



Edited by
Gabor Forgacs
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BIOFABRICATION

Micro- and Nano-Fabrication, Printing,
Patterning, and Assemblies

Micro & Nano Technologies Series

Biofabrication

Micro- and Nano-Fabrication, Printing, Patterning, and Assemblies

Edited by



AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO

William Andrew is an imprint of Elsevier



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The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK
225 Wyman Street, Waltham, MA 02451, USA

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British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

ISBN: 978-1-4557-2852-7

For information on all William Andrew publications
visit our web site at books.elsevier.com

Typeset by MPS Limited, Chennai, India
www.adi-mps.com

Printed in the United States of America
Transferred to Digital Printing, 2013

12 13 14 15 16 9 8 7 6 5 4 3 2 1



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Biofabrication

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and Assemblies

Preface

Biofabrication, as the term reveals, combines the biological sciences with the physical sciences and/or engineering approaches, more generally, with technologies that assemble biologically active or biologically derived systems. Biofabrication generates models, systems, devices, interfaces, and products that can be used for a wide range of applications in tissue science and tissue engineering, disease pathogenesis studies, and the development of new drugs. One distinguishing characteristic of biofabrication is that although it relies on input from physics, chemistry, and engineering, it provides output that often triggers further developments in these disciplines.

This interplay can be well illustrated with applications in regenerative medicine, especially in the latest efforts to mitigate the chronic and increasing problem of donor organ shortage. The goal of tissue engineering is the replacement of diseased, damaged, or missing tissues or organs by growing cells—traditionally in artificial scaffolds, which are convenient extracellular matrix mimics—until functional tissues are created. Biofabrication goes beyond tissue engineering in that it can develop the optimal “hardware” to build the organ and tissue substitutes. In particular, biofabrication methods led to the adaptation of three-dimensional additive manufacturing technologies—such as 3D printing—for building architecturally complex tissue scaffolds and biological structures. In turn, 3D bioprinting led to novel engineering solutions that aided in the development of new tissue engineering methods, such as scaffold-free tissue engineering, which relies exclusively on the inherent self-assembly properties of cells and tissues.

Another example of this interplay is the role of biofabrication in the integration of biological components with electronics. This assisted in the development of biosensors—devices that couple the molecular recognition capabilities of biological systems with the data processing capabilities of electronics for rapid, sensitive, and selective analysis.

This book, the first of its kind, introduces the most salient approaches and methods used by practitioners of this emerging discipline. The authors are leaders in the field, with many of them pioneers of new technologies or solutions to outstanding problems at the interface of the medical, life, physical, and engineering sciences. We hope readers will share our enthusiasm about biofabrication and that this book will encourage them to explore this ultimately multidisciplinary field.

Finally, the editors wish to acknowledge the support and dedication of the many colleagues and friends in the field of biofabrication, as well as the support of the International Society of Biofabrication and the journal *Biofabrication*, which made the publication of this book possible.

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In Vitro Biofabrication of Tissues and Organs

1

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INTRODUCTION

After the sensational images of the mouse growing a human ear were broadcast around the world in the late 1990s, the in vitro fabrication of tissues and the regeneration of internal organs were no longer regarded as science fiction but as possible remedies for the millions suffering from chronic degenerative diseases.