

Preface

Though nobody can go back and make a new beginning... Anyone can start over and make a new ending.

Integrating biology progressively offers more inspiration for new medicine and bioengineering. As the inspiration of nanotechnology concern for living systems, it is emerged through the new era of technology by merging with old era drug, otherwise called as “merge to emerge”. At the same time, directing the new synthesized technologies through the potential transformation of bioengineering ideas and tools are being brought to bear upon important challenges in biology. More research on targeted drug delivery is required to provide a formal platform especially towards the drugs for medically treated diseases. Integrating biology, nanotechnology and medicine are exciting, deeply interdisciplinary and intellectual thrust areas which play a vital role on real life and information sciences.

The discovery of nanomaterials is widely acknowledged as a major triumph of human ingenuity in modern times. This discovery has led the emerging field of nanotechnologies, which is paving the way for a new technological revolution across the globe. Such developments may usher in new industrial revolutions, capable of radically transform almost (everything) all industrial sectors in the coming years. Since all industrial sectors depend on materials and devices based on atoms in principle, and they can all be improved by the application of nanomaterials.

The notions of Nanosciences and nanotechnology pop up in every sector of modern knowledge. Young scientists today are likely to be attracted by the depth and novelty of this new technology, setting off on a voyage of discovery in an unknown world, where the ways have not yet been signposted. One of the aims of this book is precisely to provide a tool for students, teachers and research scientists. It has been written by research workers and university teachers who are expert in their own fields and fully up to date with the latest developments.

Most of the industries have already begun to establish a significant share in the global market and are expected to exert a major beneficial impact on every sphere of life. Future developments in nanotechnologies will need an understand-

ing and interdisciplinary approaches. Thus, a nursery of future researchers with an understanding of the physical, biological, chemical and technological aspects will contribute to the new solutions for the major challenges facing the world. For example, the need for sustainable energy, clean water, affordable food, healthcare, clean environment, safety and security.

In fact, different scientific disciplines including every single sector have their own paradigm. This is why innovations and industrial developments are profoundly different. Moreover, these fields are strongly interlinked with the nano-world. It is therefore necessary to make our studies more interdisciplinary in order to enable us to understand the world of nano-science. A basic understanding of these diverse disciplines through nanotechnologies will help the researchers to develop and potentially change the way of living in near future by an appreciation of the wider aspects of sciences and technologies involved in it. This will also provide an opportunity to the researchers and experts of same and other fields to acquire an over view of principles and utilities of nanotechnologies. The various topics given in this book are detailed enough to accumulate and capture the interest of curious readers and at the same time to motivate them further exploration of the subjects in future.

Chapter 1, “Nano-Biotechnology and Therapeutics,” refers to the nanotechnology which progress rapidly with regard to in vivo imaging and therapeutics. Recent improvements in engineering at the nanoscale level have led to the development of a variety of new, novel nanoscale platforms (quantum dots, nanoshells, gold nanoparticles, paramagnetic nanoparticles, carbon nanotubes), which currently are under development and investigation. The topic also deals with scientific and technological revolutions of the novel and improved methods of cancer detection. They are used as contrast agents, fluorescent materials, molecular research tools and drugs with targeting antibodies. Some of the nanoparticles used for diagnostic purposes are paramagnetic nanoparticles, quantum dots, nanoshells and nanosomes. Drugs with high toxic potential like cancer chemotherapeutic drugs can be given with a better safety profile with the utility of nanotechnology. These can be made to act specifically at the target tissue by active as well as passive means. Simultaneously, other alternative ways of therapy such as heat induced killings of cancer cells by nanoshells and gene therapy are also being developed.

Chapter 2, “Polymeric Nanocarriers for Vaccine Delivery,” describes the development of new generation vaccines, through antigen delivery for achieving protection against lethal diseases. Under this state of affairs polymeric nanoparticles (NPs) have shown promising marks and thus maintains long lasting immune responses to the antigens. They are biocompatible, biodegradable and do not cause any significant localized or systemic toxicities.

Chapter 3, “Nanomedicine as a Newly Emerging Approach Against Multidrug-Resistant Tuberculosis (MDR-TB),” is an approach towards the development of nanoparticle-based aerosol vaccines for tuberculosis and provide current knowledge about potential nanomedicine to improve MDR-TB therapy. The chapter also briefs the current TB diagnostic assays and treatment by nanotechnologies and highlight recent advances in Anti-TB Drug (ATD) delivery systems with anti-TB drug encapsulation.

Chapter 4, “Biomedical Applications of Gold Nanoparticles: Recent Advances and Future Prospects,” focuses on the recent advances and current challenges gold nanoparticles for biomedical applications in the area of diagnostic imaging, biosensing, drug delivery, and photo-thermal and photodynamic strategies. It also provides an overview of the advantages of the gold nanoparticles with respect to synthesis, functionalization, biodistribution and toxicity.

Chapter 5, “Mycofabrication of Nanoparticles and Their Novel Applications,” focused on the interaction of microbes with the metals and its application on various *in vitro* techniques for drug delivery and as promising therapeutic agents against resistant pathogens. Mycofabricated biosilver nanoparticles interrupt quorum sensing systems of pathogenic bacteria. Silver nanoparticles have been widely applied as antimicrobial agents against human pathogenic bacteria and fungi, but not for the attenuation of bacterial QS. Gold nanoparticles have found prominence in pharmaceutical applications due to their unique physical properties as well as their inert nature.

Chapter 6, “Nanoencapsulation of Food Ingredients,” briefly explains about the important applications of food nanotechnology, where the food ingredients with specific functional attribute into their products may slowly degrade and lose their activity or become hazardous due to oxidation reactions. The protection of food ingredients against degradation and interaction through the nano-encapsulation technique helps to increase the bioavailability of food ingredients (bioactive compounds) through their protection during the digestive processes, as well as their improved uptake in the gastrointestinal tract and enhanced transport to the target sites.

Chapter 7, “Impact of Nanotechnology on Environment,” explains the efficacy of nanotechnology products on the biosphere by direct or indirect way. Different discussions are there in this chapter about the nanoparticles which can be used an individual product in pure form or as an adjuvant with existing products in order to enhance their activities as beneficial aspects. The chapter describes the basic understanding about the bioaccumulation of nanomaterials and their effects on living systems including their routes of environmental exposure, deposition, transformation, bio-persistence, clearance, and translocation, as well as mechanisms for their absorption, distribution, metabolism, and excretion by organisms.

Chapter 8, “Applications of Gold Nanoparticles in Cancer,” deals with various strategies related to gold nanoparticles in controlling cancer and surrounding issues of cancer. Cancer nanotechnology seeks to characterize the interaction of nanoscale devices with cellular and molecular components specifically related to cancer diagnosis and therapy. The potential of cancer nanotechnology lies in the ability to engineer vehicles with unique therapeutic properties that, because of their small size, can penetrate tumors deeply with a high-level specificity. Diagnostic measures of the cancer cell are given in a brief way by different techniques based on DNA/Protein detection, bimolecular regulators, cell imaging and cancer cell diagnostics. The chapter also describes the multifunctional gold nanoparticles are attractive towards organic, inorganic hybrid material composed of an inorganic metallic gold core surrounded by an organic or bimolecular monolayer they provide desirable attributes for the creation of drug delivery in cancer.

Chapter 9, “New Horizons of Nanotechnology in Agriculture and Processing Industry,” is capable itself to solve the complex set of engineering and scientific challenges in the agriculture and food processing industry. Nanotechnology based products and its applications not only provides the knowledge in agriculture include nano-fertilizers, nano-herbicides, nano-pesticides, recalcitrant contaminants from water but also gives information to the researchers about the advantages of nanotechnology in nano-scale carriers, nano-sensors, veterinary care, fisheries and food processing industries. This chapter also speaks how the revolutionized nanotechnology plays an important role in the field of agriculture and food industry by innovation of new techniques such as: precision farming techniques, more efficient and targeted use of inputs, disease detection and control, withstand environmental pressures and effective systems for processing and packaging.

Chapter 10, “Setting Priorities for the Development of Medicinal Plants Sector in J&K (Kashmir) and Their Progress towards Nanotechnology,” is a resurgence of interest in herbal medicine has largely been an outcome of the realization of ill-effects which other systems are inflicting on the human beings. This explores about the Himalayas which has vast biodiversity hotspots harbor around 8,000 species of flowering and about 590 medicinal plant species are found at different altitudes in the Kashmir valley. Nearly 40% of the known medicinal plants of Himalayan region are used in the Indian Pharmaceutical industry alone. Medicinal plants have assumed global importance in view of their ever increasing usage in health care system all over the world. In India more than 7,500 of the plants are being regularly employed in treating various kinds of ailments. However, the continued exploitation of this resource from natural habitats in the absence of any cultivation programme has resulted in the extirpation of many herbs which require formulation of sound policies on the part of Government and their effective implementation at the ground

level. The chapter provide an overview about the combination of nanotechnology with traditional herbal medicine may provide a very useful tool in designing future medicines with improved bioavailability profile with less toxicity drugs.

Chapter 11, “Role of Bioinformatics in Nanotechnology: An Initiation towards Personalized Medicine,” describes towards the recent advancements in bio-computing and nano-technology accelerated the discovery of novel biomarkers in the emerging field of personalized medicine. Personalized medicine deals with disease detection and therapy from the molecular profile of each individual. Personalized medicine is also called as predictive medicine that uses genetic/molecular information to predict disease development, progression, and clinical outcome. It also discusses the advantages of using nanotechnology to understand biological systems with an example of the biomarker discovery of cancer. Recent developments in bio computing served as the base for the identification of multiplexed probes in a nanoparticle, which can be used as a therapy for cancer and other diseases.

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