Edited by
Gabor Forgacs
Wei Sun

BIOFABRICATION

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

Micro & Nano Technologies Series

Biofabrication

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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 pathogeneses studies, and the development of new drugs. One distinguishing characteristics 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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Contents

CHAPTER

In Vitro Biofabrication of Tissues and Organs

1

Koichi Nakayama

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CONTENTS

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.

Biofabrication.