Dedication

To my wife Cynthia and my children Ti, Michaela, and Victoria
—Cato T. Laurencin

To my wife Hua and my children Richard and Suri, with much love and thanks
—Tao Jiang
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Foreword

We are truly delighted to write the foreword for Bone Graft Substitutes and Bone Regenerative Engineering. Edited by Professor Cato Laurencin and Professor Tao Jiang, the book exemplifies the use of Convergence in the design of new technologies for bone repair and regeneration. Over the past several decades, bone grafting has been a common task for orthopedic surgeons and each year millions of patients receive bone grafts worldwide. As the first generation bone grafting products, autologous bone grafts have been considered the gold standard; however, these grafts are severely limited by supply. Since the late 1980s, Dr. Laurencin and others pioneered a new area of research called bone tissue engineering (BTE). BTE has gradually emerged as a promising alternative to bone autografts in treatment scenarios. As such, several engineered products such as MicroFuse® have been inspired by technologies that originated in Dr. Laurencin’s laboratory. Nevertheless, various challenges in bone tissue engineering still exist, such as the need for advanced biomaterials, appropriate and reliable cell sources, and a thorough understanding of regenerative biology and tissue morphogenesis as new technologies influencing regeneration. Therefore, many believe that Regenerative Engineering, a new field described by Dr. Laurencin with a focus on Convergence integrating biology, biomedical science, physics and engineering, serves as the future of tissue engineering. In the past decades, the Raymond and Beverly Sackler Foundation has supported and endowed numerous programs that embrace the concept of Convergence in scientific research. We are happy to have supported the creation of the Raymond and Beverly Sackler Center for Biomedical, Biological, Physical and Engineering Sciences at the University of Connecticut Health Center directed by Dr. Laurencin to support his efforts in defining the new field of Regenerative Engineering.

This timely book provides a well-rounded and articulate summary of the present status of using allogeneic, xenogenic, and synthetic bone graft substitutes to reconstruct bone tissues. Specifically, fifteen concise and comprehensive chapters are prepared by experts in their fields from both academia and industry. These chapters encompass numerous topics discussing the use of a wide selection of bone graft substitutes ranging from bone allografts and xenografts derived from human and animal tissues to synthetic biomaterials, cells, and growth factors. While many of these bone graft substitutes have experienced great clinical successes and have helped improve patients’ health, challenges still remain to reconstruct functional bone tissue mimicking natural bone morphogenesis. This is precisely where bone Regenerative Engineering has a niche and a significant role to play. In this regard, the book also includes a number of chapters discussing frontier paradigms such as advanced materials, stem cells,
nanobiotechnology, and developmental biology aiming to regenerate bone tissue in a more natural and effective way. Convergent technologies integrating the aforementioned disciplines promise to continue extending research frontiers, pushing bone regeneration therapies towards a more personalized approach that can truly benefit individual patients.

This book presents an outstanding view of the subject. It will appeal to a broad audience including researchers, clinicians, and regulatory specialists in both academia and industry and will serve as a valuable resource to these professionals. We believe that this book will be a welcome addition to personal collections, libraries, and classrooms throughout the world.

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Founder and President,  Executive Director,
Raymond and Beverly Sackler Foundation  Raymond and Beverly Sackler Foundation
Preface

In 2003, the American Society for Testing and Materials (ASTM International) published a landmark book entitled *Bone Graft Substitutes*. The book was a direct result of a workshop cosponsored by ASTM International and American Academy of Orthopaedic Surgeons (AAOS) that one of us chaired (CTL). Since the publication of the book, more than a decade has passed and the field of bone grafting has seen many dramatic changes. While the use of both autogenous and allogeneic bone grafts still remains a viable and important choice to surgeons, new technologies and strategies have gradually emerged and attracted great interests from both academia and industry. Therefore, we feel that it is necessary to publish a new book that updates the trends involved with this important field.

Among the new technologies and strategies for bone regeneration, advanced materials, nanotechnology, stem cell science, and bone developmental biology are central pieces of significant research and development interests and have added to the toolbox available to biomaterials scientists and engineers to regenerate bone tissues. The convergence of these disciplines has opened a new field that we define as *Regenerative Engineering*. We believe that regenerative engineering is an invaluable tool and will ultimately help researchers and surgeons better regenerate individual musculoskeletal tissues and more complex organs. Successful regeneration of tissue and organ systems will rely on a multidisciplinary strategy integrating the biological principles involved in cell and developmental biology with advanced biomaterials, nanofabrication, biomechanics, and tissue engineering. To reflect on the importance of the concept of convergence, we renamed the book *Bone Graft Substitutes and Bone Regenerative Engineering* to capture the excitement of this new field. The chapters of the book are written by well-known researchers in academia, surgeons, industry leaders, and regulatory specialists. We believe that this book will be of value to people who work in all fields involving bone.

We want to acknowledge the efforts of all the contributing authors in completing this exciting project. A number of individuals who contributed to the first edition of the book have been very enthusiastic about this new book. As such, Dr. Barbara Boyan, Dr. Joseph Lane, Dr. Mark Borden, Dr. Dhirendra Katti, Dr. Yusuf Khan, Dr. Treena Arinzeh, and Dr. Sergio Gadaleta have been extremely supportive and contributed to this new work. We also want to thank Dr. Saadiq El-Amin, Dr. Steven Gitelis, Dr. Syam Nukavarapu, Dr. Jeffery Hollinger, Dr. Peter Ma, Dr. Thomas Webster, and Dr. Yunzhi Peter Yang for their fine contributions to the book and their unique perspectives on a variety of important areas on bone repair and regeneration. The publication of this book would be impossible without the assistance from numerous people at ASTM.
Preface

International. We would like to thank Dr. Michael Mitchell (Editor-in-Chief of the Journal of Testing and Evaluation), Ms. Kathy Dernoga, Ms. Heather Blasco, and Ms. Monica Siperko for their diligence, professionalism, and tremendous support in all phases during the production of the book. Finally, we thank the Raymond and Beverly Sackler Foundation for their tremendous support in our efforts to define the new field of Regenerative Engineering.

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