



An Introduction to Plant Tissue Culture: Advances and Perspectives

Victor M. Loyola-Vargas and Neftalí Ochoa-Alejo

Abstract

Plant tissue culture techniques are the most frequently used biotechnological tools for basic and applied purposes ranging from investigation on plant developmental processes, functional gene studies, commercial plant micropropagation, generation of transgenic plants with specific industrial and agronomical traits, plant breeding and crop improvement, virus elimination from infected materials to render high-quality healthy plant material, preservation and conservation of germplasm of vegetative propagated plant crops, and rescue of threatened or endangered plant species. Additionally, plant cell and organ cultures are of interest for the production of secondary metabolites of industrial and pharmaceutical interest. New technologies, such as the genome editing ones combined with tissue culture and *Agrobacterium tumefaciens* infection, are currently promising alternatives for the highly specific genetic manipulation of interesting agronomical or industrial traits in crop plants. Application of omics (genomics, transcriptomics, and proteomics) to plant tissue culture will certainly help to unravel complex developmental processes such as organogenesis and somatic embryogenesis, which will probably enable to improve the efficiency of regeneration protocols for recalcitrant species. Additionally, metabolomics applied to tissue culture will facilitate the extraction and characterization of complex mixtures of natural plant products of industrial interest. General and specific aspects and applications of plant tissue culture and the advances and perspectives are described in this edition.

Key words Aseptic culture, Genetic modified organisms, Large-scale propagation, Metabolic engineering, Plant cell culture, Proteomics, Transcriptomics

1 Introduction

Plant tissue culture is a broad term that refers to the culture of any part of a plant (cells, tissues, or organs) in artificial media, in aseptic conditions, and under controlled environments. This set of techniques emerged as an experimental approach to demonstrate the cell theory, which establishes that all living organisms are constituted of cells, the basic units of structure and reproduction, and also the totipotency concept, which is defined as the genetic potential of a cell to generate an entire multicellular organism [1]. Different attempts were conducted by several researchers to investigate the

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Perspectives in Plant Cell and Tissue Culture Indra K. Vasil, 1980 **Cell and Tissue Culture in Forestry** J.M. Bonga, D.J. Durzan, 2013-06-29 Since the first edition of our book *Tissue Culture in Forestry* in 1982 we have witnessed remarkable advances in cell and tissue culture technologies with woody perennials In addition to forest biologists in government industry and universities we now have molecular biologists genetic engineers and biochemists using cell and tissue cultures of woody species routinely There fore the time has come for an update of the earlier edition In our present effort to cover new developments we have expanded to three volumes 1 General principles and Biotechnology 2 Specific Principles and Methods Growth and Development 3 Case Histories Gymnosperms Angiosperms and Palms The scientific barriers to progress in tree improvement are not so much lack of foreign gene expression in plants but our current inability to regenerate plants in true to type fashion on a massive and economic scale To achieve this in the form of an appropriate biotechnology cell and tissue culture will increasingly require a better understanding of basic principles in chemistry and physics that determine structural and functional relationships among molecules and macromolecules proteins RNA DNA within cells and tissues These principles and their relationship with the culture medium and its physical environment principles of clonal propagation and genetic variation and ultrastructure are discussed in volume one *Cell and Tissue Culture Techniques for Cereal Crop Improvement*, 1983 **Biotechnology** G. Thottappilly, 1992 Need for biotechnology research in Africa Enhancing the genetic base Cell and tissue culture Controlled gene manipulation Using molecular markers Other selected applications of biotechnology Policy issues *Biology of the Rhizobiaceae* Kenneth L. Giles, Alan G. Atherly, 2013-10-15 *Biology of the Rhizobiaceae* covers the genetics molecular biology agricultural and morphological aspects of the rhizobia The book discusses the taxonomy and identification of the Rhizobiaceae the biology of *Agrobacterium tumefaciens* and the specific events in the disease cycle of crown gall and the agricultural control of *Agrobacterium tumefaciens* The text also describes the growth potential of crown gall tumors and crown gall teratoma plasmid studies in crown gall tumorigenesis and the biology and microbiology of *Agrobacterium rhizogenes* The recognition in rhizobium legume symbioses the rhizobium bacteroid state and the exchange of metabolites and energy between legume and rhizobium are also considered The book further tackles the mutants of rhizobium that are altered in legume interaction and nitrogen fixation as well as the significance and application of Rhizobium in agriculture Botanists agriculturists geneticists molecular biologists microbiologists plant pathologists and agronomists will find the book invaluable **Aspects of Cell Regulation** G. H. Bourne, J. F. Danielli, 2013-11-06 *Aspects of Cell Regulation* deals with the various aspects of cellular control

mechanisms The book begins with a discussion of the role of hormones in the control of cell differentiation and biochemical control over the life of an organism This is followed by separate chapters on an intracellular control problem namely the proper reproduction of cellular organelles and their apportionment between daughter cells at cell mitosis cell mutants with different temporal order for macromolecular synthesis and the control of a plant enzyme that converts triglycerides into carbohydrate during the early stages of postgerminative growth within seed cotyledon Subsequent chapters deal with the possible role of mitochondria in changing the control mechanism of cells to that associated with carcinogenesis the possibility of transforming genes being detectable in the genome after the transformation to neoplastic cell the correlation between viruses and tumor cells and whether viruses can originate from cells rather than coming before cells **The 5-year Outlook on Science and Technology**, 1982 The Five-year Outlook on Science and Technology, 1982 Committee on Science, Engineering, and Public Policy (U.S.), 1983 *Gene Manipulation in Plant Improvement* J. Perry Gustafson, 2012-12-06 The results obtained to date involving the use of in methods to facilitate wide hybridization in plants are voluminous and impressive The techniques of embryo culture ovule culture and in pollination and fertilization represent an extension of the normal sexual hybridization process Successes recorded in obtaining hybrids stem largely from circumventing prezygotic or postzygotic hybridization barriers Numerous recent successful hybridizations were possible because of the development of improved tissue and cell culture systems for crop plants and attention given to genotypes used in hybridization attempts Interspecific and intergeneric hybridization utilizing the process of protoplast fusion will bypass the limits set by all sexual methods In addition to combining complete genomes from two different species through protoplast fusion this system affords unique opportunities for creating novel cytoplasmic combinations transfer of individual chromosomes transfer of cytoplasmic organelles manipulation of male sterility and for single gene transfer Some caution must be noted with regard to the extent of hybridization possible between distantly related species Although practically no limit exists to the physical fusion of protoplasts from widely divergent species the restrictions imposed by somatic incompatibility have not been adequately addressed Regeneration of plants from the protoplast or single heterokaryon level is still a major hurdle for many important crop species before somatic cell fusion can be exploited to produce interspecific and intergeneric hybrids Identification and selection of hybrids is also a limitation to the efficient application of cell fusion methods Membrane Research: Classic Origins and Current Concepts A. L. Muggleton-Harris, 2013-10-15 Membrane Research Classic Origins and Current Concepts is a special volume of the International Review of Cytology dedicated to Dr Danielli on the occasion of his retirement from official duties The central theme of the volume is membranes The diversity of topics ranges from the biogenesis of membranes and their components to the use of optical and lectin probes as a means to study the structure physiology and interactions of cell components and organelles in plant and animal systems The book begins with a study on the cell surface of the mammalian embryo and the events associated with the formation of the

differentiated blastocyst This is followed by separate chapters on the structural associations between the inner and outer bacterial membrane the interactions of cell wall and membrane in plant cells the morphological and functional aspects of membranes and methods for studying the physiology of cell and organelles at the membrane level Subsequent chapters deal with the synthesis of cellular proteins and glycoproteins techniques for fixing and preserving the ultrastructure of the membrane the synthesis of artificial organelles and the effects of drugs and chemicals on membrane transport utilizing kidney tissue and vesicles This book provides an outstanding reference source for all scientific researchers and teachers

Chemistry and World Food Supplies L. W. Shemilt,1983 **Embryogenesis** Ken-Ichi Sato,2012-04-20 The book Embryogenesis is a compilation of cutting edge views of current trends in modern developmental biology focusing on gametogenesis fertilization early and or late embryogenesis in animals plants and some other small organisms Each of 27 chapters contributed from the authorships of world wide 20 countries provides an introduction as well as an in depth review to classical as well as contemporary problems that challenge to understand how living organisms are born grow and reproduce at the levels from molecule and cell to individual **Plant Protoplasts** Kenneth L. Giles,2013-10-15 Plant Protoplasts covers the techniques involved with and uses of protoplast technology The book discusses isolation fusion and culture of higher plant protoplasts lower plant protoplasts and blue green algal protoplast The text also describes the production of haploid protoplasts from developing pollen grains the use of protoplasts in mutant selection schemes and the development of protoplast systems for use with monocotyledonous plants The book will be invaluable to plant technologists botanists biochemists research workers as well as advanced students interested in gaining a background knowledge of the field **Cultivo de tejidos en la agricultura** W. M. Roca,Luis A. Mroginski,1991 Principios basicos metodologias y tecnicas del cultivo de tejidos vegetales Aplicaciones del cultivo de tejidos a especies vegetales economicamente importantes Aplicaciones de tecnicas bioquimicas y moleculares al cultivo de tejidos vegetales [New Perspectives in Plant Science](#) Annals of Botany Company. Centenary Symposium,1987 **Advances in Agronomy** ,1991-01-02 Advances in Agronomy

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