

METHODS IN MOLECULAR BIOLOGY™

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Nanotechnology in Regenerative Medicine

Methods and Protocols

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Preface

Nanotechnology encompasses the understanding of the fundamental physics, chemistry, biology, and technology of nanometer scale objects (*Institute of Physics – Nanotechnology Journal*, UK). Nanotechnology could also be defined as the study of manipulating matter on the atomic and molecular scale. Nanotechnology has become in recent years a popular and well-accepted term and a central pillar in many nationally funded research programs. The potential strength of nanotechnology is due to the fact that engineering materials and devices at the nanoscale implies not only the manipulation of the individual atoms and molecules to arrange them, forming bulk macroscopic bodies (bottom-up approach), but it also implies the possibility to analyze and evaluate matter at the nanolevel. Moreover, considerable funding has been allocated and invested in the development of this discipline in many countries such as the USA, Korea, Japan, Australia, and the European Union, including also several individual member states.

Life is organized at the level of cells, but it is well known that natural cellular events, interactions, and processes take place at the subcellular scale and at the molecular level. This is the reason why nanotechnology is meant to play a key leading role in developing tools able to identify, measure, and study such events at the nanometric level, as well as in contributing to the disclosure of unknown biological interactions and mechanisms. Moreover, it should also be key in engineering issues, such as producing material structures able to mimic the biological ones, efficient delivery systems, as well as devices aiming among other issues to identify and track proteins and cells.

The great existing interest in elucidating such unknown biological interactions has led to the convergence of disciplines, such as engineering, physics, chemistry, and molecular and cellular biology into a novel field known as nanobiotechnology. This new technology should allow detecting, evaluating, analyzing, and engineering biological nanostructures. This means to open wide the whole field of nanomedicine, including nanodevices for diagnostic and therapy, drug delivery systems, and regenerative medicine. The implication of nanotechnology to regenerative medicine is the objective of this book. In fact, regenerative medicine is meant to develop innovative in situ and cost-effective therapies by repairing and regenerating tissues for diseases and problems without solution at present, as well as for overcoming many present bionic solutions.

Taking the above point of view and given the importance and potential impact of nanotechnology in medicine, this book aims to provide an overview of a very wide range of the different currently used technologies and methods that involve nanotechnology principles and that may be used in tissue regeneration. Being that the application of nanotechnology to regenerative medicine is a very broad field, this book focuses its interests on particular areas, such as its use as a means to produce efficient platforms and structures for tissue engineering, delivery systems and biosensors, as well as the use of some techniques to study materials surfaces and the interactions between cells, biomolecules, and surfaces at the nanoscale.

Rather than a compilation of chapters, where the state-of-the-art of these technologies is reviewed, this book is a collection of experimental protocols, where an in-depth and step-by-step description of various nanotechnology involving methods is carried out.

The book is divided into 19 chapters. The first chapter is an introduction to the importance and the potential capacity of nanotechnology to develop new tools and means to have a better understanding of the biological interactions and processes with the ultimate aim to bring up new therapies for regenerative medicine. There are five overview chapters presenting a comprehensive review of very important topics in the field such as the development of novel strategies to engineer tissue in vitro, the design of diagnosis devices, modeling of bio/non-bio interactions, and also the ethical, legal, and social issues related to regenerative medicine.

The other chapters are dedicated to the full description of methodologies followed for the synthesis of new biomolecules and biomaterials, the fabrication of 3D scaffolds at the nanoscale, surface chemical modification through functionalization with biomolecules and protein patterns, and the detection and analysis of biological entities and events.

This volume provides established scientists, junior researchers, and students involved in the bioengineering, biotechnology, and biomedical fields with a sound foundation of a wide variety of nanotechnology approaches in regenerative medicine. Finally, we would like to acknowledge all the authors and colleagues that participated in the preparation of this book, not only for their outstanding contributions, but also for their effort and willingness in putting together a book with such a diversity of expertise and such an interdisciplinary approach.

Barcelona, Spain
Barcelona, Spain

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Josep A. Planell

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