Preface

Nanoscience and nanotechnology are a fast growing and dynamic areas, which include novel class of materials that are being developed for various applications. Nanotechnology has immense potential in almost every field of science and technology, primarily due to their size and/or shape dependent intrinsic physicochemical, optoelectronic, catalytic and biological properties and greater surface area. As some may know, modern nanotechnology originated in the year 1959 after an oral presentation given by Dr. Richard Feynman, "*There's plenty of room at the bottom*." The impetus for modern nanotechnology was provided by interfacing nanoscience with biology, medicine, electronics and advanced analytical tools. Researchers and industrialists believe that one day nanotechnology will likely impact the perspective of things being looked at, and will drastically revolutionize the industries and pharmaceutical companies with great emphasis on human health, environment safety and sustainability. Nanotechnology has already begun to improve many facets of science and technology, and researchers are revisiting several useful aspects with a nanoperspective to understand how similar things could work at the nanoscale. This phenomenon is likely to revolutionize pharmaceutical sciences, and many drugs are being reconsidered for possible deliveries using smart multifunctional nanomaterials.

This book emphasizes two distinct but interrelated and novel aspects with respect to nanoparticles: ecologically benign and cost effective production of nanoparticles, and issues related to safety concerns of nanoparticles on the biotic environment. Nanoparticles in distinct forms are extensively used in various consumer products as additives and therefore are required in huge quantities. In that respect it has become highly imperative to be able to produce nanoparticles at the mega scale, using both ecologically friendly and economic procedures. Also, as the nanoparticles are getting implemented more and more widely, they are released into the environment in one form or another, following it a host for new potential health issues. To prevent this risk, one must look at the proper development and use of these nanomaterials and the fate, transport and impacts of such engineered nanostructures on the environment must be addressed. Interactions between the nanoparticles and microorganisms in the environment are

unavoidable, but the pandemic consequences of such interactions are beginning to be investigated. This book will also illustrate how naturally occurring microorganisms and manmade nanoparticles interact, and the consequences of such interaction, using suitable examples from our studies published in several peer reviewed International Journals. Because of its uniqueness in content and scope, I am positive that this volume will be helpful not only to the scientific and industrial community but it will also attract the attention of students and researchers in different areas of sciences such as microbiology, biotechnology, nanotechnology, toxicology, materials science, biomedical engineering, cell and molecular biology etc. The several objectives of this brief are to introduce nanobiotechnology along with the fast emerging "green biosynthesis" for their manufacture, and to let the readers aware on the potential interactions of engineered nanoparticles with microorganisms. Impacts of noble metal and metal oxide nanoparticles such as gold, silver and cerium oxide on the growth and viability of several Gram-negative and Gram-positive bacteria will be presented. Differences in the interactions using different forms of nanomaterials, nanoparticles synthesis methodology, surface coatings, and the various analytical assays used to determine the bactericidal activity will be described. Mechanistic insights on the relationship between the bacterial growth inhibition, reactive oxygen species generation and up and/or down regulation of transcriptional stress responsive genes will also be discussed. Finally, how we made use of the emerging advance imaging techniques such as transmission electron and atomic force microscopes that will shed impacts towards a better understanding on the overall microbial–nanoparticle interactions will be discussed.

Overall, the book contains five chapters. Chapter 1 includes the basic and general introduction to nanoscience and nanotechnology, properties of nanoparticles, synthesis methodologies employed to produce various nanoparticles, physical characterizations of nanoparticles, and the applications of nanoparticles, with emphasis on biological and medicinal applications. Chapter 2 details the microbial based biofabrication of nanoparticles, mechanism involved behind biofabrication, and the advantages of biosynthesis over the existing conventional chemical and physical routes of synthesis. Moreover, the reliability of biosynthesis technique with detailed description on the biosynthesis with suitable example, thorough physical characterizations of the synthesized particles so as to assess their morphology, crystallinity, surface characteristics based on advanced analytical tools will be presented. Chapter 3 discusses the bactericidal properties of engineered metal nanoparticles and analysis the comparative toxicity assessments of engineered silver nanoparticles on bacteria and discusses the toxicity assessments of nanoparticles, deemed reasons for nanoparticles being considered toxic and the necessity to address the potential toxicity of nanoparticles. It then proceeds to describes the external factors that might govern nanoparticles mediated toxicity and the proposed mechanisms behind the toxicity. Additionally, it discusses the details of the various techniques used to evaluate bactericidal activity, their advantages and limitations along with the influence of size, shape, surface coatings of nanoparticles on the toxicity and the mechanistic of bacteria-nanoparticle

interactions. Chapter 4 focuses on the biocompatibility and inertness of gold nanocrystallites and analyses the inert nature of gold nanoparticles along with its biosynthesis and physical characterizations. Last but not least, Chap. 5 examines the antibacterial properties of engineered metal oxide nanocrystallites and the stress mechanism involved. As an example, it describes our work on the effects of engineered cerium oxide nanoparticles on the growth and viability of several Gram-negative and Gram-positive bacterial strains. It then discusses the relation between the growth inhibition, reactive oxygen species generation and up and or down regulation of transcriptional stress genome. Finally, it analyses the use of advanced analytical tools like the transmission electron microscopy to evaluate the bacterial response mechanisms.

I am pleased that I have been invited to write this book published by Dr. Sonia Ojo, senior publishing editor at Springer within the Springer Briefs in Biometals series by Prof. Larry Barton. To all I wish a happy reading!

Duarte, 12 December 2011 Anil K. Suresh