

Index

- a**
- ABI 3100 Genetic Analyzer 520
 - ablative, vacuum, and transported bed
 - pyrolysis reactors 153
 - absorption-enhanced reaction (AER) gasifiers 230
 - acetaldehyde production 385–386
 - acetogenesis 135
 - acetone–butanol–ethanol (ABE) fermentation
 - adsorption *see* adsorption process
 - biobutanol concentration 255
 - butanol concentration 255
 - distillation *see* distillation process
 - gas stripping
 - – cooling temperature 257
 - – distillation system 259
 - – fed-batch mode 257
 - – fermentation broth 256
 - – gas flow 256
 - – *in situ* gas stripping separation processes 259
 - – integration processes 257
 - – kinetic models 257
 - – online butanol recovery 257, 258
 - – partial pressure of component 257
 - – phase separation 259
 - – process 256
 - – single-pass mode 256
 - – stripping rate constant 257
 - – vacuum pump 259
 - – water fraction 257
 - liquid–liquid extraction
 - – butanol–biodiesel mixture 260
 - – distillation system 262
 - – fermentation broth 260
 - *in situ* liquid–liquid separation process 261–262
 - – limitations 261
 - – organic-based extraction system 260
 - – partition coefficients 260
 - – perstraction technique 261
 - – solvent extractants 260, 261
 - pervaporation
 - – binary/multicomponent flowing liquid 266
 - – chemical–thermal stability 267
 - – condensed ethanol product 271
 - – *in situ* ABE separation 271, 272
 - – integration processes 271, 273
 - – mechanical properties 267
 - – membrane module configurations 267, 268
 - – mixed matrix membranes (MMMs) 267
 - – organophilic and hydrophilic membranes 267
 - – permeate flux 267
 - – process 267
 - – PV membranes 267, 269–270
 - – separation factor 267
 - acetone formation pathway 337
 - acetyl coenzyme A (CoA) 183
 - N*-acetyl-D-neuraminic acid (Neu5Ac) aldolase
 - *N*-acetyl-D-glucosamine (GlcNAc) 26
 - activity ratio 29
 - chromosomal heat shock proteins 28
 - over-expressed fusion proteins 27
 - particle size 28
 - retro-aldolase (RA) 29
 - reversible aldol condensation 26
 - SEM images 27
 - solubilization tags 26–27
 - xylanase 29
 - acidogenesis 135
 - adipose-derived stem cells (ADSCs) 622
 - adsorption–drying–desorption (ADD) process 263

- adsorption process
 - adsorbents 264–266
 - adsorption–drying–desorption (ADD) process 263
 - energy-efficient separation technique 262
 - factors 262–263
 - hydrophobic adsorption sites 263
 - hydrophobic zeolites 266
 - industrial biobutanol production process 266
 - methods 263
 - selective adsorption property 262
 - thermal stability 266
- advanced gasification process 229
- Aeropyrum pernix* esterase 43
- Affymetrix HuSNPTM DNA microarrays 533
- agricultural biotechnology 4
- agricultural residues 163, 168
- L-alanine production 385
- albumin fusion technology 648–650
- Alcohol dehydrogenases (ADH) 44
- aldehyde–alcohol dehydrogenase (*aad*) gene 337
- alkali-catalyzed processes 138
- allele-specific enzymatic reactions 531
- allele-specific oligonucleotide competitive hybridization (ASOCH)
 - applications 532–533
 - body labeling method 534
 - capture probes 532
 - fluorescence-labeled nucleotides 532
 - immobilization method 533
 - peptide nucleic acid (PNA) probe sequences 534
 - probe design 533
 - sample preparation 533
 - target–probe hybridization efficiency 534
- allele-specific probe hybridization 531
- American Institute of Chemical Engineers (AIChE) 8
- 5-aminolevulinic acid (5-ALA) 501, 504, 505
- 6-aminopenicillanic acid (6-APA) 43
- ammonia fiber explosion (AFEX) 106
- amplification of a separated ligation-dependent probe (ASLP) technology 546–248
- α -amylase 84
- anaerobic digestion (AD) pathway
 - batch type reactors 136
 - biochemical reactions 134–135
 - bio-filters 134
 - biogas 133, 134
 - chemical reactions 133
 - granular activated carbon (GAC) filters 134
 - high solids (HS) processes 135
 - low solids (LS) reactors 135
 - mesophilic bacterium 133
 - microbial lipid production 206
 - multistage process 135–136
 - organic feedstocks 133
 - organic fraction 133, 134
 - pretreatment technology 196–198
 - renewable natural gas (RNG) 136–137
 - single-stage process 135
 - total solids (TS) content 135
 - volatile fatty acids (VFAs) 175, 176
 - waste-management infrastructure 134
- antibiotic compound 4
- antibiotic resistance-based methods 308–309
- antibody-based target-specific drug delivery 612–613
- antibody–drug conjugate (ADC) 613
- artificial supramolecular protein assemblies
 - biomolecular assembly system 93
 - gram-positive bacteria 94
 - horseradish peroxidase (HRP) 93
 - multienzymatic complexes 93
 - recombinant functional proteins, classification 94
 - self-assembly processes 93
 - – covalent assembly 98, 100
 - – non-covalent assembly 97–99
 - site-specific conjugation 93
 - site-specific ligand–receptor interaction 93
 - specific interaction/reaction sites
 - – covalent manipulation 95
 - – lysine residues 96
 - – microbial transglutaminase (MTG) 96
 - – molecular functions and systems 94, 95
 - – non-covalent alignment 94–95
 - – nucleic acid scaffolds 96–97
 - – protein of interest (POI) 96
 - transglutaminases 93, 94
- aryl alcohols 105
- ASEAN Countries 169 *see also* lignocellulosic biomass resources
- Asian herbal medicine texts 445
- Z-aspartame 42
- atomic force microscopy (AFM)
 - actin antibody-modified microsphere probe 570
 - actin-modified surface and actin antibody-modified microsphere probe 572
 - adhesion force 570–571

- antigen–antibody interaction force analysis 568
- Cu ion-binding force measurement 568–569
- force–distance curve 570
- Gaussian curve fitting 571
- peptide probe and Cofilin protein 571–572
- physical interactions 567–568
- principle 568
- protein–protein interaction 568
- protein–protein interaction force measurement, peptide probes 569
- scanning probe microscopy (SPM) 567
- single molecular order interaction force 571
- auger-type gasifiers 221
- auto-gasification 217
- autotrophic microalgae 210
- azeotropic phase separation 274
- Azospirillum* sp. 430–431
- Azotobacter* spp. 431–432
- b**
- Bacillus* spp. 432–433
- bacterial biofertilizers
 - *Azospirillum* sp. 430–431
 - *Azotobacter* spp. 431–432
 - *Bacillus* spp. 432–433
 - biofertilizers, definition 429
 - bio-inoculant 429–430
 - chemical fertilizers 429
 - *Pseudomonas* spp. 434–435
 - *Rhizobia* spp. 435–436
- ball milling method 106
- batch/fed-batch cultures 183
- batch process simulation 739, 742
- Bead array platform-based SNP genotyping
 - assay platforms 550–551
 - hybridization conditions 549, 550
 - oligonucleotide probes 549
 - Sentrix Array Matrix (SAM) 549
 - Sentrix BeadChip 549
- BioCADi framework 793, 794
- biocatalysts, definition 81
- biocatalytic reactions, enzymatic
 - bioconjugation 93–101
- biochemical engineering 7 *see also*
 - biotechnology engineering
 - education 10–11
- biodiesel production 203
 - brown grease 138
 - non-food lipids 138
 - triglycerides 137
- waste oils and lipids, non-food sources 137
 - yellow grease 137–138
- bioelectronic nose
 - applications 487, 488
 - environmental monitoring 491, 492
 - food quality 490, 491
 - fragrance and flavor industries 492
 - medical 488–490
 - olfactory receptors (OR) 477
 - olfactory sense 477
 - primary transducers 477, 478
 - biological sensing materials 479
 - cytochalasin B 480
 - highly selective and sensitive detection 481, 482
 - nanomaterial-based sensor 479
 - olfactory-nanovesicle-fused carbon nanotube-transistor biosensor (OCB) 481
 - olfactory receptor protein 479, 480, 483–484
 - single-walled carbon nanotube-field effect transistors (SWNT-FET) sensor 481
 - whole-cell-like signaling process 480
 - secondary transducer 477, 479
 - field effect transistor 486–487
 - quartz crystal microbalance (QCM) 485
 - surface plasmon resonance (SPR) 486
- bioenergy and bio-based products 131
- bioenergy conversion pathways 133
 - anaerobic digestion (AD) pathway *see* anaerobic digestion (AD) pathway
 - aquatic biomass
 - algae 140–141
 - bio-based products 140
 - cellulosic feedstocks 140
 - duckweed 141–142
 - transportation fuels 140
 - biogas and by-products 132
 - cellulosic ethanol
 - acid hydrolysis 139
 - agricultural residues and wastes 138, 139
 - biomass-to-sugars pathways 138
 - corn feedstocks 138
 - enzymatic hydrolysis 139–140
 - first-generation biofuels 132
 - food sources 132
 - organic waste 132
 - transesterification pathway
 - biodiesel and glyceride by-products 137
 - brown grease 137, 138
 - fossil diesel fuel 137
 - free fatty acids (FFA) 138
 - long-chain fatty acids 137

- bioenergy conversion pathways (*contd.*)
 - mono-alkyl esters 137
 - non-food lipids 138
 - plant oils 137
 - yellow grease 137–138
 - transesterification process 132
- bioethanol production 84
- biofuel fermentation 75
- biofuel production 75, 205
 - acidogenesis stage 173
 - advantages and disadvantages 178–179
 - algae 140–141
 - bio-based products 140
 - biomass properties 178
 - cellulosic feedstocks 140
 - duckweed 141–142
 - ethanol production 177–178
 - microalgae-based carbon capture and utilization
 - bio-oil yield and quality 289
 - cultivation condition 290
 - dewatering and disruption 291
 - extraction 291
 - harvesting 291
 - strain selection 289–290
 - transesterification 291
 - municipal solid wastes (MSWs) 173
 - platforms 173, 174, 205–207
 - sugar platform 173–174
 - syngas platform 174–175, 177
 - transportation fuels 140
- bioinformatics 13
- bio-inoculant 429–430
- biological engineering 12–13
- biomass feedstocks 131
- biomass sustainability
 - components 129
 - economic and environmental sustainability 130
 - legality and social equity 130
 - transparency 131
- biomass-to-energy pathway 129
- biomaterials 14
 - biomaterial-based three-dimensional (3-D) systems 617
 - cell transplantation 618
 - hydrogel-based cell delivery
 - cellular transport processes 623, 624
 - extrinsic factors 623
 - pancreatic islets delivery 623–625
 - stem cells delivery 625–626
 - polysaccharide-based biomaterials 617
 - protein-based biomaterials 617
 - scaffold-based cell delivery
 - integrin receptors 621
 - pancreatic islets delivery 621–622
 - stem cell delivery 622–623
 - synthetic ECM 620
 - surface modification
 - applications 618
 - cell mimicking 620
 - cells protection 620
 - covalent binding 618
 - hyperacute inflammatory reactions 618
 - hyperbranched 6-arm-PEG-catechol 619
 - immediate blood-mediated inflammatory reaction (IBMIR) 619–620
 - PEGylation 619
 - techniques 618, 619
 - synthetic biomaterials 617
 - tissue engineering 617
- biomedical engineering 13, 15–17
- biomedical medical engineering activities 11
- biomimetics 13
- biomolecular assembly system 93
- biomusical engineering 17
- biopolymeric chitosan nanoparticles 69
- biopolymers
 - bioplastics 399–400
 - monomeric compounds 399
 - petroleum-based plastics 399
 - poly(butylene succinate) (PBS) 400
 - biodegradability 405–407
 - furfural oxidation 400
 - hydrophilicity 404–405
 - mechanical properties 402–404
 - modification 407–419
 - polymerization 401
 - synthesis 400–401
 - thermal properties 402
 - poly(butylene succinate adipate) (PBSA) 400
 - poly(butylene succinate terephthalate) (PBST) 400
- bioprocess engineering, 13 *see* biotechnology engineering
- Bioprocess simulation
 - benefits, computer aids 723, 724
 - enterprise resource planning and manufacturing resource planning (ERP/MRP) tools 724
 - “lean manufacturing” principles 725
 - multiproduct plant modeling tools 724
 - process development 723
 - raw materials and utilities 723
 - sensitivity analyses 725
 - total capital investment 723

- bioprocess simulation
 - computational fluid dynamics (CFD) 715, 718–719
 - control 718
 - modeling and design 715–716
 - monitoring 716–717
- bio-products pathway 129
- bioreactor systems 761
- biorefineries 131–132
- biosensing applications
 - Boolean logic operations 466
 - cell-based/whole-cell biosensors 465
 - immobilize cells and cell viability 468–469
 - mammalian and microbial cells 465
 - microbial biosensors 466, 467
 - – transducers 469–472
 - microbial reporter cells
 - – DNA recombination technology 466
 - – fluorescence- and luminescence-based signals 466–467
 - – human metabolic disorders 468
 - – multiple gene regulatory systems 467
 - – mutant bacteria 468
 - mimic human metabolism 465–466
 - molecular reporter system 466
 - real-time inspection and monitoring 465
- biosensors
 - atomic force microscopy (AFM)
 - – actin antibody-modified microsphere probe 570
 - – actin-modified surface and actin antibody-modified microsphere probe 572
 - – adhesion force 570–571
 - – antigen–antibody interaction force analysis 568
 - – Cu ion-binding force measurement 568–569
 - – force–distance curve 570
 - – Gaussian curve fitting 571
 - – peptide probe and Cofilin protein 571–572
 - – physical interactions 567–568
 - – principle 568
 - – protein–protein interaction 568
 - – protein–protein interaction force measurement, peptide probes 569
 - – scanning probe microscopy (SPM) 567
 - – single molecular order interaction force 571
 - chiral recognition, nanoscale gravimetric measuring system
 - – affinity force analysis, L-Phe-modified probe tip 563–564
 - – chiral selector immobilization 560, 561
 - – enantiomers 558
 - – F–R diagram model 563
 - – gravimetric technique 558
 - – L-MA derivative-modified QCM sensor, liquid phase 562–563
 - – nanogram order chirality detection 560
 - – L-Phe-modified QCM, gas phase 561–562
 - – quartz crystal microbalance (QCM) 559–560
 - definition 557
 - nanoscale motion detection
 - – AC electric field principle 573–574
 - – AC microelectrophoresis 573, 574
 - – biotin-IgG and IgG beads mixed samples 575–576
 - – IgG- and biotin-IgG-modified microspheres 574–575
 - – microflow channel 573
 - – profilin-modified microspheres 575
 - – result 576
 - physical/chemical properties 557
 - self-diagnosis 557
 - two-photon-adsorbed photopolymerization (TPAP)
 - – AFM imaging tool 564–565
 - – fast Fourier transform (FFT) 567
 - – force–distance curves 565, 566
 - – hydrophilic surface, repulsive force 565
 - – line profile analyses 566, 567
 - – photoreactive resins 564
 - – polymeric tip 565
 - – three-dimensional (3-D) printing 564
 - – tip–sample interaction 566
 - – water contact angle 565
- biosynthesis, silver nanoparticles 579–586
- biotechnology engineering
 - applications 4–5, 8
 - definition 3
 - genetic modification/genetically modified organism (GMO) 6
 - industries 5
 - markets 6
 - penicillin production 8–10
 - tools 6
- bioterrorism and defense 17
- biotin-functionalized enzymes 71
- biotin-labeled ddNTPs 539–540
- Björkman method 106
- body labeling method 534
- bone marrow-derived stem cells (BMSCs) 622
- bone tissue engineering 661

- Boolean logic operations 466
- BRCA gene 533, 538
- bubbling fluidized-bed gasifiers 147
- bubbling fluidized bed (BFB) gasifiers 234, 236–239
- bubbling fluidized-bed pyrolysis 152
- Burkholderia cepacia* lipase 51
- butanol production
 - ABE production, fermentation 332–333
 - acetone formation pathway 337
 - aldehyde–alcohol dehydrogenase (*aad*) gene 337
 - chemical market 331
 - clostridial strains 336
 - direct butanol-forming pathway 337
 - fermentation performance 337, 338
 - genetic tools 336–337
 - glycerol 334–335
 - history of 331–332
 - isopropanol-producing strain 337
 - lignocellulose 334
 - marine macroalgae 335
 - metabolomics 341
 - pentose utilization 339, 340
 - protein waste 336
 - sporulation and solvent production 339, 341
 - sugar metabolism, characteristics 332, 333–334
 - syngas 335
- c**
- cancer cell membrane-camouflaged nanoparticles 640
- Candida antarctica* lipase B (CALB) 40
- capillary electrophoresis (CE) 509, 519–523
- carbohydrate polymers 191
- carbon nanotubes (CNTs) 75
 - agglomeration 412
 - electrical conductivities 412
 - tensile properties 411
 - thermal properties 410
 - Young's modulus 411
- carbon reduction 203
- carboxylated polypyrrole nanoparticles 489
- carboxylated polypyrrole nanotube (CPNT) 486
- carboxy-terminal peptide (CTP) fusion technology 651–652
- cascade separation process 276, 277
- cell-based/whole-cell biosensors 465
- cell delivery systems *see* biomaterials
- cell-derived vesicles
 - cell membrane-camouflaged nanoparticles
 - – cancer cell membrane-camouflaged nanoparticles 640
 - – erythrocyte membrane-coated nanocarriers 638–639, 640
 - – leukocyte membrane-camouflaged nanoparticles 639
 - – platelet membrane-camouflaged nanoparticles 639–640
 - eukaryotic cell-derived nanocarriers
 - – extracellular vesicles 634–638
 - – yeast 633–634
 - nanocarrier-based medicines 631
 - natural barrier- and transporter-like properties 631
 - prokaryotic cell-derived nanocarriers
 - – bacterial minicells 632
 - – outer membrane vesicles (OMVs) 632–633
 - cell membrane-camouflaged nanoparticles
 - cancer cell membrane-camouflaged nanoparticles 640
 - erythrocyte membrane-coated nanocarriers 638–639, 640
 - leukocyte membrane-camouflaged nanoparticles 639
 - platelet membrane-camouflaged nanoparticles 639–640
- cell transplantation 618
- cellular engineering 13
- cellular systems design
 - COBRA framework 771, 772
 - COBRA software applications
 - – features 782, 783–784
 - – *in silico* strain design 781–782
 - – model reconstruction 774–777
 - – phenotype analysis 777–781
 - – stages 772, 773
 - – timeline 774
 - physiological behavior 771
 - reaction stoichiometry 771
- cetane number (CN) 209
- chaperone protein network 22
- chemical engineering 12–13
 - biological engineering 13–14
 - engineering elements 8
 - quantity and quality, bulk chemicals 7
- chemical hydrolysis 43
- chemical looping combustion (CLC) technology 229
- chemical looping gasifier (CLG) 229
- chemical pretreatment 194
- Chiral recognition
 - affinity force analysis, L-Phe-modified probe tip 563–564

- chiral selector immobilization 560, 561
 - enantiomers 558
 - F–R diagram model 563
 - gravimetric technique 558
 - L-MA derivative-modified QCM sensor, liquid phase 562–563
 - nanogram order chirality detection 560
 - L-Phe-modified QCM, gas phase 561–562
 - quartz crystal microbalance (QCM) 559–560
 - Choren gasifier 248
 - circulating fluidized bed (CFB) gasifier 239–241, 242
 - circulating fluidized-bed gasifiers 147
 - circulating fluidized-bed pyrolysis 153
 - citrate-based mussel-inspired tissue bioadhesive 664
 - class II peroxidases 111
 - Clostridium acetobutylicum* 3–4
 - Clostridium thermocellum* 94–95
 - COBRA software applications
 - case study
 - – constraint-based modeling tools 785
 - – GDBB 786, 787
 - – OptGene 786
 - – OptKnock 785
 - – succinate 782
 - features 782, 783–784
 - *in silico* strain design 781–782
 - model reconstruction 775–776
 - – draft reconstruction 777
 - – gap filling 777
 - – manual refinement 777
 - – process 774
 - phenotype analysis
 - – cellular metabolism 777
 - – flux variability analysis (FVA) 778, 779–780
 - – genetic perturbations 778–781
 - – global solution space 778, 779–780
 - – regulatory flux balance analysis (rFBA) 781
 - stages 772, 773
 - timeline 774
 - co-firing biomass 145
 - co-gasification 217
 - cohesin–dockerin interaction 94, 95
 - coir fiber composites 414
 - tensile properties 415–416
 - community metabolic network reconstruction 795–796
 - computational fluid dynamics (CFD) 715, 718–719
 - computer-aided design (CAD)
 - microbial interactions
 - – BioCADi framework 793, 794
 - – community metabolic network reconstruction 795–796
 - – *in silico* tools 793
 - – interspecies interaction scoring 796–797
 - – modeling dynamic interactions 798
 - – steady-state flux modeling 797
 - – top-down and bottom-up approaches 793, 794
 - constitutive expression system 376, 378, 379
 - controlled release systems 608
 - Corynebacterium glutamicum*
 - chassis 326
 - devices and genetic biosensors 324–326
 - DNA parts 323–324
 - gene expression control 321
 - metabolic engineering 321
 - natural/nonnatural chemicals and materials 321
 - plasmids 324
 - synthetic biology platform 321, 322
 - synthetic biology-powered microbial cell factories 321
 - cotton 418, 419
 - CRISPR/Cas9-mediated genome engineering 310–311
 - crop-based oil 183
 - cross-linked enzyme aggregates (CLEAs) 71
 - cross-linked enzymes (CLEs) 70
 - C-terminus free display systems 83–84
 - cutting-edge technologies 607
 - 3-cyanobenzamide production 47
 - cytochalasin B 480
- d**
- decarboxylation/carboxylation 117, 118
 - deep eutectic solvents (DESs) 37
 - demethylation 116, 117
 - denaturing high performance liquid chromatography (DHPLC) 531
 - denitrification process 184–185
 - dental adhesives 662
 - diacetyl production 384–385
 - dibutylethanolammonium octanoate (DBAO) 46
 - 1,3-dicyanobenzene (1,3-DCB) 47
 - differential gel electrophoresis (DIGE) 704
 - differentially expressed proteins (DEPs) 703
 - functional enrichment and network analyses 704–705
 - integrative analysis 705–706

- digester gas 136–137
- 2,3-dimercaptopropan-1-ol tributyl ester 85
- direct/autothermal gasifiers
 - auger-type gasifiers 221
 - combustion heat and exhaust gas 219, 221
 - entrained flow gasifiers 221, 223
 - fixed (moving) bed gasifiers 221, 222
 - fluidized bed gasifiers 223–224, 225–226, 227–228
- direct butanol-forming pathway 337
- direct combustion
 - co-firing biomass 145
 - composition and physiochemical properties 144
 - decomposition products 142–143
 - fixed-bed combustion systems 144
 - fluidized-bed combustion 144
 - gaseous emissions 144
 - oxidation process 142
 - particulate matter (PM) 144
 - proximate analysis 142, 143
 - solid biomass 142
 - steam turbine 142
- direct contact-based electron transfer (DET) 296
- discrete-event simulation (DES) 742–743
- distillation process
 - azeotropic phase separation 274
 - cascade separation process 276, 277
 - decanter 275, 276
 - dehydration membrane 277
 - 2-ethyl-1-hexanol solvent 273
 - genetic and metabolic engineering methods 271
 - heat exchange system 275, 276
 - hybrid butanol purification process 276
 - liquid–liquid extraction 273, 274
 - stages 274, 275
 - two-column distillation decanter coupled system 274, 275
- DNA-based revolutionary biotechnologies 12
- DNA capture matrix 512
- DNA chip analysis 532–533
- DnaK–DnaJ–GrpE system 22
- DNA microarray-based technologies
 - allele-specific oligonucleotide competitive hybridization (ASOCH) 532–534
 - bead array platform-based SNP genotyping 549–551
 - classification 531
 - universal amplification-based technology 542–548
 - zip-code microarray 534–542
- DNA recombination technology 466
- DOPA-ended PEG/polycaprolactone (PCL) copolymers 659
- DOPA-functionalized PEG-based triblock copolymers 657
- DOPA-functionalized Pluronic 657
- double-stranded DNA break repair system-based methods
 - CRISPR/Cas9-mediated genome engineering 310–311
 - nonhomologous end joining (NHEJ) 309
 - site-specific nucleases 309
 - TALENs-based methods 310
 - zinc-finger nucleases (ZFNs) 309, 310
- Droop model 716
- drug delivery devices (DDD)
 - external drug delivery devices 594–597
 - image-guided drug delivery devices. 600–602
 - *in vivo* applications 593
- drug delivery implants (DDIs) 593
 - internal drug delivery implants 597–599
- drug delivery systems (DDS)
 - advantages 607
 - antibody-based target-specific drug delivery 612–613
 - clinical development 613–614
 - controlled release systems 608
 - cutting-edge technologies 607
 - drug concentration 608
 - gold nanoparticles (AuNPs) system 611–612
 - hyaluronate (HA)-conjugated system 609, 610
 - hydrogel depot system 610–611
 - long-acting systems 608
 - long-term therapy 607
 - magnetic nanoparticle system 612
 - peptide-based target-specific drug delivery 613
 - polyethylene glycol (PEG) system 609
 - polymeric micro/nanoparticle depot system 609–610, 611
 - targeted delivery systems 608
- drug depot systems 609–611
- drug-eluting contact lenses 595
- drug-eluting stent 597–598
- dual fluidized bed (DFB) gasifiers 226, 228, 229
- dual fluidized bed gasifiers (DFBGs) 217, 241, 243–245, 246

e

- electroactive biofilm
 - biocompatible materials 297–298
 - electron transfer 298–299
 - microbial fuel cells 299–300
- electrochemical microbial biosensors 471–472
- electrospun nanofibers 662
- enantiomers 558
- encapsulation/entrapment method 69–70
- endothermic process 215
- engineering
 - classification 7
 - definition 6–7
- enterprise resource planning and manufacturing resource planning (ERP/MRP) tools 724
- entrained-flow gasifiers 147–148
- environmental biotechnology 4, 15
- enzymatic pretreatment 195–196
- enzyme-bound transition metals 111
- enzyme-immobilized nanoparticles *see* enzyme nanoparticles (EnNPs)
- enzyme nanoparticles (EnNPs)
 - biofuel production 75
 - biomedical application
 - – antibacterial treatment 73
 - – inflammation and oxidative stress therapy 72–73
 - – thrombolytic therapy 72
 - – toxic and systemic immune reactions 71
 - biosensor applications 73–75
 - enzyme immobilization methods 68, 69
 - green chemistry 67
 - preparation
 - – aluminum hydroxide carrier 68
 - – bioaffinity interaction 71
 - – covalent attachments 70
 - – cross-linked enzyme aggregates (CLEAs) 71
 - – cross-linked enzymes (CLEs) 70
 - – encapsulation/entrapment method 69–70
 - – physical adsorption 68–69
 - – polysaccharide beads 68
 - – protein–protein and protein–small molecule interactions 71
 - recombinant DNA technology 67
 - water-soluble catalyst 67
- enzyme secretion system 81
- epoxide hydrolase 43
- equivalence ratio (ER) 217
- erythrocyte membrane-coated nanocarriers 638–639, 640
- erythropoietin (EPO) 648
- Escherichia coli* 4
 - endogenous host genes 307
 - functional genomic studies 307
 - homologous recombination-mediated tools
 - – antibiotic resistance-based methods 308–309
 - – complementary ssDNA molecules 308
 - – double-stranded DNA break repair system-based methods 309–311
 - – phage-encoded recombination functions 308
 - IgG monoclonal antibodies
 - – aglycosylated antibodies 688
 - – antibody fragments 687
 - – engineering aglycosylated Fc domain 689–691
 - – factor VIII deficiency hemophilia 689
 - – mammalian cell culture system 687
 - – translation initiation region (TIR) 687–688
 - inclusion bodies (IBs)
 - – *N*-acetyl-D-neuraminic acid (Neu5Ac) aldolase 26–29
 - – applications 25–26
 - – chaperone protein network 22
 - – DnaK–DnaJ–GrpE system 22
 - – folding modulators 22
 - – β -galactosidase 21
 - – α -glucosidase 23–24
 - – GroEL–GroES complex 22
 - – heat shock proteins 23
 - – industrial biocatalysis 21
 - – molecular chaperones 23
 - – non-covalent hydrophobic/ionic interactions 23
 - – protein quality and enzymatic activity 24–25
 - – sequential mechanism 23
 - – soluble proto-aggregates 22
 - – sponge-like supramolecular organization 23
 - – target recombinant protein 23
 - – trigger factor (TF) 22
 - – lactate-containing polyesters production 349, 350, 355
 - lactic acid bacteria (LAB) 376, 378
 - over-expressing recombinant proteins 21
 - plasmid-based expression 307
 - single-strand DNA-mediated recombination
 - – modified multiplex automated genome engineering 313, 314
 - – multiplex automated genome engineering (MAGE) 312–313

- Escherichia coli* (*contd.*)
 - λ -Red system 312
 - strain improvement 307
- esterases 42–43
- esterification 113
- ethanol precipitation method 511
- ethylenediaminetetraacetic acid (EDTA) 519–520
- ethylene glycol acrylate
 - methacrylate-dopamine (EGAMA-DOPA) 659–660
- eukaryotic cell-derived nanocarriers
 - extracellular vesicles 634–638
 - yeast 633–634
- European Food Safety Authority (EFSA) 375
- external drug delivery devices
 - drug-eluting contact lenses 595
 - microneedle drug delivery devices 594–595
 - wearable drug delivery devices 595–597
- extracellular electron transfer (EET)
 - biocatalyst 295
 - biofilm *see* electroactive biofilm
 - vs. chemical fuel cells 296
 - direct contact-based electron transfer (DET) 296
 - *Geobacter* species 297
 - metal-reducing bacterium 297
 - two-chamber MFCs 295, 296
- f**
 - Fan's approach 538
 - fast/flash pyrolysis 152
 - fast protein liquid chromatography (FPLC) 717
 - fatty acid ethyl ester (FAEE) 137
 - fatty acid methyl ester (FAME) 137
 - Fc-fusion technology 647–648
 - fed-batch bioreactor 765–766
 - field effect transistor 486–487
 - first-generation biofuels 128–129
 - Fischer–Tropsch (FT) reaction 149
 - fixed-bed combustion systems 144
 - fixed-bed gasifiers 147
 - fixed (moving) bed gasifiers 221, 222, 233–234, 235
 - flavin adenine dinucleotide (FAD) 368
 - flavin mononucleotide (FMN) 368
 - FLETGAS process 230
 - flow-through biochip assembly 537
 - fluidized-bed combustion 144
 - fluidized-bed gasifiers 147, 223–224, 225–226, 227–228
 - fluidized-bed reactors 152
 - fluorescence diagnosis
 - cervical cancer
 - cold knife conization 500
 - fluorescence colposcopy 500
 - human papillomavirus 501
 - pathological assessment 500
 - prevalence 499, 500
 - radioactive treatment 500
 - skin disease 498–499
 - fluorescence endoscopic surgery
 - bladder cancer 501–502
 - sentinel lymph node (SLN) 502–503, 504
 - fluorescence image-guided intraoperative open surgery
 - 5-aminolevulinic acid (5-ALA) 504, 505
 - medical imaging equipment 503
 - open brain surgery 504, 505
 - photodynamic treatment 504
 - real-time see-and-treat approach 505
 - fluorescence-labeled nucleotides 532
 - fluorescent pseudomonads 434
 - flux balance analysis (FBA) 716, 763
 - flux variability analysis (FVA) 778, 779–780
 - folate 368–369
 - folate production 386–387
 - food–energy–water (FEW) Nexus concept
 - biomass sustainability 129–131
 - decision making 128
 - sustainable biomass 128–129
 - United Nations projects 128
 - food-grade gene expression system
 - complementation selection markers 381–382
 - dominant selection markers 381
 - transformation vectors 381
 - food ingredients production
 - biological production
 - human milk oligosaccharides (HMOs) 361–365
 - microbial fermentation 361, 362
 - sugar alcohols 361, 365–367
 - vitamins 367–369
 - cellular activities 359
 - combinatorial approaches 360–361
 - rational manipulations 359
 - target metabolic pathway 359
 - value-added biotransformation 359, 360
 - food-to-fuel pathway 129
 - forensic biotechnology 4–5
 - forensic STR typing system
 - fluorescence dyes 523
 - fully integrated microdevice 524–525
 - RapidHITTM system 523, 524
 - forest residues 165

- Formate dehydrogenases (FDH) 44
- fossil diesel fuel 137
- fossil transition fuels 127
- four-copper(II) cluster 108
- fourth industrial revolution 17, 18
- free fatty acids (FFA) 138
- 2-fucosyllactose (2-FL) 361, 363–365

- g**
- β -galactosidase 21, 41
- galactosyltransferase 46
- Gas chromatography (GC) 717
- gasification (syngas platform)
 - drying 146
 - Fischer–Tropsch (FT) reaction 149
 - gasifier types 146–148
 - operating parameters 146
 - oxidation 146
 - partial oxidation process 145
 - power and heat generation 148–149
 - pyrolysis 146
 - reduction 146
 - stages 145
 - steam gasification 146
 - sustainable and waste biomass 145
 - syngas cleaning 148
- gasification technologies
 - absorption-enhanced reaction (AER) gasifiers 230
 - advanced gasification process 229
 - auto-gasification 217
 - biomass gasifier, types 219, 220
 - characteristics 230, 231
 - chemical looping gasifier (CLG) 229
 - classification 218–219
 - co-gasification 217
 - and combustion reactions 216
 - components 216
 - direct/autothermal gasifiers
 - auger-type gasifiers 221
 - combustion heat and exhaust gas 219, 221
 - entrained flow gasifiers 221, 223
 - fixed (moving) bed gasifiers 221, 222
 - fluidized bed gasifiers 223–224, 225–226, 227–228
 - dual fluidized bed gasifiers (DFBGs) 217
 - endothermic process 215
 - equivalence ratio (ER) 217
 - features 219
 - FLETGAS process 230
 - fluidized bed systems 217
 - gasifier temperature 217
 - greenhouse gas reduction 217
 - heterogeneous reaction 216
 - indirect/allo-thermal gasifiers
 - dual fluidized bed (DFB) gasifiers 226, 228, 229
 - endothermic gasification reaction 224
 - heat pipe gasifiers 228, 229
 - plasma/plasma-assisted gasifiers 224
 - industrial biomass
 - Choren gasifier 248
 - fluidized bed systems 245
 - Güssing gasifier 247
 - indirect gasification systems 247
 - Lahti gasifier 247
 - municipal solid waste (MSW) 247
 - renewable energy development 246
 - wood pellets 247
 - partial oxidation 216
 - performance evaluation
 - bubbling fluidized bed (BFB) gasifiers 234, 236–239
 - circulating fluidized bed (CFB) gasifier 239–241, 242
 - demo and commercial plants 230, 232
 - dual fluidized bed (DFB) gasifiers 241, 243–245, 246
 - fixed (moving) bed gasifiers 233–234, 235
 - operating conditions 230
 - plants design 217
 - pyrolysis and combustion 215
 - sustainable energy sources 217
 - tar production 218
 - thermal energy 216
 - water–gas shift reaction 230
- gas stripping
 - cooling temperature 257
 - distillation system 259
 - fed-batch mode 257
 - fermentation broth 256
 - gas flow 256
 - *in situ* gas stripping separation processes 259
 - integration processes 257
 - kinetic models 257
 - online butanol recovery 257, 258
 - partial pressure of component 257
 - phase separation 259
 - process 256
 - single-pass mode 256
 - stripping rate constant 257
 - vacuum pump 259
 - water fraction 257
- Gaussian curve fitting 571
- GDBB 786, 787

- gelatin-based tissue adhesive 660–661
- gel electrophoresis 509
- GeneChip p53 assay 533
- genetically modified organism (GMO) 6
- genetic engineering 13
- genetic fusion techniques
 - active peptide/protein 645
 - albumin fusion technology 648–650
 - carboxy-terminal peptide (CTP) fusion technology 651–652
 - Fc-fusion technology 647–648
 - glomerular filtration 646
 - injection/continuous infusion 645
 - linear/branched-chain monomethoxy PEG 646
 - transferrin fusion technology 650–651
- genomic DNA isolation 510
- glucagon-like peptide (GLP)-1-Fc-fusion protein 648
- β -1,6-glucan chains 85
- glucoamylase 84
- glucose isomerase (GI) 46
- α -glucosidase 23–24
- glutathione S-transferase (GST) 26–27, 111
- glycerol 334–335
- glycosaminoglycans (GAGs) 668
- glycoside hydrolases 41
- glycosidic flavonoids 449, 451
- glycosyl acceptor 41
- glycosylation 113–114
- glycosylphosphatidylinositol (GPI)-anchoring system 82, 83
- GoldenGate assay 545, 546, 550–551
- gold nanoparticles (AuNPs) system 611–612
- G-protein-coupled receptors (GPCRs) 479
- gram-positive bacteria 94
- graphene oxide nanosheets 75
- green tea seed (GTS) flavonol glycoside
 - chemical constituents 446
 - DPPH scavenging activities 449–450, 451
 - green tea seed extract (GTSE) 447
 - kaempferol production 448–449, 450, 451
 - phenolic compounds 446
 - purification and identification 447
- GroEL–GroES complex 22
- gross national product 3
- Güssing gasifier 247

- h**
- hard tissue adhesives
 - bone adhesives 661
 - catechol-modified hyper-branched nanocomposite polymer adhesives 662
 - cell and tissue responses 662, 663
 - citrate-based mussel-inspired tissue bioadhesive 664
 - dental adhesives 662
 - electrospun nanofibers 662
 - mussel-inspired surface modification 664
 - poly(methyl methacrylate) (PMMA) 661
 - polydopamine-modified PLLA nanofibers 664
 - polylactide-based biocompatible polymers 661
- heat exchange system 275, 276
- heat pipe gasifiers 228, 229
- heat shock proteins 23
- hepatocyte nuclear factor-1 α (HNF-1 α) gene 533
- herbaceous plants residues 165–168
- heterologous hydrolytic enzymes 84
- high density cultivation *see* bacterial biofertilizers
- high-fructose corn syrup (HFCS) 46
- high performance liquid chromatography (HPLC) 717
- homologous recombination-mediated tools
 - antibiotic resistance-based methods 308–309
 - complementary ssDNA molecules 308
 - double-stranded DNA break repair system-based methods 309–311
 - phage-encoded recombination functions 308
- horseradish peroxidase (HRP) 93, 98, 100
- Human Genome Project (HGP) 531
- human milk oligosaccharides (HMOs)
 - chemical synthesis 361
 - 2-fucosyllactose (2-FL) 361, 363–365
 - health-promoting functions 361
 - lacto-*N*-oligosaccharide derivatives 365
- hyaluronate (HA)-conjugated system 609, 610
- hybrid butanol purification process 276
- hydrogel-based cell delivery
 - cellular transport processes 623, 624
 - extrinsic factors 623
 - pancreatic islets delivery 623–625
 - stem cells delivery 625–626
- hydrogel depot system 610–611
- hydrolysis 134–135
- hydrolytic enzymes 82
 - *Candida antarctica* lipase B (CALB) 40
 - cellulose-dissolving ILs 40
 - chemical bond, cleavage promotion 39
 - chemical hydrolysis 43
 - epoxide hydrolase 43
 - esterases 42–43

- glycoside hydrolases 41
 - glycosyl acceptor 41
 - lipase-catalyzed reactions 40
 - papain 42
 - penicillin G amidase (PGA) 43
 - polar and nonpolar compounds 40
 - *Pseudomonas cepacia* lipase (PCL) 40
 - thermolysin-catalyzed synthesis 42
 - thermostable glycosidase 41–42
 - *Trichoderma reesei* cellulase 41
 - hydroxyapatite (HA) 599
 - hydroxylation/monooxygenation 115–116
 - hydroxynitrile lyases 46
 - hyper-branched poly(amino ester) polymer 659
- i**
- IgG monoclonal antibodies
 - crystal structure 679, 680
 - in *Escherichia coli*
 - aglycosylated antibodies 688
 - antibody fragments 687
 - engineering aglycosylated Fc domain 689–691
 - factor VIII deficiency hemophilia 689
 - mammalian cell culture system 687
 - translation initiation region (TIR) 687–688
 - large-scale manufacturing processes 679
 - in mammalian cells
 - biosimilar drugs 680, 681
 - formulation and filling processes 683
 - large-scale cell culture 682
 - large-scale purification 682–683
 - physicochemical and functional analyses 683–685
 - preclinical and clinical evaluations 686
 - process development 681–682
 - Muromonab 679
 - in yeast 686–687
 - image-guided drug delivery systems 600–602
 - immobilization method 533
 - indirect/allo-thermal gasifiers
 - dual fluidized bed (DFB) gasifiers 226, 228, 229
 - endothermic gasification reaction 224
 - heat pipe gasifiers 228, 229
 - plasma/plasma-assisted gasifiers 224
 - indirect gasification systems 247
 - indirect land use change (iLUC) effects 132
 - Indonesian Center for Agricultural Engineering Research and Development (ICAERD) 169
 - inducible gene expression system 378–380
 - industrial biocatalysis 21
 - industrial biotechnology 4
 - inflammation and oxidative stress therapy 72–73
 - inorganic fillers
 - biodegradability 409
 - carbon nanotubes (CNTs)
 - agglomeration 412
 - electrical conductivities 412
 - tensile properties 411
 - thermal properties 410
 - Young’s modulus 411
 - graphene 412, 413
 - molecular weight 409
 - nanocomposite pellets 407
 - organically modified layered silicates (OMLS) 407, 408
 - tensile properties 408, 409
 - wide-angle X-ray diffraction (WAXD) analysis 407
 - in silico* metabolic pathway model
 - acetaldehyde production 385–386
 - L-alanine production 385
 - biosynthetic capacity and metabolic versatility 384
 - diacetyl production 384–385
 - folate production 386–387
 - lactic acid production 384
 - mannitol production 386
 - next-generation sequencing analysis 382, 383
 - polysaccharides production 387
 - whole genome sequencing 383
 - integrated gasification combined cycle (IGCC) plants 223
 - intelligent drug delivery implant 599
 - internal drug delivery implants
 - drug-eluting stent 597–598
 - intelligent drug delivery implant 599
 - programmable drug delivery implants 598–599
 - interspecies interaction scoring 796–797
 - ionic liquids (ILs)
 - air- and water-sensitive characteristics 35
 - cations and anions structure 35, 36
 - deep eutectic solvents (DESs) 37
 - designer solvents 35
 - enzymatic reactions 39
 - applications 49
 - biocatalysts 37–38
 - catch-and-release mass spectrometry tag 46

- ionic liquids (ILs) (*contd.*)
 - – dibutylethanolammonium octanoate (DBAO) 46
 - – disadvantages 49
 - – enantioselective enzymatic reaction 37
 - – glucose isomerase (GI) 46
 - – high-fructose corn syrup (HFCS) 46
 - – hydrogen bonding capacity 48–49
 - – hydrolases 37, 38 *see also* hydrolytic enzymes
 - – hydrophobicity 49
 - – hydroxynitrile lyases 46
 - – mass transfer limitation 47
 - – monophasic IL-based system/biphasic system 37
 - – N-heterocyclic carbenes (NHC) complex 37
 - – oxidoreductases 37, 38 *see also* nonhydrolytic enzymes
 - – physicochemical properties 47, 48
 - – polar solvents 48
 - – polymerase chain reactions (PCR) 46
 - – thermolysin-catalyzed synthesis 37
 - – water miscibility 49
 - – whole cell catalysts 37, 39, 47
 - enzyme-compatible ionic liquids 52
 - enzymes modification 50–51
 - ethylammonium nitrate 35
 - physicochemical properties 35
 - room temperature ionic liquids (RTILs) 35
 - solvents modification 51–52
 - “task-specific” ILs 35
- ion liquid lignin 106
- j**
- jute fiber 416
 - characteristics 417
 - tensile properties 417, 418
- k**
- Klason lignin 106
- Korean fermented soybean (KFS)
 - anti-melanogenesis effect, *in vitro* study 453–454, 455
 - biological effect 450–451
 - purification and identification 451–453, 454
- Korean herbal cosmetics
 - Asian herbal medicine texts 445
 - characteristics 442
 - Kun-Shin-Choa-Sa principle 445
 - medicinal herbs, dermatological effects 442–443, 444
 - natural compounds
 - – functional components 446
 - – green tea seed (GTS) flavonol glycoside 446–450
 - – human health hazard 446
 - – soybean, isoflavone microbial hydroxylation *see* Korean fermented soybean (KFS)
 - pharmacological principles 445
 - preparation process 443
 - processing methods 444
 - Rehmanniae Radix 443
 - skin delivery systems
 - – drug permeation 454
 - – liposomes 455–456
 - – polymer micelles and polymersomes 456–457
 - – solid lipid nanoparticles (SLN) 458
 - – surface modification 457
 - stabilization 441
 - Kraft lignin 106, 107
 - Kun-Shin-Choa-Sa principle 445
 - l**
 - lab on a chip (LOC) 510
 - laccase 108
 - laccases 140
 - β -lactam penicillin antibiotics 43
 - lactate-containing polyesters production
 - acetyl-CoA 353, 354
 - biosynthetic pathway 351
 - enzymes 352, 353
 - *Escherichia coli* 349, 350, 355
 - glass transition temperature 354
 - hydroxyacyl-CoAs (HA-CoAs) 349, 351
 - lactate monomer 352
 - lactyl-CoA 354
 - PHA synthase (PhaC) 349
 - P(3HB) homopolymer 351
 - site-directed mutagenesis 351
 - thermal and mechanical properties 354
 - type II PHA synthases 352
 - lactic acid bacteria (LAB)
 - anti-inflammatory effects 388
 - anti-specific immune response 388
 - applications 376, 377
 - constitutive expression system 376, 378, 379
 - diseases 387
 - expression systems 376, 378
 - fermentation product 375
 - food-grade gene expression system
 - – complementation selection markers 381–382
 - – dominant selection markers 381

- transformation vectors 381
- functions 375–376
- homologous and heterologous proteins 388, 389
- inducible gene expression system 378–380
- “omics” studies 376
- *in silico* metabolic pathway model
 - acetaldehyde production 385–386
 - L-alanine production 385
 - biosynthetic capacity and metabolic versatility 384
 - diacetyl production 384–385
 - folate production 386–387
 - lactic acid production 384
 - mannitol production 386
 - next-generation sequencing analysis 382, 383
 - polysaccharides production 387
 - whole genome sequencing 383
- probiotic culture 376
- secretion system 380–381
- therapeutic proteins 388
- lactic acid production 384
- lacto-*N*-oligosaccharide derivatives 365
- Lahti gasifier 247
- landfill gas 136–137
- laser-induced fluorescence detector 519
- “lean manufacturing” principles 725
- leukocyte membrane-camouflaged nanoparticles 639
- life cycle analysis (LCA) 130, 131–132
- ligase detection reaction (LDR) 536
- ligation-based method 536–538
- lignin
 - aromatic monomers
 - ammonia fiber explosion (AFEX) 106
 - ball milling/Björkman method 106
 - class II peroxidases 111
 - enzyme-bound transition metals 111
 - four-copper(II) cluster 108
 - glutathione-*S*-transferase 111
 - ion liquid lignin 106
 - Klason lignin 106
 - Kraft lignin 106, 107
 - laccase and peroxidase 108
 - lignosulfonate lignin 106
 - LiP reaction 111
 - mechanocatalysis 106–107
 - organosolv lignin 106
 - phenolic derivatives 107
 - phenylpropanoid derivatives 111, 112
 - physicochemical processes 107, 108
 - plant biomass 106
 - pretreatment procedures 105–106
 - radical and non-radical mechanisms 108
 - steam explosion methods 106
 - chemical structures 105, 106
 - composition 105
 - phenol derivatives 112
 - phenolic compounds 107, 109
 - bio-based materials 114
 - biotransformation processes 112
 - decarboxylation/carboxylation 117, 118
 - demethylation 116, 117
 - esterification 113
 - glycosylation 113–114
 - hydroxylation/monooxygenation 115–116
 - methylation 116, 117
 - modifications 114
- lignocellulosic biomass 105, 334
 - agricultural residues 163, 168
 - carbohydrate polymers 191
 - cellulose 164
 - degradation process 191
 - fermentation substrate 191
 - forest residues 165
 - gasification *see* gasification technologies
 - hemicelluloses 164
 - herbaceous plants residues 165–168
 - organic substances 191
 - sources 163
 - sterilization process 192
 - structure 163, 164
 - sugar platform 192
- lignocellulosic matrix 193
- lignosulfonate lignin 106
- linear/branched-chain monomethoxy PEG 646
- linear programming (LP) 764
- lipase-catalyzed reactions 40
- lipase enzymes 85
- lipid-forming algae 141
- lipid production 183
- liquid chromatography–tandem MS (LC–MS/MS) analysis 698
 - depletion and enrichment methods 700–702
 - discovery procedure 698
 - protein identification capacity 698
 - protein quantification accuracy 698
 - sample fractionation methods 702–703
 - workflow 699, 700
- liquid fuels manufacturing 149

- liquid–liquid extraction
 - butanol–biodiesel mixture 260
 - distillation system 262
 - fermentation broth 260
 - *in situ* liquid–liquid separation process 261–262
 - limitations 261
 - organic-based extraction system 260
 - partition coefficients 260
 - perstraction technique 261
 - solvent extractants 260, 261
- locus-specific oligonucleotide (LSO) 545
- long-acting systems 608
- Loss of heterozygosity (LOH) 533
- luteinizing hormone-releasing hormone (LH–RH) 609–610
- lysine residues 96

- m**
- magnetic microparticles (MMP) 570
- magnetic multi-walled carbon nanotubes 75
- magnetic nanoparticles 72, 612
- mannitol production 386
- marine/aquatic biotechnology 4
- marine biotechnology 14–15
- Marine Board of European Science and Foundation (ESF) 15
- marine macroalgae 335
- mass balance equation 715
- mass spectrometry-based proteomic methods 697–707
- mathematical optimization tools 743
- MaxQuant software/linear programming method 704
- medical biotechnology 4
- melanin-based pigmentation 499
- metabolic engineering
 - *Escherichia coli* 307–314
 - lactate-containing polyesters production 349–355
 - microbial metabolic engineering *see* food ingredients production
 - solventogenic clostridia 331–341
- metabolic network modeling, microbial interactions
 - BioCADi framework 793, 794
 - community metabolic network reconstruction 795–796
 - *in silico* tools 793
 - interspecies interaction scoring 796–797
 - modeling dynamic interactions 798
 - steady-state flux modeling 797
 - top-down and bottom-up approaches 793, 794
- metabolism-combined growth model
 - construction
 - bioreactor optimization scheme 761, 762
 - cost yield 766
 - fed-batch bioreactor 765–766
 - feed rate strategy 767, 768
 - heuristic-based approaches 761
 - “macroscopic” mathematical model 762
 - modification methods
 - dynamic model 763
 - flux balance analysis (FBA) 763
 - intracellular metabolism 764
 - linear programming (LP) 764
 - lipid concentration 763
 - mass balance 762
 - microbial behavior 762
 - model-based optimization 764
 - Monod-type description 763
 - operational decision making 761
 - optimal decision-making system 765
 - time-varying simulation result 767, 768
- methanogenesis 135
- methylation 116, 117
- microalgae-based carbon capture and utilization
 - application 291–292
 - biofuel production
 - bio-oil yield and quality 289
 - cultivation condition 290
 - dewatering and disruption 291
 - extraction 291
 - harvesting 291
 - strain selection 289–290
 - transesterification 291
 - inorganic carbon, photosynthesis
 - dynamic ionization equilibrium 288
 - factors 288
 - glyceraldehyde-3-phosphate 288–289
 - light-dependent and light-independent reactions 287
 - light intensity 288
 - photorespiration 289
 - steam-powered machineries 287
- microbial biosensors 466, 467
 - transducers
 - application 469, 470
 - electrochemical microbial biosensors 471–472
 - optical microbial biosensors 469, 471
- microbial-derived diesels 203
- microbial fuel cells (MFCs)
 - biocatalyst 295
 - biofilm *see* electroactive biofilm
 - vs. chemical fuel cells 296

- direct contact-based electron transfer (DET) 296
- *Geobacter* species 297
- metal-reducing bacterium 297
- two-chamber MFCs 295, 296
- microbial lipids/oil 182, 184
- microbial pretreatment 194–195
- microbial reporter cells
 - DNA recombination technology 466
 - fluorescence- and luminescence-based signals 466–467
 - human metabolic disorders 468
 - multiple gene regulatory systems 467
 - mutant bacteria 468
- microbial transglutaminase (MTG) 96
- microbiological culture 3
- microcapillary electrophoresis (μ CE) 521
- micro-electromechanical systems (MEMS) 596
- microfabrication techniques 510
- microfluidic-based STR typing process 525, 526
- microneedle drug delivery devices 594–595
- micro total analysis system (μ TAS) 510
- Ministry of Energy (MOE) 169
- MixAlco[®] process 180, 181
- mixed matrix membranes (MMMs) 267
- modeling dynamic interactions 798
- model reconstruction process 774, 775–776
 - draft reconstruction 777
 - gap filling 777
 - manual refinement 777
- modified multiplex automated genome engineering 313, 314
- molecular inversion probe (MIP) technology
 - complementary zip-code sequence 542
 - DNA annealing sites 542, 543
 - gap-filling extension and ligation 543, 544
 - gene copy alterations and deletion mutations 544
- IgA nephropathy 544
- nonreactive probes 543
- probe design and chip fabrication technology 545
- molecular reporter system 466
- mono-alkyl esters 137
- monoclonal antibody (MAb) 725, 726–728
- Monod equation 716
- multidisciplinary (OMICS) approach 17
- multiple gene regulatory systems 467
- multiple automated genome engineering (MAGE) 312–313
- multiproduct plant modeling
 - applications 740
 - capacity analysis and strategic planning 740–741
 - facility design and debottlenecking 741
 - production scheduling 741
 - batch process simulation 739, 742
 - capacity analysis and strategic planning 744–745
 - discrete-event simulation (DES) 742–743
 - mathematical optimization tools 743
 - production scheduling
 - buffer preparation and holding 749–751
 - facility design and debottlenecking 754
 - floor space, mobile units 757, 758
 - labor constraints 751–752
 - production tracking and rescheduling 752–754
 - resource limits 745
 - schedule generation 745–749
 - utility systems sizing 755–757
 - recipe-based scheduling tools 743–744
 - single isolated process 740
 - spreadsheet tools 742
- multiproduct plant modeling tools 724
- municipal solid waste (MSW) 247
- mussel adhesive proteins (MAPs) 655
- mussel-mimetic biomaterials
 - L-3,4-dihydroxyphenylalanine (DOPA) 655
 - adhesion chemistry 655, 656
 - biomolecule immobilization and drug delivery 664, 666–667
 - applications 665
 - catechol group 669
 - copolymer 668
 - gel curing and silver nanoparticles 668
 - glycosaminoglycans (GAGs) 668
 - osteogenic cellular behaviors 667
 - polydopamine-coated CaP cement 665
 - polydopamine-coated PLLA nanofibers 665
 - polydopamine-modified 3-D PLGA scaffolds 667
 - protein nanoparticle system 669
 - rMAP-silver-binding peptide fusion 669
 - vascular endothelial growth factor (VEGF) 665, 667
 - covalent bonds 655
 - hard tissue adhesives
 - bone adhesives 661
 - catechol-modified hyper-branched nanocomposite polymer adhesives 662
 - cell and tissue responses 662, 663
 - citrate-based mussel-inspired tissue bioadhesive 664

- mussel-mimetic biomaterials (*contd.*)
 - dental adhesives 662
 - electrospun nanofibers 662
 - mussel-inspired surface modification 664
 - poly(methyl methacrylate) (PMMA) 661
 - polydopamine-modified PLLA nanofibers 664
 - polylactide-based biocompatible polymers 661
 - mussel adhesive proteins (MAPs) 655
 - natural polymer 657
 - short peptides 657, 658
 - soft tissue adhesives
 - alginate–dopamine conjugate 661
 - DOPA-ended PEG/polycaprolactone (PCL) copolymers 659
 - DOPA-functionalized PEG-based triblock copolymers 657
 - DOPA-functionalized Pluronics 657
 - elastomeric membrane defects 658
 - ethylene glycol acrylate methacrylate-dopamine (EGAMA-DOPA) 659–660
 - gelatin-based tissue adhesive 660–661
 - hyaluronic acid 660
 - hyper-branched poly(amino ester) polymer 659
 - *in vivo* adhesive studies 658
 - poly(ester urea)-based biomimetic adhesive polymer 659
 - polyvinylpyrrolidone (PVP) 659
 - rMAP-based water-immiscible protein bioadhesive 660
 - wound management 657
 - synthetic polymers 656–657
- n**
 - nanomaterial-based sensor 479
 - nanoparticle-based systems 611–612
 - nanoscale measuring system *see* biosensors
 - nanoscale motion detection
 - AC electric field principle 573–574
 - AC microelectrophoresis 573, 574
 - biotin-IgG and IgG beads mixed samples 575–576
 - IgG- and biotin-IgG-modified microspheres 574–575
 - microflow channel 573
 - profilin-modified microspheres 575
 - result 576
 - nanotube field-effect transistors (NT-FETs) 486
 - nanovesicle-based bioelectronic nose 481
 - National Energy Policy Council (NEPC) 169
 - natural fibers
 - chemical composition and structural parameters 413, 414
 - coir fiber composites 414
 - tensile properties 415–416
 - vs. conventional man-made fibers 413, 414
 - cotton 418, 419
 - jute fiber 416
 - characteristics 417
 - tensile properties 417, 418
 - petroleum-based polymers 413
 - next-generation sequencing analysis 382, 383
 - N-heterocyclic carbenes (NHC) complex 37
 - nonhomologous end joining (NHEJ) 309
 - nonhydrolytic enzymes
 - activity and stability 45
 - catalase 45
 - dehydrogenases 44
 - glucose oxidase 45
 - living cells metabolism 44
 - monophenolase and diphenolase activity 45
 - oxidative biotransformation 44
 - peroxidases and laccase 44
 - tyrosinase 45
 - noninvasive optical imaging techniques
 - advantages 497
 - computed tomography (CT) 497
 - fluorescence diagnosis
 - cervical cancer 499–501
 - skin disease 498–499
 - fluorescence endoscopic surgery
 - bladder cancer 501–502
 - sentinel lymph node (SLN) 502–503, 504
 - fluorescence image-guided intraoperative open surgery
 - 5-aminolevulinic acid (5-ALA) 504, 505
 - medical imaging equipment 503
 - open brain surgery 504, 505
 - photodynamic treatment 504
 - real-time see-and-treat approach 505
 - functional imaging 497
 - medical techniques 497
 - nucleic acid scaffolds 96–97
- o**
 - off-chip-based capillary electrophoretic separation 519–521
 - off-chip-based DNA extraction 511–512, 513
 - off-chip-based STR amplification 517–518
 - oleaginous microorganisms 183

- oleaginous yeast 204–205
 - oleic acid component 209
 - olfactory-nanovesicle-fused carbon
 - nanotube-transistor biosensor (OCB) 481
 - olfactory receptor (OR) 477–493
 - olfactory receptor protein 479, 480
 - peptide 483–484
 - on-chip-based capillary electrophoretic separation 521–523
 - on-chip-based DNA extraction 512–514
 - on-chip-based STR amplification 518–519
 - OptGene 786
 - optical microbial biosensors 469, 471
 - optical spectrometry 717
 - OptKnock 785
 - organic-based extraction system 260
 - organic waste biomass 203
 - organosolv lignin 106
 - oxidoreductases 37, 38 *see also*
 - nonhydrolytic enzymes
- P**
- papain-mediated asymmetric hydrolysis 42
 - partial oxidation process 145
 - pathogen-derived proteins 81
 - penicillin G amidase (PGA) 43
 - penicillin production 4, 7
 - fermentation research 9
 - *in vivo* bactericidal action 8
 - large-scale production 9–10
 - War Production Board 9
 - peptide assemblies 97
 - peptide-based target-specific drug delivery 613
 - peptide nucleic acid (PNA) probe sequences 534
 - peptide receptor-based bioelectronic nose (PRBN) 483
 - peroxidases 108, 140
 - pervaporation
 - binary/multicomponent flowing liquid 266
 - chemical–thermal stability 267
 - condensed ethanol product 271
 - *in situ* ABE separation 271, 272
 - integration processes 271, 273
 - mechanical properties 267
 - membrane module configurations 267, 268
 - mixed matrix membranes (MMMs) 267
 - organophilic and hydrophilic membranes 267
 - permeate flux 267
 - process 267
 - PV membranes 267, 269–270
 - separation factor 267
 - petroleum-based chemicals 175
 - petroleum refineries 131
 - photosynthesis, inorganic carbon
 - dynamic ionization equilibrium 288
 - factors 288
 - glyceraldehyde-3-phosphate 288–289
 - light-dependent and light-independent reactions 287
 - light intensity 288
 - photorespiration 289
 - physical adsorption 68–69
 - physical pretreatment 193–194
 - pig liver esterase (PLE) 42
 - plasma/plasma-assisted gasifiers 224
 - platelet membrane-camouflaged nanoparticles 639–640
 - poly(2-hydroxyethyl methacrylate) (PHEMA) 595
 - poly(butylene succinate) (PBS) 400
 - biodegradability
 - – carboxylic acid end groups 405
 - – in compost 405–407
 - – data 405, 406
 - furfural oxidation 400
 - hydrophilicity 404–405
 - mechanical properties
 - – biodegradable polymer recycling 402, 403
 - – degradation behavior 403
 - – hydrolysis and dehydration reactions 403, 404
 - – hydrolysis and polymerization 403, 404
 - – melt processing 403
 - – petroleum-based equivalent 402
 - – semicrystalline polymers 402
 - – three-point bending tests 403
 - modification
 - – biodegradable aliphatic thermoplastic polyester 407
 - – blending 407
 - – compositing 407
 - – copolymerization 407
 - – inorganic fillers 407–413
 - – materials types 407
 - – natural fibers 413–419
 - polymerization 401
 - synthesis 400–401
 - thermal properties 402
 - poly(butylene succinate adipate) (PBSA) 400
 - poly(butylene succinate terephthalate) (PBST) 400
 - poly(lactic-co-glycolic acid) (PLGA) 609
 - poly(methyl methacrylate) (PMMA) 661

- poly(ester urea)-based biomimetic adhesive polymer 659
- polydimethylsiloxanes (PDMS) 136–137
- polydopamine-coated CaP cement 665
- polydopamine-coated PLLA nanofibers 665
- polydopamine-modified 3-D PLGA scaffolds 667
- polydopamine-modified PLLA nanofibers 664
- polyethylene glycol (PEG) system 609
- polylactic acid (PLA)
 - acetyl-CoA 353, 354
 - biosynthetic pathway 351
 - enzymes 352, 353
 - *Escherichia coli* 349, 350, 355
 - glass transition temperature 354
 - hydroxyacyl-CoAs (HA-CoAs) 349, 351
 - lactate monomer 352
 - lactyl-CoA 354
 - PHA synthase (PhaC) 349
 - P(3HB) homopolymer 351
 - site-directed mutagenesis 351
 - thermal and mechanical properties 354
 - type II PHA synthases 352
- polylactide-based biocompatible polymers 661
- polymerase chain reaction (PCR) 46, 536
- polymer-conjugated drug delivery systems 609
- polymeric micro/nanoparticle depot system 609–610, 611
- polymer nanofiber 14
- polysaccharide-based biomaterials 617
- polysaccharide beads 68
- polysaccharides production 387
- polyvinylpyrrolidone (PVP) 659
- power and heat generation 148–149
- production scheduling
 - buffer preparation and holding 749–751
 - facility design and debottlenecking 754
 - floor space, mobile units 757, 758
 - labor constraints 751–752
 - production tracking and rescheduling 752–754
 - resource limits 745
 - schedule generation 745–749
 - utility systems sizing 755–757
- programmable drug delivery implants 598–599
- prokaryotic cell-derived nanocarriers
 - bacterial minicells 632
 - outer membrane vesicles (OMVs) 632–633
- protein and peptide therapeutics *see* drug delivery systems (DDSs)
- protein-based biomaterials 617
- Protein-based nanoparticles 25–26
- protein biomarkers
 - biomarkers, definition 697
 - clinical symptoms 697
 - liquid chromatography–tandem MS (LC–MS/MS) analysis 698
 - – depletion and enrichment methods 700–702
 - – discovery procedure 698
 - – protein identification capacity 698
 - – protein quantification accuracy 698
 - – sample fractionation methods 702–703
 - – workflow 699, 700
 - proteomic data analysis
 - differential gel electrophoresis (DIGE) 704
 - differentially expressed proteins (DEPs) 703, 704–706
 - MaxQuant software/linear programming method 704
 - peptide quantification 703
 - two-dimensional electrophoresis (2-DE) 704
 - proteomics-based discovery 698, 699
 - verification and validation 706–707
- protein nanoparticle system 669
- protein of interest (POI) 96
- protein waste 336
- proteomic data analysis
 - differential gel electrophoresis (DIGE) 704
 - differentially expressed proteins (DEPs) 703, 704–706
 - MaxQuant software/linear programming method 704
 - peptide quantification 703
 - two-dimensional electrophoresis (2-DE) 704
- protoporphyrin IX (PPIX) 501
- Pseudomonas cepacia* lipase (PCL) 40
- Pseudomonas* spp. 434–435
- pyrolysis 146
 - ablative, vacuum, and transported bed pyrolysis reactors 153
 - bio-oil 153–154
 - bubbling fluidized-bed pyrolysis 152
 - circulating fluidized-bed pyrolysis 153
 - fast/flash heating conditions 151
 - fast/flash pyrolysis 152
 - fluidized-bed reactors 152
 - fractional catalytic pyrolysis 153
 - heating rates 149

- kinetic characteristics 150
 - noncondensable gaseous products 149
 - organic and inorganic biomass components 150
 - plasma gasification 150–151
 - reaction parameters 150
 - reactor design 151
 - slow pyrolysis, fixed-bed reactors 151–152
 - sustainable fuels and chemicals 150
- q**
- QIAGEN 512, 513
- quartz crystal microbalance (QCM) 485, 559–560
- r**
- RapidHIT™ system 523, 524
- reactive oxygen species (ROS) 72
- real-time genetic analysis 510
- recombinant DNA technology 67
- λ-Red system 312
- regulatory flux balance analysis (rFBA) 781
- Rehmanniae Radix 443
- renewable biofuels 203
- reticuloendothelial system (RES) 609
- retro-aldolase (RA) 29
- Rhizobia* spp. 435–436
- riboflavin (vitamin B₂) 368
- rMAP-silver-binding peptide fusion 669
- room temperature ionic liquids (RTILs) 35
- RSID™ -Blood 511
- s**
- SBE-based method
- biotin-labeled ddNTPs 539–540
 - deletion mutations 540
 - Fan's approach 538
 - insertion mutation 540
 - intensity ratio 538
 - recurrent LOH 538
 - representative scheme 538, 539
 - single-base extension–tag array 538
- scaffold-based cell delivery
- integrin receptors 621
 - pancreatic islets delivery 621–622
 - stem cell delivery 622–623
 - synthetic ECM 620
- scanning probe microscopy (SPM) 567
- secretion system 380–381
- self-assembly processes 93
- covalent assembly 98, 100
 - non-covalent assembly 97–99
- sensitivity analysis 736–739
 - Sentrix Array Matrix (SAM) 549
 - Sentrix BeadChip 549
 - Sepabead® 44
 - short peptides 657, 658
 - short tandem repeats (STRs)
 - autosomal/Y-chromosome STR (Y-STR) 509
 - biological samples 509
 - capillary electrophoresis (CE) 509
 - commercial autosomal and Y-STR STR kits 516
 - DNA quantification 514–515
 - DNA sample sources and collection 510–511
 - forensic STR typing system
 - fluorescence dyes 523
 - fully integrated microdevice 524–525
 - RapidHIT™ system 523, 524
 - gel electrophoresis 509
 - genomic DNA isolation 510
 - human genome project 509
 - lab on a chip (LOC) 510
 - markers, forensic DNA testing 515–516
 - microfabrication techniques 510
 - microfluidic-based STR typing process 525, 526
 - micro total analysis system (μTAS) 510
 - off-chip-based capillary electrophoretic separation 519–521
 - off-chip-based DNA extraction 511–512, 513
 - off-chip-based STR amplification 517–518
 - on-chip-based capillary electrophoretic separation 521–523
 - on-chip-based DNA extraction 512–514
 - on-chip-based STR amplification 518–519
 - real-time genetic analysis 510
 - siloxane removal technologies 136–137
- silver nanoparticles (AgNPs)
- applications 585
 - biological mode 581
 - biological synthesis 581
 - biomedical applications 582
 - capping agents 582
 - characteristics 582
 - mechanism 584–585
 - metal nanoparticles 581
 - metal precursor 583
 - pH effect 583
 - plant-mediated AgNP synthesis 579
 - plants in 582–583
 - reaction time/rate 583–584

- silver nanoparticles (AgNPs) (*contd.*)
 - size- and shape-dependent unique properties 580
 - surface-to-volume ratio 579
 - temperature effect 584
 - top-down and bottom-up strategies 580
- single batch bioprocesses
 - Batch Process Technologies 725
 - chemical and petrochemical industries 725
 - cycle time analysis and reduction 725
 - downstream 729–730
 - economic evaluation
 - – consumables cost breakdown 735, 737
 - – equipment specification and purchase costs 734, 735
 - – financial analysis 733
 - – fixed capital estimate summary 734, 736
 - – MAb process model 734
 - – operating cost summary 734, 737
 - – raw materials cost breakdown 735, 738
 - material balances 730–731
 - monoclonal antibody (MAb) 725, 726–728
 - multiple bioreactor trains 726
 - scheduling and cycle time reduction 731–733
 - sensitivity analysis 736–739
 - upstream 729
- single-strand conformation polymorphism (SSCP) 531
- single-strand DNA-mediated recombination
 - modified multiplex automated genome engineering 313, 314
 - multiplex automated genome engineering (MAGE) 312–313
 - λ -Red system 312
- single-walled carbon nanotube-field effect transistors (SWNT-FET) sensor 481
- skin delivery systems
 - drug permeation 454
 - liposomes 455–456
 - – surface modification 457
 - polymer micelles and polymersomes 456–457
 - solid lipid nanoparticles (SLN) 458
- smart drug delivery devices and implants *see* drug delivery devices (DDD); drug delivery implants (DDIs)
- soft tissue adhesives
 - alginate–dopamine conjugate 661
 - DOPA-ended PEG/polycaprolactone (PCL) copolymers 659
 - DOPA-functionalized PEG-based triblock copolymers 657
 - DOPA-functionalized Pluronic 657
 - elastomeric membrane defects 658
 - ethylene glycol acrylate methacrylate-dopamine (EGAMA-DOPA) 659–660
 - gelatin-based tissue adhesive 660–661
 - hyaluronic acid 660
 - hyper-branched poly(amino ester) polymer 659
 - *in vivo* adhesive studies 658
 - poly(ester urea)-based biomimetic adhesive polymer 659
 - polyvinylpyrrolidone (PVP) 659
 - rMAP-based water-immiscible protein bioadhesive 660
 - wound management 657
- sol–gel encapsulation 50
- sol–gel matrix 513
- solid lipid nanoparticles (SLN) 458
- solid-phase extraction method 512
- soluble chemical oxygen demand (SCOD) 185
- solventogenic clostridia
 - ABE production, fermentation 332–333
 - acetone formation pathway 337
 - aldehyde–alcohol dehydrogenase (*aad*) gene 337
 - clostridial strains 336
 - direct butanol-forming pathway 337
 - fermentation performance 337, 338
 - genetic tools 336–337
 - glycerol 334–335
 - history of 331–332
 - isopropanol-producing strain 337
 - lignocellulose 334
 - marine macroalgae 335
 - metabolomics 341
 - pentose utilization 339, 340
 - protein waste 336
 - sporulation and solvent production 339, 341
 - sugar metabolism, characteristics 332, 333–334
 - syngas 335
- sorbitol 367
- starch-forming algae 141
- steady-state flux modeling 797
- steam-blown reactor 237
- steam explosion methods 106
- steam gasification 146
- sterilization process 192, 206
- streptokinase 72
- sugar alcohols 361
 - sorbitol 367

- sweetness and health-promoting benefits 365–366
 - xylitol 366–367
 - sugar metabolism 332, 333–334
 - superoxide dismutase (SOD) 72
 - surface plasmon resonance (SPR) 486
 - surface-tethered zip-code probes 537
 - sustainable development
 - energy planning 128
 - food–energy–water (FEW) Nexus concept
 - biomass sustainability 129–131
 - decision making 128
 - sustainable biomass 128–129
 - United Nations projects 128
 - goals 127
 - market transformation 128
 - nutritional food supply 128
 - renewable power and fuel 128
 - SWNT-FET 487
 - syngas 335
 - cleaning 148
 - synthetic biomaterials 617
- t**
- TALENs-based methods 310
 - targeted delivery systems 608
 - targeted drug delivery systems 612–613
 - theranostic system 596
 - thermochemical conversion processes
 - advantages 142
 - direct combustion
 - co-firing biomass 145
 - composition and physiochemical properties 144
 - decomposition products 142–143
 - fixed-bed combustion systems 144
 - fluidized-bed combustion 144
 - gaseous emissions 144
 - oxidation process 142
 - particulate matter (PM) 144
 - proximate analysis 142, 143
 - solid biomass 142
 - steam turbine 142
 - gasification (syngas platform)
 - drying 146
 - Fischer–Tropsch (FT) reaction 149
 - gasifier types 146–148
 - operating parameters 146
 - oxidation 146
 - partial oxidation process 145
 - power and heat generation 148–149
 - pyrolysis 146
 - reduction 146
 - stages 145
 - steam gasification 146
 - sustainable and waste biomass 145
 - syngas cleaning 148
 - pyrolysis *see* pyrolysis
 - sustainable biomass 142
 - ThermoChem Recovery International, Inc. (TRI) 237
 - thermolysin-catalyzed synthesis 42
 - thermostable glycosidase 41–42
 - thrombolytic therapy 72
 - tissue engineering 617
 - mussel-mimetic biomaterials 655–670
 - tissue-type plasminogen activator (tPA) 72
 - titanium dioxide nanotube structures 599
 - total capital investment 723
 - transesterification reaction
 - brown grease 138
 - non-food lipids 138
 - triglycerides 137
 - waste oils and lipids, non-food sources 137
 - yellow grease 137–138
 - transferrin fusion technology 650–651
 - transglutaminases 93, 94
 - Trichoderma reesei* cellulase 41
 - trigger factor (TF) 22
 - trimethylamine (TMA) 483
 - N*-tris(hydroxymethyl)methyl-3-aminopropanesulfonic acid (TAPS) 519–520
 - twin-bed fluidized-bed gasifiers 147
 - two-column distillation decanter coupled system 274, 275
 - two-dimensional electrophoresis (2-DE) 704
 - two-photon-adsorbed photopolymerization (TPAP)
 - AFM imaging tool 564–565
 - fast Fourier transform (FFT) 567
 - force–distance curves 565, 566
 - hydrophilic surface, repulsive force 565
 - line profile analyses 566, 567
 - photoreactive resins 564
 - polymeric tip 565
 - three-dimensional (3-D) printing 564
 - tip–sample interaction 566
 - water contact angle 565
 - type 3 maturity-onset diabetes of the young (MODY) 533
- u**
- U.K. Institution of Chemical Engineers (IChemE) 8

- universal amplification-based technology
 - amplification of a separated ligation-dependent probe (ASLP) technology 546–248
 - GoldenGate assay 545, 546
 - molecular inversion probe (MIP) technology 542–545
 - multiplex PCR 542
 - whole genome amplification (WGA) 542
- urokinase-type plasminogen activator (uPA) 72
- v**
- vascular endothelial growth factor (VEGF) 665, 667
- vitamins
 - folate 368–369
 - intracellular coenzymes 367
 - riboflavin (vitamin B₂) 368
 - unbalanced diets 367
- volatile fatty acid (VFA) production
 - lignocellulosic biomass
 - – carbohydrate polymers 191
 - – degradation process 191
 - – fermentation substrate 191
 - – organic substances 191
 - – sterilization process 192
 - – sugar platform 192
 - pretreatment technology
 - – anaerobic digestion (AD) 196–198
 - – chemical pretreatment 194
 - – enzymatic pretreatment 195–196
 - – lignocellulosic matrix 193
 - – microbial pretreatment 194–195
 - – physical pretreatment 193–194
- volatile fatty acids (VFAs)
 - anaerobic digestion (AD) process 175, 176
 - biofuel production
 - – acidogenesis stage 173
 - – advantages and disadvantages 178–179
 - – biomass properties 178
 - – ethanol production 177–178
 - – municipal solid wastes (MSWs) 173
 - – platforms 173, 174
 - – sugar platform 173–174
 - – syngas platform 174–175, 177
 - commercialization activities 187–188
 - cost analysis 185–186
 - denitrification process 184–185
 - homoacetogenic bacteria 177
 - hydrogenation reaction 177
 - in industrialization 186, 187
 - – microbial lipid production
 - – advantages and disadvantages 207
 - – anaerobic digestion stages 206
 - – autotrophic microalgae 210
 - – biodiesel production 203
 - – biofuel production 205
 - – carbon reduction 203
 - – carbon source 207–209
 - – cetane number (CN) 209
 - – cost assessment 210
 - – economical process 206
 - – hydrolysis 206
 - – limiting factor 203
 - – microbial-derived diesels 203
 - – oleaginous bacteria 210
 - – oleaginous yeast 204–205
 - – oleic acid component 209
 - – organic waste biomass 203
 - – renewable biofuels 203
 - – sterilization process 206
 - – wet oxidation process 204
 - – mixed VFAs fermentation 176
 - – pure and mixed acids 179–180, 181
 - – value-added products
 - – acetyl coenzyme A (CoA) 183
 - – batch/fed-batch cultures 183
 - – crop-based oil 183
 - – extended VFA platform 180, 182
 - – extracellular and intracellular products 183
 - – heterotrophic microbial cells 184
 - – hydrogenation reaction 181
 - – lipid production 183
 - – microbial lipids/oil 182, 184
 - – MixAlco[®] process 180, 181
 - – mixed alcohols, esters, and ketones 182
 - – oleaginous microorganisms 183
 - – transesterification/esterification 181
- w**
- War Production Board 9
- waste oils 137–138
- water–gas shift reaction 230
- wearable drug delivery devices 595–597
- Wearable technology 595–597
- wet oxidation process 204
- whole cell biocatalysts, yeast cell surface display
 - α -amylase 84
 - applications 88, 89
 - biocatalyst separation 82
 - bioethanol production 84
 - biomass-degrading activities 81

- cellulase- and hemicellulase-displaying yeast strains 84
 - C-terminus free display systems 83–84
 - 2,3-dimercaptopropan-1-ol tributyl ester 85
 - enzyme secretion system 81
 - fermentation characteristics 85
 - gene cassettes 81, 82, 86–87
 - β -1,6-glucan chains 85
 - glucoamylase 84
 - glycosylphosphatidylinositol (GPI)-anchoring system 82, 83
 - heterologous hydrolytic enzymes 84
 - host cells, gene deletion 87
 - hydrolytic enzymes 82
 - immobilize enzymes 81
 - lipase enzymes 85
 - pathogen-derived proteins 81
 - ratio optimization 87, 88
 - starchy materials 84
 - xylitol production 84–85
 - whole cell catalysts 37, 39, 47
 - whole genome amplification (WGA) 542
 - whole genome sequencing 383
 - wood pellets 247
- x**
- xylanases 29, 140
 - xylitol 366–367
 - production 84–85
- y**
- Y-chromosome STR (Y-STR) 509
- z**
- zinc-finger nucleases (ZFNs) 309, 310
 - zip-code microarray
 - complementary zip-code sequence 535
 - cross-hybridization 536
 - gene-specific microarrays 534
 - immobilized capture oligonucleotides 534
 - ligation-based method 536–538
 - SBE-based method 538–540
 - SSS cleavage reaction-based method 540–542
 - tetramers arrangement 536
 - zip-code sequences 535
 - zymotechnology 3

