

Subject Index

Page numbers in **boldface** indicate sections on the topic. Page numbers in *italics* indicate a table or figure. Index terms under genera include only places with substantial description of the subject and not just brief reference or mention of the genus.

- abscisic acid (ABA), 92
- absorption spectra. *See* light
- accessory pigments. *See* carotenoids, etc.
- Acetabularia*
 - cap morphology, 6
 - cyst development, 25
 - cyst morphogenesis, 28
 - homeobox genes, 46
 - life history, 27
 - morphogenetic substances, 46
 - nucleo cytoplasmic interactions, 45, 46
- Acrochaete*
 - endophytic pathogen of *Chondrus*, 172
 - endophytism in *Chondrus*, 145
- adelphoparasites, 173
- agar
 - Gelidium* production and products, **428**
 - Gracilaria* production and products, **429**
 - structure, 214
- agars, 213
- algae
 - evolutionary origin, 2, 3
- algal turf
 - pre-emptive competition, 139
- algal-herbivore interactions, **164**
 - bioactive chemicals, **164**
- alginate
 - commercial use of *Saccharina*, 423
 - composition, 212
 - in propagule adhesion, 79

- properties, 424
- structure, 213
- synthesis, 41
- alkaline phosphatase, 266
- allelopathy, **140**, 142
 - criteria, 143
 - defense against pathogens, 145
- alternation of generations, 49, 53
- amino acids
 - uptake, 258
- ammonium
 - depletion and uptake, 248
 - incorporation, 262
 - local excretion and seaweed diversity, 288
 - uptake, 248, 256
 - uptake kinetics, 255
 - uptake vs. ammonium concentration, 257
- amyloplasts, 23, 25
 - in rhizoid orientation, 90
- amylose, 210
- Antarctic
 - Circumpolar Current, 118
 - Desmarestia* temperature optima, 306
 - endophytes, 172
 - environment, 117
 - heat shock protein induction, 314
 - Himantothallus* ammonium uptake, 285
 - Iridaea* life history, 57
 - Palmaria* fatty acid composition, 314
 - Q₁₀ values, 301
 - seaweed communities vs. global warming, 319
 - seaweeds, temperature tolerance, 315
 - Ulva* susceptibility to UV, 343
- antifouling compounds, 399
 - booster biocides, 399
 - volatile halogenated organic compounds, 143
- antioxidant metabolism, **310**
 - water-water cycle, 311
- Antithamnion*
 - cell growth, 32, 33
- apical development
 - Gracilariopsis*, 13
 - Sphacelaria*, 86
- apparent free space, 243
- aragonite, 268–9
- Arctic
 - Laminaria* nitrogen uptake, 285
 - seaweed communities vs. global warming, 319
 - seaweeds, temperature tolerance, 315
- Arctic seaweeds, 118
- Ascophyllum*, 124
 - canopy facilitation of invertebrate communities, 137
 - competition with mussels, 154, 155
 - epiphytism by *Vertebrata*, 142
 - facilitation along stress gradient, 137
 - ice disturbance, 154
 - inducible defense against grazers, 167
 - phlorotannin content vs. grazing, 167
 - phlorotannin induction, 169
 - pollution impact on photosynthesis and productivity, 410
 - symbiosis with fungus *Mycophycias*, 171
- assimilation
 - kinetics, 261
- attachment, **78**
 - adhesive substances, 79
 - in morphogenesis, 90
 - ultrastructural changes, 78
- auxins, 92
 - role in *Ectocarpus* development, 93
- bacteria
 - as morphogenetic factor, 91
- basal bodies, 27
- bicarbonate utilization, 203
- bioaccumulation
 - effects of environmental factors, 382
 - of metals, 380
- biomarkers, **230**
- biomass budget, 235
- biotic interactions, **136**
 - facilitation, 137
- blue light, 89
 - in morphogenesis, 59
 - non-photosynthetic effects, 89
- Bonnemaïsonia*
 - predicted tetrasporogenesis, 67
 - reproductive timing, 65
 - tetrasporangium formation, 67
- boring and endolithic algae
 - vs. grazers, 157
- brackish waters
 - seaweed flora, 330
- branching, 88
 - effects of light, 88
- Bryopsis*
 - morphology, 4
 - regeneration, 96
 - wound healing, 95

538 **Subject Index**

- cadmium
 - concentrations along estuary, 389
 - toxicity, 387
- calcification, 268
 - and ocean acidification, 273
 - and pH stress, 341
 - antagonism by orthophosphate, 272
 - aragonite deposition, 269
 - calcite deposition, 269
 - Corallinales, 271
 - disadvantages, 273
 - factors, 271
 - ion fluxes in *Halimeda*, 270
 - mechanisms, 271
 - models, Corallinaceae, 272
 - sites and forms, 270
 - vs. CO₂ concentration, 340
- calcite, 268–9
 - vs. CO₂ concentration, 340
- calcium
 - cellular functions, 273
- calcium carbonate
 - crystalline forms, 268
- callus
 - in mariculture, 436
- calmodulin, 273
- Calvin cycle, 179, 180, 206
- carbon budgets
 - autecological models, 227
- carbon concentrating mechanisms, 204
 - δ¹³C, 209
- carbon dioxide uptake, 204
- carbon fixation, 202
- carbonate equilibrium, 202
- Carbon-Nutrient Balance Model, 166
- carotenoids, 189
 - structure, 190
- carrageenans, 213
 - commercial production, 426
 - gel strengths, 427
 - production, uses, future prospects, 427
 - structure, 214
- Caulerpa*
 - morphology, 4
 - pre-emptive competition, 123
 - regeneration, 97
 - wound healing, 95, 98
- cell differentiation, 85
- cell division, 32. *See also* cytokinesis.
 - asymmetric, fucoids, 84
- cell fusion, 97
- cell growth, 32, 33
- cell repair, 97
- cell structure, 17
 - basal bodies, 27
 - eyespots, 30
 - secondary metabolite bodies, 17
 - walls, 17, 20
- cell volume
 - and osmotic control, 326
 - changes with salinity, 328
- cell wall
 - localized specialization, 21
- cellulose microfibrils, 19, 20
- centrioles, 27, 29, 35
- Chaetomorpha*
 - nutrient competition with *Ulva*, 279
- chemical composition and nutrient limitation, 280
- chemical defenses
 - activated, 167
 - algal compounds used by grazers, 170
 - constitutive, 167
 - costs, 169
 - evolution/strategies, 166
 - geographic variation, 169
 - inducible, 167
- chemical ecology, 164
- chlorophylls, 188
 - reaction centers, 191
 - structure, 190
- Chondrus*
 - defense against *Acrochaete*, 145
 - genome, 42
 - sloughing epiphytes, 142
 - temperature effects on morphology, 90
 - versus *Ulva* and grazers, 152
- chromatic adaptation, 200, 202
- circadian (diel) rhythms
 - in photosynthetic rate, 222
- circadian clock, 35
- circadian gating, 35
- coastal waters
 - light spectra with depth, 184
 - subtidal light, 182
 - temperatures and salinities, 295
- Codium*
 - dispersal as invasive species, 123
 - filamentous vs. spongy thalli, 88
 - growth vs. internal nitrogen, 277
 - morphology, 4

- pre-emptive competition, 139
- communities, 103
- community analysis, **124**
- community food web interactions, 286
- community interactions
 - with nutrient enrichment, **286**
- community structure
 - impact of grazing, 148
 - “top-down” versus “bottom-up” control, 155
 - under nutrient enrichment, 287
- compatible solutes, 327
- competition, **138**
 - between corals and seaweeds, 145
 - mechanisms, 138
- concentration boundary layer, 243, 353–4, 354
 - and kelp blade morphology, 357
 - and nutrient fluxes, 353
 - synchronization of propagule release, 359
- construction. *See* thallus construction.
- copper
 - cellular effects, 385
 - effect on physiology, 387
 - effect on relative growth response, 377
 - effects on photosynthesis, 385
 - effects on reproduction and growth, 386
 - in antifouling paints, 399
 - in seaweed food chains, 389
 - seawater concentrations, 386
 - toxicity, 385
- coral reefs, 115
 - algal turf communities, 114
 - calcifying seaweeds, 114
 - eutrophication and macroalgal abundance, **404**
 - eutrophication, 403
 - foliose seaweeds, 115
 - recovery after sewage diversion, 402
 - seaweed communities, 113
 - seaweed growth after urchin die-off, 149
- Corallinales
 - calcification, 269, 271
- corps en cerise*, 17, 143
- critical tide levels, 101, 104
- cultivation mutualism, 159
- currents, **349**
 - effects of coastal topography, 350
- cuticle, 20
- cyanelles, 193
- cytokinesis, 34, 85
 - brown seaweeds, 33
- cytokinins, 92
- cytoplasmic organelles, **21**
- cytoskeleton, **25**
- Dasycladus*
 - wound healing, 95
- day length, 65. *See also* photoperiodism.
 - and irradiance, latitudinal variation, 58
 - interacting factors, 65
 - Scytosiphon* erect thallus formation, 66
- Delisea*
 - allelopathic compounds, 143
- demography, 128, 146
 - frond dynamics in clonal seaweeds, 147
 - Gini-coefficient (G'), 146
- depth refugia
 - from warm water, 186
- desiccation
 - amino acid leakage, 335
 - effect on photochemical yield, 336
 - effect on quantum yield, 336
 - inorganic carbon supply, 334
 - recovery, 334
 - stress, **333**
- Desmarestia*
 - Antarctic, temperature requirements, 317
 - sulfuric acid content, 170
- development of adult form, **88**
- diatoms
 - epiphytism, 141
 - in farmer-fish territories, 159
- Dictyosphaeria*
 - bloom in sewage eutrophication, 402
- diffusion boundary layer, 353. *See also* concentration.
 - boundary layer
- dispersants, oil
 - toxicity, 398
- disturbance
 - and community changes, 367
 - by water motion, 366
 - categories, **366**
 - Dynamic Equilibrium Model, 368
 - ice scour, 154
 - Intermediate Disturbance Hypothesis, 368
 - sand scour, 370
 - seasonal burial, 370
 - sediment, 369
 - vs. stress, 132
- DNA Barcoding, 37, 38, 39
- drag
 - forces, 360

- drag (cont.)
 - forces vs. morphology, 362
 - reduction in aggregates, 361
- Ecklonia*
 - and disturbance, 367
 - geographic variation, 9
 - productivity, contribution to coastal ecosystems, 231
- ecosystem models, 235
- ecotypic variation, 9
- Ectocarpus*
 - and multicellularity, 5
 - as model seaweeds, 41
 - auxins in sporophyte development, 93
 - genome, 41
 - life history, 52
 - model life history, 53
 - morphological development, 85
- effective shore level, 104
- El Niño/Southern Oscillation (ENSO), **319**
 - kelp canopy area, 228
- emersion
 - component factors, 7
- endophytes, **172**
 - grazing defense, 173
- endosymbiosis
 - origin of plastids, 3
 - plastids and mitochondria, 21
- environmental stressors, **294**
 - interactions, 343
 - intertidal zone, **297**
 - temperature, **300**
- environmental-factor interactions, **5**
 - between physico-chemical and biological factors, 7
 - sequential effects, 7
- epibionts. *See also* epiphytes.
 - and allelopathy, **140**
- epiphytes
 - impact on basiphytes, 140–1
 - obligate, 141
 - removal by sloughing, 142
- essential elements, **238**
 - concentrations in seawater and seaweeds, 240
 - functions and compounds, 239
- establishment and germination, **81**
- estuaries and bays
 - temperatures and salinities, **296**
- ethylene, 94
- Eucheuma/Kappaphycus*
 - cultivation, **426**
 - use for carrageenans, **426**
- eutrophication, **400**
 - changes in communities, 401
 - effects on communities, **286**, 400
 - non-sewage nutrient sources, **407**
- exploitative competition, 138, 145
 - laboratory studies, 147
- exudation, 225
- eyespot (stigma), 30, 31
- facilitation, **136**, 136–7, 137
- farmerfish, 159, 159
- fatty acids
 - as biomarkers in food webs, 232
- feeding deterrents
 - calcified algae, 162
- fertilization, **68**
 - post-fertilization events, red algae, 72
 - red algal mechanisms, 72
 - spermatium ultrastructure, 74
 - strategies, 68
- flagella, **27**
 - in attachment process, 79
 - in gamete recognition, 71
 - roles, 30
 - synthesis, 27, 31
- floridean starch, 210
- fluorescence
 - ratio of variable to maximal, as stress indicator, 346
- foundation species, **136**
- freezing, **336**
 - cryoprotectants, 337
 - tolerance vs. vertical zonation, 337
- fucoidan
 - in propagule adhesion, 79
- fucoids
 - asymmetric cell division, 84
 - phosphorus uptake, zonation, season, 265
- Fucus*
 - competition in nutrient-rich mesocosms, 287
 - demography, 146
 - desiccation, 336
 - desiccation and recovery, 336
 - desiccation tolerance, 335
 - development, 10
 - effect of DIC and water flow on gamete release, 360

- fertilization, 71
- freezing tolerance, 309
- growth vs. salinity, 331
- hybridization, 44
- in salt marshes, 120
- intertidal zonation factors, 106
- net production in water vs. air, 205
- nitrogen uptake during desiccation, 251
- nitrogen uptake, germlings, 253
- plastid ultrastructure, 24
- recovery after oil spill cleanup, 397
- recovery from desiccation stress, 334
- sperm surface carbohydrates, 21
- stress tolerance, 311
- survival vs. density, 147
- thallus construction, 15
- wound healing, 98
- functional form
 - absorptance spectra, 195
 - and opportunistic vs. late-successional seaweeds, 132
 - grazing susceptibility, 160
 - groups, 14, 114
 - growth rate–light relationships, 200
 - in light trapping, **194**
 - light-harvesting ability, 194
 - models, **11**
 - monolayered vs. multilayered, 195
 - photosynthesis, 223
 - resource acquisition, water motion, **356**
 - SA : V ratios, micro- vs. macroalgae, 254
- gamete
 - approach, brown algae, 70
 - recognition, 70–1
 - release, 68
 - release, effect of DIC and water flow, 360
- gametogenesis, 63
- Gelidium*
 - agar production and products, **428**
 - productivity model, 227
 - tetraspore development, 82
 - thallus construction, 15
- genetics
 - breeding experiments, 42
- genomics, 41
- geographic distribution
 - amphi-equatorial seaweeds, 316, 318
 - and temperature, **321**
 - effect of currents, 321
 - poleward shifts in Australia, 323
- germination
 - after UV irradiation, 329
 - cell division patterns, 83
- global warming
 - poleward shifts in Australia, 323
- glycolysis, 211
- Gracilaria*
 - agar production and products, 429
 - C : N ratios, 281
 - clonal thalli, 16
 - genetic inheritance, 42
 - growth rate vs. tissue C : N ratio, 281
 - mariculture, 429
 - mitotic recombination, 44
 - nitrogen storage, 263
 - nitrogen uptake and desiccation, 251
 - non-Mendelian inheritance, 43
 - oxidative burst against pathogens, 145
 - spore coalescence, 17
 - unstable mutants, 43
- Gracilariopsis*
 - apical development, 13
 - developmental control by parasitic red algae, 173
 - effect of copper on growth, 377
 - effect of copper on physiology, 387
- Grateloupia*
 - role of polyamines, 93
- grazing, **148**. *See also* mesograzers.
 - amphipods, 160, 160
 - as morphogenetic factor, 91
 - associational escapes, **158**, 170
 - constitutive defenses, 167
 - feeding choice assays, 161
 - feeding preferences, 160
 - generalists vs. specialists, 163
 - impact on community structure and zonation, **148**
 - impact on seaweed individuals, **156**
 - impact on zonation, 153
 - influence on seaweed competition, 152
 - interactions with competition, wave action, 154
 - limpets, latitudinal changes, 153
 - refuges, 157, 158
 - seaweed defenses, 157
 - structural and chemical deterrents, **160**
 - susceptibility vs. functional group, 162
 - temporal and spatial escapes, **157**
 - urchin barrens, 148

542 **Subject Index**

- growth
 - relation to nutrients, 276
 - vs. internal nitrogen, 277
- growth kinetics, **276**
 - and tissue nutrients, **276**
 - measurement, **276**
- growth rate
 - nitrogen and light, **284**
 - vs. nitrogen, 277
 - vs. tissue C : N ratio, 281
- growth substances, **91**
- hairs
 - and concentration boundary layer, 354, 357
 - in nutrient acquisition, 90
 - in nutrient uptake, 280
- Halimeda*
 - activated chemical defense, 167
 - aragonite crystals, 269
 - calcification, 268–9
 - calcification schematic, 270
 - carbonate production, 114
 - diel plastid migration, 25
 - herbivore defenses, 170
 - life history, 51
 - morphology, 4
 - plastid migration, 26
- Harveyella*
 - evolution and range extension, 173
- heat shock proteins, 314, 345
- herbivores. *See also* grazing.
 - and nutrient impacts on seaweeds, 288
 - community interactions with nutrient enrichment, 287
 - effect on kelp nitrate uptake, 288
- Hijikia*
 - arsenic content in hijiki, 390
- Hincksia*
 - amino acid uptake, 258
- horizontal gene transfer, 43
 - alginate biosynthesis, 212
- hybridization, 37, 44
- hydrodynamic force, 349
- hydrodynamic forces
 - component factors, 6
 - destructiveness, 352
 - field measurements, 361
 - on *Nereocystis* blades, 365
 - seaweed reconfiguration, 361
- hyperparasitism, 173
- inorganic carbon
 - forms in seawater vs. pH and salinity, 203
 - sources and uptake, **202**
 - transport and CO₂ accumulation, 208
- Integrated Multi-Trophic Aquaculture, **431**
 - concept map, 433
- interference competition, **138**, 138. *See also* farmerfish.
 - “gardening”, 140
 - whiplash, 139
- intergeneric hybrids, 37
- intertidal seaweed community, 106
- intertidal zonation, **100**, **101**, 102
 - biological factors, 105
 - controlling factors, **104**
 - effects of grazers, 153
 - effects of grazing and competition, 153
 - modeling communities, 111
 - submersion-emersion data, 105
 - year-to-year changes, 103
- intertidal zone
 - salinities, 298
 - temperatures and salinities, 297
- intraspecific competition, 146
- invasive seaweeds, **121**, 122
 - biotic characteristics, 122
 - ecological impacts, 123
- iodine
 - accumulation by kelp, 275
- iridescence, 20
- irradiance, **179**, 181
 - compensation levels, 198
 - measurement, **179**
 - saturation levels, 198
 - spectra vs. depth, 187
 - transmission, water types, 185
 - underwater heterogeneity, 183
- Kappaphycus*. *See also* *Eucheuma*/*Kappaphycus*.
- kelp
 - Arctic, vs. UVB radiation, 339
 - blade development and water motion, 359
 - blade morphology and light harvesting, 358
 - canopy vs. ENSO, 228
 - community recovery after ENSO, 320
 - deep-water refuge model, 187
 - gametophytes endophytism, 172
 - impact of global warming, 322, 324
 - productivity flow to other ecosystems, 232
 - productivity in near-shore, 234

- productivity, geologic past, 228
- sporophyte growth vs. temperature, 307
- subtidal, and surge, 365
- temperature optima for growth, 306
- tropical deep-water populations, 186
- urchin grazing, 148
- urchins and sea otters, 148
- kleptoplasty, **173**
- kombu mariculture. *See* *Saccharina*.
- laboratory culture versus field experiments, **8**
- laminaran, 210
- Laminaria*. *See also* *Saccharina*
 - geographic shifts under global warming, 322
 - life-history control, 61
 - nitrogen depletion, 285
 - photoperiodism, 62
 - seasonal changes in enzymes, 300
 - thallus construction, 15
 - translocation, 218
- Laminariales
 - carbon translocation, 215
 - phlorotannin protection of spores, 226
- laminarian life history, 55
- Lessonia*
 - whiplash interference, 139
- Lessoniopsis*
 - phylogeny, 37
- Liebig's law of the minimum, 240
- life histories, **48**
 - and grazing, 158
 - environmental factors, **54**, 61
 - growth vs. reproduction, 54
 - latitudinal variation, 65
 - light photoperiod and wavelength, **58**
 - lunar rhythms, 62
 - ploidy levels, 50
 - seasonal anticipators and responders, **55**
 - short-day algae, 60
 - sporulation inhibitors, 62
 - temperature, **56**
 - temperature effects, 308
 - types, 48
 - variations, 52
- light. *See also* irradiance.
 - absorption spectra, 195, 196
 - absorption spectra vs. solar spectrum, 181
 - and photosynthesis, **176**
 - annual total irradiance, 186
 - changing radiation climate, **186**
 - component factors, 6
 - growth limitation, 284
 - intertidal and in estuaries, 182
 - light harvesting, **188**
 - light-harvesting complexes, 192
 - light-saturation curves, 197
 - limits to growth, **185**
 - penetration into ocean water, **182**
 - photon flux density (PFD), 181
 - photosynthetically active radiation (PAR), 179
 - photosystems I, II, 191
 - physical properties, absorption, 176
 - P-I curves, 197, 224
 - spectral changes with depth, **184**
 - underwater heterogeneity, **182**
 - water surface effects, **184**
 - water types, 184
- light-independent carbon fixation, 179, **207**, 211
- long-distance transport. *See* translocation.
- low molecular weight carbohydrates, 206, 207
 - in osmoregulation, 328
- lunar and tidal cycles, 66
- Macrocystis*
 - as foundation species, 136
 - blade morphology and boundary layers, 357
 - carbon translocation, 216, 275
 - forces from wind waves, 352
 - geographic variation, 9
 - kelp forest, 116
 - nitrogen composition, 282
 - nitrogen-uptake rates, 250
 - ontogenetic gradients in photosynthesis, 222
 - productivity models, 229
 - recovery from ENSO, 320
 - urchin impacts, 149, 150
 - variation in photosynthesis, 225
- magnesium
 - cellular functions, 273
- mannitol
 - in osmoregulation, 327
- mariculture, **413**
 - Eucheuma/Kappaphycus*, **426**
 - for biomitigation, **431**
 - global production, 414
 - Gracilaria*, 429
 - Integrated Multi-Trophic Aquaculture, **431**, 433
 - kelp cultivation, 423

- mariculture (cont.)
 - offshore/open ocean, **431**
 - Pyropia* methods, *418*
 - Saccharina*, **422**
 - tank cultivation, **430**
 - Undaria*, **425**
- mercury
 - toxicity, 385
- mesochiton, 68
 - role in attachment, 79
- mesograzers, 164. *See also* grazing.
 - control by predators, 152
 - feeding behavior with dictyol E, *168*
 - impact on seaweeds, 152
- meta-ecosystem
 - dynamics, **107**
 - ecology, 110
 - food webs, *109*
- metals, **378**
 - accumulation by seaweeds, 380
 - adsorption, uptake, accumulation, and biomonitors, **380**
 - associated with particulates, 382
 - detoxification, 384
 - ecological aspects, **389**
 - effects on algal metabolism, **384**
 - essential elements and performance, 378
 - exclusion of ions, 383
 - factors affecting toxicity, **388**
 - relative toxicity, 385
 - sources and forms, **378**
 - tissue concentration factors, fucoids, *381*
 - tolerance mechanisms, 383
 - toxicity tolerance mechanisms, **383**
 - trace elements baseline concentrations, *381*
 - trace metal concentrations and species in open ocean, *379*
- Michaelis-Menten equation, 244
- mitochondria
 - genome size, 21
 - inheritance, 22, 22
- mitosis
 - diurnal rhythm, 35
- mitotic recombination, 42, 44
- molecular biology of seaweeds, **35, 36**
- morphogenesis, **48**
 - blue light, 59, 89
 - effects of nutrients on *Petalonia*, 90
 - grazing effect on *Padina*, 91
 - red light, 59, 89
 - rhodomorphins, 97
 - temperature and daylength, 57
 - thallus, **83**
- morphological plasticity
 - Padina*, 92
- mucilage
 - in attachment, 79
 - in spermatia strands, 72
- multicellularity
 - and algal evolution, 5
 - and alternatives for use of water column, 4
 - and tissue differentiation, 5
 - cell-cell interactions, 5
 - decreased SA : V ratio and nutrient uptake, 280
- mycosporine-like amino acids
 - Antarctic red algal vs. photosynthesis, 338
 - in UVB protection, 338
- Nereocystis*
 - and water motion, 364
 - effect of water motion on blade morphology, 358
 - hydrodynamic forces, 365
 - life history, *64*
- nitrate
 - storage in vacuole, 261
 - uptake, 256
 - uptake kinetics, 255
- nitrate reductase, 258, 260
- nitric oxide
 - in wound healing, 95
- nitrite
 - uptake, 256
- nitrogen. *See also* ammonium, nitrate, nitrite.
 - assimilation, 258
 - cycle, marine, *242*
 - incorporation, **263**
 - isotope ratios detect pollution sources, 407
 - limitation, 281
 - sources, 241
 - storage, 263
 - tissue concentrations, 278
 - uptake, **256**
 - uptake and assimilation pathways, 262
 - uptake by Antarctic kelp, 285
 - uptake kinetic parameters, 258, 259
 - uptake rate measurements, 246
- non-Mendelian inheritance
 - somatic mutations, 42, 43
- nori. *See Pyropia*.
- nuclear genome, 45
- nucleocytoplasmic interactions, **45**

- nutrient enrichment. *See* eutrophication.
- nutrient requirements
 - essential elements, **238**
 - limiting nutrients, **240**
 - vitamins, **239**
- nutrient uptake
 - active transport, **244**
 - biological factors, **252**
 - facilitated diffusion, **243**
 - ion entry, **242**
 - kinetics, **244**
 - methods, **247**
 - passive transport, **243**
 - rate measurements, **246**
 - variation over time, **247**
- nutrient-uptake rates, **245**
 - chemical factors, **252**
 - intrathallus variation, **253**
 - phytoplankton vs. macroalgae, **254**
 - “safety factor”, **254**
 - vs. age classes, **252**
 - vs. desiccation, **251**
 - vs. light, **249**
 - vs. surface-area
 - volume ratio, **252–3**
 - vs. temperature, **250**
 - vs. water motion, **251**
- nutrients, **238**. *See also* specific elements, nutrient uptake, nutrient uptake rates, nutrient requirements.
 - availability in seawater, **240**
 - calcium and magnesium, **267**
 - component factors, **6**
 - critical tissue concentrations, **277**
 - effect of supply, **279**
 - functional-form effects, **279**
 - in morphogenesis, **90**
 - iron, **274**
 - movement to and through the membrane, **243**
 - phosphorus, **264**
 - relation to growth, **276**
 - storage and availability, **282**
 - sulfur, **274**
 - trace elements, **274**
 - uptake, assimilation, incorporation, and metabolic roles, **255**
- ocean acidification, **301**
 - and calcification, **273**
 - community impacts, **340**
 - inorganic carbon and calcification, **301**
- taxonomic variation of effects, **344**
- oil, **390**
 - crude oil components, **390**
 - diesel, effect on seaweed growth, **395**
 - dispersants in spill cleanup, **398**
 - disruption of cellular metabolism, **395**
 - effects on metabolism, life histories, communities, **394**
 - effects on sexual reproduction, **395**
 - environmental variables in situ, **396**
 - factors affecting spill, **393**
 - fate of spills in the ocean, **392**
 - hydrocarbon groups, **391**
 - microbial degradation, **393**
 - pathways for environmental fate, **393**
 - slick weathering, **392**
 - spill and cleanup impacts on habitats, **396**
- opportunistic vs. late-successional seaweeds
 - characteristics, **133**
 - costs and benefits, **134**
- Optimal Defense Theory, **166**
- osmoregulation, **328**
 - cell volume, **326**
- osmotic potential
 - component factors, **6**
- oxidative burst, **145**
- oxidative stress, **295**, **343**
- ozone depletion, **337**
- Padina*
 - grazing and morphogenesis, **91**, **92**
- parasitic red algae, **172–3**
- parthenogenesis, **53**
- patchiness, **125**, **126**
- pesticides, **398**
- Petalonia*
 - nutrients in morphogenesis, **90**
- pH. *See also* ocean acidification.
 - Desmarestia* sulfuric acid content, **170**
 - fluctuations at thallus surface, **342**
- phenotypic plasticity, **5**, **88**
 - temperature tolerance, **306**
- pheromones, **68**
 - brown algal, **69**
- phlorotannins, **143**, **165**, **169**
 - UV protection, **226**, **345**
- phosphorus
 - assimilation in tropical seaweeds, **281**
 - availability, **264**
 - critical and maximum tissue concentrations, **283**

546 Subject Index

- phosphorus (cont.)
 limitation, 266
 limitation in temperate seaweeds, 282
 phosphate organic sources, 266
 sources, 242
 tissue concentrations, 278
 translocation in kelps and fucoids, 275
 uptake and assimilation, 264
 uptake kinetics, 265
 uptake variation with shore position and season, 265
 uptake, assimilation and storage, 265
- photoinhibition, 199
 by UV radiation, 199
 dynamic, mechanisms, 199
 from desiccation, 334
 temperature dependent, 313
- photon growth yield (PGY), 200
- photoperiodism, 59, 61, 64, 88
 life histories, 60
 predicted tetrasporogenesis, 67
- photoreceptor proteins, 30
- photorespiration, 207, 209
- photosynthesis. *See also* photoinhibition
 and functional form, 222
 and salinity change, 330
 Antarctic red algae vs MAA concentrations, 338
 Calvin cycle, 179
 circadian rhythms, 222
 effects of spectral composition, 199
 electron transport rate, 220
 intrinsic variation, **222**
 light reactions, 176
 measurement, **218**
 overview, **176**
 pathways, **206**
 photosynthetic quotient (PQ), 219
 Photosystem II energy flow, 221
 photosystems I, II, 178
 quantum yield, 220
 rates, 218
 reaction centers, 177
 rhythms, 226
 vs. irradiance, **197**
 vs. temperature, light, 305
 vs. temperature, salinity, 328
 vs. water content, 335
 Z scheme, 177, 177
- phototaxis, 76
- phototropism, 89–90
- phycobilins
 structure, 190
- phycobiliproteins, 191
- phycobilisomes, 191, 193
- physodes, 17, 18
- phytochromes, 59
- phytohormones. *See* growth substances. *See also* abscisic acid,
 auxins, cytokinins, ethylene, polyamines.
- pigments. *See also* carotenoids, chlorophylls,
 phycobilins.
 antenna size vs. irradiance, 199
 structures, 190
- Pilinia*
 obligate epiphytism, 141
- pit connections, 11
 secondary, in parasitism, 173
- plasmids, 45
- plasmolysis, 326
- plastids, 23, 24
 autonomy and kleptoplasty, 25
 diel migration, 224
 evolutionary origin, 2, 3
 genome maps, 39
 inheritance, 22
 migration, 25, 26, 170
 sequenced genomes, 21
 types, 189
- plastids, pigments, and pigment–protein complexes,
188
- polar seaweeds
 and global warming, 319
 seasonal changes in enzyme activities, 303
 temperature tolerance, **315**
- polarity
 of zygotes, 81
- pollution, **374**. *See also* metals, oil.
 biogeochemical processes, 375
 community effects, 374
 component factors, 6
 effects at various levels of organization, 375
 impact on individuals, 376
 mixing of freshwater inputs, 380
 oil, **390**
 radioactivity, **408**
 seaweeds in standard tests, 376
 synthetic organic chemicals, **398**
 test organisms, 377
- polyamines, 93
- polyphosphates, 267

- polysaccharides, **210**
 - gel strength, 214
 - storage, 213
 - storage polymers, **210**
 - synthesis, **215**
 - wall matrix, **211**, 213
 - wall matrix, red algae, 214
- polyspermy, 71
- population dynamics, **128**, 146
 - dispersal, 130
 - mortality, 131
 - propagule bank, 131
 - reproductive effort, 129
 - reproductive success, 130
 - survivorship curves, 131
- Porphyra*, *See also Pyropia*
- Porphyra* mariculture. *See Pyropia*, nori.
- Postelsia*
 - and disturbance, 367
 - interference competition with mussels, 140
- productivity, **218**
 - autecological models, **227**
 - carbon losses, **225**
 - ecological impact, **229**
 - tissue loss, 227
 - tracking through food webs, **230**
- proteomics, 41
- protoplasts
 - fusion, 436
 - regeneration, 436
- Pterygophora*
 - stipe flexibility, 365
 - washed ashore, 366
- pyrenoids, 23
- Pyropia*
 - cell growth, 32
 - cultivation, **417**
 - cultivation methods, 418
 - culture problems, **419**
 - diseases in cultivation, 419
 - genetic selection for mariculture, 420
 - life history, 64, 416
 - mariculture, 415
 - mariculture production, 415
 - mariculture, future trends, **420**
 - nori production flow chart, 417
 - vegetative propagation, 420
- Pyropia nereocystis*
 - life history, 64
- radioactivity, **408**
- reactive oxygen species, 295, 310, 312, 345–6
 - in cell polarity, 83
 - in wound healing, 95
- red algal parasites
 - transfer into host cells, 174
- red light
 - in morphogenesis, 59, 89
- Redfield ratio, 280, 282
- regeneration, 86, 87, **94**, 97, 98
 - from sub-protoplasts, 96
 - polarity, 97
- Relative Dominance Model, 114
- relative growth rate
 - vs. nitrogen, 289
- reproduction, **48**, *See also* life histories, fertilization
 - asexual vs. sexual, 48
 - synchronicity, 65
- respiration
 - measurement, **218**
- Reynolds number, 353
- rhodomorphins, 97
- RuBisCO (ribulose 1,5-bisphosphate carboxylase-oxygenase)
 - properties, 206
- Saccharina*
 - breeding, 424
 - commercial cultivation, **422**
 - commercial cultivation of gametophytes, 424
 - commercial harvest for alginates, 423
 - commercial utilization and future prospects, **423**
 - copper effects on reproduction and growth, 386
 - for food and alginates, 421
 - growth and chemistry vs. light, nitrogen, 284
 - mitochondrial inheritance, 22
 - offshore cultivation test, 431
 - photosynthesis vs. temperature, 305
 - seasonal changes in enzymes, 300
 - seasonal growth vs. nitrogen, light, 284
 - temperature dependence of primary photosynthetic reactions, 302
 - temperature, photosynthesis acclimation, 304
- salinity. *See also* osmoregulation.
 - adaptations, Baltic Sea, 330
 - biochemical and physiological effects, **325**
 - component factors, 6, 325
 - effect on quantum yield, 332

548 **Subject Index**

- salinity. (cont.)
 - effects on photosynthesis and growth, **328**
 - estuaries, 296
 - growth of *Fucus*, 331
 - in tide pools, 299
 - measurement, 295
 - natural ranges, **295**
 - short-term responses to change, 327
 - tolerance and acclimation, **330**
 - tolerance, calcium and bicarbonate, 330
 - water potential, 325
- salt marshes
 - seaweed communities, 119
- sampling, 125
- sampling units
 - area sampled vs. number of taxa, 125
- sand
 - scour and burial, 371
- Sargassum*
 - propagule attachment, 78
 - settlement, 78
- Scytosiphon*
 - day length and life history, 65
 - erect thallus formation, 66
 - life history and anatomy, 50
 - mitochondrial inheritance, 22
 - morphogenesis cues, 57
- sea otters and kelp productivity, 148
- sea urchin grazing, 148
 - and otters, Alaska, 148
 - Macrocystis* beds, 149
 - tropics, 149
- seagrass, 3
 - tropical, 115
- seawater pH. *See* ocean acidification.
- seaweed communities, **113**
 - deep water, **120**
 - estuaries, **119**
 - floating seaweeds, **120**
 - kelp beds, 116
 - polar regions, **117**
 - salt marshes, 119
 - temperate floras, **116**
 - tide pools, **118**
 - tropical habitats, **113**
 - vs. CO₂ concentration, 343
- seaweeds
 - allelopathy in competition with corals, 145
 - as animal feeds, 434
 - as biomonitors, 380
 - as soil conditioners, fertilizer, 434
 - as term, 1
 - biomechanical properties, **360**
 - biotechnology, **435**
 - commercial production, 414
 - consumption history and production, 413
 - cultivated, 415
 - edible, production, 414
 - genetics, **42**
 - heavy metal accumulation, 389
 - herbivore interactions, **156**
 - in cosmetics, 435
 - in standard pollution tests, 376
 - interference competition with sessile animals, 140
 - morphology and anatomy, **9**
 - morphology vs. wave exposure, 363
 - nutrient removal from wastes, 435
 - phycocolloid production, 415
 - productivity in near-shore ecosystems, 234
 - tank cultivation, **430**
 - tensile strength, 363
 - thalli and cells, **1**
 - uses, 414
 - wall composition and tensile strength, 364
- secondary metabolites, 164
- sediment
 - as a substratum, 372
 - effects on rocky coast communities, 369
 - impact on settlement, 369
- self-fertilization, 45
- self-thinning, 146
- settlement, **74**
 - and boundary layer, 74
 - motility, 75
 - on bacterial biofilm, 77
 - propagules in fecal pellets, 76
 - selection, 77
 - sinking rates, 75
 - strategies, 75
 - substratum roughness, 78
 - surface properties, 77–8
 - Ulva* spores, 81
 - zoospore ultrastructure, 80
- sewage
 - ammonium toxicity, **403**
 - coral reef recovery, Hawaii, 402
 - effect on communities, **400**
 - effect on succession, 402
 - nutrient uptake by seaweeds, 435
 - outfall impacts, 401

- shell-boring algae
 - bicarbonate source, 204
- sieve tubes
 - ultrastructure, 217
- signaling pathways
 - in cell repair, 95
- Siphonocladales
 - wound healing, 97
- siphonous green seaweeds
 - morphology, 4, 4
- somatic cell hybridization
 - in mariculture, 436
- somatic embryogenesis, 44
- spatial scale and methodology, 127
- sperm limitation, 72
- Sphacelaria*
 - apical development, 86
 - development, 10
 - morphological development, 85
- sponges
 - symbiosis with seaweeds, 171
- Spongites*
 - response to limpet grazing, 163, 163
- sporulation inhibitors, 62, 63
- stable isotopes
 - as biomarkers in food webs, 232
- starch, 210
- stratification in coastal waters, 296
- stress, **294**
 - breaking, red and brown seaweeds, 363
 - disruptive, 294
 - factor interactions, 295
 - limitation, 294
 - physiological indicators, **346**
 - types, 294
 - vs. disturbance, 132
- stress response
 - heat shock proteins, molecular chaparones, 314
- subtidal zonation, **111**, 113
 - cold temperate, 112
 - functional-form groups, 113
- succession, 128
 - following disturbance, 367
 - investigational approaches, 128
- sulfation, 83
 - in attachment, 79
- surface-area : volume ratio and morphology, **279**
- surge
 - and growth rates, 357
- symbiosis, **170**
 - Agarum* and bryozoans, 141
 - fungi in seaweeds, 171
 - mutualism, **171**
 - red seaweeds and sponges, 171
 - Spongites* and limpets, 163
 - whole community mutualism, 171
- synchronization, gamete and spore release, **359**
- temperature
 - adaptation, heat shock proteins and molecular chaparones, 314
 - adaptation, membrane composition, 314–15
 - adaptation, physiological mechanisms, **312**
 - and geographic distribution, **321**
 - and reproductive timing, 308
 - as environmental stressor, **300**
 - chemical reaction rates, 300
 - community responses, 322
 - critical, 321
 - effects on metabolic rates, **303**
 - freezing stress, 308, 313
 - global warming, 322
 - growth optima, **304**
 - high, thallus damage, 309
 - in morphogenesis, 90
 - in tide pools, 299
 - microclimates, 298
 - natural ranges, **295**
 - optima for kelp growth, 307
 - requirements, Antarctic *Desmarestia*, 317
 - requirements, Antarctic red algae, 316
 - tolerance, **308**
 - tolerance, and global warming, 319
 - tolerance, phenotypic variation, 306
 - tolerance, polar seaweeds, **315**
- temperature-photosynthesis acclimation, 304
- temperature-salinity diagram, 296, 297
- terpenoids, 165
- tetrasporangium formation
 - temperature and daylength, 67
- thallus construction, **9**
 - clonal, 15, 16
 - filamentous, 11, 12
 - modular, 15
 - parenchymatous, 9, 10, 18
 - spore coalescence, 16
 - unitary, 15
- thermal pollution, **409**. *See also* temperature.
 - impact on photosynthesis and productivity, 410

- thermal pollution (cont.)
 - physical disorders, 409
- thigmotropism, 90
- thylakoid
 - structure, cyanelles, 193
- thylakoids
 - distribution of pigments and electron transport, 178
- tide pools
 - seaweed communities, **118**
- tides, **100**
 - predicted submersion/emersion curves, 104
 - sea-level changes, 101
- tin
 - antifouling compounds, 399
- tissue nitrogen
 - in competition and succession, 278
- totipotency, 87
- transcriptomics, 41
- translocation, **275**
 - long distance, carbon, **215**
 - mechanism, 216
- transposons, 43
- trophic cascade, 149, 151
- turbidity
 - and downward irradiance, 182
- turgor pressure, 325
 - regulation, 326
- ultraviolet radiation, **337**
 - effect on spore germination, 339
 - impact on organisms, 338
 - tolerance by Arctic seaweeds, 315
 - UVB, 186
 - UVB, ozone hole, 337
- Ulva*
 - allelopathic compounds, 144
 - ammonium uptake, 248
 - bubble mutant, 87
 - circadian gating in cell cycle, 35
 - diel plastid migration, 224
 - gametogenesis and gamete release, 63
 - in toxicant bioassays, 377
 - life-cycle regulation, 62
 - nitrogen starvation, 252
 - nitrogen uptake, 249
 - nutrient competition with *Chaetomorpha*, 279
 - phosphorus ecology, 265
 - photoperiodism, 62
 - settlement, 77, 77
 - settlement and adhesion, 81
 - ulvan, 212
 - versus *Chondrus* and grazers, 152
 - zoospore ultrastructure, 80
- ulvan, 212
- Undaria*
 - cultivation, **425**
 - dispersal as invasive species, 123
 - food products and future trends, **425**
 - photoperiodism, 62
 - use as food, 424
- uptake kinetics
 - phosphorus, 264
- urchins
 - intertidal and flash flood, 7
- urea
 - assimilation, 263
 - uptake, 258
- vacuole
 - nitrate storage, 261
- vegetation analysis, **124**
 - quantitative sampling, 124
 - remote sensing, 128
 - species diversity, 127
- velocity boundary layer, 352, 354
- vitamins
 - requirements, **239**
- wakame mariculture. *See Undaria.*
- wall polysaccharides
 - as cation exchangers, 243
- water motion, **349**
 - acceleration, lift and impingement, 362
 - and seaweed tensile strength, 363
 - boundary layers, 354
 - drag, 360
 - effect on morphology, 358
 - flow around *Macrocystis* blade, 356
 - flow over surfaces, **352**
 - in giant kelp bed, 351
 - laboratory flumes, 356
 - laminar flow and eddies, 353
 - laminar vs. turbulent flow, 352
 - measuring, **355**
 - resource acquisition, functional form, **356**
 - tenacity, 362
 - thallus reconfiguration, 361
 - waves, 352

- water potential, **325**
 - desiccation and freezing stress, **333**
 - regulation, 326
- water–water cycle, 310
- wave action
 - and productivity, 365
 - disturbance, **366**
 - water velocity and acceleration, 352
- wave-exposure indices, 355
- waves
 - energies, 351
 - physical nature, **350**
 - surge, 350
- wound healing, **94**
 - Bryopsis*, 95
 - in multicellular algae, 97
- wound plug assembly
 - biochemistry, 94
- zonation. *See* intertidal zonation, subtidal zonation.
- zygotes
 - asymmetric cell division mechanism, 84