

CONTENTS

Contributors

ix

Preface

xiii

1. Towards Complete Elucidation of Monoterpene Indole Alkaloid Biosynthesis Pathway: *Catharanthus roseus* as a Pioneer System 1

Vonny Salim and Vincenzo De Luca

1. Introduction 2
2. Division of MIA Biosynthesis Pathway 5
3. Organisation and Spatial Separation of MIA Biosynthesis 18
4. Large-Scale Genomic Approaches in Functional Characterisation of Genes Involved in MIA Biosynthesis 21
5. Metabolic Engineering of the MIA Biosynthesis Pathway 24
6. Conclusions and Perspectives 27
- Acknowledgements 29
- References 29

2. Increasing the Pace of New Discoveries in Tropane Alkaloid Biosynthesis 39

Jan Jirschitzka, Franziska Dolke, and John C. D'Auria

1. Introduction 40
2. Tropane Alkaloids in Plants: From Herbs To Trees 44
3. Biosynthesis of Tropane Alkaloids 49
4. Metabolic Engineering of Tropane Alkaloids 59
5. Conclusions 63
- Acknowledgements 63
- References 63

3. Deciphering the Evolution, Cell Biology and Regulation of Monoterpene Indole Alkaloids 73

Benoit St-Pierre, Sébastien Besseau, Marc Clastre, Vincent Courdavault, Martine Courtois, Joel Crèche, Eric Ducos, Thomas Dugé de Bernonville, Christelle Dutilleul, Gaëlle Glévarec, Nadine Imbault, Arnaud Lanoue, Audrey Oudin, Nicolas Papon, Olivier Pichon, and Nathalie Giglioli-Guivarc'h

1. Introduction 74
2. Regulation of MIA Biosynthesis Pathway 86

3. Spatial Organization of MIA Biosynthesis	93
4. Conclusions	101
Acknowledgements	102
References	102
4. Biosynthesis and Catabolism of Purine Alkaloids	111
Hiroshi Ashihara, Takao Yokota, and Alan Crozier	
1. Introduction	112
2. Occurrence of Purine Alkaloids in Plant Kingdom	113
3. Biosynthesis of Purine Alkaloids	115
4. Catabolism of Caffeine	126
5. Distribution of Purine Alkaloids in Tissues and Cells	128
6. Biotechnology of Purine Alkaloids	129
7. <i>In Planta</i> Function of Purine Alkaloids	131
8. Conclusions and Perspectives	133
References	133
5. Camptothecin: Biosynthesis, Biotechnological Production and Resistance Mechanism(s)	139
Supaart Sirikantaramas, Mami Yamazaki, and Kazuki Saito	
1. Introduction	140
2. Camptothecin Biosynthetic Pathway	143
3. Biotechnological Production of Camptothecin and Its Derivatives	150
4. Resistance Mechanism(s) in Camptothecin-Producing Plants	154
5. Conclusions	155
Acknowledgements	156
References	156
6. Improved Production of Plant Isoquinoline Alkaloids by Metabolic Engineering	163
Fumihiko Sato	
1. Introduction	164
2. Isoquinoline Alkaloid Biosynthesis and Pathway Characterization	165
3. Metabolic Pathway Engineering	171
4. Perspectives	176
5. Conclusions	177
Acknowledgement	177
References	177

7. Bioengineering of Isoquinoline Alkaloid Production in Microbial Systems	183
Akira Nakagawa, Eitaro Matsumura, Fumihiko Sato, and Hiromichi Minami	
1. Introduction	184
2. Design of IQA Biosynthetic Pathways and Their Enzymes in Bacteria	186
3. Perspectives	198
4. Conclusions	199
Acknowledgements	199
References	199
8. From Bioreactor to Entire Plants: Development of Production Systems for Secondary Metabolites	205
Thi Khieu Oanh Nguyen, Rebecca Dauwe, Frédéric Bourgaud, and Eric Gontier	
1. Introduction	206
2. General Strategies to Produce Secondary Metabolites from Plant Material	208
3. Tropane Alkaloids Produced by Solanaceae	210
4. Furanocoumarins Produced by Rutaceae	211
5. Evaluating Plant Bioproduction and Selecting High-Producing Genotypes	212
6. First Steps in the Development of Agronomical Bioproduction	216
7. Biotechnological Approaches: From Callus to Organ <i>In Vitro</i> Culture	217
8. Process Engineering and Low-Cost 'Bioreactor' Design	218
9. Comparison Between Biotech (<i>In Vitro</i>) and Field Production	222
10. Hydroponics and Aeroponics as Open Bioreactors for the Production and Exploitation of High-Quality Biomass	223
11. Future Perspectives and Limitations; Concluding Remarks	226
Acknowledgements	228
References	228
9. New Methods of Analysis and Investigation of Terpenoid Indole Alkaloids	233
Guitele Dalia Goldhaber-Pasillas, Young Hae Choi, and Robert Verpoorte	
1. Introduction	235
2. Extraction and Purification Methods	236
3. Analytical Methods	242
4. Applications in Fingerprint Analysis	260
5. Conclusions	262
References	263

10. Like Cures Like: Caffeine Immunizes Plants Against Biotic Stresses	273
Hiroshi Sano, Yun-Soo Kim, and Yong-Eui Choi	
1. Introduction	274
2. Caffeine Biosynthesis	276
3. Caffeine-Producing Transgenic Plants	278
4. Biotic Stress Tolerance	280
5. Activation of Defence System	283
6. Caffeine Targets	284
7. Caffeine Signal Cascade	287
8. Plant Immunization	291
9. Concluding Remarks	293
Acknowledgements	295
References	295
11. Alkaloids from Marine Bacteria	301
Sergey B. Zotchev	
1. Introduction	302
2. Occurrence and Biological Activities of Alkaloids from Marine Bacteria	302
3. Biosynthesis of Alkaloids in Marine Bacteria	319
4. Conclusions	327
Acknowledgements	327
References	327
Author Index	335
Subject Index	367