Micro/Nano Technology Systems for Biomedical Applications: Microfluidics, Optics, and Surface Chemistry

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In daily life, we are accustomed to working with length scales of feet or meters, but the building blocks from which our bodies are constructed are many orders of magnitude smaller. The technologies that are being developed to intervene at these minute scales have the potential to improve human health and significantly enrich our lives.

Revolutionary micro/nano technology platforms have led to dramatic advances in sample preparation, analysis and cell culture. From the 1990s through to the very beginning of the twenty-first century, the focus was on the development of manufacturing technologies. Through elegant design and sophisticated fabrication, the micro- to nano-scale manipulation of fluids and particles has become routine. Since then, it has become possible to control molecular interactions at device surfaces, and optical manipulation, imaging and sensing techniques can also be incorporated. Micro/nano technology platforms are already being used to study and direct biological processes at the cellular and sub-cellular level, and to detect disease with greater sensitivity and specificity. The challenges and excitement in the near future will be in engineering these sophisticated, multifunctional devices to seamlessly interface with complex biological systems.

Providing a clear guide that moves from molecules through devices to systems, this book reviews fundamental aspects of microfluidic devices, including fabrication, surface property control, pressure-driven and electrokinetic flow, and functions such as fluid mixing, particle sorting and molecular separations. The integration of optical and plasmonic imaging, optoelectronic tweezers for single particle manipulation, and optical and electrical signal transduction methods for biosensing are shown to provide extraordinary capabilities for bioanalytical and biomedical applications. These represent key areas of research that will lead to the next generation of micro/nano-based systems. Anyone working in this fast-changing field will benefit from this comprehensive review of the latest thinking, while researchers will find much to inspire and direct their work.

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