

Contents

1	Introduction and Background Information	1
1.1	Introduction	1
1.2	Common Prejudices Against Enzymes	2
1.3	Advantages and Disadvantages of Biocatalysts	3
1.3.1	Advantages of Biocatalysts	3
1.3.2	Disadvantages of Biocatalysts	7
1.3.3	Isolated Enzymes vs. Whole Cell Systems	9
1.4	Enzyme Properties and Nomenclature	11
1.4.1	Structural Biology in a Nutshell	11
1.4.2	Mechanistic Aspects of Enzyme Catalysis	13
1.4.3	Classification and Nomenclature	23
1.4.4	Coenzymes	26
1.4.5	Enzyme Sources	27
	References	27
2	Biocatalytic Applications	31
2.1	Hydrolytic Reactions	31
2.1.1	Mechanistic and Kinetic Aspects	31
2.1.2	Hydrolysis of the Amide Bond	51
2.1.3	Ester Hydrolysis	60
2.1.4	Hydrolysis and Formation of Phosphate Esters	111
2.1.5	Hydrolysis of Epoxides	120
2.1.6	Hydrolysis of Nitriles	130
2.2	Reduction Reactions	139
2.2.1	Recycling of Cofactors	140
2.2.2	Reduction of Aldehydes and Ketones Using Isolated Enzymes	145
2.2.3	Reduction of Aldehydes and Ketones Using Whole Cells	153
2.2.4	Reduction of C=C-Bonds	166

2.3	Oxidation Reactions	173
2.3.1	Oxidation of Alcohols and Aldehydes	173
2.3.2	Oxygenation Reactions	176
2.3.3	Peroxidation Reactions	204
2.4	Formation of Carbon–Carbon Bonds	211
2.4.1	Aldol Reactions	211
2.4.2	Thiamine-Dependent Acyloin and Benzoin Reactions	225
2.4.3	Michael-Type Additions	231
2.5	Addition and Elimination Reactions	233
2.5.1	Cyanohydrin Formation	233
2.5.2	Addition of Water	237
2.5.3	Addition of Ammonia	240
2.6	Transfer Reactions	242
2.6.1	Glycosyl Transfer Reactions	242
2.6.2	Amino Transfer Reactions	254
2.7	Halogenation and Dehalogenation Reactions	257
2.7.1	Halogenation	258
2.7.2	Dehalogenation	263
	References	268
3	Special Techniques	315
3.1	Enzymes in Organic Solvents	315
3.1.1	Ester Synthesis	324
3.1.2	Lactone Synthesis	342
3.1.3	Amide Synthesis	343
3.1.4	Peptide Synthesis	346
3.1.5	Peracid Synthesis	351
3.1.6	Redox Reactions	352
3.1.7	Medium Engineering	354
3.2	Immobilization	356
3.3	Artificial and Modified Enzymes	367
3.3.1	Artificial Enzyme Mimics	367
3.3.2	Modified Enzymes	368
3.3.3	Catalytic Antibodies	373
	References	377
4	State of the Art and Outlook	391
	References	396
5	Appendix	397
5.1	Basic Rules for Handling Biocatalysts	397
5.2	Abbreviations	400
5.3	Suppliers of Enzymes	401

Contents	xi
5.4 Commonly Used Enzyme Preparations	402
5.5 Major Culture Collections	404
5.6 Pathogenic Bacteria and Fungi	405
Index	407