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NANOSCIENCE AND NANOTECHNOLOGY

（影印版）

Therapeutic Micro/Nano Technology

面向医学治疗的微纳米技术

〔加〕Tejal Desai
〔美〕Sangeeta Bhatia

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内 容 简 介

本书讨论了正在兴起的治疗性微米和纳米技术领域。本书所覆盖的主题包括:基于细胞的治疗技术,再生医学——细胞与微米和纳米系统整合(融合),MEMS与细胞和组织的集成;药物的传递-用于血管内药物靶向传递的纳米粒子和非血管系统的药物传递系统(植入性的、口服的、吸入性的);用于生物界面的分子表面工程,生物分子图案化和细胞图案化。

本书可供从事纳米科技、材料科学、生物化学和医学的科研人员,高等院校研究生、教学人员参考。

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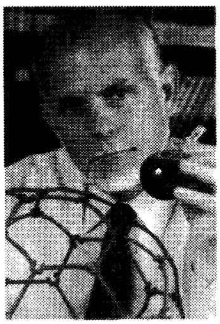
Dedicated to Richard Smalley (1943–2005), in Memoriam



To Rick,

father founder of nanotechnology
prime inspiration for its applications to medicine
gracious mentor to its researchers
our light—forever in the trenches with us

(Rick Smalley received the 1996 Chemistry Nobel Prize
for the co-discovery of carbon-60 buckeyballs)

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Foreword

Less than twenty years ago photolithography and medicine were total strangers to one another. They had not yet met, and not even looking each other up in the classifieds. And then, nucleic acid chips, microfluidics and microarrays entered the scene, and rapidly these strangers became indispensable partners in biomedicine.

As recently as ten years ago the notion of applying nanotechnology to the fight against disease was dominantly the province of the fiction writers. Thoughts of nanoparticle-vehicled delivery of therapeuticals to diseased sites were an exercise in scientific solitude, and grounds for questioning one's ability to think "like an established scientist". And today we have nanoparticulate paclitaxel as the prime option against metastatic breast cancer, proteomic profiling diagnostic tools based on target surface nanotexturing, nanoparticle contrast agents for all radiological modalities, nanotechnologies embedded in high-distribution laboratory equipment, and no less than 152 novel nanomedical entities in the regulatory pipeline in the US alone.

This is a transforming impact, by any measure, with clear evidence of further acceleration, supported by very vigorous investments by the public and private sectors throughout the world. Even joining the dots in a most conservative, linear fashion, it is easy to envision scenarios of personalized medicine such as the following:

- patient-specific prevention supplanting gross, faceless intervention strategies;
- early detection protocols identifying signs of developing disease at the time when the disease is most easily subdued;
- personally tailored intervention strategies that are so routinely and inexpensively realized, that access to them can be secured by everyone;
- technologies allowing for long lives in the company of disease, as good neighbors, without impairment of the quality of life itself.

These visions will become reality. The contributions from the worlds of small-scale technologies are required to realize them. Invaluable progress towards them was recorded by the very scientists that have joined forces to accomplish the effort presented in this 4-volume collection. It has been a great privilege for me to be at their service, and at the service of the readership, in aiding with its assembly. May I take this opportunity to express my gratitude to all of the contributing Chapter Authors, for their inspired and thorough work. For many of them, writing about the history of their specialty fields of *BioMEMS and Biomedical Nanotechnology* has really been reporting about their personal, individual adventures through scientific discovery and innovation—a sort of family album, with equations, diagrams, bibliographies and charts replacing Holiday pictures....

It has been a particular privilege to work with our Volume Editors: Sangeeta Bhatia, Rashid Bashir, Tejal Desai, Michael Heller, Abraham Lee, Jim Lee, Mihri Ozkan, and Steve Werely. They have been nothing short of outstanding in their dedication, scientific vision, and generosity. My gratitude goes to our Publisher, and in particular to Greg Franklin for his constant support and leadership, and to Angela De Pina for her assistance.

Most importantly, I wish to express my public gratitude in these pages to Paola, for her leadership, professional assistance throughout this effort, her support and her patience. To her, and our children Giacomo, Chiara, Kim, Ilaria and Federica, I dedicate my contribution to BioMEMS and Biomedical Nanotechnology.

With my very best wishes

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Preface

The human body is composed of structures organized in a hierarchical fashion: from biomolecules assembled into polymers, to multimeric assemblies such as cellular organelles, to individual cells, to tissues, to organ systems working together in health and disease- each dominated by a characteristic length scale. Decades of science and engineering are now converging to provide tools that enable the orderly manipulation of biological systems at previously inaccessible, though critically important, length scales (<100 microns). Thus, the approaches described in this volume provide a snapshot of how micro- and nanotechnologies can enable the investigation, prevention, and treatment of human disease.

The volume is divided into three parts. The first part, *Cell-based therapeutics*; covers the merger of cells with micro- and nanosystems for applications in regenerative medicine spanning the development of novel nanobiomaterials, methods of tissue assembly with control over tissue microarchitecture, and methods to specify patterns of protein distribution that vary on the micro- and nanoscale for application in tissue regeneration (A), and therapeutic applications of integrating MEMS with cells and tissues including label-free microfluidic sorting of cells based on their function, using living cell arrays as biosensors, and micron-scale devices for surgical applications (B). The second part, *Drug Delivery*; covers intravascular delivery of nanoparticles such as semiconductor quantum dots and metal nanoshells in the context of vascular specialization or 'zip codes' (A) as well as non-vascular modes of delivery including implantation, oral, and inhalation using both encapsulated drugs as well as living cells that produce therapeutic products (B). Finally, the third part, *Molecular Surface Engineering for the Biological Interface*; covers platforms that provide enabling tools for fundamental investigations of cells in culture as they interact with biomolecular structures such as responsive biomaterials and lipid bilayers (A) as well as micropatterned adhesive and fluidic environments (B).

We would like to thank the contributing authors, our co-editors in this exciting compilation of volumes, and Dr. Mauro Ferrari for his tireless efforts to lead this endeavor. We hope the collected works will provide an excellent reference for an audience with a diversity of background and interests including industry, students, academic researchers, policy-makers, and enthusiasts.

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