

Preface

Nanotheranostics (multifunctional engineered nanomaterial for diagnosis and therapy) and nucleic acid-based therapies are two exciting and emerging fields in biomedicine, the combination of which has the potential to greatly improve the quality of life for patients suffering from various diseases. In more detail, gene therapy—hailed as a new breakthrough in molecular medicine—involves the insertion of exogenous nucleic acids (DNA, mRNA, or miRNA) into an individual patient's cells or tissues to treat genetic diseases in which deleterious or point genetic mutations have occurred. Consequently, nucleic acids offer the potential for highly selective treatment of a wide set of diseases, for example, by expressing therapeutically active proteins with gene vectors or modulating the gene expression with RNA interference.

However, despite the tremendous advances, a key issue is still hampering the definitive successful application of nucleic acid therapies in clinical practice: the availability of a suitable delivery and monitoring system. In fact, when injected intravenously, nucleic acids are rapidly cleared by renal filtration and undergo degradation by extracellular RNases or DNases. Furthermore, due to their large molecular weight and net negative charge, naked nucleic acids are not able to cross the plasma membrane finally entering the cells.

To this scope, the awesome progress achieved in the last decades by nanotechnology has enabled a new generation of different advanced nanomaterials with special ability for nucleic acids-based theranosis.

At the moment, the application scope of nucleic acids nanotheranostics is quite limited, encompassing oncology, ophthalmology, and cardiovascular and respiratory diseases within the most investigated medical topics. However, the great number of already ongoing clinical trials clearly demonstrates the impressive interest of the biomedical community (public as well as private) toward this promising research field.

Hence, taking together all the considerations discussed above, we decided to design this book by offering a comprehensive overview focusing on the improvements and new trends in fabrication and application of nanostructures as theranostic carriers in gene therapy. The pros and cons related to viral and nanomaterial-based delivery of nucleic acids in terms of biosafety, carrier selection, synthesis, and bioimaging have been fully dissected. Besides the technological aspects described above, we also resolved combining in the same volume the most recent biomedical advances in nucleic acids mediated diagnosis, therapy, and imaging. Finally, to answer the crucial question "*where is the nucleic acid based nanotheranosis field now?*" special attention has been paid to the analysis of nanoformulations approved for clinical use and those under preclinical evaluation.

In this sense, we imagined this book as a general "instruction manual" for researchers, academics, or personnel belonging to industry that would expand their knowledge of nanotheranostic materials for gene therapy at all levels and for all related scientific areas (physicians, chemists, engineers, or biologists).

As Cato the Elder (234 BC–149 BC) said, “*Rem tene, verba sequuntur* (grasp the subject, and the words will follow).” Consequently, to achieve the proposed aim, all the chapters contained in this book have been prepared by outstanding international researchers and experts coming from academia, industry, and clinical areas (or combinations thereof) who have made important contributions in a precise field within the main domain of nanotechnology and gene therapy.

In conclusion, nucleic acids nanotheranosis is a very dynamic field entirely open to new ideas and advances. Counting from the earlier beginning of gene therapy, many challenges have been elegantly overcome, though many

questions are still unanswered, as conveniently highlighted in the different chapters. However, each milestone that has been achieved has not simply represented another brick in the wall of nanotechnology basic research. Conversely, each issue that has been tackled has become a novel step on the stairway to the definitive translational application of nucleic acids nanotheranotics. We truly believe that the work presented in this book will increase the knowledge and awareness regarding this extremely exciting and multidisciplinary research field.

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