
CONTENTS

<i>Preface</i>	xv
<i>Introduction</i> by William F. Thompson	xix
 PART I. BASIC TECHNIQUES IN PLANT BIOTECHNOLOGY	 1
 1. Vectors for Gene Transfer in Higher Plants	 3
<i>Frank F. White</i>	
1.1 <i>Agrobacterium</i> -Mediated Transformation	4
1.2 <i>Agrobacterium</i> Vectors	9
1.3 Uses of <i>Agrobacterium</i> Vectors	18
1.4 Host Range of <i>Agrobacterium</i>	21
1.5 Alternative DNA Transfer Methods	22
1.6 Conclusions	26
References	26
 2. Methods for Transforming Plant Cells	 35
<i>Ray Wu</i>	
2.1 Transformation of Dicotyledenous Plants	36
2.2 Transformation of Monocotyledenous Plants	38

X Contents

2.3	Conclusions and Future Prospects	49
	Addendum	49
	References	50
3.	Techniques in Plant Cell and Tissue Culture	53
	<i>David A. Evans</i>	
3.1	Clonal Propagation	54
3.2	Somaclonal Variation	57
3.3	Gametoclonal Variation	62
3.4	In Vitro Cell Selection—Mutant Isolation	65
3.5	Protoplast Fusion	66
3.6	Synthesis of Secondary Products	69
3.7	Concluding Remarks	72
	References	72
4.	Selected Topics in the Genetic Manipulation of the Nuclear Genome	77
	<i>R.J. Griesbach</i>	
4.1	Chromosome Transfer	78
4.2	Microcell Transfer	83
4.3	Microinjection	86
4.4	Conclusion	89
	References	90
5.	Regulation and Expression of Plant Genes in Microorganisms	93
	<i>A.A. Gatenby</i>	
5.1	Recognition of Plant Sequences That Function as Promoters of Transcription in Microorganisms	94
5.2	Increasing the Rate of Transcription of Cloned Genes	96
5.3	Translational Features of Plant Gene Expression and Regulation	98
5.4	Recognition of Plant Signal Peptides	100
5.5	Assembly of Multisubunit Plant Proteins	102
5.6	Production of Proteins for Commercial Applications and Analytical Studies	103
5.7	Synthesis of Plant Proteins for Screening and Clone Identification	105
5.8	Complementation of Bacterial Mutations	105
5.9	Protein Stability, Solubility, and Accumulation	106
5.10	Expression in Other Bacterial Species	109
	References	109

PART II. REGULATION OF GENE EXPRESSION IN PLANTS 113

6. The Molecular Architecture of Plant Genes and Their Regulation	115
<i>Keith Elliston and Joachim Messing</i>	
6.1 The Elements of Primary Structure	116
6.2 The Analysis of Primary Structure	117
6.3 Functional Organization of Genes	119
6.4 The Use of Computers in Structural Analyses	120
6.5 Storage Protein Genes	122
6.6 Light-induced Genes	127
6.7 Stress-induced Genes	131
6.8 Nodulation Genes	134
6.9 Housekeeping Genes	134
6.10 Conclusion	135
References	138
7. Induction, Commitment, and Progression of Plant Embryogenesis	141
<i>J.H. Choi and Zinmay R. Sung</i>	
7.1 Developmental Biology of Embryogenesis	142
7.2 Somatic Embryogenesis	143
7.3 Gene Expression in Carrot Culture	145
7.4 Immunological Approach to the Identification of Developmentally Regulated Genes	149
7.5 Conclusion	156
References	158
8. Photoregulation of Gene Expression in Plants	161
<i>John C. Watson</i>	
8.1 Effects of Light on rRNA Gene Expression	164
8.2 Effects of Light on Transcript Abundance	168
8.3 Effects of Plant Hormones	184
8.4 Chloroplast Transcript Accumulation	185
8.5 Plastid Development and Nuclear Gene Expression	186
8.6 Gene Transfer Experiments	188
8.7 Trans-Acting Factors and Transcription In Vitro	197
8.8 Conclusion	198
References	199
9. Hormonal and Stress Regulation of Gene Expression in Cereal Aleurone Layers	207
<i>Tuan-hua David Ho</i>	
9.1 The Cereal Aleurone Layers	207
9.2 Effect of Gibberellins on Gene Expression	209

xii Contents

9.3	Effect of ABA on Gene Expression	216
9.4	Summary and Perspective	226
	References	227
10.	Auxin-Regulated Gene Expression in Plants	229
	<i>Athanasios Theologis</i>	
10.1	Enhancement of Specific Translational Products by IAA in Pea Tissue	230
10.2	Isolation of DNA Sequences Complementary to Some IAA-Regulated mRNAs in Pea	230
10.3	Characterization of the Hormonal Response	234
10.4	Dose Response Curve	238
10.5	Model for Regulation of the Auxin Genes	240
10.6	Conclusions and Future Directions	243
	References	243
11.	Cytokinin-modulated Macromolecular Synthesis and Gene Expression	245
	<i>Chong-maw Chen</i>	
11.1	Active Forms of Cytokinins	246
11.2	Cytokinin-regulated Synthesis of Macromolecules	247
11.3	The Complex Nature of Cytokinin-regulated Gene Expression	249
11.4	Regulation of Gene Expression by Combinations of Hormones	250
11.5	Enhancement of Light-regulated Gene Expression by Cytokinin	251
11.6	Cytokinin-binding Molecules	252
11.7	Concluding Remarks	253
	References	254
12.	Organization and Expression of Genes for Photosynthetic Pigments-Protein Complexes in Photosynthetic Bacteria	257
	<i>Yu Sheng Zhu and John E. Hearst</i>	
12.1	Metabolic Versatility	260
12.2	Photosynthetic Apparatus	261
12.3	Organization of Genes Coding for LH, RC, and Pigment Biosynthetic Enzymes and Cytochromes	265
12.4	Regulation of Expression of the Genes Coding for LH, RC, Bchl, and Crt Biosynthesis	274
12.5	Conclusion	285
	References	287

PART III. PROSPECTS FOR MANIPULATION OF CHLOROPLAST GENOMES	293
13. Organization and Expression of the <i>Nicotiana</i> Chloroplast Genome	295
<i>Masahiro Sugiura</i>	
13.1 Chloroplast DNA	296
13.2 Genes for rRNAs	298
13.3 Genes for tRNAs	299
13.4 Genes for Stromal Polypeptides	302
13.5 Genes for Thylakoid Polypeptides	305
13.6 Gene Expression	307
13.7 Conclusions	311
References	312
14. Genetic Manipulation of the Chloroplast Genome	317
<i>John C. Gray</i>	
14.1 Chloroplast Transformation by <i>Agrobacterium tumefaciens</i>	318
14.2 The Chloroplast Genome	320
14.3 Introduction of DNA into Plastids	324
14.4 Integration of Foreign Genes into Chloroplast DNA	326
14.5 Autonomously Replicating Plasmids	328
14.6 Selectable Markers for Chloroplast Transformation	332
14.7 Prospects	333
References	333
15. A Perspective on the Biotechnology of Ribulose Bisphosphate Carboxylase/Oxygenase	337
<i>Harry Roy</i>	
15.1 Properties of Rubisco	339
15.2 Fixing Rubisco	340
15.3 Molecular Analysis of Rubisco Function	342
15.4 Cloning and Expression of Hexadecameric Rubisco	344
15.5 Fixing Plants	346
15.6 Some Critical Reservations	346
15.7 Alternative Biological Strategies for Enhancing Photosynthesis	347
Addendum	350
References	350
16. Applications of Nucleic Acid Electron Microscopy and In Situ Hybridization Techniques in the Study of Plant Genomes	355
<i>Madeline Wu</i>	
16.1 Electron Microscopy of Organelle Genomes	356
16.2 DNA-DNA Heteroduplex Analysis	360

xiv Contents

16.3	Electron Microscopy of DNA-RNA Hybrids	362
16.4	Localization of DNA Replication Initiation Sites by Electron Microscopy	363
16.5	Chromosomal Localization of Cloned Genes by In Situ Hybridization	365
	References	369
17.	Molecular Evolution of <i>Nicotiana</i> Chloroplast Genomes	373
	<i>Shain-dow Kung</i>	
17.1	Chloroplast Genomes	374
17.2	Commonality and Diversity of <i>Nicotiana</i> Chloroplast Genomes	375
17.3	Molecular Evolution of <i>Nicotiana</i> Chloroplast Genomes	377
17.4	Concluding Remarks	388
	References	389
PART IV.	APPLICATIONS OF BIOTECHNOLOGY IN PLANT SYSTEMS	393
18.	Genetic Engineering for Crop Improvement	395
	<i>Robert T. Fraley</i>	
18.1	Plant Transformation	396
18.2	Crop Improvement	398
18.3	Conclusions	404
	References	405
	<i>Index</i>	409