

# Contents

Introduction . . . . .	ix
Abbreviations . . . . .	xiii
<b>1 ENZYMES — CATALYSTS OF LIFE . . . . .</b>	<b>1</b>
1.1 Classification of enzymes . . . . .	1
1.2 Principles of the kinetics of enzymatic reactions . . . . .	3
1.2.1 Inhibitors, inhibition with substrate and product . . . . .	5
1.3 Effects of organic solvents on enzymes . . . . .	7
1.4 Effects of temperature and pH on the stability and activity of enzymes . . . . .	11
1.5 Units of enzymatic activity . . . . .	12
<b>2 THE BIOCATALYST FORM . . . . .</b>	<b>17</b>
2.1 Free enzymes . . . . .	13
2.1.1 Characteristics of free enzymes . . . . .	14
2.1.2 Modified enzymes . . . . .	14
2.2 Immobilized enzymes . . . . .	17
2.2.1 Methods of the enzyme immobilization . . . . .	18
2.2.2 Properties of immobilized enzymes . . . . .	33
2.3 Cells of microorganisms . . . . .	35
2.3.1 Transformations by growing cells . . . . .	36
2.3.2 Transformations by preliminarily grown cells . . . . .	36
2.4 Immobilized cells of microorganisms . . . . .	37
2.4.1 Methods of cell immobilization . . . . .	38
2.4.2 Simultaneous immobilization of several biocatalysts . . . . .	40
2.5 Plant and animal cells . . . . .	40
2.6 Non-enzymatic biopreparations . . . . .	42
<b>3 BIOCATALYSTS AND THE PROBLEM OF SELECTIVITY IN ORGANIC SYNTHESIS . . . . .</b>	<b>46</b>
3.1 Specificity of chemical action and substrate specificity of enzymes . . . . .	47
3.2 Differentiation of enantiomers . . . . .	47
3.3 Differentiation of enantiotopic groups . . . . .	51
3.4 Differentiation of enantiotopic sides . . . . .	54
<b>4 SUBSTITUTION REACTIONS USING BIOCATALYSTS . . . . .</b>	<b>58</b>
4.1 Methylations . . . . .	58
4.2 Halogenations . . . . .	59
4.3 Substitution reactions in the side chain of amino acids . . . . .	62
4.4 Substitutions on aromatic systems with the formation of a C—C bond . . . . .	65
4.5 Substitutions at C-1 in saccharides . . . . .	66

5	ELIMINATION AND ADDITION REACTIONS . . . . .	70
5.1	Additions to the C=C bond . . . . .	70
5.2	Additions to the C=O bond . . . . .	78
6	SYNTHESES AND HYDROLYSES OF ESTERS . . . . .	91
6.1	Syntheses of esters . . . . .	91
6.2	Chemo- and regioselective hydrolyses of esters . . . . .	104
6.3	Kinetic resolutions of racemic esters, acids and alcohols . . . . .	109
6.3.1	Hydrolysis and transesterification of esters of racemic acids . . . . .	109
6.3.2	Resolution of racemic alcohols through esters . . . . .	127
6.4	Diesters of prochiral dicarboxylic acids . . . . .	162
6.5	Prochiral diols . . . . .	177
7	SYNTHESES AND HYDROLYSES OF AMIDES . . . . .	188
7.1	Syntheses of amides and peptides . . . . .	188
7.2	Hydrolyses of amides and nitriles . . . . .	198
8	OXIDATIONS . . . . .	208
8.1	Oxidation of alcohols . . . . .	208
8.2	Further oxidation reactions . . . . .	220
8.2.1	The Baeyer–Villiger oxidation . . . . .	220
8.2.2	Hydroxylations . . . . .	223
8.2.3	Dehydrogenations of the CH—CH bond . . . . .	229
8.2.4	Oxidations of amino acids to oxo acids . . . . .	230
8.2.5	Oxidations of nitrogenous heterocyclic compounds . . . . .	232
8.2.6	Oxidations on nitrogen, sulphur or selenium atoms . . . . .	233
9	REDUCTIONS . . . . .	236
9.1	Reductions of aldehydes and acyclic ketones . . . . .	237
9.2	Reductions of cyclic ketones . . . . .	252
9.3	Reductions of di- and tricarbonyl compounds . . . . .	258
9.4	Reductions of oxo acids, oxo esters and oxo amides . . . . .	270
9.5	Reductions of the carbonyl group in organometallic compounds . . . . .	288
9.6	Reductions of the C=C bond . . . . .	291
9.7	Syntheses of $\alpha$ -amino acids from $\alpha$ -oxo acids . . . . .	294
9.8	Reductions of the nitro group . . . . .	297
9.9	Miscellaneous reductions . . . . .	298
	References . . . . .	301
	Subject index . . . . .	329