

Index

a

acenocoumarol metabolism 104–105
 O-acetyl α -haloketone formation 445
 N-acetyl amino acids 211
 acetylation 212, 220, 222, 364, 438, 439
N-acetyl-D-lactosamine (LacNAc) 141, 143,
 148–152, 378, 379
N-acetylneuraminic synthase (NeuS) 364,
 368, 369, 371, 372, 380
N-acetylneuraminic acid (Neu5Ac) 361, 364,
 365, 367–379, 381, 383, 385, 387
N-acetyl neuraminic acid synthase (NeuS)
 364
 acrylic fibers 255
 activity fingerprinting 316
 activity-based protein profiling (ABPP)
 404–405
 acyl compounds racemization 182–183
 acylase capillary reactor–microextractor
 system 211
 acylase-catalyzed amide hydrolysis 446
 acylation 202, 212, 213, 218, 219, 431,
 433–434
 N-acylation 299
 O-acylation 433
 acyl-transfer 181
 adenosine triphosphate (ATP) 235, 318, 400,
 402, 408, 409
S-adenosyl-L-methionine (SAM) dependent
 methyltransferases
 – acting on small molecules 398–400
 – cascade applications 410–415
 – cofactor (re)generation 406–410
 – cofactors 400–403
 – higher homologs and derivatives 403–406
 – radical-SAM enzymes 395–396
 – substrates 396–400
N-adenosylaziridine 406

S-adenosyl-L-methionine (SAM) 394, 395,
 403
 ADH. *See* alcohol dehydrogenase
 adrenodoxin reductase (AdR) 114–115
 agitated tube reactor (ATR) system 204–206
Agrobacterium tumefaciens(At β car) enzyme
 163, 166, 167, 169–173
 – α , β , γ and δ amino acids 169–171
 – L-enantiomers and D-antipodes 172–173
 – α -methionine and β -alanine 171–173
 α -alanine 161
 β -alanine 162
 L-alanine 446
 Alcalase® 186–188, 190–192
 alcohol
 – amination of 70, 71
 – kinetic resolution of 215–220
 alcohol dehydrogenase (ADH) 29–31, 34, 45,
 47, 52, 57, 110–111, 443, 448
 – catalyzed reactions 23, 31, 34, 35
 – catalyzed reduction 444, 447–449, 451, 452
 aldehyde decarbonylase. *See*
 aldehyde-deformylating oxygenase (ADO)
 aldehyde dehydrogenase (AldDH) 52, 121,
 414
 aldehyde-deformylating oxygenase (ADO)
 233
 aldol reaction 339, 348–350, 353, 382, 449,
 451, 452
 aldolase-catalyzed reaction 439
 aldoxime dehydratase-nitrile
 hydratase-amidase 255–256
 aldoxime dehydratases 256
 aliphatic amidase enzymes 304
 aliphatic (*S*)-2-hydroxyamides 261
 aliphatic nitrilases 278–279
 alkane degradation 52
 1,ω-alkane diamines 72

- α -alkyl- α -hydroxycarboxylic acids 261
aluminum catalyzed racemization 434
Amberlite XAD-7 207
amberlite-based racemization 438
amidase
– activity and stability, nitrile effect 289–293
– cascade substrate selectivity 304–308
– structure and mechanism 304
amidase-and nitrile hydratases-catalyzed reaction 286
amide formation 305
amination 67–69
– of alcohols 70, 71
amine-catalyzed racemization 438
amines 434–436
– kinetic resolution of 213, 214
amino acid esters racemization 187
amino acid oxidase (AAO) 233
amino acid precursors 331–334
N-protected-amino acid thioesters 191–192
 α -amino acids 162, 170–171, 182, 298
 α -D-amino acids 163
 β -amino acids 297–309
– production 161–174
 δ -amino acids 170–171
L-amino acids 436
 α -amino esters 436, 437
 α -amino- α -caprolactam racemase 257
aminoacylase 299–300
– cross linked enzyme aggregate (CLEA) of 211
amino-and hydroxynitriles 303
2-amino-1,3,4-butanetriol 207
aminocyclitol synthesis 340–351
2-aminoethylphosphonate (2-AEP) 161
 β -aminoisobutyric acid 161–162, 166
2-aminonitriles 254
 β -aminonitriles 254, 306
aminotransferases 66
amminolysis, of *N*-Boc-aminothioesters 193
ammonolysis, of phenylglycine methyl ester 186
amperometric transketolase assay 323–325
aromatase CYP19A1 catalysis 94, 96
aromatic nitrilases 278
artemisinin-based combination therapies (ACTs) 120
artificial cascade reactions, cytochrome P450 enzymes
– cofactor regenerating enzymes 108–113
– multi-enzyme cascades, *in vivo* 120–124
– multi-enzyme cascades, isolated enzymes 116–120
– regeneration, whole-cell biocatalysts 114–115
artificial cascades 257
aryl olefins, biocatalytic asymmetric dihydroxylation 49
arylacetonitrilases 277–278
L-arylanilines 443
asymmetric dihydroxylation, aryl olefins 49
asymmetric reductive amination 66–69
ATP-binding cassette (ABC) protein 235
auxiliary agents, enzymes as 317–325
azetidine-2-carbonitriles 251
azobisisobutyronitrile (AIBN) 435
- b**
- bacterial methyltransferases 404
bacterial nitrilases 274
Baeyer–Villiger monooxygenase (BVMO) 27, 45, 46, 52, 53, 56, 57
Baeyer–Villiger oxidation 45, 59, 60
 β -alanine 172
 β -alanine synthase. *See N*-carbamoyl- β -alanine amidohydrolase (NC β AA)
 β -amino acids
– biocatalytic preparation of enantiopure 299–301
– chemical methods for generating 298–299
– stereoselective synthesis of 297–309
base-catalyzed enolization 183
base-catalyzed racemization 180, 183–185, 189
 β -carbamoylase 166, 173, 174
benzaldehyde dehydrogenase (BZDH) 52
benzofuran 441
3-(oxiran-2-yl)benzoic acid 48
benzonitrile 252, 253, 263, 285, 289
benzyl alcohol dehydrogenase (BADH) 52
N-benzyloxycarbonyl (Cbz)-protected aminoaldehyde derivatives 340–341, 349, 350
biaryl-substituted alcohol 447
Bifidobacterium longum UDP-sugar pyrophosphorylase (BLUSP) enzyme 148
biocatalyst engineering 153
biomimetic reductive amination process 203
(+)–biotinamidohexanoic acid hydrazide 142
biphasic MTBE/buffer system 190
blood-tolerant laccase 9
N-Boc-amino acid thioesters hydrolysis 193
N-Boc-aminothioesters 193
N-Boc-phenylglycine thioesters 191
bovine adrenodoxin (Adx) 114–115
bovine serum albumin (BSA), 319–325

- Brevibacterium* sp. K1309 (*Bs*-NOX) enzyme 33–34
- Burkholderia cepacia* lipase 219
- BVMO. *See* Baeyer–Villiger monooxygenase
- c**
- CaLB. *See* *Candida antarctica* lipase B
- calcium channel blocker 102
- camphor oxidation 113
- Candida antarctica* lipase B (CaLB) 212, 214, 220, 300, 435
- Candida rugosa* lipase (CrL) 186, 207, 209, 210, 213
- capravirine metabolism 96–98
- ε-caprolactone (ε-CL) 445
- carbaldehyde, amination of 77
- N*-carbamoyl-α-methyl-β-alanine 167
- L-N-α-carbamoylase and D-N-α-carbamoylase 167, 169
- N*-carbamoyl-β-alanine amidohydrolase (NCβAA) 162, 163, 166–173
- N*-carbamoyl-β-amino acids 163
- carbohydrate-active enzyme (CAZy) 134, 377
- carbohydrates 351–355
- carbon–carbon bond formation 80, 259, 319, 322, 326, 355, 368, 371, 398, 438, 439, 446
- carbonyl amination 75–78
- 3-carboxymuconate 53
- catalytic cycle, P450 monooxygenases 89–90
- catechol-O-methyltransferase (COMT) 398, 400
- CAZy. *See* carbohydrate-active enzyme
- cell-free systems (*in vitro*) 108–113
- cellobiose dehydrogenase (CDH) 5
- chemocatalysis 428, 439–442
- chemo-enzymatic cascade reactions 56–60, 133–153, 325–326
- chemoenzymatic multistep one-pot processes 427–453
- chemo process 443–452
 - isomerization and derivatization 429–438
 - isomerization of substrate 428
 - substrate synthesis and derivatization 438–452
- chemoenzymatic synthesis 323, 340, 379
- chiral amines 65
- chirophtal measurements 191–192
- 1-chloro-2-acetoxy-3-(1-naphthoxy)-propane 222
- chlorobenzene dioxygenase (CBDO) 263
- cholesterol oxidation 93
- ciliatine 161
- cinnamyl alcohol 54
- cis*-dihydrodiols 262
- cis*-dihydroxylation of benzonitrile 263
- CLEA. *See* cross-linked enzyme aggregate
- CMP-sialic acid synthetase (CSS) 372, 374–377, 389
- coenzyme A (CoA) 161
- coenzyme regeneration enzyme (CRE) 46, 108
- cofactor recycling 44–46
- Co-(II) nitrile hydratases 304
- combinatorial libraries enhanced by recombination in yeast (CLERY) 16
- compartmentalization 237, 240
- continuous ideally stirred tank reactor (CISTR) 200, 201
- continuous stirred ultrafiltration (UF)-membrane bioreactors (CSMRs) 284, 285, 287, 289, 290, 292
- continuous-flow enzyme reactors 206
- continuous-flow kinetic resolution 212, 213, 220
- continuous-flow systems
- homogeneous *vs.* heterogeneous 199–200
 - micro *vs.* mini reactors 202
 - reactions in 199–204
- continuous-flow/stopped-flow (SF) methods 203
- continuous-stirred tank reactors (CSTRs) 210, 220, 237, 238
- convergent synthesis 138, 151–153
- Coprinopsis cinerea* peroxidase (CIP) 12
- creatinine analysis 203
- cross-linked enzyme aggregate (CLEA) 211, 252
- cyanide hydratases 273–275
- properties and applications 277–279
- cyanide-transforming enzymes 279
- (±)-α-cyano-α-fluoro-α-phenylacetic acid (CFPA) 253
- 1-cyano-2-methoxymethyl ferrocene 255
- cyanopyridine 256, 259
- cyclic β-amino acid 438
- cyclic malonic acid monoester derivative 449
- cycloalkanones synthesis 117
- trans*-1,2-cyclohexanediol acetylation 220
- cyclohexanol oxidation 48
- cytidine 5'-monophosphate sialic acid synthetase (CSS) 364
- cytidine triphosphate (CTP) 372
- cytochrome P450 enzymes, artificial cascade reactions
- cofactor regenerating enzymes 108–113
 - multi-enzyme cascades, *in vivo* 120–124
 - multi-enzyme cascades, isolated enzymes 116–120

- cytochrome P450 enzymes, artificial cascade reactions (*contd.*)
– regeneration, whole-cell biocatalysts 114–115
- cytochrome P450 monooxygenases 87–125
- cytosine 405
- d**
- N-dealkylations 102, 104
- dehydrogenase-catalyzed oxidation reactions 23
- demethylation, of lanosterol 97
- N-demethylations 106
- deoxycorticosterone, oxidation 94
- deoxysugars 340
- deracemization 66–67
– of profen thioesters 189
– of racemic amines 78–79
- 3,5-dichlorosalicylaldehyde-catalyzed racemization 437
- dihydropyrimidinase 163–166
- 5-dihydouracils 163
- dihydouracils (DHUs), 5-and 6-monosubstituted 162, 164, 165
- dihydroxyacetone (DHA) 330, 346–351, 353, 355
- dihydroxyacetone phosphate (DHAP) 317, 320, 322, 340, 341, 343–345, 347
- dinitriles 253, 279
- directed molecular evolution 1–3
- disaccharides 370–371
- 2,6-disubstituted piperidines 75
- DKR. *See* dynamic kinetic resolution
- DL-Ac-Phe, kinetic resolution of 211
- DNA
– methylation 393, 394, 400
– methyltransferases 398, 404, 407
- dodecanoic acid methyl ester 55
- dopamine methylation 400
- dTDP-activated deoxysugar synthesis 139
- dTDP-deoxy sugars synthesis 141
- dTDP-2-deoxy-*arabino*-hexose 139
- dTDP-deoxyhexoses 139
- dTDPdeoxysugars 147
- dTDP-2,6-dideoxyhexoses synthesis 140
- dynamic kinetic resolution (DKR) 179–194, 210, 212, 428–438
– of amino acid esters 186
– of aminoesters 187
– applications of 183–193
– of N-Boc-phenylglycine thioesters 191
– of oxoesters 185–188
– of thioesters 188–193
- e**
- ebastine metabolism 103–104
- enantioselective acylation, of prochiral diols 212
- enoate reductase 53, 57
- ent*-kaurene oxidation 101
- enzyme engineering 60, 265, 404
- enzyme-mediator systems 35–37
- D-erythrose-4-phosphate (D-E4P) 318
- ester hydrolysis 436–437, 449
- ethyl carbamate oxidation 100
- f**
- D-fagomine 349
- farnesyl pyrophosphate (FPP) 120
- FDH. *See* formate dehydrogenase
- Fe-(III) nitrile hydratases 304
- ferredoxin hydrogenase 29
- flavin mononucleotide (FMN) cofactor 28
- flow-through approach, advantages 199
- fluidized-bed reactors 201
- fluorescent intensity (FLINT) 318
- fluorogenic transketolase assay 319–321
- 5-or 9-fluorophore-labeled sialoconjugates 381
- fluoropyruvate 381
- formate dehydrogenase (FDH) 24–26, 111–112
- Friedel-Crafts-type alkylation 452
- D-fructose 6-phosphate (D-F6P) 318
- D-fructose 429, 430
- fructose-6-phosphate aldolase (FSA) 330, 342, 348–350, 352, 355
- L-fuculose-1-phosphate aldolase (FucA) 341–344, 347, 348
- fusion engineering 27
- g**
- γ -amino-*n*-butyric acid (GABA) 161
- ganglioside 144
- geranylgeranyl pyrophosphate (GGPP) 122
- glucose dehydrogenase (GDH) 24–26
- glucose-6-phosphate dehydrogenase (G-6P-DH) 29, 108–110
- regeneration of NADPH by 30
- glycan microarray technology 388
- glycan-binding proteins 388
- glycans 133, 137, 144, 148–151
- D-glyceraldehyde 3-phosphate (D-G3P) 317, 318
- D-glycerol 3-phosphate 317
- glycerol-3-phosphate dehydrogenase (GPDH) 318
- glycoconjugates 363

- synthesis 133–153
 glycolaldehyde (GO) 349, 352–354, 356
 glycomics 133
 glycosidases 136–137
 glycosyl fluorides 137
 glycosylation 133
 glycosylazides 137
 glycosyltransferases (GTs) 134–135, 139, 147, 149, 150, 377, 378
 glycosynthases 136–137
 guanosine monophosphate (GMP) 148
- h***
 Heck reaction 448
 Henry reaction 350, 438, 439
 heparin oligosaccharide 144
 heparosan oligosaccharides 144
 (R) -heptanol and heptanone synthesis 118
 high-redox potential laccases (HRPLs) 3, 5, 6
 – directed evolution of ligninolytic 8–11
 high-throughput screening (HTS) 2, 8, 10, 15, 316, 318, 321, 326, 376
 hollow fiber membrane bioreactor 208, 210
 β -homoalanine 161
 Horner–Wadsworth–Emmons olefination reaction 439
 horse liver alcohol dehydrogenase (HLADH) 204
 horseradish peroxidase (HRP) 12
 hyaluronan oligosaccharides 144
 hydantoinase process 162–164
 hydantoins, 5-monosubstituted 162, 163
 hydrogenase 27–29
 hydrolase-catalyzed acylation 211, 213
 hydrolase-catalyzed continuous-flow techniques 214
 hydrolase-filled continuous-flow reactors 215–217
 hydrolases 203, 207, 211
 hydrolytic enzymes 203, 410
 hydrolytic processes, in continuous-flow system 211
 hydrolytic reactions 202, 208
 ω -hydroxy acids 50
 β -hydroxy nitriles 251
 2-hydroxy- γ -butyrolactone (HBL) 208
 hydroxyacetone (HA) 349–354, 356
 hydroxyaldehyde 321
 hydroxybutanone (HB) 349, 352–354
 (S) -2-hydroxycarboxylic amides 262
 hydroxylation reaction, P450 monooxygenases 88, 89
 5-hydroxymethylcytosine (hmC) 404
 hydroxynitrile lyase-nitrilase 259–261
- hydroxynitrile lyase-nitrilase-amidase 261
 hydroxynitrile lyase-nitrile hydratase 261–262
 hydroxynitrile lyases (HnLs) 259–261
 hydroxypyruvate (HPA) 315, 316
- i***
 (S) -ibuprofen 208, 213
 iminocyclitol synthesis 340–351
 immobilization, enzyme 220–222
 immobilization techniques evolution 199–200
in situ enzymatic recycling, NAD(P)(H) cofactors 23–38
in situ nitrile hydratase/amidase enzymatic system 283
in situ product removal (ISPR) technique 30, 31, 241
in situ regeneration of oxidized NAD(P)+ cofactors 31–37
in situ regeneration of reduced NAD(P)H cofactors 24–31
in vivo assembly of mutant libraries (IvAM) 14, 16
in vivo metabolism 329
in vivo multistep biocatalysis 51–56
in vivo overlap extension (IVOE) 14, 16
 induced resistance defense mechanism 161
 inorganic phosphite oxidation 26
 ion-exchange-polymer-catalyzed epimerization 59
 L-isoaspartate 398
- k***
 ketones 67, 260
 – oxidation 50
 – reduction 202, 448
 (S) -ketoprofen 208
 kinetic resolutions (KRs) 66–67, 179, 208, 210–220, 222, 299
- l***
 laccase-catalyzed biotransformation 450, 452
 laccase-mediator systems 7
 laccases
 – blood-tolerant 9
 – directed evolution of 6–11
 – PM1 8, 10, 11, 16
 β -lactam carbonitriles 251
 β -lactam-recognizing enzymes (BLREs) 307
 lactate dehydrogenase (LDH) 28, 31–32
 layered double hydroxides (LDHs) 322
 Lecitase® Ultra 208

- Leloir pathway 363, 366, 367, 372, 389
 Leloir-glycosyltransferases 134, 135
 Leloir-path sialyltransfer enzymes 368
 lignin
 – combustion 3
 – degradation 3, 5
 lignin peroxidases (LiPs) 3, 5, 11
 lignin polymer 5
 ligninolytic enzymatic consortium 1, 3–6
 ligninolytic high-redox potential laccases,
 directed evolution of 8–11
 ligninolytic oxidoreductases 1–17
 ligninolytic peroxidases 11
 lignocellulosic materials 6
 Li-HPA 325, 326, 330
 linear cascade reactions 69–82
 lipase-catalyzed acylation 212, 213
 lipase-catalyzed hydrolytic reactions 252
 lipase-catalyzed kinetic resolution 212
 lipase-catalyzed reactions 204
 lipase-nitrile hydratase-amidase 263–264
 lipases 207, 211, 231, 299–300, 450
 low-redox potential laccases, directed
 evolution of 7
- m**
- mediator-coupled enzyme systems 35–37
 medium-redox potential laccases, directed
 evolution of 7–8
 membrane bioreactors (MBRs) 201, 208, 210
 metabolic diversification 385
 metabolic engineering 16, 385, 409
 metal catalysis 445–449
 metal catalysts 283, 430, 432, 433, 436, 445
 metal-catalyzed hydrogenation 446
 metal-catalyzed racemization 431, 433
 metal-catalyzed transformation 449
 metallo-enzymes 302
 metathesis 449
 α -methionine 172
 methyl dodecanoate 72
 methylation 393, 394, 398, 400
 methylene groups oxidation 49, 50, 119
 methylenedioxo motif 416
 3-methylthietan-2-one hydrolysis 207
 O-methyltransferase (OMT) 410, 414, 416,
 417
 methyltransferases (MTs) 393–417
 – bacterial 404
 methyltransferases, *S*-adenosyl-L-methionine
 (SAM) dependent
 – acting on small molecules 398–400
 – cascade applications 410–415
 – cofactor (re)generation 406–410
 – cofactors 400–403
 – higher homologs and derivatives 403–406
 – radical-SAMenzymes 395–396
 – substrates 396–400
 N-methyltransferases (NMTs) 414, 417
 Michaelis–Menten kinetics, PFR type reactor
 200–201
 microbial transketolase 315
 microreactor technology 199, 203
 mining genomes for nitrilases 271–279
 mitochondrial CYP11B2 93
 mitochondrial cytochrome CYP11A1 92, 93,
 95
 Mn peroxidases 11
 molecular oxygen fixation, monooxygenases
 44
 monooxygenase-catalyzed redox cascade
 biotransformations 43–61
 monooxygenated metabolites 97
 5-monosubstituted hydantoins 162, 163
 5-and 6-monosubstituted dihydouracils
 (DHUs) 162, 164, 165
 multienzyme system
 – biocatalyst options 233–237
 – classification 233, 234
 – compartmentalization 237
 – process control 244
 – process development 239–244
 – process engineering 241
 – process modeling 241–244
 – transport limitations 235–237
 multistep cascade reactions 87–88
 multistep oxidations catalyzation
 – multiple P450 102–108
 – single P450 92–101
 mutagenesis, site-directed 134, 135
 mutagenic organized recombination process
 by homologous in vivo grouping
 (MORPHING) 14–16
Myceliophthora thermophila laccase (MtL) 7,
 8, 16
- n**
- NAD(H)-dependent dehydrogenases
 317–319
 NADH cofactor regeneration 28
 NAD(P)H oxidases (NOXs) 32–34
 NADH regeneration 30, 37
 NADH-dependent dehydrogenase 318
 NAD(P)H-dependent dehydrogenases 23
 (S)-naproxen 208, 210
 natural cascades 250–257
 neo-sialoconjugates synthesis 378–388
 neuraminic acid 370

- neuraminic acid aldolase (NeuA) 368–371, 381, 383, 385
 neuraminic acid synthase 371–372
 nicotinic acid 254
 nitrilase-amidase 258–259
 nitrilase-catalyzed transformations 272
 – hypothetical mechanism of 273
 nitrilases 258, 271–272
 – analysis of specific regions 276
 – bacterial 274
 – enzyme mutants analysis 276–277
 – in fungi 274–275
 – mining genomes for 271–279
 – in plants 275
 – properties and applications 277–279
 – sequence clustering 275–276
 – sequences diversity 272–274
 – structure and mechanism 301
 – structure-function relationships in 275–277
 – substrate selectivity 302
 nitrile containing compounds 249, 250, 264
 nitrile converting biocatalysts 300–301
 nitrile converting enzymes 249–265
 nitrile hydratase-amidase 250–255, 257–258
 nitrile hydratases (NHases) 250, 251, 302
 – activity and stability 287–289
 – cascade substrate selectivity 304–308
 – structure and mechanism 303
 nitrile hydratases-amidase bi-enzymatic cascade system 284–287
 nitrile hydrolysis enzymes 301
 Ni-nitrolotriacetic acid (Ni-NTA) complex 207
 non-nucleoside reverse transcriptase inhibitor 96
 nonstereoselective enzymatic processes 204
 nucleoside diphosphate (NDP) 146
 nucleotide activation of sialic acids 372–373
 nucleotide sugars 135, 139–141, 146–148
- o**
 omeprazole metabolism 102–103
 one-pot reduction–oxidation–hydrolysis 54
 one-pot synthesis 134, 138, 146–151, 258, 379–385
 – of poly-LacNAc structures 143
 opium alkaloids 415
 organocatalysis 231, 440, 449–452
 organocatalytic dehydration 440
 organonitriles detoxification 283
 orthogonal cascades 44
 oxazinone hydrolysis 438
 oxidoreductase-catalyzed reactions 442
- oxoesters, dynamic kinetic resolution of 185–188
 oxy-functionalized heteroaromatic compounds 452
 oxygenase-nitrilase 262–263
 oxynitrilase. *See* hydroxynitrile lyases (HnLs)
- p**
 packed bed reactor (PBR) 208, 218–220, 222, 237, 238
 – in hydrolase-catalyzed acylation 213
 – hydrolysis in 208
Pasteurella multocida hyaluronan synthase (PmHAS) 144–145
 pathway engineering 121, 122, 414
 peptide glycosylation 151
 peptidomimetics 297–298
 peroxidases and peroxygenases, directed evolution of 11–15
 peroxygenases, unspecific 3, 15, 16
 phenol red 326–329
 phenylacetonitrile 257
 phenylglycine methyl ester, ammonolysis of 186
 phenylpropanoids 410
 phosphatase-catalyzed reaction 439
 phosphite dehydrogenase (PTDH) 26–27
 5'-phosphoadenosine 3'-phosphosulfate (PAPS) 146
 phosphoenolpyruvate (PEP) 364
 phosphoglucomutase (PGM) 139
 physiological cascade reactions, P450 91–108
 α-pinene 114, 115
 L-pipecolic acid 442
 plug-flow reactor (PFR) 200, 201
 PM1 laccase (PM1L) 8, 10, 11, 16
 polyacrylonitriles (PANs) 255
 polyhydroxylated compounds 351–355
 poly-LacNAc oligomers 151
 poly-LacNAc structures
 – convergent synthesis of 152
 – one-pot synthesis of 143
 polymerase chain reaction (PCR) 2, 26
 polyphenol oxidase 321–322
 polyphenoloxidase (PPO) biosensor 322–324
 poly(ethylene glycol) (PEG)-polymer 149
 poly(ϵ -caprolactone)-type polyester 446
 porcine pancreas lipase (PPL) 213
 post-synthetic diversification 386–387
 potential reactor configurations 238
 process engineering 241

- prochiral diols, enantioselective acylation of 212
- profen thioesters deracemization 189
- progesterone oxidation 116
- promiscuity 169
- protein engineering 2, 24, 37, 65, 87, 124, 135, 137, 144, 180, 240, 241, 244, 245, 346, 356, 384, 389
- protein methylation 400
- protein molecular models 350
- protein processing, maturation and exocytosis 13
- proteins arginine-*N*-methyltransferase (PRMT) 398
- proteomics 203–204
- Pseudomonas cepacia* lipase (PcL) 207
- Pseudomonas fluorescens* lipase (Pfl) 212
- putative racemization mechanism 190
- putrescine-NMT 414–415
- Pycnoporus cinnabarinus* laccase (PcL) 8, 10, 11, 16
- pyrene oxidations 97, 99
- pyridinedicarbonitriles 253
- pyridoxal phosphate (PLP) 66, 185, 186
– catalyzed racemization 436
- pyridoxamine-5'-phosphate (PMP) 66
- pyrolytic graphite (PG) particles 28
- r**
- racemization, amine-catalyzed 438
- reaction engineering 181, 194, 453
- reactor configurations, potential 238
- recombinant DNA (rDNA) technology 240
- redox and redox-neutral cascade reactions 70–75
- redox chromophore 325–326
- redox systems, P450 monooxygenases 89–90
- redox toolbox concept 56
- redox-balanced biocatalytic system 45
- regio-and stereoselective dihydroxymyristic acid synthesis 109
- L-rhamnulose-1-phosphate aldolase (RhuA) 341, 342, 344–349
- rhodium catalyzed racemization 431
- Rhodococcus erythropolis* A4 252–254, 258, 264
- Rhodococcus erythropolis* AJ270 251, 253
- Rhodococcus rhodochrous* PA-34 whole cells 255
- (R)-rhododendrol 448
- D-ribose 5-phosphate (D-R5P) 317, 330
- RNA methylation 400
- ruthenium catalyzed racemization 432, 433
- s**
- Saccharomyces cerevisiae* biomolecular tool box 15–16
- selenium-based cofactor analog 404
- self-supported chiral titanium cluster (SCTC) catalyst 203
- sialoconjugate arrays applications 388
- sialoconjugate diversity 361–389
- sialoconjugate libraries 363–378
- sialoconjugates, 5-or 9-fluorophore-labeled 381
- sialyl acceptor 378–379
- sialylated oligosaccharide 361, 362, 383
- sialylation 361, 383
- sialyltransfer reactions 382
- sialytransferase (SiaT) 364, 377–379, 381, 383
- Sinorhizobium meliloti* (SmelDhp) 163–165
- sitagliptin 298
- staggered extension process (StEP) 14, 16
- stereoselective acylations 211–220
- stereoselective carboligation 330
- stereoselective enzyme reactions 204–222
- stereoselective hydrolase-catalyzed process 199–222
- stereoselective hydrolytic reactions 207–211
- stereoselective synthesis
– of β-amino acids 297–309
– of 14(S), 15(R)-epoxyeicosatrienoic acid 110
– of epoxyhexane 111
- steroid 11β-hydroxylase. *See* mitochondrial CYP11B2
- Strecker reaction 203, 254
- styrene monooxygenase (SMO) 46, 47
- β-substituted β-adrenergic agents 297
- substrate binding model 373–376
- substrate engineering 181, 183, 194
- substrate-binding interactions 375
- substrate-coupled approach 29
- subtilisin-catalyzed process 214
- sucrose synthase (SuSy) 146
- Suzuki reaction 446–448
- t**
- tamoxifen metabolism 104, 106, 107
- taurine 161
- taxol 120, 122
- tetrasaccharide synthesis 382
- tetrazolium red 325
- thermophilic alcohol dehydrogenase (TADH) 206

thiamine diphosphate (ThDP)-dependent enzyme 315
 thioesterification 184
 thioesters 180
 – dynamic kinetic resolution of 188–193
 D-threose 352, 355
 toluene oxidation 52
Trametes versicolor laccase (TvL) 11
 transaminases 300
 ω -transaminases (TAs) 65–83, 207
 – cascade reactions 80–82
 – catalyzed amination 77
 – catalyzed reactions 68, 69
 – linear cascade reactions involving 69–72
 α -transaminases 66
 transamination 203
 transglycosylation 136, 142, 151
 transition-metal-catalyzed heterogeneous hydrogenation 59
 transketolase (TK) 207
 – activity by *in vivo* selection 329–330
 – activity in *E. coli* 331–334
 – activity *in vitro* 317–329
 – applications of 315–335
 – microbial 315
 triose phosphate isomerase (TPI) 317

u

UDP-Gal and UDP-GalNAc synthesis 142
 ultra low molecular weight (ULMW) heparin 145

umbelliferone 320
 unspecific peroxygenases (UPOs) 3, 15, 16
 β -ureidopropionase. *See N*-carbamoyl- β -alanine amidohydrolase (NC β AA)

v

vanillin 53, 414
 verapamil metabolism 102
 veratryl alcohol (VA) 3, 11
 versatile peroxidases (VPs) 5, 11–13
 vitamin D₃ metabolism 107

w

Wacker oxidation 448, 449
 whole-cell biocatalysts 114–115, 235, 250, 252, 253, 260
 wild-type FucA 343
 wild-type transketolase 330–331
 Wittig reaction 443, 444

x

xenotransplantation antigen glycan synthesis 148–149
 xylene-monoxygenase (XMO) 52
 xylulokinase (XK) 318
 D-xylulose 5-phosphate (D-X5P) 317, 318

