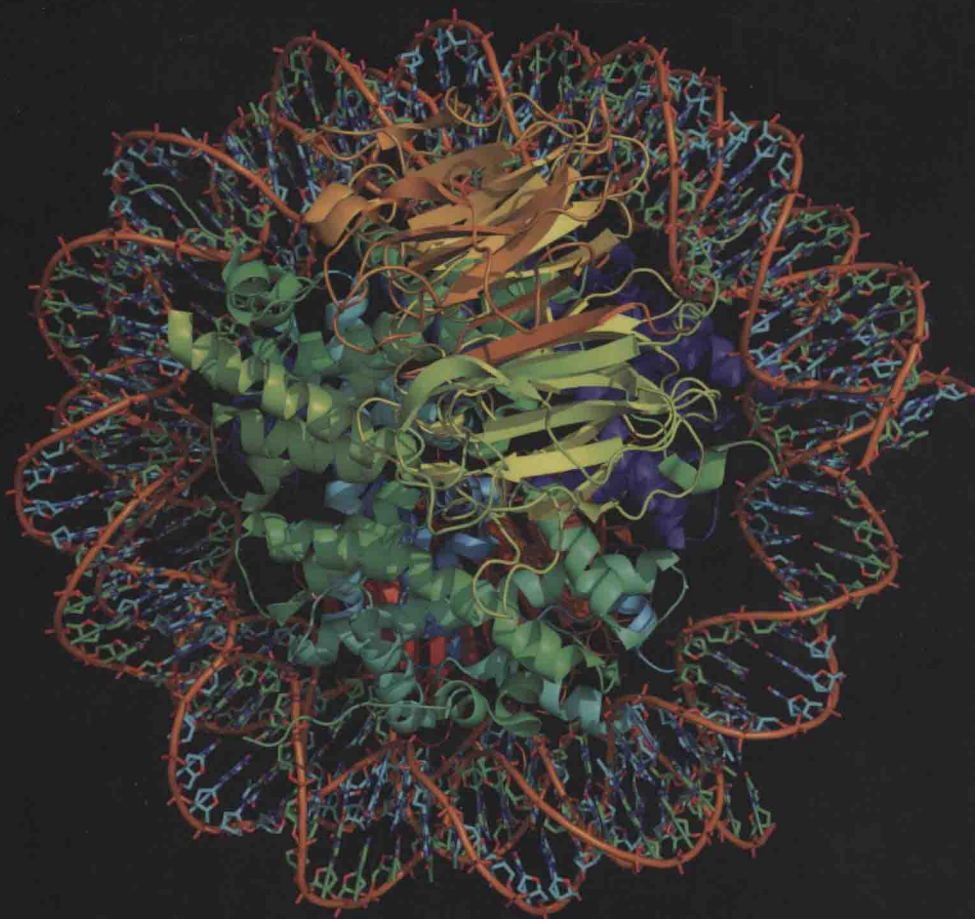



BIOCATALYSIS

Biochemical Fundamentals and Applications

Second Edition



Peter Grunwald

 **World Scientific**

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Biochemical Fundamentals and Applications

Second Edition

Peter Grunwald

University of Hamburg, Germany



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Preface

To the first edition

The book tries to cover the application of biocatalysis in various fields together with appropriate biochemical as well as some chemical fundamentals. The latter does not mean that biochemistry textbooks are dispensable; readers are in fact encouraged to consult the excellent biochemical literature nowadays available. The term “biochemical fundamentals” as related to this book should be understood as first background information in context with the different aspects of biocatalysis put up for discussion here.

The core of this book is Chapter 10 about the application of biocatalysts in the synthesis of organic compounds. Preceding are chapters providing additional knowledge useful for understanding some general principles of biocatalysis. Chapter 4 is devoted to non-protein groups, mainly the coenzymes, supplemented by further examples in Chapter 7 the main emphasis of which are reaction mechanisms; included here is the discussion of some biocatalysts having particular application potential as, e.g., hydrogenases (hydrogen production) or nitrogenases (ammonia synthesis), and aspects of methanogenesis. Enzyme mimics are also considered in this chapter and elsewhere. Chapters 5 and 6 introduce into fundamentals in kinetics, and enzyme kinetics, respectively. A brief discussion about antibiotics, focusing on nonribosomal peptide synthesis is the content of Chapter 8, and in Chapter 9 the different methods of enzyme immobilization together with the properties of immobilized biocatalysts, including aspects of heterogeneous kinetics, are treated.

Chapter 10 is followed by enzymatic catalysis in unconventional media (Chapter 11). Two further chapters deal with the possibility to improve the performance of biocatalysts through evolutionary methods (Chapter 13) and by pathway engineering (Chapter 14) both being rather new techniques that revolutionized biocatalysis within a rather short period of time. One aim of this book was to address aspects of biocatalysis that are sometimes more or less disregarded in textbooks on biocatalysis. To these belong not only the already mentioned non-ribosomal peptide synthesis but also catalytic antibodies (Chapter 14) or RNA-catalysts (Chapter 15); all three research areas at the present time are not of higher importance for direct application, however, this may change in the future. Irrespective of that they are part of the substantial arsenal of possibilities symptomatic for biocatalysis.

Within several chapters some aspects are discussed in more detail if they are instructive to students for reasons others than just conveying expert-knowledge, e.g., the scientific debate on the mechanism of the enzyme methyl coenzyme M reductase, catalyzing the formation of methane, the recently detected bi-directional glycosyltransferases, *etc.*; these selected examples may in some cases also deliver some insight into how science functions.

Chapter 10 itself is organized in a way deviating from the EC numbering system (Chapter 3) in that it starts with the enzyme class 3, the hydrolases because they are the biocatalysts used most frequently in Organic Synthesis. In connection with epoxide hydrolases it seemed to make sense to also discuss the biological synthesis of epoxides by monooxygenases belonging to the enzyme class 1. Nitrile hydratases, though members of the enzyme class 4 (lyases) are included within the sub-chapter nitrile-hydrolyzing enzymes for similar reasons. A separate and more detailed chapter deals with carbohydrate modifying enzymes comprising hydrolases as well as transferases (enzyme class 2), thus allowing for the great importance of glycobiotechnology. This is followed by a survey of oxidoreductases (Chapter 10.3), and lyases (aldolases and hydroxynitrile lyases, Chapter 10.4). In the final sections of Chapter 10, enzymes are reconsidered that catalyze various other reactions among them the most important racemases and epimerases of the enzyme class 5.

The last two chapters about the application of biocatalysts in industry not only provide an insight into the commercial use of this class of catalysts for the production of fine chemicals, pharmaceuticals, agrochemicals, or bulk chemicals including polymers, and for the improvement of various processes. Industrial biotransformations will envisage a promising future as they represent a green technology compared with traditional chemical processes, and it is to be expected that biotechnology becomes more and more competitive with petroleum-based productions. Thus, due to the ecological benefit of biocatalysts, applied biocatalysis is a typical sustainable technology, expressed since some years by the term White Biotechnology.

Peter Grunwald

To the second edition

As in the 1st edition published 2009 Chapter 10 makes up the largest part of the book but the contents of this and the other chapters have not only been revised but also updated to consider new developments in the biocatalysis field. In addition the order of Chapters has been changed in part and new Chapters have been added: In Chapter 10.7 *amminomutases and ammonia lyases* are discussed and Chapter 11 introduces *cascade reactions*, followed by *catalytic antibodies* (Chapter 12), *nucleic acids as catalysts* (Chapter 13) and *enzymes in non-conventional media* (Chapter 14). Chapters 15 and 16 deal with *methods to improve biocatalysts*, and *metabolic engineering*, respectively, thereby accounting for the enormous advances in synthetic biology and systems biology. The following three Chapters 17 to 19 about *non-coding RNAs*, *fluorescence*, and *biocatalysis and nanotechnology* are new, and finally Chapters 16 and 17 of the 1st edition have been combined to Chapter 20 about *Industrial Biocatalysis*.

Peter Grunwald

Contents

Preface	v
1. Introduction	1
1.1 Advantages and Disadvantages of Biocatalysts	2
1.2 Strategies to Improve the Performance of Biocatalysts	4
1.3 Biocatalysis — An Interdisciplinary Science	5
1.4 The Impact of Biocatalysis on Teaching Natural Science	7
2. History of Biocatalysis	10
3. Classification of Enzymes	14
3.1 Promiscuous Enzymes	18
4. Non-protein Groups in Biocatalysis	22
4.1 Thiamine	25
4.2 Niacin and Riboflavin	28
4.3 Vitamin B6	30
4.4 Folic Acid, Tetrahydrofolate and Dihydrobiopterin	36
4.5 Cofactors in Methanogenesis	42
4.6 Ascorbic Acid Exerts a Protective Function	47
4.7 Some Concluding Comments	49
5. Introduction into Kinetics	52
5.1 Rate of Reaction and Rate Equations	52
5.2 Reaction Mechanisms	54
5.3 Steady-state	56
5.4 Pre-equilibria	57
5.5 Temperature Dependence	58
5.5.1 Chemical equilibria and temperature	59
5.5.2 Arrhenius parameters	62
5.5.3 Transition state theory	63
5.6 Reactions in Solutions	66

5.6.1 Diffusion controlled reactions	68
6. Enzyme Kinetics	72
6.1 The Michaelis-Menten Equation	73
6.1.1 Determination of K_M and r_{\max}	77
6.1.2 Integrated Michaelis-Menten equation	79
6.1.3 Reversible equilibria	80
6.1.4 Inhibition	84
6.1.4.1 Non-competitive inhibition	88
6.1.4.2 Competitive inhibition	90
6.1.4.3 Uncompetitive inhibition	92
6.1.4.4 Substrate inhibition	94
6.1.4.5 Some examples of inhibition	95
6.1.4.6 Activity-based protein profiling	96
6.1.5 Formation of intermediates	99
6.1.6 Bisubstrate reactions	101
6.1.7 Multi-substrate reactions	105
6.1.8 King and Altman method	109
6.1.9 Importance of K_M and k_{cat}	112
6.2 Parameters Affecting Enzymatic Activity	118
6.2.1 pH-dependence	119
6.2.2 Temperature-dependence	123
6.2.3 New insights into the transition-state theory	126
6.3 The Kinetic Isotope Effect and Hydrogen Tunneling	128
6.3.1 The kinetic isotope effect	129
6.3.1.1 Kinetic isotope effect and reaction mechanisms	130
6.3.2 Hydrogen tunnelling and protein dynamics	133
6.3.3 Protein dynamics in solution	140
6.3.4 Intrinsically disordered proteins	142
7. Mechanisms in Enzymatic Catalysis and Enzyme Models	147
7.1 Enzyme-Substrate Interactions	147
7.2 Enzymes and Other Catalysts — The Entropy Effect	151
7.3 Single Mechanisms with Examples	152
7.3.1 Acid-base catalysis	153
7.3.2 Covalent catalysis	154
7.3.3 Metal ion catalysis	158
7.3.3.1 Methanogenesis — the role of nickel	160
7.3.3.2 Methylmalonyl-CoA mutase — a cobalamin enzyme	164
7.3.3.3 β -lactamases	168
7.4 Further Metalloenzymes of Biotechnological and Ecological Relevance	169

7.4.1	Additional aspects of methanogenesis	169
7.4.2	Hydrogenases	173
7.4.2.1	Hydrogenase enzyme models	182
7.4.3	Enzymes of the nitrogen cycle	186
7.4.4	Dinitrogenoxide reductase	190
7.4.5	Vanadium and vanadium-containing enzymes	191
7.4.5.1	Vanadium-nitrogenases	194
7.4.5.2	Fe-nitrogenases	197
7.4.5.3	VNase model compounds	197
7.4.5.4	Vanadium haloperoxidases	199
8.	Synthesis of Peptide Antibiotics	207
8.1	Antibiotics — Some General Aspects	207
8.2	Mechanism of Nonribosomal Peptide Synthesis	213
8.3	Other Multi-functional Enzymes	217
8.3.1	Fatty acid synthetases	217
8.3.2	Polyketide synthetases	219
8.4	Naturally Occurring Peptide/Polyketide Hybrids	226
8.5	Application of Nonribosomal Peptide Synthetases	228
8.6	The Case Mycosubtilin	232
8.7	Ribosomal Synthesis of Antibiotics	235
8.7.1	Labyrinthopeptins	238
9.	Immobilized Biocatalysts	243
9.1	Definition and Characterization	244
9.2	Reasons for Immobilizing Biocatalyst	246
9.3	Properties of Carriers for Immobilization	247
9.4	Different Types of Carrier Materials	248
9.5	Immobilization Methods	250
9.5.1	Immobilization by adsorption	250
9.5.2	Covalent immobilization	252
9.5.3	Immobilization by crosslinking	256
9.5.4	Entrapment of biocatalysts	258
9.5.4.1	Sol-gel processes — inorganic polymers	259
9.5.5	Encapsulation	260
9.6	Kinetics of Immobilized Biocatalysts	261
9.6.1	Conformational changes	261
9.6.2	Partitioning effects	262
9.6.3	Diffusion limitation	263
9.7	Improving the Properties of Enzymes by Immobilization	265
9.7.1	Plasma-treatment of carrier surfaces	270
9.8	Carrier-free Immobilizates	271

9.8.1	Crosslinked enzyme crystals	271
9.8.1.1	Application of CLECs	273
9.8.2	Crosslinked enzyme aggregates	280
9.9	Protein Microarrays	287
10.	Structure, Function, and Application of Enzymes	298
10.1	Hydrolases	299
10.1.1	Lipases — general aspects	300
10.1.1.1	Reaction behavior of lipases	300
10.1.1.2	Stereoselectivity of lipases	301
10.1.1.3	Different types of lipases and nomenclature	302
10.1.1.4	Kinetic resolution	304
10.1.1.5	The Kazlauskas rules	308
10.1.1.6	Dynamic kinetic resolution	311
10.1.1.7	Enantioselectivity	313
10.1.1.8	Asymmetric syntheses	318
10.1.2	Esterases	323
10.1.2.1	Structural aspects and mechanism	324
10.1.2.2	Application of esterases	326
10.1.2.3	Screening assays	329
10.1.2.4	Pig liver esterase	331
10.1.2.4.1	Pig liver esterase model	335
10.1.2.5	Acetylcholinesterase	337
10.1.2.6	Cholesterol esterase and carbohydrate esterases	340
10.1.2.7	The salicylic acid-binding protein	341
10.1.3	Epoxide hydrolases and epoxides	343
10.1.3.1	Chemical synthesis of epoxides	344
10.1.3.2	Biological synthesis of epoxides	346
10.1.3.2.1	Bacterial monooxygenases	346
10.1.3.3	Structural aspects of epoxide hydrolases	350
10.1.3.4	Application of epoxide hydrolases in synthesis	359
10.1.3.5	Epoxide hydrolases from yeasts	368
10.1.4	Nitrile-converting enzymes	372
10.1.4.1	Nitrile hydratases; Fe- and Co-NHases	373
10.1.4.1.1	Mechanism of Fe-NHases	378
10.1.4.1.2	Co-Nitrile hydratase	382
10.1.4.1.3	Application of NHases and amidases in organic synthesis	384
10.1.4.1.4	Desymmetrization	391
10.1.4.1.5	Nitrile hydratase active site models	392
10.1.4.2	Nitrilases	394
10.1.4.2.1	Reaction mechanism of nitrilases	396

10.1.4.2.2	Application of nitrilases	398
10.1.5	Hydantoinases	401
10.1.5.1	Structural and functional aspects of hydantoinases	402
10.1.5.2	Engineering of hydantoinases and related enzymes	406
10.1.5.3	Application of hydantoinases	409
10.2	Carbohydrate-Modifying Enzymes	423
10.2.1	The glycosidic linkage	425
10.2.2	Glycosidases	426
10.2.2.1	Application of glycosidases	431
10.2.2.2	Synthesis of glycoconjugates	434
10.2.2.3	Stable glycosidic bonds	437
10.2.2.4	Examples of unusual glycosidases	444
10.2.3	Glycosyltransferases	448
10.2.3.1	Structural and mechanistic aspects	458
10.2.3.2	Synthesis of glycoconjugates catalyzed by GTs	463
10.2.3.3	High-throughput screening for GTs	469
10.2.3.4	Bidirectional glycosyltransferases	471
10.2.4	Some applications of glycoconjugates	476
10.2.5	Click-glycosylation	484
10.2.6	Carbohydrate-modifying enzymes and diseases	488
10.3	Catalysts for Redox Reactions	504
10.3.1	Oxidoreductases — general aspects	504
10.3.1.1	Stereochemical aspects	505
10.3.1.2	Cofactor regeneration	506
10.3.1.2.1	Electrochemical methods of cofactor regeneration	508
10.3.1.3	Oxidoreductases — some general remarks	514
10.3.2	Dehydrogenases	515
10.3.2.1	NAD(P) ⁺ -dependent dehydrogenases	515
10.3.2.2	Flavin-dependent dehydrogenases	517
10.3.2.3	Dehydrogenases — properties and applications	517
10.3.3	Monooxygenases	525
10.3.3.1	Cytochrom P-450 oxygenases	526
10.3.3.2	Aromatic hydroxylases	533
10.3.3.3	Baeyer-Villiger Monooxygenases	535
10.3.3.3.1	Chemical mechanism	536
10.3.3.3.2	Examples of Baeyer-Villiger monooxygenases	537
10.3.3.3.3	Mechanism of Baeyer-Villiger monooxygenases	538

10.3.3.3.4	Further applications of Baeyer-Villiger monooxygenases	544
10.3.3.3.5	Screening for new BVMOs	551
10.3.3.4	Enoate reductases	552
10.3.3.5	Monoamine oxidase family	557
10.3.4	Dioxygenases	565
10.3.4.1	Application of dioxygenases	567
10.3.5	Other non-heme Fe(II)-dependent oxygenases	573
10.3.5.1	Catechol dioxygenases	573
10.3.5.2	2-oxoglutarate-dependent dioxygenases	577
10.3.5.3	Lipoxygenases	582
10.3.5.3.1	Mechanistic aspects of LOXs	587
10.3.5.3.2	Mn-LOX	592
10.3.5.3.3	LOX-mimics	594
10.3.5.3.4	Application of LOXs	597
10.3.6	Laccases	599
10.3.6.1	Occurrence and structural aspects	600
10.3.6.2	Catalytic properties and mechanism	603
10.3.6.3	Laccase-mediator systems	605
10.3.6.4	Applications of laccases	605
10.3.7	Imine reductases	610
10.3.8	Myoglobin-mediated catalysis	614
10.4	Lyases	628
10.4.1	Aldolases	628
10.4.1.1	The aldol reaction	628
10.4.1.2	Aldolases — mechanism and mimics	630
10.4.1.3	DHA(P)-dependent aldolases in organic synthesis	636
10.4.1.3.1	DHAP — problems and solutions	648
10.4.1.4	DHA-dependent aldolases	651
10.4.1.5	Pyruvate- and phosphoenolpyruvate-dependent aldolases	655
10.4.1.6	DER aldolases	671
10.4.1.7	Glycine-dependent aldolases	678
10.4.1.8	Aldolases — environmental aspects	684
10.4.2	Thiamine diphosphate-dependent enzymes	686
10.4.2.1	Acyloin condensation	688
10.4.3	Phenolic acid decarboxylases	698
10.4.4	Transketolases	701
10.4.4.1	Application of transketolases	705
10.4.5	Hydroxynitril lyases	717

10.4.5.1	Mechanism of hydroxynitrile lyases and structural aspects	718
10.4.5.2	Application of hydroxynitrile lyases	721
10.4.5.3	Engineering of HNLs	727
10.4.5.4	Further applications of HNLs	732
10.4.5.5	Immobilized HNLs/-oxynitrilases	739
10.5	Epimerases and Racemases	746
10.5.1	Racemases	748
10.5.2	Conversion of a racemase into an aldolase	752
10.5.3	Industrial application of racemases	753
10.5.4	Isomerases	756
10.6	Transaminases — Catalysts for the Synthesis of Amino Acids and Chiral Amines	761
10.6.1	Omega-transaminases — synthesis of beta-amino acids	766
10.6.2	Chiral amines	769
10.6.3	New (<i>R</i>)-selective ω -transaminases	773
10.7	Aminomutases and Ammonialyases	779
10.7.1	The mechanism of <i>Taxus</i> phenylalanine aminomutase	787
10.7.2	Aminomutases for amino acid synthesis	791
11.	Cascade Reactions	798
11.1	Enzyme Cascades — Advantages and Limitations	799
11.2	Classification of Enzyme Cascade Reactions	800
11.3	Further Application Examples of <i>in vitro</i> Cascades	802
11.3.1	Polymersomes nanoreactors	806
11.3.2	A glycerol cascade	808
11.3.3	Cascade reactions and biofuel cells	809
11.4	Microbial Cascade Reactions	814
11.4.1	Natural enzyme cascades	815
11.4.2	Artificial <i>in vivo</i> cascades	817
12.	Catalytic Antibodies	824
12.1	Antibodies	826
12.2	Some Historical Aspects	830
12.3	Cleavage of C—O bonds and C—N Bonds	832
12.4	Generation of Catalytic Antibodies	835
12.5	Examples	838
12.6	Evolution of Binding Energy and Catalysis	851
12.7	Catalytic Antibodies as Therapeutics	854
12.7.1	Catalytic antibodies for detoxification	854
12.7.2	Activation of prodrugs	857
12.8	Chemically programmed Antibodies	861

12.9 Intrabodies	864
13. Ribozymes and DNAzymes	868
13.1 Nucleic Acids as Catalysts	868
13.1.1 Nucleic acid catalysts and protein enzymes	872
13.2 Mechanisms of RNA Catalysis	876
13.3 Characterization of a Ribozyme	882
13.4 Selection of Catalytic Nucleic Acids	887
13.4.1 Cell-SELEX	891
13.5 RNA- and DNA-based Catalysts	895
13.5.1 Further examples of ribozymes	895
13.5.2 DNA-based catalysts	905
13.6 The Potential of High-throughput Sequencing	910
14. Enzymes In Non-conventional Media	917
14.1 Enzymes in Organic Solvents	917
14.1.1 Thermal stability of enzymes in organic solvents	921
14.1.2 The role of water	923
14.1.3 The role of solvent properties	925
14.1.4 pH-Memory in organic solvents	930
14.1.5 (Low) Enzymatic activity in organic solvents	930
14.1.6 Structure of enzymes in organic solvents	933
14.1.7 Improving enzymatic activity in organic solvents	934
14.2 Other Non-conventional Media	935
14.2.1 Supercritical fluids	935
14.2.1.1 The influence of pressure	938
14.2.2 Ionic liquids	941
14.2.2.1 Ionic liquids in biocatalysis	944
14.2.2.2 Combination of ILs with scCO ₂	951
14.2.2.3 Advanced ionic liquids	954
14.2.2.4 Toxicity of ionic liquids	959
15. Methods to Improve Biocatalysts	965
15.1 Ways Towards 'New' Enzymes — General Aspects	965
15.2 Recombinant Techniques	970
15.2.1 The PCR reaction	972
15.2.2 Restriction enzymes and DNA ligases	974
15.3 Engineering of New Proteins	980
15.3.1 Directed evolution — generating diversity	985
15.3.1.1 Error-prone PCR	985
15.3.1.2 Saturation mutagenesis	986
15.3.1.3 Gene-shuffling, recombining methods	991

15.3.2 (Semi-)rational design techniques	997
15.3.2.1 CAST — substrate range	998
15.3.2.2 ISM — enantioselectivity	999
15.3.2.3 B-factor iterative test, B-FIT — thermal stability	1004
15.3.2.4 OSCAR	1007
15.3.2.5 3DM analysis	1008
15.3.2.6 HotSpot Wizard	1009
15.2.3 De-novo computational enzyme design	1010
15.3.3.1 Stability versus fitness	1016
15.3.3.2 Recent advances and perspectives	1019
15.4 Protein Engineering by Genetic Code Expansion	1022
16. Metabolic Engineering, Synthetic Biology, and Systems Biology	1037
16.1 General and Historical Aspects	1038
16.2 Systems Metabolic Engineering Approaches	1040
16.2.1 Systems biology	1041
16.2.2 Synthetic biology	1043
16.3 Useful Tools for Pathway Engineering	1045
16.4 Further Methods for Engineering on the Genome Scale	1053
16.5 Tailored Genome Modification	1057
17. Non-coding RNAs	1069
17.1 Antisense-oligonucleotides	1071
17.1.1 Chemical modification of antisense oligonucleotides	1073
17.1.2 Intracellular delivery of antisense oligonucleotides	1074
17.1.3 Some applications of antisense oligonucleotides	1075
17.1.4 Mechanism of antisense activity	1076
17.2 RNA-induced Gene Silencing	1078
17.2.1 Small RNAs and RNA-induced silencing	1080
17.2.2 Micro RNAs, small interfering RNAs, and piRNAs	1082
17.2.2.1 Dicer enzymes	1085
17.2.2.2 Argonaute proteins — the core of silencing	1087
17.3 Antisense Therapy for Mis-splicing Diseases	1090
17.4 RNAi and miRNA in Treating Human Diseases	1093
18. Fluorescence, Fluorescence Dyes, and Reporter Constructs	1103
18.1 Fluorescence	1103
18.2 Traditional Fluorescent Dyes	1104
18.3 Reporter Constructs and Fluorescence	1106
18.3.1 In situ hybridization	1107
18.3.2 Luciferases	1109

18.3.3	The green fluorescent protein	1112
18.3.4	GFP and GFP-like proteins	1116
18.3.5	Applications	1120
18.3.6	Fluorescence and bioluminescence RET	1122
18.3.6.1	Applications of BRET	1126
18.4	Limitations of Fluorescent Proteins and Solutions	1129
18.4.1	Small-sized fluorescent probes	1130
18.4.2	Photoreceptor-based fluorescent proteins	1132
19.	Biocatalysis and Nanotechnology	1141
19.1	Definition of Nanotechnology	1143
19.2	Nanomaterials — Different Shapes, Composition and Application Potentials	1145
19.2.1	Magnetic nanoparticles	1148
19.3	Toxicology of Nanomaterials	1150
19.4	Theoretical Fundamentals	1152
19.4.1	Plasmon resonance	1154
19.5	Synthesis of Quantum dots	1156
19.6	Applications in Biocatalysis	1160
19.7	Nanomaterials for Enzyme Immobilization	1164
19.7.1	Nanomaterials for biofuel production	1167
19.7.2	Nanomaterials for biosensor fabrication	1172
19.8	Catalytically Active Nanomaterials	1175
20.	White Biotechnology and Industrial Biocatalysais	1185
20.1	Twelve Principles of Green Chemistry	1186
20.2	Use of Enzymes in Industry	1188
20.2.1	General considerations	1188
20.2.2	The global enzyme market and competitive structures	1190
20.2.3	Industrially used enzymes	1192
20.3	Industrial Biocatalysis – traditional Processes	1196
20.3.1	Enzymes for starch conversion	1197
20.3.2	Milk processing	1201
20.3.3	Cheesemaking	1202
20.3.4	Enzymes and beer	1202
20.3.5	Bread processing	1203
20.3.6	Application in fruit juice production	1205
20.3.7	The detergent industry	1206
20.3.8	Textile applications	1207
20.3.9	Pulp and paper processing	1208
20.4	Recent Developments in Industrial Biocatalysis	1209
20.4.1	Biofuels	1210