

Contents

List of Contributors XVII

- 1 Catalytic Enantioselective Alkylation of Prochiral Ketone Enolates 1**
Corey M. Reeves and Brian M. Stoltz
Background 1
Strategy and Results 1
Asymmetric Allylic Alkylation in Total Synthesis 4
Conclusions 8
CV of Corey M. Reeves 8
CV of Brian M. Stoltz 8
References 8
- 2 Point-to-Planar Chirality Transfer in Total Synthesis: Scalable and Programmable Synthesis of Haouamine A and Its Atropisomer 11**
Noah Z. Burns and Phil S. Baran
Introduction 11
Synthetic Strategy Featuring Point-to-Planar Chirality Transfer 11
Programmable Synthesis of Haouamine A and Its Atropisomer 12
CV of Noah Z. Burns 15
CV of Phil S. Baran 15
References 16
- 3 Tethered Aminohydroxylation 17**
Timothy J. Donohoe and Stefanie Mesch
Introduction and Background 17
Tethered Aminohydroxylation 17
 - a) First Generation of Reoxidants 18
 - b) N-Sulfonyloxy Carbamates 19
 - c) Carbonyloxycarbamates as Reoxidants for Osmium 21Amide-Based Reoxidants 22
Evidence for the Mechanism of the TA Reaction 23
Applications in Organic Synthesis 24
Conclusion and Future Work 24

	CV of Timothy J. Donohoe	24
	CV of Stefanie Mesch	26
	References	26
4	Organocatalyzed Transformations of α, β-Unsaturated Carbonyl Compounds through Iminium Ion Intermediates	29
	<i>Julian H. Rowley and Nicholas C. O. Tomkinson</i>	
	CV of Nicholas C. O. Tomkinson	33
	CV of Julian H. Rowley	33
	References	34
5	The Renaissance of Silicon-Stereogenic Silanes: A Personal Account	35
	<i>Andreas Weickgenannt and Martin Oestreich</i>	
	Background	35
	Results	36
	a) Intermolecular Chirality Transfer from Silicon to Carbon: Diastereoselective Palladium(II)-Catalyzed C–Si Bond Formation	36
	b) Silicon-Stereogenic Silane as Stereochemical Probe: B(C ₆ F ₅) ₃ -Catalyzed Carbonyl Reduction	37
	c) Kinetic Resolution with Silicon-Stereogenic Silanes: Cu–H-Catalyzed Diastereoselective Si–O Coupling	39
	Conclusion	41
	CV of Martin Oestreich	41
	CV of Andreas Weickgenannt	41
	References	41
6	Asymmetric Dienamine Activation	43
	<i>Mathias Christmann</i>	
	Introduction	43
	Historic Background	43
	Results	44
	Conclusion	47
	CV of Mathias Christmann	47
	References	47
7	Asymmetric Brønsted Acid Catalysis	49
	<i>Iuliana Atodiresei, Uxue Uria, and Magnus Rueping</i>	
	Introduction and Background	49
	Strategy	49
	Results	50
	Summary	52
	CV of Iuliana Atodiresei	52
	CV of Uxue Uria	52

- CV of Magnus Rueping 53
References 53
- 8 Quaternary Stereogenic Centers by Enantioselective β -Carbon Eliminations from *tert*-Cyclobutanols 55**
Nicolai Cramer and Tobias Seiser
Background 55
Objective: Enantioselective Formation of Quaternary Stereogenic Centers in Combination with Reactive Alkyl-Rhodium Intermediates 56
Selective Generation of the Alkyl-Rhodium Species and Its Downstream Reactivities 56
CV of Nicolai Cramer 57
CV of Tobias Seiser 59
References 59
- 9 Total Synthesis of Oseltamivir and ABT-341 Using One-Pot Technology 61**
Hayato Ishikawa and Yujiro Hayashi
Introduction 61
Results 61
a) Total Synthesis of (–)-Oseltamivir via Two One-Pot Processes 61
b) Total Synthesis of ABT-341 by One-Pot Sequence 63
Conclusions 64
CV of Yujiro Hayashi 65
CV of Hayato Ishikawa 65
References 65
- 10 Enantioselective Annulations with Chiral N-Mesityl N-Heterocyclic Carbenes 67**
Jessada Mahatthananchai and Jeffrey W. Bode
Introduction 67
Catalytic Generation of Chiral Enolate Equivalents 68
Catalytic Generation of Homoenolate Equivalents 70
Enantioselective Cascade Reactions Catalyzed by Chiral N-Heterocyclic Carbenes 70
Catalytic Annulations via α, β -Unsaturated Acyl Azoliums 72
Conclusions 74
CV of Jeffrey Bode 76
CV of Jessada Mahatthananchai 76
References 76
- 11 Asymmetric Counteranion-Directed Catalysis (ACDC) 79**
Manuel Mahlau and Benjamin List
Concept 79

Application of ACDC to Organocatalysis	80
Application of ACDC to Transition Metal Catalysis	81
Application of ACDC to Lewis Acid Catalysis	82
CV of Manuel Mahlau	83
CV of Prof. Dr. Benjamin List	84
References	84

12 Enantioselective Organo-SOMO Catalysis: a Novel Activation Mode for Asymmetric Synthesis 87

David W. C. MacMillan and Sebastian Rendler

Background 87

Objective 88

Results 90

CV of David W.C. MacMillan 92

CV of Sebastian Rendler 93

References 93

13 Enantioselective Passerini Reaction 95

Qian Wang, Jieping Zhu, and Mei-Xiang Wang

Introduction 95

Background 95

Results 96

Conclusion and Perspective 99

CV of Qian Wang 99

CV of Jieping Zhu 99

CV of Mei-Xiang Wang 100

References 100

14 Rapid Enantiomeric Excess Determination 103

Oliver Trapp

CV of Oliver Trapp 106

References 106

15 Asymmetric Catalysis of Reversible Reactions 109

Lukas Hintermann

Thermochemistry of Asymmetric Catalyses Close to the Equilibrium 109

Kinetic Modeling of a Reversible Asymmetric Catalytic Reaction 111

Case Study: a Reversible Asymmetric Organocatalytic Reaction 112

Conclusions 115

CV of Lukas Hintermann 115

References 115

- 16 Exploiting Fluorine Conformational Effects in Organocatalyst Design: The Fluorine–Iminium Ion *Gauche Effect*** 117
Christof Sparr, Lucie E. Zimmer, and Ryan Gilmour
 CV of C. Sparr 121
 CV of L. Zimmer 123
 CV of R. Gilmour 123
 References 124
- 17 Dutch Resolution** 125
Richard M. Kellogg
 CV of Richard M. Kellogg 129
 References 129
- 18 Construction of *anti*-Me-OH Vicinal Relationships in Polyketides** 131
Vaidotas Navickas and Martin E. Maier
 Introduction 131
 Marshall–Tamaru Reaction 131
 Conclusions 136
 CV of Vaidotas Navickas 136
 CV of Martin E. Maier 136
 References 136
- 19 Photoswitchable General Base Catalysts** 139
Philipp Viehmann and Stefan Hecht
 Introduction and Background 139
 Strategy and Results 141
 Outlook 143
 CV of Philipp Viehmann 144
 CV of Stefan Hecht 145
 References 145
- 20 Asymmetric Halonium Addition to Olefins** 147
Scott A. Snyder and Alexandria P. Brucks
 Introduction 147
 Intramolecular Lactonizations, Etherifications, and Aminations 147
 Polyene Cyclizations 150
 Intermolecular Additions to Alkenes 150
 Conclusion 152
 CV of Scott A. Snyder 154
 CV of Alexandria P. Brucks 154
 References 154
- 21 Catalytic Asymmetric Gosteli–Claisen Rearrangement (CAGC)** 157
Julia Rehbein and Martin Hiersemann
 CV of Julia Rehbein 162

	CV of Martin Hiersemann	162
	References	162
22	Biomimetic Total Synthesis of the Penifulvin Family	165
	<i>Tanja Gaich and Johann Mulzer</i>	
	Introduction	165
	The Penifulvin Family: Isolation and Biogenetic Origin	166
	Total Syntheses of Penifulvins A, B, and C	168
	Summary	175
	CV of Prof. Johann Mulzer	175
	CV of Tanja Gaich	175
	References	176
23	Catalyst-Controlled 1,3-Polyol Syntheses	179
	<i>Tobias Harschneck and Stefan F. Kirsch</i>	
	CV of Stefan F. Kirsch	184
	CV of Tobias Harschneck	184
	References	185
24	Enantioselective Carbonyl Allylation and Crotylation from the Alcohol Oxidation Level via C–C Bond Forming Transfer Hydrogenation	187
	<i>Joseph Moran and Michael J. Krische</i>	
	Introduction and Background	187
	Strategy	187
	Results	188
	CV of Michael Krische	190
	CV of Joseph Moran	191
	References	195
25	Stereoselective Synthesis with Hypervalent Iodine Reagents	197
	<i>Umar Farid and Thomas Wirth</i>	
	CV of Umar Farid	201
	CV of Thomas Wirth	201
	References	202
26	Asymmetric Gold-Catalyzed Reactions	205
	<i>Núria Huguet and Antonio M. Echavarren</i>	
	Introduction	205
	Diphosphine-Gold Complexes in Enantioselective Catalysis	205
	Monophosphine-Gold Complexes in Enantioselective Catalysis	208
	CV of Núria Huguet	209
	CV of Antonio M. Echavarren	210
	References	210

- 27 Asymmetric Catalysis in the Total Synthesis of Lipids and Polyketides 213**
Santiago Barroso and Adriaan J. Minnaard
 Background 213
 Tuberculostearic Acid: One Isolated Methyl Group 213
 Ant Pheromones: Vicinal Methyl Branches 214
 Deoxypropionates: 1,3-Methyl Arrays 215
 Membrane-Spanning Lipids: 1,4-Dimethyl Units 215
 Saturated Isoprenoids: 1,5-Methyl Arrays 217
 CV of Santiago Barroso 218
 CV of Adriaan J. Minnaard 218
 References 218
- 28 The Evolving Role of Biocatalysis in Asymmetric Synthesis 221**
Mélanie Hall, Wolfgang Kroutil, and Kurt Faber
 Background – First- and Second-Generation Biotransformations 221
 Results–Third-Generation Biotransformations 221
 a) Asymmetric Bioreduction of C=C Bonds 221
 b) Asymmetric Transamination 226
 Conclusions and Future Perspectives 228
 CV of Mélanie Hall 229
 CV of Wolfgang Kroutil 229
 CV of Kurt Faber 229
 References 229
- 29 Bifunctional Thiourea Catalysts 233**
Yoshiji Takemoto and Tsubasa Inokuma
 Background 233
 Results 233
 a) Amino thiourea 233
 b) Hydroxy thiourea 235
 CV of Yoshiji Takemoto 236
 CV of Tsubasa Inokuma 237
 References 237
- 30 Catalytic Asymmetric (4 + 3) Cycloadditions Using Allenamides 239**
Yun-Fei Du and Richard P. Hsung
 Introduction and Background 239
 Strategy 240
 Results 240
 Conclusion 242
 CV of Yun-Fei Du 246
 CV of Richard P. Hsung 246
 References 246

- 31 Application of the Achmatowicz Rearrangement for the Synthesis of Oligosaccharides 249**
Michael F. Cuccarese and George A. O'Doherty
Introduction 249
De novo Approach to Carbohydrates 249
An Iterative Pd-Catalyzed Glycosylation and Bidirectional Postglycosylation 251
Application to the Synthesis of the Anthrax Tetrasaccharide 251
CV of Michael F. Cuccarese 255
CV of George A. O'Doherty 258
References 258
- 32 Asymmetric C–C Bond Formation Using Chiral Phosphoric Acid 261**
Takahiko Akiyama
Background 261
Results 261
a) Mannich and Related Reactions 261
b) Cycloaddition Reactions 262
c) Transfer Hydrogenation Reactions 263
d) Friedel-Crafts Alkylation Reaction 264
e) Desymmetrization reaction 264
Conclusions and Future Perspectives 265
CV of Takahiko Akiyama 266
References 266
- 33 Asymmetric C–H Bond Functionalization 267**
Masayuki Wasa, Kelvin S. L. Chan, and Jin-Quan Yu
Background 267
Results 267
a) Diastereoselective C–H Functionalization 267
b) Enantioselective C–H Functionalization 269
Conclusions and Future Perspectives 271
CV of Masayuki Wasa 271
CV of Kelvin S. L. Chan 272
CV of Jin-Quan Yu 272
References 272
- 34 Asymmetric C–C Bond Formation Using Chiral Guanidine Catalysts 273**
Masahiro Terada
Background 273
Catalyst Design and Results 273
a) Design of Novel Axially Chiral Guanidine Base Catalysts 273
b) Type I Axially Chiral Guanidine Catalysts (Nine-Membered Ring) 275

- c) Type II Axially Chiral Guanidine Catalysts (Seven-Membered Ring) 276
 - CV of Masahiro Terada 278
 - References 278

- 35 Enantioselective Synthesis of Lactones via Rh-Catalyzed Ketone Hydroacylation 279**
Matthew M. Coulter and Vy M. Dong
 Background and Introduction 279
 Strategy and Results 279
 Conclusions and Future Directions 283
 CV of Vy M. Dong 283
 CV of Matthew M. Coulter 284
 References 284

- 36 Radical Haloalkylation 285**
Armen Zakarian
 CV of Armen Zakarian 290
 References 291

- 37 Asymmetric Hydrovinylation of Alkenes 293**
T. V. (Babu) RajanBabu
 Introduction 293
 New Protocols for the Heterodimerization of Ethylene/Propylene and Vinylarenes, 1,3-Dienes, and Norbornene 293
 Catalytic Asymmetric Hydrovinylation Reactions: Effects of Hemilabile Ligands 295
 All-Carbon Quaternary Centers via Catalytic Asymmetric HV 295
 Hydrovinylation (HV) of 1,3-Dienes and Asymmetric Variations 296
 Asymmetric Hydrovinylation of Unactivated Linear 1,3-Dienes Using Co(II) Catalysis 296
 Scope and Applications of Hydrovinylation Reactions: Exocyclic Stereocontrol 296
 A Stereoselective Route to either Steroid-C20(S) or -C20(R) Derivatives 298
 Asymmetric Hydrovinylation of Strained Alkenes 298
 Conclusions and Future Perspectives 300
 CV of T. V. (Babu) RajanBabu 300
 References 301

- 38 Heterocycle Construction via Asymmetric Rhodium-Catalyzed Cycloadditions 303**
Kevin M. Oberg and Tomislav Rovis
 Background 303
 Strategy 304

	Results	305
	Application to Other Reactions	306
	Conclusion and Future Perspectives	307
	CV of Tomislav Rovis	307
	CV of Kevin M. Oberg	307
	References	307
39	<i>N</i>-Heterocyclic Carbene-Catalyzed Aldol Desymmetrizations	309
	<i>Karl A. Scheidt, Eric M. Phillips, and Julien Dugal-Tessier</i>	
	Introduction	309
	Strategy and Results	309
	Application to the Syntheses of Bakkenolides I, J, and S	312
	Conclusion	314
	CV of Karl A. Scheidt	315
	CV of Eric M. Phillips	315
	CV of Julien Dugal-Tessier	315
	References	316
40	Strategies for the Asymmetric Total Synthesis of Natural Products: “Chiral Pool” versus Chiral Catalysts	317
	<i>Karl Gademann</i>	
	Introduction	317
	Catalytic Stereoselective Total Synthesis	317
	Natural Product Synthesis Starting from Chiral, Nonracemic Starting Materials	320
	Conclusion	321
	CV of Karl Gademann	321
	References	322
41	Dynamic Kinetic Asymmetric Transformations Involving Carbon–Carbon Bond Cleavage	323
	<i>Andrew T. Parsons and Jeffrey S. Johnson</i>	
	Background	323
	Donor–Acceptor Cyclopropanes as DYKAT Substrates	323
	Lewis Acid Catalysis	323
	Palladium Catalysis	326
	Deracemization of Tertiary Propargyl-Allyl Alcohols via Rhodium-Catalyzed Sequential Rearrangement/Enantioselective Conjugate Addition	329
	Conclusion	329
	CV of Andrew Parsons	331
	CV of Jeffrey Johnson	331
	References	331

- 42 Iron-Catalyzed Allylic Substitutions 333**
Markus Jegelka and Bernd Plietker
 Allylic Substitutions Catalyzed by the Hieber-Anion
 $[\text{Fe}(\text{CO})_3(\text{NO})]^-$ 333
 Allylic Substitutions Catalyzed by $\text{Fe}_2(\text{CO})_9$ 338
 CV of Markus Jegelka 340
 CV of Bernd Plietker 340
 References 341
- 43 Asymmetric Conia-ene Carbocyclizations 343**
Filippo Sladojevich and Darren J. Dixon
 Introduction and Background: the Conia-ene Reaction 343
 Strategy: Organo/Metal Cooperative Catalysis 343
 Results 344
 CV of Filippo Sladojevich 349
 CV of Darren J. Dixon 349
 References 350
- 44 Tactics and Strategies in the Total Synthesis of Chlorosulfolipids 353**
Christian Nilewski and Erick M. Carreira
 Background 353
 Stereoselective Synthesis of *vic*-Dichloride Fragments 353
 Total Synthesis of Hexachlorosulfolipid 357
 Conclusions 360
 CV of Christian Nilewski 360
 CV of Erick M. Carreira 360
 References 360
- 45 Linear Free Energy Relationships (LFERs) in Asymmetric Catalysis 363**
Elizabeth N. Bess and Matthew S. Sigman
 Introduction and Background 363
 Hammett Electronic Parameters and Their Application to
 (salen)Mn(III)-Catalyzed Asymmetric Epoxidation Reactions 364
 Relating Brønsted Acidity to Enantiomeric Ratio in an Asymmetric
 Hydrogen-Bond-Catalyzed Diels-Alder Reaction 365
 An LFER Describing the Influence of Steric Bulk in a
 Nozaki-Hiyama-Kishi Asymmetric Allylation of Acetophenone 367
 Correlating Quadrupole Moment to Enantioselectivity in
 Cation- π -Mediated Asymmetric Polycyclization 367
 Simultaneously Correlating Hammett and Charton Parameters to
 Enantioselectivity in Two-Dimensional Free Energy Relationships 368
 Conclusions 369
 CV of Elizabeth Bess 369
 CV of Matt Sigman 369
 References 370

46	Asymmetric Diamination of Alkenes	371
	<i>José A. Souto and Kilian Muñiz</i>	
	Introduction and Background	371
	Strategy	371
	Results	371
	CV of José Souto	374
	CV of Kilian Muñiz	375
	References	375
47	Enzymatic Asymmetric Synthesis of Tertiary Alcohols	377
	<i>Michael Richter</i>	
	Introduction	377
	YerE—a Unique ThDP-Dependent Enzyme	377
	Hydroxynitrile Lyases	379
	Conclusion	380
	CV of Michael Richter	381
	References	381
48	Oxidative Dearomatization and Organocatalytic Desymmetrization	383
	<i>Alice E. Williamson and Matthew J. Gaunt</i>	
	Introduction	383
	Desymmetrization of Cyclohexadienones	383
	A One-Pot Oxidative Dearomatization and Catalytic Desymmetrization	384
	Oxo- and Aza-Michael Additions	384
	Further One-Pot Methods for Oxidative Dearomatization and Catalytic Desymmetrization	386
	Alkylative Dearomatization	386
	Summary	389
	CV of Matthew J. Gaunt	389
	CV of Alice E. Williamson	390
	References	390
49	Total Synthesis of All (–)-Agelastatin Alkaloids	391
	<i>Mohammad Movassaghi and Sunkyu Han</i>	
	Introduction	391
	Biosynthetically Inspired Plan for Total Synthesis	391
	Total Synthesis of the Agelastatin Alkaloids	393
	CV of Mohammad Movassaghi	395
	CV of Sunkyu Han	396
	References	396
	Index	397