

# Contents

|                                                             |           |
|-------------------------------------------------------------|-----------|
| <i>Contributors</i>                                         | ix        |
| <i>Preface</i>                                              | xiii      |
| <b>1 Evolution of DNA Marker Technology in Plants</b>       | <b>3</b>  |
| Robert J. Henry                                             |           |
| Introduction                                                | 4         |
| Early Marker Technologies                                   | 4         |
| Evolving Range of Applications of DNA Markers in Plants     | 12        |
| Applications                                                | 13        |
| Future Developments                                         | 15        |
| References                                                  | 15        |
| <b>2 Whole-Genome Sequencing for Marker Discovery</b>       | <b>21</b> |
| Mark Edwards                                                |           |
| Sequencing Strategies                                       | 22        |
| Sequencing Technologies                                     | 23        |
| Epigenetic Markers                                          | 31        |
| Genome-Wide Selection                                       | 32        |
| Data Analysis Resources                                     | 32        |
| References                                                  | 33        |
| <i>Color plate section located between pages 34 and 35.</i> |           |
| <b>3 Amplicon Sequencing for Marker Discovery</b>           | <b>35</b> |
| Timothy R. Sexton and Frances M. Shapter                    |           |
| Introduction                                                | 36        |
| Background                                                  | 36        |
| Maximizing Efficiency Through Sample Pooling                | 38        |
| Limitations of Amplicon-Based MPS                           | 44        |
| Bioinformatics                                              | 51        |
| Concluding Remarks                                          | 52        |
| Acknowledgments                                             | 52        |
| References                                                  | 53        |
| <b>4 Transcriptome Sequencing for Marker Discovery</b>      | <b>57</b> |
| Susan Gillies                                               |           |
| Introduction                                                | 58        |
| Basic Approach                                              | 58        |

|                                                                                                |            |
|------------------------------------------------------------------------------------------------|------------|
| Conclusions                                                                                    | 64         |
| References                                                                                     | 64         |
| <b>5 Molecular Markers in Plant Improvement</b>                                                | <b>67</b>  |
| Peter J. Prentis, Edward K. Gilding, Ana Pavasovic,<br>Celine H. Frere, and Ian D. Godwin      |            |
| Introduction                                                                                   | 68         |
| Plant Domestication and Traditional Breeding                                                   | 68         |
| Application of Molecular Markers to Breeding                                                   | 70         |
| Next-Generation Approaches to QTL Discovery                                                    | 75         |
| Conclusion                                                                                     | 77         |
| References                                                                                     | 78         |
| <b>6 Applications of Molecular Markers in Plant Conservation</b>                               | <b>81</b>  |
| Maurizio Rossetto and Paul D. Rymer                                                            |            |
| Introduction                                                                                   | 82         |
| Traditional Approaches                                                                         | 86         |
| The Way Forward                                                                                | 91         |
| Conclusion                                                                                     | 95         |
| References                                                                                     | 96         |
| <b>7 Molecular Markers for Plant Biosecurity</b>                                               | <b>99</b>  |
| Andrew D.W. Geering                                                                            |            |
| Introduction                                                                                   | 100        |
| The Present—PCR for Specific Diagnosis and for DNA<br>Barcoding                                | 101        |
| The Future—Next-Generation Sequencing Methods to<br>Revolutionize Plant Quarantine Diagnostics | 105        |
| Conclusions                                                                                    | 110        |
| Acknowledgments                                                                                | 111        |
| References                                                                                     | 111        |
| <b>8 Molecular Markers for Harnessing Heterosis</b>                                            | <b>119</b> |
| Gopala S. Krishnan, A.K. Singh, Daniel L.E. Waters,<br>and Robert J. Henry                     |            |
| Introduction                                                                                   | 120        |
| Molecular Markers for Understanding the Genetic<br>Basis of Heterosis                          | 122        |
| Molecular Diversity and Heterosis—Molecular<br>Markers for Predicting Heterosis                | 123        |
| Conclusion                                                                                     | 131        |
| References                                                                                     | 132        |

|                                                                                                                   |            |
|-------------------------------------------------------------------------------------------------------------------|------------|
| <b>9 Genetic Variant Discovery and Its Use in Genome Characterization of Agronomically Important Crop Species</b> | <b>137</b> |
| Stéphane Deschamps and Matthew A. Campbell                                                                        |            |
| Introduction                                                                                                      | 138        |
| Sanger Resequencing                                                                                               | 140        |
| Single Feature Polymorphisms                                                                                      | 140        |
| Next-Generation Sequencing                                                                                        | 143        |
| High-Density Genotyping using the Illumina Golden Gate Platform                                                   | 153        |
| Genotyping by Sequencing                                                                                          | 155        |
| Genome Characterization and Haplotypes                                                                            | 157        |
| Conclusions and Perspectives                                                                                      | 159        |
| References                                                                                                        | 160        |
| <b>10 Future Prospects of Molecular Markers in Plants</b>                                                         | <b>169</b> |
| Reyazul R. Mir and Rajeev K. Varshney                                                                             |            |
| Introduction                                                                                                      | 170        |
| Molecular Markers: The Past                                                                                       | 172        |
| Molecular Markers: The Present                                                                                    | 173        |
| Molecular Markers: The Future                                                                                     | 175        |
| Novel Approaches or Platforms for Plant Breeding                                                                  | 180        |
| Conclusions                                                                                                       | 183        |
| Acknowledgments                                                                                                   | 184        |
| References                                                                                                        | 184        |
| <i>Index</i>                                                                                                      | 191        |