

Index

A

- Abiotic stresses, 343
- Accelerated multiplication of plants, 336–338
- Agro-bacterium-mediated plant transformation, 350, 351
- Agro-food industrial sector
 - agro-ecosystem needs, 195
 - animal health needs, 194
 - hygiene and safety, 194
 - packaging, 193
 - pathogen control needs, 195
 - public awareness
 - evidence sources, 196
 - physical proximity with food, 195
 - social-demographic and cultural features, 196
 - reformulation, 194
 - sensing needs, 194
 - traceability and authenticity, 194
 - treatment and recovery needs, 195
- Agro-industrial wastes, 142
- Algae
 - CNMs
 - fullerenes, 260
 - graphene, 258, 259
 - graphene oxide (GO), 259
 - metabolomics analysis, 259
 - nutrient depletion-induced indirect toxicity, 260
 - reduced graphene oxide (rGO), 259
 - SWCNTs and MWCNTs, 260–262
 - metal nanoparticles
 - cerium dioxide nanoparticles, 275, 276
 - classification, 269
 - Cr₂O₃ nanoparticles, 273
 - CuNPs concentrations, 269, 270

- iron oxide (FeNPs), 272
- nickel oxide, 272, 273
- renewable biofuels, 268
- silver nanoparticles, 273, 274
- titanium dioxide nanoparticles, 276–278
- trace metal micronutrients, 269
- zinc oxide, 270–272
- Aluminum oxide NPs, 350
- Antimicrobial packaging, 42
- Antioxidant active packaging
 - nanoencapsulation, 233–235
 - nanoparticles, 235
 - oxygen colorimetric indicators, 235
- Artificial seeds, 338, 340, 341
- Atomic absorption spectroscopy (AAS), 111, 112

B

- Banana cultivation, 338
- Barrier packaging, 42
- Biannual cycle of carrot, 336
- Biodegradable packaging, 43
- Biofuels, 155, 156
- Biogas, 154, 155
- Biomimetics, 66
- Biomimetics, 66
- Bionic materials
 - calcium ions, 75
 - cosmetic prosthesis, 75
 - definition, 73
 - hydrogels, 74
 - nanoparticle carriers, 75
 - pectin films, 74
 - photosynthesis, 77

- Bionic materials (*cont.*)
 PLGA nanoparticles, 76
 stomata, 76
 synthetic materials, 73
- Biopesticides
 categories, 166
 chemical pesticides, 167
 definition, 166
 EOs, 167
- Bioreactors, 335, 338
- Bioremediation, 69
- Biosensors
 AChE-based, 176
 biorecognition element, 145
 classification, 145
 microorganism detection in water, 145
 optical detection, 176
 pathogen detection, 145
 plasmon, 177
 types, 176
- Biotechnologies in Developing Countries
 (BioDeC), 335
- Biotic and abiotic stresses, 334
- Bloodstain examination, 21
- Brassinosteroids, 339
- Bruker d8 Advance X-ray Diffractometer, 112
- C**
- Carbon-based nanomaterials (CNMs)
 agglomeration and adsorption, 258
 geometrical structure, 258
 vascular plants (*see* Vascular plants)
- Carbon-based quantum dots, 10
- Carbon nanoparticles
 down and bottom-up synthesis, 3, 4
 synthesis procedure, 4, 5
- Carbon nanotubes (CNTs), 73, 152, 352
- Carica papaya*, 339
- Cellular proliferation, 339
- Cerium dioxide nanoparticles
 algae, 275, 276
 vascular plants, 293–297
- Cerium oxide (CeO₂) NPs, 345
- Chemical/synthetic pesticides, 166
- Chemical vapor deposition (CVD) method, 6
- Chitosan, 49, 50
 chemotherapeutic drugs, 48
 ionic gelation method, 49
 nanomaterials
 agriculture and medical sciences, 115
 biological applications, 104
 DLS, 105–108
 elemental analysis, 108–112
 interaction analysis, 108
 ionic gelation method, 104
 physicochemical properties, 104, 105
 solid-state properties, 112–113
 surface and internal properties,
 113–115
 types, 104
 natural polymer, 48
- Chromosomal variations, 337
- Coffea arabica*, 340, 341
- Coffea canephora*, 339
- Contamination
 bacterial, 346
 fungi, 346
 microbial, 346, 353, 357, 358
- Controlled release formulations (CRFs), 174
- Copper oxide nanoparticles, 348
 algae, 269, 270
 vascular plants, 278–282
- Copper sulfate (CuSO₄) NPs, 347
- Cr₂O₃ nanoparticles, 273
- Cryopreservation, 341, 344
- Cytochrome c, 305
- D**
- Decontaminant agents, plant tissue culture
 Ag NPs, 355–356
 application, NPs, 354, 355
 bacteria, 353
 fungi, 353
 in vitro culture, 353
 metal and metal oxide NPs, 354, 355
 TiO₂ NPs, 356–357
 ZnO NPs, 357–358
- Dendrimers, 49, 51
- Doping, 147
- Dye sensitization, 147
- Dynamic light scattering (DLS)
 Brownian motion, 105
 Henry equation, 107
 PDI, 107
 Stokes-Einstein equation, 106
- E**
- Eco-friendly technology, 147
- Ecotoxicology, 177, 178
- Electron spectroscopy for chemical analysis
 (ESCA), 108–109
- Energy
 agro-industrial waste, 154
 biofuels, 155, 156
 biogas, 154, 155

- photoelectrochemical cells, 157
 - photovoltaic cells, 155–157
 - Environment degradation
 - antibiotic-resistance mechanisms, 95
 - bacteria
 - Eloquent ex situ model, 89
 - flagellar homologous system, 89
 - multimeric complex, 89
 - RAPD-PCR, 89
 - secretion system, 89
 - virus control, 90
 - enzymes and viruses, 88–91
 - Halo-organic compounds, 93
 - inorganic nanoparticles and metabolism
 - interactions, 87–88
 - MEMS, 86–87
 - micro- and nanoplastic effects, 94
 - micro and nano pollutants, 86
 - nanoplastic pollutants, 83–85
 - non-genotoxic carcinogenic mechanisms, 95
 - phthalates/chlorinated compounds, 93
 - pollution tax, 95
 - Pseudomonas/Aromatoleum aromaticum*, 95
 - terrestrial and aquatic environments, 94
 - viruses and nitrification inhibitors, 91, 92
 - xenobiotics degradation, 94
 - Environmental deterioration, 334
 - Essential oils (EOs), 167
 - Eva program, 112
 - Ex situ conservation, 334, 340
 - Explosive detection, 21
- F**
- Fertilizers, 152–153
 - Fingerprint detection, 20, 21
 - Food and Agriculture Organization's (FAO)
 - database, 335
 - Food industries
 - functional foods, 191
 - herbicides and fertilizers, release of, 191
 - multinational companies, 191
 - nanoparticle emulsions, 192
 - nano-spheres/microspheres, 191
 - omega-3 food additives, 191
 - packaging materials, 191
 - Food packaging
 - antimicrobial, 42
 - barrier, 42
 - biodegradable, 43
 - description, 41
 - function, 189
 - novel trending technology, 189
 - spoilage/loss of food nutrients, 189
 - use, 190
 - Food packaging materials (FPMs), 237
 - Food processing
 - nanodrops, 41
 - nanoparticles in food sectors, 41, 42
 - Food science
 - and agriculture sectors, 187
 - nano-foods, 187
 - progressions in industrial sectors, 187
 - Food sector
 - additives and packing, 188
 - agro-food industrial, 188
 - application matrix, 189
 - nanoscience approach, 188
 - novel functional materials, 187
 - public and future workforce, 187
 - Forensic genetics, 19, 20
 - Forensic sciences
 - criminal investigation, 17
 - novel methods, 17
 - PMI estimation, 17, 18
 - toxicological analysis, 18
 - Fourier transform infrared (FTIR)
 - spectroscopy, 108
 - Fragaria vesca*, 344
 - Freshwater sources, 144
 - Fullerenes
 - algae, 260
 - allotropic form of carbon, 121
 - and CNTs, 121
 - vascular plants, 264
- G**
- Genetic improvement of crops, 342–343
 - Germplasm, 343–344
 - Glomus etunicatum*, 339
 - Glowing plants, 75, 77
 - Gold nanoparticles (AuNPs), 52–54, 345
 - Graphene
 - algae, 258
 - vascular plants, 263, 264
 - Graphene oxide (GO)
 - algae, 259
 - vascular plants, 263, 264
 - Gunshot residue analysis, 21
- H**
- Hybrid nanomaterials, 122

I

- In vitro conservation, 340
- In vitro culture, 336, 343–347, 353, 358
- Indium oxide (In₂O₃) NPs, 345
- Industrial production of propagules, 338
- Inorganic nanoparticles, 52–54
- International Agency for Research on Cancer (IARC), 92, 95
- Ionic gelation method, 104, 105
- Iron oxide nanoparticles (FeNPs), 272, 286–289, 348

L

- Liposomes, 51, 52, 353
- Living organisms, 334, 335

M

- Macronutrient nanofertilizers, 37, 38
- Magnetic nanoparticles, 150, 151
- Meat and milk products
 - antibacterial mechanism, 211–228
 - antifungal mechanism, 228
 - bacterial food-borne pathogens, 207
 - bacterial genus *Enterococcus*, 208
 - cheese spoilage, 208
 - chemical hazards, 236, 237
 - nanoencapsulated plant extracts, 208–210 (*see also* Oxidation)
 - pathogenic and spoilage microorganisms, 208
- Mesoporous silica NPs (MSN), 346
- Metal-/alloy-based quantum dots
 - applications, 17
 - characterization, 16
 - chemical modification, 15
 - electronic transitions, 15
 - size and composition, 15
 - synthesis procedures, 15, 16
- Metal nanomaterials
 - agriculture and crop management, 120
 - biological and engineering applications, 119
 - mainly top-down and bottom-up synthesis, 120
 - non-invasive imaging and drug delivery system, 120
- Metal nanoparticles
 - algae (*see* Algae)
 - vascular plants
 - cerium dioxide, 293–297
 - copper oxide, 278–282
 - environmental contamination, 278
 - iron oxide (FeNPs), 286–289
 - silver, 290–293
 - titanium dioxide, 297–300
 - uptake and accumulation, 278
 - zinc oxide, 282–286

- Metallic nanoparticles, 150, 151
- Microbial pesticides, 166
- Micro-electro-mechanical systems (MEMS)
 - green revolution, 87
 - plastic monomer polymerization, 86
 - POCT, 87
- Micrografting, 343
- Micronutrient nanofertilizers, 37, 38
- Micropropagation, 337–339
- Morphogenic callus, 339
- Multiwalled CNTs (MWCNTs)
 - algae, 260–262
 - vascular plants, 264–268

N

- Nano zero valent iron (nZVI), 88
- Nanoagriculture
 - agro-industrial wastes, 142
 - applications, 142
 - energy (*see* Energy)
 - fertilizers, 152–153
 - global food production, 142
 - knowledge-based economy, EU, 193
 - nanosensors, 193
 - particle farming, 193
 - pesticides, 152–153
 - smart agro-chemical delivery systems, 153
 - smart sensors and delivery systems, 193
 - water (*see* Water)
- Nanobionics
 - agricultural production, 66
 - biological entities, 381
 - biomimetics, 66 (*see also* Bionic materials)
 - bioremediation, defined, 69
 - definition, 65
 - drought biosensors, 70, 71
 - exceptional optical properties, 66
 - nanotubes penetration, 381
 - near-infrared signal shift,
 - chemiluminescent emission, 381
 - nitroaromatics, 66, 67
 - novel biotechnological material, 65
 - pectins (*see* Pectins)
 - photosynthesis and chemical sensing, 380
 - radio signals/color change detection, 69 (*see also* Smart dust)
- Nanoceuticals, 43
- Nanoencapsulation
 - antioxidant active packaging, 233–235
 - bioactive compounds, 203
 - biological activity, nanoemulsions, 205

- Brownian motion effects, 205
- cyclodextrins, 204
- emulsion-based delivery systems, 205
- essential oils, 203
- food bioactive compounds, 204
- hydrophilic and lipophilic compounds, 204
- materials, 203
- organoleptic properties, 203
- Ostwald ripening phenomenon, 205
- phytosome, lipophilic molecular complex, 204
- plant nanocarriers, 204
- SCF methods, 204
- spoilage microorganisms, 202
- starch, polysaccharide in plants, 203
- Nanofertilizers
 - controlled release of, 125
 - crop development, 39
 - micronutrient and macronutrient, 37, 38
- Nanofiltration, 149
- Nanoformulations
 - copper nanoparticles, 174
 - CRFs, 174
 - description, 173
 - insoluble compounds, 174
 - polymer encapsulated formulations, 174
 - silica-based NPs, 174
 - silver (I) oxide, 174
- Nanofungicides, 172
- Nanoherbicides, 171
- Nanoinsecticides, 170
- Nanomaterials
 - abiotic stress-induced damage, 118
 - agriculture field, 118
 - bottom-up synthesis, 124
 - carbon based materials, 120, 121
 - description, 118
 - fertilizers, 152–153
 - hybrid, 122
 - manufacture and electronics, 44
 - metals (*see* Metal nanomaterials)
 - nanopesticide, 119
 - pesticides (*see* Phytotoxicity of nanomaterials)
 - plant growth, 124, 125
 - plant tissue culture
 - decontaminant agents (*see* Decontaminant agents)
 - plant biotransformation, 350–353
 - polymeric, 121
 - properties, 152
 - researchers, 118, 123
 - top-down synthesis, 123
 - types of, 118
- Nanomedicine
 - definition, 46
 - drug delivery and therapeutics, 46
 - liposomal doxorubicin, 46
- Nanomembranes, 149, 150
- Nanonematocides, 169
- Nanoparticles (NPs)
 - advantages and disadvantages, 3
 - Ag, 345–349, 355, 356
 - aluminum oxide, 350
 - application, 9, 355
 - in calli, 348
 - CeO₂, 345
 - Cu and Co, 349
 - CuO, 348
 - CuSO₄, 347
 - Fe₃O₄, 348
 - In₂O₃, 345
 - metal and metal oxide, 354
 - morphology, 8
 - MSN, 346
 - nanosilver, 356
 - organic and inorganic, 2
 - properties, 345
 - Raman spectra, 9
 - seed germination, 35, 36
 - SEM and SEM-based methods, 8
 - silica, 352
 - silica-silver, 346
 - starch, 352
 - structural characterization, 8
 - TiO₂, 356, 357
 - ZnO, 346–349, 357, 358
- Nanopesticides
 - agricultural fields, 168
 - avermectin, 40
 - chemical insecticides, 169
 - fungal diseases, 173
 - nanocarrier, 169
 - nanoformulation, 38
 - nanoparticles, 168
 - pest and pathogen control, 38
 - polymeric materials, 40
 - target-specific herbicide molecule, 169
- Nanoporous materials, 149, 150
- Nanosensors
 - in agriculture, 40, 41
 - applications, 143
 - characteristics, 144
 - contaminants detected in water, 146
 - food preservation, 44
 - microfluidic systems, 44
 - microorganism, 145
 - NEMS and DTS, 44

- Nanosensors (*cont.*)
 quality water diagnostics, 144
 silicon-based materials, 44
 soil, 154
 types, 143
- Nanosilver NPs, 356
- Nanotechnology
 benefit, 192
 ecological influences, 184
 in environment, 45, 46
 examples of, 184, 185 (*see also* Food industries) (*see also* Food science) (*see also* Food sectors)
 innovative applications, 196
 innovative branch of, 184
 and nanoagriculture (*see* Nanoagriculture)
 novel innovative food products and process, 184
 nutritional and nutraceuticals packing, 186
 and plant tissue culture (*see* Plant tissue culture)
 produce sensors, 185
 risks for, 192
See also Agro-food industrial sectors
- Neomycin phosphotransferase II gene (NPT II), 353
- Nickel oxide nanoparticles, 272, 273
- Non-GM biotechnology, 335
- Non-homologous end-joining (NHEJ), 343
- N use efficiency (NUE), 94
- O**
- Organic nanoparticles
 chitosan, 48–50
 dendrimers, 49, 51
 encapsulated drugs, 47
 liposomes, 51, 52
 PLGA, 47, 48
 polymeric, 46
- Ostwald ripening phenomenon, 205
- Oxidation
 antioxidative mechanism, 231–233
 description, 229
 nanoencapsulated plant extracts, 230, 231
 peroxide value, 229
 physical and chemical tests, 229
 sensory attributes, 229
- Oxygen colorimetric indicators, 235
- Oxygenic photosynthesis
 crop management techniques, 257
 description, 256
 elements/compounds utilization, 256
 energy conversion, 257
 plant gene expression, 257
 US National Nanotechnology Initiative, 256
- P**
- Pectins
 and charged ions, 72
 high temperature detection, 73
 MWCNT/epoxy, 73
 photosynthesis, 73
 TCR construction, 73
- Pentachlorophenol (PCP), 93
- Persistent organic pollutant (POPs), 167
- Pesticides, 152–153
 agricultural crops protection, 165
 application, 166
 biotransformation, 167
 carbamic acid, 168
 chemical/synthetic, 166
 chromatographic strategies, 175
 classification, 166
 cross placenta, 167
 definition, 165
 dermal, ocular and inhalation, 167
 electrochemical sensors, 175
 in situ electrochemical gadgets improvement, 175
 in surface water, 167 (*see also* Nanopesticides)
 nontarget species, 166
 organophosphate, 168
 plant ailments and bug administration, 175
 POPs, 167
 pyrethroid, 168
 transducers, 176
- Photocatalysis, 147–149
- Photoelectrochemical cells, 157
- Photon correlation spectroscopy (PCS), 105
- Photosynthetic apparatus
 chloroplasts, thylakoids and photosynthetic pigments, 306, 307
 cyanobacteria and alga, 307, 308
 cytochrome c, 305
 hole-electron pairs, 300
 photosystem I and II, 301–305
 plasmon enhancement, photon fields, 301
 reaction centers (RCs), 301
 semiconductor/photosynthetic protein, 301
- Photovoltaic cells, 155–157
- Physical vapor deposition (PVD) method, 7, 8
- Phytotoxicity of nanomaterials
 biochemical, physiological and molecular obstruction, 134
 nanotoxicity and plant growth, 133, 134

- Plant biotransformation
 - agro-bacterium, 350, 351
 - binary BAC system, 351
 - calli/PLB, 352
 - carbon nanotubes, 352
 - crown gall tumorigenesis, 351
 - indirect method, 350
 - liposomes, 353
 - MWCNTs, 352
 - PLL-StNP, 352
 - SWCNT, 351
 - SWCNT/FITC, 352
 - SWCNT/single-stranded DNA-FITC, 352
 - T-DNA, 351
 - vectors and methodologies, 350
 - Plant extracts
 - nanoencapsulation (*see* Nanoencapsulation)
 - Plant-incorporated-protectants (PIPs), 167
 - Plant-mediated synthesis
 - chemical factories, 205
 - chromatograms, 207
 - functional groups, 206
 - green nanoparticle preparation, 205–206
 - in vivo conditions, 207
 - physical and chemical methods, 206
 - Plant metabolism
 - AgNPs, 378
 - apoplastic pathway, 379
 - artemisinin and diosgenin, 380
 - biotic and abiotic stress, 378
 - nanostructured biomaterials, 377
 - N-glycans, 379
 - physical and chemical, 377
 - physiological parameters, 378
 - Rubisco (ribulose-1, 5-bisphosphate carboxylase/oxygenase), 379
 - ZnO NPs uptake, 378
 - Plant nanobionics approach, 308–310
 - Plant systems
 - description, 372
 - foliar/shoot and root system, 373
 - growth and development, 375, 376
 - hydathodes, 373
 - nanomaterials, 373
 - nanoparticles movement, 374
 - Plant tissue culture
 - accelerated multiplication, 336–338
 - advance of nanotechnology
 - biological contaminants in banana, 346
 - callus, 348
 - concentrations, 348
 - cultivars of rice, 345
 - fungi contamination, potato apices, 346
 - NPs (*see* Nanoparticles (NPs))
 - seed germination, 345
 - somatic embryogenesis, 347
 - TIS, 346
 - in agriculture
 - applications, 335
 - biotechnology, 334, 335
 - definition, 335
 - non-GM biotechnology, 335
 - productivity, 334
 - world agriculture, 334
 - genetic improvement, 342–343
 - germplasm, 343–344
 - history and development, 336
 - in vitro culture, 336
 - nanomaterials (*see* Nanomaterials)
 - technology uses
 - advantages, 338
 - application, 342
 - artificial seeds, 340
 - banana cultivation, 338
 - brassinosteroids, 339
 - Carica papaya*, 339
 - cellular proliferation, 339
 - cryopreservation, 341
 - ex situ conservation, 340
 - in vitro conservation, 340
 - regenerating plants, *Coffea arabica*, 340, 341
 - seed industry, 342
 - somatic embryogenesis, 339, 340
 - sweet potato, 339
 - vitrification, 341
 - totipotency, 336
 - PLGA nanoparticles, 47, 48
 - Point-of-care testing (POCT), 87
 - Polydispersity index value (PDI), 107
 - Poly-L-lysine-starch NPs (PLL-StNP), 352
 - Postmortem interval (PMI) estimation, 17, 18
 - Proteobacteria, 95
 - Protocorm-like bodies (PLB), 352
- Q**
- Quantum dots (QDs), 54, 55
 - applications, 13, 14
 - carbon-based, 10
 - characterization, 13
 - synthesis procedures, 11–13

R

- Rapid expansion of supercritical solutions (RESS), 204
- Reduced graphene oxide (rGO), 259
- Resonant energy transfer (RET) system, 44
- Root growth promotion (RGP), 346

S

- Scanning electron microscopy (SEM), 113
- Secondary metabolism, 377, 380
- Seed germination, 345
- Seed industry, 342
- SEM combined with energy-dispersive X-ray spectroscopy (SEM-EDX), 113
- Sensors
 - classification, 143
 - contaminants detected, 146
 - converts physical parameters, 143
 - microorganism, 144, 145
 - non-biological, 143
 - quality, 144
 - to monitor soil conditions, 153, 154
- Silica-silver NPs, 346
- Silver nanoparticles (Ag NPs), 345–349, 352, 355, 356
 - algae, 273, 274
 - vascular plants, 290–293
- Single-walled CNTs (SWCNTs)
 - algae, 260–262
 - fluorescein isothiocyanate (FITC), 352
 - single-stranded DNA-FITC, 352
 - vascular plants, 264–268
- Smart agro-chemical delivery systems, 153
- Smart dust
 - defined, 78
 - fluorescent oligo capture probe, 79
 - motes, 78
 - natural environment, 79
 - person-to-person communication, 79
 - wireless network computer connection, 78
- Somaclonal variation, 342, 343
- Somatic embryogenesis, 335, 338–341, 347, 349, 356, 357
- Starch-NPs, 352
- Stokes-Einstein equation, 106
- Supercritical antisolvent (SAS), 204
- Supercritical fluid (SCF) methods, 204
- Supercritical fluid extraction of emulsions (SFEE), 204
- Sweet potato, 339

T

- Taxus brevifolia*, 344
- Temperature coefficient of electrical resistance (TCR), 73
- Temporary immersion systems (TIS), 338, 344, 346
- Thermoplastic starch (TPS), 88
- Thermotherapy, 343
- Thylakoids, 306, 307
- Titanium dioxide nanoparticles
 - algae, 276–278
 - vascular plants, 297–300
- Titanium dioxide nanoparticles (TiO₂ NPs), 356, 357
- Totipotency, 336
- Transgenic organisms, 343
- Transmission electron microscopy (TEM), 114

V

- Vascular plants
 - CNMs
 - carbon black NPs, 263
 - fullerenes, 264
 - graphene, 263, 264
 - graphene oxide (GO), 263, 264
 - H₂O₂ content, lipid peroxidation and antioxidant enzyme activities, 263
 - SWCNTs and MWCNTs, 264–268
 - metal nanoparticles
 - cerium dioxide, 293–295, 297
 - copper oxide, 278–282
 - iron oxide (FeNPs), 286–289
 - silver, 290–293
 - titanium dioxide, 297–300
 - zinc oxide, 282–286
- Viruses and nitrification inhibitors, 91, 92
- Vitamin sprays, 44
- Vitrification, 341

W

- Wastewater
 - remediation and purification, 143
 - treatment, 143
- Wastewater treatment plants (WWTPs)
 - micro- and nanopollutants, 85
 - mismanagement, 86
- Water
 - contaminants, 143
 - human use and agriculture, 143
 - purification, 146–151

- remediation and purification of wastewater, 143
 - sensor (*see* Sensor)
 - Water purification
 - conventional process, 146, 147
 - magnetic nanoparticles, 150, 151
 - metallic nanoparticles, 150, 151
 - nanomembranes, 149, 150
 - nanoporous materials, 149, 150
 - photocatalysis, 147–149
 - wastewater treatment, 146
 - zeolites, 149, 150
- X**
- X-ray diffraction (XRD), 112
 - X-ray photoelectron spectroscopy (XPS), 108, 109
- Z**
- Zeolites, 149, 150
 - Zinc oxide nanoparticles (ZnO NPs), 346–349, 357, 358
 - algae, 270–272
 - vascular plants, 282–286