

Index

A

A/C₁ curve 193, 226, 227, 231, 232, 326, 349, 395, 398, 420, 421, 423
A₀ 83
A₁ 83
abscisic acid (ABA) 45, 241–243, 245, 247–249, 349, 358, 359, 363, 473
absorbance 59, 72
 cross sections 5, 72
 cytochrome *f* 74
 spectroscopy 27, 31, 48, 59
acceptor side-induced photoinhibition 106, 112, 128
acclimation 175, 211, 214, 287, 288, 293, 299, 324, 368, 380, 393, 395, 396
 growth irradiance 86–90
 temperature 380
Acer saccharum 464
acid invertase 272
activase 332
Adenocaulon bicolor 326, 341
ADP 34, 80, 81
ADP/ATP 82
ADPglucose pyrophosphorylase 154, 165, 209, 210, 212, 268, 269
ADPglucose starch synthase 209
Agave americana 206
AGPase 172, 179
 flux control coefficients 173
 overexpression 179
Agrobacterium tumefaciens 312
air pollution 410, 411, 418
Al³⁺ 245
aldolase 178
algae 375, 455
alkoxy radical 126
Allium cepa 437
Alocasia 232, 234, 285, 286, 287, 288, 333
 macrorrhiza 289, 297, 325, 326, 330, 332, 335, 340, 342
amino acid sequence
 ascorbate peroxidase 135
 monodehydroascorbate reductase 138
aminoethoxyvinylglycine (AVG) 423
amphistomatous 292
anion channels 245–246
ankyrin proteins 313
Antarctic diatoms 374
antenna 5–9, 46
 complexes
 core 4
 peripheral 4
 pigments 2–21
 detrapping 10
 light-harvesting function 5
 PS II 52
 quenching sites 18
 size 89
antheraxanthin 28, 32, 36, 37, 39
Anthoceros 455

anthocyanins 444
antioxidant 234
antisense
 mutations 374,461
 rbcS DNA 233
 rbcS tobacco plants 174
 RNA 312
apoplast 243, 252
 guard cell 249
aquatic 391
 angiosperms 392
 environment 389,391,392
 plants 398
Arabidopsis 45, 162, 179, 444, 445
 thaliana 309, 315, 393
 rca mutant 160
Arachis hypogea 439
Arbutus unedo 351
arctic plants 214
Argyrodendron 288
Arrhenius plots 194
ascorbate 138,412,445
ascorbate peroxidase 132, 135, 136, 138, 139, 141, 142, 144
 inhibitors 137
aspen canopies 342
assimilatory charge 336, 340, 342
ATP 29, 53, 68, 71, 77, 80
 generation 73
 synthase 32, 350, 475
 synthesis 54,73, 81, 158
[ATP]/[ADP][Pi] ratio 80
ATP-phosphofructokinase 250
ATPase 81,82,87, 170,438
 H⁺-extruding 241, 242
 K⁺-exchange 413
Atriplex 202
 glabriuscula 212
 lentiformis 212
 nummularia 212
 patula 294
 rosea 200
 sabulosa 205
autoproteolytic event 115
autotrophs
 submersed 398
auxin 244,443
AVG. *See* aminoethoxyvinylglycine
avonoid 437
azide 107

B

Bacillus
 subtilis 274
 thuringiensis 306
barium 245
barley 263, 272, 311, 371
barnyard grass 398

- bean 210, 212
 French 354, 362
 kidney 396
- Benson-Calvin cycle 154–156, 162, 177, 197, 214, 224, 231, 316, 370, 371, 472
- Beta vulgaris* 295
- betaïne 356
- biotechnology 305
- blue fluorescence 32, 34, 57
- blue light effects 244
- blue light receptor 330
 protein 315
- Boehmeria cylindrica* 393
- Boltzman equilibrium 47
- boundary layer 170, 454
 conductance 173
 flux control coefficients 173
- Bouteloua gracilis* 211
- branching enzyme 179
- Brassica*
carinata 443
campestris 443
napus 373, 378
oleracea 439, 442
- bronzing 410
- brussels sprouts 442
- Bryophyllum tubiflorum* 205
- bryophytes 455
- Bryopsis* 129
- Bt toxin 306
- bundle sheath 200, 267, 340, 378
- Bunsen coefficient
 ozone 415
- C**
- C24 14
- C₃ 192, 453, 458, 459
- C₃-C₄ intermediates 456
- C₄ 192, 202, 205, 458, 459
 cycle 204
 enzymes 205
 pathways 458
 photosynthesis 200–205, 340
 chilling sensitivity 202
 photosynthetic pathway 453
 species 203, 397
 tropical grasses 202
- C550 34
- Ca²⁺ 166, 243, 245–8, 423, 425
 balance 429
 channel 243, 246
 homeostasis 414
- cab 378
- cabbage 395
- cacti 206
- Callitriche cophocarpa* 399
- calmodulin 247, 315
- Caltha intraloba* 212
- Calvin cycle 154–156, 162, 177, 197, 214, 224, 231, 316, 370, 371, 472
 intermediates 154
- CAM. *See* crassulacean acid metabolism
- canopies 323
- canopy photosynthesis 294
- CAP. *See* chloramphenicol
- carbamylation 160, 233, 329
- carbodiimides 38
- carbohydrate 213, 266
 content 207
 export 207
 partitioning 356
 production 396
 soluble 422, 460
- carbon
 partitioning 224
 stable isotopes 452
- carbon cycle 388
- carbon dioxide. *See* CO₂
- carbon isotope ratio 341
- carbon metabolism 249–253, 373, 472
- carbon partitioning
 starch 207
 sucrose 207
- carbon reduction
 photosynthetic 352
- carbon reduction cycle
 photosynthetic 350
- carbonic anhydrase 297
- carboxyarabitol 1 -phosphate 161
- carboxyarabitol (CA) 232
- carboxyarabitol 1-phosphate 206, 232, 329
- carboxyarabitol 1,5-bisphosphate (CABP) 158
- carboxylation 70, 195, 440
 capacity 226, 340
 conductance 454
 efficiency 193, 198, 202, 227, 391, 394, 473
 energetic requirements 71
 rate 354, 355
- carboxysome 455
- carotene 57
 β 4,110, 445
- carotenoid 6, 37, 48, 103, 427, 439, 442
 electrical field-induced shifts 53
 excited states 15
 triplet 109
- carrot 400
- cassava 443
- Castanea* 231
- catalase 134, 212, 412
- cattails 398
- CCM. *See* CO₂ concentrating mechanism
- cdc2a* 273
- cDNA. *See* complementary DNA
- Cecropia* 286
- cell division 272
- cell volume 350, 351
- cercosporin 126
- CF₁ 156, 328
- CF₁CF₀-ATP synthase 329
- chalcone synthase 444
- chalcone-flavanone isomerase 444
- Chara corallina* 247
- charge separation 10, 106
- chemical stress 47
- Chenopodium album* 360
rubium 267
- chilling 198, 316, 233

- C_4 photosynthesis 202, 471
 - damage to PS I 41
 - injury 376
 - sensitivity 376
 - stress 233
- chimeric gene constructs 313
- Chlamydomonas* 108, 445
 - reinhardtii* 29, 45, 373
- chloramphenicol (CAP) 102, 103, 116
- Chlorella* 418, 427
 - sorokiniana* 417
 - vulgaris* 372, 373, 374, 375, 379
- chlorofluorocarbons (CFCs) 436
- chlorophyll 48, 442
 - a 4, 5
 - a/b* 289, 299
 - a/b* ratio 88, 89, 290, 293, 298
 - b 6
 - content 87, 286, 290
 - electrical field-induced shifts 53
 - excited states 2
 - fluorescence 12, 18, 28, 32, 74, 83, 349, 417, 456
 - singlet state 80
 - triplet state 6, 32, 84, 107, 126
- chlorophyll 670 110
- chloroplast
 - biogenesis 306, 307, 377
 - development 308, 313, 377, 473
 - genome 307
 - movement 82
 - ribosomes 200, 205
 - surface 291
- chlorosis 410, 427
- chromanoxo radical 126, 138
- chromosome addition 461
- circadian control 378
- cis*-acting elements 313
- citric acid 459
- citrus 231
- Cl 245, 246
- Clarkia* 165
 - mutants 165
 - xanthiana* 179
- cloud cover 331
- clover 272
- Clusia minor* 459, 460
- CO_2
 - compensation point 226, 388, 390, 392, 402, 454
 - concentrating mechanism 389–391, 396, 397, 399, 455
 - concentration 175, 244, 348, 354
 - chloroplast 355, 356
 - intercellular 287, 349, 355, 412, 419, 423
 - conductance 174
 - enrichment 399, 400
 - external partial pressures 453
 - fixation 68, 69, 70, 198
 - predicting rates 201
 - quantum yield 71, 72, 87, 198, 202
 - photorespiratory 456, 458
 - respiratory 456, 463
 - response curves 287, 288
 - sensitivity 209
 - transfer conductance 456
 - uptake 343, 372
- cold 167
- cold acclimation proteins 214
- cold hardening 375
- cold-responsive genes 309
- collard 439
- Colocasia* 288
- Commelina communis* 252
- compartmentation 265
- compensation point 226, 388, 390, 392, 402, 454
- complementary DNA (cDNA) 309
 - library 310
- conifers 373, 375
- connectivity theorem 170
- continuously stirred tank reactors (CSTR) 418
- control analysis
 - connectivity theorem 169, 170
 - deviation index 172
 - elasticity coefficient 169, 170
 - flux control coefficient 168, 171
 - response coefficient 169
- control coefficients 170
- core antenna complexes 4
- cotton 395, 396
- 4-coumerate-CoA-ligase 444
- coupling factor 283, 284, 290, 297, 378
 - CF_i 328
- cowpea 400
- CP24 27, 36–38, 40
- CP26 14, 27, 36–38, 40
- CP29 14, 27, 36–40
- CP43 4, 37, 115
- CP47 4, 37
- Crassula argentea* 206
- crassulacean acid metabolism (CAM) 192, 205, 316, 456, 458, 459
 - pathways 458
 - plants 397
- Cretaceous 390, 391
- Creegee mechanism 414
- crop canopies 324, 341
- crop ecotypes 462
- cryoprotectant 374
- CSTR. *See* continuously stirred tank reactors (CSTR)
- cucumber 129, 138
- Cucumis* 286, 296
- cuticular conductance 326
- cuticular transpiration 349, 356
- cyanobacteria 376, 377, 455
- cyclic electron transport 52, 73, 82, 125, 362, 372
- cyclic photophosphorylation 203
- cyclobutane pyrimidine 445
- Cyperus papyrus* 398
- cytochrome
 - b 34, 48
 - b_{559} 36, 37, 106, 115
 - b_6 32
 - b_6/f complex 76–79, 81, 85–87, 283, 284, 288, 290
 - bc* complex 115
 - bf* complex 29, 53, 54
 - c oxidase 272, 273
 - f 32, 34, 48, 74, 76, 77, 87, 88, 284, 293, 297, 298, 378, 439, 475
- cytosol 243, 250

D

D1 protein 35, 37, 85, 102, 105, 106, 111, 129, 427, 428, 445, 470, 475
 degradation, 104, 112
 folding model 105, 113
 phosphorylation 112
 turnover 90, 116, 291
 D1/D2 heterodimer 106
 D2 protein 37, 105, 106, 111, 445
 degradation 114
 phosphorylation 112
 protein folding model 105
Dactylis glomerata 212
 dark respiration 206
 DBMIB. *See* 2,5-dibromo-3-methyl-6-isopropyl-*p*-benzoquinone
 DCCD. *See* dicyclohexylcarbodiimide
 DCMU. *See* 3-(3,4-dichlorophenyl)-1,1-dimethyl urea
 DCPIP. *See* 2,6-dichlorophenolindophenol
 de-epoxidase 32
 de-epoxidation 33, 38, 53
 violaxanthin 27, 138
 dehydroascorbate 140
 dehydroascorbate reductase 132, 140, 141
 delayed fluorescence 31, 36
 delayed light emission 27, 428
 delayed luminescence (DL) 46, 47
 photometer 47
desA 376
 deuterium 458
 development 267
 developmental response 368
 deviation index 172
 diacylglycerol 248
 di-isopropylfluorophosphate 115
 1,2 diacylglycerol (DAG) 247
 diamine oxidase 412
 diatoms 373
 Antarctic 374
 2,5-dibromo-3-methyl-6-isopropyl-*p*-benzoquinone (DBMIB) 114
 dicarboxylate carrier 158
 2,6-dichlorophenolindophenol (DCP IP) 439
 3-(3,4-dichlorophenyl)-1,1-dimethyl urea (DCMU) 36, 106, 111, 114
 dicyclohexylcarbodiimide (DCCD) 38, 40
 DIDS. *See* 4,4' diisothiocyantostilbene-2,2' disulfonic acid
 differential display 311
 differential expression 312
 differential screening 309, 310, 314
 diffused beam spectrophotometer 54
 diffusion 454
Digitaria decumbens 210
 sanguinalis 204
 dihydroxyacetone phosphate/phosphate translocator 226
 4,4' diisothiocyantostilbene-2,2' disulfonic acid (DIDS) 246
 discrimination 453
 instantaneous 459
 dissipation of excitation energy
 PS I 82
 PS II 83
 dithiothreitol 137
 DL. *See* delayed luminescence
 DNA damage 445

DNA dimerization 445
 DNA-binding proteins 311
 down regulation 33, 225, 234, 267
 PS II 125, 144
 drought 348–363
 drought-induced stomatal closure 71
 duckweeds 398
Dunaliella tertiolecta 212, 375
 dyes
 pH-indicating 34
 dynamic model 342

E

Echinochloa crusgalli 204, 398
 ecological CO₂ 390
 compensation point 390
 ecotypes 453, 460
 efficiency
 photochemical 11
Eichhornia crassipes 398
 elasticity coefficients 153
Elatostema repens 351
 electrical field-induced shifts
 carotenoids 53
 chlorophylls 53
 electrochromic change 32, 53, 55
 electrochromic shift 34, 48, 50, 53, 55, 199
 electron acceptor
 primary 104
 electron donor
 primary 104
 electron transfer chain 28–3, 48
 electron transport 26, 68, 70, 78, 226, 227, 231, 333, 374
 apparent rate constant 77
 capacity 290
 control 81
 cyclic 52, 73, 362
 in vivo 74
 limitation 76
 pseudo-cyclic 52, 73
 site of limitation 75
 temperature dependence 197
 whole chain 349, 352, 354, 355
Eleusina indica 352
Elodea canadensis 390, 399
 Emerson enhancement 56, 88
 emission spectra 57
Encelia farinosa 462
 end-product inhibition of photosynthesis 207
 energetic regulation 14
 energetic requirements
 carboxylation 71
 photorespiration 71
 energy storage
 photosynthetic 46
 energy-dependent quenching (q_E) 13, 28, 29, 32, 33, 35–38, 56, 371
 enzyme regulation 332
 epicuticular waxes 443
 epidermis 267
Eragrostis orcuttiana 397
Eriophorum vaginatum 395

- ethylene 414
ethylene production 422, 423
ethylene release 423
Eucalyptus 211, 212
 grandis 230
 pauciflora 214
Euphorbia forbesii 340
evaporation 457
evergreens 380
excitation energy
 non-photochemical quenching 8, 12, 26, 35, 41, 74, 81, 83, 84, 375
 transfer 4, 9, 16
excited states
 carotenoid 15
 chlorophyll 2
 dynamics 9, 19
 lifetime 9, 20
exciton density
 PS II 84
exciton life-time
 PS II 84
- F**
- F_{∞} 37
 F_{AM} 83
Fagus 231
 sylvatica 340
Faris banding 205
fast vacuolar (FV) channels 245
fatty acids 376
FBPase. *See* fructose 1,6-bisphosphatase
Fe-SOD 130
feedback 202
 inhibition
 photosynthesis 371
ferredoxin 34, 50, 54, 80, 81, 83, 87, 91, 125, 132, 142
Festuca arundinacea 213
fiber optic microprobe 437
field photosynthesis 224
flash measuring-beam kinetic spectrophotometer 53
Flaveria
 linearis 209
 pringlei 196
 trinervia 196
flavins 57, 244
flavonoids 444, 445
flavoprotein 244
Flindersia 288, 291
flowering 274
fluctuating light 321–343
fluidity of the membrane 377
fluorescence 12, 26, 31, 33, 41, 43, 50, 51, 55, 57, 82, 224, 234, 471
 blue 32
 chlorophyll 12, 18, 28
 decay kinetics 57
 imaging 44, 473
 induction 32
 measurements 59
 pulse-modulated chlorophyll 339
 pulsed kinetic 34
 video imaging 44
 yield 33
fluorimeter
 modulated 41
 multi-flash kinetic 44
 PAM 44
 pulsed kinetic 41, 42
flux control coefficients 153, 168, 171, 173, 181
footprinting 314
forest 323
 understories 323
fractionation occurring against $^{13}\text{CO}_2$ 452
free radicals 2, 126, 445
free-air CO_2 enrichment systems 393
French bean 354, 362
fructan 264, 267, 268, 270, 374
 synthesis 374
fructose 1,5-bisphosphate 328
fructose 1,6-bisphosphatase (FBPase) 80, 129, 154, 155, 173, 207, 212, 233, 250, 251, 269, 328, 329, 332, 370, 396, 425, 426, 472
 cytosolic 154, 162, 164, 166, 180, 203, 209, 210, 212, 213
 plastidic 155, 156, 170, 178
 flux control coefficients 173
fructose 1,6-bisphosphate (FBP) 233
fructose 2,6-bisphosphate 162, 251, 269, 472
fructose 6-phosphate 328
fruit abortion 274
fumarase 272, 273
fungal infections 47
fusococcin 244
 F_v/F_m 83, 234
 F_x 83
- G**
- G-proteins 248, 315
gas exchange 69
gel retardation assays 314
gene
 phosphoenolpyruvate carboxylase 316
 cold-responsive 309
gene expression 166, 207, 262, 267, 270, 307, 472
 light-regulated 314
gene regulation 274–275
genetic engineering 306
genomic clone 313
genotype 306
genotypic differences 460
geological time 388
glucan synthase 412
glucans 460
glucose 396
glucose 6-phosphate 250, 251
glutamate 40
glutamine synthetase 129, 143
glutathione 133, 412, 444, 445
glutathione reductase 140, 374
glyceraldehyde-phosphate dehydrogenase 206, 297
glycerate 3-phosphate kinase 205
glycerol 3-phosphate acyl transferase 312
glycine decarboxylase 143, 391
glycolate oxidase 134, 143

glycolytic 251
 groundwater 458
 growth irradiance 285, 287, 288, 292, 294
 acclimation 86–90
 photosynthetic acclimation 284
 GTP248
 GTP-binding proteins 245
 guard cell 242–244, 422, 442
 apoplast 249
 plasmalemma 241
 ATPase 250

H

H'
 ATPase 244
 electrochemical potential difference 80–82
 extruding ATPase 241, 242
 extrusion 244
 pumps 246
 H'-pyrophosphatase 247
 H'/e- stoichiometry 73
 H'K'-pyrophosphatase 247
 heat stress 370
 heat-shock protein
 hsp-90 115
Hedera helix 230, 275
Helianthus 295
 annuus 363
 heliotropism 359
 Henry's Law 412
 herbicides 45, 306
 heterogeneity 473
 hexokinase 212, 274
 hexose 266, 274
 hexose phosphate 275
 hexose-repression 274
 high energy state quenching 371
 high salt stress 47
 high temperature 210
 stress 47, 205
 Hill activity 283–288, 294, 296–298
 Holocene 388
Hordeum vulgare 195
 host-parasite interactions 463
 hydraulic conductivity 230, 292
 hydraulic lift 464
Hydrilla verticillata 390
 hydrogen
 stable isotopes 452
 hydrogen peroxide 132, 133, 412, 445
 scavenging 134, 141
 sensitive enzymes 129
 production
 spontaneous disproportionation of superoxide 132
 hydroxyl radical 108, 127, 412
 hydroxylamine 137
 hydroxyurea 137
Hymenoclea salsola 360

I

IAA. *See* indole acetic acid

imaging
 fluorescence video 44, 473, 474
 immunocytology 378
Impatiens valeriana 351
 in vitro transcription assay 309
 indole acetic acid (IAA) 443
 induction 324, 326, 329
 responses 340
 state 232, 325
 infrared
 gas analysis 30
 spectroscopy 56
 inositol 1,4,5-trisphosphate(IP3) 247, 248
 insertional mutagenesis 315
 intercellular CO₂ 287
 concentration (C_i) 70
 pressure 326
 intercellular transport 200
 internal CO₂ concentration 45, 348
 intracellular compartmentation 264
 intraleaf acclimation 293
 intrathylakoid pH 78, 81, 84
 invertase 213, 267, 396
 invertase genes 274
 hexose-repression 274
 ion channels 245, 246
 ionic control of photosynthesis 425
 IP3. *See* inositol 1,4,5-trisphosphate
 IRMS. *See* isotope ratio mass spectrometers
 iron-sulfur acceptor complex 41
 iron-sulfur centers 372
 irradiance 166
 isolines 444
 isotope effect 453
 isotope ratio mass spectrometers (IRMS) 453, 457, 458
 isotopic composition
 water 457
 isotopic steady state 457, 458

K

K' 242, 243, 244, 245, 246, 247, 252
 channels 245, 248
 exchange via ATPase reactions 413
 salts 243
 stimulated ATPase 416
 kidney bean 395, 396
 kinetic absorbance measurements 48
 kinetic fluorimeter 34
 kinetic properties 172
 kinetic spectrophotometry 48
 kinetics
 rapid fluorescence rise 34

L

Laminaria saccharina 373
Lasrea divaricata 213
 leaf
 absorbance 87
 anatomy 444
 chlorophyll fluorescence 353
 conductance 249

- development 291, 442
 - disc oxygen electrode 349, 351
 - energy budgets 359
 - flutter 342
 - forms 174
 - gas exchange 472–475
 - models 224
 - longevity 295
 - morphology 283, 442
 - movement 359
 - nitrogen 283, 287, 291, 294, 296, 297, 299
 - protein accumulation 378
 - proteins 283
 - pubescence 443
 - temperature 230, 428
 - thickness 291, 443
 - wilting 82
 - leaf water deficit (LWD) 350, 351, 360
 - Lemna* species 398
 - LHCII. *See* light harvesting complex II
 - lichens 455, 456
 - Liebig's law of the minimum 70
 - light
 - absorption 8
 - excess 2
 - energy transduction
 - thylakoids 470
 - fluctuating 322–343
 - modulation 206
 - scattering 49
 - changes 50
 - stress 379
 - utilization 359
 - PS II 360
 - regulation 349
 - light-harvesting apparatus 29
 - light-harvesting complex 27, 36, 37, 38, 289, 290, 361
 - light-harvesting complex I {LHC I} 5, 378
 - light-harvesting complex II (LHC II) 5, 13, 27, 36, 37–41, 370, 372, 378, 379
 - aggregation 18, 19
 - phosphorylation 13, 20
 - light-harvesting function
 - antenna 5
 - light-induced absorbance change around 820 nm 74
 - light-induced scattering changes 55
 - light-regulated gene expression 314
 - light-scattering 32, 48, 55, 199
 - lightfleck 324, 334–340
 - lightfleck use efficiency (LUE) 336, 337, 340
 - utilization 229
 - lignin 57
 - lipid 127, 375
 - peroxidation 445
 - peroxides 140
 - synthesis 375, 424
 - loblolly pine 440, 443
 - Lolium* 264
 - perenne* 272, 402
 - temulentum* 209, 210, 267, 270, 271
 - low night temperatures 198
 - low temperature 164, 209, 475
 - sensitivity 202
 - stress 47
 - LUE. *See* lightfleck use efficiency
 - luminal pH 26, 29
 - luminescence 34, 107
 - delayed 47
 - LWD. *See* leaf water deficit
 - Lycopersicon esculentum* 440
- ## M
- Macadamia* 231
 - integrifolia* 230
 - macroalgae 399
 - Macroptilium purpureum* 360
 - magnesium 155
 - maize 129, 164, 204, 205, 270, 271, 272, 340, 352–354, 360, 378, 379, 460, 471, 473
 - chloroplast development 473
 - malate 246, 249, 250, 251
 - malic acid 459
 - malondialdehyde 417
 - manganese cluster 105
 - mangroves 225
 - Rhizophora* 234
 - Manihot esculentum* 445
 - mannose 209
 - Marchantia polymorpha* 307
 - marine phytoplankton 376
 - maximum apparent quantum yield 352
 - maximum capacity for photosynthesis 87
 - maximum quantum yield 362
 - MDA. *See* monodehydroascorbate
 - MDA reductase. *See* monodehydroascorbate reductase
 - Medicago sativa* 443
 - Mehler reaction 68, 71, 73, 78, 234, 339, 359, 361, 362, 471
 - Mehler-ascorbate peroxidase cycle 234
 - membrane 413
 - fluidity 377
 - permeability 409, 413, 415, 417, 418
 - potential 245
 - structure 423
 - transport 417
 - viscosity 376
 - Mesembryanthum crystallinum* 316
 - mesophyll 267
 - cells 378
 - conductance 202, 231, 298, 420
 - resistance 419
 - metabolic demand 80
 - meteoric water 458
 - methane 436
 - microcompartmentation
 - scavenging systems 141
 - CuZn-superoxide dismutase 131, 132
 - microprobe
 - fiber optic 437
 - mid-day depression 225
 - Miocene 390, 391
 - mirage effect
 - photothermal beam deflection 57
 - mitochondrial F₁-ATPase 158
 - mitochondrion 250
 - Mn-cluster 35
 - Mn-superoxide dismutase 130
 - mobilization of starch 210

model of photosynthesis 71, 287
 modulated fluorimeters 41
 molecular genetics 308
 molecular techniques 305
 monocyclic sinapic acid ester phenolic compounds 444
 monodehydroascorbate 126, 132, 138, 139, 144, 234
 ferredoxin-dependent photoreduction 139
 monodehydroascorbate reductase 132, 138, 139, 141, 142
 morphogen 273
 mRNA 440
 accumulation 378
 stability 308
 multi-flash kinetic fluorimeter 44
 multi-wavelength modulated spectrophotometer 54
 mutagenesis 315
 insertional 315
 random 315
 mutants
 transgenic plants 171
 mycorrhiza 422

N

NAD(P)H-mediation 125
 NADH 57
 NADP 30, 32, 34, 76, 80
 NADP-glyceraldehyde-phosphate dehydrogenase 129, 205, 212, 328
 NADP-malate dehydrogenase (NADP-MDH) 75, 156, 158, 204
 NADP-malic enzyme 205, 206
 NADP-MDH. *See* NADP-malate dehydrogenase
 NADP-ME. *See* NADP-malic enzyme
 NADPH 34, 57, 58, 68, 71, 77, 80, 438
 generation 73
 pyridine nucleotide 58
 [NADPH]/[NADP] 80
 near infrared absorbance spectroscopy 31, 34
 near infrared (NIR) 49, 52
 absorbance changes 55
 P₈₂₀ 34, 91, 92
 necrosis 410, 427
 negative thermal modulation 194
Nerium oleander 199, 211, 212, 213, 363, 376
 neutral invertase 272
 NH₂OH 36
Nicotiana tabacum 285, 292, 307
 NIR. *See* near infrared
 nitrate 165
 nitrate reductase 166, 206, 357, 396
 nitrate reduction 158, 356
 5-nitro-2,3-phenylpropylaminobenzoic acid (NPPB) 246
 nitrogen 176, 283, 284, 294
 deficiency 299
 effect of limiting 175
 leaf 291, 294, 296, 297, 299
 plant 296
 supply 167, 214
 thylakoid 285, 286, 289
 nitrous oxide 436
Nitzschia closterium 375
 non-heme iron 105
 non-photochemical quenching 8, 12, 26, 35, 41, 74, 81, 83, 84, 375

non-photochemical quenching coefficient 83
 non-radiative relaxation (heat) 55
 NOx 418
 NPPB. *See* 5-nitro-2,3-phenylpropylaminobenzoic acid
 NPQ. *See* non-photochemical quenching
 nuclear run-off analysis 309
 nucleolar activity 214
 nucleotide sequence 311
 numbra 324
 nutrients 392, 393, 395, 399, 401, 402
 nutrient deficiency 299
 nutrition 281, 282–300

O

O₂. *See* superoxide
 O₂-sensitivity 209, 213
 O₂/CO₂ solubility ratio 357
¹⁸O composition 464
¹⁸O fractionation 452
 O₂-induced oscillations 47
 oat, wild 443
 OEC. *See* oxygen evolving complex
Oenothera stricta 445
 'OH 128
Olea europaea 392
 ontogeny 268
 open-top chambers 393
 optimum temperature 211
Opuntia inermis 206
 oscillatory behavior 208
 osmosis
 stomatal movements 242
 osmotic adjustment 351, 359
 osmotic water flow 242
 osmotin 314
 overwintering 375
 oxaloacetate carrier 158
 oxidation
 water 104
 oxidative products 410
 oxygen
 active species 127
 singlet 126, 128
 stable isotopes 452
 oxygen electrode 352, 353
 oxygen evolution 57, 69, 372
 quantum efficiency 72
 quantum yield 72, 87
 S-state model 42
 oxygen evolving complex (OEC) 36, 371, 372
 oxygen polarography 34
 oxygen production 30
 oxygen radical 108, 445
 oxygen-evolving complex 29, 41, 42
 oxygen-evolving reactions 36
 oxygenase 70
 Rubisco 352, 354, 355
 oxygenase/carboxylase activities 196
 oxygenation 70, 195, 357
 rate 354, 355
Oxyria 214
digyna 212

- ozone 409, 410–429
 Bunsen coefficient 415
 depletion 436
 solubility 414
- P**
- p-aminophenol 137
 p-nitrodiphenyl ether 126
 P_{820}
 absorbance changes 34, 91, 92
 P680 32, 49, 91, 108, 110
 primary electron donor 104
 P680' 32, 34, 35, 36, 37, 42, 51, 72
 triplet 128
 P700 21, 32, 48, 49, 52, 53, 74, 77, 78, 79, 80, 83, 91, 298, 372
 triplet 83
 P700' 29, 34, 41, 51, 52
 reduction 81
 Paleozoic 390, 391
 palisade cells 443
 palisade parenchyma 424
 PAM-fluorimeter 44
Panicum
maximum 203, 204, 294
miliaceum 203, 204
virgatum 210
Paphiopedilum tonsum 248
 papyrus 398
 paraheliotropic 298
 paraheliotropism 359, 360
 paraquat 126
 radicals 127
 parenchymatous bundle sheath 267
 particle bombardment 312
 partitioning 178, 182
 between starch and soluble sugar 356
 carbon 224
Paspalum conjugatum 340
 patch-clamp 244
 patchy distributions 45
 patchy stomatal behavior 228, 326, 349, 356
 PC. *See* plastocyanin
 PCO. *See* photorespiratory carbon oxidation
 PCR. *See* polymerase chain reaction
 PCR cycle. *See* photosynthetic carbon reduction cycle
 pea 139, 209, 439
 peanut 205, 439
 penumbra 324
 PEP. *See* phosphoenolpyruvate
 PEPC. *See* phosphoenolpyruvate carboxylase
Peperomia obtusifolia 437
 Perilla 290
 peroxide 412
 peroxisomes 132, 133
 peroxy radical 126
 pH
 indicating dyes 34
 lumenal 26, 29
 regulation 245
Phaeodactylum tricoratum 375
 phase transition 376
Phaseolus 232
vulgaris 193, 232, 395
 phenotypic
 differences 460
 responses 453
 phenoxy radicals 126
 phenylalanine ammonia-lyase 444
 pheophytin 35, 36, 104, 439
 phloem 265
 phosphate 34, 80, 81, 82, 162, 209
 limitation 336, 370, 371
 optimum 208
 sequestering agents 208
 status 213
 translocator 198, 207, 251, 370
 phosphatidylglycerol (PG) 376
 phosphoenolpyruvate 250
 phosphoenolpyruvate carboxylase (PEPC) 203, 205, 206, 212, 250,
 251, 316, 391, 397
 genes 316
 phosphofructokinase 203, 250, 251
 phosphoglucose isomerase 165, 180, 212
 phosphoglucose mutase 179, 212
 phosphoglycerate kinase 212, 297
 phosphoglyceric acid 328, 338, 352
 ratio with triose 370
 phosphoglycolate phosphatase 209
 phosphohexoseisomerase 212
 phosphoinositide 247
 phospholipase C 247
 phospholipid hydroperoxide glutathione peroxidase 141
 phosphoribulokinase 154–156, 170, 173, 178, 206, 297
 phosphoroscope 48
 Becquerel-type 47
 phosphorylation
 D1 112
 D2 112
 LHCII 13, 20
 phosphotidylinositol 4,5-bisphosphate 247
 photoacoustic spectrometry 32
 photoacoustic spectroscopy 18, 34, 56, 73, 74
 photobaric signals 57
 photobleaching 427
 photochemical efficiency 11, 74, 80, 193
 open (oxidized) PS II 353
 photochemical quenching (q_p) 8, 12, 41, 76, 83, 234, 353, 371,
 470
 photochemistry 26
 efficiency 6
 in vivo 74
 PS II
 quantum yield 353
 photodamage 2, 84, 470
 acceptor side-induced 106
 donor side-induced 109
 photodamaged Photosystem II
 repair 116
 photoinactivation
 donor side-induced 113
 PS II 104, 106
 photoinduced stress 103
 photoinhibition 13, 33, 35, 68, 83–85, 101–117, 127, 198, 202,
 225, 350, 361, 368, 375, 378, 427
 acceptor-side 128
 donor-side 128

- photoinhibition (cont'd)
 protection 144
 PS II 102–117
 photoinhibitory damage 339
 photoinhibitory quenching (q_i) 13
 photolyase 445
 photomorphogenesis 314
 photon flux density 323
 photooxidation 425
 photooxidative damage 37
 photophosphorylation 199, 208, 337, 350, 439
 photoprotection 2, 225, 233, 445
 photorepair 437
 photorespiration 68, 70, 73, 82, 125, 143, 158, 162, 195, 197, 209,
 228, 336, 355–357, 361, 362, 389–391, 396, 454
 energetic requirements 71
 photorespiratory carbon oxidation (PCO) 389–391, 396, 456, 458
 photorespiratory CO_2 release 335
 photosynthesis
 feedback inhibition 371
 maximum capacity 87
 model 71, 287
 temperature response 369, 372–375
 photosynthetic acclimation 211, 283, 286, 289, 380
 growth irradiance 284
 photosynthetic apparatus
 stoichiometry 86
 photosynthetic carbon reduction cycle 350, 352, 356, 357
 photosynthetic control 77, 226
 photosynthetic efficiency 83, 378
 photosynthetic electron transport 26, 68, 70, 78, 226, 227, 231,
 333, 374
 apparent rate constant 77
 capacity 290
 control 81
 cyclic 52, 73, 362
 in vivo 74
 limitation 72, 76
 poising 158
 pseudo-cyclic 52, 73
 site of limitation 75
 temperature dependence 197
 whole chain 349, 352, 354, 355
 photosynthetic energy storage 46
 photosynthetic gene expression 308
 photosynthetic oxygenation cycle 357
 photosynthetic units
 size and composition 89
 Photosystem I 4, 30, 32, 36, 41, 50, 52, 53, 54, 58, 68, 72, 74, 80,
 86, 87, 129, 130, 438
 cyclic electron flow 372
 dissipation of excess energy 82
 light-induced damage 83
 photochemistry 82
 effective cross-section 88
 quantum efficiency 52, 74
 reaction center
 stoichiometry 88
 turnover time 90
 regulation 20
 Photosystem II 4, 31, 36, 37, 39, 41, 43, 45, 54, 56, 68, 74, 80, 86,
 87, 102–117, 127, 128, 439
 antenna 52
 Photosystem II (cont'd)
 charge separation 72
 cores 112
 dissipation of excess energy 83
 donor side mechanism 102
 donor side reactions 32
 donor side-induced photodamage 109
 donor side-induced photoinactivation 113
 donor-side photoinhibition 128
 down regulation 125, 144
 efficiency 199
 exciton density 84
 exciton life-time 84
 light utilization 360
 loss of efficiency 83
 photochemical efficiency 353
 short and long term regulation 85
 photochemistry 427, 428
 effective cross-section 88
 quantum yield 353
 photoinactivation 85, 104, 106
 photoinhibition 102–117
 polypeptides 372
 PS II:PS I 289, 299
 PS II α 372
 PS II β 5, 20, 372
 quantum efficiency 74, 339, 471
 reaction center 445
 stoichiometry 88
 reaction center complex 104
 regulation 85
 repair of photodamage 116
 thermal inactivation 199
 thermal stability 372
 turnover time 90
 photosystems
 relative absorbance cross-sections 88
 photothermal beam deflection 56, 57
 mirage effect 57
 photothermal radiometry 34, 56, 74
 photothermal signal 57
Phragmites australis 398
 phytochrome 174, 314, 315, 316
 phytohormones 437
 phytoluminography 48
 phytoplankton 399
 Pi. *See* phosphate
 pigment-protein 284, 289
 complexes 4, 282, 284, 297
 pigments
 antenna 2–21
 pineapple 397
Pinus
 banksiana 446
 sylvestris 445
 taeda 440
Piper auritum 327, 330, 331
Pisum 284, 285, 286, 287, 288, 290
 sativum 252, 289, 439
 plant nitrogen 296
 plant water content 358
Plantago major 462, 463
 plasma membrane 413, 429
 K⁺-stimulated ATPase 416

- plasmalemma 243, 244–245, 245–246
 ATPase
 guard cell 241, 250
 H⁺ ATPase 250
 H⁺ pump 242
 P-type ATPase 244
- plastid fructose biphosphatase 170, 178
- plastid gene 307
 expression 308
- plastid phosphoglucose isomerase 179
- plastocyanin (PC) 29, 32, 48, 50, 77, 83, 87, 91
- plastoglobuli 424
- plastoquinol (PQH₂) 29, 43, 76, 78, 81, 85–87
- plastoquinone (PQ) 32, 33, 43, 46, 104, 338, 439, 440
 reduction state 76
- plastosemiquinone anion (Q_B⁻) 439
- Poa pratensis* 395
- poising
 photosynthetic electron transport 158
- polyacrylamide gel electrophoresis 311
- polyamines 445
- polymerase chain reaction (PCR) 311
- polymorphisms 461
- polyphenolic compounds 57
- poplar 129
- Populus*
deltoides 330
fremontii 323
tremuloides 323, 330, 340
- Porphyra yezoensis* 399
- post-translational modification 378
- potassium channels 244–245
- potato 129, 138
 tubers 210
- PPDK. *See* pyruvate orthophosphate dikinase
- PQ. *See* plastoquinone
- PQH₂. *See* plastoquinol.
- precipitation 457
- procaine 248
- proline 356
- protease inhibitors 111
- protection from photoinhibition 142, 144
- protein
 blue light receptor 315
 DNA-binding 311
 import 378
 kinase 413
 kinase C 247
 phosphorylation 116
 soluble 286, 288
 synthesis 214
trans-acting regulatory 315
 turnover 102
- proteolytic cleavage 111
- proton
 ATPase 244
 domain 14
 extruding ATPase 241, 242
 extrusion 242, 244
 pumps 246, 248
- proton/electron stoichiometry 73
- protoporphyrin IX 126
- Prunus* 231
- PS I. *See* Photosystem I
- PS II. *See* Photosystem II
- psbA* 440
- psbI* 106
- psbO*-less mutant
Synechocystis 6803 110
- pseudo-cyclic electron transport 52, 73, 82
- psychrophilic 369
- pteridines 57
- pulse-chase labeling 116
- pulse-modulated chlorophyll fluorescence 339
- pulse-saturation fluorescence techniques 56
- pulsed kinetic fluorescence 34
- pulsed kinetic fluorimeter 41, 42
- pulvini action 82
- pumpkin 371
- purple bacteria 104
- pyrenoids 455
- pyridine nucleotide 58
- pyrophosphatase 180
- pyrophosphate 425
- pyrophosphate:fructose 6-phosphate phosphotransfer 180
- pyruvate kinase 212
- pyruvate orthophosphate dikinase (PPDK) 201, 203, 204, 316
- ## Q
- Q cycle 30, 73
- Q-enzyme 213
- q_E. *See* energy-dependent quenching
- q_I. *See* photoinhibitory quenching
- q_N. *See* non-photochemical quenching
- q_{NP}. *See* non-photochemical quenching
- q_P. *See* photochemical quenching
- q_O 32, 33
- Q_m 194, 197, 199, 210
- Q_A 32, 33, 36, 42, 76, 83, 104, 108
- Q_A⁻ 41, 44, 72
- Q_B 42, 43, 44, 46, 104, 108
- Q_B Site 106
- quantum yield
 CO₂ fixation 71, 72, 87, 193, 198, 202, 471
 oxygen evolution 72, 87
 PS I photochemistry 41, 52, 70, 74,
 PS II photochemistry 52, 70, 74, 202, 339, 353, 402, 471, 473
- quencher 82
- quenching
 energy-dependent 371
 high energy state 371
 mechanisms 14
 non-photochemical 8, 12, 26, 35, 41, 74, 81, 83, 84, 375
 photochemical 8, 12, 41, 76, 83, 234, 353, 371, 470
- quenching sites
 antenna 18
 reaction center 18
- Quercus*
macrocarpa 332
pubescens 393
- quinone analogs 57
- quinones 57

R

R-type channel 246
radiation interception 82
radical pair 101
radical scavengers 109
radish 400
Ramonda mykoni 351
random mutagenesis 315
rapeseed 212
Raphanus sativus 251
rbcS-3A 313
rca mutant
 Arabidopsis thaliana 160
reaction center 4, 32
 P680 32, 34, 35, 36, 37, 42, 51, 72, 49, 91, 104, 108, 110, 128, 445
 P700 21, 29, 32, 34, 48, 49, 51, 52, 53, 74, 77, 78, 79, 80, 83, 91, 298, 372
 reduction 81
 quenching 18
 quenching sites 18
 stoichiometries 88
recombination 55
red light
 stimulation of stomatal openings 244
redox potential
 thioredoxin 81
 ferredoxin 81
redwood forest understories 341
reed 398
regeneration 226
regulation
 short-term 262
 sucrose 269
regulation of light utilization 349
regulation of PS II 85
regulatory capacity 153, 167
regulatory genes 306
relative humidity 229
relative water content 350
repair process 111
reproduction 400
reproductive growth 400
respiration 207, 272, 273, 275, 388, 389, 392, 400, 401, 417, 441, 454
respiratory CO₂ 456, 463
reverse O₂-sensitivity 209
Rheum rhaponticum 442
Rhizophora mangroves 234
Rhodophyta 399
rhubarb 442
riboflavin 57
ribose 5-phosphate 328
ribosomes 205
ribulose 1,5-bisphosphate (RuBP) 69, 159, 269, 324, 352, 356
 regeneration 70, 198, 199, 207, 233, 287, 325, 327, 332, 352, 356
 capacity 227
 limitation 326, 395
 substrate 441
ribulose 1,5-bisphosphate carboxylase-oxygenase (Rubisco) 69, 154, 155, 158, 159, 162, 167, 168, 170, 174, 175, 177, 182,

ribulose 1,5-bisphosphate carboxylase-oxygenase (cont'd)
 195, 196, 198–201, 204, 206, 207, 211, 212, 214, 231, 233, 252, 268, 282, 285, 287, 288, 291, 293–299, 325, 327, 332, 334, 342, 354, 355, 356, 357, 373, 374, 308–397, 389, 400, 402, 414, 420, 424, 428, 429, 436, 440, 452, 454, 472
 activase 160, 161, 199, 206, 232, 330, 371, 378
 activation 200, 231, 298, 371
 carbamylation (activation) state 160
 concentration 86
 flux control coefficients 173, 176
 oxygenase function 143, 199, 352–355
 ribulose 1,5-bisphosphate saturation 159, 168
 specificity factors 195, 355, 390, 391
ribulose 5-phosphate 328
ribulose 5-phosphate kinase 129, 328, 329
rice 212, 316, 396, 398, 442, 443
 chilling sensitivity 316
RNA (Northern) blot 311
root 249, 264, 272
 mycorrhiza 422
 signal 358
Rubisco. *See* ribulose 1,5-bisphosphate carboxylase-oxygenase
RuBP. *See* ribulose 1,5-bisphosphate
Rumex patens 441
rye 369, 373, 379
rye grass 402

S

S-states 48
 model for oxygen evolution 42
 S₁ 42
 S₂ 42
 transitions 29
S-type channel 246
sac X 275
sac Y 275
salinity-stress 401
Salix herbacea 392
saturating pulse 33, 45
saturation pulse technique 27
SBPase. *See* sedoheptulose 1,7-bisphosphatase
scavenging systems 79, 134
 microcompartmentation 141
Scenedesmus 110
Scirpus 398, 402
 olneyi 395, 398
Scots pine 373
seagrasses 399
sedoheptulose 1,7-bisphosphatase (SBPase) 80, 129, 154–156, 162, 170, 206, 212, 328
sedoheptulose 1,7-bisphosphate (SBP) 233, 328
Selanastrum minutum 165
semiquinone 44
semiquinone radical 126, 127
Senecio douglasii 360
senescence 267, 411
serine-proteases 115
Sesbania sesban 461, 462
shade 215, 283
 flecks 324
 plants 286
 -intolerant species 329

- signal molecule 265
- signal perception 314
- signal transduction 315
- silicomolybdate 110
- singlet 46, 47, 80
 - oxygen 2, 6, 83, 84, 101, 107, 108
 - quencher 107
- sink 264, 271–274, 398
 - activity 207, 210
 - alternative 71
 - capacity 394, 396
 - limitation 81, 262, 370
 - metabolism 272
 - regulation 167
- Skeletonema costatum* 214, 373, 374
- slow vacuolar (SV) channels 245
- snff* 274
- SOD. *See* superoxide dismutase
- soil drying 249, 358
- soil-plant-air research (SPAR) units 393
- Solanum aviculare* 286
 - dulcamara 286
- sorghum 205
- Sorghum bicolor* 203, 204, 210
- source-sink capacities 396
- source:sink ratios 264
- soybean 138, 205, 327, 328, 333, 395, 402
 - canopy 342
 - trypsin inhibitor 115
- Spartina*
 - patens* 397, 398
 - townsendii* 202
- specific leaf weight 442
- specificity factor
 - Rubisco 195, 355, 390, 391
- spectrophotometer
 - diffused beam 54
 - flash measuring-beam kinetic 53
 - multi-wavelength modulated 54
- spectroscopy
 - absorption 59
 - FTIR 111
 - kinetic 48
 - near infrared and visible absorption 34
 - photoacoustic 18, 56, 73, 74
 - UV absorption 34
- spin-polarized chlorophyll triplet state 107
- Spinacea* 284–287, 290, 293, 296, 298
 - oleracea* 292
- spinach 129, 142, 212, 351, 371
 - cold tolerant 369
- Spirodella oligorhiza* 443
- spongy mesophyll 443
- SPS. *See* sucrose phosphate synthase
- stable isotope 452–459
- starch 172, 209, 210, 249, 250, 251, 252, 270, 396, 398
 - carbon partitioning 207
 - degradation 166
 - mobilization 210
 - synthase 210
 - synthesis 165, 179, 181, 182, 357, 374
 - low temperature 213
- State transitions 13, 20, 32, 89, 125
- steady-state model 342
- Stern-Volmer equation 361
- stomata 45, 71, 168, 170, 228, 241, 330, 348, 418, 422, 442, 473
 - flux control coefficients 173
- stomatal aperture 412
- stomatal closure 33, 85, 349, 350, 356, 361, 362
 - drought-induced 71
- stomatal conductance 193, 227, 229, 230, 249, 299, 325, 326, 331, 342, 357, 389, 392, 394, 397, 398, 400, 401, 424, 428, 429, 453, 473
- stomatal control 224
- stomatal density 392, 393, 462, 463
- stomatal efficiency 392
- stomatal limitations 231
- stomatal models 229
- stomatal movements 241, 247
 - osmosis 242
- stomatal opening 47, 329
 - O₃-induced oscillations 47
- stomatal openings
 - red light stimulation 244
- stomatal optimization 230
- stomatal resistance 45, 357, 369
- storage 268
- stress
 - chemical 47
 - drought 348–363
 - environmental 47
 - high salt 47
 - high temperature 47
 - light 379
 - low temperature 47
 - water 45, 82
- stromal pH 155
- submersed vegetation 391, 398
- subsidiary cells 422
- subtractive hybridization 311
- sucrose 209, 213, 250–252, 262–264, 266, 270, 272–275, 396, 426
 - carbon partitioning 207
 - cytosolic 267
- sucrose phosphate synthase (SPS) 162, 165, 166, 167, 206, 210, 213, 268, 269, 357, 358, 396, 425, 472
 - activation state 213
 - activity
 - increase in cold 167
 - flux control coefficients 173
 - phosphorylation 163
- sucrose regulation 269
- sucrose synthase 210, 213, 252, 272, 426
- sucrose synthesis 162, 164, 165, 180, 181, 200, 357, 370, 374
 - low temperature 213
- sucrose-phosphate synthase 154, 180, 210, 212, 252
- sucrose-sucrose fructosyl transferase 210
- sucrose/starch accumulation 371
- sugar
 - soluble 460
 - sugar pools 263
 - sugar synthesis 182
- suicide inhibitors 137
- sulfhydryls 412
- sun leaves 174
- sun plants 286

sun-shade transitions 86, 331
 sunflecks 294, 322–343
 sunflower 233, 351, 400, 442
 superoxide 2, 71, 79, 83, 110, 130–133, 141, 234, 412
 superoxide dismutase (SOD) 110, 130–133, 144, 142, 312, 412, 445
susI 272
 sycamore 273
Synechococcus 390
 lividus 380
 psbO-less mutant 110
 PCC6803 116, 376, 377, 380

T

Taraxacum officinale 209
 temperature 71
 acclimation 380
 compensation 193
 dependence
 electron transport 197
 response 194, 195
 photosynthesis 369, 372–375
 tetacyclis 358
 tetraethylammonium 245
 thermal breakpoints 205
 thermal dissipation 360
 thermal inactivation
 PS II 199
 thermal radiometry 27, 32, 55, 56
 thermal stability
 PS II 372
 thermoluminescence 31
 thermophilic algae 369
 thiol groups 54
 thiols 137
 thioredoxin 54, 68, 155, 156, 158, 206, 233
 redox potential 81
 thioredoxin *f* 328, 329
 thioredoxin-regulated enzymes 54
 thyl 138
 thylakoid
 energization 350
 light energy transduction 470
 lipid composition 378
 membranes 438
 membrane electrical potential difference 30, 31, 39, 46
 nitrogen 285, 286, 289
 protein 298
 proton electrochemical potential difference 14, 16, 30, 31, 36, 46, 55
 stacking 87
Tidestromia oblongifolia 205
 time
 geological 388
 tissue culture 273
 tissue wounding 422
 tobacco 212, 396
 antisense *rbcS* 161, 174
 transgenic 160
 tocopherol 57, 144, 445
 tomato 233, 371, 378, 233
 cold sensitive 369
 tonoplast 243, 246–247
 transport processes 246–247
Toona 288
Tradescantia
 albiflora 252, 290
 ohioensis 252
 trans-acting factor 313, 314
 trans-acting regulatory proteins 315
 transcription 270, 308, 313
 circadian control 378
 in vitro assay 309
 transfer conductance 231
 CO₂ 456
 transfer equilibrium 10
 in q_p , quenching 18
 transgenic plants
 chimeric gene constructs 313
 mutants 171
 technology 305, 312
 tobacco 233
 transition metal ions 126, 127
 translocation 210, 370, 422
 transpiration 358, 400
 efficiency 460
 transport processes 417
 transthylakoid $\Delta\mu_{H^+}$ 80–83, 330, 361
 transthylakoidal proton gradient 80–83, 330, 361
Trifolium repens 401
 triose phosphate 269, 328, 352, 422, 426
 triose phosphate translocator 154, 180
 triplet state 36, 55, 101, 125,
 chlorophyll 6
 spin-polarized chlorophyll 107
Triticum aestivum 292, 297
 tropical forest 342
 understories 341
 trypsin inhibitors 140
 turgor 249, 265
 turnover time
 PS I 90
 PS II 90
 two-electron gate 41, 43, 48
Typha 231, 398
 tyrosine 113, 439

U

Udotea flabellum 391
 UDPglucose pyrophosphorylase 213
 ultraviolet-B radiation. *See* UV-B radiation
Ulva lactuca 399
 umbra 324
 understory
 aspens 342
 redwood forest 341
 tropical forest 341
 unprimed ADP glucose starch synthase 209
Urtica 291
 UV
 absorption spectroscopy 34
 irradiation 35
 radiation 44, 47
 UV-A (320–400 nm)/blue light 437

UV-B 114, 435–446, 473
UV-damage 45

V

vacuole 243, 247, 250, 264, 267
valve reaction 109
vanadate 244
vapor pressure deficit 193, 230, 358
vascular tissue 273
veins 267
Vicia faba 245, 246, 251, 252, 272, 295, 420
video imaging
 fluorescence 44, 473, 474
Vigna luteola 195
violaxanthin 14, 32, 37, 38, 53, 138, 144, 234
 deepoxidation 27, 33, 38, 85, 138
viral infection 45, 47
viral resistance 306
vitamin E 445
vitamin K 57

W

water
 deficiency 249
 deficit 348, 349, 350, 356
 groundwater 458
 isotopic composition 457
 meteoric 458
 oxidation 104
 potential 230, 348
 stress 45, 82, 166, 167, 174, 201, 372
 uptake 359
water hyacinth 398

water-logging 410, 424
water use efficiency (WUE) 389, 392, 397, 401, 402, 462, 464
wheat 199, 212, 369, 373, 400, 443
 endosperm 210
white clover 272
white oak 395
wild-oat 443
winter rye 213
wounding response 413, 416
WUE. *See* water use efficiency

X

Xanthium strumarium 360
 strumerium 45
xanthophyll 234, 361
xanthophyll cycle 14, 27, 32, 37, 103
xenon flashlamp 41
xylem
 ABA concentration 249

Y

Y_z 42
 Y_D 105
yellow poplar 395
Yucca treculeana 437
 Y_z 105

Z

Z scheme 72
Zea mays 369, 441
zeaxanthin 14, 28, 32, 36–39, 53, 138, 227, 234, 361
Zebrina pendula 363