
Preface

Advancements in nanotechnology promise to revolutionize drug manufacturing, drug delivery, and medical diagnostics. Nanoscale materials hold great potential for medical applications due to their differential behavior at the cellular and molecular level. In this context, the term nanomedicine has been coined to refer to the application of nanoscale materials, which can be used as drug delivery vehicles to develop highly selective and effective drugs. Nanomedicine market is expected to grow at a compounded annual growth rate (CAGR) of 12.3 % during the period 2013–2019 to reach US\$177.60 billion.

The existing generation of drugs is largely based on small molecules with a mass of 1000 Da or less. These small molecules possess certain limitations, viz., poor bioavailability, lesser in vivo stability, first pass metabolism, non-targeted delivery to site of action, therapeutic ineffectiveness, side effects, etc. Nanomedicines have an upper hand compared to the standard drugs in view of several aspects, e.g., these reduce renal excretion, volume of distribution, improve the ability of drugs to accumulate at pathological sites and improve their therapeutic value. In addition, nanomedicine also assist therapeutic agents to overcome biological barriers. Nanotechnology-based drug delivery systems have been used to overcome this problem by combining specificity, targeted delivery and therapeutic action. Recent trend in nanomedicine research which came into play has developed a lot of formulations containing both drugs and imaging agents. Nanotechnology combined with molecular imaging probes has generated theragnostic nanoparticles which allow simultaneous detection and monitoring of diseases.

Tissue engineering has also become an advanced research interest during the last decade, offering the potential for regenerating almost every tissue and organ of human body. The production of artificial skin, tissue-engineered trachea and blood vessels, cartilages, urinary bladder, urethra substitutes, and cellular therapies are among the most exciting medical applications. Fabricating scaffolds that imitate the design of tissue at nanoscale is one of the key challenges in the tissue engineering field. Fortunately, nanofibers have really improved the scope for biomedical scaffolds, as nanofibers easily mimic the architecture of natural human tissues to support cell adhesion, proliferation, migration, and differentiation.

Despite the fast progress in nanomedicine, we are aware of the lack of good books in the area of biomedical applications of nanoscale materials. Though there are excellent reviews, books, and book chapters dealing with

one or several topics in the area of nanomedicine, a book containing a comprehensive coverage and up-to-date progress of drug delivery, theragnosis, and tissue engineering is not available.

This book aims to discuss the use of nanoscale materials for biomedical applications with special emphasis on drug delivery, theragnosis, and tissue regeneration. The book mainly focuses on nanomedicine which comprises of biodegradable nanoparticles, metallic nanoparticles, liposomal formulations, and nanocellulose along with the cellular response of therapeutic and theragnostic nanoparticles.

The book mainly consists of seven chapters. Chapter 1 gives a brief introduction about nanotechnology and elaborates the topic to discuss different techniques used in nanoparticle synthesis and characterization. Additionally it also provides information on various nanoscale carriers used as drug delivery vehicle. Chapter 2 gives detailed information about the synthesis methods of different biodegradable nanoparticles, their use as targeted drug delivery agent, corresponding drug release mechanisms, and biological barriers encountered by such biodegradable nanoparticles with their in vivo fate and toxicity reports. Chapter 3 emphasizes on various aspects of metallic nanoparticles, including their synthesis (physical, chemical, and biological) and characterization, properties, behavioral dependency based on particle size, shape, and surface chemistry and finally the wide applications of metal nanoparticles in biomedical field with reports of toxicity studies. Chapter 4 takes into account various preparation methodologies of liposomes and phytosomes, their physico-chemical characterisation, surface modifications, delivery of different molecules, behavior in biological systems, and applications in medical field. Chapter 5 includes the introduction of nanocellulose, a specific biomaterial of current interest due to its exciting properties. A discussion is made on the structure and morphology, types and dimensions, sources, physico-chemical properties, preparation approaches, surface modifications, applications of nanocellulose in formation of nanocomposites, drug delivery and tissue engineering and regeneration. Chapter 6 discusses the definition of theragnosis keeping specific focus on different imaging modalities related to nanoparticles as molecular imaging probes, disease diagnosis, and therapy. This chapter will also cover the various factors affecting nanotechnology-based disease diagnosis and therapy and future directions of theragnosis. Chapter 7 reports cellular response of nanoscale materials. Different types of nanomaterials are administered into the body by various routes. This chapter will focus on characteristics of different types of nanoscale materials affecting cellular response.

In this book, we have tried to cover recent developments in the area of drug delivery, theragnosis, and tissue regeneration. To make this book understandable, contents of book are methodically and rationally developed from the elementary level. To make each chapter more informative we have compressed available literature into an understandable description within a reasonable size. Important references have been included in each chapter for the benefit of readers who wish to pursue any of these topics further in a greater depth. We aim to satisfy the need of textbook for research students and a reference book for professionals in this field.

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