covered. The chapters are well documented and intelligently written. In fact, the volume parts

