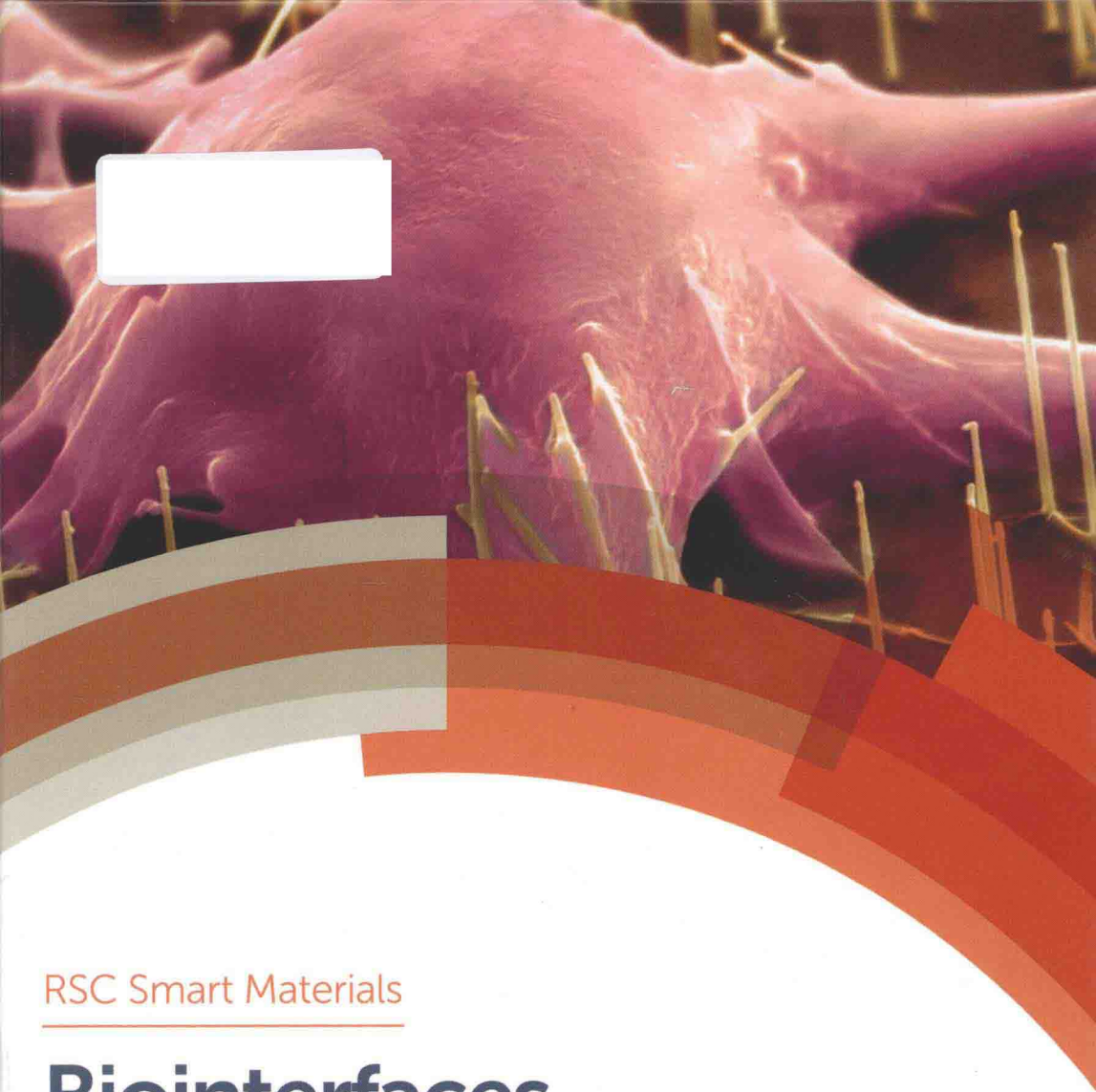

RSC Smart Materials

Biointerfaces

Where Material Meets Biology

Edited by Dietmar W Hutmacher
and Wojciech Chrzanowski

ROYAL SOCIETY OF CHEMISTRY

Biointerfaces
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Preface

Biointerfaces: Surfaces that Guide Biology!

This book brings together scientists and engineers that work in diverse fields of physics, chemistry, biology, biotechnology, materials science, diagnostics, and medicine, with a broad focus on biointerface science. The engineered biomolecular interfaces described and discussed in the book are designed to recapitulate the functions of their natural counterparts. By uniting physical science and the engineering of surfaces with biology, fresh prospects are opened up and bridge the gap between fundamental research and development of application-oriented technologies and products.

The rapidly ageing population, maintaining high levels of activity well into retirement, together with the rising incidence of obesity- and diabetes-related dysfunction of the musculoskeletal system, results in an increasing number of surgeries that require implantable devices. There are now millions of cases each year requiring implantable fixation devices (over 6 million fractures in the USA alone; 11 fractures every minute). Regeneration of tissues can be aided with new classes of materials, *e.g.*, bioceramics, hydrogels or composites, which are emerging as the most promising approaches in many clinical applications. Despite many advances in materials synthesis and device design, the implantation of biomaterials almost universally leads to the device being enveloped in avascular fibrotic tissue that walls off the device from the body. This can be detrimental to the function of the implant/device, reducing its lifetime, and often necessitates repeated surgery and device replacement.

The implantation of a material/device into body is followed by the immediate interactions of body fluids, cells and tissues with the surface. These interactions are critical for obtaining the desired functionality of the material/device and, subsequently, they determine the success of the specific medical procedure. The communication between biological structures

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(*i.e.*, cells and tissues) and implanted physical objects (*i.e.*, device or material) occurs at the interface (termed the biointerface), and the surface of the implanted material is a key element that determines the outcomes of this communication. Surface properties are of special significance when biological and microbiological interactions are considered.

There are several, surface-related cues presented to biological milieu, which includes surface texture (also topography), mechanical properties, chemical composition, surface charge and stability of the surface (degradability). These cues can be presented to cell and tissues as two- and three-dimensional structures. It is well established that each of the surface parameters can modulate first interactions with the body fluids, and then cellular responses such as cell attachment, migration and differentiation. Although each of the individual parameters has been shown to be effective in controlling some of the biological functions, it is well known that there is a complex interplay between these parameters that may strengthen (cumulative effects) or weaken specific design modalities. Therefore, by tailoring the mechanical properties of materials, chemical composition, topography, and charge it is possible to design functional surfaces, which effectively control biological and microbiological responses. For example, osseointegration is often a key aim, which can be achieved by nanopatterning of the surface or attaching signalling molecules such as peptides.

This book describes the most recent advances in the manufacture and characterisation of biointerfaces that aim to provide the desired and predicted biological responses. It covers a wide range of materials and techniques used in the investigations of biomaterials, with a focus on musculoskeletal applications. Importantly, the book includes several examples of translational research and contains many 'how to do' or 'walk the talk' sections, which makes it suitable for student readers to gain a new knowledge how to design, fabricate and characterise a new generation of technologies and products based on biointerface science.

D. W. Hutmacher
W. Chrzanowski

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