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# **Cell Culture and Somatic Cell Genetics of Plants**

**INDRA K. VASIL**

Editor-in-Chief

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**VOLUME 4**

**Cell Culture in Phytochemistry**

**FRIEDRICH CONSTABEL**

**INDRA K. VASIL**

Editors



# Cell Culture and Somatic Cell Genetics of Plants

VOLUME 4

Cell Culture in Phytochemistry

Edited by

**FRIEDRICH CONSTABEL**

*Plant Biotechnology Institute  
National Research Council  
Saskatoon, Saskatchewan, Canada*

**INDRA K. VASIL**

*Laboratory of Plant Cell  
and Molecular Biology  
University of Florida  
Gainesville, Florida*



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# Cell Culture and Somatic Cell Genetics of Plants

VOLUME 4

Cell Culture in Phytochemistry

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# General Preface

Recent advances in the techniques and applications of plant cell culture and plant molecular biology have created unprecedented opportunities for the genetic manipulation of plants. The potential impact of these novel and powerful biotechnologies on the genetic improvement of crop plants has generated considerable interest, enthusiasm, and optimism in the scientific community and is in part responsible for the rapidly expanding biotechnology industry.

The anticipated role of biotechnology in agriculture is based not on the actual production of any genetically superior plants, but on elegant demonstrations in model experimental systems that new hybrids, mutants, and genetically engineered plants can be obtained by these methods, and the presumption that the same procedures can be adapted successfully for important crop plants. However, serious problems exist in the transfer of this technology to crop species.

Most of the current strategies for the application of biotechnology to crop improvement envisage the regeneration of whole plants from single, genetically altered cells. In many instances this requires that specific agriculturally important genes be identified and characterized, that they be cloned, that their regulatory and functional controls be understood, and that plants be regenerated from single cells in which such gene material has been introduced and integrated in a stable manner.

Knowledge of the structure, function, and regulation of plant genes is scarce, and basic research in this area is still limited. On the other hand, a considerable body of knowledge has accumulated in the last fifty years on the isolation and culture of plant cells and tissues. For example, it is possible to regenerate plants from tissue cultures of many plant species, including several important agricultural crops. These procedures are now widely used in large-scale rapid clonal propagation of plants. Plant cell culture techniques also allow the isolation of mutant cell lines and plants, the generation of somatic hybrids by protoplast fusion, and the regeneration of genetically engineered plants from single transformed cells.

Many national and international meetings have been the forums for discussion of the application of plant biotechnology to agriculture. Neither the basic techniques nor the biological principles of plant cell culture are generally included in these discussions or their published proceedings. Following the very enthusiastic reception accorded the two volumes entitled "Perspectives in Plant Cell and Tissue Culture" that were published as supplements to the *International Review of Cytology* in 1980, I was approached by Academic Press to consider the feasibility of publishing a treatise on plant cell culture. Because of the rapidly expanding interest in the subject both in academia and in industry, I was convinced that such a treatise was needed and would be useful. No comprehensive work of this nature is available or has been attempted previously.

The organization of the treatise is based on extensive discussions with colleagues, the advice of a distinguished editorial advisory board, and suggestions provided by anonymous reviewers to Academic Press. However, the responsibility for the final choice of subject matter included in the different volumes, and of inviting authors for various chapters, is mine. The basic premise on which this treatise is based is that knowledge of the principles of plant cell culture is critical to their potential use in biotechnology. Accordingly, descriptions and discussion of all aspects of modern plant cell culture techniques and research are included in the treatise. The first volume describes every major laboratory procedure used in plant cell culture and somatic cell genetics research, including many variations of a single procedure adapted for important crop plants. The second and third volumes are devoted to the nutrition and growth of plant cell cultures and to the important subject of generating and recovering variability from cell cultures. An entirely new approach is used in the treatment of this subject by including not only spontaneous variability arising during culture, but also variability created by protoplast fusion, genetic transformation, etc. Future volumes are envisioned to cover most other relevant and current areas of research in plant cell culture and its uses in biotechnology.

In addition to the very comprehensive treatment of the subject, the uniqueness of these volumes lies in the fact that all the chapters are prepared by distinguished scientists who have played a major role in the development and/or uses of specific laboratory procedures and in key fundamental as well as applied studies of plant cell and tissue culture. This allows a deep insight, as well as a broad perspective, based on personal experience. The volumes are designed as key reference works to provide extensive as well as intensive information on all aspects of plant cell and tissue culture not only to those newly entering the field but also to experienced researchers.

## Preface to Volume 4

The three previous volumes of this treatise have provided comprehensive coverage of the wide variety of laboratory procedures used in plant cell culture, the fundamental aspects of cell growth and nutrition, and plant regeneration and variability. The accumulation of phytochemicals (secondary metabolites) in plant cell cultures has been studied for more than thirty years. However, in recent years there has been considerable interest and activity in the subject due to the expectation of biotechnological application and industrial production. Inasmuch as this expectation became a problem, attention turned toward analysis of the synthesis and accumulation of plant products. At present two important events are taking shape: the realization of industrial plant cell culture for the production of phytochemicals, and a molecular biological approach to understanding the regulation of product synthesis. For the expeditious advancement of these two concepts and components, it appeared desirable to compile and review phytochemistry as studied by employing plant cell cultures. A comprehensive treatment of the subject in the tradition of the earlier volumes of this treatise required two volumes: *Cell Culture in Phytochemistry* (Volume 4) and *Phytochemicals in Cell Cultures* (Volume 5). Plant physiologists and biochemists will forgive our taking the liberty—for the sake of brevity—of using the term phytochemistry in a broad sense to cover their respective disciplines.

The timeliness of the proposed volumes must have been recognized worldwide as the call for manuscripts was received with great enthusiasm. Reports at international conferences and workshops on phytochemistry and plant tissue culture had fallen far short of providing a comprehensive account of the remarkable progress made in the subject. Here we gratefully acknowledge the cooperation of all our colleagues who submitted up-to-date and thorough reviews of their fields of study. At one point we felt overwhelmed by the amount of material received, while at the same time we realized that a few groups of chemicals could not be included.



A science in flux is a fabric of differing thoughts, approaches, and interpretations, all in a state of evolution. A comprehensive treatise such as this should reflect this state, and thus we were anxious not to streamline the presentations. Some overlap in various chapters and some divergence of opinions should therefore be seen as helpful in a broad understanding of the subject. Students as well as colleagues in academia and industry will appreciate the overall effort and the diverse viewpoints presented.

We acknowledge the support of the Editorial Advisory Board in identifying this important area of plant cell culture research for these volumes. The assistance of our colleagues at the Plant Biotechnology Institute (PBI) in Saskatoon, Saskatchewan, Canada, particularly Drs. Balsevich, DeLuca, Eilert, Kurz, and Tyler, and the PBI secretarial staff, is gratefully acknowledged. Spouses of the editors deserve special thanks for enduring countless hours alone: thank you, Christa and Vimla!

*Friedrich (Fred) Constabel*  
*Indra K. Vasil*

# Contents of Previous Volumes

## VOLUME 1

1. Organization of a Plant Tissue Culture Laboratory, *by Daniel C. W. Brown and Trevor A. Thorpe*
2. Educational Services for Plant Tissue Culture, *by Paul J. Bottino*
3. Plant Cell Cultures: Nutrition and Media, *by Oluf L. Gamborg*
4. Callus Culture: Induction and Maintenance, *by F. Constabel*
5. Induction and Maintenance of Embryogenic Callus Cultures of Gramineae, *by Vimla Vasil and Indra K. Vasil*
6. Clonal Propagation: Shoot Cultures, *by Horst Binding and Gabriela Krumbiegel-Schroeren*
7. Clonal Propagation: Adventitious Buds, *by Trevor A. Thorpe and Kamlesh R. Patel*
8. Clonal Propagation: Orchids, *by Yoneo Sagawa and John T. Kunisaki*
9. Clonal Propagation: Somatic Embryos of Citrus, *by T. S. Rangan*
10. Clonal Propagation: Palms, *by Brent Tisserat*
11. Clonal Propagation: Gymnosperms, *by Jenny Aitken-Christie and Trevor A. Thorpe*
12. Culture Methods for Bryophytes, *by Martin Bopp and Bernd Knoop*
13. Culture of Shoot Meristems: Pea, *by K. K. Kartha*
14. Culture of Shoot Meristems: Fruit Plants, *by Olivia C. Broome and Richard H. Zimmerman*
15. The Acclimatization of Micropropagated Plants, *by D. I. Dunstan and K. E. Turner*
16. Induction and Maintenance of Cell Suspension Cultures, *by Patrick J. King*
17. Induction, Maintenance, and Manipulation of Development in Embryogenic Cell Suspension Cultures, *by Philip V. Ammirato*
18. Isolation and Maintenance of Embryogenic Cell Suspension Cultures of Gramineae, *by Vimla Vasil and Indra K. Vasil*
19. Fractionation of Cultured Cells, *by Tatsuhito Fujimura and Atsushi Komamine*
20. Large-Scale Cultures of Cells in Suspension, *by M. W. Fowler*
21. Synchronization of Suspension Culture Cells, *by A. S. Wang and R. L. Phillips*
22. Photoautotrophic Cell Cultures, *by Wolfgang Hüsemann*
23. Quantitative Plating Technique, *by Robert B. Horsch*
24. The Feeder Layer Technique, *by D. Aviv and E. Galun*
25. Culture of Isolated Mesophyll Cells, *by Hans Willy Kohlenbach*
26. The Multiple-Drop-Array (MDA) Screening Technique, *by Christian T. Harms*
27. Culture of Ovaries, *by T. S. Rangan*
28. Culture of Ovules, *by T. S. Rangan*
29. Culture of Cotton Ovules, *by C. A. Beasley*

30. Culture of Embryos, by G. B. Collins and J. W. Grosser
31. Culture of Endosperm, by Sant S. Bhojwani
32. *In Vitro* Pollination and Fertilization, by Maciej Zenktele
33. *In Vitro* Pollination, Fertilization, and Development of Maize Kernels, by Burle G. Gengenbach
34. Anther Culture of *Nicotiana tabacum*, by N. Sunderland
35. Anther Culture of *Solanum tuberosum*, by G. Wenzel and B. Foroughi-Wehr
36. Anther Culture of *Brassica*, by W. A. Keller
37. Anther Culture of Cereals and Grasses, by G. Wenzel and B. Foroughi-Wehr
38. Isolation and Culture of Protoplasts: Tobacco, by Itaru Takebe and Toshiyuki Nagata
39. Isolation and Culture of Protoplasts: *Petunia*, by Horst Binding and Gabriela Krumbiegel-Schroeren
40. Isolation and Culture of Protoplasts: *Datura*, by O. Schieder
41. Isolation and Culture of Protoplasts: *Brassica*, by Hellmut R. Schenck and Franz Hoffmann
42. Isolation and Culture of Protoplasts: Tomato, by Elias A. Shahin
43. Isolation, Culture, and Regeneration of Potato Leaf Protoplasts from Plants Preconditioned *in Vitro*, by Elias A. Shahin
44. Isolation and Culture of Protoplasts from Carrot Cell Suspension Cultures, by Denes Dudits
45. Isolation and Culture of Embryogenic Protoplasts of Cereals and Grasses, by Vimla Vasil and Indra K. Vasil
46. Mechanical Isolation and Single-Cell Culture of Isolated Protoplasts and Somatic Hybrid Cells, by Y. Y. Gleba, V. A. Sidorov, and Franz Hoffmann
47. Fusion of Protoplasts by Polyethylene Glycol (PEG), by F. Constabel
48. Fusion of Protoplasts by Dextran and Electrical Stimulus, by Toshiaki Kameya
49. Inactivation of Protoplasts before Fusion to Facilitate Selective Recovery of Fusion-Derived Clones, by Laszlo Mencel
50. Selection of Somatic Hybrid Cells by Fluorescence-Activated Cell Sorting, by David W. Galbraith
51. Enucleation of Protoplasts: Preparation of Cytoplasts and Miniprotoplasts, by Horst Lörz
52. Isolation of Organelles: Nuclei, by L. Willmitzer
53. Isolation of Organelles: Chromosomes, by Gyula Hadlaczky
54. Isolation of Organelles: Chloroplasts, by J. Kobza and G. E. Edwards
55. Liposome Preparation and Incubation with Plant Protoplasts, by Robert T. Fraley
56. Inoculation of Protoplasts with Plant Viruses, by Itaru Takebe
57. Uptake of Organelles, by Anita Wallin
58. Transformation of Tobacco Cells by Coculture with *Agrobacterium tumefaciens*, by László Márton
59. Ti-Plasmid DNA Uptake and Expression by Protoplasts of *Nicotiana tabacum*, by F. A. Krens and R. A. Schilperoort
60. Immobilization of Cultured Plant Cells and Protoplasts, by P. Brodelius
61. Mutagenesis of Cultured Cells, by Patrick J. King
62. Cell Culture Procedures for Mutant Selection and Characterization in *Nicotiana plumbaginifolia*, by Pal Maliga
63. Induction, Selection, and Characterization of Mutants in Carrot Cell Cultures, by J. M. Widholm
64. Induction, Selection, and Characterization of Mutants in Maize Cell Cultures, by Kenneth A. Hibberd
65. Elimination of Viruses, by K. K. Kartha
66. Cocultures of Plant and Bacterial Cells, by Minocher Reporter

67. Isolation and Bioassay of Fungal Phytotoxins, *by Jonathan D. Walton and Elizabeth D. Earle*
68. Freeze Preservation of Cells, *by Lyndsey A. Withers*
69. Freeze Preservation of Meristems, *by K. K. Kartha*
70. Selection of Cell Lines for High Yields of Secondary Metabolites, *by Yasuyuki Yamada*
71. Isolation and Analysis of Terpenoids, *by Joseph H. Lui*
72. Isolation and Analysis of Alkaloids, *by W. G. W. Kurz*
73. Protein Extraction and Analysis, *by L. R. Wetter*
74. Isolation and Analysis of Plant Growth Regulators, *by Kerry T. Hubick and David M. Reid*
75. Plastic Embedding for Light Microscopy, *by Claudia Botti and Indra K. Vasil*
76. Histological and Histochemical Staining Procedures, *by Edward C. Yeung*
77. Staining and Nuclear Cytology of Cultured Cells, *by Alan R. Gould*
78. Chromosome Analysis, *by R. L. Phillips and A. S. Wang*
79. Preparation of Cultured Cells and Tissues for Transmission Electron Microscopy, *by Larry C. Fowke*
80. Preparation of Cultured Tissues for Scanning Electron Microscopy, *by Vimla Vasil and Indra K. Vasil*
81. Microspectrophotometric Analysis, *by Jerome P. Miksche and Sukhraj S. Dhillon*
82. Cell Cycle Analysis by Conventional Methods, *by Alan R. Gould*
83. Flow Cytometric Analysis of the Cell Cycle, *by David W. Galbraith*
84. Autoradiography, *by Edward C. Yeung*
85. Immunofluorescence Techniques for Studies of Plant Microtubules, *by Larry C. Fowke, Daina Simmonds, Pieter Van Der Valk, and George Setterfield*

## VOLUME 2

1. History of Plant Tissue and Cell Culture: A Personal Account, *by R. J. Gautheret*
2. Dynamics of Plant Cell Cultures, *by K. Lindsey and M. M. Yeoman*
3. The Mass Culture of Plant Cells, *by A. H. Scragg and M. W. Fowler*
4. Nutrition of Plant Tissue Cultures, *by Peggy Ozias-Akins and Indra K. Vasil*
5. Cytodifferentiation, *by Hiroo Fukuda and Atsushi Komamine*
6. Photoautotrophic Growth of Cells in Culture, *by Wolfgang Hüseemann*
7. Cryopreservation of Cultured Cells and Meristems, *by Lyndsey A. Withers*

## VOLUME 3

### Part I Regeneration

1. Attainment and Retention of Morphogenetic Capacity *in Vitro*, *by Walter Halperin*
2. Plant Regeneration by Organogenesis, *by Daniel C. W. Brown and Trevor A. Thorpe*
3. Regeneration in Legumes, *by N. Hammatt, T. K. Ghose, and M. R. Davey*
4. Plant Regeneration from Tissue Cultures of Soybean by Somatic Embryogenesis, *by J. P. Ranch, L. Oglesby, and A. C. Zielinski*
5. Plant Regeneration from Tissue Cultures of Soybean by Organogenesis, *by M. S. Wright, M. G. Carnes, M. A. Hinchee, G. C. Davis, S. M. Koehler, M. H. Williams, S. M. Colburn, and P. E. Pierson*
6. Regeneration in Cereal and Other Grass Species, *by Indra K. Vasil and Vimla Vasil*
7. Regeneration in Vegetable Species, *by John F. Reynolds*
8. Regeneration in Bananas and Plantains, *by Sandra S. Cronauer and A. D. Krikorian*

9. Regeneration in Liliaceae, Iradaceae, and Amaryllidaceae, *by A. D. Krikorian and R. P. Kann*
10. Regeneration in Palms, *by Avril L. Brackpool, Richard L. Branton, and Jennet Blake*
11. Regeneration in Forest Trees, *by David I. Dunstan and Trevor A. Thorpe*
12. Regeneration in Woody Ornamentals and Fruit Trees, *by Richard H. Zimmerman*
13. Regeneration from Protoplasts, *by Horst Binding*
14. Pollen Developmental Biology in Cultured Anthers, *by V. Raghavan*
15. Production of Gynogenetic Haploids, *by L. H. San and P. Gelebart*
16. Ultrastructural Cytology of Cultured Plant Tissues, Cells, and Protoplasts, *by L. C. Fowke*

## Part II Genetic Variability

17. Case Histories of Genetic Variability *in Vitro*: Celery, *by T. J. Orton*
18. Case Histories of Genetic Variability *in Vitro*: Wheat and Triticale, *by P. J. Larkin*
19. Case Histories of Genetic Variability *in Vitro*: Rice, *by Kiichi Fukui*
20. Case Histories of Genetic Variability *in Vitro*: Tobacco, *by H. Dulieu*
21. Case Histories of Genetic Variability *in Vitro*: Tomato, *by David A. Evans*
22. Case Histories of Genetic Variability *in Vitro*: Oats and Maize, *by G. Benzion, R. L. Phillips, and H. W. Rines*
23. Case Histories of Genetic Variability *in Vitro*: Potato, *by K. Sree Ramulu*
24. Isolation and Characterization of Mutant Cell Lines and Plants: Auxotrophs and Other Conditional Lethal Mutants, *by J. P. Bourgin*
25. Isolation and Characterization of Mutant Cell Lines and Plants: Herbicide-Resistant Mutants, *by R. S. Chaleff*
26. Isolation and Characterization of Mutant Cell Lines and Plants: Disease Resistance, *by M. D. Sacristán*
27. Isolation and Characterization of Mutant Cell Lines and Plants: Cold Tolerance, *by Tony H. H. Chen and Lawrence V. Gusta*
28. Isolation and Characterization of Mutant Cell Lines and Plants: Salt Tolerance, *by D. W. Rains, S. S. Croughan, and T. P. Croughan*
29. Factors Controlling Generation of Variability *in Vitro*, *by Alan R. Gould*
30. Protoplast Fusion and Generation of Somatic Hybrids, *by Otto Schieder and Hubertus Kohn*
31. Protoplast Fusion and Generation of Cybrids for Transfer of Cytoplasmic Male Sterility, *by S. Izhar and A. Zelcer*
32. Chloroplast Transfer and Recombination through Protoplast Fusion, *by Pal Maliga and Laszlo Menczel*
33. Variability through Wide Crosses and Embryo Rescue, *by V. Raghavan*

# Contents

|                              |      |
|------------------------------|------|
| General Preface              | ix   |
| Preface to Volume 4          | xi   |
| Contents of Previous Volumes | xiii |

## Part I Introduction

|          |                                       |    |
|----------|---------------------------------------|----|
| <b>1</b> | <b>Cell Culture in Phytochemistry</b> |    |
|          | <b>FRIEDRICH CONSTABEL</b>            |    |
|          | I. History                            | 3  |
|          | II. Cytodifferentiation               | 4  |
|          | III. Outlook                          | 10 |
|          | References                            | 10 |

## Part II Accumulation of Phytochemicals

|          |  |    |
|----------|--|----|
| <b>2</b> | <b>Physiology of the Accumulation of Secondary Metabolites with Special Reference to Alkaloids</b>   |    |
|          | <b>MICHAEL WINK</b>  |    |
|          | I. Introduction  | 17 |
|          | II. Biosynthesis   | 18 |
|          | III. Accumulation of Secondary Metabolites   | 24 |
|          | IV. Conclusion   | 34 |
|          | References   | 35 |
| <b>3</b> | <b>The Compartmentation of Secondary Metabolites in Plant Cell Cultures</b>                          |    |
|          | <b>J. GUERN, J. P. RENAUDIN, and S. C. BROWN</b>   |    |
|          | I. Introduction  | 43 |
|          | II. The Analytical Approach to Cell Compartmentation   | 45 |
|          | III. Compartmentation as a Result of Membrane Transport and Accumulation Processes at Specific Sites | 49 |

|                                    |  |     |
|------------------------------------|--|-----|
|                                    | IV. Compartmentation Related to Growth and Cell Specialization             | 65  |
|                                    | V. Conclusion  | 68  |
|                                    | References   | 69  |
| <b>4</b>                           | <b>Regulation of Synthesis of Phenolics</b>                                |     |
|                                    | <b>RAGAI K. IBRAHIM</b>  |     |
|                                    | I. Introduction  | 77  |
|                                    | II. Phenolic Production in Cultured Tissues                                | 78  |
|                                    | III. Regulation of Phenolic Synthesis                                      | 80  |
|                                    | IV. Conclusion   | 88  |
|                                    | References   | 89  |
| <b>5</b>                           | <b>Cell Growth and Accumulation of Secondary Metabolites</b>               |     |
|                                    | <b>MASAAKI SAKUTA and ATSUSHI KOMAMINE</b>                                 |     |
|                                    | I. Introduction  | 97  |
|                                    | II. Factors Controlling Growth in Plant Cell Cultures                      | 98  |
|                                    | III. Production of Secondary Metabolites and Control of Cell Growth        | 101 |
|                                    | IV. Relationship between Growth and Accumulation of Secondary Metabolites  | 106 |
|                                    | References   | 110 |
| <b>Part III Special Techniques</b> |  |     |
| <b>6</b>                           | <b>Cell Cloning and the Selection of High Yielding Strains</b>             |     |
|                                    | <b>DONALD K. DOUGALL</b>   |     |
|                                    | I. Introduction  | 117 |
|                                    | II. Clones and Cloning   | 117 |
|                                    | III. Heterogeneity in Cell Cultures  | 118 |
|                                    | IV. Stability of Clones and Subclones                                      | 120 |
|                                    | V. High Yielding Strains   | 122 |
|                                    | References   | 123 |
| <b>7</b>                           | <b>Selection of Mutants which Accumulate Desirable Secondary Compounds</b> |     |
|                                    | <b>JACK M. WIDHOLM</b>   |     |
|                                    | I. Introduction  | 125 |
|                                    | II. Selection Systems  | 126 |
|                                    | III. Conclusion  | 133 |
|                                    | References   | 135 |
| <b>8</b>                           | <b>New Approaches to Genetic Manipulation of Plants</b>                    |     |
|                                    | <b>DENES DUDITS</b>  |     |
|                                    | I. Introduction  | 139 |
|                                    | II. Somatic Hybridization by Protoplast Fusion                             | 140 |

|  |     |
|--|-----|
| III. Isolated Plant Chromosomes as Potential Vectors for Gene Transfer   | 146 |
| IV. DNA Transformation   | 146 |
| V. Conclusion  | 147 |
| References   | 148 |
| <b>9 Elicitation: Methodology and Aspects of Application</b>   |     |
| <b>UDO EILERT</b>  |     |
| I. Introduction  | 153 |
| II. Terminology  | 153 |
| III. Elicitors and Their Mode of Action  | 154 |
| IV. Methodology of Elicitation   | 156 |
| V. Factors of Elicitor-Induced Accumulation  | 169 |
| VI. Elicitation of Protoplasts and Isolated Cells  | 178 |
| VII. Elicitation and Cell Ultrastructure   | 179 |
| VIII. Induction and Proteinase Inhibitors  | 179 |
| IX. Biochemical and Molecular Genetic Aspects  | 180 |
| X. Conclusion  | 185 |
| Appendix: Elicitor-Induced Product Accumulation as Presented at the Sixth IAPTC Congress, Minneapolis, 1986            | 187 |
| References   | 188 |
| <b>10 Techniques, Characteristics, Properties, and Commercial Potential of Immobilized Plant Cells</b>                 |     |
| <b>MICHAEL M. YEOMAN</b>   |     |
| I. Introduction  | 197 |
| II. Early Research on Immobilization Systems   | 198 |
| III. Techniques of Cell Immobilization   | 199 |
| IV. Characteristics and Properties of Immobilized Plant Cells which Make Them Suitable for the Production of Chemicals | 203 |
| V. Bioreactor Configurations for Use with Immobilized Cells  | 206 |
| VI. Future Commercial Exploitation   | 209 |
| References   | 213 |
| <b>11 Cryopreservation of Secondary Metabolite-Producing Plant Cell Cultures</b>                                       |     |
| <b>K. K. KARTHA</b>  |     |
| I. Introduction  | 217 |
| II. Cryopreservation Components  | 218 |
| III. Prospects   | 225 |
| References   | 226 |
| <b>12 Plant Regeneration</b>   |     |
| <b>P. S. RAO</b>   |     |
| I. Introduction  | 229 |
| II. General Methodology  | 229 |



|           |  |            |
|-----------|--|------------|
|           | III. Modes of Plant Regeneration                                   | 231        |
|           | IV. Regeneration in Medicinal Plant Tissue Cultures                | 234        |
|           | References   | 247        |
| <b>13</b> | <b>Two-Phase Culture</b>   |            |
|           | <b>R. BEIDERBECK and B. KNOOP</b>                                  |            |
|           | I. Introduction  | 255        |
|           | II. Accumulation Phases  | 256        |
|           | III. Discussion  | 263        |
|           | References   | 265        |
| <b>14</b> | <b>Continuous Culture of Plant Cells</b>                           |            |
|           | <b>J. STEFAN ROKEM</b>   |            |
|           | I. Introduction  | 267        |
|           | II. Characteristics of Plant Cells                                 | 267        |
|           | III. Various Techniques for Continuous Culture of Plant Cells      | 268        |
|           | IV. Fermentor Design   | 273        |
|           | V. Theory and Practice of Continuous Culture Principles            | 275        |
|           | VI. Biomass Production   | 278        |
|           | VII. Metabolite Production   | 279        |
|           | VIII. Future Prospects   | 282        |
|           | References   | 283        |
| <b>15</b> | <b>Use of Immunoassays in the Detection of Plant Cell Products</b> |            |
|           | <b>HEATHER A. KEMP and MICHAEL R. A. MORGAN</b>                    |            |
|           | I. Introduction  | 287        |
|           | II. Methodology of Radioimmunoassay                                | 288        |
|           | III. Use of Radioimmunoassay in the Measurement of Phytochemicals  | 291        |
|           | IV. Methodology of Enzyme-Linked Immunosorbent Assays (ELISAs)     | 293        |
|           | V. Use of ELISA in the Measurement of Phytochemicals               | 295        |
|           | VI. Conclusions  | 298        |
|           | References   | 300        |
|           | <b>Index</b>   | <b>303</b> |