Preface

Even five years into the new millennium, cancer continues to torment humanity as the second leading cause of death with 10.9 million newly diagnosed cases worldwide in the year 2005 alone. Despite new discoveries of drugs and treatment combinations as evidenced by reports of close to 200,000 experimental studies on mice, two million scientific publications and an annual spending of around 15 billion US dollars world wide, the mortality rate due to cancer did not change in the past five to six decades. Therefore, there is still a strong need for a paradigm shift in the approach to cancer diagnosis and therapy. The advent of nanotechnological revolution offers an opportunity to achieve this paradigm shift. Since the biological processes in general and those that lead to cancer in particular occur at the nanoscale, there is a great opportunity for nanotechnologists to treat cancer at an as early stage as possible. Several innovative nanoscale constructs have been demonstrated to radically change cancer therapy with capabilities to deliver large doses of chemotherapeutic agents or therapeutic genes into malignant cells while sparing healthy cells. They have also shown great promise in enabling rapid and sensitive detection of single cancer cells and cancer-related molecules. Reports of these investigations are being published in a very broad range of journals spanning several traditional disciplines. It is becoming difficult for researchers to gather all the available information on 'Cancer Nanotechnology'. I am, therefore, pleased to share with you, again on behalf of dedicated team of researchers in cancer nanotechnology, two volumes of the ten volume series on nanotechnologies for the life sciences specifically dedicated to cancer. The first of these two volumes, sixth in the series, that is being presented to you here is dedicated to cancer therapy and is aptly titled as *''Nanomaterials for Cancer Therapy.''*

The book is divided into eleven chapters encompassing a number of therapeutic approaches in cancer treatment through use of a variety of nanomaterials. It begins with a chapter reviewing the progress that has been made to date in utilization of conventional chemotherapeutic drug nanoparticles for cancer treatment. The chapter *Conventional Chemotherapeutic Drug Nanoparticles for Cancer Treatment* contributed by Loredanna Serpa from the University of Turin, Italy, is an up to date review of literature on advances being made in cancer treatment through use of nanoparticle formulations containing conventional chemotherapeutic drugs such as doxorubicin, cisplatin, paclitaxel and other drugs. Moving from conventional anticancer

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drugs to conventional therapies that are being affected by nanotechnological tools, the second chapter starts with fundamental aspects of Photo Dynamic Therapy (PDT) that has been found to be promising in selectively treating tumors as well as metastasis without affecting the surrounding healthy tissue. The chapter *Nanoparticles for Photodynamic Therapy of Cancer*, written by Florence Delie and her team from the Laboratory of Pharmaceutical Technology and Biopharmaceutics, University of Geneva, Switzerland, provides an in-depth analysis of how nanoparticles, with special emphasis on polymeric biodegradable ones, are being developed to improve the conventional approaches to PDT. Continuing on a similar theme of improving conventional therapies, Yoshinobu Fukumori and co-workers from Kobe Gakuin University in Japan provide a general background on neutron capture therapy (NCT), a new radiotherapy that differs from the conventional radiotherapies, in the third chapter. This is followed by the authors reviewing more specifically both gadolinium neutron capture therapy (GdNCT) and boron neutron capture therapy (BNCT) with reference to use of nanomaterials. The remainder of the chapter *Nanoparticles for Neutron Capture Therapy of Cancer* provides a detailed account of the authors' experiences in developing Gd-containing lipid nanoemulsions and chitosan nanoparticles to demonstrate the usefulness of nanoparticle technology in NCT. Addressing a different facet of NCT, the fourth chapter entitled *Nanovehicles and High Molecular Weight Delivery Agents for Boron Neutron Capture Therapy* focuses on various high molecular weight (HMW) agents consisting of macromolecules and nanovehicles such as monoclonal antibodies, dendrimers, liposomes, dextrans, polylysine, avidin and folic acid, epidermal and vascular endothelial growth factors (EGF and VEGF) as delivery vehicles for introducing boron atoms. In it, Gong Wu, Rolf F. Barth, Weilian Yang, Robert Lee, Werner Tjarks, Marina V. Backer and Joseph M. Backer from the Department of Pathology at Ohio State University in Columbus, USA, have done a remarkable job in describing procedures for introducing boron atoms into HMW agents in addition to providing information on their chemical properties, bio-distribution based on in vivo studies, delivery across the blood brain barrier and various routes of their administration. Overall, the work reported in chapters three & four is very valuable and exciting not only from the scientific point of view, but also from the commercial point of view as recently clinical BNCT trials mainly for brain tumors were carried out in Japan.

Switching gears from earlier parts of the book where applications of nanotechnology to already well established treatments for cancer are presented, the rest of the chapters describe 'non-traditional' and innovative approaches completely based on nanotechnology that are being investigated for cancer therapy. Christoph Alexiou and Roland Jurgons from the Policlinic for otorhinolaryngological Illnesses of Friedrich-Alexander University, Erlangen-Nuremberg, Germany, contributed the fifth chapter, *Local Cancer Therapy with Magnetic Drug Targeting using Magnetic Nanoparticles*, in which they review current literature on the use of magnetic nanoparticles in biomedicine in general and local chemotherapies, focusing especially on regional cancer therapy, in particular. In the sixth chapter, *Nanomaterials for Controlled Release of Anticancer Agents*, the team lead by Do Kyung Kim at the

Massachusetts Institute of Technology, Cambridge, USA, has done a remarkable job in capturing nuances of nanotechnologies, particularly those based on polymeric nanomaterials, being developed for controlled release of anticancer agents. In this chapter, the authors discuss various design aspects, theoretical models and kinetics of controlled release of anticancer drugs. The seventh chapter on the other hand provides a much broader perspective to cancer therapy using nanomaterials by providing a critical analysis of various approaches. While the chapter starts with a description of the tools of nanoparticle technology that can be used to treat cancer, it goes a step further in critically reviewing and discussing the advantages and drawbacks of nanoparticles for the targeted delivery of anticancer agents to defined cells of human cancers. The chapter entitled *Critical Analysis of Cancer Therapy using Nanomaterials* contributed by Lucienne Juillerat-Jeanneret from the University Institute of Pathology in Lausanne, Switzerland, concludes the section with a final section that describes the author's own design of how an ideal nanoparticulate system should be for the targeted treatment of human cancers.

Treating cancer using heat has been known for a long time as cells are known to undergo apoptosis when exposed to temperatures around 40 °C. Thermotherapy, as it is called, as performed using conventional approaches has several drawbacks. In the eighth chapter, *Nanoparticles for Thermotherapy*, a team of cancer specialists lead by Andreas Jordan describe, based on their own experience, how some of these drawbacks are being overcome using magnetic nanoparticles. The chapter is particularly valuable as the team from the Center of Biomedical Nanotechnology (CBN), Berlin, Germany, share their experience in conducting the first ever clinical trials with thermotherapy using magnetic nanoparticles. Moving conceptually to a more elegant approach, the ninth chapter entitled *Ferromagnetic Filled Carbon Nanotubes as Novel and Potential Containers for Anticancer Treatment Strategies* explores the feasibility of different applications using magnetic multi-walled CNTs (MWCNTs) more specifically as heat mediators for hyperthermia of solid tumors. While authors Ingolf Mönch et al. from the Leibniz Institute for Solid State and Materials Research in Dresden, Germany, are upbeat about potential opportunities in the use of different types of functionalized MWCNTs, they restrict their review to only those that are novel and those that have benefits specifically in the treatment of prostate cancer.

Several types of nanomaterials are currently being investigated for targeted delivery of anticancer agents and there is a need for understanding the pros and cons of using these different types of nanomaterials. Chapter ten written by Yong Zhang and Dev K. Chatterjee from the Division of Bioengineering at the National University of Singapore provides a platform for comparing the efficacy of different types of nanomaterials for targeted delivery. The chapter, *Liposomes, Dendrimers and other Polymeric Nanoparticles for Targeted Delivery of Anticancer Agents – A Comparative Study*, provides a unique perspective on different types of nanomaterials in general and three major types in particular that are gaining importance in this field. The chapter is a must for those interested in learning about background information on mechanisms and methods of targeting cancer cells. At this point of time, liposomes seem to have an edge over the other types of nanomaterials and in the au-

thor's own words, ''the most exciting news is the performance of Epeius Biotechnologies Corporation's liposomal based active targeting system that delivers genetic material to treat several cancers, including pancreatic head carcinoma, which has one of the worst prognoses among all neoplasms.'' In the eleventh and final chapter of the book, the team lead by Jack-Michel Renoir from University of Paris-Sud in Châtenay-Malabry, France, focuses on the benefits of encapsulating a class of anticancer drugs known as antiestrogens (AEs) to improve antitumoral activities in vivo. In addition, the authors discuss in this chapter, *Colloidal Systems for the Delivery of Anticancer Agents in Breast Cancer and Multiple Myeloma*, the use of passive targeting through long-circulating drug delivery systems in different types of xenografts. They strongly believe that the approach using colloidal systems is promising not only for the administration of antiestrogens in estrogen-dependent breast cancers and multiple myeloma (MM), but also for the delivery of much more toxic anticancer agents such as taxol, thalidomide, bortezomib, VEGF inhibitors, farnesyltransferase inhibitors, histone transferase inhibitors and hsp90 inhibitors.

I am pleased by the broad range of useful information gathered by the dedicated contributors working in the area of cancer nanotechnology, and I am hoping that the book will be a guide for all those who wish to be associated with the growing field of 'Nanomaterials for Cancer Therapy'. I am indebted to all the authors for their extraordinary efforts and as always grateful to my employer, family, friends and Wiley VCH publishers for making this book a reality. I am thankful to you, the reader, who has taken time to join the journey with fellow cancer nanotechnologists. It will be my pleasure to hear back from you and I look forward to receiving your comments, suggestions and constructive criticism in order to make further improvements in the next editions of the book.

April 2006, Baton Rouge *Challa S. S. R. Kumar*