

Subject Index

- (-)-Abacavir, Corey-Winter olefin synthesis, 358–359
- ACE-inhibitor microginin, Davis oxaziridine reagents, 32
- Acetophenone *N*-arylimine derivatives, Noyori catalytic asymmetric hydrogenation, 62
- Acetylenes, Regitz diazo reactions, 659–660
- Acetylinic ketones, Midland reduction, 40–41
- Acid-base extraction:
Nef reaction, 646
Tamao-Kumada-Fleming oxidation, 244
- Acid hydrolysis:
 α,β -diaminoadipic acid, 449
Sommelet reaction, 691–692
- Acoradiene, Martin's sulfurane dehydrating reagent, 253–256
- Acromelic acid, Chugaev elimination, 340–341
- Actinomyces*, Dess-Martin periodinane oxidation, 234–235
- Acyclic alkenes, Martin's sulfurane dehydrating reagent, 253–256
- Acyclic amines, Cope elimination reaction, 344–345
- Acyclic stereocontrol, Luche reduction, 119–120
- Acyclic tertiary α -hydroxy acids, Davis oxaziridine reagents, 26–29
- α -(Acylamino)acrylic acids, Noyori catalytic asymmetric hydrogenation, 47
mechanisms of, 48–53
synthetic utility, 56–58
- β -(Acylamino)acrylates, Noyori catalytic asymmetric hydrogenation, 58
- Acylation:
Perkin reaction, 363–364
Regitz diazo reactions, 675
Yamada reactions, 509
Yamaguchi esterification, 545–546
- O*-Acylation, Yamada reactions, 501
- S*-Acylation, Yamada reactions, 501
- Acyl cyanides:
Krapcho decarboxylation, 636
Midland reduction, 42–43
- Acyl hypobromite, Hunsdiecker reaction, 624
- α -(acyloxy)acrylate, Noyori catalytic asymmetric hydrogenation, 59
- Acyl pyridinium salt, Yamaguchi esterification, 545–546
- 2-Adamantanol, Swern oxidation, 292
- 1,4-Addition, Luche reduction:
hydride donors, 112
regioselectivity, 114
- Adenosine derivatives, Regitz diazo reactions, 669
- Adenosine triphosphate (ATP), Sharpless asymmetric hydroxylation reactions, 78–80
- Adipic acid, Fischer-Speier esterification, 459–460
- Agelastatin, Brown hydroboration reaction, 187–188
- Agnostic interaction, Wacker-Tsuji oxidation, 319–321
- Agrochemicals, Perkow reaction, 381–383
- Aigialomycin, Martin's sulfurane dehydrating reagent, 257–258
- Aklavinone, Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 29–33
- α -Alanine, Strecker amino acid synthesis, 492
- α -Alanine, Strecker amino acid synthesis, 492

- Alcohols:**
Burgess dehydrating reagent,
secondary/tertiary dehydration, 203–204
Chugaev elimination:
primary alcohols, 335–336
secondary alcohols, 336–339
tertiary elimination, 339–340
Oppenauer oxidation:
primary, 269–270
saturated alcohols, 266–268
unsaturated alcohols, 268–269
- Aldehydes:**
Corey-Kim oxidation, 211–212
Perkin reaction, 364–367
- Aldimine:**
asymmetric Strecker amino acid synthesis,
489
Sommelet reaction, 690
- Aldol additions, Regitz diazo reactions, 675**
- Alkaline iodine, Haloform reaction, 613–614**
- Alkanes, Regitz diazo reactions, 675**
- Alkenes:**
Buchwald-Hartwig amination, coupling
reactions, 602–604
epoxidations, Davis oxaziridine reagents,
23–25
Martin's sulfurane dehydrating reagent:
5-membered rings, 261–263
6-membered rings, 259–261
8- and 9-membered rings, 258–259
acyclic structures, 253–256
macrocyclic compounds, 257–258
Perkow reactions, phosphate reductive removal
to, 378–379
Regitz diazo reactions, 659–660
electron-rich alkenes, 675
Sharpless asymmetric hydroxylation reactions,
74–77
stereochemistry, Shapiro reaction, 405–407
Alkenylboronic acids, Shapiro reaction, 408–409
Alkenyllithium intermediates, Shapiro reaction,
405
Alkenylstannanes, Shapiro reaction, 408–409
Alkoxy ligands, Martin's sulfurane dehydrating
reagent, 249
Alkoxy-sulfonium ions, Martin's sulfurane
dehydrating reagent, 249
C-Alkylation, Perkow reaction, enolate cleavage,
377–378
N-alkylation, amides, Eschweiler-Clark reductive
alkylation of amines, 87–88
Alkylation agents:
Krapcho decarboxylation, 639
Swern oxidation and, 302
B-Alkyl-9-borabicyclo[3.3.1]nonanes, Midland
reduction, 40–41
N-Alkyl-2-halopyridinium salts, Mukaiyama
esterification, 462
Alkylhydrazines, Swern oxidation and, 303–304
Alkyl radical, Hunsdiecker reaction, 624
Alkynes, Brown hydroboration reaction,
184–185
(S)-N-Allyl-N-(cyano(*m*-tolyl)methyl)-2,2,2-
trifluoroacetamide, Strecker amino acid
synthesis, 496
Allyl halides, Corey-Kim oxidation, 212–213
Allylic alcohol:
Burgess dehydrating reagent, 191–192
Corey-Bakshi-Shibata (CBS) reduction, 19
Allyl xanthates, Chugaev elimination, 334
 α 1-Blockers, Yamada reactions, 509
Alpine borane, Midland reduction, 40
propargylic alcohol addition, 44
synthetic utility, 43–44
variations and improvements, 42–43
Aluminum alkoxide catalyst, Meerwein-
Ponndorf-Verley reduction, 123
Aluminum-based salen catalyst, asymmetric
Strecker amino acid synthesis, 489–490
Aluminum hydrides, Meerwein-Ponndorf-Verley
reduction, 124
Alzheimer's disease, amyloid proteins, Corey-
Bakshi-Shibata (CBS) reduction, 16–18
(-)-Amathaspiramide F, Nef reaction, 647–649
Ambruticin S, Martin's sulfurane dehydrating
reagent, 256
Amides:
Buchwald-Hartwig amination, coupling
reactions, 597–601
N-alkylation, Eschweiler-Clark reductive
alkylation of amines, 87–88
Sharpless asymmetric hydroxylation reactions,
75–77
Yamada reactions, 502–515
Amidocarbonylation, Strecker amino acid
synthesis, 483–484
Amidophosphine ligands, Noyori catalytic
asymmetric hydrogenation, 55–56

- Aminals:
Gabriel synthesis, 447–448
Nef reaction, 649
- Amine oxide, Cope elimination reaction, 343–344
- Amines:
Cope elimination reaction:
acyclic amines, 344–345
cyclic amines, 345–347
heterocyclic amines, 347
unsymmetrical hydroxylamines, 347–348
- Eschweiler-Clark reductive alkylation:
N-alkylation of amides, 87–88
a-amino amides, 89
aromatic aniline methylation, 89
basic principles, 86
5-bromo-1,4,6-trimethyl-2,3-dihydro-1H-pyrrolo[2,3b]pyridine, 92
cyclic aminol ethers to *n,n*-dialkylamino derivatives, 88–89
historical perspective, 86
mechanisms of, 86–87
solvent- and formaldehyde-free conditions, 88
synthetic utility, 90–92
- Fukuyama amine synthesis:
basic principles, 424
historical perspective, 425–427
mechanism, 427
N-(4-methoxy-benzyl)-2-nitro-*N*-(3-phenyl-propyl)-benzenesulfonamide, 435
(4-methoxy-benzyl)-(3-phenyl-propyl)-amine, 435
synthetic utility, 427–432
limitations and side products, 430–432
nitrogen heterocycles, 428–429
secondary/differentially protected primary amines, 427–428
solid phase synthesis, 430
total synthesis applications, 429–430
- variations, 432–434
chemoselectivity, 433
nosyl deprotection and functionalization, 434
phosphine oxide removal, 432
protected hydroxylamines, 433–434
regioselectivity, 432
- Gabriel synthesis:
basic principles, 438
 α,δ -diaminoadipic acid, 449
dimethyl α,δ -diphthalimidoadipate, 449
historical perspective, 438
mechanism, 438–439
synthetic utility, 446–448
variations and improvements, 439–446
- Leuckart-Wallach reaction:
basic principles, 451
dimethyl-(3,5,5-trimethyl-hexyl)-amine, 455
Eschweiler-Clark reductive alkylation of amines, 86
historical perspective, 451
mechanism, 451–452
synthetic utility, 453–454
variations, 452–453
- Staudinger reaction:
amine 53, 148
one-pot transformations, 134–135
primary preparation, 137–142
- α -Aminobutyric acid, Strecker amino acid synthesis, 492–493
- α -Amino acids:
enolate oxidation, 22
Strecker amino acid synthesis:
asymmetric reactions, 486–487
basic principles, 477
mechanisms, 478
Ugi reaction, 483
variations and modifications, 479
- β -Amino acids, Davis oxaziridine reagents, 32–33
- β -Amino alcohols:
Midland reduction, 42–43
reduction reactions, 3
- α -Amino amides, Eschweiler-Clark reductive alkylation, 89
- α -Aminonitrile, Strecker amino acid synthesis, 477–478, 485–487, 489–490, 494–495
- 2-Amino-2-(3-chlorophenyl)acetonitrile hydrochloride, Strecker amino acid synthesis, 496
- Aminocyclitol, Yamada reactions, 507
- α -Amino esters, Yamada reactions, 510–511
- Aminoglycoside antibiotics, Staudinger reaction, 138–142
- Aminopyridines, Eschweiler-Clark reductive alkylation of amines, 90–91

- Aminostannanes, Buchwald-Hartwig amination, 599
- Amino-Suzuki techniques, Buchwald-Hartwig amination, 566
- Aminotamoxifen, Balz-Schiemann reaction, 555
- Ammonia equivalents, Buchwald-Hartwig amination, 593–595
- Ammonium formate, Leuckart-Wallach reaction, 452–453
- Amyloid precursor protein (APP), Corey-Bakshi-Shibata (CBS) reduction, 16–18
- Angiotensinogen analogs, Yamada reactions, 529
- Anilides, Dess-Martin periodinane oxidation, 227–228
- Anilines:
- Buchwald-Hartwig amination, 572–573
 - unexpected aromatic methylation, Eschweiler-Clark reductive alkylation, 89
- Anthraquinone, Sharpless asymmetric hydroxylation reactions, 72–77
- Anti-addition, Wacker-Tsuji oxidation, Wacker-type oxidation, 314–318
- Antibacterial agents, Staudinger reaction, 141
- Antibiotics:
- Dess-Martin periodinane oxidation, 232–235
 - Yamada reactions, 519–520
- Anti-cancer agents:
- Dess-Martin periodinane oxidation, 229
 - Luche reduction, 117–119
 - Sharpless asymmetric hydroxylation reactions, 778
 - Staudinger reaction, 140–142
 - Yamada reactions, 520–522
- Anti-elimination:
- Burgess dehydrating reagent, 191–192
 - Chugaev elimination, 335
 - Martin's sulfurane dehydrating reagent, alkenes, 259–261
 - Zaitsev elimination, 416
- Antifungal agents, Yamada reactions, 529–530
- Anti-Markovnikov products:
- Brown hydroboration reaction, 183
 - Wacker-Tsuji oxidation, 311–314, 322–323
- Antiperiplanar migration:
- Baeyer-Viliger oxidation, 165–167
 - Martin's sulfurane dehydrating reagent, 249–251, 258–259
 - Zaitsev elimination, 415
- Antitumor agents, Yamada reactions, 522–523
- Anti-viral agents, Sharpless asymmetric hydroxylation reactions, 778
- Anti-Zaitsev product, formation of, 417
- Aparatoxin family, tandem intramolecular Staudinger/aza-Wittig reaction, 144–147
- Aprotic solvents, Krapcho decarboxylation, 635
- Aragusterol H, Luche reduction, 119
- Arbuzov reaction, Perkow reaction, 373–375
- Arenastatin A, Yamada reactions, 526
- Argon, Gribble reduction, 96
- Aromatic diazonium fluoborate, Balz-Schiemann reaction, 552
- Aromatic heterocycles, Buchwald-Hartwig amination, 585–588
- Aromaticity, Tamao-Kumada-Fleming oxidation, 239
- Aromatic methylation, anilines, Eschweiler-Clark reductive alkylation, 89
- β -Aryl- β -(acylamino)acrylates, Noyori catalytic asymmetric hydrogenation, 55–56
- Aryl cation, Balz-Schiemann reaction, 553
- Aryl chloride, Buchwald-Hartwig amination, 576–582
- coupling reactions, 583–585
- Aryl diazonium salts, Balz-Schiemann reaction, 553, 556–559
- Aryl fluoride, Balz-Schiemann reaction, 552
- Arylfulfonylhydrazones, Shapiro reaction, 405
- Aryl guanidinylation, Buchwald-Hartwig amination, 598
- Aryl ketones, Meerwein-Ponndorf-Verley reduction, 125–126
- N*-Aryl sulfoximes, Buchwald-Hartwig amination, 599
- Aryl sulfonyl azide reactions, diazo phosphono compounds, 661–662
- Aspartic acid, Strecker amino acid synthesis, 492
- (–)-Aspercilin ligands, Buchwald-Hartwig amination, 588–592
- Asymmetric aminohydroxylation (AA), Sharpless asymmetric hydroxylation reactions, 67–81
- Asymmetric conjugate addition, Krapcho decarboxylation, 640
- Asymmetric dihydroxylation (AD), Sharpless asymmetric hydroxylation reactions, 67–81
- Asymmetric eliminations, Martin's sulfurane dehydrating reagent, 256

- Asymmetric oxidation, Davis oxaziridine reagents, 36–37
- Asymmetric reduction reactions. *See also* Corey-Bakshi-Shibata (CBS) reduction
Davis oxaziridine reagents, 24–29
historical background, 2–3
Meerwein-Ponndorf-Verley reduction, 125–126
- Asymmetric Strecker amino acid synthesis, 486–488
- Asynchronous, 4-centered transition state,
Brown hydroboration reaction, 183–184
- Attention-deficit hyperactivity disorder,
norepinephrine reuptake antagonists,
Corey-Bakshi-Shibata (CBS) reduction, 17–18
- Avellanins A/B, Yamada reactions, 534–535
- Axial attacks, Woodward *cis*-dihydroxylation, 328
- Azasugars, Sharpless asymmetric hydroxylation reactions, 77–80
- Aza-Wittig reactions, Staudinger reaction:
basic principles, 129
cyclic imines, 131
- Aza-ylide, intermolecular Staudinger/aza-Wittig reaction, 142–147
- Aziral groups, Midland reduction, stereochemical rationalization, 41–42
- Azides, Staudinger reaction, 129
electron-deficient compounds, 138–142
tertiary variations, 131–136
tetrahydrofuran addition, 148
- Azidinium salt, Regitz diazo reactions,
phosphono compounds, 661–662
- Azidoaldehyde, tandem intramolecular
Staudinger/aza-Wittig reaction, 143–147
- 4-Azidobenzoic acid, Staudinger reaction, 133–136
- Azido-ester, tandem intramolecular
Staudinger/aza-Wittig reaction, 146–147
- Azidoalcohols, Prilezhaev reaction, 278
- Azidoketone, Staudinger reaction, 132–136, 149
tandem intramolecular Staudinger/aza-Wittig reaction, 142–147
- (±)-Azimic acid, Luche reduction, 117
- Aziridines:
Davis oxaziridine reagents, 24
Fukuyama amine synthesis, 431–432
Prilezhaev reaction, 278
Azirine esters, Swern oxidation, 304
- Azo ester, Japp-Klingemann hydrazone synthesis, 630
- Azole antifungals, Davis oxaziridine reagents,
enantioselective oxidation, 35–36
- Azoles, Buchwald-Hartwig amination,
intermolecular vinylation, 602–604
- B3LYP method, asymmetric Strecker amino acid synthesis, 488–489
- Baclofen 111, Baeyer-Viliger oxidation, 179–180
- (–)-Baconipyrene C, Yamaguchi esterification, 547
- Baeyer-Viliger oxidation:
basic principles, 160
enzyme catalysis, 173–178
5-ethoxycarbonyl-5-(*n*-undecyl)- δ -valerolactone, 180–181
general mechanisms, 162–163
historical perspective, 160–162
metal catalysis, 168–172
migrating group mechanism, 163–167
Prilezhaev reaction, 275–277
synthetic utility, 178–180
Tamao-Kumada-Fleming oxidation vs., 239
variations and improvements, 167–178
- B_{AL}2 mechanism, Krapcho decarboxylation, 636
- Balanol, Mukaiyama esterification, 465–466
- Balz-Schiemann reaction:
basic principles, 552
4-chloro-2-fluoronitrobenzene, 560
diazonium tetrafluoroborates, 559–561
2,6-dichloro-3-fluoropyridine, 560
8-fluoro-1-tetralone, 560–561
historical perspective, 552–553
synthetic utility, 557–559
variations and improvements, 553–557
- Barton modification:
Hunsdiecker reaction, 626
Wharton reaction mechanism, epoxy-zanthate, 155
- Base-catalyzed elimination:
Cope elimination reaction, 348
Regitz diazo reactions, 1,2-diketones, 667–669
- Base-cleavage mechanism, Haloform reaction, 611
- Bayliss-Hillman adducts:
Burgess dehydrating reagent, 201–203
Swern oxidation and, 302

- Bengamide A, Yamada reactions, 507–508
- Benzenediazonium chloride, Japp-Klingemann hydrozone synthesis, 630
- (*Z*)- α -(Benzoamido)cinnamic acid, Noyori catalytic asymmetric hydrogenation, 48
- Benzoates, Burgess dehydrating reagent, 199–203
- Benzodiazepines, Staudinger reaction, 139–142
tandem intramolecular Staudinger/aza-Wittig reaction, 145–147
- Benzoic acid, Haloform reaction, 619
- ¹³C₁₂-Benzoic acid, Haloform reaction, 615–616
- Benzooin/benzil conversion, Burgess dehydrating reagent, 196–197
- (–)-Benzomalvin compounds:
Staudinger reaction, 150
tandem intramolecular Staudinger/aza-Wittig reaction, 146–147
- Benzophenones:
Buchwald-Hartwig amination, 596–597
Gribble reduction of aryl ketones and, 99–107
- p*-Benzoquinone, Oppenauer oxidation, 265
- Benzothiazolium, Mukaiyama esterification, 463–464
- Benzoylperoxide (BPO), Sommelet reaction, 694
- (*S*)-*N*-Benzoylphenylalanine, Noyori catalytic asymmetric hydrogenation, 48
- Benzyl halides, Corey-Kim oxidation, 212–213
- Benzylic oxidation/hydrolysis, Dess-Martin periodinane oxidation, 223–224
- Benzylic ozonides, Gribble reduction of aryl ketones and, 99
- 5-Benzoyloxy-3-hydroxy-pentanoic acid *tert*-butyl ester, Noyori catalytic asymmetric hydrogenation, 64
- Benzylphosphonates, Davis oxaziridine reagents, enantioselective oxidation, 36
- Benzyltrimethylammonium tribromide, Haloform reaction, 612–614
- Berberine, Eschweiler-Clark reductive alkylation of amines, 91
- Bergman cyclization, Ramberg-Bäcklund reaction, 396
- Bi-aryl phosphines, Buchwald-Hartwig amination, 577–582, 592–593
indole synthesis, 597
- Bicyclic amidines, Zaitsev elimination, 417
- Bicyclic systems, reverse Cope elimination, 349
- Bicyclo[3.1.0]hexane-2,4-diones, Luche reduction, 118–119
- Bicyclo[3.1.0]hexane-2-ones, Luche reduction, 118–119
- Bicyclo[3.3.0]octane framework:
Corey-Bakshi-Shibata reduction, 4
convex scaffold properties, 11–15
Martin's sulfurane dehydrating reagent, five-membered ring alkenes, 261–262
- Bicyclo triamino phosphines, Buchwald-Hartwig amination, 580–582
- Bimolecular reduction:
Midland reduction, 42–43
Zaitsev elimination, 415
- BINAP (2,2'-bis(diphenylphosphino)-1,1'-binaphthyl) ligand, Noyori catalytic asymmetric hydrogenation:
basic properties, 46–47
historical perspective, 47
mechanism, 48–53
unsaturated alcohols, 60
variations and improvements, 53–56
- BINAP ligands, Noyori catalytic asymmetric hydrogenation, 55–56
- BINOL catalysts:
Meerwein-Ponndorf-Verley reduction, 125–126
Strecker amino acid synthesis, 491–492
- Biological Haloform reaction, natural products, 617–618
- BIPHEMP compound, Noyori catalytic asymmetric hydrogenation, 53–56
- Birch reduction, carboxylic acid derivatives, 26–29
- Bisamide, Yamada reactions, 506
- Bis-amination, Buchwald-Hartwig amination, 573
- 2,4-Bis-diazo-1,3,5-triketone, Regitz diazo reactions, 673
- 4,4'-Bis(dimethylamino)benzophenone, Gribble reduction, 93–94
- Bisphosphane ligands, Noyori catalytic asymmetric hydrogenation, 54–56
- Bisphosphinites, Noyori catalytic asymmetric hydrogenation, 55–56
- Bisphosphites, Noyori catalytic asymmetric hydrogenation, 55–56
- Bisphosphonites, Noyori catalytic asymmetric hydrogenation, 55–56

- Bis-sulfone, Ramberg-Bäcklund reaction, 396–397
- (–)-Bistatramide, Burgess dehydrating reagent, 195
- (–)-Blebbistatin, Davis oxaziridine reagents, enantioselective oxidation, 34–36
- B*-Me-CBS substituent, Corey-Bakshi-Shibata (CBS) reduction method, 2
- N*-Boc-glycine, Midland reduction, 43–44
- Borane:
- Corey-Bakshi-Shibata (CBS) reduction, 2
 - Midland reduction, alpine borane, 40
- Boronate esters:
- Brown hydroboration reaction, 184–185
 - Corey-Bakshi-Shibata reduction, 6
- Boronic acid, Strecker amino acid synthesis, 482
- Boron species, Corey-Bakshi-Shibata reduction, tetraordinated structure, 12–16
- Brassindole, Ramberg-Bäcklund reaction, 399–402
- Bredereck's reagent, Regitz diazo reactions, 669
- Bredt's rule, Gribble reduction of aryl ketones and alcohols to, 107
- Bromal, Perkow reaction, 371–375
- Bromfenvinphos, Perkow reaction, 381–383
- 1-Bromo-3-chlorocyclobutane, Hunsdiecker reaction, 628–629
- (Bromodimethyl)sulfonium bromide, Strecker amino acid synthesis, 481
- Bromoketone, Perkow reaction, 376
- Bromomethane-sulfonyl bromide, Ramberg-Bäcklund reaction, 398–399
- 1-Bromo-5-methyl-2-(4-methylbenzyl)benzene, Gribble reduction, 108
- (*R*)-1-(3'-Bromophenyl)-ethanol, Corey-Bakshi-Shibata (CBS) reduction, 19
- N*-bromosuccinimide, Corey-Kim oxidation, 212–213
- Bromosufone, Ramberg-Bäcklund reaction, 392–393
- photolysis, 398
- 5-Bromo-1,4,6-trimethyl-2,3-dihydro-1H-pyrrolo[2,3-*b*]pyridine, 92
- Brown hydroboration reaction:
- basic principles, 183
 - historical perspective, 183
 - mechanism of, 183
 - synthetic utility, 185–188
- tricycle 39 experiment, 188
 - variations and improvements, 184–185
- Bryostatins, Luche reduction, 117
- Bucherer-Bergs reaction, Strecker amino acid synthesis, 482–483, 494–495
- Buchwald-Hartwig amination:
- amide, carbamate, and hydrazine, and sulfoxime coupling, 597–601
 - ammonia equivalents, 593–595
 - applications, 588–592
 - basic principles, 564
 - N*-hexyl-2-methyl-4-methoxyaniline, 604
 - historical perspectives, 564–566
 - indole synthesis and functionalization, 596–597
 - ligand summary, 592–593
 - mechanism, 566–567
 - synthetic utility, 567–593
 - aromatic heterocyclic coupling, 585–588
 - aryl chloride coupling, 583–585
 - bulky phosphines and *N*-heterocyclic carbenes, 574–582
 - chelating phosphines, 569–574
 - monodentate phosphines, 567–569
- Bulgecin, Yamada reactions, 519–520
- Bulky phosphines, Buchwald-Hartwig amination, 574–582
- aromatic heterocycles, 588
 - aryl chlorides, 583–585
- (*S*)-di-*t*-Bu-MeOBIPHEP-Ru complex, Noyori catalytic asymmetric hydrogenation, 59–60
- Burgess dehydrating reagent:
- basic principles, 189
 - historical perspective, 189–190
 - Martin's sulfuranone dehydrating reagent, 256
 - mechanism, 190–192
 - secondary and tertiary alcohol dehydration, 203–204
 - toluene agents, 205
 - variations, improvements, and synthetic utility, 192–203
- Butenolide diol, Ramberg-Bäcklund reaction, 401
- 2-*t*-(Butoxycarbonyloximino)-2-phenylacetonitrile (Boc-on), Staudinger reaction, 134–135
- Butterfly mechanism, Prilezhaev reaction, 274–275

- di-*t*-Butyldicarbonate (Boc₂O), Staudinger reaction, 134–135
- (2*S*,3*R*)-*tert*-Butyl-2-hydroxy-3-(*N*-benzyloxycarbonyl)-aminobutanoate, Sharpless asymmetric hydroxylation reactions, 81
- C₂-TunaPhos, Noyori catalytic asymmetric hydrogenation, 59
- Calcium channel antagonists, Yamada reactions, peptides, 516–519
- Calyculins A/B, Yamada reactions, 536
- Camphor sulfonic acid (CSA), Davis oxaziridine reagents, 27–29
- Camphorsulfonyl(oxaziridine):
Davis oxaziridine reagents, 26–29, 31–33
- (+)-Cannabisativine, Luche reduction, 119–120
- Capensifuranone, Davis oxaziridine reagents, 28–29
- Carbamates:
Buchwald-Hartwig amination, 597–601
Sharpless asymmetric hydroxylation reactions, 75–77
tethered aminohydroxylation, 79–80
Staudinger reaction, one-pot transformation-protected amines, 134–135
- Carbapenem intermediates:
Baeyer-Viliger oxidation, 169–172
Corey-Kim oxidation, 212
Perkow reaction, 380–381
- Carbene intermediate:
Corey-Winter olefin synthesis, 355
Regitz diazo reactions, 683
- Carbenium ion, Ritter reaction, 471–475
- N*-Carbobenzoxypenicillin phenacyl ester, Yamada reactions, 520
- Carbohydrates:
Strecker amino acid synthesis, 485–486
Wacker-Tsuji oxidation, 319–321
- α -Carboline, Buchwald-Hartwig amination, 590–592
- Carbon-14-labeled isomers, Eschweiler-Clark reductive alkylation of amines, 86
- Carbon-hydrogen insertion, Regitz diazo reactions, 682–683
- Carbon-silicon bond, Tamao-Kumada-Fleming oxidation, 238–239, 241–242, 245–246
- Carbonyl addition-elimination-hydrogenation sequence, Martin's sulfoxide dehydrating reagent, 254–256
- Carbonyldiimidazole, Corey-Winter olefin synthesis, 354–355, 359–360
- Carbonyls, Staudinger/aza-Wittig reaction, one-pot transformation, 136
- Carboximides, Davis oxaziridine reagents, 27–29
- (Carboxycyclopropyl)glycines, Corey-Bakshi-Shibata (CBS) reduction, 10–15
- Carboxylic acid derivatives synthesis:
Fischer-Speier esterification:
basic principles, 458
historical perspective, 458
mechanism, 458–459
N-methyltryptophan methyl ester hydrochloride, 460
synthetic utility, 459–460
- Mukaiyama esterification:
basic principles, 462
experimental procedures, 469
historical perspective, 462–463
synthetic utility, 465–469
variations and improvements, 463–465
- Ritter reaction:
basic principles, 471
carbenium ion stabilization, 473
cascade reactions, 474–475
N-formyl- α , α -dimethyl- α -phenethylamine, 475–476
heteroatom stabilization, 474
historical perspective, 471
mechanism, 471–472
synthetic utility, 475
transition metal stabilization, 473–474
variations, 472
weaker acids, rearrangement promotions, 472–473
- Strecker amino acid synthesis:
(*S*)-*N*-allyl-*N*-(cyano(*m*-tolyl)methyl)-2,2,2-trifluoroacetamide, 496
2-amino-2-(3-chlorophenyl)acetonitrile hydrochloride, 496
basic principles, 477
historical perspective, 477
mechanism, 478
synthetic utility, 492–495
TMSCN and asymmetric variations, 496
variations, improvements and modifications, 478–492

- Yamada reactions:
 basic principles, 500
 dolastatin 18, 540–541
 historical perspective, 500
 methyl-(2*S*)-*N*-(2-aminopyrazidinecarbonyl)pyrrolidine-2-carboxylate, 540
 synthetic utility, 502–539
 amides, 502–515
 antibiotics, 519–520
 anticancer agents, 520–522
 antifungal agents, 529–530
 antitumor agents, 522–523
 cytotoxic depsipeptides, 525–526
 folic acid analogues, 531–539
 peptides, 515–519
 renin inhibitors, 527–529
 thrombin inhibitors, 523–525
 variations and improvements, 500–502
 vitamin B₁₂ derivative, 541
- Yamaguchi esterification:
 basic principles, 545
 historical perspective, 545
 mechanism, 545–546
 4-methyl-hex-2-enedioic acid,6-[4-iodo-2-methyl-1-(2-methyl-1-[1,3]dioxolan-2-yl-methyl)-pent-3-enyl]ester-1-methyl ester, 550
 synthetic utility, 549
 variations and improvements, 546–549
- Carboxyl radicals, Hunsdiecker reaction, 624
- 3-Carboxypropolone, Haloform reaction, 619
- Cardiovascular disease, endothelins, Corey-Bakshi-Shibata (CBS) reduction, 18
- Caro's acid, Baeyer-Viliger oxidation, 161
- Carveol, catalytic Oppenauer oxidation, 271
- Carvone, catalytic Oppenauer oxidation, 271
- Cascade reactions:
 Oppenauer oxidation, 271–272
 Ritter reaction, 474–475
- Castanospermine, Corey-Kim oxidation, 212
- Catalytic cycle:
 Buchwald-Hartwig amination, 564
 Migita reaction, 566
 Oppenauer oxidation, 266
 Wacker-Tsuji oxidation, 310–311
- Catalytic Oppenauer oxidation, 270–271
- Catalytic transfer hydrogenolysis (CAT), Gabriel synthesis, 444–445
- Catechol borane, Brown hydroboration reaction, 184–185
- Cationic rearrangement, Burgess dehydrating reagent, ring contraction, 204
- Cavitands, Gribble reduction and deoxygenation, 104
- (±)-Cephalotaxine, Corey-Kim oxidation, 215–216
- Cerium(III) chloride, Luche reduction, 112–119
- Chan modification, Ramberg-Bäcklund reaction, 402–403
- σ -type Chelate complexes, Noyori catalytic asymmetric hydrogenation, 53–56
- Chelating phosphines, Buchwald-Hartwig amination, 567, 569–574, 579–582
 aryl chlorides, 585
- Chemoselectivity:
 Dess-Martin periodinane oxidation, 228–235
 Fukuyama amine synthesis, 433
 Haloform reaction, 616–617
 Prilezhaev reaction, 275–277
 Rubottom oxidation, 287–288
 Swern oxidation, 300
- Chiral auxiliaries:
 borane reduction, historical evolution of, 3
 Davis oxaziridine reagents, 23
 asymmetric oxidation, 24–29
 Martin's sulfurane dehydrating reagent, 256
 Sharpless asymmetric hydroxylation reactions, 72–77
 Strecker amino acid synthesis, 485–487
 Wacker-Tsuji oxidation, 318
- Chiral bis(oxazoline) ligand, Wacker-Tsuji oxidation, 321
- Chiral diphosphine rhodium complex, Noyori catalytic asymmetric hydrogenation, 48–53
- Chiral ligands, Sharpless asymmetric hydroxylation reactions, 67
- Chiral Schiff bases, Strecker amino acid synthesis, 490
- Chloral, Perkow reaction, 371–375
- Chloramines:
 Regitz diazo reactions, 668–669
 Sharpless asymmetric hydroxylation reactions, 69
- Chlorfenvinphos, Perkow reaction, 381–383
- Chlorination, Haloform reaction, 612
- Chlorobenzoate, Sharpless asymmetric hydroxylation reactions, 71–77

- 3-Chloro2-(diethoxyphosphoryl)oxy-1-propene,
Perkow reaction, 377–378
- 4-Chloro-2-fluoronitrobenzene, Balz-Schiemann
reaction, 560
- Chloroform, biological Haloform reaction,
617–618
- Chloroformates, Staudinger reaction, one-pot
transformations, 134–135
- 2-Chloro-1-methylpyridine iodide, Mukaiyama
esterification, 462
- 3-Chloro-2-oxopentanoates, Perkow reaction,
374
- Chloropeptins, Strecker amino acid synthesis,
484–485
- m*-Chloroperbenzoic acid (*m*-CPBA):
enolate oxidation, 23
Prilezhaev reaction, 275–277
- Chloroperoxidase-catalyzed humic acid
degradation, biological Haloform
reaction, 618
- Chloropropenylphosphonate, Perkow reactions,
377–378
- Chloro-sulfone, Ramberg-Bäcklund reaction,
395
natural products, 399–402
ring structure, 396–397
- Chlorosulfonyl isocyanate (CSI), Burgess
dehydrating reagent, 201–203
- Cholesterol:
Chugaev elimination, 334–335
Swern oxidation, 292
- γ -Cholesterol, Oppenauer oxidation, 267–268
- Cholic amides, Yamada reactions, 510
- Chrysoicins, Ramberg-Bäcklund reaction,
400–402
- Chugaev elimination:
basic principles, 334
- Cope elimination reaction vs., 343
(4a,*S*,6*R*,7*S*,7a*R*,11a*R*,2'*S*,3a'*R*,6a')-7-
(hexahydrofuro[2,3-*b*]furan-2'-yl)-
3,3,6,7-tetramethyl-11-
methylenecyclohexanophtho[1,8a-*d*][1,3]
dioxine, 341
historical perspective, 334–335
mechanisms, 335
synthetic utility, 335–340
primary alcohols, 335–336
secondary alcohols, 336–339
tertiary alcohols, 339–340
variations, 340–341
- Chymotrypsin, Yamada reactions, 527–529
- Cinchona alkaloids, Sharpless asymmetric
hydroxylation reactions, 71–77
- Cinnamaldehyde, Perkin reaction, 366
- Cinnamate:
Davis oxaziridine reagents, 31–33
Sharpless asymmetric hydroxylation reactions,
76–77
- Cinnamic acids:
Haloform reaction, 618–619
Perkin reaction, 363–367
- Cis* elimination, Cope elimination reaction,
cyclic amines, 345–347
- Citralitrone, Tamao-Kumada-Fleming oxidation,
241
- Citronellol complexes, Noyori catalytic
asymmetric hydrogenation, 60
- Claisen distillation, Hunsdiecker reaction, 629
- Claisen rearrangement:
Chugaev elimination, ene reaction, 338–339
Regitz diazo reaction, 663–667
- Clasto*-lactacystin β -lactone proteasome
inhibitor, Martin's sulfurane dehydrating
reagent, 256
- Clavulactone, Krapcho decarboxylation, 638
- Clodrin, Perkow reaction, 381–383
- Co-factors, Baeyer-Viliger oxidation, enzyme
catalysis, 173–178
- Colneleic ester, Perkow reactions, 378–379
- Combinatorial chemistry, Strecker amino acid
synthesis, 490
- Concerted [3+2] reaction, Sharpless asymmetric
hydroxylation reactions, 68–81
- Configuration reaction:
Burgess dehydrating reagent, 198–203
Krapcho decarboxylation, 638
- Conformer migration, Baeyer-Viliger oxidation,
166–167
- Conjugate additions:
Krapcho decarboxylation, 640, 642
Martin's sulfurane dehydrating reagent, five-
membered ring alkenes, 261–262
Tamao-Kumada-Fleming oxidation, 246
- Conjugate elimination, Swern oxidation and,
302–303
- Con* rotation, Mukaiyama esterification,
468–469
- Copalon, Wacker-Tsuji oxidation, 321–322

- Cope elimination reaction:
 basic principles, 343
 historical perspective, 343
 mechanisms, 344
 synthetic utility, 344–347
 acyclic amines, 344–345
 cyclic amines, 345–347
 heterocyclic amines, 347
 1*L*-(1,4/5)-3,4,5-tri-*O*-benzyl-1-((*tert*-butyl)diphenylsilyloxy)methyl)cyclopent-2-ene-3,4,5-triol, 352
 variations, 347–352
 base-catalyzed elimination, 348
 reverse elimination, 348–349
 sila-Cope elimination, 350–351
 solid-phase linker cleavage, 350
 unsymmetrical hydroxylamines, 347–348
- Co-planarity, transition states, Chugaev elimination, 337–338
- Corey-Bakshi-Shibata (CBS) reduction:
 allylic alcohol, 19
 (*R*)-1-(3'-bromophenyl)-ethanol, 19
 historical perspective, 2–3
 ketone reductions, 2
 mechanism, 3–6
 synthetic utility, 15–18
 variations, improvements, and modifications, 6–15
- Corey-Kim oxidation:
 basic principles, 207
 historical perspective and improvements, 207–211
 mechanisms, 210–211
 odor-free variation, 208
 synthetic utility, 211–216
 aldehyde/ketone preparation, 211–212
 benzyl/allyl halide preparation, 212–213
 dicarbonyl preparation, 213–214
 epi-45 synthesis, 216
 hydroxyketones and diketones, 214–216
 recyclable compounds, 217
- Corey lactone, Baeyer-Viliger oxidation, 177–178
- Corey-Nicolaou protocol, Yamaguchi esterification, 549
- Corey-Winter olefin synthesis:
 basic principles, 354
 trans-3,4-Didehydro-3,4-dideoxy,1,2,5,6-di-*O*-isopropylidene-*D*-threo-hexitol, 361
 didehydrostemofoline, 360–361
 historical perspective, 354–355
 mechanism, 355–356
 synthetic utility, 357–360
 variations and improvements, 356–357
- Coumarins, Mukaiyama esterification, 466–467
- Coupling agents:
 Buchwald-Hartwig amination:
 alkenes, 602–604
 aryl chlorides, 583–585
 Yamada reactions:
 antifungal agents, 529–530
 DEPC as, 500–501
- Cram's rule, Luche reduction, acyclic stereocontrol, 119–120
- Criegee intermediate, Baeyer-Viliger oxidation, 160
 enzyme catalysis, 173–178
 general mechanisms, 162–163
 metal catalysis, 169–172
 migrating groups, 164
- Cristol-Firth modification, Hunsdiecker reaction, 624–625
- Crotylsilane, Prins reaction, 656
- (+)-Curacin A, Burgess dehydrating reagent, 193–194
- CY, Cy-oxoProNOP ligand, Noyori catalytic asymmetric hydrogenation, ketones, 61–62
- Cyanohydrins, Strecker amino acid synthesis, 487–488, 490–491
- Cyclamenol A, Yamada reactions, 508–509
- Cyclic amines:
 Cope elimination reaction, 345–347
 sila-Cope elimination reaction, 350–351
- Cyclic amino ethers:
 Martin's sulfurane dehydrating reagent, 248, 251
 reductive cleavage to *N,N*-dialkylamino-derivatives, Eschweiler-Clark reductive alkylation of amines, 88–89
- Cyclic concerted transition state:
 Chugaev elimination:
 mechanisms of, 335
 secondary alcohols, 336–339
 Cope elimination reaction, 344
 Oppenauer oxidation, 266
- Cyclic dienes, Martin's sulfurane dehydrating reagent, 256–257

- Cyclic enol phosphate, Perkow reaction, 382
Cyclic imines, Staudinger reaction, 131–132
Cyclic ketone, Regitz diazo reactions, 677
Cyclic β -oxosulfone, Regitz diazo reactions, 660–661
Cyclic peptides, Yamada reactions, 533–539
Cyclic stereocontrol, Luche reduction, 114–119
Cyclic sulfamidates, Burgess dehydrating reagent, 198–203
Cyclic thionocarbonate, Corey-Winter olefin synthesis, 354
Cyclic vinyl phosphate, Perkow reaction, 374–375
Cyclization/oxidation reaction, Swern oxidation, 304–305
[2+2]-Cycloaddition reaction:
 Corey-Kim oxidation, carbapenem antibiotics, 212
 Mukaiyama esterification, 468–469
Cycloadducts, Krapcho decarboxylation, 639
Cyclobutenes, Ramberg-Bäcklund reaction, 391–392
Cyclodextrins:
 Haloform reaction, 612–614
 Strecker amino acid synthesis, 481
 β -Cyclodextrins, Strecker amino acid synthesis, 481–482
Cyclodimerization, Yamada reactions, 512–513
Cyclo-elimination, Corey-Bakshi-Shibata reduction, 6
Cycloheptanol, Dess-Martin periodinane oxidation, 225
Cyclohexane monooxygenase (CHMO), Baeyer-Viliger oxidation, 173–178
Cyclohexanone, Oppenauer oxidation, 265
Cyclohexenes, Ramberg-Bäcklund reaction, 393–395
Cyclomarin A, Strecker amino acid synthesis, 493
Cyclooctanol, Dess-Martin periodinane oxidation, 236
2-Cyclopentenone, Luche reduction, 112–113
Cyclopentadiene:
 Corey-Bakshi-Shibata (CBS) reduction, 13–15
 Ramberg-Bäcklund reaction, 392–393
Cyclopentane monooxygenase (CPMO), Baeyer-Viliger oxidation, 173
Cyclopentenones, Ramberg-Bäcklund reaction, 392–393
Cyclopentenones, Ramberg-Bäcklund reaction, 392–393
Cyclophanes:
 Gribble reduction and deoxygenation, 104
 Ramberg-Bäcklund reaction, 396–397
Cyclophellitol, Nef reaction, 650
Cycloreversion, Corey-Winter olefin synthesis, 355
Cyclotheonamide B, Yamada reactions, 523–525
Cylindramide A, Martin's sulfurane dehydrating reagent, 261–262
Cytosine, Martin's sulfurane dehydrating reagent, 252
Cytotoxic depsipeptides, Yamada reactions, 525–526
Cytotoxicity:
 (–)-Iepadins, Davis oxaziridine reagents, 33
 macrolides, Staudinger reaction, 140–142
 marine natural products, tandem intramolecular Staudinger/aza-Wittig reaction, 144–147
Cytovaricin, Meerwein-Ponndorf-Verley reduction, 126
Daunomycine, Davis oxaziridine reagents, enantioselective oxidation, 35–36
Davis oxaziridine reagents:
 basic properties, 22
 (–)-(*R*)-2-Ethyl-5,8,-dimethoxy-2-hydroxyl-1,2,3,4-tetrahydronaphthalen-1-one, 37–38
 historical perspective, 22–23
 mechanistic interpretations, 23–25
 synthetic utility, 25–37
 asymmetric oxidation via chiral auxiliaries, 25–29
 enantioselective oxidation, 33–37
 substrate-directed diastereoselective hydroxylation, 29–33
(–)-7-Deacetylcalcyonin acetate, Prins reaction, 655
Deamidation diazo transfer reaction, Regitz diazo reactions, 666
Deaminative fluorination, Balz-Schiemann reaction, 555
Dean-Stark apparatus, Gabriel synthesis, 439–440
Debenzoylation diazo transfer reactions, Regitz diazo reactions, 662–667

- cis/trans* α -Decalols, Oppenauer oxidation, 267–268
- α -Decalones, Oppenauer oxidation, 267–268, 272
- Decarboxylation:
- carboxylic acids, Yamada reactions, 502
 - Japp-Klingemann hydrazone synthesis, 631–634
- Krapcho process:
- basic principles, 635
 - historical perspective, 635
 - mechanism, 636
 - synthetic utility, 636–643
- Decarboxylation/bromination, Dess-Martin periodinane oxidation, 230–235
- Decarboxylative Ramberg-Bäcklund reaction, 390
- Decomplexation, Meerwein-Ponndorf-Verley reduction, 124
- Decomposition reaction, Regitz diazo reactions, 682–683
- Deformylation diazo group transfer reaction, Regitz diazo reaction, 5-diazojasmonate, 664
- Dehydration:
- Balz-Schiemann reaction, 553
 - cyclic systems, Chugaev elimination, 339–340
 - Yamaguchi esterification, 547
 - Zaitsev elimination, 414, 417
- Dehydroamino acid derivatives, Noyori catalytic asymmetric hydrogenation, 56–58
- Dehydrobromination, Zaitsev elimination, 418 intermediates, 419
- Dehydrocorticosterone, Oppenauer oxidation, 267–268
- Dehydrohalogenation, Zaitsev elimination, 414, 417
- acyclic halides, 418
- Dehydroxylation, Burgess dehydrating reagent, secondary/tertiary alcohols, 203–204
- Delépine amine synthesis, Sommelet reaction, 689–692
- Dendrimer structures, Buchwald-Hartwig amination, 591–592
- Density functional theory (DFT), asymmetric Strecker amino acid synthesis, 488–489
- Deoxoartemisinin, Ramberg-Bäcklund reaction, Meyers-Chan modification, 400
- (\pm)-Deoxocassine, Luche reduction, 117–118
- Deoxygenation reaction, Gribble reduction, 96–97
- diarylmethanols, 102–103
- Deoxymannojirimycin, Luche reduction, 118
- 17-Deoxytroflamycin, Prins reaction, 655–656
- Deprotection-oxidation-Wittig reaction, Dess-Martin periodinane oxidation, 231–235
- Depsipeptide fragments:
- Martin's sulfurane dehydrating reagent, 255–256
 - Yamada reactions, 525–526
- Desoxycorticosterone, Oppenauer oxidation, 268–269
- Desoxyephedrine-boron complex, asymmetric reduction, 2–3
- Dess-Martin periodinane oxidation:
- basic principles, 218
 - historical perspective, 218–219
 - mechanisms, 219–220
 - synthetic utility, 228–235
 - variations and improvements, 220–228
- Desymmetrization, Prins reaction, 655
- Deuterium-labeling experiments, Shapiro reaction, 405
- Diacetoxyiodine phosphonium salts, Woodward *cis*-dihydroxylation, 329–330
- N,N*-Dialkylamino-derivatives, cyclic amino ether reduction to, 88–89
- Diamide, Yamada reactions, 504
- Di-amination reactions, Buchwald-Hartwig amination, 589–590
- α,δ -Diaminoadipic acid, Gabriel synthesis, 449
- Diapen, Noyori catalytic asymmetric hydrogenation, 61–62
- Di-arylation, Buchwald-Hartwig amination, 594
- Diaryl ketones, Gribble reduction:
- basic principles, 93
 - historical perspective, 93–94
 - hydrogen gas liberation, 107–108
 - mechanism, 94–96
 - synthetic utility, 99–107
 - variations and improvements, 96–99
- Diarylmethanes, Gribble reduction of diaryl ketones to, 93
- Diarylmethanols, Gribble reduction, 93–95
- deoxygenation reaction, 102–103
- Diastereomers, Corey-Kim oxidation, 216–217

- Diastereoselectivity:
 chiral auxiliaries, Davis oxaziridine reagents, 25–29
 Davis oxaziridine reagents, substrate-directed hydroxylation, 29–33
 Shapiro reaction, 41 i
 Woodward *cis*-dihydroxylation, 329–330
 Djazaonamide A, Yamada reactions, 513–514
 Diazaphospholidine, Corey-Winter olefin synthesis, 356–358
 Diazene, Wharton reaction mechanism, 152–153
 vinyl carbanion, 154–155
 (+)-(1*S*,2*R*,3*R*,4*R*)-2,3-Diazido-1,4-dimethoxycyclohex-5-ene, Ramberg-Bäcklund reaction, Meyers modification, 403
 α -Diazoaminal, Regitz diazo reactions, 675
 Diazoanthrone, Regitz diazo reactions, 659
 Diazo dihexyl ketone, Regitz diazo reactions, 685
 Diazo esters, Regitz diazo reactions, 683
 5-Diazojasmonate, Regitz diazo reaction, 664
 α -Diazo ketones, 662–667
 Diazonamide A, Prilezhaev reaction, 278
 Diazonium fluorosilicates, Balz-Schiemann reaction, 553
 Diazonium hexafluorophosphates, Balz-Schiemann reaction, 553–554
 Diazonium salt, Japp-Klingemann hydrazone synthesis, 630
 Diazonization, Balz-Schiemann reaction, 552–553
 2-Diazo-1-phenyl-butane-1,3-dione, Regitz diazo reactions, 686
 α -Diazo sulfonyl compounds, Regitz diazo reactions, 660–661
 Diazothioanthrone, Regitz diazo reactions, 659
 Diazotization, Regitz diazo reactions, 672–673
 Diazo transfer reactions, Regitz diazo reactions:
 basic principles, 658
 diazo dihexyl ketone, 685
 2-diazo-1-phenyl-butane-1,3-dione, 686
 1,4-dimethyl-5,6,8,9-tetrahydro-6-diazo-7H-benzo[*a*]cyclohepten-7-one, 686
 historical perspective, 658
 indene methyl ester, 686
 mechanism, 658
 synthetic utility, 674–685
 acylation, 675
 aldol type addition, 675
 cyclic ketone addition, 677
 diazo 1,3-diketone addition to α,β -unsaturated ketones, 675–676
 diazo 1,3-diketone reduction to diazo hydroxyketones, 677–678
 electrono-rich alkene addition, 675
 elimination, 682
 halogenation, 674
 heterocycles, 684–685
 hydrogenation, 679
 metalation, 674–675
 nitration, 674
 rhodium-mediated intramolecular C-H insertion, 682–684
 ring cleavage reactions, 679
 silylation, 678–679
 sulfeneamine addition, 676–677
 Wolff rearrangement, 679–682
 tricyclic α -keto ester, 686
 variations and improvements, 659–674
 2,4-bis-diazo-1,3,5-triketone, 673
 diethyl diazo malonate, 660
 diazo 1,3-diketones, 669–673
 diazo alkenes and acetylenes, 659–660
 diazo β -keto esters, 673
 α -diazo ketones, 662–666
 diazo methylene compounds, 659
 diazo oxazolidone, 674
 α -diazo phosphono compounds, 661–662
 α -diazo sulfonyl compounds, 660–661
 1,2-diketones to diazoketones, 667–669
 4-(2,2-Dibromovinyl)-5-[3-(4-methoxybenzyloxy)-propyl]-2,2-dimethyl-[1,3]-dioxolane, Swern oxidation, 306–307
 1,3-Dicarbonyls, Corey-Kim oxidation, 213–214
 Dichloro(camphorsulphonyl)oxaziridine, enantioselective oxidation, 36
 2,6-Dichloro-3-fluoropyridine, Balz-Schiemann reaction, 560
 Dichloromethane:
 Burgess dehydrating reagent, 205
 Gribble reduction, 96
 Dichloropyridazine, Swern oxidation, 305
 Dichlorovinylamide, Yamada reactions, 510
 Dicyclohexylcarbodiimide (DCC):
 Swern oxidation, 291–292
 Yamada reactions, 501

- 5,8-Dideaza folic acid analogue, Yamada reactions, 532
- trans*-3,4-Didehydro-3,4-dideoxy,1,2,5,6-di-*O*-isopropylidene-*D*-threo-hexitol, Corey-Winter olefin synthesis, 361
- Didehydrosternofoline, Corey-Winter olefin synthesis, 358–361
- 2',3'-Dideoxyadenosine, Corey-Winter olefin synthesis, 359
- Diels-Alder reactions:
- Buchwald-Hartwig amination, 602–604
 - Corey-Bakshi-Shibata (CBS) reduction, 11–15
 - Fukuyama amine synthesis, 429–430
 - Krapcho decarboxylation, 637–638
 - Ramberg Backlund reaction, 389–391
 - Regitz diazo reactions, 681–682
- Dienes:
- Martin's sulfurane dehydrating reagent, 256–257
 - macrocyclic compounds, 257–258
 - Ramberg-Bäcklund reaction, 398–399
- Diethylaluminum azide, Prilezhaev reaction, 278
- Diethylaminoethylamine (DEAEA), Gabriel synthesis, 443
- Diethylazodicarboxylate (DEAD), Fukuyama amine synthesis, 424
- (2*R*)-4-(*N,N*-Diethylcarbamoxy)-5,5-difluoropent-4-en-1,2-diol, Sharpless asymmetric hydroxylation reactions, 80
- Diethyl diazo malonate, Regitz diazo reactions, 660
- Diethyl phosphorocyanidate (DEPC):
- Strecker amino acid synthesis, 479
 - Yamada reactions:
 - amides, 502–515
 - anticancer agents, 521–522
 - antitumor agents, 522–523
 - folic acid analogues, 531–539
 - historical perspective, 500–502
 - peptides, 516–519
- Diformylamide, Gabriel synthesis, 442
- Dihedral angles, Zaitsev elimination, 415
- 1,1,1-triacetoxy-1,1-Dihydro-1,2-benziodoxol-3(1*H*)-one (DMP), Dess-Martin periodinane oxidation, 218–219, 229–235
- Dihydroclerodin, Chugaev elimination, 335–336
- Dihydro-4,4-dimethyl-2,3-furandione, Noyori catalytic asymmetric hydrogenation, 56
- ketones, 61–62
- Dihydroerythronolide A, Yamaguchi esterification, 546–547
- (-)(4*R*)-Dihydroisomyricoidine, Yamada reactions, 508
- Dihydropyrans:
- Luche reduction, 116–119
 - Martin's sulfurane dehydrating reagent, everninomicin, 259–261
- 1,4-Dihydropyridine, Dess-Martin periodinane oxidation, 228–235
- Dihydropyridine esters, Haloform reaction, 616–617
- Dihydroquinidine, Sharpless asymmetric hydroxylation reactions, 71–77
- Dihydroquinine, Sharpless asymmetric hydroxylation reactions, 71–77
- 7,11-Dihydroxyguaianolides, Burgess dehydrating reagent, 204
- Dihydroxylation:
- asymmetric Strecker amino acid synthesis, 489
 - Woodward *cis*-dihydroxylation, 327–332
 - cis*-Dihydroxylation, Woodward *cis*-dihydroxylation, 327–328
- Diisopropylamine, Swern oxidation, 294
- 1,2-Diketones, Regitz diazo reactions, 667–669
- 1,3-Diketones, Regitz diazo reactions, 669–673, 677–678
- α -Diketones, Corey-Kim oxidation, 214–216
- Dimerization, Baeyer-Viliger oxidation, 161
- 6,7-Dimethoxynaphthalene-2-carboxylic acid, Haloform reaction, 619
- Dimethylaminopyridine (DMAP), Yamaguchi esterification, 545–549
- Dimethylchlorosulfonium species, Swern oxidation, 292–293
- 3,3-Dimethylcyclobut-1-ene, Zaitsev elimination, 420
- Endo*-1,3-Dimethyl-2,9-dioxabicyclo[3.3.1]nonane, Corey-Bakshi-Shibata (CBS) reduction, 14–15
- Dimethyl dioxirane (DMDO):
- Nef reaction, 648
 - Rubottom oxidation, 285–287
- Dimethyl α,δ -diphthalimidoadipate, Gabriel synthesis, 449
- Dimethylfarnesylphosphate, enantioselective oxidation, Davis oxaziridine reagents, 36

- Dimethylsulfide (DMS), Corey-Kim oxidation, 207
- Dimethylsulfonium dicarbonylmethylides, Corey-Kim oxidation, 213–214
- Dimethyl sulfoxide (DMSO), Krapcho decarboxylation, 635
- 1,4-Dimethyl-5,6,8,9-tetrahydro-6-diazo-7H-benzo[a]cyclohepten-7-one, Regitz diazo reactions, 686
- Dimethyl-(3,5,5-trimethyl-hexyl)-amine, Leuckart-Wallach reaction, 455
- 2,4-Dinitro-benzenesulfonamide, Fukuyama amine synthesis, 424
- Dinoflagellates, Luche reduction, 114–119
- cis*-Diol, Woodward *cis*-dihydroxylation, 327–330
- trans*-Diol, Woodward *cis*-dihydroxylation, 329–330
- Dione, Meerwein-Ponndorf-Verley reduction, 127
- Diorganozinc reagents, Krapcho decarboxylation, 640
- Dioxanes, Prins reaction, 653
- Dioxiranes:
 Baeyer-Viliger oxidation, 161–163
 Davis oxaziridine reagents, 23–25
 Rubottom oxidation, 286–287
- DIPAMP bisphosphane, Noyori catalytic asymmetric hydrogenation, 55–56
- Dipeptide 250, Yamada reactions, 537–538
- 1,2-Diphenyl-12-diaminoethane(stilbenediamine, stien), Corey-Bakshi-Shibata (CBS) reduction, 13–15
- Diphenylmethane, Gribble reduction, 108
- 4-(Diphenylmethyl)-1,1'-biphenyl, Gribble reduction, 108
- Diphenyl phosphorazide (DPPA), Yamada reactions, 501
- peptides, 515–519
- Diphenylphosphoro ester azide (DPPA), Regitz diazo reaction, 665
- Diphenyl phthalazine, Sharpless asymmetric hydroxylation reactions, 72–77
- Diphenyl pyrazinopyridazine, Sharpless asymmetric hydroxylation reactions, 72–77
- Diphenylpyrimidine, Sharpless asymmetric hydroxylation reactions, 72–77
- Diphosphine, Noyori catalytic asymmetric hydrogenation, BINAP ligands, 48–53
- 1,3-Dipolar cycloaddition, Regitz diazo reactions, 685
- Dipole neutralization, Baeyer-Viliger oxidation, 166–167
- meso*-Dipyranone, Luche reduction, 116–117
- Diradical structures, Krapcho decarboxylation, 637
- Discodermolide, Corey-Winter olefin synthesis, 360
- Distamycin analogs, Haloform reaction, 617
- β,β -Disubstituted α -dehydroamino acids, Noyori catalytic asymmetric hydrogenation, 56–58
- Diterpene, Corey-Kim oxidation, 214
- Dithioacetals, Dess-Martin periodinane oxidation, 224
- Dithioketals, Dess-Martin periodinane oxidation, 224
- Dolabelide D, Wacker-Tsuji oxidation, 320–321
- Dolastatins, Yamada reactions:
 Dolastatin 10, 517–519
 Dolastatin 18, 540–541
- Doliculide, Yamada reactions, 525–526
- Double amination, Buchwald-Hartwig amination, 573
- Double bond migration:
 Cope elimination reaction, 344
 Oppenauer oxidation, 265, 268–269
- Double elimination, Zaitsev elimination, strained ring systems 418
- Double hydroxylation, Rubottom oxidation, 287
- Double Perkow reaction, synthetic utility, 379–380
- DPEphos ligand, Buchwald-Hartwig amination, 598, 600
- DuPhos ligand, Noyori catalytic asymmetric hydrogenation, 49–53
- enol esters, 59
- modification of, 54–56
- Dynamic kinetic resolution, Noyori catalytic asymmetric hydrogenation, 62–63
- Dysidiolide, Wacker-Tsuji oxidation, 321–322
- Elcb mechanism, Zaitsev elimination, 415–417
- E1/E2 pathways:
 Martin's sulfuranone dehydrating reagent, 249, 255–256

- Ritter reaction, 471–472
Zaitsev elimination, 415–417
- (–)-Eburnamonine, Krapcho decarboxylation, 638
- Echinocandin D, Yamada reactions, 538–539
- Electrogenerated acids (EGA), Ritter reaction, 472–473
- Electrolysis, Ritter reaction, 472–473
- Electron-rich alkenes, Regitz diazo reactions, 675
- Electron-rich ligands, Buchwald-Hartwig amination, 564
- Electron-withdrawing groups (EWGs):
Baeyer-Viliger oxidation, 163–167
Buchwald-Hartwig amination, 567–569
- Electrophilic aromatic substitution, Fukuyama amine synthesis, 430
- Electrophilic interactions:
Noyori catalytic asymmetric hydrogenation, carbon molecules, 53
Swern oxidation, chlorine, 301
Wacker-Tsuji oxidation, aromatic ring palladation, 316–318
- Electrophilicity, Prilezhaev reaction, 274
- Elimination, Regitz diazo reactions, 682
- β -Elimination pathway:
Buchwald-Hartwig amination, 568–574
Zaitsev elimination, 414–415
- Enamides, Noyori catalytic asymmetric hydrogenation, 48–53
enantioselectivity, 57–58
variations and improvements, 53–56
- Enantiocontrol, Corey-Bakshi-Shibata (CBS) reduction, stereoselectivity improvements, 6–15
- Enantiomeric excess:
Corey-Kim oxidation, aldehydes and ketones, 211–212
Midland reduction, 42–43
Noyori catalytic asymmetric hydrogenation, 46–47
- Enantioselectivity:
Buchwald-Hartwig amination, 571–572, 599, 603
Davis oxaziridine reagents, 33–36
Krapcho decarboxylation, 640
Meerwein-Ponndorf-Verley reduction, 125–126
Prilezhaev reaction, 277
Strecker amino acid synthesis, 489–490
- Ender's chiral hydrazones, Strecker amino acid synthesis, 487–488
- Endocyclic olefins, Cope elimination reaction, 346–347
- Endothelin, Corey-Bakshi-Shibata (CBS) reduction, 18
- Endo-tropanamine, Leuckart-Wallach reaction, 454–455
- Eneaminoketones, Regitz diazo reactions, 669
- Ene-type mechanisms, Prins reaction, 653–654
- Eneynes, Ramberg-Bäcklund reaction, 398–399
- Enolate hydroxylation, Davis oxaziridine reagents, 22–25
substrate-directed diastereoselective hydroxylation, 29–33
- Enol esters, Noyori catalytic asymmetric hydrogenation, 59
- Enol phosphates:
Perkow reaction, 370–371
C-alkylation cleavage of, 377–378
 β -ketophosphonate rearrangement, 375–376
pharmaceutical syntheses, 380–381
Perkow reactions, reductive removal to alkenes, 378–379
- Enolsilanes, Rubottom oxidation, 282–283
variations, 285–288
- Enones, Luche reduction, 115–119
- Enzyme catalysis, Baeyer-Viliger oxidation, 173–178
- EP4 receptor antagonists, Corey-Bakshi-Shibata (CBS) reduction, 15–18
- (–)-Ephedrane, tandem intramolecular Staudinger/aza-Wittig reaction, 147
- (+)-1-Epiaustraline, Tamao-Kumada-Fleming oxidation, 243–244
- Epimers:
Dess-Martin periodinane oxidation, 2-iodoxybenzoic (IBX), 222
exo/endo mixture, Davis oxaziridine reagents, 30–33
Mukaiyama esterification, 465–469
- Episulfones, Ramberg-Bäcklund reaction, 387
ring structures, 397
- Epothilone:
Corey-Bakshi-Shibata (CBS) reduction, 16–18
Davis oxaziridine reagents, 28–29
- Epoxides:
Burgess dehydrating reagent, 199–203
Davis oxaziridine reagents, 24

- Epoxides (*continued*)
 Martin's sulfurane dehydrating reagent, 251
 Prilezhaev reaction, 279–280
 Rubottom oxidation, 283
 Wharton reaction mechanism, 153
 Epoxydictymene, Rubottom oxidation, 287–288
 1,4-Epoxy-1,4-dihydronaphthalenes, Gribble
 reduction of aryl ketones and, 99
 Epoxyhydrazones, Wharton reaction mechanism,
 155
 α,β -Epoxy ketones:
 Luche reduction, 120
 Wharton reaction, 152–155
 Epoxypropelladiene, Ramberg-Bäcklund
 reaction, 392
 Epoxy-Ramberg-Bäcklund reaction, 390–391
 (+)-Eremantholide, Ramberg-Bäcklund reaction,
 401–402
 α -Ergosterol, Oppenauer oxidation, 267–268
 Erythronolide A, Yamaguchi esterification, 547
 Eschweiler-Clark reductive alkylation, of
 amines:
 α -amino amides, 89
 aromatic aniline methylation, 89
 basic principles, 86
 5-bromo-1,4,6-trimethyl-2,3-dihydro-1H-
 pyrrolo[2,3b]pyridine, 92
 cyclic aminol ethers to *n,n*-dialkylamino
 derivatives, 88–89
 historical perspective, 86
 mechanisms of, 86–87
N-alkylation of amides, 87–88
 solvent- and formaldehyde-free conditions, 88
 synthetic utility, 90–92
 Esterification:
 Fischer-Speier esterification, 458–459
 basic principles, 458
 historical perspective, 458
 mechanism, 458–459
N-methyltryptophan methyl ester
 hydrochloride, 460
 synthetic utility, 459–460
 Gabriel synthesis, 448
 Mukaiyama esterification:
 basic principles, 462
 experimental procedures, 469
 historical perspective, 462–463
 synthetic utility, 465–469
 variations and improvements, 463–465
 pyrolysis, Cope elimination reaction, 343
 Yamada reactions, 501
 Yamaguchi esterification:
 basic principles, 545
 historical perspective, 545
 mechanism, 545–546
 4-methyl-hex-2-enedioic acid, 6-[4-iodo-2-
 methyl-1-(2-methyl-1,3-dioxolan-2-yl-
 methyl)-pent-3-enyl]ester-1-methyl ester,
 550
 synthetic utility, 549
 variations and improvements, 546–549
 (+)-Estradiol, Ramberg-Bäcklund reaction, 394
 Ethanolic cleavage, Haloform reaction, 613–614
 5-Ethoxycarbonyl-5-(*n*-undecyl)- δ -valerolactone,
 Baeyer-Viliger oxidation, 180–181
 (*R*)-4-Ethoxy- γ -lactam, Noyori catalytic
 asymmetric hydrogenation, 59–60
S-Ethyl 3-benzenepropanethionates, Yamada
 reactions, 501–502
 2-Ethyl-2-chloro-1-(phenylsulfonyl)indole,
 Gribble reduction, 108
 (–)-(*R*)-2-Ethyl-5,8,-dimethoxy-2-hydroxyl-
 1,2,3,4-tetrahydronaphthalen-1-one,
 Davis oxaziridine reagents, 37–38
 Ethyl-(1*R**,5*S**)-3-ethyl-9-oxobutyl-3-
 azabicyclo[3.3.1]nonane-1-carboxylate,
 Wacker-Tsuji oxidation, 325
 Ethyl pyruvate *o*-nitrophenylhydrazone, Japp-
 Klingemann hydrazone synthesis,
 633–634
 Everninomicin, Martin's sulfurane dehydrating
 reagent, 259–261
 5-Exo cyclization, Tamao-Kumada-Fleming
 oxidation, 242
 Exo-bicyclo[3.1.0]hexan-1-ols, Luche reduction,
 118–119
 Exo-*cis* diol, Swern oxidation, 305
 Exocyclic alkenes, Martin's sulfurane
 dehydrating reagent, 260
 Exo surface of π system, Luche reduction,
 regioselectivity, 114
 Eyring relationship, Sharpless asymmetric
 hydroxylation reactions, 69
 Facial epimerization, Noyori catalytic
 asymmetric hydrogenation, 62–63
 Farnesyltransferase inhibitors, Staudinger
 reaction, 140–142
 Ferrocene-based bisphosphane ligands:
 Buchwald-Hartwig amination:

- aromatic heterocycles, 586–588
- bulky phosphines, 579–582
- chelating phosphines, 571–572, 585
- Noyori catalytic asymmetric hydrogenation, 54–56
- Ferrocenes, Gribble reduction, acyl/diacyl compounds, 101
- Ferrocenyl alcohols, Gribble reduction of, 107
- Ferrocenyl ketone hydrazines, Gribble reduction of aryl ketones and, 99
- Fetizon reagent, Swern oxidation, 299–300
- Fischer cyclization conditions, Buchwald-Hartwig amination, 597
- Fischer-Speier esterification:
 - basic principles, 458
 - historical perspective, 458
 - mechanism, 458–459
 - N*-methyltryptophan methyl ester hydrochloride, 460
 - synthetic utility, 459–460
- Fittig synthesis, Perkin reaction, 365
- Flavin-type monooxygenases, Baeyer-Viliger oxidation, 176–178
- Fleming protocol, Tamao-Kumada-Fleming oxidation, 238–239
- Fluorescence resonance energy transfer (FRE), Buchwald-Hartwig amination, 582
- Fluoro-dediazonizations, Balz-Schiemann reaction, 555–556
- (*S*)-2-(4-Fluorophenyl)-3-methylbutanoic acid, Noyori catalytic asymmetric hydrogenation, 59–60
- Fluorotamoxifen, Balz-Schiemann reaction, 555
- 8-Fluoro-1-tetralone, Balz-Schiemann reaction, 560–561
- “Fluorous dimethyl sulphide,” Corey-Kim oxidation, 208
- Fluorous extraction, Swern oxidation, 294–295
- Fluorous tagging, Mukaiyama esterification, 465
- Fluorous-tethered triphenylphosphine reagent, Staudinger reaction, 133
- Folic acid analogues, Yamada reactions, 531–539
- Formaldehyde-free conditions, Eschweiler-Clark reductive alkylation of amines, 88
- Formalin, Eschweiler-Clark reductive alkylation of amines, 90
- Formamide derivatives:
 - Eschweiler-Clark reductive alkylation of amines, 87
 - Leuckart-Wallach reaction, 452
- Formic acid, Eschweiler-Clark reductive alkylation of amines, 86
- Formylation, Regitz diazo reaction, 5-diazojasmonate, 664–667
- N*-Formyl- α,α -dimethyl- α -phenethylamine, Ritter reaction, 475–476
- 3-Formylindole, Gribble reduction, 9697
- 2-(4-Formylphenyl)-7-methoxy-4H-1-benzopyran-4-one, Sommelet reaction, 694
- Fourier-transform-infrared spectroscopy (FT-IR), Corey-Kim oxidation, 208
- FR901483 immunosuppressive agent, Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 30–33
- Fredericamycin A, Burgess dehydrating reagent, 203–204
- Friedel-Crafts reaction, Gribble reduction, 95–96
- Fukuyama amine synthesis:
 - basic principles, 424
 - historical perspective, 425–427
 - mechanism, 427
 - N*-(4-methoxy-benzyl)-2-nitro-*N*-(3-phenyl-propyl)-benzenesulfonamide, 435
 - (4-methoxy-benzyl)-(3-phenyl-propyl)-amine, 435
 - synthetic utility, 427–432
 - limitations and side products, 430–432
 - nitrogen heterocycles, 428–429
 - secondary/differentially protected primary amines, 427–428
 - solid phase synthesis, 430
 - total synthesis applications, 429–430
 - variations, 432–434
 - chemoselectivity, 433
 - nosyl deprotection and functionalization, 434
 - phosphine oxide removal, 432
 - protected hydroxylamines, 433–434
 - regioselectivity, 432
- (–)-Fumagillin, Rubottom oxidation, 287–288
- Fumaramidmycin, Dess-Martin periodinane oxidation, 232–235
- Furanaldehyde, Luche reduction, 117–119
- GABA_A agonist, Baeyer-Viliger oxidation, 179–180
- Gabriel synthesis:
 - basic principles, 438
 - α,δ -diaminoadipic acid, 449

- Gabriel synthesis (*continued*)
dimethyl α,δ -diphthalimidodipate, 449
historical perspective, 438
mechanism, 438–439
synthetic utility, 446–448
variations and improvements, 439–446
- Galbulinima alkaloid-13, Martin's sulfurane
dehydrating reagent, 253–256
- Gambierol, Luche reduction, 114–119
- Gamma-aminobutyric acid, Gabriel synthesis, 442–443
- Gauche migration, Baeyer-Viliger oxidation, 165–167
- Geodiamolide A, Yamada reactions, 530
- Geometric integrity, Gabriel synthesis, 446
- Geraniol derivative, Chugaev elimination, 338–339
- Gibberellic acid, Brown hydroboration
reaction, 187–188
- Gibberellin, Luche reduction, 115–116
- Globomycin, Yamada reactions, 505
- Glucose dehydrogenase (GDH), Baeyer-Viliger
oxidation, 173–178
- Glutamate analogs, Corey-Bakshi-Shibata (CBS)
reduction, 10–15
- Glycine, Strecker amino acid synthesis, 492
- Glycol cleavage, Corey-Kim oxidation, 215–216
- Goldberg-Ullmann type reactions, Buchwald-
Hartwig amination, 564–565
- Gram-negative/Gram-negative organisms,
Staudinger reaction, 141–142
- Green chemistry:
Corey-Kim oxidation, 209
Hunsdiecker reaction, 628
Strecker amino acid synthesis, 481–482
- Gribble reduction:
diaryl ketones:
basic principles, 93
historical perspective, 93–94
hydrogen gas liberation, 107–108
mechanism, 94–96
synthetic utility, 99–107
variations and improvements, 96–99
diaryl ketones to diarylmethanes, 93
- Grignard reagent:
Oppenauer oxidation, 272
Tamao-Kumada-Fleming oxidation, 245
- Guanacastepine, Rubottom oxidation, 284–285,
288–289
- Guanidine catalyst, Corey-Bakshi-Shibata (CBS)
reduction, 8–15
- Guest-host interactions, Strecker amino acid
synthesis, 481
- Gymnocin-A, Luche reduction, 114–119
- Gymnodimine, Prilezhaev reaction, 278
- α -Halo amides, enolate oxidation, 22–23
- 2-Halo-benzoxazolium, Mukaiyama
esterification, 463
- Haloform reaction:
basic principles, 610
benzoic acid, 619
biological reaction, 617–618
2-carboxytropolone, 619
cinnamic acid, 618–619
6,7-dimethoxynaphthalene-2-carboxylic acid,
619
historical perspective, 610
mechanism, 611–612
synthetic utility, 615–617
variations and improvements, 612–614
- Halogenation:
Haloform reaction, 610
Regitz diazo reactions, 674
- Halogen donor solvents, Hunsdiecker reaction,
626
- Halomagnesium alkoxides, Oppenauer oxidation,
272
- α -Halosulfone, Ramberg-Bäcklund reaction,
386–387
- Hamacanthins, tandem intramolecular
Staudinger/aza-Wittig reaction,
143–147
- Hammett substituent constants, Davis oxaziridine
reagents, 24
- Hard and soft acids and bases (HSAB) theory,
Luche reduction, 113
- Heck reaction, Buchwald-Hartwig amination,
581–582, 601, 603–604
- Hemiaminal, Sommelet reaction, 690
- (\pm)-Hennoxazole A, Yamada reactions, 511–512
- Heptenophos, Perkow reaction, 382
- 1-Heptyn-3-one, Midland reduction, 44
- Heteroatom coordination theory, Wacker-Tsuji
oxidation, 319–321, 323–324
- Heteroatom stabilisation, Ritter reaction, 474
- Heterobimetallic binol catalyst, Strecker amino
acid synthesis, 492

- Heterocyclic amines, Cope elimination reaction, 347
- Heterocyclic asymmetric oxidation, Davis oxaziridine reagents, 36–37
- N*-Heterocyclic carbenes, Buchwald-Hartwig amination, 574–582
- Heterocyclic methanols, Gribble reduction and deoxygenation, 104
- Heterocyclic synthesis, Regitz diazo reactions, 684–685
- Hexacyclic himandrin skeleton, Wacker-Tsuji oxidation, 324
- dl*-*anti*-*trans*-4,4a,4b,5,8,8a-Hexahydro-1,8a-dimethyl-6 β -7 β -dihydroxy-2(3*H*)-phenanthrone, Woodward *cis*-dihydroxylation, 331–332
- (4a,*S*,6*R*,7*S*,7a*R*,11a*R*,2'*S*,3a')-7-(Hexahydrofuro[2,3-*u*'3,3,6,7-tetramethyl-11-methyleneoctahydro-naphtho[1,8a-*I*dioxine, Chugaev elimination, 341
- Hexamethyl disaline, Nef reaction, 647
- Hexamethylenetetramine (HMTA), Sommelet reaction, 689
- Hexaminium salt, Sommelet reaction, 689–694
- Hexosaminidase enzyme disorders, Corey-Bakshi-Shibata (CBS) reduction, 17–18
- N*-Hexyl-2-methyl-4-methoxyaniline, Buchwald-Hartwig amination, 604
- (–)-Hispidospermidin, Shapiro reaction, 411
- Histidine derivatives, Yamada reactions, 527–529
- Homoallylic alcohols, Sharpless asymmetric hydroxylation reactions, 79–80
- Homologation, Yamada reactions, 502
- Homolytic cleavage:
- Hunsdiecker reaction, 624
 - Krapcho decarboxylation, 637
- Hormones, Oppenauer oxidation, 268–269
- Horner-Wadsworth-Emmons reactions, Rubottom oxidation, 286–287
- Human-selective adenosine A3 receptor agonists, Staudinger reaction, 140–141
- Humic acid, biological Haloform reaction, 618
- Hunsdiecker reaction:
- basic principles, 623
 - 1-bromo-3-chlorocyclobutane, 629–620
 - historical perspective, 623
 - mechanism, 624
 - synthetic utility, 627–628
- variations and improvements, 624–626
- Hydrazine:
- Buchwald-Hartwig amination, 564
 - coupling reactions, 597–601
 - α,β -epoxy ketone transformation, Wharton reaction, 152–155
 - Fukuyama amine synthesis, 431–432
 - Gabriel synthesis:
 - α,δ -diaminoadipic acid, 449
 - hydrazinolysis reactions, 438, 441–442
 - Mitsunobu conditions, 446–448
- Hydrazone:
- Corey-Winter olefin synthesis, 355
 - Japp-Klingemann hydrozone synthesis, 630–634
 - Krapcho decarboxylation, 641
 - Regitz diazo reactions, 661
 - Shapiro reaction, 405–407
 - Swern oxidation and, 303–304
 - tautomerization, Wharton reaction mechanism, 152–153
- Hydride acceptors, Oppenauer oxidation, 270–271
- Hydride agents:
- borane, Corey-Bakshi-Shibata reduction, 5–6
 - Luche reduction:
 - 1,2-addition, 112
 - stereoselectivity, 118–119
- Noyori catalytic asymmetric hydrogenation, 53–56
- β -Hydride elimination:
- Buchwald-Hartwig amination, 567
 - Wacker-Tsuji oxidation, 314–318
- Hydride donors, Leuckart-Wallach reaction, 451–452
- Hydride shift, Wacker-Tsuji oxidation, 310–311
- Hydride transfer, Sommelet reaction, 691
- Hydrobicyclo[3.1.0]hexan-2-ones, Luche reduction, 118–119
- Hydroboration, Brown hydroboration reaction, 183–188
- Hydrocarbons, Gribble reduction of aryl ketones and alcohols to, 98–99
- tris-heterocycle structures, 106
- Hydrocortisone acetate, Midland reduction, 43–44
- Hydrogenation, Regitz diazo reactions, 679
- Hydrogen bonding, Corey-Bakshi-Shibata (CBS) reduction, endocyclic oxygen, 12

- β -Hydrogen elimination, Wacker-Tsuji oxidation, 311–314
- Hydrogen gas release, Gribble reduction and, 107–108
- Hydrogenolysis, Buchwald-Hartwig amination, ammonia equivalents, 593–595
- Hydrolysis:
Ritter reaction, 471
Strecker amino acid synthesis, 477
- Hydrolytic cleavage, Japp-Klingemann hydrazone synthesis, 630
- Hydrosilylation procedure, Tamao-Kumada-Fleming oxidation, 240–241
- Hydroxamates, Fukuyama amine synthesis, 433–434
- Hydroxamines, Gabriel synthesis, 440–441
- α -Hydroxy amino acids, Davis oxaziridine reagents, 31–33
- α -Hydroxy carbonyl compounds, Davis oxaziridine reagents, 22
- α -Hydroxy dialkylphosphonate, enantioselective oxidation, 36
- α -Hydroxy esters, Midland reduction, 42–43
- Hydroxyketones, Regitz diazo reactions, 677–678
- α -Hydroxy ketone, Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 30–33
- β -Hydroxy ketone, Noyori catalytic asymmetric hydrogenation, 61–62
- α -Hydroxylation, Davis oxaziridine reagents, 25–29
- Hydroxylamine:
Cope elimination reaction, 343
unsymmetrical preparation, 347–348
Fukuyama amine synthesis, protected compounds, 433–434
- Hydroxylating agent, Davis oxaziridine reagents, 27–29
substrate-directed diastereoselectivity, 29–33
- cis*-Hydroxylation, Sharpless asymmetric hydroxylation reactions, 67–68
- Hydroxyl-hydrazine, Wharton reaction mechanism, 152–153
- α -Hydroxyketones, Corey-Kim oxidation, 214–216
- (2-Hydroxylmethyl-6-vinyl-1-azaspiro[4.5]dec-1-yl)-phenylmethanone, Tamao-Kumada-Fleming oxidation, 246
- Hydroxyphenanthrene, Gribble reduction, 101
- α -Hydroxy phosphonates, Davis oxaziridine reagents, enantioselective oxidation, 35–36
- 6-Hydroxy-10-triethylsilyloxy-1-oxaspiro[4.5]dec-7-en-2-one, Wharton reaction, 157–158
- 6-Hydroxy-3,5,5-trimethyl-2-cyclohexen-1-one, Rubottom oxidation, 289
- Hygomyacin A, Yamada reactions, 507
- Hygroscopicity, Ritter reaction, 472
- Hypiodite, Haloform reaction, 617
- Imidazopyridazines, Swern oxidation, 305
- Imidodicarbonate, Gabriel synthesis, 443
- Imidotrioxosmium (VIII), Sharpless asymmetric hydroxylation reactions, 69
- Imine products:
Davis oxaziridine reagents, 24
Eschweiler-Clark reductive alkylation of amines, 86
Noyori catalytic asymmetric hydrogenation, 62
Strecker amino acid synthesis, 489–490
Swern oxidation, 304
- Iminium ions:
Leuckart-Wallach reaction, 451
Sommelet reaction, 690–691
- Iminoether, tandem intramolecular Staudinger/aza-Wittig reaction, 146–147
- 2-Iminohydantoins, Mukaiyama esterification, 469
- Iminophosphoranes, Staudinger reaction, 129
mechanisms, 129–131
monomethylamine one-pot transformations, 135–136
synthetic utility, 136–137
tandem intramolecular Staudinger/aza-Wittig reaction, 145–147
- Indene methyl ester, Regitz diazo reactions, 686
- Indoles:
Buchwald-Hartwig amination, 595–597
Japp-Klingemann hydrozone synthesis, 632–633
- Indolizidine alkaloids, Strecker amino acid synthesis, 495
- Indolizines, reverse Cope elimination, 349
- Indomethacin, Yamada reactions, 511–512
- Ingenol:
Corey-Kim oxidation, 215

- Shapiro reaction, 411
- Ing-Manske procedure, Gabriel synthesis, 440
- Ingold terminology, Cope elimination reaction, 344
- Interleukin-1, Tamao-Kumada-Fleming oxidation, 242
- Intermediates, Zaitsev elimination, 418–419
- Intermolecular arylations, Buchwald-Hartwig amination, 600
- Intermolecular azole vinylation, Buchwald-Hartwig amination, 602–604
- Intermolecular carbocations, Gribble reduction, 103–104
- Intermolecular hydride transfer, Oppenauer oxidation, 266
- Intermolecular Staudinger/aza-Wittig reaction, imine formation, 142–147
- Intramolecular acylation, Perkin reaction, 363–364
- Intramolecular aldol-type condensation, Buchwald-Hartwig amination, 599
- Intramolecular amination, Buchwald-Hartwig amination:
 applications, 590–592
 aromatic heterocycles, 587–588
 coupling reactions, 598
- Intramolecular aryl guanidinylation, Buchwald-Hartwig amination, 598
- Intramolecular Cannizzaro reaction, Swern oxidation, 306
- Intramolecular cyclizations:
 Buchwald-Hartwig amination, 565
 applications, 588–592
 palladium-catalyzed arylation, 599–600
 Burgess dehydrating reagent, 192–193
 Yamada reactions, 508
- Intramolecular Diels-Alder reaction, Fukuyama amine synthesis, 429–430
- Intramolecular nucleophilic substitution, Ramberg-Bäcklund reaction, 387
- Intramolecular radical conjugate addition, Krapcho decarboxylation, 638
- Intramolecular Staudinger/aza-Wittig reaction, imine formation, 142–147
- Intramolecular *trans*-aminopalladation, Wacker-Tsuji oxidation, 316–318
- Intramolecular transamidation, Leuckart-Wallach reaction, 453
- Inverse phase transfer catalysis, Haloform reaction, 612–614
- Iodine catalysts, Strecker amino acid synthesis, 480
- 2-Iodoxybenzoic (IBX), Dess-Martin periodinane oxidation, 218–219, 221–223, 226–228
- “Iodoform Test,” Haloform reaction, 610
- Iodonium ion, Woodward *cis*-dihydroxylation, 328
- N*-Iodosuccinamide (NIS), Ramberg-Bäcklund reaction, 394
- Iodo-sulfone, Ramberg-Bäcklund reaction, 394
- α -Iodosulfone, Ramberg-Bäcklund reaction, 387
- Iodothiocarbonates, Corey-Winter olefin synthesis, 357
- Ionic liquids, Dess-Martin periodinane oxidation, 228
- Ion-molecule pairings, Balz-Schiemann reaction, 553
- Ψ -Ionone, Oppenauer oxidation, 271–272
- Iron(III) compounds, Baeyer-Viliger oxidation, 172
- Isoborneol, Corey-Kim oxidation, 208
- Isoclovene, Krapcho decarboxylation, 642
- Isodidehydrosternofoline, Corey-Winter olefin synthesis, 358–359
- Isoprenoid aziridines, Prilezhaev reaction, 278
- Isoschizogamine, Martin's sulfurane dehydrating reagent, 261
- Isothiocyanates, Regitz diazo reactions, 685
- Japp-Klingemann hydrazone synthesis:
 basic principles, 630
 ethyl pyruvate *o*-nitrophenylhydrazone, 633–634
 historical perspective, 630
 mechanism, 630–631
 synthetic utility, 632–633
 variation, 631–632
- Cis*-Jasmone, Perkow reactions, 378
- Jaspamide, Yamada reactions, 530
- Jatrophatrione, Tamao-Kumada-Fleming oxidation, 241
- (\pm)-Jatrophone, Corey-Kim oxidation, 214
- Jones oxidations conditions, Dess-Martin periodinane oxidation, 229–230

- Josiphos ligands, Noyori catalytic asymmetric hydrogenation, 54–56
ketones, 61–62
Julia-Kocienski olefination, Martin's sulfuranone dehydrating reagent, 256
- (–)-Kainic acid, Chugaev elimination, 340–341
Kanamycin, Staudinger reaction, 138–142
Karenia mikimotoi, Luche reduction, 114–119
Keck modification, Steglich esterification, 547
KetaliPhos ligand, Noyori catalytic asymmetric hydrogenation, 54–56
Ketalization, Nef reaction, 650
Ketene intermediate, Regitz diazo reactions, 679–680
 α -Keto esters, Midland reduction, 42–43
 β -Keto esters:
Noyori catalytic asymmetric hydrogenation, 51–53
Regitz diazo reactions, 673
Ketones:
biological Haloform reaction, 617–618
Corey-Kim oxidation, 211–212
 α -hydroxyketones and α -diketones, 214–216
diaryl ketones, Gribble reduction:
basic principles, 93
historical perspective, 93–94
hydrogen gas liberation, 107–108
mechanism, 94–96
synthetic utility, 99–107
variations and improvements, 96–99
enantioselective reductions, Corey-Bakshi-Shibata (CBS) reduction method, 2
Haloform reaction, 611–614
Meerwein-Ponndorf-Verley reduction, 126
samarium catalysts, 127–128
Midland reduction, variations and improvements, 42–43
Noyori catalytic asymmetric hydrogenation, 61–62
Perkin reaction, 364
Perkow reaction, 371–375
 α -trifluoromethylated synthesis, 379
Regitz diazo reactions, 662–667, 665–666
triphase transfer system, 671–673
1,3-Ketones, Regitz diazo reactions, 675–676
 β -Ketophosphonates, Perkow reaction and rearrangement of, 375–376
- Keto porphyrins, Gribble reduction, 100
Ketoximes, Regitz diazo reactions, 668–669
Kinetic isotope effect:
Buchwald-Hartwig amination, 590–592
Chugaev elimination, 335
Corey-Bakshi-Shibata reduction, 5–6
Gabriel synthesis, 441
Haloform reaction, 611–612
Prilezhaev reaction, 275
Tamao-Kumada-Fleming oxidation, 238–239
Klebsiella derivatives, Yamada reactions, 509
Knoevenagel-Bucherer modification, Strecker amino acid synthesis, 477
Knoevenagel modification, Perkin reaction, 365–366
Kochi-Jacobsen-Katsuki epoxidation, Prilezhaev reaction, 277–277
Kochi modification, Hunsdiecker reaction, 625
Kornblum oxidation, Swern oxidation and, 297–298
Krapcho decarboxylation:
basic principles, 635
historical perspective, 635
mechanism, 636
synthetic utility, 636–643
Kröhnke reaction, Sommelet reaction, 689–692
Kugelohr distillation, Dess-Martin periodinane oxidation, 236
- Lactacystin, Strecker amino acid synthesis, 493
 β -Lactams:
Corey-Winter olefin synthesis, 359
Mukaiyama esterification, 462–463, 468
 γ -Lactols, Dess-Martin periodinane oxidation, 223
 α -Lactone:
Mukaiyama esterification, 466
Perkin reaction, 364
Lanthanide alkoxides, Meerwein-Ponndorf-Verley reduction, 124–126
(\pm)-Laurene, Wacker-Tsuji oxidation, 321–322
Lead tetra-acetate (LTA), Hunsdiecker reaction, 625
Lennoxamine, Yamada reactions, 510
Lepadiformine, Tamao-Kumada-Fleming oxidation, 245
(–)-Lepadins, Davis oxaziridine reagents, 33
Lepicidin A aglycon, Martin's sulfuranone dehydrating reagent, 261–262

- Leuckart-Wallach reaction:
 basic principles, 451
 dimethyl-(3,5,5-trimethyl-hexyl)-amine, 455
 Eschweiler-Clark reductive alkylation of amines, 86
 historical perspective, 451
 mechanism, 451–452
 synthetic utility, 453–454
 variations, 452–453
- Levo-DOPA, Noyori catalytic asymmetric hydrogenation, 47
- Levulinonitrile, Nef reaction, 650–651
- Lewis acid catalysts:
 Bayer-Viliger oxidation, metal catalysis, 170–172
 Buchwald-Hartwig amination, aromatic heterocycles, 585–588
 catalytic Oppenauer oxidation, 270–271
 Corey-Bakshi-Shibata reduction, 11–15
 borane, 5–6
 Luche reduction, 113
 Regitz diazo reactions, 675–676
 Strecker amino acid synthesis, 479–481, 485
 Swern oxidation, 305
- Lieben iodoform/haloform reaction. *See* Haloform reaction
- Limonoids, double Perkow reaction, 379–380
- Linezolid, Staudinger reaction, 141
- Lipogrammistin-A, Fukuyama amine synthesis, 429
- Lithium aluminum hydride, Tamao-Kumada-Fleming oxidation, 241
- Lithium benzylamide, Davis oxaziridine reagents, 31–33
- Lowest unoccupied molecular orbit (LUMO), Bayer-Viliger oxidation, 164
- Luche reduction:
 acyclic stereocontrol, 119–120
 basic principles, 112
 cyclic stereocontrol, 114–119
 historical perspective, 112–113
 mechanism, 113
 methyl-((3*aS*,4*S*,6*aR*)-4,6*a*-dihydro-4-hydroxy-2,2-dimethyl-3*aH*-cyclopenta[*dj*][1,3]-dioxol-6-yl)acetate, 120–121
 regioselectivity, 113–114
 synthetic utility, 113–120
- Lumazine hydrate, Haloform reaction, 617
- Lycoricidine, Yamada reactions, 513
- Lyngbyabellin A, Yamada reactions, 522–523
- Macrocyclic alkenes/dienes, Martin's sulfurane dehydrating reagent, 257–258
- Macrocyclization:
 Fukuyama amine synthesis:
 nitrogen heterocycles, 428–429
 total synthesis reactions, 429–430
 Yamaguchi esterification, 547
- Macrolactonization, Yamada reactions, 505–506
- Macrolides:
 Corey-Kim oxidation, diterpene, 214
 Staudinger reaction, 140–142
- Macrosphelides, Wacker-Tsuji oxidation, 322–323
- Mammalian fopolypolyglutamate synthetase inhibitors, Yamada reactions, 535–536
- Manganese(OAc)₂-catalyzed Hunsdiecker reaction, 625
- Mannich reaction, Strecker amino acid synthesis, 482–483
- Manzamine A, Martin's sulfurane dehydrating reagent, 259
- Manzamine C, sila-Cope elimination reaction, 350–351
- (+)-Maritimidol, Krapcho decarboxylation, 637–638
- Martin's sulfurane dehydrating reagent:
 basic principles, 248
 historical perspective, 248–249
 mechanisms of, 249–250
 (2'*S*,3'*S*)-Methyl-3-*O*-*t*-butyldimethylsilyl-4-*O*,5-*O*-(2',3')-dimethoxybutane-2',3'-diyl-shikimate, 263
 synthetic utility, 253–262
 acyclic alkenes, 253–256
 acyclic dienes, 256–258
 alkene ring structures, 258–262
 variations and improvements, 250–251
- MCCPM chiral ligand, Noyori catalytic asymmetric hydrogenation, ketones, 61–62
- Me-BPE-type ligands, Noyori catalytic asymmetric hydrogenation, 56–58
- Me-DuPhos ligands, Noyori catalytic asymmetric hydrogenation, 56–58
- Meerwein-Ponndorf-Verley (MPV) reduction. *See also* Oppenauer oxidation

- MPV reduction (*continued*)
 basic principles, 123
 catalytic Oppenauer oxidation, 270–271
 dione, 127
 historical perspective, 123
 ketones, samarium-catalyzed reactions, 127–128
 mechanisms, 123–124
 synthetic utility, 126–127
 variations and improvements, 124–126
- Meisenheimer complex, Fukuyama amine synthesis, 427
 limitations and side products, 431–432
 nosyl deprotection and functionalization, 434
- MeO-BIPHEP compound, Noyori catalytic asymmetric hydrogenation, 53–56
- Meso-hydrobenzoin, Corey-Winter olefin synthesis, 354–355
- Mesoporous silica, Baeyer-Viliger oxidation, 172
- Mesyl azide, Regitz diazo reactions, 659
- Metabotropic glutamate receptor (mGluR)
 antagonists, Corey-Bakshi-Shibata (CBS) reduction, 10–15
- Metalation, Regitz diazo reactions, 674–675
- Metal catalysis:
 Baeyer-Viliger oxidation, 168–172
 Brown hydroboration reaction, 186–188
- Metal-free Hunsdiecker reaction, 627
- Metal-ligand combinations, Baeyer-Viliger oxidation, 169–172
- Methacrolein, Corey-Bakshi-Shibata (CBS) reduction, 13–15
- Methinyl carbanion, Japp-Klingemann hydrozone synthesis, 630–634
- Methotrexate (MTX), Yamada reactions, 522–523
- N*-(4-Methoxy-benzyl)-2-nitro-*N*-(3-phenyl-propyl)-benzenesulfonamide, Fukuyama amine synthesis, 435
- (4-Methoxy-benzyl)-(3-phenyl-propyl)-amine, Fukuyama amine synthesis, 435
- (+)-(*S*)-2-(Methoxymethyl)pyrrolidine auxiliary, Davis oxaziridine reagents, 25–29
- Methoxyquinoline, Sharpless asymmetric hydroxylation reactions, 74–77
- Methyl-(*Z*)- α -(acetamido)-cinnamate, Noyori catalytic asymmetric hydrogenation, 50
- Methyl-(2*S*)-*N*-(2-aminopyrazidinedicarbonyl)pyrrolidine-2-carboxylate, Yamada reactions, 540
- Methylbromfeninphos, Perkow reaction, 381–383
- (2'*S*,3'*S*)-Methyl-3-*O*-*t*-butyldimethylsilyl-4-*O*,5-*O*-(2,'3')-dimethoxybutane-2,'3'diylshikimate, Martin's sulfurane dehydrating reagent, 263
- 1-Methyl-2-chloropyridinium iodide, Mukaiyama esterification, 469
- Methyl cholesteryl xanthate, Chugaev elimination, 334–335
- 3-Methylcyclohexene-2-carboxaldehyde, Shapiro reaction, 412
- Methyl-((3*aS*,4*S*,6*aR*)-4,6*a*-dihydro-4-hydroxy-2,2-dimethyl-3*aH*-cyclopenta[*d*][1,3]-dioxol-6-yl)acetate, Luche reduction, 120–121
- Methyl 2-(dimethoxyphosphoryloxy)-2-pentenoate, Perkow reaction, 382–383
- "Methylene bridge," Eschweiler-Clark reductive alkylation of amines, 91
- Methylene compounds, Regitz diazo reactions, 659
- Methylenomycin, Perkow reactions, 378
- 4-Methyl-hex-2-enedioic acid,6-[4-iodo-2-methyl-1-(2-*m*35hyl-[1,3]dioxolan-2-yl-methyl)-pent-3-enyl]ester-1-methyl ester, Yamaguchi esterification, 550
- Methyl ketones, Haloform reaction, 613–616
- Methyllycaconitine, Wacker-Tsuji oxidation, 324
- 1-Methyl-2-pyridone, Mukaiyama esterification, 463
- 4-Methyl-2-quinolyl ether (MEQ), Sharpless asymmetric hydroxylation reactions, 71–77
- Methylthiomethyl ether, Swern oxidation, 299
- N*-Methyltryptophan methyl ester hydrochloride, Fischer-Speier esterification, 460
- (-)-Methyl xanthates, Chugaev elimination, 340–341
- S*-Methyl xanthates, Chugaev elimination, 340–341
- Mevinphos, Perkow reaction, 381–383
- Meyers-Chan modification, Ramberg-Bäcklund reaction, 388
 cyclohexadiene, 393–394
 cyclophanes, 396–397

- deoxyartemisinin, 400
(1E,3E,5E,7E)-1-phenyl-8-trimethylsilyl-1,3,5,7-octatetraene, 403
polyenes, 399
ring structures, 395–397
- Meyers modification, Ramberg-Bäcklund reaction, 387–388
cyclopentenone, 393
(+)-(1S,2R,3R,4R)-2,3-diazo-1,4-dimethoxycyclohex-5-ene, 403
natural products, 400–402
phenanthrene, 395
- Mibefradil, Noyori catalytic asymmetric hydrogenation, 59–60
- Michael additions:
Brown hydroboration reaction, 185–186
Buchwald-Hartwig amination, 603–604
- Michael-induced Ramberg-Bäcklund reaction, 389–390
- Michaelis-Arbusov cleavage, Perkow reaction, 369–370
- Microginin, Yamada reactions, 528–529
- Microwave radiation:
Buchwald-Hartwig amination, 578–582, 600–601
aromatic heterocycles, 586–588
Burgess dehydrating reagent, 201–203
Dess-Martin periodinane oxidation, 229
Hunsdiecker reaction, 628
Leuckart-Wallach reaction, 454
Mukaiyama esterification, 463
Perkin reaction, 367
- Midland reduction:
basic principles, 40
historical perspective, 40–41
mechanism and stereochemical rationalization, 41–42
propargylic alcohol, 44
synthetic utility, 43–44
variations and improvements, 42–43
- Migita reaction, Buchwald-Hartwig amination, 566
aminostannanes, 599
bulky phosphines and *N*-heterocyclic carbenes, 574–582
- Migrating groups, Baeyer-Viliger oxidation, 163–167
(+)-Milbemycin D, Rubottom oxidation, 288
(-)-Miltactone, Luche reduction, 116–119
- Mitochondrial complex, Sharpless asymmetric hydroxylation reactions, 78–80
- Mitsunobu reaction:
Fukuyama amine synthesis, 426
chemoselectivity, 433
limitations and side products, 430–432
secondary and differentially protected amines, 427–428
total synthesis reactions, 429–430
Gabriel synthesis, 445–447
Luche reduction, cyclic stereocontrol, 115
“Modified” Oppenauer oxidation, 270
- Momilactone, Woodward *cis*-dihydroxylation, 330–331
- Mono-arylation, Buchwald-Hartwig amination, 575–582
- Monobenzyl alcohols, Gribble reduction, 95–96, 98–100
- Mono-dentate phosphines, Buchwald-Hartwig amination, 567–569, 579–582
aromatic heterocycles, 588
- Monoisopinocampheylborane, Brown hydroboration reaction, 185
- Monomethylamines, Staudinger reaction, one-pot transformations, 135–136
(+)-Monomorine, Wacker-Tsuji oxidation, 324
- Mono-nitrobenzenesulfonamides, Fukuyama amine synthesis, 424
- Monooxygenases (MOs), Baeyer-Viliger oxidation, 173–178
- Monopyrrolinone-base HIV-1 protease inhibitors, Martin’s sulfurane dehydrating reagent, 254–256
- Montmorillonite KSF clay, Strecker amino acid synthesis, 480
- Morpholino sulfide, Corey-Kim oxidation, 209
- Mukaiyama aldol reaction, Corey-Bakshi-Shibata (CBS) reduction, 14–15
- Mukaiyama esterification:
basic principles, 462
experimental procedures, 469
historical perspective, 462–463
synthetic utility, 465–469
variations and improvements, 463–465
- (±)-Mycopoxydiene, Zaitsev elimination, 419
- Myer’s conditions, decarboxylative Ramberg-Bäcklund reaction, 390
(-)-Myrtalenol, Shapiro reaction, 410–411

- NADP, Baeyer-Viliger oxidation, 174–178
- NaHMDS, Davis oxaziridine reagents,
enantioselective oxidation, 34–36
- Naphthols, Gribble reduction, 101–102
- Natural products:
biological Haloform reaction, 617–618
Ramberg-Bäcklund reaction, 399–402
Wacker-Tsuji oxidation, 321–322
Zaitsev elimination, 419–420
- Nazumamide A, Yamada reactions, 524–525
- N*-Chlorosuccinimide (NCS), Corey-Kim
oxidation, 207
- Nef reaction:
basic principles, 645
historical perspective, 645
levulinonitrile, 650–651
mechanism, 646
octanal, 651
synthetic utility, 648–650
variations and improvements, 646–648
- Neocarzinostatin chromophore, Martin's
sulfurane dehydrating reagent, 258–259,
261–262
- Neomycin, Staudinger reaction, 138–142
- Neurokinin-1 (NK1) receptor antagonist,
Strecker amino acid synthesis, 494–495
- Neuronal cell death, Corey-Bakshi-Shibata
(CBS) reduction, 17–18
- N*-Heterocyclic carbenes (NHC), Buchwald-
Hartwig amination, 581–582
- Nitration, Regitz diazo reactions, 674
- Nitrilium ion, Ritter reaction, 471–472
- Nitroalkanes, Nef reaction, 645, 646–649
- Nitrogen-aryl bond, Buchwald-Hartwig
amination, 564
- Nitrogen atoms, Gribble reduction of aryl
ketones and, 98–99
- Nitrogen heterocycles, Fukuyama amine
synthesis, 428–429
- Nitrogen-hydrogen insertion, Regitz diazo
reactions, 684
- Nitrogen source, Sharpless asymmetric
hydroxylation reactions, 75–77
- Nitro-Hunsdiecker reaction, 627
- Nitroindole, Regitz diazo reactions, 683
- Nitronate salts, Nef reaction, 646
- Nitro-palladium complex, Wacker-Tsuji
oxidation, 311–314
- Nitrosonium tetrafluoroborate, Balz-Schiemann
reaction, 554–555
- Nitroso species, Nef reaction, 646–647
- Nitrosulfone, Nef reaction, 650
- Nitrosyl cation, Balz-Schiemann reaction, 553
- Nitrous acid, Balz-Schiemann reaction, 553
- Nonracemic oxaziridines, Davis oxaziridine
reagents, 26–29
substrate-directed diastereoselective
hydroxylation, 29–33
- Norepinephrine reuptake antagonists (NETs),
Corey-Bakshi-Shibata (CBS) reduction,
17–18
- Norneolignans, Martin's sulfurane dehydrating
reagent, 253–256
- Norsuaveoline, Yamada reactions, 503
- Nosyl deprotection and functionalization,
Fukuyama amine synthesis, 434
- Noyori catalytic asymmetric hydrogenation:
5-benzyloxy-3-hydroxy-pentanoic acid tert-
butyl ester, 64
description, 46–47
historical perspective, 47
mechanism, 48–53
synthetic utility, 56–53
(β -acylamino) acrylates, 58
dehydroamino acid derivatives, 56–57
dynamic kinetic resolution, 62–63
enamide hydrogenation, 57–58
enol esters, 59
imines, 62
ketones, 61–62
 α,β -unsaturated carbonyls, 59–60
unsaturated alcohols, 60
variations and improvements, 53–56
*n-p** stabilization, Prilezhaev reaction, 275
- ^{11}B Nuclear magnetic resonance, Corey-Bakshi-
Shibata reduction, 4
- Nucleophilic addition:
Gabriel synthesis, 447–448
Regitz diazo reactions, 677
Yamada reactions, 500
- Nucleophilic attack:
Corey-Winter olefin synthesis, 355
Fischer-Speier esterification, 459
Ritter reaction, 471–472
Staudinger reaction mechanism, 129–130
Wacker-Tsuji oxidation, 310–311
- Oct-2-en-4-one, Oppenauer oxidation, 272

- Octanal, Nef reaction, 651
- Octatrienol, Oppenauer oxidation, 268–269
- Odorless conditions, Swern oxidation, 294
- Ogialoro modification, Perkin reaction, 364
- Olefination, nitro-Hunsdiecker reaction, 627
- Olefin 39, Brown hydroboration reaction, 188
- Olefination:
- Chugaev elimination:
 - basic principles, 334
 - (4a,*S*,6*R*,7*S*,7a*R*,11a*R*,2'*S*,3a'*R*,6a')-7-(hexahydrofuro[2,3-*b*]furan-2'-yl)-3,3,6,7-tetramethyl-11-methyleneoctahydronaphtho[1,8a-*d*][1,3]dioxine, 341
 - historical perspective, 334–335
 - mechanisms, 335
 - synthetic utility, 335–340
 - primary alcohols, 335–336
 - secondary alcohols, 336–339
 - tertiary alcohols, 339–340
 - variations, 340–341
 - Cope elimination reaction:
 - basic principles, 343
 - historical perspective, 343
 - mechanisms, 344
 - synthetic utility, 344–347
 - acyclic amines, 344–345
 - cyclic amines, 345–347
 - heterocyclic amines, 347
 - 1*L*-(1,4/5)-3,4,5-tri-*O*-benzyl-1-(((*tert*-butyl)diphenylsilyloxy)methyl)cyclopent-2-ene-3,4,5-triol, 352
 - variations, 347–352
 - base-catalyzed elimination, 348
 - reverse elimination, 348–349
 - silva-Cope elimination, 350–351
 - solid-phase linker cleavage, 350
 - unsymmetrical hydroxylamines, 347–348
 - Corey-Winter olefin synthesis:
 - basic principles, 354
 - trans*-3,4-Didehydro-3,4-dideoxy,1,2,5,6-di-*O*-isopropylidene-*D*-threo-hexitol, 361
 - didehydrostemofoline, 360–361
 - historical perspective, 354–355
 - mechanism, 355–356
 - synthetic utility, 357–360
 - variations and improvements, 356–357
 - Perkin reaction:
 - basic principles, 363
 - cinnamic acid preparation, 367
 - historical perspective, 363
 - mechanisms, 363–364
 - synthetic utility, 365–367
 - variations, 364–365
 - Perkow reaction:
 - basic principles, 369
 - historical perspective, 369
 - mechanism, 369–370
 - synthetic utility, 375–384
 - agrochemicals, 381–384
 - C*-alkylation, 377–378
 - double reaction, 379–380
 - β -ketophosphonate rearrangement, 375–377
 - pharmaceuticals, 380–381
 - phosphate to alkene reductive removal, 378–379
 - ring enlargement, 380
 - α -trifluoromethylated ketones, 379
 - variations and improvements, 370–375
 - Ramberg-Bäcklund reaction:
 - basic principles, 386
 - Chan modification, 402–403
 - (+)-(1*S*,2*R*,3*R*,4*R*)-2,3-diazido-1,4-dimethoxycyclohex-5-ene, 403
 - historical perspective, 386
 - mechanism, 386–387
 - Myers modification, 403
 - (1*E*,3*E*,5*E*,7*E*)-1-phenyl-8-trimethylsilyl-1,3,5,7-octatetraene, 403
 - synthetic utility, 391–402
 - cyclobutenes, 391–392
 - cyclohexenes and phenanthrene, 393–395
 - cyclopentenes, cyclopentenones, and cyclopentadienes, 392–393
 - dienes, enynes, and polyenes, 398–399
 - large ring systems, 395–397
 - natural products, 399–402
 - variations and improvements, 387–391
 - Zaitsev elimination:
 - basic principles, 414
 - 3,3-dimethylcyclobut-1-ene, 420
 - historical perspective, 414
 - mechanisms, 415–417
 - synthetic utility, 418–420
 - dehydrohalogenation, acyclic halides, 418
 - natural products, 419–420

- Olefination (*continued*)
 strained ring systems, 418
 variations and improvements, 417–418
- Olefins:
 Dess-Martin periodinane oxidation, 235–236
- Shapiro reaction:
 basic principles, 405
 historical perspective, 405
 mechanism, 405–407
 3-Methylcyclohexene-2-carboxaldehyde, 412
 regiochemistry and alkene stereochemistry, 406–407
 synthetic utility, 410–412
 variations and improvements, 407–410
- Wacker-Tsuji oxidation, palladium-assisted intramolecular amination, 315–318
- O-Methyl oximes, Dess-Martin periodinane oxidation, 235
- One-pot transformations:
 Dess-Martin periodinane oxidation, 231–235
 Gabriel synthesis, 442
 Perkow reactions, 377–378
 Ramberg-Bäcklund reaction, 387–391
 Shapiro reaction, 408–409
- Staudinger reaction:
 amines, 134–135
 monomethylamines, 135–136
 tandem Staudinger/aza-Wittig carbonyl reactions, 136
- Swern oxidation, 293–294
- Oppenauer oxidation:
 basic principles, 265
 cascade reactions, 271–272
 catalytic process, 270–271
 cis- α -decalol, 272
 historical perspective, 265–266
 mechanisms, 266
 Meerwein-Ponndorf-Verley reduction, 123–126
 modified process, 270
 synthetic utility, 266–270
 polyhydroxyl compounds, 269
 primary alcohols, 269–270
 saturated alcohols, 266–268
 unsaturated alcohols, 268–269
- Optical purity improvements, Corey-Bakshi-Shibata (CBS) reduction, 12–15, 18
- Ortho effect, Baeyer-Viliger oxidation, 163–167
- Osmaoxetane, Sharpless asymmetric hydroxylation reactions, 69
- Osmium azaglycolate, Sharpless asymmetric hydroxylation reactions, 79–80
- Osmium tetroxide, Sharpless asymmetric hydroxylation reactions, 67–81
- OSW-1 antitumor agent, Dess-Martin periodinane oxidation, 229
- Over-oxidation:
 Dess-Martin periodinane oxidation, 219
 single electron transfer mechanism, 226–228
 Oppenauer oxidation, primary alcohols, 269–270
- Oxazaborolidine catalyst:
 Corey-Bakshi-Shibata (CBS) reduction:
 borane and, 2
 fluorous versions of, 8–15
 modifications and improvements, 7–15
 polymer-bound versions, 9–15
 proline pre-catalysts, 11–15
 stereoselectivity improvements, 6–15
 valinol-based modification, 13–15
 Corey-Bakshi-Shibata reduction, mechanism of, 3–6
- Oxazaphospholidine, Perkow reaction, 375
- Oxaziridine:
 Baeyer-Viliger oxidation, 171–172
- Davis reagents:
 basic properties, 22
 (–)-(R)-2-Ethyl-5,8-dimethoxy-2-hydroxyl-1,2,3,4-tetrahydronaphthalen-1-one, 37–38
 historical perspective, 22–23
 mechanistic interpretations, 23–25
 synthetic utility, 25–37
 asymmetric oxidation via chiral auxiliaries, 25–29
 enantioselective oxidation, 33–37
 substrate-directed diastereoselective hydroxylation, 29–33
- Oxazoldine-2-ones, Mukaiyama esterification, 468
- Oxazoles, Burgess dehydrating reagent, 195
- Oxazolidine, Regitz diazo reactions, 674
- Oxazolidinones:
 Buchwald-Hartwig amination, 601
 Dess-Martin periodinane oxidation, 227–228
 Staudinger reaction, 141

- Oxazolines:
Burgess dehydrating reagent, 195
Martin's sulfurane dehydrating reagent, 252
- Oxetanes, Martin's sulfurane dehydrating reagent, 251
- Oxidation reactions:
Baeyer-Viliger oxidation:
 basic principles, 160
 enzyme catalysis, 173–178
 5-ethoxycarbonyl-5-(*n*-undecyl)- δ -valerolactone, 180–181
 general mechanisms, 162–163
 historical perspective, 160–162
 metal catalysis, 168–172
 migrating group mechanism, 163–167
 synthetic utility, 178–180
 variations and improvements, 167–178
- Brown hydroboration reaction:
 basic principles, 183
 historical perspective, 183
 mechanism of, 183
 synthetic utility, 185–188
 tricycle 39 experiment, 188
 variations and improvements, 184–185
- Burgess dehydrating reagent:
 basic principles, 189
 historical perspective, 189–190
 mechanism, 190–192
 secondary and tertiary alcohol dehydration, 203–204
 toluene agents, 205
 variations, improvements, and synthetic utility, 192–203
- Cope elimination, solid-phase linkers, 350
- Corey-Kim oxidation:
 basic principles, 207
 historical perspective and improvements, 207–211
 mechanisms, 210–211
 synthetic utility, 211–216
 aldehyde/ketone preparation, 211–212
 benzyl/allyl halide preparation, 212–213
 dicarbonyl preparation, 213–214
 epi-45 synthesis, 216
 hydroxylketones and diketones, 214–216
 recyclable compounds, 217
- Dess-Martin periodinane oxidation:
 basic principles, 218
 historical perspective, 218–219
 mechanisms, 219–220
 synthetic utility, 228–235
 variations and improvements, 220–228
- Martin's sulfurane dehydrating reagent:
 basic principles, 248
 historical perspective, 248–249
 mechanisms of, 249–250
 (2'*S*,3'*S*)-Methyl-3-*O*-*t*-butyldimethylsilyl-4-*O*,5-*O*-(2,'3')-dimethoxybutane-2,'3'-diyl-shikimate, 263
 synthetic utility, 253–262
 acyclic alkenes, 253–256
 acyclic dienes, 256–258
 alkene ring structures, 258–262
 variations and improvements, 250–251
- Oppenauer oxidation:
 basic principles, 265
 cascade reactions, 271–272
 catalytic process, 270–271
 cis- α -decalol, 272
 historical perspective, 265–266
 mechanisms, 266
 Meerwein-Ponndorf-Verley reduction, 123–126
 modified process, 270
 synthetic utility, 266–270
 polyhydroxyl compounds, 269
 primary alcohols, 269–270
 saturated alcohols, 266–268
 unsaturated alcohols, 268–269
- Prilezhaev reaction:
 basic principles, 274
 historical perspectives, 274
 mechanism, 274–275
 synthetic utility, 278–279
 1,1,1-trifluoro-2-ethoxy-2,3-epoxy-5-phenylpentane, 280
 variations and improvements, 275–276
- Rubottom oxidation:
 basic principles, 282
 enolate oxidation, 23
 historical perspectives, 282–284
 6-hydroxy-3,5,5-trimethyl-2-cyclohexen-1-one, 289
 stereochemistry, 284–285
 synthetic utility, 287–289
 variations and improvements, 285–287
- Swern oxidation:
 basic principles, 291

- Oxidation reactions (*continued*)
- Dess-Martin periodinane oxidation, 229–230
 - 4-(2,2-dibromovinyl)-5-[3-(4-methoxybenzyloxy)-propyl]-2,2-dimethyl-[1,3]-dioxolane, 306–307
 - historical perspective, 291–292
 - mechanisms, 292–293
 - synthetic utility, 299–306
 - variations, 293–299
- Tamao-Kumada-Fleming oxidation:
- basic principles, 237
 - historical perspective, 237–238
 - (2-hydroxymethyl-6-vinyl-1-azaspiro[4.5]dec-1-yl)-phenylmethanone, 246
 - mechanism, 238–239
 - synthetic utility, 240–246
 - variations and improvements, 239–240
- Woodward *cis*-dihydroxylation:
- basic principles, 327
 - dl-anti-trans*-4,4a,4b,5,8,8a-Hexahydro-1,8a-dimethyl-6 β -7 β -dihydroxy-2(3*H*)-phenanthrene, 331–332
 - historical perspectives, 327–328
 - mechanism, 328
 - synthetic utility, 330–332
 - variations and improvements, 329–330
- N*-Oxidation reactions, Baeyer-Viliger oxidation, 167–168
- S*-Oxidation reactions, Baeyer-Viliger oxidation, 167–168
- Oxidation-reduction process, Sommelet reaction, 690
- Oxidative addition, Buchwald-Hartwig amination, 566, 573–574
- aryl chlorides, 583–585
- Oxidative cleavage:
- Nef reaction, 649
 - Tamao-Kumada-Fleming oxidation, 237
- Oxidative cyclization, Wacker-Tsuji oxidation, 316–318
- α -Oximation, Regitz diazo reaction, 664–667
- Oximes:
- Corey-Bakshi-Shibata (CBS) reduction, 10–15
 - Dess-Martin periodinane oxidation, 235
 - Nef reaction, 646–650
- Oxiranes, Prilezhaev reaction, 274
- Oxone:
- Baeyer-Viliger oxidation, 161
 - metal catalysis, 171–172
 - Dess-Martin periodinane oxidation, 2-iodoxybenzoic (IBX), 221–223
 - Rubottom oxidation, 286–287
- Oxonium species, Corey-Kim oxidation, 210–211
- Oxosulphonium ylide, Swern oxidation, 296
- α -Oxygenation, Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 30–33
- ¹⁸Oxygen tracer experiment, Baeyer-Viliger oxidation, 161–162
- Ozonolysis:
- Krapcho decarboxylation, 641
 - Strecker amino acid synthesis, 493
- Paclitaxel, Corey-Bakshi-Shibata (CBS) reduction, 16–18
- Palladacycles, Buchwald-Hartwig amination, aryl chlorides, 583–585
- Palladium-amido intermediate, Buchwald-Hartwig amination, 568–569
- Palladium catalysts:
- Buchwald-Hartwig amination, 564–567
 - arylation, 599–600
 - Wacker-Tsuji oxidation, 310–311
 - oxidative cyclization, 317–318
- Palladium-catalyzed amidation reaction, Wacker-Tsuji oxidation, 320–321
- Palladium-copper heterometallic complex, Wacker-Tsuji oxidation, 310–311
- Palytoxin, Luche reduction, 116–119
- Parikh-Doering protocol, Swern oxidation and, 298
- Pavoninin-5, Luche reduction, 119
- Pentacoordinate silicon geometry, Tamao-Kumada-Fleming oxidation, 239
- Pentamethyldisiloxane (PMDS), Tamao-Kumada-Fleming oxidation, 240
- Peptides, Yamada reactions, 515–519
- Peracids, Prilezhaev reaction, 274
- Perhydropyrimidin-4-one template, Davis oxaziridine reagents, 32–33
- Pericyclic, *syn* elimination, Chugaev elimination, 335
- Perkin reaction:
- basic principles, 363

- cinnamic acid preparation, 367
historical perspective, 363
mechanisms, 363–364
synthetic utility, 365–367
variations, 364–365
- Perkow reaction:
basic principles, 369
historical perspective, 369
mechanism, 369–370
synthetic utility, 375–384
 agrochemicals, 381–384
 C-alkylation, 377–378
 double reaction, 379–380
 β -ketophosphonate rearrangement, 375–377
 pharmaceuticals, 380–381
 phosphate to alkene reductive removal,
 378–379
 ring enlargement, 380
 α -trifluoromethylated ketones, 379
 variations and improvements, 370–375
- Peroxydicarboxylic acid esters, Yamada reactions,
502
- Peroxy radical intermediate, Baeyer-Viliger
oxidation, metal catalysis, 169–172
- Petasis reaction, Strecker amino acid synthesis,
482–483
- Pfitzner-Moffatt oxidation, Swern oxidation and,
298
- PHAL-based ligands, Sharpless asymmetric
hydroxylation reactions, 72–77
- [2.2]-PHANEPHOS ligand, Noyori catalytic
asymmetric hydrogenation, 55–56
- Pharmaceutical syntheses, Perkow reaction,
380–381
- Phase tagging, Tamao-Kumada-Fleming
oxidation, 244
- Phase transfer catalysts:
 Hunsdiecker reaction, 627
 Regitz diazo reaction, 664–667
 Yamada reactions, diamide, 504
 Zaitsev elimination, 417
- Phenanthrene, Ramberg-Bäcklund reaction,
393–395
 ring structures, 397
- Phenanthryl ether, Sharpless asymmetric
hydroxylation reactions, 71–77
- Phenethylamine, Dess-Martin periodinane
oxidation, 232–235
- R*-(+)*S*-(-)- α -Phenethylamine-borane complexes,
 asymmetric reduction, 3
Phenylacetone monooxygenase (PAMO),
 Baeyer-Viliger oxidation, 173–178
 β -Phenylalanine methyl ester, reduction
 reactions, 3
(*R*)-1-Phenylethanol, Corey-Bakshi-Shibata
 reduction, 4
trans-(\pm)-2-(Phenylsulfonyl)-3-
 phenyloxaziridine, enolate oxidation, 22
(1*E*,3*E*,5*E*,7*E*)-1-Phenyl-8-trimethylsilyl-1,3,5,7-
 octatraene, Meyers-Chan modification,
 Ramberg-Bäcklund reaction, 403
Phe-Phe-Phe-difluorostatone-Leu-Phe-NH₂,
 Yamada reactions, 529
Phorboxazoles, Martin's sulfurane dehydrating
 reagent, 253–256
Phosphamidon, Perkow reaction, 382
Phosphatase inhibitors, Yamada reactions, 536
Phosphates:
 monodentate ligands, Noyori catalytic
 asymmetric hydrogenation, 4950
 Perkow reactions, alkene reductive removal,
 378–379
Phosphazides, Staudinger reaction mechanism,
129–130
Phosphinates, Perkow reaction, 377–378
Phosphine oxide:
 Fukuyama amine synthesis, 432
 Staudinger reaction, 129–131
 variations for removal, 132–133
Phosphines, Buchwald-Hartwig amination:
 bulky phosphines, 574–582
 chelating phosphines, 569–574
 mono-dentate phosphines, 567–569
Phosphinic acid, Woodward *cis*-dihydroxylation,
329–330
Phosphite:
 Corey-Winter olefin synthesis, 354
 Perkow reaction, 370–375
Phosphoamidites, Noyori catalytic asymmetric
 hydrogenation, 49–50
Phosphoenolpyruvates, Perkow reaction,
372–373
Phospholidine, Corey-Winter olefin synthesis,
360
 α -Phosphonate esters, Perkow reaction, 377
Phosphonates:
 Perkow reaction, 369
 C-alkylation cleavage of, 377–378

- Phosphonates (*continued*)
 Sommelet reaction, 693–694
 Phosphonites, Perkow reaction, 370–375
 Phosphono compounds, Regitz diazo reactions, 661–662
 Phosphoramidate, Gabriel synthesis, 443–444
 Phosphoranes, Dess-Martin periodinane oxidation, 231–235
o-Ph-HexaMeO-Biphep, Noyori catalytic asymmetric hydrogenation, 53–56
 Phosphorus ligands, Noyori catalytic asymmetric hydrogenation, 58
 Phosphorus ylide, Corey-Winter olefin synthesis, 355
 Phosphorylation, Perkow reaction, 371–372
 agrochemicals, 383
 Photoactivatable redox protein, Yamada reactions, 514–515
 Photo-induced addition:
 Balz-Schiemann reaction, 555–556
 Ramberg-Bäcklund reaction, eneynes, 398–399
 Photolysis:
 Ramberg-Bäcklund reaction, 398–399
 Regitz diazo reactions, 674, 679–681
 Phthalazine, Sharpless asymmetric hydroxylation reactions, 72–77
 Phthalimide, Gabriel synthesis, 438
 alternative reagents, 444–445
 hydrazinolysis, 441–442
 variations and modifications, 440–446
 Phytoalexin, Luche reduction, 115–119
 Phytuberin, Luche reduction, 115–119
 Pictet-Spengler reaction, Eschweiler-Clark reductive alkylation of amines, 91
 Pinacol rearrangement, Rubottom oxidation, 284
 α -Pinene, hydroboration, Midland reduction, 40–41
 (–)- β -Pinene, Corey-Bakshi-Shibata (CBS) reduction, catalyst modification, 7–15
 (\pm)-Pinnaic acid, Mukaiyama esterification, 469
 π -Bond complex, Sharpless asymmetric hydroxylation reactions, 71
 π -Excessive/deficient heterocycles, Gribble reduction and deoxygenation, 104
 pK_a values, Krapcho decarboxylation, 635
 P,N-ligand, Buchwald-Hartwig amination, 581–582, 585
 Polarity reversal, Nef reaction, 645
 P,O-ligand, Buchwald-Hartwig amination, 585
 Polyamides, Haloform reaction, 617
 Polyamines, Eschweiler-Clark reductive alkylation of amines, 87
 Polychlorination, Ramberg-Bäcklund reaction, Meyers modification, 387–388
 Polyenes, Ramberg-Bäcklund reaction, 398–399
 Polyethylene glycol (PEG):
 Burgess dehydrating reagent, 195–196
 Staudinger reaction, triphenylphosphine resin, 133
 Polyhydroxyl compounds, Oppenauer oxidation, 269
 Polymer-based PHAL derivatives, Sharpless asymmetric hydroxylation reactions, 76–77
 Polystyrene benzenesulfonyl azide, Regitz diazo reactions, 686
 Porcine motilin, Yamada reactions, 516
 (–)-Pramanicin, Tamao-Kumada-Fleming oxidation, 245
 Prazoicin, Yamada reactions, 509
 Precatalysts:
 Corey-Bakshi-Shibata (CBS) reduction, preparation of, 8–15
 Noyori catalytic asymmetric hydrogenation, 51–53
 Prerester molecule, Martin's sulfurane dehydrating reagent, 248
 Prévost reaction, Woodward *cis*-dihydroxylation, 329–330
 Prilezhaev reaction:
 basic principles, 274
 historical perspectives, 274
 mechanism, 274–275
 synthetic utility, 278–279
 1,1,1-trifluoro-2-ethoxy-2,3-epoxy-5-phenylpentane, 280
 variations and improvements, 275–276
 Primary stereoelectronic effect, Baeyer-Villiger oxidation, 165
 Prins reaction:
 basic principles, 653
 historical perspective, 653
 mechanism, 653–654
 synthetic utility, 655–656
 (\pm)-(2 α ,3 α ,5 α)-1-(tetrahydro-2-methyl-5-phenethylfuran-3-yl)ethanone, 657
 variations and improvements, 654–655

- Prochiral starting material, Noyori catalytic asymmetric hydrogenation, 46–47
- Progesterone, Oppenauer oxidation, 268–269
- Proline pre-catalysts, Corey-Bakshi-Shibata (CBS) reduction, oxazaborolidine, 11–15
- Propargylic alcohol, Midland reduction, 44
- Propionaldehyde, Midland reduction, 44
- Prostaglandins:
Corey-Bakshi-Shibata (CBS) reduction, 14–15
synthetic utility, 15–18
Wharton reaction, 157
- Protonation, Fischer-Speier esterification, carbonyl oxygen, 459
- Proton transfer, Fischer-Speier esterification, 459
- Pseudo axial addition:
Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 29–33
hydride, Luche reduction, cyclic stereocontrol, 114–119
- Pseudobactin, Burgess dehydrating reagent, 193
- Pseudopeptides, Yamada reactions, 528
- (+)-Pulegone, Luche reduction, 116
- Pulmonary disease, endothelins, Corey-Bakshi-Shibata (CBS) reduction, 18
- Pyrankacin, Staudinger reaction, 138–142
- Pyrazole ring formation, Regitz diazo reactions, 684
- (2-Pyridyldimethylsilyl)methyl lithium, Tamao-Kumada-Fleming oxidation, 244
- Pyrimidines, Leuckart-Wallach reaction, 454–455
- Pyrimidobenzoxathiepin derivative, Yamada reactions, 509
- PYR ligands, Sharpless asymmetric hydroxylation reactions, 76–77
- Pyrolysis:
Chugaev elimination:
secondary alcohols, 336–339
variations, 340–341
Cope elimination reaction, 343
xanthates, Chugaev elimination, 334
- Pyrrrole:
Gribble reduction, 100
Regitz diazo reactions, 684
- Pyrrolidine azasugar, Sharpless asymmetric hydroxylation reactions, 778
- (+)-(S)-2-Pyrrolidinemethanol chiral auxiliary, Davis oxaziridine reagents, 25–29
- Pyrrolizidine natural products, Baeyer-Viliger oxidation, 174–178
- Pyrrolopyrimidine antifolate, Yamada reactions, 536–537
- Q-phos ligands, Buchwald-Hartwig amination, 579–582
aryl chlorides, 585
- Quasiphosphonium compound, Perkow reaction, 373–375
- Quaternisation, Eschweiler-Clark reductive alkylation of amines, avoidance of, 90
- Quinazoline folic acid analogs, Yamada reactions, 531–539
- Quinoid-like intermediate, aromatic methylation of anilines, 89
- Quinolone, Davis oxaziridine reagents, enantioselective oxidation, 34–36
- Quinone compounds:
Baeyer-Viliger oxidation, 178–179
Dess-Martin periodinane oxidation, 233–235
- Quinone-linked porphyrin, Gribble reduction and deoxygenation, 104–105
- Racemization:
Krapcho decarboxylation, 641
Noyori catalytic asymmetric hydrogenation, enantiomers, 62–63
Yamada reactions, peptides, 516–519
- rac*-MOP ligands, Buchwald-Hartwig amination, 600
- Radical cyclization, Tamao-Kumada-Fleming oxidation, 242–243
- Radical initiation, Hunsdiecker reaction, 626
- Radical intermediates, Meerwein-Ponndorf-Verley reduction, 124
- Radical polymerization, Yamada reactions, 502
- Radiolabeled compounds:
fluoride-18, Balz-Schiemann reaction, 556–559
Krapcho decarboxylation, 639
- Ramberg-Bäcklund reaction:
basic principles, 386
Chan modification, 402–403
(+)-(1*S*,2*R*,3*R*,4*R*)-2,3-diazido-1,4-dimethoxycyclohex-5-ene, 403
historical perspective, 386
mechanism, 386–387
Myers modification, 403

- Ramberg-Bäcklund reaction (*continued*)
(1E,3E,5E,7E)-1-phenyl-8-trimethylsilyl-1,3,5,7-octatetraene, 403
synthetic utility, 391–402
cyclobutenes, 391–392
cyclohexenes and phenanthrene, 393–395
cyclopentenes, cyclopentenones, and cyclopentadienes, 392–393
dienes, enynes, and polyenes, 398–399
large ring systems, 395–397
natural products, 399–402
variations and improvements, 387–391
- Raney-nickel compounds, Nef reaction, 648
- Rate-determining step, Haloform reaction, 611–612
- Redox co-catalyst, Wacker-Tsuji oxidation, 309
- Reduction reactions:
Corey-Bakshi-Shibata (CBS) reduction:
allylic alcohol, 19
(*R*)-1-(3'-bromophenyl)-ethanol, 19
historical perspective, 2–3
ketone reductions, 2
mechanism, 3–6
synthetic utility, 15–18
variations, improvements, and modifications, 6–15
- Eschweiler-Clark reductive alkylation:
of amines:
 α -amino amides, 89
aromatic aniline methylation, 89
basic principles, 86
5-bromo-1,4,6-trimethyl-2,3-dihydro-1H-pyrrolo[2,3b]pyridine, 92
cyclic aminol ethers to *n,n*-dialkylamino derivatives, 88–89
historical perspective, 86
mechanisms of, 86–87
N-alkylation of amides, 87–88
solvent- and formaldehyde-free conditions, 88
synthetic utility, 90–92
carbonyl compounds, 451
- Gribble reduction, diaryl ketones:
basic principles, 93
historical perspective, 93–94
hydrogen gas liberation, 107–108
mechanism, 94–96
synthetic utility, 99–107
variations and improvements, 96–99
- Luche reduction:
acyclic stereocontrol, 119–120
basic principles, 112
cyclic stereocontrol, 114–119
historical perspective, 112–113
mechanism, 113
methyl-(3*aS*,4*S*,6*aR*)-4,6a-dihydro-4-hydroxy-2,2-dimethyl-3*aH*-cyclopenta[*d*][1,3]-dioxol-6-yl)acetate, 120–121
regioselectivity, 113–114
synthetic utility, 113–120
- Meerwein-Ponndorf-Verley reduction:
basic principles, 123
dione, 127
historical perspective, 123
ketones, samarium-catalyzed reactions, 127–128
mechanisms, 123–124
synthetic utility, 126–127
variations and improvements, 124–126
- Noyori catalytic asymmetric hydrogenation:
5-benzyloxy-3-hydroxy-pentanoic acid tert-butyl ester, 64
description, 46–47
historical perspective, 47
mechanism, 48–53
synthetic utility, 56–53
(β -acylamino) acrylates, 58
dehydroamino acid derivatives, 56–57
dynamic kinetic resolution, 62–63
enamide hydrogenation, 57–58
enol esters, 59
imines, 62
ketones, 61–62
 α,β -unsaturated carbonyls, 59–60
unsaturated alcohols, 60
variations and improvements, 53–56
- Staudinger reaction:
amine 53 preparation, 148
basic principles, 129
historical perspective, 129
mechanisms, 129–131
one-pot transformations:
amines, 134–135
monomethylamines, 135–136
tandem Staudinger/aza-Wittig carbonyl reactions, 136
phosphine oxide removal, 132–134

- synthetic utility, 136–147
 - primary amine preparation, 137–142
 - tandem intramolecular Staudinger/aza-Wittig imine formation, 142–147
 - variations and improvements, 131–136
- Wharton reaction:
 - basic principles, 152
 - historical perspective, 152
 - 6-hydroxy-10-triethylsilyloxy-1-oxaspiro[4,5]dec-7-en-2-one, 157–158
 - mechanisms, 152–153
 - synthetic utility, 155–157
 - variations and improvements, 153–155
- Reductive amination, Leuckart-Wallach reaction, 454–455
- Reductive desulfurization, Corey-Kim oxidation, 214
- Reductive elimination:
 - Buchwald-Hartwig amination, 566
 - Wacker-Tsuji oxidation, 315–318
- Regiochemistry:
 - Shapiro reaction, 405–407
 - Wacker-Tsuji oxidation, anti-Markovnikov products, 311–314
- Regioselectivity:
 - Brown hydroboration reaction, 184–185
 - Fukuyama amine synthesis, 432
 - Lucho reduction, 113–114
 - Staudinger reaction, primary amine preparation, 138–142
 - Wacker-Tsuji oxidation, heteroatom coordination theory, 319–321
 - Yamaguchi esterification, 547–549
- Regitz diazo reactions:
 - basic principles, 658
 - diazo dihexyl ketone, 685
 - 2-diazo-1-phenyl-butane-1,3-dione, 686
 - 1,4-dimethyl-5,6,8,9-tetrahydro-6-diazo-7H-benzo[a]cyclohepten-7-one, 686
 - historical perspective, 658
 - indene methyl ester, 686
 - mechanism, 658
 - synthetic utility, 674–685
 - acylation, 675
 - aldol type addition, 675
 - cyclic ketone addition, 677
 - diazo 1,3-diketone reduction to diazo hydroxyketones, 677–678
 - diazo 1,3-ketone addition to α,β -unsaturated ketones, 675–676
 - electrono-rich alkene addition, 675
 - elimination, 682
 - halogenation, 674
 - heterocycles, 684–685
 - hydrogenation, 679
 - metalation, 674–675
 - nitration, 674
 - rhodium-mediated intramolecular C-H insertion, 682–684
 - ring cleavage reactions, 679
 - silylation, 678–679
 - sulfeneamine addition, 676–677
 - Wolff rearrangement, 679–682
- tricyclic α -keto ester, 686
- variations and improvements, 659–674
 - 2,4-bis-diazo-1,3,5-triketone, 673
 - dethyl diazo malonate, 660
 - diazo 1,3-diketones, 669–673
 - diazo alkenes and acetylenes, 659–660
 - diazo β -keto esters, 673
 - α -diazo ketones, 662–666
 - diazo methylene compounds, 659
 - diazo oxazolidone, 674
 - α -diazo phosphono compounds, 661–662
 - α -diazo sulfonyl compounds, 660–661
 - 1,2-diketones to diazoketones, 667–669
- Renin inhibitors, Yamada reactions, 527–529
- Reserpine, Prilezhaev reaction, 276–277
- Re/Si face selection, Noyori catalytic asymmetric hydrogenation, 48–49
- Resonance stabilization, Cope elimination reaction, 344
- Retention of configuration, Tamao-Kumada-Fleming oxidation, 237
- Retrohydroboration, Midland reduction, 42–43
- Retro-Michael addition, base-catalyzed Cope elimination, 348
- Reverse Cope elimination, basic principles, 348–349
- Rheumatoid arthritis therapies, Tamao-Kumada-Fleming oxidation, 242
- Rhodium complexes:
 - Noyori catalytic asymmetric hydrogenation:
 - basic principles, 46–47
 - BINAP-Rhodium combination, 48
 - BoPhos-Rh complex, 61–62
 - monodentate tertiary phosphine, 47
 - Regitz diazo reactions, 682–684

- Ring strain:
Gribble reduction of aryl ketones and alcohols to, 107
Zaitsev elimination, 418
- Ring structures:
Burgess dehydrating reagent, 199–203
 cationic rearrangement, 204
 avis oxaziridine reagents, 24
Luche reduction, 118–119
Martin's sulfurane dehydrating reagent, alkenes:
 5-membered rings, 261–263
 6-membered rings, 259–261
 8- and 9-membered rings, 258–259
Midland reduction, 44
oxazaborolidine, Corey-Bakshi-Shibata reduction, 4–5
Perkow reaction, enlargement of, 380
Ramberg-Bäcklund reaction:
 (+)-eremantholide, 401–402
 Meyers-Chan modification, 395–397
Regitz diazo reactions, 679, 680–682
 pyrazole ring formation, 684
Sharpless asymmetric hydroxylation reactions, 68–69
- Ritter reaction:
 basic principles, 471
 carbenium ion stabilization, 473
 cascade reactions, 474–475
 N-formyl- α,α -dimethyl- β -phenethylamine, 475–476
 heteroatom stabilization, 474
 historical perspective, 471
 mechanism, 471–472
 synthetic utility, 475
 transition metal stabilization, 473–474
 variations, 472
 weaker acids, rearrangement promotions, 472–473
- Rubottom oxidation:
 basic principles, 282
 enolate oxidation, 23
 historical perspectives, 282–284
 6-hydroxy-3,5,5-trimethyl-2-cyclohexen-1-one, 289
 stereochemistry, 284–285
 synthetic utility, 287–289
 variations and improvements, 285–287
- γ -Rubromycin, Nef reaction, 650
- Ruthenium complexes, Noyori catalytic asymmetric hydrogenation, 46–47
 5-benzyloxy-3-hydroxy-pentanoic acid tert-butyl ester, 64
 BINAP-ruthenium ligands, 47, 59–60, 61–63
 mechanisms of, 50–53
- Salen catalysts:
 asymmetric Strecker amino acid synthesis, 489–490
 Krapcho decarboxylation, 641–642
- Samarium compounds, Meerwein-Ponndorf-Verley reduction, 127–128
- (*S*)-1-Amino-2-methoxymethylpyrrolidine (SAMP):
 Krapcho decarboxylation, 640–641
 Strecker amino acid synthesis, 487–488
- (–)-Scabronine, Brown hydroboration reaction, 187–188
- Scandium triflate, Strecker amino acid synthesis, 480
- Schiemann reaction. *See* Balz-Schiemann reaction
- Schiff base:
 Eschweiler-Clark reductive alkylation of amines, 86–87
 Strecker amino acid synthesis, 490
- Secondary stereoelectronic effect, Baeyer-Viliger oxidation, 165
- Secretases, Corey-Bakshi-Shibata (CBS) reduction, 16–18
- SEGPPOS ligand, Noyori catalytic asymmetric hydrogenation, 54–56
- “Select flur” catalysts, Hunsdiecker reaction, 627
- Semi-synthesis reactions, Sharpless asymmetric hydroxylation reactions, 78–80
- Sequential Prins cyclization-pinacol rearrangement, 654–655
- Shapiro reaction:
 basic principles, 405
 historical perspective, 405
 mechanism, 405–407
 3-Methylcyclohexene-2-carboxaldehyde, 412
 regiochemistry and alkene stereochemistry, 406–407
 synthetic utility, 410–412
 variations and improvements, 407–410
- Sharpless asymmetric hydroxylation reactions:
 Baeyer-Viliger oxidation, 171–172

- basic principles, 67
(2*S*,3*R*)-*tert*-Butyl-2-hydroxy-3-(*N*-benzyloxycarbonyl)-aminobutanoate, 81
(2*R*)-4-(*N,N*-diethylcarbamoyloxy)-5,5-difluoropent-4-en-1,2-diol, 80
historical background, 67–68
mechanisms of, 68–71
Rubottom oxidation, 286–287
synthetic utility, 77–80
variations, improvements, or modifications, 71–77
- Shikimic acid, Martin's sulfurane dehydrating reagent, 260–261
- Sialyltransferase inhibitors, enantioselective oxidation, Davis oxaziridine reagents, 36
- α -donors, Buchwald-Hartwig amination, 580–582
- Sila-Cope elimination reaction, synthetic utility, 350–351
- Silica-anchored ligands, Sharpless asymmetric hydroxylation reactions, 75–77
- 1,4-Silicon migration, Rubottom oxidation, 283
- Silicon-tethered cycloaddition, Tamao-Kumada-Fleming oxidation, 243
- Silicon-tethered radical cyclization, Tamao-Kumada-Fleming oxidation, 242
- Silylation:
Regitz diazo reactions, 678–679
Tamao-Kumada-Fleming oxidation, 243
- Silyl enol ether:
Corey-Bakshi-Shibata (CBS) reduction, 15
Swern oxidation, 300–301
- Silyloxyoxirane, Rubottom oxidation, 283–284, 287
- Simonini reaction, Hunsdiecker reaction, 623
- Single electron transfer (SET) mechanism, Dess-Martin periodinane oxidation, 226–228
- SK-Phos ligands, Noyori catalytic asymmetric hydrogenation, 54–56
- S_N1 reaction:
Burgess dehydrating reagent, 191–192
Perkow reaction, 373–375
Rubottom oxidation, 283–284
- S_N2 reaction:
Burgess dehydrating reagent, 192
Corey-Kim oxidation, 210–211
Davis oxaziridine reagents, 24
Gabriel synthesis, 443
Hunsdiecker reaction, 623
Krapcho decarboxylation, 636, 639
Martin's sulfurane dehydrating reagent, 251–252
Perkow reaction, 369
Ramberg-Bäcklund reaction, natural products, 400–402
Rubottom oxidation, 283–284
- S_NAr reactions, Buchwald-Hartwig amination, 564
- Sodium borohydride-trifluoroacetic acid reduction. *See* Gribble reduction
- Sodium bromite, Haloform reaction, 612–614
- (+)-Solamin, Ramberg-Bäcklund reaction, 401
- Solanum* genus, Luche reduction, 115
- Solid-phase synthesis:
Cope elimination, 350
Fukuyama amine synthesis, 430
Yamada reactions, peptides, 515–519
- Solvent-free conditions, Eschweiler-Clark reductive alkylation of amines, 88, 90
- “Solventless” oxidation, Dess-Martin periodinane oxidation, 229
- Sommelet reaction:
basic principles, 689
2-(4-formylphenyl)-7-methoxy-4H-1-benzopyran-4-one, 694
historical perspective, 689
mechanism, 689–691
synthetic utility, 692–694
variations and improvements, 691–692
- (–)-Sparteine, Wacker-Tsuji oxidation, 318
- Spiroketal formation:
Corey-Bakshi-Shibata (CBS) reduction, 15
Nef reaction, 650
- Spirotryprostatin B, Martin's sulfurane dehydrating reagent, 256
- (+)-Spongistatin, Davis oxaziridine reagents, 33
- Staudinger reaction:
basic principles, 129
historical perspective, 129
mechanisms, 129–131
one-pot transformations:
amines, 134–135
monomethylamines, 135–136
tandem Staudinger/aza-Wittig carbonyl reactions, 136
phosphine oxide removal, 132–134
synthetic utility, 136–147
primary amine preparation, 137–142

- Staudinger reaction (*continued*)
 tandem intramolecular Staudinger/aza-Wittig imine formation, 142–147
 variations and improvements, 131–136
(-)-Stemospironine, tandem intramolecular Staudinger/aza-Wittig reaction, 143–147
- Stereochemistry:
 alkenes, Shapiro reaction, 405–407
 Chugaev elimination, tertiary alcohols, 339–340
 Midland reduction, 41–42
 Rubottom oxidation, 284–285
- Stereodifferentiation, Davis oxaziridine reagents, 25–29
- Stereoelectronic effects, Baeyer-Viliger oxidation, 165
- Stereoselectivity:
 Burgess dehydrating reagent, 189
 Corey-Bakshi-Shibata reduction, 6–15
 Davis oxaziridine reagents, 27–29
 Tamao-Kumada-Fleming oxidation, 246
- Steroid molecules:
 Luche reduction, 119
 Oppenauer oxidation, 265
 catalytic Oppenauer oxidation variant, 271
 Wharton reaction, 156
- Stien system, Corey-Bakshi-Shibata (CBS) reduction, aldol reactions, boron complex, 15
- Stille coupling reactions, Shapiro reaction, 408–409
- Stoichiometry, Buchwald-Hartwig amination, 575–582
- S-trans* Configuration, Staudinger reaction mechanism, 129–130
- Strecker amino acid synthesis:
 (*S*)-*N*-allyl-*N*-(cyano(*m*-tolyl)methyl)-2,2,2-trifluoroacetamide, 496
 2-amino-2-(3-chlorophenyl)acetone nitrile hydrochloride, 496
 basic principles, 477
 historical perspective, 477
 mechanism, 478
 synthetic utility, 492–495
 TMSCN and asymmetric variations, 496
 variations, improvements and modifications, 478–492
- Structure activity relationship (SAR), Sharpless asymmetric hydroxylation reactions, 78–80
- Suárez modification, Hunsdiecker reaction, 625
- Suaveoline, Yamada reactions, 503
- Substrate-directed diastereoselective hydroxylation, Davis oxaziridine reagents, 29–33
- Substrate-to-catalyst (S/C) ratio, Noyori catalytic asymmetric hydrogenation, 46–47
 ruthenium complexes, 50–53
- Suicide gene therapy, Yamada reactions, 505
- Sulfamate compounds, Burgess dehydrating reagent, 191–192
- Sulfamides, Burgess dehydrating reagent, 198–203
- Sulfenamine, Regitz diazo reactions, 676–677
- Sulfenimines, Davis oxaziridine reagents, asymmetric oxidations, 37
- Sulfide oxidation, Davis oxaziridine reagents, 23–25
 to sulfoxides, 36–37
- Sulfilimines, Martin's sulfurane dehydrating reagent, 248, 250–252
- Sulfinate, Michael-induced Ramberg-Bäcklund reaction, 390
- Sulfinimines, Strecker amino acid synthesis, 486, 493–494
- Sulfobactin A, Yamada reactions, 506–507
- Sulfonamide derivatives:
 Corey-Bakshi-Shibata (CBS) reduction, 13–15
 Fukuyama amine synthesis, 424
 Sharpless asymmetric hydroxylation reactions, 75–77
- Sulfones, Regitz diazo reactions, 660–661
- Sulfonium chloride, Corey-Kim oxidation, 210–11
- Sulfonylhydrazones, Shapiro reaction, 407–410
- Sulfonyl-triflate, Ramberg-Bäcklund reaction, 394–395
- Sulfoxide products, Davis oxaziridine reagents, 24
 asymmetric sulfide oxidation to, 36–37
- Sulfoximes, Buchwald-Hartwig amination, 597–598
 arylation reactions, 599
- Sulfoxonium intermediates, Corey-Kim oxidation, 213
- Sulfuranes, Martin's sulfurane dehydrating reagent, 248

- Sulfur dioxide, Ramberg-Bäcklund reaction, 386
- Sulfur-trioxide-pyridine complex, Swern oxidation, 298, 303–304
- Super-stoichiometric reaction, Buchwald-Hartwig amination, 565
- Supramolecular catalysis, Strecker amino acid synthesis, 481
- Suzuki cross-coupling reactions:
Brown hydroboration reaction, 186–187
Buchwald-Hartwig amination, 573
Shapiro reaction, 408–409
- Swern oxidation:
basic principles, 291
Dess-Martin periodinane oxidation, 229–230
4-(2,2-dibromovinyl)-5-[3-(4-methoxybenzyloxy)-propyl]-2,2-dimethyl-[1,3]-dioxolane, 306–307
historical perspective, 291–292
mechanisms, 292–293
synthetic utility, 299–306
variations, 293–299
- (+)-*cis*-Sylvaticin, Sharpless asymmetric hydroxylation reactions, 78–80
- Syn- β -proton transfer, Burgess dehydrating reagent, 190–192
- Synchronicity, Prilezhaev reaction, 275
- Syn-elimination transitions, Zaitsev elimination, 416
- (-)-Talaromycin A, Tamao-Kumada-Fleming oxidation, 243
- Tamao conditions, Tamao-Kumada-Fleming oxidation, 238
- Tamao-Kumada-Fleming oxidation:
basic principles, 237
historical perspective, 237–238
(2-hydroxymethyl-6-vinyl-1-azaspiro[4.5]dec-1-yl)-phenylmethanone, 246
mechanism, 238–239
synthetic utility, 240–246
variations and improvements, 239–240
- Tamiflu® (oseltamivir), Corey-Bakshi-Shibata reduction, 13–16
- Tamoxifen, Balz-Schiemann reaction, 555
- Tandem reactions:
Buchwald-Hartwig amination, 603–604
Chugaev elimination:
Claisen rearrangement-ene reaction, 338–339
intramolecular ene reaction, 340–341
Diels-Alder Ramberg Backlund reaction, 389–391
Krapcho decarboxylation, 637
Staudinger/aza-Wittig reaction:
basic principles, 129
carbonyl one-pot transformation, 136
imines, 142–147
one-pot monomethylamine transformation, 135–136
Tamao-Kumada-Fleming oxidation,
nitroalkene cycloaddition, 244
- TangPhos ligand, Noyori catalytic asymmetric hydrogenation, 58
- TaniaPhos ligand, Noyori catalytic asymmetric hydrogenation, 54–56
- Tautomeric structures:
Balz-Schiemann reaction, 553
Corey-Kim oxidation, dicarbonyls, 213–214
Nef reaction, 646–647
- Taxane:
Cope elimination reaction, 345
Nef reaction, 649
Shapiro reaction, 411–412
triene, Swern oxidation, 295
- Taxol:
Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 30–33
Luche reduction, regioselectivity, 113–114
Shapiro reaction, 411–412
- (-)-Taxol, Corey-Winter olefin synthesis, 357–358
- Taxusin, Martin's sulfurane dehydrating reagent, 258–259
- t*-Bu-Bisp derivatives, Noyori catalytic asymmetric hydrogenation, 58
- t*-Bu-MiniPhos derivatives, Noyori catalytic asymmetric hydrogenation, 58
- Terpenoid chemistry:
catalytic Oppenauer oxidation, 271
Wharton reaction, 156–157
- Tert*-butyl hypoiodide, Hunsdiecker reaction, 625–626
- Testosterone:
Corey-Kim oxidation, 208–209
Oppenauer oxidation, 268–269
- Tethered aminohydroxylation (TA), Sharpless asymmetric hydroxylation reactions, 79–80

- Tetrachlorvinphos, Perkow reaction, 381
- Tetra-coordinate organosilicon compounds,
Tamao-Kumada-Fleming oxidation, 237
- Tetradecatetraene, Sharpless asymmetric
hydroxylation reactions, 78–80
- Tetraethylammonium bromide (TEAB), Dess-
Martin periodinane oxidation, 230–235
- Tetrahedral sulfinium intermediate, Swern
oxidation, 305
- Tetrahydrofuran, Staudinger reaction, 148
- Tetrahydroisoquinoline, Gribble reduction of aryl
ketones and alcohols to, 106–107
- (±)-(2 α ,3 α ,5 α)-1-(Tetrahydro-2-methyl-5-
phenethylfuran-3yl)ethanone, Prins
reaction, 657
- Tetrahydrothiophene, Davis oxaziridine reagents,
asymmetric oxidations, 37
- Tetralone:
Gribble reduction, 96
Regitz diazo reactions, 662–669
- Tetra-substituted enamides, Noyori catalytic
asymmetric hydrogenation, 58
- Theonellamide F, Yamada reactions, 533–539
- Thermal decarboxylation, Krapcho
decarboxylation, 636
- Thermal decomposition, Balz-Schiemann
reaction, 552
- Thermal instability, Dess-Martin periodinane
oxidation, quinones, 234–235
- Thermodynamics, Chugaev elimination,
secondary alcohols, 336–339
- Thermolysis, Balz-Schiemann reaction, 552
- Thermo-oxidative instability, Wacker-Tsuji
oxidation, 320–321
- 1,2,3-Thiadiazoles, Regitz diazo reactions, 685
- Thiazoline, Burgess dehydrating reagent,
193–195
- Thienopyrimidines, Yamada reactions, 504
- Thiiranes:
Davis oxaziridine reagents, 24
Ramberg-Bäcklund reaction, dioxide
intermediate, 386–387
- Thioamides, Fukuyama amine synthesis, 434
- Thioanthrone, Regitz diazo reactions, 659
- Thioesters, Yamada reactions, 501
- Thioethers, Fukuyama amine synthesis, 427
- Thiohydroxamate esters, Hunsdiecker reaction,
626
- Thionocarbonates, Corey-Winter olefin
synthesis:
historical perspective, 354–355
mechanisms, 355–356
suspension, 361
synthetic utility, 358–360
variations and improvements, 356–357
- Thionocarbonyldiimidazole, Corey-Winter olefin
synthesis, 355
- Thiophosgene, Corey-Winter olefin synthesis,
359
- Thiostrepton, Zaitsev elimination, 419
- Three-component coupling reaction, Strecker
amino acid synthesis, 477–478
- Threonine residue, Burgess dehydrating reagent,
193
- Thrombin inhibitors, Yamada reactions, 523–525
- Ti-enolate, Regitz diazo reactions, 676
- Tilivalline, Yamada reactions, 509
- Tin-palygorskite, Baeyer-Viliger oxidation, 172
- TMEDA, Sharpless asymmetric hydroxylation
reactions, 79–80
- Toluene, Burgess dehydrating reagent, 205
- (*R*)-Tomoxetine, attention-deficit hyperactivity
disorder, Corey-Bakshi-Shibata (CBS)
reduction, 17–18
- Tosyl azide, Regitz diazo reactions, 659
1,3-diketones, 670–673
diphenylphosphoro ester azide, 665
phosphono compounds, 661–662
triphase transfer system, 671–673
- Tosyl-hydrazones, Dess-Martin periodinane
oxidation, 235
- Total synthesis reactions, Fukuyama amine
synthesis, 429–430
- T-Phos ligands, Noyori catalytic asymmetric
hydrogenation, 54–56
- Transannular addition, Regitz diazo reactions,
683
- Trans-antiperiplanar state, Zaitsev elimination,
415
- Trans*-imines, Mukaiyama esterification,
468–469
- Transition metal structures, Ritter reaction,
473–474
- Transition-state structures:
borane, Corey-Bakshi-Shibata reduction, 5–6
Corey-Bakshi-Shibata (CBS) reduction,
modifications and improvements, 7–15
Davis oxaziridine reagents, substrate-directed

- diastereoselective hydroxylation, 29–33
Midland reduction, stereochemical rationalization, 41–42
Transmetalation event, Buchwald-Hartwig amination, 566–567
Trans orientation, Zaitsev elimination, 415
Triarylmethanols, Gribble reduction, 93–95
Triarylmethyl chlorides, Gribble reduction of aryl ketones and, 99
Triazenes, Balz-Schiemann reaction, 555
Triazole, Regitz diazo reactions, 661–662
1,2,3-Triazoles, Regitz diazo reactions, 684–685
Triazolopyridine, Regitz diazo reactions, 685
1*L*-(1,4/5)-3,4,5-tri-*O*-benzyl-1-((*tert*-butyl)diphenylsilyloxy)methyl)cyclopent-2-ene-3,4,5-triol, Cope elimination reaction, 352
Tricalix[5]arene, Gribble reduction of aryl ketones and, 99–107
2,4,6-Trichlorobenzoyl chloride, Yamaguchi esterification, 545
2,4,6-Trichloro[1,3,5]triazine, Swern oxidation, 296
Tricyclic α -keto ester, Regitz diazo reactions, 686
Tricyclic thiepins/oxepins, Gribble reduction, 100–101
Tricyclodecanone, Regitz diazo reactions, 666
(–)-Tricycloillicimonel, Davis oxaziridine reagents, enantioselective oxidation, 35–36
Triethylphosphite (TEP), Perkow reaction, 370–375
Triflimide, Corey-Bakshi-Shibata reduction, Diels-Alder reaction, 12–16
Triflinate, Ramberg-Bäcklund reaction, 388–389
Henderson modification, 394–395
Trifluoroacetamide protecting group, Fukuyama amine synthesis, 426–427
1,1,1-Trifluoro-2-ethoxy-2,3-epoxy-5-phenylpentane, Prilezhaev reaction, 280
Trifluoromethanesulfinate. *See* Triflinate
 α -Trifluoromethylated synthesis, Perkow reaction, 379
(*S*)- α -Trifluoromethylisoserine, Burgess dehydrating reagent, 200–203
Triisopropylphenylsulfonyl azide (TPPSA), Regitz diazo reactions, 662–667
(+)-*o*-Trimethylbrazilin, Davis oxaziridine reagents, enantioselective oxidation, 34–36
Trimethylphosphite (TMP), Perkow reaction, 370–375
Trimethylsilyl cyanide (TMSCN), Strecker amino acid synthesis, 479–481, 496
Trimethylsilyl enol ethers, Rubottom oxidation, 282
Tripeptide 220, Yamada reactions, 532
Triphase transfer system, Regitz diazo reactions, 671–673
Triphenylmethanes, Gribble reduction and deoxygenation, 105
Triphenylphosphine resin, Staudinger reaction, 133
Tripotlyphosphate (TPP), Perkin reaction, 365–366
Tryptocallol, Tamao-Kumada-Fleming oxidation, 242
Triptoquinones, Tamao-Kumada-Fleming oxidation, 242
Tris-heterocycle structures, Gribble reduction and deoxygenation, 106
Tris(trimethylsilyl)phosphites, Perkow reaction, 372
Trisyl azide quench, Staudinger reaction, 139–142
Triterpenes, double Perkow reaction, 379–380
Tryptamine derivative, Swern oxidation, 301
Tsuji oxidation, historical perspective, 309
Turnover frequency (TOF), Noyori catalytic asymmetric hydrogenation, 46–47
Turnover number (TON), Noyori catalytic asymmetric hydrogenation, 46–47
Tyrosine kinase inhibitors, Yamada reactions, 537–538
Ugi reaction:
 Buchwald-Hartwig amination, 601
 Strecker amino acid synthesis, 483
Ultrasound, Strecker amino acid synthesis, 481
Ultraviolet spectrum, Oppenauer oxidation, 266
Unimolecular ionization, Zaitsev elimination, 415
 α,β -Unsaturated aldehydes, Luche reduction, 112
 α,β -Unsaturated carbonyls, Noyori catalytic asymmetric hydrogenation, 59–60

- α,β -Unsaturated ketones, Regitz diazo reactions, 675–676
- Unsaturated alcohols, Noyori catalytic asymmetric hydrogenation, 60
- Unsaturated dihydride mechanism, Noyori catalytic asymmetric hydrogenation, 48
- Unsaturated monohydride mechanism, Noyori catalytic asymmetric hydrogenation, 50–53
- Unsymmetrical hydroxylamines, Cope elimination reaction, 347–348
- Urenamide, Midland reduction, 44
- Ureas:
- Burgess dehydrating reagent, 195–196
 - Dess-Martin periodinane oxidation, 227–228, 234–235
- Urethane formation:
- Burgess dehydrating reagent, 201–203
 - Dess-Martin periodinane oxidation, 234–235
- Valienamine, Martin's sulfurane dehydrating reagent, 260
- L*-Valine methyl ester, borane reduction, historical evolution of, 3
- Valineserine, Burgess dehydrating reagent, 195
- S*-Valinol:
- Corey-Bakshi-Shibata reduction, 13–15
 - reduction reactions, 3
- Vedejs modification, Ramberg-Bäcklund reaction, 388
- Vinblastine, Fukuyama amine synthesis, 429–430
- Vindoline, Fukuyama amine synthesis, 430
- Vinyl anions, Wharton reaction, 153–154
- Vinylolithium, Shapiro reaction, 405, 407
- Vinylogous Ramberg Backlund reaction, 389
- Vinyl phosphates, Perkow reaction, 369, 372–375
- Vinyl phosphinates, Perkow reaction, 372–375
- Vinyl phosphites, Perkow reaction, 375
- 18-oxo-3-Virgene, Wacker-Tsuji oxidation, 321–322
- Vitamin A analogs, Oppenauer oxidation, 268–269
- Vitamin B12 derivative, Yamada reactions, 515, 541
- Wacker-Tsuji oxidation:
- anti-Markovnikov products, 311–314
 - basic principles, 309
 - ethyl(1*R**,5*S**)-3-ethyl-9-oxobutyl-3-azabicyclo[3.3.1]nonane-1-carboxylate, 325
 - historical perspective, 309
 - mechanism, 309–311
 - synthetic utility, 318–324
 - natural products, 321–324
 - variations and improvements, 311
 - Wacker-type oxidation, 314–318
- Wacker-type oxidation, Wacker-Tsuji oxidation, 314–318
- Wagner-Meerwin rearrangement:
- Burgess dehydrating reagent, 191–192
 - Leuckart-Wallach reaction, 453
- Welwitindolinone A isonitrile, Martin's sulfurane dehydrating reagent, 253–256
- Westiellamide, Burgess dehydrating reagent, 192–203
- Wharton reaction:
- basic principles, 152
 - historical perspective, 152
 - 6-hydroxy-10-triethylsilyloxy-1-oxaspiro[4,5]dec-7-en-2-one, 157–158
 - mechanisms, 152–153
 - synthetic utility, 155–157
 - variations and improvements, 153–155
- (–)-Wine lactone, Krapcho decarboxylation, 642
- Wittig-Horner reaction, Luche reduction, 116
- Wittig-type olefination, Corey-Winter olefin synthesis, 359
- Wolff rearrangement, Regitz diazo reactions, 674, 679–682
- Wolff-Kishner reduction, Wharton reaction comparison, 152–153
- Woodward *cis*-dihydroxylation:
- basic principles, 327
 - dl*-anti-trans-4,4a,4b,5,8,8a-Hexahydro-1,8a-dimethyl-6 β -7 β -dihydroxy-2(3*H*)-phenanthrene, 331–332
 - historical perspectives, 327–328
 - mechanism, 328
 - synthetic utility, 330–332
 - variations and improvements, 329–330
- Xanthates, Chugaev elimination, 334–335
- secondary alcohols, 336–339
- Xantphos ligands, Buchwald-Hartwig amination, 572–573, 577–582, 600, 603–604

- XPhos ligands, Buchwald-Hartwig amination, 578–582
 applications, 589–592
 aromatic heterocycles, 587–588
- X-ray analysis:
 Buchwald-Hartwig amination, 565, 600
 Corey-Bakshi-Shibata reduction, 4
 complexation modes, 12–13
 Davis oxaziridine reagents, substrate-directed diastereoselective hydroxylation, 30–33
 Gabriel synthesis, 445
 Perkow reaction, agrochemicals, 381–383
 Sharpless asymmetric hydroxylation reactions, 79–80
 Staudinger reaction mechanism, 129–130
 Swern oxidation, 295–296
 electrophilic chlorine, 301
 Yamada reactions, peptides, 518–519
- XylINAc-Isofagomine, Corey-Bakshi-Shibata (CBS) reduction, 17–18
- XylBINAP-Ru complex, Noyori catalytic asymmetric hydrogenation, 61–62
- Yamada reactions:
 basic principles, 500
 dolastatin 18, 540–541
 historical perspective, 500
 methyl(2*S*)-*N*-(2-aminopyrazidinecarbonyl)pyrrolidine-2-carboxylate, 540
 synthetic utility, 502–539
 amides, 502–515
 antibiotics, 519–520
 anticancer agents, 520–522
 antifungal agents, 529–530
 antitumor agents, 522–523
 cytotoxic depsipeptides, 525–526
 folic acid analogues, 531–539
 peptides, 515–519
 renin inhibitors, 527–529
 thrombin inhibitors, 523–525
 variations and improvements, 500–502
 vitamin B₁₂ derivative, 541
- Yamaguchi esterification:
 basic principles, 545
 historical perspective, 545
 mechanism, 545–546
 4-methyl-hex-2-enedioic acid, 6-[4-iodo-2-methyl-1-(2-methyl-1,3-dioxolan-2-ylmethyl)-pent-3-enyl]ester-1-methyl ester, 550
 synthetic utility, 549
 variations and improvements, 546–549
- Ylide intermediate, Corey-Winter olefin synthesis, 355
- Yonemitsu-Yamaguchi procedure, 547
- Zaitsev elimination:
 basic principles, 414
 3,3-dimethylcyclobut-1-ene, 420
 historical perspective, 414
 mechanisms, 415–417
 synthetic utility, 418–420
 dehydrohalogenation, acyclic halides, 418
 natural products, 419–420
 strained ring systems, 418
 variations and improvements, 417–418
- Zaragozic acids, Wacker-Tsuji oxidation, 317–318
- Zinc reducing agents, Luche reduction, 120
- Ziprasidone, Krapcho decarboxylation, 642–643
- Zirconium-salen complexes, Baeyer-Viliger oxidation, 170–172
- Zwitterionic intermediate, Perkow reaction, 369–370

