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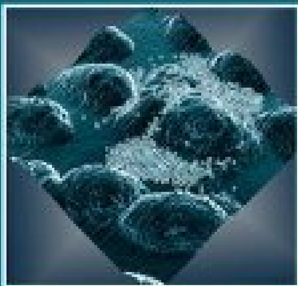

New functional biomaterials for medicine and healthcare

Elena P. Ivanova, Kateryna Bazaka
and Russell J. Crawford

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New functional biomaterials for medicine and healthcare

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Preface

As far back as antiquity, materials foreign to the human body have been employed to mitigate and repair damage caused by disease, defect or trauma. Indeed, some 2000 years ago, the Chinese, Aztecs and Romans were already using soft and malleable gold to fill tooth cavities, and high strength, relatively lightweight wood for limb and tooth prosthetics. East African indigenous tribal people and the Indians of Central America used siafu and bullet ants, respectively, as a handy source of emergency sutures. They would apply an ant close to the wound, letting the ant bite into the flesh, and then twist the ant's head off. The ant's very strong pincer-like mandibles would hold the wound closed tight and the ant's saliva would cause local swelling in the skin, hermetically sealing the wound.

To a large extent, early biomaterial enthusiasts were confined to using natural materials available in their immediate environment. Much has changed since those early days – gashes are no longer sutured using ant pincers and wooden prosthesis gave way to sophisticated creations made of plastics, carbon fibre, metals and ceramics. The twentieth century has seen a significant shift from naturally occurring biomaterials to synthetic polymers, alloys and composites. These novel materials had numerous advantages, including enhanced mechanical, chemical and biological performance, improved and augmented functionality, and high reproducibility. Importantly, their properties could be tailored to a specific application by controlling input materials and synthesis parameters.

Rapid advancements in other areas of technology provided many a material that later found its way into biomedical applications. Similarly, numerous material synthesis, fabrication and modification techniques have been adopted for biomaterial production from other industries. These developments resulted in an unprecedented increase in the number, variety, complexity, efficacy and range of applications of biomaterials. Countless patients had their lives saved and their lifestyle and productivity upheld or enhanced thanks to biomaterials-based implantable and extracorporeal devices.

However, not until the molecular biology revolution of the 1970s and advances in genomics and proteomics in the 1990s and 2000s, was the potential of biomaterials to restore lost or damaged function fully appreciated. These developments also fundamentally changed our understanding of what properties of biomaterials should be in order to achieve adequate integration within living tissues, altering the manner in which modern biomaterials are developed and used. It is during this period that biomaterials science has transitioned from a practitioner-driven discipline to a multidisciplinary field of science that encompasses many traditional and emerging scientific and engineering disciplines and clinical practices. The discovery of a complex relationship between chemical and physical properties of biomaterials and the biological response they illicit *in vitro* and *in vivo* further cemented the interdisciplinary nature of biomaterials science.

Just as in the nature of the biomaterials discipline itself, the expertise of the authors of this book spans many disciplines, from fundamental materials science, chemistry and physics, to nanoscale engineering, biochemistry and microbiology. From polymers to metals to enhanced natural materials, *New functional biomaterials for healthcare and medicine* reviews a plethora of currently available knowledge within the area, offering a refined blend of basic science, engineering and medical experience. Topics covered in this book range from discussions on critical issues pertaining to human use of biomaterials and contemporary trends in biomaterials fabrication, to surveys of current and prospective applications of major classes of biomaterials, and their fundamental properties, performance and shortcomings.

Being material- rather than application-orientated, each topic offers a comprehensive and succinct digest of essential concepts pertinent to a particular class of biomaterials, which makes this book an equally suitable reference for materials scientists concerned with specific properties and those professionals seeking to enhance their understanding of materials' biocompatibility, integration and cytotoxicity. The language and content of this book will appeal to students, aspiring and practising scientists, and engineers who are interested in becoming acquainted with major issues associated with biomaterials sciences and current models to combat those issues. Complementary skills and the diverse scientific background of the authors ensure that complex ideas are delivered using simple scientific language, avoiding overcomplicated equations and discipline-specific jargon, so making this book a suitable read for a wide audience. A laconic reference to articles published in leading journals is included to support the concept and enhance the reader's understanding of the issues, without making the book overly detailed or too technical for the readership.

This book would not have been possible without the time and energy invested by scientists and engineers into the development of the biomaterials covered. Their contributions to biomaterials science have formed the foundation for this work, and we are grateful for their efforts in transforming the lives of patients worldwide. Many thanks to our collaborators, colleagues, industry and clinical partners and postgraduate students, as their expertise and stimulating discussions have contributed significantly to the quality of this work. We are particularly grateful to many co-authors who over the years have made major contributions to original articles featured in this book. We would also like to acknowledge the staff at Woodhead Publishing Ltd, for their excellent organisational and editorial skills, helpful attitude and support, which ensured successful completion of this work. Last but not the least, we thank our families for their support, encouragement and understanding, for many a family weekend has been spent writing this book. We would also like to thank the Australian Research Council, James Cook University, Swinburne University of Technology, and Australian Institute of Nuclear Science and Engineering, who supported our research endeavours and this work.

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