Contents

Preface vii

Part 1: Pollen Biology

1. Pollen Development 7
Differentiation of Anther Layers 7
Microsporogenesis 8
Initiation of Meiosis 8
Synthesis of Macromolecules 9
Cytoplasmic Reorganization 10
Syncytium and Isolation 10
Significance of Cytoplasmic Reorganization and Isolation 12
Microgametogenesis 13
Vegetative and Generative Cells 14
Sperm Cells 16
Dimorphism of sperm cells and organization of male germ unit 17
Tapetum 18
Secretory Tapetum 20
Plasmodial Tapetum 20
Tapetal Membrane 21
Role of Tapetum 21
Supply of nutrients to developing pollen 21
Breakdown of callose wall around microspore tetrads 21
Supply of sporopollenin precursors to pollen exine 22
Supply of pollen coat substances and exine proteins 22
Gene Expression during Anther Development 22
Transmission of Pathogens through Pollen 23
Pollen Maturation and Anther Dehiscence 23

Pollen Morphology and Aeropalynology 26
Pollen Morphology 26
Applications 26

Petroleum exploration 26
Archaeology 26
Criminology 26
Testing purity of honey 27
Three Domains of Pollen Wall 27
Intine 27
Exine 27
Pollen coat substances 29
Pollen Wall Morphogenesis 29
Control of exine pattern 31
Pollen wall proteins 33
Pollen Analysis 33
Pollen size and shape 33
Compound pollen 36
Polarity 37
Apertures 38
Exine sculpture 39
LO analysis 39
Aeropalynology 40
Allergic Response 41
Diagnostic Tests 43
Allergens 43
Biological Standardization of Allergens 44

3. Pollen Viability and Vigour **45**
Pollen Viability 45
Tests for Viability 46
Fruit- and seed-set 46
Pollen germination and pollen tube growth in the pistil 47
Non-vital stains and other tests of limited use 47
Tetrazolium test 47
In-vitro germination test 49
Fluorescein diacetate test 49
Causes for Loss of Viability 50
Loss of membrane integrity 51
Quantitative changes in phospholipids 53
Phase transition and membrane integrity 53
Pollen Vigour 56
Tests for Vigour 56
In-vitro germination 56
Semivivo technique 57
In-vivo pollen germination and pollen tube growth 57
Effects of Environmental Stresses on Pollen Quality 58

4. In-vitro Pollen Germination and Pollen Tube Growth **61**
Germination Requirements 61
Hydration 61

Carbohydrate Source 62
Boron 64
Calcium 65
Effects of other Physical and Chemical Factors 66
Phases of Germination and Tube Growth 67
Lag Phase 67
Pollen Tube Emergence 68
Pollen Tube Growth 69
Role of cytoskeleton and calcium in tip growth 70
In-vitro vs in-vivo Tube Growth 72
Release of Metabolites 73
RNA and Protein Synthesis 73
In-vitro Pollen Germination Assay to Study the Effects of Toxic Chemicals 76

5. Pollen Sterility 77
Genic Male Sterility 77
Phenotypic Effects of GMS 77
Structural and Biochemical Changes 78
Hormonal Changes 80
Effects of Temperature and Photoperiod 80
Induction of Pollen Sterility through Recombinant DNA Technology 80
Cytoplasmic Male Sterility 82
Alterations in Mitochondrial Genome 84
Structural and Biochemical Changes 85
Mechanism of Cytoplasmic Male Sterility 87
Environmentally Induced Pollen Sterility 89
Chemically Induced Pollen Sterility 89

6. Pistil 90
Stigma 90
Style 93
Ovule and Embryo Sac 98

7. Pollination 102
Breeding Systems 104
Outbreeding Devices 104
Secondary Pollen Presentation 104
Pollen:Ovule Ratio 105
Modes of Pollination 105
Anemophily 105
Hydrophily 105
Zoophily 106
Evolutionary Significance of Insect Pollination 109
Floral Attractants and Rewards 110
Floral Thermogenicity 111
Pollen Travel and Gene Flow 111
Pollination Postulates 113

Pollination Efficiency 113

8. Pollen-Pistil Interaction and Fertilization **114**
Significance of pollen-Pistil Interaction 114
Screening for Compatibility 115
Screening for Quality 115
Pollen Viability and Stigma Receptivity 117
Events on Stigma Surface 118
Pollen Adhesion and Hydration 118
Pollen Germination and Pollen Tube Entry into Stigma 119
Pollination Stimulus 120
Pollen Tube Growth through Style 121
Regulation of Pollen Tube Number 124
Internal Geitonogamy 125
Pollen Tube Guidance 125
On Stigma Surface 127
In Ovary 128
Pollen Tube Entry into Ovule and Embryo Sac 130
Double Fertilization 131
Preferential Fertilization 131
Inheritance of Plastids 132
Positional Effect of Ovules 133
In-vitro Pollination and Fertilization 133
In-vitro Pollination 134
Pollination of cultured pistils 134
Poliination of cultured ovules 134
In-vitro Fertilization 137
Applications of in-vitro Pollination and Fertilization 138

9. Self-incompatibility **140**
Evolution of SI 140
Homomorphic SI 141
Genetics 141
Cytology 144
Physiological and Biochemical Studies 146
Temporal Expression of SI 148
Operation of SI 149
Characterization of S-allele Products and S-alleles in Pistil 149
Sporophytic systems 149
Gametophytic systems 152
Papaver system 153
S-allele-specific components in pollen 153
Basis of S-allele Specificity 154
Mechanism of Pollen Recognition and Inhibition 154
Heteromorphic SI 158
Dimorphic Systems 158
Trimorphic Systems 163