

Contents

Preface ix

1	Introduction	1
1.1	Advantages of Enzyme Catalysis	3
1.1.1	Chemoselectivity	3
1.1.2	Regioselectivity	4
1.1.3	Stereoselectivity	7
1.1.4	Mild Reaction Conditions	8
1.2	Modes of Chemoenzymatic Transformations	10
1.2.1	“Separate-Pot Two-Step” Mode	10
1.2.2	“One-Pot Two-Step” Mode	11
1.2.3	“One-Pot One-Step” Mode	12
	References	14
2	“Separate-pot Two-step” Chemoenzymatic Transformation	19
2.1	Lipases	20
2.2	Nitrilases	31
2.3	Carbonyl Reductases	33
2.4	Ene Reductases	39
2.5	Transaminases	42
2.6	Imine Reductases	46
2.7	Cytochromes P450s	48
2.8	Baeyer–Villiger Monooxygenases (BVMOs)	56
2.9	Aldolases	59
2.10	Epoxide Hydrolases	64
2.11	Other Enzymes	67
2.12	Integration of Multienzyme Cascade with Chemical Transformation	74
2.13	Summary and Outlook	77
	References	77
3	One-pot Sequential Chemoenzymatic Reactions	85
3.1	Lipases and Esterases	85

3.2	Carbonyl Reductases	94
3.3	Ene Reductases	113
3.4	Transaminases	114
3.5	Epoxide Hydrolases (EHs)	124
3.6	Other Enzymes	126
3.6.1	Aldolases	126
3.6.2	Halohydrin Dehalogenases	128
3.6.3	Phenylalanine Ammonia Lyases	129
3.6.4	D-Amino Acid Dehydrogenases (DAADHs)	131
3.6.5	Halogenases	132
3.6.6	Imine Reductases	134
3.6.7	Decarboxylases	135
3.6.8	Cytochrome P450s	136
3.6.9	Hydroxynitrile Lyases	137
3.6.10	Nitrilases	138
3.6.11	Laccases	138
3.6.12	Transglutaminases	139
3.6.13	α -Ketoglutarate (α -KG)-dependent Non-heme Iron Oxygenases	140
3.6.14	Galactose Oxidases	142
3.6.15	FAD-dependent Monooxygenases	143
3.7	Summary and Outlook	144
	References	146
4	Chemoenzymatic Dynamic Kinetic Resolution	155
4.1	Enzymatic Kinetic Resolution	155
4.2	Dynamic Kinetic Resolution	156
4.3	Racemization Techniques	158
4.4	DKR of Chiral Alcohols	160
4.5	DKR of Chiral Amines	188
4.6	DKRs of Other Compounds	193
4.7	Summary and Outlook	204
	References	205
5	Chemoenzymatic Concurrent Deracemization	217
5.1	Deracemization of Amino Acids and Amines	218
5.2	Deracemization of Hydroxy Acids and Alcohols	235
5.3	Deracemization of Chiral Sulfoxides	239
5.4	Summary and Outlook	239
	References	240
6	One-pot Concurrent Chemoenzymatic Reactions	245
6.1	One-pot Concurrent Chemoenzymatic Cascades	247
6.1.1	Lipases	247
6.1.2	Carbonyl Reductases	267
6.1.3	Enoate Reductases	275

6.1.4	Transaminases	277
6.1.5	Monoamine Oxidases	279
6.1.6	Cytochrome P450s	284
6.1.7	Halohydrin Dehalogenases	286
6.1.8	Vanadium Haloperoxidases	287
6.1.9	Laccases	290
6.2	Integration of Chemical Reaction with Metabolism of Living Organisms	293
6.3	One-pot Concurrent Chemoenzymatic Cascades via Compartmentalization	297
6.4	Summary and Outlook	302
	References	303
7	Photocatalytic and Biocatalytic Cascade Transformations	313
7.1	Photoenzymes	313
7.2	Light-Activation of Redox Enzymes Without Cofactor Regeneration	317
7.3	Light-Activated Cofactor Regeneration for Redox Enzymes	325
7.4	Photoinduced Catalytic Promiscuity of Redox Enzymes	330
7.5	Photocatalysis and Biocatalysis Cascades	335
7.6	Summary and Outlook	353
	References	354
8	Perspectives	361
	References	365
	Index	369