Nanotechnology in the Life Sciences

Series Editor

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Nano and biotechnology are two of the 21st century's most promising technologies. Nanotechnology is demarcated as the design, development, and application of materials and devices whose least functional make up is on a nanometer scale (1 to 100 nm). Meanwhile, biotechnology deals with metabolic and other physiological developments of biological subjects including microorganisms. These microbial processes have opened up new opportunities to explore novel applications, for example, the biosynthesis of metal nanomaterials, with the implication that these two technologies (i.e., thus nanobiotechnology) can play a vital role in developing and executing many valuable tools in the study of life. Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale, to investigating whether we can directly control matters on/in the atomic scale level. This idea entails its application to diverse fields of science such as plant biology, organic chemistry, agriculture, the food industry, and more.

Nanobiotechnology offers a wide range of uses in medicine, agriculture, and the environment. Many diseases that do not have cures today may be cured by nanotechnology in the future. Use of nanotechnology in medical therapeutics needs adequate evaluation of its risk and safety factors. Scientists who are against the use of nanotechnology also agree that advancement in nanotechnology should continue because this field promises great benefits, but testing should be carried out to ensure its safety in people. It is possible that nanomedicine in the future will play a crucial role in the treatment of human and plant diseases, and also in the enhancement of normal human physiology and plant systems, respectively. If everything proceeds as expected, nanobiotechnology will, one day, become an inevitable part of our everyday life and will help save many lives.

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Plant Nanobionics

Volume 1, Advances in the Understanding of Nanomaterials Research and Applications

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Preface

The purpose of this book is to describe the application and advances in the understanding of mechanisms involved in response to smart nanoparticles and plants. This work on nanomaterials and nanotechnologies (herbicides, pesticides, sensors, and food industries) covers the interdisciplinary fields such as plant biology and agriculture and nanotechnological improvements to increase crop yields, with special emphasis on environmental sustainable management. This approach has become an attractive focus in plant nanotechnology research toward resource efficient and sustainable development. The book covers the application of tailored nanoparticles targeted at food, medicine, agriculture, and toward new applications that integrate biological system with nanomaterials to produce bio-hybrids and the next generation of bionic architectures.

The first chapter by Emul et al. reviews new perspectives of nanomaterials and applications in the near future. Chapter 2 by Kumari et al. highlights the recent progress of the nanomaterials in the agriculture and food sector and clinical landscape. In Chap. 3, Sharma and Kar describe plant nanobionics and its applications. Plastics, nanomaterials, and microbe-plant interactions in the environment are discussed by Benckiser in Chap. 4. In Chapter 5, Choudhary et al. emphasize characterization techniques such as DLS, FTIR, XRD, XPS, AAS, SEM, and TEM provide reliable, consistent, and accurate results of chitosan-based nanomaterials. In Chap. 6, Omar et al. highlight on the impact (plant growth and toxicity) of nanomaterials in plant systems. In Chap. 7, Cásarez-Santiago describes that nanoagriculture offers new alternatives to increase the efficiency of crops, the quality of water, and the use of agro-wastes for energy production. In Chap. 8, Boddula et al. highlight on nanopesticides and nanosensors in agriculture system. In Chap. 9, Sundarraj highlights on nanoagriculture in the food industry. Boskovic et al. detail that nanoencapsulation of plant extracts and plant extract-mediated synthesis of nanoparticles and their potential application improve the safety and quality and prolong the shelf life of meat and milk products in Chap. 10. In Chap. 11, Jampílek and Kráľová give an overview of impact of nanoparticles on photosynthesizing organisms and their use in hybrid structures and components of photosynthetic apparatus. The applications of nanoparticles in plant tissue culture are discussed in Chap. 12 by Álvarez et al.

Finally, advances in nanomaterials with special reference to plant metabolism are presented by Verma et al. Chap. 13.

This book is designed for undergraduate and postgraduate students, researchers, policy makers, and other professionals in plant biology, biotechnology-, and nanotechnology-related disciplines. I honor the leading experts with extensive, in-depth experience and expertise in plant system and nanoscience who took the time and effort to develop these outstanding chapters. Each chapter is written by globally renowned researchers/scientists so the reader is given an up-to-date and detailed account of knowledge of the nanoscience and innumerable applications of plant biology.

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Ram Prasad, Ph.D. is associated with Amity Institute of Microbial Technology, Amity University, Uttar Pradesh, India, since 2005. His research interest includes applied microbiology, plant-microbe interactions, sustainable agriculture, and nanobiotechnology. Dr. Prasad has more than one hundred fifty publications to his credit, including research papers, review articles, and book chapters, and five patents, issued or pending, and has edited or authored several books. Dr. Prasad has 12 years of teaching experience, and he has been awarded the Young Scientist Award (2007) and Prof. J.S. Datta Munshi Gold Medal (2009) by the International Society for Ecological Communications; FSAB Fellowship (2010) by the Society for Applied Biotechnology; the American Cancer Society UICC International Fellowship for Beginning Investigators, USA (2014); Outstanding Scientist Award (2015) in the field of microbiology by the Venus International Foundation; BRICPL Science Investigator Award (ICAABT-2017); and Research Excellence Award (2018). He has been serving as editorial board member in *Frontiers in Microbiology*, *Frontiers in Nutrition*, and *Academia Journal of Biotechnology* including series editor of *Nanotechnology in the Life Sciences*, Springer Nature, USA. Previously, Dr. Prasad served as visiting assistant professor at the Whiting School of Engineering, Department of Mechanical Engineering, Johns Hopkins University, USA, and presently working as research associate professor at the School of Environmental Sciences and Engineering, Sun Yat-sen University, Guangzhou, China.