Biomaterials for Clinical Applications
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Preface

The field of biomaterials science currently faces an unprecedented opportunity to improve and save the lives of millions worldwide. A unique integration of chemistry, biology, engineering, and medicine, biomaterials science brings novel materials to bear on medical problems. The past few years have witnessed an explosion in the field of biomaterials, with an expansion of both the compositions and the applications of medical implant materials. While traditional biomaterials have been designed from polymers, ceramics, and metals, the newest generation of biomaterials incorporates biomolecules, therapeutic drugs, and living cells. At the same time that biomaterials science is advancing in the laboratory, the incidence of serious diseases is rising in the global community. The increasing proportion of older people in the global population is contributing to the increase of age-associated chronic diseases, including heart disease and cancer. Infectious diseases also represent a significant burden to global health; mortality from HIV/AIDS, tuberculosis, and infectious gastrointestinal diseases remains high. Physicians and biomedical researchers must be ready to address growing healthcare needs in every part of the world. Innovative biomedical materials will only reach the clinic if these technologies solve pressing clinical problems.

Biomaterials scientists who wish to impact global health must first understand where the most urgent clinical needs lie. Translation of innovative technologies into clinical usage will require close collaboration between physicians and biomaterials scientists, so that scientists can address unmet clinical needs and physicians can appreciate novel technologies. The present volume aspires to bridge the gap between the laboratory and the clinic, by identifying needs for biomedical materials in the context of the most prevalent diseases worldwide. The book is organized according to the World Health Organization’s report of the top 10 causes of death worldwide and lays out opportunities for both biomaterials scientists and physicians to tackle each of these leading contributors to mortality. The introductory chapter discusses the global burden of disease. Each of the subsequent 10 chapters focuses on a specific disease process, beginning with the leading cause of death worldwide, cardiovascular disease. Every chapter begins by describing the underlying pathology of the disease and then discusses prospective research areas for novel biomaterials to modify the disease process. Diseases addressed in the book include coronary
artery disease, HIV/AIDS, pneumonia, cancer, stroke, and gastrointestinal disease, as well as traumatic injuries. The book also covers a wide range of technologies necessary to defeat these diseases, including imaging agents, drug delivery platforms, biosensors, tissue engineered constructs, antimicrobials, and vaccines.

Several excellent biomaterials books describe novel technologies in biomedical materials and proceed to envision potential applications for such technologies. The present volume is not intended to replace those books. Rather, this book aims to provide a complementary perspective to the existing biomaterials literature; while other books take a technology-centered approach to biomaterials, this book takes a disease-centered approach. The book addresses the question, “Where are clinical needs most urgent, and how can biomaterials be designed to meet those needs?” The book provides detailed descriptions of relevant disease pathologies, both to provide necessary background for biomaterials development and to inspire new innovations in medical technology. This perspective may provide useful insights for biomaterials scientists and engineers, as well as physicians and surgeons who utilize emerging biomedical materials technologies in their clinical practice. Such an approach can aid researchers and administrators in allocating resources and setting research priorities, to ensure that biomaterials advances and new technologies actually fulfill an unmet clinical need. In addition, the disease-centered approach is valuable for science and engineering education, as it conveys to students the excitement and relevance of materials science to solving the world’s most pressing healthcare problems. Finally, this approach enables scientists and engineers to converse knowledgeably with clinicians regarding disease processes and technological solutions.

It is indeed an exciting time to work in the field of biomaterials science. The emerging class of biomedical materials, including surface-modified biomaterials, smart biomaterials, bioactive biomaterials, and tissue engineered materials, will have improved properties of biocompatibility, tunability, and biological functionality. This book advocates for disease-oriented biomaterials research, so that emerging technologies can be most effectively deployed from “bench to bedside” to defeat existing diseases. If appropriately designed, innovative new biomedical materials will have the capacity to lower morbidity and mortality, lessen suffering, and improve the quality of life for patients worldwide. The global imperative for novel biomedical materials is clear, now more than ever.
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