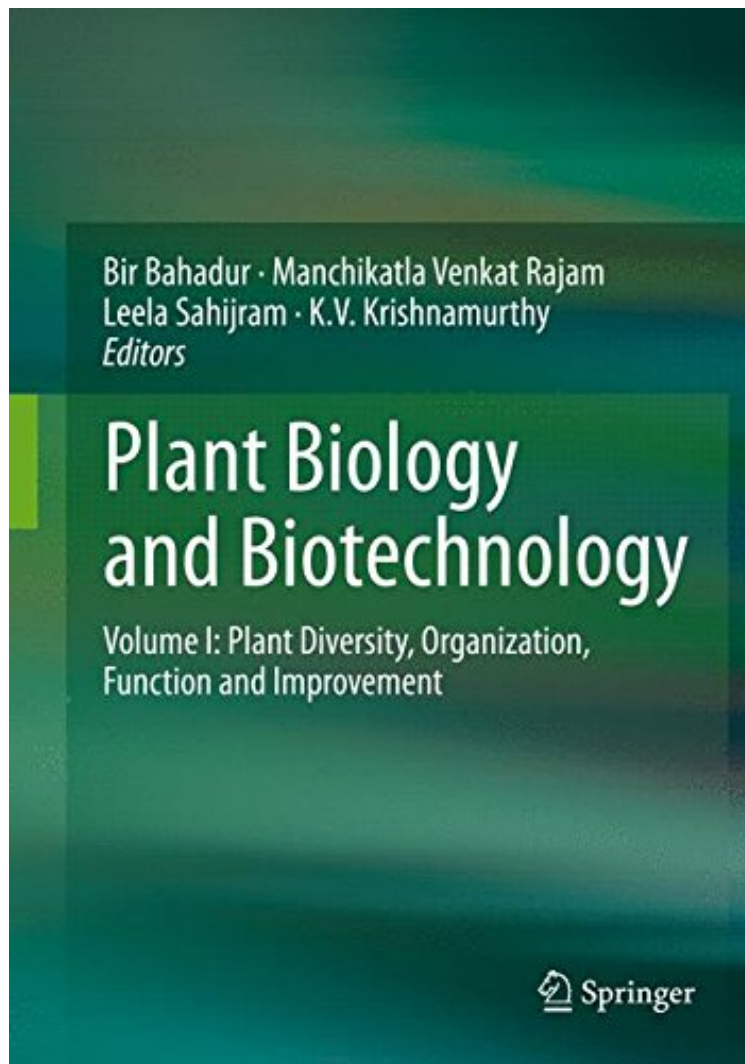


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This volume offers a much-needed compilation of essential reviews on diverse aspects of plant biology, written by eminent botanists. These reviews effectively cover a wide range of aspects of plant biology that have contemporary relevance. At the same time they integrate classical morphology with molecular biology, physiology with pattern formation, growth with genomics, development with morphogenesis, and classical crop-improvement techniques with modern breeding methodologies. Classical botany has been transformed into cutting-edge plant biology, thus providing the theoretical basis for plant biotechnology. It goes without saying that biotechnology has emerged as a powerful discipline of Biology in the last three decades. Biotechnological tools, techniques and information, used in combination with appropriate planning and execution, have already contributed significantly to economic growth and development. It is estimated that in the next decade or two, products and processes made possible by biotechnology will account for over 60% of worldwide commerce and output. There is, therefore, a need to arrive at a general understanding and common approach to issues related to the nature, possession, conservation and use of biodiversity, as it provides the raw material for biotechnology. More than 90% of the total requirements for the biotechnology industry are contributed by plants and microbes, in terms of goods and services. There are however substantial plant and microbial resources that are waiting for biotechnological exploitation in the near future through effective bioprospection. In order to exploit plants and microbes for their useful products and processes, we need to first understand their basic structure, organization, growth and development, cellular process and overall biology. We also need to identify and develop strategies to improve the productivity of plants. In view of the above, in this two-volume book on plant biology and biotechnology, the first volume is devoted to various aspects of plant biology and crop improvement. It includes 33 chapters contributed by 50 researchers, each of which is an expert in his/her own field of research. The book begins with an introductory chapter that gives a lucid account on the past, present and future of plant biology, thereby providing a perfect historical foundation for the chapters that follow. Four chapters are devoted to details on the structural and developmental aspects of the structures of plants and their principal organs. These chapters provide the molecular biological basis for the regulation of morphogenesis of the form of plants and their organs, involving control at the cellular and tissue levels. Details on biodiversity, the basic raw material for biotechnology, are discussed in a separate chapter, in which emphasis is placed on the genetic, species and ecosystem diversities and their conservation. Since fungi and other microbes form an important component of the overall biodiversity, special attention is paid to the treatment of fungi and other microbes in this volume. Four chapters respectively deal with an overview of fungi, arbuscular mycorrhizae and their relation to the sustenance of plant wealth, diversity and practical applications of mushrooms, and lichens (associated with a photobiont). Microbial endosymbionts associated with plants and phosphate solubilizing microbes in the rhizosphere of plants are exhaustively treated in two separate chapters. The reproductive strategies of bryophytes and an overview on Cycads form the subject matter of another two chapters, thus fulfilling the need to deal with the non-flowering Embryophyte group of plants. Angiosperms, the most important group of plants from a biotechnological perspective, are examined exhaustively in this volume. The chapters on angiosperms provide an overview and cover the genetic basis of flowers development, pre- and post-fertilization reproductive growth and development, seed biology and technology, plant secondary metabolism, photosynthesis, and plant volatile chemicals. A special effort has been made to include important topics on crop improvement in this volume. The importance of pollination services, apomixes, male sterility, induced mutations, polyploidy and climate changes is discussed, each in a separate chapter. Microalgal nutraceuticals, vegetable-oil-based nutraceuticals and the importance of alien crop resources and underutilized crops for food and nutritional security form the topics of three other chapters in this volume. There is also a special chapter on the applications of remote sensing in the plant sciences, which also provides information on biodiversity distribution. The editors of this volume believe the wide range of basic topics on plant biology that have great relevance in biotechnology covered will be of great interest to students, researchers and teachers of botany and plant biotechnology alike.

Plant Biology and Biotechnology will be the go-to resource for complete and accurate information on almost any plant-related question. The chapter titles provide clear and accurate descriptions of their contents. I bet that by just reading the chapter titles, you have already begun to think more deeply and broadly about the value of plants in the world. It will be good for the soul of the individual and the soul of plant biology and biotechnology. (Randy Wayne, *The Quarterly of Biology*, Vol. 91 (2), June, 2016) From the Back Cover This volume offers a much-needed compilation of essential reviews on diverse aspects of plant biology, written by eminent botanists. These reviews effectively cover a wide range of aspects of plant biology that have contemporary relevance. At the same time they integrate classical morphology with molecular biology, physiology with pattern formation, growth with genomics, development with morphogenesis, and classical crop-improvement techniques with modern breeding methodologies. Classical botany has been transformed into cutting-edge plant biology, thus providing the theoretical basis for plant biotechnology. It goes without saying that biotechnology has emerged as a powerful discipline of Biology in the last three decades. Biotechnological tools, techniques and information, used in combination with appropriate planning and execution, have already contributed significantly to economic growth and development. It is estimated that in the next decade or

two, products and processes made possible by biotechnology will account for over 60% of worldwide commerce and output. There is, therefore, a need to arrive at a general understanding and common approach to issues related to the nature, possession, conservation and use of biodiversity, as it provides the raw material for biotechnology. More than 90% of the total requirements for the biotechnology industry are contributed by plants and microbes, in terms of goods and services. There are however substantial plant and microbial resources that are waiting for biotechnological exploitation in the near future through effective bioprospection. In order to exploit plants and microbes for their useful products and processes, we need to first understand their basic structure, organization, growth and development, cellular process and overall biology. We also need to identify and develop strategies to improve the productivity of plants. In view of the above, in this two-volume book on plant biology and biotechnology, the first volume is devoted to various aspects of plant biology and crop improvement. It includes 33 chapters contributed by 50 researchers, each of which is an expert in his/her own field of research. The book begins with an introductory chapter that gives a lucid account on the past, present and future of plant biology, thereby providing a perfect historical foundation for the chapters that follow. Four chapters are devoted to details on the structural and developmental aspects of the structures of plants and their principal organs. These chapters provide the molecular biological basis for the regulation of morphogenesis of the form of plants and their organs, involving control at the cellular and tissue levels. Details on biodiversity, the basic raw material for biotechnology, are discussed in a separate chapter, in which emphasis is placed on the genetic, species and ecosystem diversities and their conservation. Since fungi and other microbes form an important component of the overall biodiversity, special attention is paid to the treatment of fungi and other microbes in this volume. Four chapters respectively deal with an overview of fungi, arbuscular mycorrhizae and their relation to the sustenance of plant wealth, diversity and practical applications of mushrooms, and lichens (associated with a photobiont). Microbial endosymbionts associated with plants and phosphate solubilizing microbes in the rhizosphere of plants are exhaustively treated in two separate chapters. The reproductive strategies of bryophytes and an overview on Cycads form the subject matter of another two chapters, thus fulfilling the need to deal with the non-flowering Embryophyte group of plants. Angiosperms, the most important group of plants from a biotechnological perspective, are examined exhaustively in this volume. The chapters on angiosperms provide an overview and cover the genetic basis of flowers development, pre- and post-fertilization reproductive growth and development, seed biology and technology, plant secondary metabolism, photosynthesis, and plant volatile chemicals. A special effort has been made to include important topics on crop improvement in this volume. The importance of pollination services, apomixes, male sterility, induced mutations, polyploidy and climate changes is discussed, each in a separate chapter. Microalgal nutraceuticals, vegetable-oil-based nutraceuticals and the importance of alien crop resources and underutilized crops for food and nutritional security form the topics of three other chapters in this volume. There is also a special chapter on the applications of remote sensing in the plant sciences, which also provides information on biodiversity distribution. The editors of this volume believe the wide range of basic topics on plant biology that have great relevance in biotechnology covered will be of great interest to students, researchers and teachers of botany and plant biotechnology alike.

About the Author: Dr. Bir Bahadur, born 5 April 1938, studied at City College, Hyderabad, for 5 years including an Intermediate Course (Osmania University) and graduated from Nizam College and postgraduated from University College, Osmania University, both in the first division. He obtained his Ph.D. in Plant Genetics from Osmania University. He was closely associated with late Prof. J.B.S. Haldane, F.R.S., a renowned British geneticist who encouraged him to study heterostyly and incompatibility in Indian plants, a subject first studied by Charles Darwin. He made significant contributions in several areas, especially heterostyly, incompatibility, plant genetics, mutagenesis, plant tissue culture and biotechnology, morphogenesis, application of SEM in botanical research, plant asymmetry, plant morphology and anatomy, and lately biofuel plants *Jatropha* and *castor*. He served as Lecturer and Reader at Osmania University, Hyderabad, and as Reader and Professor at Kakatiya University, Warangal. He also served as Head of Department; Chairman, Board of Studies; Dean, Faculty of Science; and Co-ordinating Officer/Dean UGC Affairs at Kakatiya University. He has over 40 years of teaching and over 50 years of research experience. He has supervised 29 Ph.D. students and 3 M.Phil. students in both these universities and has published about 250 research papers/reviews which are well received and cited in national and international journals, textbooks and reference books. He was a postdoctoral fellow at the Institute of Genetics, Hungarian Academy of Sciences, Budapest, and worked on mutagenesis and chromosome replication in *Rhizobium*. He is a recipient of the direct award from the Royal Society Bursar, London. He also worked at Birmingham University (UK). He was conferred with the title of Honorary Research Fellow by the Birmingham University. He studied species differentiation in wild and cultivated solanums using interspecific hybridization and the enzyme-etched seeds technique in combination with scanning electron microscopy to assess the relationship among various *Solanum* species. At the invitation of the Royal Society, he visited Oxford University, Leeds University, Reading University and London University, including the Royal Botanic Gardens, Kew, and various research labs. He was invited for international conferences by the US Science Foundation at the University of Missouri, St. Louis, and the University of Texas, Houston (USA), and at the SABRO international conference at Szukoba, Japan. He has extensively visited most countries of Eastern and Western Europe as well as Tanzania and the Middle East. He has authored/edited ten books.

One of his important books is entitled *Jatropha, Challenges for a New Energy Crop*, Vol. 1 and 2, published by Springer, New York, USA, 2013, jointly edited with Dr. M. Sujatha and Dr. Nicolas Carels. These books are considered significant contributions to bioenergy in recent times. He was Chief Editor, *Proceedings of Andhra Pradesh Akademi of Sciences*, Hyderabad, and Executive Editor, *Journal of Palynology* (Lucknow). He is the recipient of the Best Teacher Award by the Andhra Pradesh Government for mentoring thousands of students in his teaching career spanning over 40 years. He was honoured with Prof. Vishwamber Puri, Medal of Indian Botanical Society for his original contributions in various aspects of plant sciences. He has been honoured with the Bharat Jyoti Award at New Delhi for outstanding achievements and sustained contributions in the fields of education and research. He has been listed as one of the 39 prominent alumni of City College, a premier institution with a long history of about 90 years as per the latest update on its website. He has been chosen for distinguished standing and has been conferred with an Honorary Appointment to the Research Board of Advisors by the Board of Directors, Governing Board of Editors and Publications Board of the American Biographical Institute, USA. He is a fellow of over a dozen professional bodies in India and abroad, including the following: Fellow of the Linnean Society, London; Chartered Biologist and Fellow of the Institute of Biology, London. Presently, he is an Independent Board of Director of Sri Biotech Laboratories India Ltd., Hyderabad, India. Dr. Manchikatla Venkat Rajam is currently Professor and Head, Department of Genetics, University of Delhi South Campus, New Delhi, India. He obtained his Ph.D. in Botany (1983) from Kakatiya University, Warangal, India. He was a postdoctoral fellow at the prestigious Yale University, New Haven (1984-1985), and also worked at BTI (Cornell University, Ithaca) for a couple of months as a visiting research associate. At Yale University, his work led to the discovery of a new method for the control of fungal plant infections through selective inhibition of fungal polyamine biosynthesis. This novel method has been adapted by several research groups globally for the control of a variety of fungal infections, and a large number of research articles have been published in this line of work. He returned to India to join as Pool Officer (CSIR) and worked for about 2 years (1986-1987) at Kakatiya University. Subsequently, he joined the University of Delhi South Campus, where he has been on the faculty since 1987. He had worked in ICGEB, New Delhi, for 6 months as a National Associate of DBT (1994). He made several short visits to various countries, including France, Italy, China and Indonesia, under the collaborative projects supported by the EU and Indo-French. He is a Fellow of the prestigious Indian National Science Academy (FNA), National Academy of Sciences, India (FNASc); National Academy of Agricultural Sciences (FNAAS); Andhra Pradesh Akademi of Sciences (FAPAS); and Association of Biotechnology and Pharmacy (FABAP) and is an elected member of the Plant Tissue Culture Association, India, since 1995. He was awarded the Rockefeller Foundation Biotech Career Fellowship in 1998 (but could not avail it); the Shiksha Rattan Puraskar by the India International Friendship Society in 2011; Department of Biotechnology National Associateship in 1994; and National Scholarship for Study Abroad (Government of India) in 1984 and for Research in 1985 by the Rotary International Club of Hyderabad. He is serving as an Associate Editor and member of the editorial board of several reputed journals, including *BMC Biotechnology* and the *OMICS journal Cell and Developmental Biology*, and is a member of the advisory or other committees of some universities, institutions as well as other bodies. He has guided 28 Ph.D. students, 7 M.Phil. students and over 22 postdoctoral fellows and has published over 120 papers (80 research articles in peer-reviewed journals, 15 review articles, 20 book chapters and general articles). He has one Indian patent to his credit. He has vast experience in plant biotechnology and RNA interference and has handled over 22 major projects in these areas. Dr. Leela Sahijram is currently Principal Scientist, Division of Biotechnology, Indian Institute of Horticultural Research, Bangalore, India, and heading the Plant Tissue Culture Laboratory. She obtained her M.Sc. in Botany (Plant Physiology) with distinction from Osmania University, Hyderabad, India (1976), and Ph.D. in Plant Physiology (1983) from the Indian Agricultural Research Institute, New Delhi, India. She was deputed under the USAID Programme to the University of California at Davis, USA (1992), for plant transformation. She has also undergone training in bioinformatics at IISR, Calicut, India (2003). She has published several papers in national and international journals and has guided students for their masters and doctoral degree programmes. She was identified by the Department of Biotechnology (DBT), New Delhi, for training on Biotechnology and Intellectual Property Rights (IPR) at the National Law School of India University (NLSIU), Bangalore (2003). She attended a residential course on Creative Writing in Agriculture at the Indian Institute of Mass Communication (IIMC), New Delhi (2011). Her team pioneered the micropropagation of banana (globally, the leading tissue-culture-propagated fruit crop), which has spawned a multibillion-dollar industry worldwide. In 1990, she successfully demonstrated over 20 choice clones of banana from across India to be micropropagatable, including cultivars of the Cavendish Group. She was member of the Task Force for the rehabilitation of Nanjangud Rasabale (Pride of Karnataka) syn. Rasthali, Silk group a clone threatened with extinction. She has also worked extensively on micropropagation and specific pathogen free (SPF) plantlet production through meristem culture/micrografting in crops like citrus, caladium, bougainvillea and chrysanthemum, besides bananas and plantains. She specializes in hybrid embryo rescue in perennial horticultural crops (intergeneric/interspecific/intervarietal crosses), particularly in fruit crops, namely mango, seedless grapes/citrus, banana and papaya. In 2000-2001, she pioneered hybrid embryo culture and ex vitro grafting in controlled crosses of mango. She was conferred with Dr. Vikram Govind Prasad Award 1999-2000 for research on molecular diagnostics of

viruses in micropropagated bananas. She was also honoured with the Horticultural Society of India Award 2006/2007 for research on hybrid embryo rescue in seedless grapes and with the Rashtriya Sanman Award 2007 for developing biotechnologies for horticultural crops. She has been editing the Journal of Horticultural Sciences, an international journal, for the past 9 years, as a Founder Editor. She has also edited a book entitled Biotechnology in Horticultural and Plantation Crops. She has several book chapters in national and international publications to her credit. She is the author of many technical and semi-technical popular articles and a laboratory manual, besides having trained hundreds of personnel from development departments for setting up commercial plant tissue culture laboratories. She has travelled widely.

Dr. K.V. Krishnamurthy is currently an Adjunct Professor at the Institute of Trans-Disciplinary Health Science and Technology (IHST), Bangalore, India, and offering consultancy services in Ayurvedic Pharmacognosy. He obtained his M.Sc. in Botany with University First Rank from Madras University, Chennai, in 1966 and Ph.D. in Developmental Plant Anatomy from the same university in 1973. After a brief stint in government colleges in Tamil Nadu, he joined the present Bharathidasan University, Tiruchirappalli, in 1977 and became a Full Professor in 1989. He has an overall teaching and research experience of more than 47 years and has guided 32 Ph.D. scholars, more than 50 M.Phil. scholars and hundreds of masters degree holders. He has published more than 180 research papers and 25 books including Methods in Cell Wall Cytochemistry (CRC Press, USA) and a textbook on biodiversity (Science Publishers, USA), Bioresources of Eastern Ghats: Their Conservation and Management (with Bishen Singh Mahendra Pal Singh, Dehradun). His major research areas include plant morphology and morphogenesis, biodiversity, wood science, cytochemistry, plant reproductive biology and ecology, tissue culture, and herbal medicine and pharmacognosy. He has operated more than 15 major research projects so far. He has been a Fulbright Visiting Professor at the University of Colorado, Boulder, in 1993 and has visited and lectured in various universities in the UK in 1989. His outstanding awards and recognitions include the following: INSA Lecture Award 2011; Prof. A Gnanam Endowment Lecture Award 2010; President 2007, Indian Association for Angiosperm Taxonomy; Prof. V. Puri Award 2006 by the Indian Botanical Society; Rashtriya Gaurav Award 2004 by India International Friendship Society, New Delhi; Scientist of the Year Award 2001 by the National Environmental Science Academy, New Delhi; Tamil Nadu State Scientist Award 1997/1998 in the Field of Environmental Science; Dr. V.V. Sivarajan Gold Medal Award by the Indian Association for Angiosperm Taxonomy for Field Study in the year 1997/1998; Prof. Todla Ekambaram Endowment Lecture Award, Madras University, 1997; Prof. G.D. Arekal Endowment Lecture Award, Mysore University, 1997/1998; Prof. V.V. Sivarajan Endowment Lecture Award, Calicut University, 1997; Prof. Rev. Fr. Balam Memorial Lecture Award, 1997; the 1984 Prof. Hiralal Chakraborty Award instituted by the Indian Science Congress in recognition of the significant contributions made to the science of botany, 1960; Dr. Pulney Andy Gold Medal awarded by Madras University as University First in M.Sc. Botany, 1966; Dr. Todla Ekambaram Prize awarded by Madras University for standing first in M.Sc. Plant Physiology, 1966; The Maharaja of Vizianagaram Prize awarded by Presidency College, Madras, for outstanding postgraduate student in science, 1965/1966; and Prof. Fyson Prize awarded by Presidency College, Madras, for the best plant collection and herbarium, 1965/1966. He has been a fellow of the following: Fellow of the National Academy of Sciences of India (FNASc); Fellow of the Linnean Society, London (FLS); Fellow of Indian Association for Angiosperm Taxonomy (FIAT); Fellow of International Association of Wood Anatomists, Leiden; Fellow of the Plant Tissue Culture Association of India; and Fellow of the Indian Botanical Society. He has been the Editor and editorial member of many journals in and outside India and has also been reviewer of research articles for many journals. He has also served in various committees, the major funding organizations of India and several universities of India. He has been the Registrar and Director, College and Curriculum Development Council; Member of Syndicate and Senate; Coordinator of the School of Life Sciences and Environmental Sciences; Head of the Department of Plant Sciences; and a Visiting Professor in the Department of Bioinformatics at Bharathidasan University, Tiruchirappalli before assuming the present job after retirement.