

# Index

## A

ABI's SOLiD, 33  
Actinomycetes, 102  
Activated carbon, 361–362  
Acute lymphoblastic leukemia (ALL), 22  
Acute toxic effect, 358  
Adsorption, 63  
Aerobic granular sludge (AGS), 265  
Aerobic granular sludge-sequencing batch reactor (AGS-SBR), 254  
Agar-vinasse medium (AVM), 193  
Agar-vinasse plates, 193  
Air sparging, 81  
Alkaliphilic fungi, 322, 324  
Alkane hydroxylase, 110  
Alkylphenols, 80, 138  
*Alphaproteobacteria*, 163  
American Petroleum Institute (API), 201  
4-Aminoantipyrine assay, 249  
Ammonia/ammonium (NH<sub>4</sub>), 30  
Ammoniacal copper quat (ACQ), 32  
Amorphous metal oxides, 361  
Amplicon surveys, 5  
Anaerobic biodegradation, 147, 148  
Anthraquinone dye, 359  
Anthropogenic origin, 138  
Anti-inflammatory drug, 310  
Aquatic organisms, 191  
Arbuscular mycorrhizal fungi (AMF), 88, 90, 91  
Archaeal communities, 125, 126  
Argyria, 378  
Aromatics, 116  
Arsenic (As), 376  
Ascomycetes, 85  
Aspergillus Genome Database (AspGD), 66  
*Aspergillus penicillioides*, 323

Asphaltenes, 116  
Assimilation, 109  
Autochthonous vinasse-degrading fungus, 192–195  
    data interpretation and statistical approaches, 193–195  
    experimental procedures, 193

## B

Bacteria, 84, 85  
    and archaea, 141–148  
    secrete antibiotics, 163  
Bacterial communities, 123–125  
Bacterial degradation, 101  
Bacterial population extraction, soil matrix  
    bioremediation-oriented microbial isolation, 10, 11  
    chemical dispersing agent, 10  
    culture media enrichment, 10  
    microorganisms, 9  
        biosurfactants, 14, 15  
        enzymatic characterization, 13, 14  
        metabolic characterization, 13  
        morphological characterization, 12, 13  
        selection by agar diffusion test, 12  
        selection by channels in plates, 12  
        selective enrichment, 11  
        siderophores synthesis, 15  
    (NaPO<sub>3</sub>)<sub>6</sub> method, 10  
Basidiomycetes, 85  
Benzene, 226  
Benzene, toluene, ethylbenzene and xylene (BTEX), 30, 204  
Bimetallic nanoparticles, 309  
Bioaccumulation, 3, 62, 310

- Bioaugmentation, 46, 83  
*See also* Fluorinated compounds
- Biodegradation, 140, 190
- Biodeterioration, 108
- Biofilm formation, 263
- Bio-fragmentation, 109
- Biogenic uraninite, 307
- Bioinformatics, 17
- Biological contaminants, 379–380
- Biological degradation, 101
- Biologically controlled mineralization (BCM), 19
- Biologically induced mineralization (BIM), 19
- Biological oxygen demand (BOD), 204
- Biological remediation, 83
- Biological treatments, 140
- Biom mineralization, 19, 20, 63
- BIOPOL™, 289
- Bioreactors, 251, 266
- Bioremediation, 5, 46, 57, 83, 118, 119
- Bio stimulation, 46, 83, 119
- Biosurfactants, 14, 15
- Biotransformation *vs.* biodegradation, 258
- Biotreatment process, 141
- Bladder cancers, 343
- BLASTMatrix, 67
- Borohydride, 348
- Brazilian Environmental Legislation, 206
- C**
- Cadmium (Cd), 376
- Calixarenes, 306
- Carbamate compounds, 84
- Carbohydrate active enzyme (CAZymes), 36, 64
- Carbon-based gels, 374
- Carbon based materials, 382
- Carbon based nano-materials, 361, 371, 381  
 classification, 371, 372  
 contribution, 371
- Carbon based supercapacitors, 383
- Carbon-fluorine bond, 240
- Carbon materials, 384
- Carbon nanostructures  
 carbon-based gels, 374  
 carbon sponge, 374  
 CNFs, 373  
 CNTs, 373  
 fullerenes, 372  
 graphene, 373
- Carbon nanotubes (CNTs), 305, 306, 362, 373, 383
- Carbon sponge, 374
- Carbon structured material, 371
- Carboxymethyl cellulose (CMC), 309
- Carcinogenic effects, 138
- Carotenoids, 20
- Catabolic genes, 245
- Cation exchange, 319
- Cellobiohydrolases (CBH), 30
- Cetyltrimethylammonium bromide (CTAB), 36
- Chemical contaminants, 375–378  
 arsenic, 376  
 cadmium, 376  
 carcinogen agent, 376  
 chromium, 377  
 lead, 377  
 mercury, 377  
 selenium, 377  
 xenobiotic compounds, 376
- Chemical oxygen demand (COD), 171, 204
- Chemostat-enrichment systems, 246
- Chemotrophic  
 aerobic, 123  
 anaerobic, 123
- Chlorella sorokiniana*, 168
- Chlorella vulgaris*, 169, 170
- Chlorinated and nitro-derivatives, 140
- 2-Chlorophenol (2-CP), 309
- Chlorophenols, 138
- Chlorophyta*, 174
- Chromated copper arsenate (CCA), 32
- Chromium (Cr), 377
- Chromophores, 356
- Citric acid cycle, 330
- Clay minerals, 319
- Clustered regularly interspaced short palindromic repeats and associated proteins (CRISPR/Cas), 69–72
- CNT-based polymeric materials, 306
- Cold-adapted microalgae, 168
- Comparative Fungal Genomics Platform (CFGP), 66
- Constructed wetlands (CWs)  
 capital, operation and maintenance costs, 228, 229  
 classification, 208  
 design, 207, 208  
 hybrid, 217, 218  
 macrophytes, 221–224  
 microorganisms  
 crude oil polluted medium, 227  
 hydrocarbons, 225, 226  
 microbial ecology, 224, 225  
 substrate medium, 226, 228  
 petroleum refinery wastewater, 208–210  
 petroleum wastewater treatment, 212–214

- removal pathways, 218–220
  - SF, 210, 211
  - SSF (*see* Subsurface flow (SSF) CWs)
  - Contaminants, 375
  - Continuous source molecular absorption spectrometry (CS-MAS), 259
  - Coprinopsis cinerea* peroxidases, 64
  - Creosote, 32
  - Cretaceous-Permian extinction, 321
  - Cultivation systems, 164
  - Cyanobacteria and eukaryotic microalgae, 153
  - Cytochrome P450 (CYP) enzymes, 64
  - Cytosol, 3
- D**
- Dead Sea, 323
  - Defluorination, 244
  - Degradation pathways, 149
  - Dehydrogenase, 13, 14
  - Dendrimers, 307, 308
  - Department of Chemical Engineering, 190
  - Dermatitis, 101
  - Dichloro diphenyl trichloroethane (DTT), 80
  - Dichlorvos (2,2-dichlorovinyl dimethyl phosphate), 36
  - Diepoxybutane (DEB), 67
  - Diepoxyoctane (DEO), 67
  - Diethyl adipate (DOA), 104
  - Diethyl phthalate (DOP), 104
  - Dispersal, ability, 310
  - Distillery wastes, 187, 188
  - Double-stranded breaks (DSBs), 68
  - Dyeing process, 356
  - Dye removal efficiency, 362
  - Dyes, 356, 375
    - acute toxic effect, 358
    - classification, 358
    - genotoxic textile, 358
    - toxicology effects, 357–360
    - types, 357
  - Dye-sensitized solar cells, 382–383
- E**
- Ecological microalgae-bacteria interactions, 161–163
  - Ecotoxicity, ability, 310
  - Effects analysis, 194, 195
  - Efficient mixing, 168
  - Electrochemical energy storage devices, 383
  - Electrolytic conductivity (EC), 318
  - Electromigration, 82
  - Electroosmosis, 82
  - Electrophoresis, 82
  - Enantioselectivity, 253, 254
  - Endoglucanase B (EGLB), 327
  - Endophytic fungi, 89
  - Endophytic microbes, 89
  - Energy, 378
  - Engineered polymeric nanoparticles, 307
  - Environmental biotechnology, 63, 64
  - Environmental cleaning, 375
  - Environmental cleanup techniques, 301
  - Environmental management, 45
  - Environmental pollution, 79, 80
  - Environmental Protection Agency (EPA), 376
  - Environmental remediation
    - and energy application, 371
    - and energy storage, 371
    - industrialization, 375
    - water contamination, 375
  - Enzymatic characterization
    - dehydrogenase and oxidoreductase, 13
    - hydrolytic enzymes, 13
    - laccases, 14
    - peroxidases, 14
  - Enzymatic hydrolysis process, 327
  - Esterases, 104, 110
  - Ethyl methanesulfonate (EMS), 67
  - Eukaryotic algae, 163
  - EuPathDB, 66
  - Evolved beta-galactosidases (EBG), 30
  - Exocellular polymeric substances (EPS), 12
  - Exopolysaccharide (EPS), 30
  - Experimental factors, 194
  - Extracellular nanoparticles, 326
  - Extracellular polymeric substances (EPS), 263
- F**
- Federal Environmental Protection Agency (FEPA), 224
  - Fermentation/distillation conditions, 186
  - Fertile soil, 332
  - Filamentous fungi, 66, 72, 188
  - Fluidized bed bioreactor (FBR), 191
  - Fluoranthene, 283
  - Fluoride (F), 343
    - adsorbents, 344
    - chemical component, 345
    - compounds, 345
    - excessive intake, 345
    - geographical distribution, 345
    - industries and agriculture, 346
    - nanobioremediation, 346
    - nanomaterials, 346
    - pollution, 345

- Fluoride (F) (*cont.*)  
 sources, 343, 346  
 USPHS recommendation, 347
- Fluorinated compounds  
 analytical methods, 258–260  
 bioaugmentation  
 application, 264–266  
 delivery approaches, 262–264  
 principles and strategies, 260–262  
 biodegradation, 243–245  
 biogenic, 242  
 co-contamination, 252, 253  
 enantioselectivity, 253, 254  
 enrichments, 245, 246, 249–251, 261  
 environmental concerns, 240, 241  
 hydroxyl groups, 240  
 mineralization *vs.* biotransformation,  
 254–256, 258  
 naturally produced, 241–243  
 protein-ligand interactions, 240  
 selection/attainment, degrading organisms,  
 245, 246, 249–252  
 stability, lipophilicity and biological  
 activity, 240
- Fluorine-19 nuclear magnetic resonance  
 spectroscopy (<sup>19</sup>F NMR), 258, 259
- Fluoroacetic acid (fluoroacetate), 241
- Fluorobenzene, 252
- 4-Fluorocinnamic acid (4-FCA), 265
- 2-Fluorophenol (2-FP), 265
- Fluoroquinolones, 240
- 6:2 Fluorotelomer alcohol (6:2 FTOH), 256, 257
- Fluoxetine, 240
- 454FLX Titanium platform, 38
- Forced bed aeration system, 215
- Fossil fuel, 378
- Free-water surface (FWS), 210
- Freshwater microalgae, 167
- Fullerenes (C60), 372
- Full factorial design, 195
- Fungal biomass, 188
- Fungal bioremediation  
 ABC transporters, 36  
 antibacterial compounds, 30  
 cDNA libraries, 37  
 cellulolytic enzymes, 30  
 cellulose and hemicellulose compounds, 36  
 D1/D2 region, 32  
 DNA microarrays, 37  
 dye terminator sequencing technology, 38  
 elements, 30  
 environmental authorities' procedures, 38  
 enzymatic/phenol-chloroform extraction  
 methods, 31  
 eukaryotic genomes, 37  
 function-based, 32  
 fungal cell walls, 31  
 heat-shock resistance, 37  
 interference molecules, 38  
 ITS region, 32  
 metabolic plasticity, 30  
 metatranscriptomics, 37  
 microbial metabolism, 31  
 microorganisms, 30, 31  
 nucleic acids extraction technique, 31  
 omics technologies, 33  
 pathogenesis, 37  
 petrochemical products, 36  
 phyla, 30  
 pollutants, 29  
 454 pyrosequencing, 38  
 radiation resistance, 37  
 restoration procedures, 37  
 RNA extraction, 36  
 sequence-based, 32  
 toxic environments, 31  
 transcriptomics, 32, 34–35, 37  
 xenobiotic compounds, 29, 39
- Fungal communities, 126–128
- FungiDB, 66
- Fungal degradation, 101, 282
- Fungal engineering, 65–67
- Fungal enzymes, 65
- Fungal growth, 193
- Fungal-metal interactions, 285
- Fungal nanoparticles, 332
- Fungal pellets, 189
- Fungal strains, 149–151
- Fungal xenobiotic metabolism, 72, 73
- Fungal xenometabolites, 73
- Fungi, 85, 86
- Fungus-based aerobic processes, 188
- Fungal spores, 193
- G**
- Garbage dumps, 100
- Gas chromatography (GC), 259
- Gaseous contaminants, 378–379
- Gene-centric approach, 46
- Gene-editing, 68
- Gene manipulation  
 biotechnology techniques, 68  
 categorization, 67  
 chemical and physical mutagens, 67  
 CRISPR/Cas, 69, 70  
 endonuclease-mediated tools, 69  
 endonucleases, 68

- exogenous DNA, 67
- induce random/quasi-random insertional mutagenesis, 67
- microbial metabolism, 67
- MNs, 69
- mRNAs, 68
- site-directed mutagenesis, 68
- TALENs, 69
- transgenesis, 68
- ZFNs, 69
- Genotoxic textile, 358
- Geobacter sulfurreducens*, 84
- Global Industry Analysts, 99
- Glomalin related soil protein (GRSP), 88
- Glucanases, 36
- $\beta$ -Glucosidases, 30
- Glycosyl hydrolases, 36
- Gram-negative and Gram-positive strains, 147
- Graphene (GN), 344, 373, 383
  - properties, 349
  - sheets, 383
- Graphene based nanomaterials, 382
- Graphene oxide (GO), 344, 349
- Green bioremediation, 344
- Greener approach, 310
- Green method, 351
- GS-FLX, 38
- Guide RNA (gRNA), 71
- Gypsum, 329
  
- H**
- Haloalkaliphilic fungi, 320, 332
- Halogenated organic compounds (HOCs), 309
- Halophilic and alkaliphilic fungi, 331
- Halophilic Archaea, 148
- Halotolerant/halophilic fungi, 322, 323
  - extracellular nanoparticles, 326
  - gallic acids, 328
  - genomic sequence, 328
  - inorganic metallic ions, 325
  - microbes, 327
  - nanoparticles, 325, 326
  - nitrate reductase and sulfite reductase, 327
  - organic acids, 328
  - stressful factors, 326
  - Verticillium* fungus, 325
- Hapalosiphon*, 172
- Hazardous pollutants, 355
- Heart and lung related disease, 378
- Heavy metals, 205, 206
- Heterotrophic microorganisms, 282
- High-density polyethylene (HDPE), 105, 289
  
- High performance liquid chromatography (HPLC), 259
- High-rate algal ponds (HRAP), 166
- Homing nucleases, 69
- Homologous recombination (HR), 68
- Homology-directed repair (HDR), 68
- Homology modelling, 251
- Horizontal gene transfer (HGT), 261
- Horizontal subsurface flow (HSSF), 208, 209, 216, 217
- Hybrid carbon nanotubes (HCNTs), 306
- Hybrid CWs, 217, 218
- Hydraulic loading rate (HLR), 215
- Hydraulic retention times (HRT), 210
- Hydrocarbons, 102, 107, 116, 200, 225, 226, 282
- Hydrofluorocarbon (HFC), 254
- Hydrolases, 13
- Hydrolytic enzymes, 327
- Hydrophobicity, 344
  
- I**
- Ibuprofen, 80, 310
- Illumina technologies, 123
- Illumina's Solexa, 33
- Immobilization, 63
- Incineration process, 101
- Induced systemic resistance (ISR), 87
- Industrial Revolution, 61
- Industrial wastewater generation, 355
- International Standardization Organization (ISO), 7
- Intracellular and extracellular nanoparticles, 325
- Intracellular enzymatic system, 64
- Ion-selective electrodes, 259
- Iron nanoparticles, 304
  
- K**
- $\beta$ -Ketoadipate pathway, 64
  
- L**
- Laccase, 14, 30, 36, 109, 111, 292
- Landfills, 100
- L-asparaginase, 22
- Lead (Pb), 377
- Light saturation, 167
- Lignin-modifying enzymes (LMEs), 64, 292
- Ligninolytic fungi, 292
- Lignin peroxidase (LP), 14, 30, 111, 292
- Li-ion battery, 384

- Linear low-density polyethylene (LLDPE), 103  
 Lipases, 104  
 Liquid chromatography (LC), 17, 259  
 Low-density polyethylene (LDPE), 105, 289  
 Lytic polysaccharide monoxygenases (LMPO), 30
- M**
- Macromolecule degradation enzymes, 331  
 Macrophytes, 221–224  
 Magnetic nanoparticles (MNPs), 306  
 Manganese-dependent peroxidase (MnP), 14  
 Manganese peroxidase (MnP), 30, 111, 292  
 Marine-derived fungi  
   biofilm formation, 282, 283  
   heavy metaloids removal, 284–286  
   petroleum oil, 290–293  
   and plastic degradation  
     anthropogenic sources, 288  
     biota and humans, 288  
     PE, 289, 290  
     PHAs, 288, 289  
     polymers, 287  
   synthetic dyes and textile-dye effluent, 286, 287  
 Mass spectrometry (MS), 259  
 Matrix-associated laser desorption/ionization time-of-flight MS (MALDI-TOF-MS), 17  
 Medium chain length (MCL)-PHAs, 288  
 Meganucleases (MNs), 69  
 Membrane filtration technology, 364  
 Mercury (Hg), 377  
 Metabolic characterization, 13  
 Metabolic degradation pathways, 153  
 Metabolic engineering, 66  
 Metabolism-dependent active  
   bioaccumulation, 3  
 Metabolism-independent passive biosorption, 3  
 Metabolomics, 17  
 Metagenomic analysis, 5  
 Metagenomics, 15, 16, 44–47  
 Metal-associated enzymes, 329  
 Metal based electrode material, 370  
 Metal entry, 4  
 Metallothioneins, 86  
 Metaproteomics, 16, 17, 44, 52–56  
 Metatranscriptomics, 16, 44  
 Methane, 101  
 Methyl tert-butyl ether (MTBE), 204  
 Microalgae, 152, 154–160, 164  
 Microalgae-bacteria consortia, 159–161, 168–174  
 Microbes, 101  
 Microbial application, 329  
 Microbial cell wall, 310  
 Microbial consortia, 140, 161  
 Microbial diversity, 4  
 Microbial isolation  
   extremophiles, 5  
   soil sampling design  
     biotic and abiotic factors, 6  
     metagenomic analysis, 9  
     plant-microorganism interactions, 7  
     sample collection and transportation, 7, 8  
     samples processing and storage, 8, 9  
 Microbial networks, 53  
 Microbial peroxidases, 112  
 Microbial respiration, 121  
*Microcystis aeruginosa*, 169  
 Microorganisms, 2, 3  
 Mineralization, 109  
 Mineralization vs. biotransformation, 254–256, 258  
 Molecular docking, 251  
 Molecular scissors, 69  
 Monocyclic aromatic hydrocarbons, 116  
 Mono (2-hydroxyethyl) terephthalic acid (MHET), 103  
 Morphological characterization  
   endospore staining, 13  
   gram staining, 12  
   staining with methylene blue, 13  
 Multiwalled carbon nanotubes (MWNTs), 306, 347  
 Mycelia, 85  
 Mycophytoremediation, 90  
 Mycoremediation, 329–331  
   *See also* Fungal bioremediation  
 Mycorrhizoremediation, 88
- N**
- Nano-adsorbents, 360–362  
   adsorption phenomenon, 361  
   copper oxide nanoparticles, 361  
   materials, 380  
   oxide-based nano-adsorbents, 361  
   surface activities, 362  
 Nano-bioremediation, 346, 350, 356, 360  
   adsorption, 344  
   conventional technologies, 343–344  
   WHO guidelines, 343  
 Nano-catalysts, 363  
 Nanocrystals, 305, 306  
 Nanoiron, 304, 305

Nanomaterials, 303, 347, 360, 370  
Nano-membranes, 364, 381  
Nanoparticles, 321, 322  
  applications, 303  
  bimetallic, 309  
  biogenic uraninite, 307  
  engineered polymeric, 307  
  green synthesis, 310  
  in situ and ex situ remediations, 304  
  microbe-derived, 310  
  organic and inorganic, 302  
  single-enzyme, 306  
  TiO<sub>2</sub>, 308, 309  
Nanoparticle zero-valent iron (nZVI), 348  
Nanoremediation, 311  
  bimetallic nanoparticles, 309  
  biogenic uraninite nanoparticles, 307  
  dendrimers, 307, 308  
  engineered polymeric nanoparticles, 307  
  nanocrystals and CNTs, 305, 306  
  nanoirons, 304, 305  
  single-enzyme nanoparticles, 306  
  TiO<sub>2</sub>, 308, 309  
Nanoscale particles (NSPs), 302  
Nanoscale zero-valent iron (nZVI), 304  
Nano-sized materials, 380  
Nanotechnology, 302, 303, 310, 360, 380  
  nanotubes, 347–348  
Nanowire, 370  
Natural attenuation, 118  
Next generation sequencing, 32  
Next Industrial Revolution, 302  
N-fixing cyanobacterium, 320  
Nicotinamide adenine dinucleotide  
  (NAD<sup>+</sup>), 13  
Nicotinamide adenine dinucleotide phosphate  
  (NADP), 13  
Nitrate reductase and sulfite  
  reductase, 333  
4-Nitroquinoline 1-oxide (4NQO), 67  
N-methyl-N'-nitro-N-nitrosoguanidine  
  (MNNG), 67  
Nonaqueous phase liquids (NAPLs), 307  
Nonhomologous end joining  
  (NHEJ), 68  
Non-ligninolytic fungi, 293  
Nonrenewable fossil fuels, 370  
Nonsteroidal antiinflammatory drugs  
  (NSAIDs), 80  
Nucleic acid extraction (DNA-RNA)  
  techniques, 31  
Nucleic acid extraction protocol, 173  
Nutrients, 206  
Nylons, 99

**O**  
Oil and grease (O&G), 205  
Olive oil production, 170  
Olive oil washing water (OWW), 141,  
  171, 173  
Omics approach  
  culture dependent and independent, 44  
  fluxomics, 44  
  genomics, 43  
  interatomics, 44  
  metabolomics, 44  
  metagenomics, 45–47  
  proteomic in degradation concept  
    (*see* Proteome)  
  proteomics, 44  
  transcriptomics, 43, 47  
Omics technologies  
  culture-independent methods, 15  
  metabolomic, 17  
  metagenomics, 15, 16  
  metaproteomics, 16, 17  
  metatranscriptomics, 16  
Open-culture systems, 167  
Operation and maintenance (O&M), 229  
Organic acid excretion, 3  
Organic micropollutants, 79  
Organic pollutants, 204, 205  
Organic solvents, 200  
Organofluorine compounds, 241,  
  246–249  
Organophosphate, 84  
Oxidation-reduction system, 50  
Oxide-based nano-adsorbents, 361  
Oxidoreductases, 13, 14, 329  
**P**  
Paracetamol, 80  
PCR amplification methods, 68  
PCR-DGGE, 250  
Pentachlorophenol, 32  
5-(Pentafluorosulfanyl)2-aminophenol, 256  
Pentafluorosulfanyl group (-SF<sub>5</sub>), 255  
Perfluorinated compounds, 256  
Permeable reactive bio-barriers, 82  
Peroxidases, 14  
Persistence, ability, 310  
PETase, 103  
Petroleum contaminants  
  heavy metals, 205, 206  
  nutrients, 206  
  nutrients and toxic compounds, 204  
  organic pollutants, 204, 205  
Petroleum (crude oil), 115, 116

- Petroleum hydrocarbons (PHCs)
  - activities, 117
  - bioremediation, 118, 119
  - biostimulation, 119
  - environmental compartments, 117
  - microbial communities (*see* Soil microbial communities)
  - pollutants, 117
  - soil, 117
  - thermal, chemical and physicochemical technologies, 117
- Petroleum oil, 290–293
- Petroleum PAHs, 292
- Petroleum refining industry, 200
- Petroleum refining wastewater
  - characteristics, 202–203
  - conventional wastewater treatment technologies, 206, 207
  - CWs (*see* Constructed wetlands (CWs))
  - types, 200, 201
- PHC-contaminated soils, 119–122, 125, 126, 128
- Phenol hydroxylase, 147
- Phenolic compounds (PCs), 136
  - aerobic treatment, 160
  - aquatic systems, 138
  - bacteria, 159
  - bioremoval, 153
  - chloro- and nitro-derivatives, 138
  - classification, 136
  - CO<sub>2</sub> concentrations, 160
  - concentrations, 137, 162
  - degradation pathway, 149, 153
  - fungi, 149
  - microalgae, 152, 159
  - natural sources, 137
  - nonylphenol/triclosan, 159
  - photosynthetically enhanced biodegradation, 168
  - physicochemical methods, 139
  - polyphenolic molecules, 137
  - salicylate removal rates, 169
  - wastewater treatment, 152
  - yeast cultures, 149
- Phenolic molecules, 140
- Phospholipid fatty acids (PLFA), 121
- Phosphorus, 206
- Photobioreactors (PBRs), 165, 172, 173
  - advantages and limitations, 165
  - characteristics, 164
  - closed systems, 166
  - culture flows, 166
  - laboratory-scale, 169
  - light, 166
  - microalgae cells, 167
  - N and P nutrients, 167
  - open, 165
  - OWW, 171
  - pH influences, 167
  - phenol removal, 170
  - sunlight, 167
  - surface/volume ratios, 165
  - temperature, 167
  - treatments, 170
  - tubular, 166, 168
  - types, 165
- Photocatalytic efficiency, 363
- Photooxidation, 62
- Photosynthetically active radiation (PAR), 166
- Photosynthetic efficiency, 168
- Photosynthetic oxygenation, 170
- Phototrophic, anoxygenic, 123
- Photovoltaic cell, 382
- Phthalate esters, 80
- Phycoremediation, 152
- Phylogenetic Investigation of Communities by Reconstruction of Unobserved States (PICRUSt), 250
- Physicochemical and microbiological technologies, 186
- Physicochemical methods, 138, 140
- Phytodegradation, 86
- Phytoremediation, 98, 209
  - arbuscular mycorrhizal symbiosis, 87
  - and fungi, 88–91
  - phytodegradation, 86
  - phytostabilization, 86
  - plant hormones, 87
  - plant-microbe associations, 87
  - rhizodegradation, 86
  - rhizosphere, 87
  - surface root colonization and endophytic microorganisms, 87
  - xenobiotics, 86
- Phytoremediation process, 344
- Phytostabilization, 86
- Phytovolatilization, 86
- Plasticized polyvinyl chloride (pPVC), 104
- Plastics
  - biodegradation
    - assimilation, 109
    - bacteria, 102–104
    - biodeterioration, 108
    - bio-fragmentation, 109
    - factors, 106, 107
    - fungi, 104, 105
    - microbes, 101, 102
    - microbial enzymes, 109–111



- mineralization, 109
    - steps, 108
  - containers, 98
  - defined, 97
  - degradation, 98
  - mechanisms, 102
  - non-biodegradable, 98
  - pollution, 98–101
  - types, 98, 99
- Pollutants**
- biomineralization, 19, 20
  - biopolymers, 22
  - carcinogens, 301
  - carotenoids, 20
  - exocellular polymeric substances, 21
  - hydrolases, 22
  - microbial interaction produces, 18
  - microorganisms, 18
  - polycyclic hydrocarbons, 18
  - stress cell protection, 18
  - surfactants, 22
- Pollution, 2, 79**
- Poly- and perfluoroalkyl substances (PFASs), 245**
- Polyamidoamine (PAMAM), 307
  - Polycaprolactone (PCL), 103, 104, 106
  - Polychlorinated biphenyls (PCBs), 66, 80
  - Polychlorinated hydrocarbons, 66
  - Polycyclic aromatic hydrocarbons (PAHs), 48, 66, 80, 116, 201, 291, 307
  - Polycyclic phenolic compounds, 136
  - Polyester polyurethane (PUR), 104
  - Polyethylene (PE), 98, 99, 289, 290
  - Polyethylene terephthalate (PET), 99, 103, 110
  - Polyfluoroalkyl compounds, 240
  - Polyhydroxyalkanoates (PHAs), 102, 288, 289
  - Polynuclear aromatic hydrocarbons (PAHs), 15
  - Polyphenol oxidase and laccase enzymes, 153
  - Polypropylene (PP), 99
  - Polystyrene (PS), 99
- Polythenes**
- bacteria, 102–104
  - classes, 98
  - constituent, 111
  - ethylene monomers, 97
  - HDPE and LDPE, 105
  - hydrocarbons, 107
  - microbial enzymes, 109–111
  - and plastics (*see* Plastics)
- Polyurethane (PUR), 99**
- Polyvinyl chloride (PVC), 99, 101**
- Proteome**
- alachlor biotransformation pathway, 50
  - anthracene biotransformation, 50
  - benzo[a]pyrene degradation, 50
  - biodegradative processes, 48
  - 2-DE-based and gel-free quantitative, 48, 49
  - environmental biotechnology, 48
  - herbicide, 50
  - isoenzymes, 50
  - metaproteomics, 52, 53
  - 4-*n*-nonylphenol, 50
  - phenanthrene degradation, 50
  - posttranslational modifications, 48
  - secretome, 48
  - Sphingomonas* sp. GY2B, 50, 51
  - xenobiotics, 48, 52
- Protospacer adjacent motif (PAM), 71**
- Pseudomonas*, 111**
- Pyrosequencing, 123**
- Q**
- Quantitative PCR (qPCR), 121**
- Quantum dots, 370**
- R**
- Redox chemical reactions, 364**
- Refined products, 200**
- Remediation technologies**
- air sparging, 81
  - contaminants, 81
  - electrodes, 82
  - ex-situ* method, 81
  - global climate change, 80
  - human activities, 80
  - in situ* method, 81
  - incineration/thermal adsorption, 83
  - organic and inorganic water contaminants, 82
  - physical-chemical, 83
  - soil flushing and washing, 81
  - surfactants/acidic solutions, 82
  - toxic materials, 81
  - vacuum extraction system, 82
- Repeat variable di-residue (RVD), 69**
- Resins, 116**
- Resuscitation-promoting factor (Rpf), 250**
- Reverse osmosis (RO), 218**
- Reversibility, ability, 310**
- Rhizobiaceae*, 163**
- Rhizodegradation, 66**
- Rhizosphere, 330**
- Rhodamine B (RB), 309**
- RNA interference (RNAi), 68**
- Roche's 454, 33**

**S**

Saline-alkali conditions, 330  
 Saline-alkaline soils, 330  
 Saline and arable lands, 319  
 Saline environment-derived fungi  
   alkaliphilic fungi, 322  
   amelioration, 321  
   *A. penicillioides*, 323  
   CCHA, 324  
   halophilic fungi, 323  
   halotolerant fungi, 323  
   microorganisms, 320  
   sodic soils, 318  
   soil-forming processes, 318  
   soil microorganisms, 320  
   soil salinization, 317  
   source, 317  
   subhumid and humid climates, 317  
   tillage operations, 318  
 Saline soil remediation, 332  
 Salt-affected soils, 320  
 Sanger methodology, 38  
 Saturates, 116  
 Scientific community, 39  
 Secretome, 48  
 Selenium (Se), 377  
 Sequencing batch reactors (SBRs), 246  
 Short chain length (SCL)-PHAs, 288  
 Siderophores synthesis, 15  
 Single-enzyme nanoparticles, 306  
 Single-walled carbon nanotubes (SWCNTs),  
   306, 347, 362  
 Soda saline-alkaline soils, 318  
 Soil, 2, 6, 117  
 Soil alkali, 318  
 Soil-charcoal perfusion system, 246  
 Soil fungi, 330  
 Soil-inhabitant fungi, 332  
 Soil microbial communities  
   abundance, 121, 122  
   activity, 120, 121  
   archaeal communities, 125, 126  
   bacterial communities, 123, 125  
   fungal communities, 126–128  
   high-throughput sequencing  
     techniques, 122  
 Soil microorganisms, 320  
 Soil mycoremediation, 320, 329–331  
 Soil salinization, 317  
 Solar cells, 382  
 Stable isotope probing (SIP), 250  
 Subsurface flow (SSF) CWs, 210  
   HSSF, 216, 217  
   VSSF, 211, 215, 216

**Sugarcane vinasse**

  anaerobic digestion, 188  
   bioethanol production, 186  
   biological conditioning, 186  
   bioreactor, 191  
   conventional practices, 186  
   degradation, 192  
   distillery wastes, 186  
   FBR, 191  
   filamentous fungi, 189  
   fungal products, 189  
   management, 187  
   microbial technologies, 186  
   phenol and color removal, 190  
   phenolic compounds, 190  
   pollutants, 189  
   treatment, 190  
   white-rot fungus, 190  
 Supercapacitors, 383–384  
 Surface flow (SF) CWs, 210, 211  
 Surface functionalization, 381  
 Surface plasmon resonance, 302  
 Sustainable development, 311  
 Systemic acquired resistance (SAR), 87

**T**

*Tetrademus obliquus*, 168  
 Textile dyes, 357  
 Textile effluents, 363  
 Textile wastewater, 356  
 Thermal desorption, 82  
 Thiocalixarenes, 306  
 Titanium dioxide (TiO<sub>2</sub>), 308, 309  
 Total dissolved solids (TDS), 218  
 Total petroleum hydrocarbon-diesel range  
   organics (TPH-DRO), 215  
 Toxic dyestuffs, 359  
 Transcription activator-like effector nucleases  
   (TALENs), 69  
 Transcriptomics, 37, 38, 47  
 Trichloroethylene (TCE), 305  
 Trifluoroacetic acid (TFA), 254  
 Trifluoromethyl group, 254, 255  
 TRI Reagent kit (Sigma), 36  
 Two-dimensional polyacrylamide gel  
   electrophoresis (2-DE), 17

**U**

US Department of Energy Joint Genome  
   Institute, 67  
 US Environmental Protection Agency  
   (EPA), 138

**V**

- Versatile peroxidase (VP), 14
- Vertical subsurface flow (VSSF), 208, 209, 211, 215, 216
- Viable but non-culturable (VBNC), 250
- Victoria's agricultural land, 318
- Vinasse composition, 186
- Vinasse neutralization, 191
- Vitrification technology, 82
- Volatile organic compounds (VOC), 378

**W**

- Wastewater biotreatments, 52
- Wastewater treatment processes, 159
- Water contamination, 375
- World Health Organization (WHO), 224

**X**

- Xenobiotic compounds, 61–63, 376
- Xenobiotics, 61, 79, 80, 111

**Y**

- Yarrowia lipolytica*, 283
- Yeasts, 85
- Yellow laccases, 84

**Z**

- Zero dimension carbon materials
  - fullerenes (C<sub>60</sub>), 372
- Zinc finger nucleases (ZFNs), 69