

Contents



Foreword	v
Preface	vii
1. Tissue Culture	1
1.1 Introduction to Cell and Tissue Culture	1
1.2 Tissue Culture Media (Composition and Preparation)	2
1.3 Stock Solutions	8
1.4 Sterilization and Agents of Sterilization used in Tissue Culture Laboratories	10
1.5 Initiation and Maintenance of Callus and Cell Suspension Culture	13
1.6 Nutritional Requirement for <i>In vitro</i> Culture	15
1.7 Concept of Cellular Totipotency	16
1.8 Single Cell Clones and Organogenesis	17
1.9 Organogenesis	19
1.10 Artificial Seeds	20
1.11 Micropropagation	22
1.12 Somatic Embryogenesis	27
1.13 Transfer and Establishment of Whole Plants in Soil	28
1.14 Shoot Tip Culture	38
1.15 Rapid Clonal Propagation and Production of Virus-free Plants	41
1.16 Embryo Culture and Embryo Rescue	44
1.17 Protoplast Culture and Fusion	45
1.18 <i>In vitro</i> Mutation Methods	50
1.19 Selection of Hybrid Cells and Regeneration of Hybrid Plants	54
1.20 Symmetric and Asymmetric Hybrids	56



1.21	Cybrid Production and its Application in Crop Improvement	57
1.22	Cryobiology of Plant Cell Culture and Establishment of Gene Bank	58
1.23	Production of Virus-free Plants using Meristem Culture	62
1.24	Anther, Pollen, and Ovary Culture for Production of Haploid Plants and Homozygous Lines	63
	<i>References</i>	67
2.	Tissue-culture Applications	71
2.1	Regeneration	71
2.2	Production of Haploids	73
2.3	Germplasm Conservation	82
2.4	Production of Secondary Metabolites from Plant Cell Culture	92
2.5	Industrial Production of Useful Biochemicals by Higher-plant Cell Cultures	103
2.6	Industrial Production of Food Additives and Fragrances	105
2.7	Bioreactor Systems	108
2.8	Greenhouse Technology	123
	<i>References</i>	129
3.	Plant Transformation Technology	131
3.1	Introduction	131
3.2	Hairy Root	136
3.3	Structure and Functions of Ti and Ri Plasmids and their Application	137
3.4	<i>Agrobacterium</i> -mediated Gene Transfer, <i>Agrobacterium</i> -based Vectors, and their Application	139
3.5	Binary Vectors	158
3.6	Uses of 35S Promoter	165
3.7	Reporter Genes	166
3.8	Matrix Attachment Region	168
3.9	Biolistic Gene Transfer	171
3.10	Transgene Stability and Gene Silencing	172
	<i>References</i>	176



4. Plant Genetic Engineering for Productivity and Performance	179
4.1 Resistance to Herbicides	179
4.2 Insect Resistance	186
4.3 Abiotic Stress—Salt	198
References	211
5. Molecular Marker-aided Breeding	213
5.1 Molecular Markers	213
5.2 DNA Extraction—Beginning of Molecular Markers Analysis	214
5.3 Types of Molecular Markers	216
5.4 Types of Markers	218
5.5 Restriction Fragment Length Polymorphism	220
5.6 Linkage Analysis	224
5.7 RAPD Markers	228
5.8 Microsatellites	231
5.9 Sequence-characterized Amplified Region	237
5.10 Single Nucleotide Polymorphism	238
5.11 Amplified Fragment Length Polymorphism	241
5.12 Quantitative Trait Loci	244
5.13 Mapping Functions	249
References	250
6. Application of Plant Biotechnology	257
6.1 Introduction	257
6.2 Industrial Enzymes	259
6.3 Genetic Engineering	262
6.4 Edible Vaccines	275
6.5 Plantibodies	292
6.6 Phenylpropanoid Pathway	299
6.7 Shikimate Pathway	302
6.8 Transgenics	303
References	305



7. Biotechnological Applications	307
7.1 Mass Multiplication of Economically Important Plants	307
7.2 Biopesticides (Insecticides)	311
7.3 Biofertilizers	324
7.4 Vermiculture	334
7.5 Phytoremediation	334
7.6 Nutraceuticals	337
7.7 Cosmeceuticals	339
7.8 Biofuels	347
7.9 Single-cell Protein	351
References	353
8. Important Issues in Plant Biotechnology	355
8.1 Introduction	355
8.2 Commercial Status and Public Acceptance	356
8.3 Biosafety Guidelines for Research Involving the Benefits and Risks of Genetically Modified Organisms	360
8.4 Socio-economic Impacts and Ecological Consideration of Genetically Modified Organisms	367
8.5 Private Sector, Trade Regulations, and Intellectual Property Rights	368
8.6 Genetic Use Restriction Technology	369
8.7 Biosafety	370
8.8 Weaknesses in Testing and Regulations	371
8.9 Public Participation	372
8.10 Gene Flow, IPR, and IPP	374
References	393
<i>Index</i>	401
<i>About the Author</i>	423