

Index

a

- acetamides, reduction 284
- acetamidomalonic ester (EtAAM) 458
- acetoin 96
- acetolactate synthase 96
- acetophenone 584
- achiral β -amino acids 300ff.
- acid hydrolysis 585, 589, 629
- acyclic β -amino acids, synthesis 353
- acyclic transformation 501
- N*-acyl amino acids, reduction 283
- N*-acyl-L-amino acid amidohydrolase 81
- acyl transferase (AT) 151
- N*-acylamino acid racemase 82
- β -acylamino acrylates 333
- acylase 81f., 86, 509
- acyloxazolidinone 605
- addition-cyclization 339
- s*-adenosylmethionine (SAM) 123ff., 127
- β -alanine 132
 - biosynthesis 120f.
 - biosynthesis from pyrimidines 121
 - biosynthesis from spermine 121
- L-alanine 92, 96
 - production 92
- albothricin 124
- aldehyde 578
- aldimine 647
- aldimine-borane adduct 594
- aldol-type reactions 316ff.
- alkene-derived γ -amino acids 539f.
- alkenyl aziridine 555
- alkenylation 327
- N*-alkyl amino acids 245ff.
- N*-alkyl α -amino acids
 - asymmetric synthesis 284
- (*S*)-2-alkyl-3-aminopropionic acid 356
- alkyl radical addition 357
- alkylation 357, 452, 484, 601
 - N*-alkylation 259f., 285
- 5-alkynyl enones 351
- allylation 340
- allylboration 595
- allylic alcohol 427
- allylic amination 323
- L-allysine ethylene acetal 101
- amidase 83ff.
 - process for α,α -disubstituted α -amino acids 86ff.
- amidation 368
- amide 429
 - borane reduction 264
 - *N*-methylation 249ff.
- amine 427f.
- amino acid alphabet 47ff., 63, 66
 - biochemical diversity 60f.
 - evolution 49ff.
 - evolutionary expansion 53ff.
 - initial amino acid alphabet 55
 - members of standard amino acid alphabet 52
 - origins 48
- amino acid dehydrogenase (AADH) 94, 99ff., 473ff.
- γ -amino acid oligopeptides 545
- amino acid oxidase 514
- δ -amino acid precursor 553
- amino acid selection 57
- amino acid synthesis 79ff.
 - use of enzymes 79ff.
- amino acids 3ff., 16, 43ff.
 - *N*-alkylation 280
 - enantiomerically pure amino acids 80
 - natural synthesis 50ff.
 - stability against space radiation 9
 - use of amino acids 79f.
- α -amino acids 532
 - *N*-alkylation 284f.

- methods to prepare 495f.
- *N*-methylation 276f.
- β -amino acids 119ff., 367, 377
 - β -amino acid with unknown biosynthesis 152f.
- asymmetric synthesis 327
- asymmetric synthesis by addition of chiral enolates 314
- biological importance 119
- biosynthesis from α -amino acids 122f.
- *de novo* biosynthesis by PKSs 139
- enantioselective synthesis 298ff.
- miscellaneous methods for synthesis 340ff.
- synthesis by addition or substitution reactions 328
- synthesis by conjugate addition of nitrogen nucleophiles to enones 300ff.
- synthesis by homologation of α -amino acids 291ff.
- synthesis by nucleophilic additions 316ff.
- synthesis by stereoselective hydrogenation 330ff.
- synthesis by use of chiral auxiliaries 334ff.
- synthesis via 1,3-dipolar cycloaddition 312ff.
- synthesis via radical reactions 338
- γ -amino acids 527ff., 538ff., 567
 - synthesis 527ff., 539, 544
- δ -amino acids 527ff., 547ff.
 - as reverse turn mimetics 554
 - for PNA design 562f.
 - synthesis 527ff., 552
- L*-amino acids 64
- 3-amino acrylate 330
- δ -amino alcohol 594
- β -amino ester 326, 328, 394
 - enantioselective hydrolysis 396
- (*S*)-4-amino-3-hydroxybutanoid acid (GABOB) 574, 607, 610, 615f., 650, 671
 - synthesis 607
- β -amino ketones 324
- (*S*)-1-amino-2-methoxymethylpyrrolidine (SAMP)-hydrazone 590f.
- (2*S*,9*S*)-2-amino-8-oxo-9,10-epoxydecanoic acid (Aoe) 208, 210
- aminoacylase I 509
- D*-aminobutyric acid 98
- γ -aminobutyric acid (GABA) 528ff., 567, 573ff., 641, 666
 - synthesis 573ff.
- 2-aminocyclobutanecarboxylic acid 384ff.
- β -aminocyclohexanecarboxylic acid 390
- 2-aminocyclopentanecarboxylic acid 386
- aminoester 342
- aminohydroxy alkanooates 430
- β -aminoisobutyric acid 120ff.
 - biosynthesis from pyrimidines 121
 - biosynthesis from spermine 121
- (*S*)-2-(aminomethyl)-4-phenylbutanoic acid 350
- aminomutase 120ff., 128, 130f., 154
 - types 123
- aminotransferase 94ff., 511f.
 - application 95
 - production of *D*- α -H- α -amino acids 97
- ammonia lyase 90ff., 510
- ammonium ion 89
- antarctic micrometeorites (AMMs) 23, 26
- anti- γ -amino- β -hydroxy carboxylic acid 626
- antibiotics 367
- antipode 496
- apoptosis 169
- arginine 55
- β -arginine 124
- Ariza's synthesis of 3-hydroxyleucine 199
- Armstrong's synthesis of *anti*- β -methylaspartate ethyl ester 204
- Arndt-Eistert homologation 532ff., 592, 599, 635
- Arndt-Eistert synthesis 291f.
- β -aryl- β -amino acids 333
- β -aryl-GABA 530
- β -aryl-GABA derivative 588
- asparagine 424
 - enantioselective synthesis 298
- aspartase 91, 510
- aspartase-decarboxylase cascade 92
- aspartate derivatives 202
- aspartic acid 426
 - enantioselective synthesis 298
- L*-aspartic acid
 - production 91
 - use of *L*-aspartic acid 91
- Aspergillus oryzae* 82
- asteroid 23
- astrobiology 48f.
- asymmetric acetylation 586
- asymmetric addition 589
- asymmetric alkylation 490, 500
- asymmetric allylic alkylation 598
- asymmetric catalysis 304, 308ff., 414
- asymmetric deprotonation 595
- asymmetric dihydroxylation 591
- asymmetric hydrogenation 332, 374f., 487, 504, 507, 518ff., 614
- asymmetric reduction 505

asymmetric synthesis 272ff., 338, 370, 386, 483, 567
 asymmetric transformation 497
 autoimmune disease 207
 aza-Henry reaction 416
 azalactone 272
 azetidinone 400
 azetines 341
 azide formation 551
 azido acid 551
 δ -azido ester 566
 azidolysis 542
 aziridine 418, 443, 456, 548, 602
 aziridine opening 341, 602

b

baclofen 573f., 582, 584ff., 590, 641
 baclofen analogs 584ff.
 – synthesis 592
 baclofen hydrochloride 669
 Baeyer-Villiger oxidation 532, 587
 barbamide, biosynthesis 455
 Barbas's synthesis of (2S,3S)-3-hydroxyleucine 193
 Baylis-Hillman reaction 581, 637
 benzene sulfonamides, base-mediated alkylation 282
 (S)-1-benzoyl-5-iodo-2-isopropyl-2,3-dihydropyrimidin-4(1H)-one 350
 (2S,5S)-1-benzoyl-2-isopropyl-5-phenethyltetrahydro-pyrimidin 351
 benzyl (S)-3-(bis((R)-1-phenylethyl)amino)-2-alkyl-3-oxopropylcarbamate 356
 benzyl 3-(bis((R)-1-phenylethyl)amino)-3-oxopropylcarbamate 355
 benzylidenemalonate 530
 bestatin 151
 1,1'-bi-2-naphthol (BINOL) 308, 323
 biocatalysis 489
 biocatalyst 85, 87, 98
 biosynthesis 119ff., 154
 biotransformation 396, 463, 465, 476, 483
 Birch reduction 597
 (S)-2,2'-bis(diphenylphosphino)1,1'-binaphthyl (BINAP) 589, 634
 3,3'-bisnaphthol (BINOL) 506f.
 blasticidin S 125
 bleomycin 135f.
 Boc-L-leucinal 673
 Boger's synthesis of fragments of ristocetin and teicoplanin 225
 borane reduction 264
 borohydride reduction 263
 β -branched amino acids 508

bromination 451f., 461ff., 663
 α -bromo acids
 – formation via diazotization 247
 – S_N2 substitution 246ff.
 bromoacetonitrile 577
 bromoalanine 444
 BTA (bicycles from tartaric acid and amino acid) 560f.
 Bucherer-Bergs reaction 421

c

camphorsulfonamide 614
 cancer 574
 capreomycin 137f., 211ff., 412
 – biosynthesis 137
 carbamate, *N*-methylation 249ff.
 D-*N*-carbamoylase 88
 carbocyclic β -amino acids 367ff.
 – analytical methods for enantiomeric separation 397f.
 – biological potential 367
 – enzymatic routes to carbocyclic β -amino acids 393ff.
 – synthesis 368ff.
 – synthesis by Curtius and Hoffmann rearrangements 368
 – synthesis by cycloaddition reactions 375
 – synthesis by enantioselective desymmetrization of meso anhydrides 378
 – synthesis by ring-closing metathesis 371f.
 – synthesis from chiral monoterpene β -lactams 377
 – synthesis from cyclic β -keto esters 372ff.
 – synthesis from β -lactams 368
 – synthesis of functionalized carbocyclic β -amino acid derivatives 385ff.
 – synthesis of small-ring carbocyclic β -amino acid derivatives 383ff.
 – synthesis via lithium amide-promoted conjugate addition 369f.
 carbocyclic β -keto ester 372
 carbocyclic nitriles 396
 carbohydrate 564
 carbon backbone
 – C-C bond formation 411ff., 420ff.
 – C-N bond formation 412
 – construction 411ff.
 – introduction of nitrogen atoms from alkenoates 429ff.
 – introduction of nitrogen atoms from allylic alcohols and amines 427f.
 – introduction of nitrogen atoms from halo alkanoates 428

- introduction of nitrogen atoms from β -keto esters 433
 - introduction of nitrogen atoms from readily available α -amino acids 425ff.
 - carbonaceous chondrites 11f., 16
 - amino acid concentration 13ff.
 - compound-specific stable isotope composition 20f.
 - L-2-carboxy-6-hydroxyoctahydroindole (L-choi) 177, 182f.
 - carboxylate 421
 - carboxypeptidase A 477
 - Cardillo's synthesis of (3S)-hydroxy-L-aspartic acid 200
 - carnitine 607f., 615f.
 - catalytic asymmetric reaction 613
 - catalytic asymmetric synthesis 226
 - catalytic hydrogenation 333
 - cell proliferation 574
 - central nervous system (CNS) 573f.
 - Chamberlin's synthesis of β -methylaspartate 202
 - champhorsultam 485f.
 - chemical asymmetric methods 483ff.
 - chemo-enzymatic method 585
 - chemo-enzymatic synthesis 615
 - chemoselective opening 608
 - chiral α -substituted β -alanine, synthesis 355
 - chiral β -amino acids, synthesis by diastereoselective radical addition 357
 - chiral acceptor 306
 - chiral ammonia, addition 304
 - chiral epoxide opening 208
 - chiral phase transfer catalysis 226
 - chiral pool strategy 477ff., 489
 - chiral stationary phases (CSPs) 397
 - chiral sulfinimines 318
 - chiral synthon 515
 - chirality 18, 64
 - chlorination 451, 453ff., 461ff.
 - chlorodysinosin A, synthesis 456
 - β -chlorophenylalanine 459
 - chlorosulfonyl isocyanate (CSI) 368
 - chlorotrimethylsilane (TMSCl) 345, 427, 442, 445
 - D-6-chlorotryptophan 462
 - chondrites 16
 - classification 11
 - petrographic types 11
 - chromatographic separation 620f.
 - circumstellar medium 4f.
 - cispentacin 367, 375f.
 - synthesis 376, 382
 - Claisen condensation 640
 - Claisen rearrangement 220, 508, 580
 - coevolution theory 54
 - cofactor 99, 474
 - column chromatography 675
 - comet 9ff., 22f., 26
 - amino acids in comets 11
 - condensation 613, 623
 - conformational analysis 557f.
 - conjugate addition 303, 369f., 581f., 625
 - conversion 645, 664
 - Corey's synthesis of β -hydroxyleucine 190
 - Corey's synthesis of (S)-pipecolic acid *tert*-butyl ester 178
 - Crich's synthesis of β -hydroxy aromatic amino acids 201
 - cross-coupling 674
 - cross-enantiomeric inhibition 64
 - crystallization 585, 622
 - Curtius rearrangement 576, 606, 648f.
 - cyanomethylation 577
 - cyclic amino acids (CAAs) 164ff.
 - cyclic β -amino acids 345f., 367, 398
 - synthesis 353
 - cyclic γ -amino acids 644ff.
 - cyclic tetrapeptides 208
 - cyclization 564, 624
 - cycloaddition 385, 417f., 590, 660
 - cycloaldolization 660
 - cycloalkene β -amino acids 398
 - cycloalkenes 368
 - cyclobutyl γ -amino acid 648
 - cyclohexanecarboxylic acid 391
 - cyclohexyl γ -amino acid 663
 - cyclomarin A 218
 - cyclopentene 656
 - cyclopentyl γ -amino acid 653
 - cyclopentylmethyl ether (CPME) 323
 - cyclopropane 583, 645f., 650
 - cyclopropene 647
 - cyclopropyl γ -amino acid 644ff.
 - cycloreversion 275
 - cyclosporin A 207
- d**
- Danishefsky's synthesis of *anti-cis* Hpi 186f.
 - debenzylation 613, 624
 - decarboxylase 515
 - dehydro- α -amino acids 333
 - dehydrogenase 513
 - deoxygenation 549f.
 - deprotection 478, 602, 616, 626, 657
 - N-deprotection 370
 - deprotonation 640
 - deracemization 598

- Dess-Martin oxidation 664
 desymmetrization 378ff.
 α,β -dialkyl- β -amino acids 339
 α,β -diamino acids
 – biosynthesis from α -amino acids 132
 – structure and occurrence in nature 132ff.
 – synthesis 411ff.
 β,γ -diaminocarboxylates 393
 diaminocyclohexanecarboxylic acid 392
 diaminopropanoic acid (Dap) 132ff.
 – biosynthesis 136
 diaminosuccinate 418
 diastereoisomer 534, 581
 diastereomer 198
 diastereomeric selectivity 481
 diastereoselective addition 621
 diastereoselective conjugate addition 307
 diastereoselective reduction 618
 diastereoselectivity 173, 192, 327, 311, 337, 370, 414, 484, 576
 diastereotopic labeling 481
 diazoketone 292f., 349
 dicyclohexylcarbodiimide 336
 Dieckmann cyclization 654
 Diels-Alder cycloaddition 375
 (diethylamino)sulfur trifluoride (DAST) 660
 L-3,3-difluoroalanine 447
 (2S,3S,4S)-3,3-dihydroxyhomotyrosine (Dhht) 215ff.
 dihydroxylation 296
 L-3,4-dihydroxyphenylalanine (DOPA) 277, 298f., 441, 504
 diisobutylaluminum hydride (DIBALH) 297, 633
 dimethyl (S,S)-(-)-3-*N,N*-bis(α -methylbenzyl)-amino-2-oxopropylphosphonate 672
 1,3-dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidinone (DMPU) 296
 dimethylamine 608
 3,3-dimethyldioxirane (DMDO) 185
 (2S,3S,4R)-3,4-dimethylglutamine (DiMeGln) 204ff.
 dioxane 603
 dioxocyclam 292
 diphenylphosphoryl azide (DPPA) 311
 1,3-dipolar cycloaddition 353
 direct templating 57
 disubstituted γ -amino acids 600ff.
 α,α -disubstituted α -amino acids 86
 α,β -disubstituted β -amino acids 312
 α,β -disubstituted γ -amino acids 600
 α,γ -disubstituted γ -amino acids 601ff.
 β,β -disubstituted γ -amino acids 604
 β,γ -disubstituted γ -amino acids 604
 DNA 562f., 567
 dynamic kinetic resolution (DKR) 82, 102, 189, 192, 195
 dysidenamide 455
e
 echinocandins 213, 215, 218
 electrochemical oxidation 610
 electrophiles 411
 electrophilic amination 431f.
 electrophilic synthetic equivalent 423f.
 β -elimination 456
 enamide 506
 enamine 373
 enaminones 344
 enantioselective addition 320
 enantioselective approaches 304ff.
 enantioselective biotransformation 578
 enantioselective hydrogenation 331f., 417, 433, 590
 enantioselective hydrolysis 404, 586, 615f.
 enantioselective *N*-acylation 394
 enantioselective *O*-acylation 394
 enantioselective reduction 590
 enantioselective ring cleavage 402
 enantioselective synthesis 298ff., 321, 396
 enantioselectivity 83, 87, 192, 196, 307, 309f., 313, 327, 333, 587
 enolates 431f.
 enones 303
 enzymatic resolution 654
 enzyme 634
 enzyme-catalyzed reaction 473
 enzyme-membrane reactor (EMR) 100
 epichlorohydrin 583, 608
 epimerization 254, 257, 262, 276, 370, 374, 379, 454, 566, 605
 epoxidation 387f., 400, 613, 634
 epoxide 220, 635, 637
 α -epoxy- β -amino acids 315
 epoxy 2-aminocyclopentanecarboxylate 392
 erythritol 597
 esterification 575
 (R)-2-ethyl-4-nitrobutanoic acid 668
 ethylenediaminetetraacetic acid (EDTA) 317
 Evan's aldol methodology 638
 Evan's alkylation 581
 Evan's oxazolidinone 499
 Evan's synthesis of (2S,3S,4S)-3-OH-4-MePro derivative 175
 Evan's synthesis of β -hydroxyphenylalanines and β -hydroxytyrosines 194
 Evan's synthesis of Hht 216
 Evan's synthesis of MeBmt 207

Evan's synthesis of the AB-fragment of
vancomycin 224
evolution 43ff.
experimental procedures 348ff., 399ff., 434f.,
489ff., 516ff., 666ff.
extraterrestrial amino acids 3ff., 26
– delivery to the earth 24ff.

f

Fadel's synthesis of (R)-pipecolic acid 180
fluorination 464ff.
formaldehyde 260, 268
formate dehydrogenase (FDH) 474f.
Friedel-Crafts reaction 594
fumaric acid 91f.
functional group 567
furanoid δ -SAA 547f.

g

GABA analogs 528ff., 573
– clinical use 573
gabapentin 529, 573f., 584
GABOB derivatives 618
gas chromatography (GC) 398
gas-phase reaction 8f.
generic β -turn 556
generic bicyclic δ -amino acid 556
genetic code 43f.
genetic engineering 47f.
glucosamine 552, 554, 627
 β -glutamate 132
glutamate dehydrogenase 475
glutamic acid 593
 β -glutamine 132
glycinates 411f.
– dimerization 416ff.
glycine 6ff., 412
Grignard reagent 624

h

halo alkanoates 428
halogenated α -amino acids
– application 441
– halogenated amino acids with a hydrocarbon
side-chain 442ff.
– halogenated amino acids with an aromatic
side-chain 457ff.
– halogenated amino acids with branched
hydrocarbon side-chains 445ff.
– halogenated amino acids with heteroatoms in
the aliphatic side-chain 463ff.
– synthesis 441ff.
halogenated γ -amino acids 599
halogenated alanine 442ff.

halogenated aspartic acid 463f.
halogenated glutamic acid 463f.
halogenated histidine 460
halogenated isoleucine 445ff.
halogenated leucine 451ff.
halogenated lysine 465
halogenated phenylalanine 457ff.
halogenated proline 442ff.
halogenated threonine 465
halogenated tryptophan 462
halogenated tyrosine 457ff.
halogenated valine 445ff.
halogenation 441, 456, 458
haloperoxidase 452
Hamada's synthesis of 3-OH MePro 170f.
Hanessian's synthesis of aspartate
derivatives 202
Hanessian's synthesis of L-choi
derivative 183
hapalosin analog 627
hemiesther 379
herbatic acid 455
 ω -heterocyclic- β -amino acids 343f.
hexamethylphosphoramide (HMPA) 306
high-performance liquid chromatography
(HPLC) 397f., 449, 648, 651
homoallylic amines 340
homochirality 64
homoisoserine 574
homologation method 294
Horner-Wadsworth-Emmons olefination
642f.
hot molecular cores 3
Huang's synthesis of (2S,3S,4S)-3-OH-4MePro
derivative 176
Huisgen cycloaddition 312
hydantoin 510
hydantoin racemase 90
hydantoinase 88, 102, 510
hydrazine 454, 601, 623
hydroboration 595, 624, 630ff.
hydrogen bonding 246, 252
hydrogenation 266, 504, 588, 593, 653, 664
hydrogenolysis 336f., 343, 346, 618
hydrolysis 654f.
hydropyrroloindole (Hpi) 184, 186f.
hydroxy- γ -amino acids 605
 α -hydroxy- β -amino acids 296, 338, 343
 α -hydroxy- γ -amino acids 534, 605
– synthesis 536
 β -hydroxy- α -amino acids 188, 216
– natural products containing β -hydroxy- α -
amino acids 188
 β -hydroxy- γ -amino acids 535, 606ff.

– synthesis 536
 β -hydroxy-disubstituted γ -amino acid 638
 (2S,3R,4R,6E)-3-hydroxy-4-methyl-2-(methylamino)-6-octenoic acid (MeBmt) 207, 209
 α -hydroxy- γ -substituted γ -amino acids 619
 β -hydroxy- γ -substituted γ -amino acids 619ff.
 (2S,3R)-3-hydroxyhomotyrosine (Hht) 213, 215f.
 hydroxyleucine 197, 199
 β -hydroxyleucine 190f., 193
N-hydroxymethylated β -lactams 394
 β -hydroxyphenylalanine 194
 β -hydroxytyrosine 194

i
 ice mantle 8
 icofungipen 367, 378
 – synthesis of icofungipen analogs 380
 imidazolidine 621
 imidazolidines 413, 420
 imidazolidinone 483
 imidazolidinone catalyst 309
 imidazolines 419f.
 imines 414
 imino species 261f.
 interplanetary dust particle (IDP) 3, 23, 25
 interstellar ice 7f.
 interstellar medium (ISM) 3ff., 26
 – formation of amino acids via gas-phase reactions 8f.
 – formation of amino acids via solid-phase reactions 6ff.
 inversion 519, 655, 657
 iodination 459, 461, 463
 L-3-iodoalanine, synthesis 446
 iodolactonization 389
 iodonium ion opening 551
 iodooxazine formation 389
 isomer 374
 isomerization 379, 385, 401, 497, 634, 642
 isotope labeling 473, 477ff.
 isotopic labels 488
 isotopically labeled α -amino acids 473ff.
 – stereoselective synthesis 787
 – synthesis 486
 – synthesis by enzyme-catalyzed methods 473ff.
 isoxazoline 314
 iturin 149

j
 Joulie's synthesis of DiMeGln derivative 206
 Jurczak's synthesis of (2R-3S)-3-OH Pro

k
 Katsuki's synthesis of Aoe 210
 α -keto- β -amino acids 139
 – biosynthesis from α -amino acids 139f.
 ketoreductase 536f., 633
 Knowles' catalyst 518
 Krebs cycle 54

l
 β -lactam 377, 390f., 419, 610, 649, 656f.
 – enantioselective opening 346f.
 – enantioselective ring cleavage 395
 β -lactam antibiotics 133
 β -lactam dienes 372
 lactam ring formation 556, 558
 lactam ring opening 378, 400
 lactone 266, 273, 389, 548, 582, 587, 608
 lactone ring opening 559
 Larcheveque synthesis of (2S,3S)-3-OH Pro 166
 last universal common ancestor (LUCA) 46
 β -leucine 132
 Leuckart reaction 260f.
 Lewis acid 308, 310, 345, 621
 Ley's synthesis of *syn-cis* isomer of Hpi 187
 lipase 586, 616
 lipase B 348, 402, 404
 lipopeptide 216
 lithium diisopropylamide (LDA) 299, 413
 lithium hydroxide 454
 long-chain β -amino acid 149f.
 – biosynthesis 150
 β -lysine 124
 lysine aminotransferase 512

m
 malic acid 608
 malimide derivative 627
 Mannich-type electrophile 294
 Mannich-type reactions 316ff., 324ff., 415, 599
 mars 23f.
 – mineralogical composition of soils 24
 – surface 24
 Maruoka's synthesis of (2S,3S)-3-hydroxyleucine 191
 Meldrum's acid 592f.
 meteorite 11ff., 16, 22, 24, 51
 – origin 11
 meteoritic amino acids 17ff.
 – detection of unusual amino acids 17
 – determination of compound-specific stable isotope ratios 18f.
 – determination of enantiomeric ratios 18

- determination of the amino acid content 17
 - hydrogen isotope composition 19
 - sources 17
 - synthesis 19ff.
 - methionine 598
 - p-methoxyphenyl (PMP) 322
 - N-methyl amino acids 245, 274
 - N-methyl analog (NMA) 246ff., 251ff., 263f., 272, 274, 277f.
 - 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD) 250
 - N-methylaminonitriles 278
 - β-methylaspartate 201ff.
 - methylation 554
 - N-methylation 245ff., 265ff., 285
 - of trifluoroacetamides 257
 - via alkylation 246ff.
 - via Schiff's base reduction 259ff.
 - via silver oxide/methyl iodide 252
 - via sodium hydride/methyl iodide 253
 - via the Mitsunobu reaction 257ff.
 - N-methylcysteine 270f.
 - Michael addition 22f., 303, 305f., 328, 336, 346, 431, 588
 - Michael reaction 576, 582
 - microcystins 152f.
 - microginin 151
 - micrometeorites (MMs) 23, 25
 - microsclerodermins 150
 - Miller-Urey-type experiment 51f.
 - molecular cloud 3
 - monoterpene 377
 - Morita-Baylis-Hillman (aza-MBH) reaction 321ff.
 - morphine-based amino acid 564
 - Murchison meteorite 51, 58f., 61f.
 - amino acids 59
- n**
- L-neopentylglycine 101
 - neurotransmitter 573
 - Nicolaou's synthesis of the AB-fragment of vancomycin 223
 - nitrile 278, 595
 - nitrile hydrolysis 396
 - nitroalkane 582
 - N-nitrobenzenesulfonamides, base mediated alkylation 250ff.
 - nitrogen electrophile 517
 - nitrogen nucleophile, addition 306
 - nitrone 315, 375f.
 - noncoded amino acids 163ff., 185ff.
 - with elaborate side-chains 205ff.
 - nonproteinogenic α-amino acids 495ff.
 - application 495
 - carboxylic acid introduction 503
 - enzymatic methods for synthesis 508ff.
 - hydrogenation 504
 - incorporation 495
 - introduction of functionality 502
 - nitrogen introduction 502, 517
 - side-chain introduction 497ff., 516
 - nonproteinogenic cyclic amino acids 164ff.
 - examples 165
 - nonproteinogenic natural cyclic amino acids 184
 - nonribosomal peptide synthases (NRPSs) 136
 - norcarnitine 614
 - norstatine 622
 - nuclear magnetic resonance (NMR) spectroscopy 473
 - nucleobase 563
 - nucleophile 411, 421
 - nucleophilic synthetic equivalent 420ff.
- o**
- Ohfuné's Claisen rearrangement synthesis of β-methylaspartate products 203
 - Ohfuné's synthesis of Hht 215
 - Ohfuné's synthesis of Hmp 173f.
 - olefin 329
 - olefination 593
 - olefinic bond 385
 - olefinic double bond 558
 - oligomerization 552
 - open reading frame (ORF) 47
 - oppolzer 614
 - organocatalysis 226
 - organozirconocene 647
 - ornithine 511
 - ornithine aminotransferase 511f.
 - oryzoxymycin 367, 386f.
 - β-N-oxalyl-L-α,β-diaminopropionic acid (β-ODAP) 133
 - biosynthesis 135f.
 - oxathiazinanes 342
 - oxazaborolidine 632
 - oxazine 484
 - oxazinone 637
 - 1,3-oxazolidin-5-ones 265ff.
 - N-alkylation 284f.
 - oxazolidine 624
 - oxazolidinone 559, 632
 - oxazolidinone enolate 517
 - oxazolidone 631
 - oxazoline 198, 443, 580, 630
 - oxazolone 631

oxidative cleavage 610
 oxidative degradation 646
 oxime ether 327
 oxime reduction 663
 oxirane 424
 oxirane ring opening 399, 401
 oxyzinone 412

p

Palomo's synthesis of Dhht 217
 Park synthesis 167f.
 – of (2S,3S)-3-OH Pro 167
 – of (2R,3S)-3-OH Pro 168
 Parkinson's disease 299, 504
 penicillin, biosynthesis 137
 peptide 383, 554, 561
 peptide nucleic acid (PNA) 547, 562ff., 567
 peptidomimetics 154, 527, 541
 peptidyl carrier protein (PCP) 136
 Perrin's synthesis of Hpi dipeptide 187
 pestati 535
 phase-transfer 588
 phase-transfer catalyst 498, 500, 516
 α -phenyl-GABA 586
 phenylalanine 600
 β -phenylalanine 127ff.
 L-phenylalanine, production 93
 phenylalanine ammonia lyase (PAL) 93, 510f.
 phenylisoserine 128
 phosphite 507
 phosphocarnitine 618
 phosphoramides 254
 phosphoramidite 506
 phosphorus-metal complexes 331
 photocycloaddition 383
 photolysis 450
 phthalimide 575, 599
 Pictet-Spengler reaction 501
 pig liver esterase (PLE) 579, 615
 pipecolic acid 177f., 178ff., 422
 pivaloyl chloride (PivCl) 336
Plasmodium falciparum 460
 polyethylene glycol (PEG) 100
 polyhydroxylated β -amino acid 391
 polyketide synthase (PKS) 120, 139
 polyketide-type β -amino acid
 – aliphatic polyketide-type β -amino acids 143, 145
 – aromatic polyketide-type β -amino acids 147
 – general biosynthesis 141
 – structures and occurrence in nature 142
 polyoxytoxins 169
 polysubstituted γ -amino acids 543

porcine pancreas lipase (PPL) 537, 650
 post-translational modification 44
 pregabalin 573f., 581ff.
 – synthesis 581
 proline 422, 557
 protease inhibitor 535, 643
 protected amino acids 578
 protected γ -amino acid 543
 protection 624
 N-protection 266, 270
 proteins 43, 56
 pseudoephedrine 273, 335f.
Pseudomonas putida 83ff.
 Pummerer reaction 629
 purification 654
 pyranoid δ -SAA 552f.
 pyridoxal 5'-phosphate (PLP) 123, 126
 pyroglutamate 454
 pyrrole 598
 pyrrolidine 601
 pyrrolidine ring 559
 pyrrolidinone ring 424
 pyrrolidinones 546
 pyrrollysine (Pyl) 46, 65
 pyrrollysine insertion sequence (PYLIS) 46
 – translation 46

q

quaternization 261f.

r

racemase 98
 racemic syntheses 277ff.
 racemization 82, 88f., 509f., 607
 radical cyclization 443, 558
 Raghavan's synthesis of MeBmt 209
 recrystallization 613, 626, 640, 651
 reduction 333
 reductive alkylation 275
 reductive amination 264, 513
 reductive cyclization 531
 Reformatsky reaction 319, 642
 regiochemistry 196
 regioselective ring-opening 390f., 635
 regioselectivity 335, 487
 resolution 496ff., 508, 514f.
 reverse-phase chromatography 589
 reverse turn inducer 554
 rhamnose 639
 rhodium complex 507
 Riera's preparation of (S)-N-Boc-pipecolic acid 179
 ring-closing metathesis 371
 ristocetin 222, 224f.

s

sarcosine 265
 Schiff's base 259ff.
 – borohydride reduction 280ff.
 – reduction via borohydrides 263
 – reduction via formic acid 260f.
 Schmidt's synthesis of Aoe 210
 scytonemin A 146, 149
 selenocysteine (Sec) 45f., 65
 – translation 45
 serine 426, 610
 Shibasaki's synthesis of L-Choi derivative 182
 side chain 497ff.
 – modification 500f.
 silyl nitronates 415
 Simmons-Smith reaction 646
 sodium borohydride reduction 281
 sodium cyanoborohydride reduction 281
 sodium triacetoxymborohydride reduction 282
 solid-phase reaction 6ff.
 solvolysis 618
 spirocyclopropane 341
 standard amino acids 62f., 65
 – biosynthesis 62
 – evolution 62f.
 statine 535, 574, 620, 622ff., 675
 – stereoselective synthesis 625
 statine amide 637
 statine analog 535, 627, 632f.
 stereocenter 623
 stereochemical theories 57
 stereochemistry 502, 579
 stereodivergent synthesis 651, 660
 stereoisomer 497
 stereoselective alkylation 334ff., 478, 485, 546
 stereoselective epoxidation 390f.
 stereoselective hydrogenation 195
 stereoselective synthesis 369, 476, 478f.
 stereoselectivity 189
 stop codon 45f.
 Strecker reaction 496, 503
 Strecker synthesis 177, 379, 422
 Strecker-cyanohydrin synthesis 22
 streptolidine 137, 213
 – biosynthesis 137
 streptothricin F 124, 213
 α -substituted γ -amino acids 575ff.
 β -substituted α -amino acids 514
 β -substituted α,α -difluoro- β -amino acids 319
 β^3 -substituted β -amino acids 353
 β -substituted γ -amino acids 579ff., 616
 – synthesis 579
 γ -substituted γ -amino acids 538, 592ff.
 N-substituted β -amino acids 302

succinimide (Suc) 338
 sugar amino acids (SAAs) 528, 547f.
 – applications 541
 – synthesis 541
 sulfinimine 414
 N-sulfinyl β -amino carbonyl compounds 318
 sulfonamide
 – N-alkylation 282f.
 – N-methylation 249ff.
 synthesis 163ff.
 synthetic biology 48f.

t

taxol 128
 teicoplanin 224f.
 terrestrial amino acids 44ff.
 – definition 44
 tert-butanessulfinyl imines 319
 (R)-4-(tert-butoxycarbonylamino)-2-ethylbutanoic acid 668
 (R)-3-tert-butoxycarbonylamino-3-phenylpropionic acid isopropyl ester 354
 N-tert-butyl- β -p-chlorophenyl- γ -lactam 669
 N-tert-butyl-N-(p-chlorophenylethyl) α -diazoacetamide 669
 tert-butyldimethylsilyl chloride (TBMDSCL) 297
 tert-butyldiphenylsilyl (TBDPS) ether 619
 (S)-3-(tert-butyloxycarbonylamino)-1-diazo-4-phenylbutan-2-one 348
 (S)-3-(tert-butyloxycarbonylamino)-4-phenylbutanoic acid, synthesis 348f.
 tetrabutylammonium fluoride (TBAF) 307
 tetrahydrofuran (THF) 253, 414, 542, 548ff.
 N,N,N',N'-tetramethylethylenediamine (TMEDA) 315
 2,2,6,6-tetramethylpiperidinoxy (TEMPO) 342
 theonellamide 148
 thiazinane 559
 thiazolidine 269
 thiourea 326
 N-tosyl sulfonamides, base-mediated alkylation 249
 transaminase, *see* aminotransferase
 transesterification 537
 transfer RNA (tRNA) 45
 transformation 368, 479, 501, 546, 595
 triethylbenzylammonium chloride (TEBA) 251
 triethylsilane 269
 triflate displacement 249
 trifluoroacetic acid (TFA) 293, 621
 β -trifluoromethyl β -amino acid 329

trifluoromethoxyzolidines 329
 triphenylphosphine-iodine complex (TPP-I₂) 295
 trisubstituted γ -amino acids 604ff.
 tryptophan synthase 476
 tubuvaline 619
 β -turn 555, 561, 567
 β -tyrosinase 476
 β -tyrosine 127ff.
 – biosynthesis 131

u

unnatural amino acids 495ff., 527
 unsaturated β -amino acids 319f.
 unsaturated γ -amino acids 640ff.
 unsaturated substituted γ -amino acids 641ff.

v

Valentecovich and Schreiber's synthesis of *D*-syn- β -methylaspartate 203
 valerolactam 564
 valine 622
 valinol 619

vancomycin 222ff.
 vigabatrin 529, 573f., 597ff.
 – synthesis 597f.
 viomycin 125

w

White's π -allyl palladium synthesis of (+)-(2S,3S)-3-hydroxyleucine 197
 William's synthesis of capreomycidine 212
 Williams' oxazine 490
 Wittig olefination 626
 Wittig reaction 580, 592, 598, 629, 664
 Wittig-Horner reaction 584
 Wolff rearrangement 292f., 533

y

Yao's synthesis of 3-OH MePro 172
 Yao's synthesis of (2S,3R)-2-Fmoc-amino-3,5-dimethylhex-4-enoic acid 221

z

Zabriskie's synthesis of capreomycidine 214

