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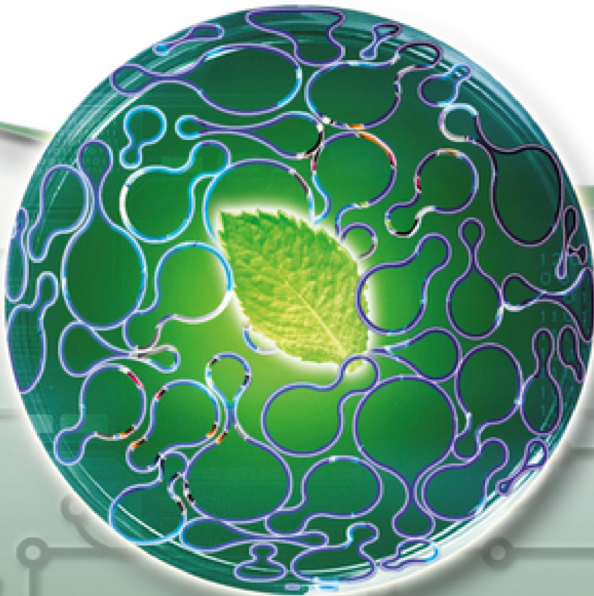

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Contents

List of Contributors *XIX*

1 **Introduction** *1*
Toshiomi Yoshida
1.1 Introduction *1*
1.2 Enzyme Technology *2*
1.3 Microbial Process Engineering *2*
1.3.1 Bioreactor Development *2*
1.3.2 Measurement and Monitoring *3*
1.3.3 Modeling and Control *4*
1.3.4 Solid-State Fermentation *4*
1.4 Plant Cell Culture *5*
1.5 Animal Cell Culture *5*
1.6 Environmental Bioengineering *6*
1.7 Composition of the Volume *7*
References *7*

Part I Enzyme Technology *11*

2 **Enzyme Technology: History and Current Trends** *13*
Klaus Buchholz and Uwe T. Bornscheuer
2.1 The Early Period up to 1890 *13*
2.1.1 Observations and Empirical Results *13*
2.1.2 Theoretical Approaches *14*
2.2 The Period from 1890 to 1940 *16*
2.2.1 Scientific Progress *16*
2.2.2 Theoretical Developments *17*
2.2.3 Technological Developments *18*
2.3 A New Biocatalyst Concept – Immobilized Enzymes *19*
2.3.1 Fundamental Research *19*
2.3.2 Examples of Industrial Development: The Case of Penicillin Amidase (PA) – Penicillin Hydrolysis and Derivatives *20*

2.3.3 Examples of Industrial Development: The Case of Sugar Isomerization *23*
2.4 Expanding Enzyme Application after the 1950s *24*
2.5 Recombinant Technology – A New Era in Biocatalysis and Enzyme Technology *27*
2.5.1 New Enzymes – A Key to Genetic Engineering *27*
2.5.2 Analytical and Diagnostic Enzymes *29*
2.5.3 Expanding Market of Industrial Enzymes *31*
2.6 Current Strategies for Biocatalyst Search and Tailor Design *32*
2.6.1 Enzyme Discovery from the Metagenome or Protein Databases *32*
2.6.2 Protein Engineering of Enzymes *34*
2.6.3 Enzyme Cascade Reactions *35*
2.6.4 Metabolic Engineering *37*
2.7 Summary and Conclusions *39*
Acknowledgment *40*
Abbreviations *40*
References *40*

3 Molecular Engineering of Enzymes *47*
Maria Elena Ortiz-Soto and Jürgen Seibel
3.1 Introduction *47*
3.2 Protein Engineering: An Expanding Toolbox *48*
3.2.1 From Sequence to Fold and Function *49*
3.2.2 Improving Enzyme Properties by Rational Design and Directed Evolution *49*
3.2.3 Designing Smart Libraries *51*
3.2.4 *In Vivo* Continuous Directed Evolution *54*
3.2.5 Diversification of Enzyme Functionalities by Recombination *55*
3.3 High-Throughput Screening Systems *56*
3.4 Engineered Enzymes for Improved Stability and Asymmetric Catalysis *58*
3.4.1 Stability *58*
3.4.1.1 Cellulases *59*
3.4.1.2 Lipases *60*
3.4.2 Asymmetric Biocatalysis *62*
3.5 *De Novo* Design of Catalysts: Novel Activities within Common Scaffolds *65*
3.6 Conclusions *69*
References *69*

4 Biocatalytic Process Development *81*
John M. Woodley
4.1 A Structured Approach to Biocatalytic Process Development *83*
4.2 Process Metrics *83*
4.2.1 Reaction Yield *84*

4.2.2 Productivity *85*
4.2.3 Biocatalyst Yield *85*
4.2.4 Product Concentration *86*
4.3 Technologies for Implementation of Biocatalytic Processes *87*
4.3.1 Biocatalyst Engineering *87*
4.3.1.1 Protein and Genetic Engineering *87*
4.3.1.2 Biocatalyst Immobilization *87*
4.3.2 Reaction Engineering *88*
4.3.2.1 Reactant Supply *89*
4.3.2.2 Product Removal *89*
4.3.2.3 Two-Phase Systems *90*
4.4 Industrial Development Examples *91*
4.4.1 Development of a Biocatalytic Route to Atorvastatin (Developed by Codexis Inc., USA) *91*
4.4.2 Development of a Biocatalytic Route to Sitagliptin (Developed by Codexis Inc., USA and Merck and Co., USA) *92*
4.5 Future Outlook *95*
4.6 Concluding Remarks *96*
References *96*

5 Development of Enzymatic Reactions in Miniaturized Reactors *99*
Takeshi Honda, Hiroshi Yamaguchi, and Masaya Miyazaki
5.1 Introduction *99*
5.2 Fundamental Techniques for Enzyme Immobilization *100*
5.2.1 Enzyme Immobilization by Adsorption *101*
5.2.1.1 Monoliths and Particles *109*
5.2.1.2 Synthetic Polymer Membranes and Papers *109*
5.2.1.3 Adsorption to Channel Walls *109*
5.2.2 Enzyme Immobilization by Entrapment *110*
5.2.2.1 Silica-Based Matrices *111*
5.2.2.2 Non-Silica-based Matrices *117*
5.2.3 Enzyme Immobilization by Affinity Labeling *119*
5.2.3.1 His-Tag/Ni-NTA System *119*
5.2.3.2 GST-Tag/Glutathione System *125*
5.2.3.3 Avidin/Biotin System *125*
5.2.3.4 DNA Hybridization System *126*
5.2.3.5 Other Techniques Using Nucleotides for Enzyme Immobilization *126*
5.2.4 Enzyme Immobilization by Covalent Linking *127*
5.2.4.1 Immobilization to Solid Supports *127*
5.2.4.2 Direct Immobilization to a Channel Wall *142*
5.2.4.3 Enzyme Polymerization *146*
5.2.5 Enzyme Immobilization by Other Techniques Using Organisms *149*

5.2.6 Application of Immobilized Enzymes in Microfluidics *149*
5.3 Novel Techniques for Enzyme Immobilization *150*
5.3.1 Polyketone Polymer: Enzyme Immobilization by Hydrogen Bonds *151*
5.3.2 Thermoresponsive Hydrogels *151*
5.3.3 Immobilization Methods Using Azide Chemistry *152*
5.3.3.1 Staudinger Ligation *152*
5.3.3.2 Click Chemistry *152*
5.3.4 Graphene-Based Nanomaterial as an Immobilization Support *153*
5.3.5 Immobilization Methods Using Proteins Modified with Solid-Support-Binding Modules *154*
5.4 Conclusions and Future Perspectives *155*
Abbreviations *156*
References *157*

Part II Microbial Process Engineering *167*

6 Bioreactor Development and Process Analytical Technology *169*
Toshiomi Yoshida
6.1 Introduction *169*
6.2 Bioreactor Development *170*
6.2.1 Parallel Bioreactor Systems for High-Throughput Processing *171*
6.2.1.1 Microtiter Plate Systems *172*
6.2.1.2 Stirred-Tank Reactor Systems *178*
6.2.1.3 Microfluidic Microbioreactor Systems *184*
6.2.1.4 Bubble Column Systems *188*
6.2.1.5 Comparison of Various Parallel-Use Micro-/Mini-Bioreactor System *189*
6.2.2 Single-Use Disposable Bioreactor Systems *193*
6.2.2.1 Features of Single-Use Bioreactors *194*
6.2.2.2 Sensors and Monitoring *194*
6.2.2.3 Single-Use Bioreactors in Practical Use *195*
6.3 Monitoring and Process Analytical Technology *196*
6.3.1 Monitoring and State Recognition *196*
6.3.1.1 Sensors for Monitoring Bioprocesses *196*
6.3.1.2 Spectrometry *199*
6.3.2 Process Analytical Technology (PAT) *200*
6.3.2.1 PAT Tools *201*
6.3.2.2 PAT Implementations *202*
6.4 Conclusion *203*
Abbreviations *204*
References *204*

7 Omics-Integrated Approach for Metabolic State Analysis of Microbial Processes *213*
Hiroshi Shimizu, Chikara Furusawa, Takashi Hirasawa, Katsunori Yoshikawa, Yoshihiro Toya, Tomokazu Shirai, and Fumio Matsuda
7.1 General Introduction *213*
7.2 Transcriptome Analysis of Microbial Status in Bioprocesses *214*
7.2.1 Introduction *214*
7.2.2 Microbial Response to Stress Environments and Identification of Genes Conferring Stress Tolerance in Bioprocesses *215*
7.2.3 Transcriptome Analysis of the Ethanol-Stress-Tolerant Strain Obtained by Evolution Engineering *217*
7.3 Analysis of Metabolic State Based on Simulation in a Genome-Scale Model *219*
7.3.1 Introduction *219*
7.3.2 Reconstruction of GSMs and Simulation by FBA *219*
7.3.3 Using Prediction of Metabolic State for Design of Metabolic Modification *221*
7.4 ^{13}C-Based Metabolic Flux Analysis of Microbial Processes *223*
7.4.1 Introduction *223*
7.4.2 Principles of ^{13}C-MFA *223*
7.4.3 Examples of ^{13}C-MFA in Microbial Processes *225*
7.5 Comprehensive Phenotypic Analysis of Genes Associated with Stress Tolerance *227*
7.5.1 Introduction *227*
7.5.2 Development of a High-Throughput Culture System *228*
7.5.3 Calculation of Specific Growth Rate *228*
7.5.4 Results of Comprehensive Analysis of Yeast Cells Under Conditions of High Osmotic Pressure and High Ethanol Concentration *228*
7.5.5 Identification of Genes Conferring Desirable Phenotypes Based on Integration with the Microarray Analysis Method *230*
7.6 Multi-Omics Analysis and Data Integration *230*
7.7 Future Aspects for Developing the Field *231*
Acknowledgments *233*
References *233*

8 Control of Microbial Processes *237*
Kazuyuki Shimizu, Hiroshi Shimizu, and Toshiomi Yoshida
8.1 Introduction *237*
8.2 Monitoring *238*
8.2.1 Online Measurements *238*
8.2.2 Filtering, Online Estimation, and Software Sensors *239*
8.2.3 Algorithm of Extended Kalman Filter and Its Application to Online Estimation of Specific Rates *239*
8.3 Bioprocess Control *242*
8.3.1 Control of Fed-Batch Culture *242*

8.3.2 Online Optimization of Continuous Cultures *244*
8.3.3 Cascade Control for Mixed Cultures *246*
8.3.4 Supervision and Fault Detection *249*
8.4 Recent Trends in Monitoring and Control Technologies *250*
8.4.1 Sensor Technologies and Analytical Methods *251*
8.4.2 Control Technologies *252*
8.5 Concluding Remarks *253*
Abbreviations *254*
References *254*

Part III Plant Cell Culture and Engineering *259*

9 Contained Molecular Farming Using Plant Cell and Tissue Cultures *261*
Stefan Schillberg, Nicole Raven, Rainer Fischer, Richard M. Twyman, and Andreas Schiermeyer
9.1 Molecular Farming – Whole Plants and Cell/Tissue Cultures *261*
9.2 Plant Cell and Tissue Culture Platforms *263*
9.2.1 Cell Suspension Cultures *263*
9.2.2 Tissue Cultures *264*
9.2.3 Light-Dependent Expression Platforms *264*
9.3 Comparison of Whole Plants and *In Vitro* Culture Platforms *265*
9.4 Technical Advances on the Road to Commercialization *267*
9.4.1 Improving the Quantity of Recombinant Proteins Produced in Cell Suspension Cultures *267*
9.4.2 Improving the Quality and Consistency of Recombinant Proteins Produced in Cell Suspension Cultures *269*
9.5 Regulatory and Industry Barriers on the Road to Commercialization *271*
9.6 Outlook *273*
Acknowledgments *275*
References *275*

10 Bioprocess Engineering of Plant Cell Suspension Cultures *283*
Gregory R. Andrews and Susan C. Roberts
10.1 Introduction *283*
10.2 Culture Development and Maintenance *286*
10.3 Choice of Culture System *288*
10.4 Engineering Considerations *291*
10.4.1 Cell Growth and Morphology *291*
10.4.2 Gas Requirements *292*
10.4.3 Aggregation *292*
10.4.4 Medium Rheology *293*
10.4.5 Shear Sensitivity *293*
10.5 Bioprocess Parameters *294*

10.5.1 Medium Composition and Optimization *294*
10.5.2 Temperature and pH *294*
10.5.3 Agitation *295*
10.5.4 Aeration *295*
10.6 Operational Modes *296*
10.7 Bioreactors for Plant Cell Suspensions *297*
10.7.1 Conventional Bioreactors *297*
10.7.1.1 Stirred-Tank Reactors *297*
10.7.1.2 Pneumatic Bioreactors *300*
10.7.2 Disposable Bioreactors *301*
10.8 Downstream Processing *303*
10.8.1 Specialized Metabolite Extraction and Purification *303*
10.8.2 Recombinant Protein Extraction and Purification *304*
10.9 Yield Improvement Strategies *306*
10.9.1 Specialized Metabolites and Recombinant Proteins *306*
10.9.1.1 Cell Immobilization *306*
10.9.1.2 *In Situ* Product Removal *306*
10.9.2 Specialized Metabolite Specific Strategies *307*
10.9.2.1 Elicitation *307*
10.9.2.2 Metabolic Engineering *308*
10.9.3 Recombinant-Protein-Specific Strategies *309*
10.9.3.1 Expression Systems *309*
10.9.3.2 Minimizing Post-Translational Loss of Recombinant Proteins *309*
10.10 Case Studies *310*
10.10.1 Protalix and the ProCellEx™ Platform *310*
10.10.1.1 Background *311*
10.10.1.2 The ProCellEx® Platform *311*
10.10.1.3 Future Outlook *312*
10.10.2 Phyton Biotech, Paclitaxel, and Plant Cell Fermentation (PCF™) *314*
10.10.2.1 Background *314*
10.10.2.2 Why Plant Cell Culture? *314*
10.10.2.3 Plant Cell Fermentation (PCF™) *315*
10.10.2.4 PCF™ Compared to Other Production Platforms *315*
10.11 Conclusion *315*
References *316*

11 The Role of Bacteria in Phytoremediation *327*
Zhaoyu Kong and Bernard R. Glick
11.1 The Problem *327*
11.1.1 Metals and Organics in the Environment *328*
11.1.2 Traditional Clean-up Procedures *328*
11.2 Defining Phytoremediation and Its Components *329*
11.3 Role of Bacteria in Phytoremediation *330*
11.3.1 Biodegradative Bacteria *330*

11.3.2 Plant-Growth-Promoting Bacteria *333*
11.3.2.1 Role of IAA *333*
11.3.2.2 Role of Ethylene *335*
11.3.2.3 Role of Nitrogen Fixation *336*
11.3.2.4 Role of Siderophores *339*
11.3.3 Interaction with Mycorrhizae *340*
11.4 Examples of Phytoremediation in Action *342*
11.5 Summary and Perspectives *343*
References *344*

Part IV Animal Cell Cultures *355*

12 Cell Line Development for Biomanufacturing Processes *357*
Mugdha Gadgil and Wei-Shou Hu
12.1 Introduction *357*
12.2 Host Cell *359*
12.2.1 Host Cell Engineering *359*
12.3 Vector Components *360*
12.3.1 Promoter/Enhancer *360*
12.3.2 Intron *362*
12.3.3 Poly-Adenylation Signal *362*
12.3.4 Selection Marker *363*
12.3.5 Secretion Leader Sequence *364*
12.3.6 Components for Plasmid Cloning in *E. coli* *364*
12.4 Transfection *365*
12.4.1 Method of Transfection *365*
12.4.2 Plasmid Conformation *366*
12.5 Integration of Foreign DNA into Host Chromosome *366*
12.5.1 Site-Specific Integration *367*
12.5.2 Use of cis-Acting DNA Elements *367*
12.6 Amplification *369*
12.7 Single-Cell Cloning *370*
12.7.1 Culture Medium for Single-Cell Cloning *371*
12.7.2 Automated High-Throughput Screening for High-Producer Clones *372*
12.8 Selecting the Production Clone *373*
12.8.1 Screening Platform *373*
12.8.2 Adaptation *374*
12.8.3 Process and Product Attributes *374*
12.8.4 Scale-Down Model *375*
12.9 Clone Stability *376*
12.10 Conclusion *376*
Acknowledgments *377*
References *377*

13 Medium Design, Culture Management, and the PAT Initiative *383*
Ziomara P. Gerdtzen
13.1 Historical Perspective on Culture Medium *383*
13.2 Cell Growth Environment *384*
13.2.1 Natural Cellular Environment *384*
13.2.1.1 The Role of Medium *384*
13.2.1.2 Medium Design *384*
13.3 Media Types *386*
13.4 Medium Components *387*
13.4.1 Growth-Associated, Unconsumed, and Catalytic Components *388*
13.4.1.1 Growth-Associated Components *388*
13.4.1.2 Unconsumed Components *388*
13.4.1.3 Catalytic Macromolecular Components *388*
13.4.2 Water in Media Preparation *388*
13.4.3 Sugars and Amino Acids *390*
13.4.3.1 Sugars as the Main Carbon Source *390*
13.4.3.2 Amino Acids *390*
13.4.4 Vitamins, Nucleosides, Fatty Acids, and Lipids *392*
13.4.4.1 Vitamins' Role *392*
13.4.4.2 Fatty Acids and Lipids *393*
13.4.5 Bulk Ions and Trace Elements *395*
13.4.6 Non-Nutritional Medium Components *396*
13.4.6.1 Phenol Red *396*
13.4.6.2 Sodium Bicarbonate Buffer *396*
13.4.6.3 Alternative Buffers *397*
13.4.6.4 Antioxidants *398*
13.4.6.5 Mechanical-Damage-Protective Agents *398*
13.4.6.6 Antibiotics *399*
13.5 High Molecular Weight and Complex Supplements *400*
13.5.1 Serum *400*
13.5.1.1 Functions of Serum in Cell Culture Medium *400*
13.5.1.2 Disadvantages of Serum in Cell Culture Medium *401*
13.5.2 Insulin and Insulin-Like Growth Factors *402*
13.5.3 Transferrin *402*
13.5.4 Serum Albumin and Other Carrier Proteins *403*
13.5.5 Cell Adhesion Molecules *404*
13.5.6 Protein Hydrolysates *405*
13.5.7 Lipid Supplements *406*
13.6 Medium for Industrial Production *407*
13.6.1 Medium Design and the PAT Initiative *409*
13.7 Conclusions *411*
References *412*
Further Reading/Resources *416*

14 Advanced Bioprocess Engineering: Fed-Batch and Perfusion Processes *417*
Sarika Mehra, Vikas Chandrawanshi, and Kamal Prashad
14.1 Primary Modes of Bioreactor Operation *417*
14.2 Fed-Batch Mode of Operation *419*
14.2.1 Design of Feed Composition *419*
14.2.2 Feeding Strategies for Fed-Batch Culture *422*
14.2.2.1 Culture Working Volume as Control *423*
14.2.2.2 Concentration of Indicator Metabolite as Control *423*
14.2.2.3 Nutrient Consumption Rate as Control *426*
14.2.2.4 Predicted Growth Rate as Control *427*
14.2.2.5 Culture pH as Control *427*
14.2.2.6 Oxygen Uptake Rate as Control *428*
14.2.3 Mode and Frequency of Feeding *429*
14.2.4 Challenges in Fed-Batch Culture and Future Directions *430*
14.3 Perfusion Mode of Bioreactor Operation *435*
14.3.1 Types of Perfusion Devices *435*
14.3.1.1 Gravity Settlers *435*
14.3.1.2 Filtration *438*
14.3.1.3 Centrifuges *441*
14.3.1.4 Hydrocyclones *443*
14.3.1.5 Acoustic Settlers *444*
14.3.2 Feeding Strategies for Perfusion Cultures *445*
14.3.2.1 Cell-Density-Based Feeding *445*
14.3.2.2 Metabolite-Based Feeding *445*
14.3.3 Challenges in Perfusion Culture and Future Directions *446*
14.4 Use of Disposables in Cell Culture Bioprocesses *447*
14.5 Analytical Methods to Monitor Key Metabolites and Parameters *450*
14.5.1 Enzymatic Assays *450*
14.5.2 Spectroscopy-Based Methods *452*
14.5.3 Chromatography-Based Methods *452*
14.5.4 Microscopy-Based Methods *452*
14.5.5 Electrochemical Methods *453*
14.6 Concluding Remarks *453*
Nomenclature *455*
References *456*
Further Reading/Resources *468*

Part V Environmental Bioengineering *469*

15 Treatment of Industrial and Municipal Wastewater: An Overview about Basic and Advanced Concepts *471*
Jyoti K. Kumar, Parag R. Gogate, and Aniruddha B. Pandit
15.1 Types of Wastewater *471*
15.2 Biological Treatment *471*
15.3 Wastewater Regulations *473*
15.4 Biological Treatment Processes *473*
15.5 Aerobic Techniques *475*
15.5.1 Mathematical Modeling *475*
15.5.2 Types of Aerobic Treatment *476*
15.5.2.1 Activated Sludge Process (ASP) *476*
15.5.2.2 Trickling Filters *481*
15.5.2.3 Rotating Biological Contactors (RBCs) *483*
15.5.2.4 Submerged Biological Contactors (SBCs) *484*
15.5.2.5 Powdered Activated Carbon Treatment (PACT) Systems *484*
15.5.2.6 Membrane Bioreactors *484*
15.5.2.7 Biological Aerated Filters (BAFs) *485*
15.5.2.8 Hybrid Processes-Integrated Fixed Film Activated Sludge System *486*
15.5.2.9 Use of Ultrasound to Improve the Sludge Characteristics *487*
15.6 Anaerobic Techniques *488*
15.6.1 Types of Anaerobic Treatment Systems *489*
15.6.1.1 Upflow Anaerobic Sludge Blanket (UASB) *489*
15.6.1.2 Anaerobic Baffled Reactors (ABR) *490*
15.6.1.3 Anaerobic Fluidized Bed Reactors *491*
15.6.1.4 Expanded Granule Sludge Blanket (EGSB) Reactor *492*
15.6.1.5 Anaerobic Membrane Reactors *492*
15.6.2 Improvements for Sludge Management *494*
15.7 Aerobic – Anaerobic Processes *495*
15.8 Modified Biological Processes *496*
15.8.1 Cavitation *496*
15.8.2 Fenton Chemistry *500*
15.8.3 Ozonation *501*
15.8.4 Photocatalysis *503*
15.8.5 Overview of Literature Dealing with Combined Processes *505*
15.8.6 A Typical Case Study of Biodegradability Enhancement of Distillery Wastewater Using Hydrodynamic Cavitation *507*

15.8.7 Short Case Study of Intensification of Biological Oxidation Using Acoustic Cavitation/Fenton Chemistry *509*
15.8.8 Summary of Pretreatment Approaches *511*
15.9 Overall Conclusions *511*
List of Acronyms/Abbreviations *512*
List of Variables and Coefficients *513*
References *514*

16 Treatment of Solid Waste *521*
Michael Nelles, Gert Morscheck, Astrid Lemke, and Ayman El Naas
16.1 Biological Treatment of Source Segregated Bio-Waste *522*
16.1.1 Composting *522*
16.1.1.1 Composting Process *522*
16.1.1.2 Composting Technologies *525*
16.1.1.3 Compost Use and Quality *531*
16.1.1.4 Status of Composting in Europe and Germany *532*
16.1.2 Anaerobic Digestion *532*
16.1.2.1 Process of Anaerobic Digestion *532*
16.1.2.2 AD Technologies *534*
16.1.2.3 Digestate Use and Quality *538*
16.1.2.4 Status of Anaerobic Digestion in Europe and Germany *538*
16.2 Mechanical–Biological Treatment of Mixed Municipal Solid Waste *538*
16.2.1 MBT Technologies *539*
16.2.1.1 MBT – Mechanical–Biological Treatment *539*
16.2.1.2 MBS – Mechanical–Biological Stabilization *540*
16.2.1.3 MPS – Mechanical–Physical Stabilization *541*
16.2.1.4 Status for Germany and Europe *541*
16.3 Biological Treatment of Agricultural Waste *542*
16.4 Conclusion *542*
References *542*

17 Energy Recovery from Organic Waste *545*
Yutaka Nakashimada and Naomichi Nishio
17.1 Advantage of Methane Fermentation for Energy Recovery from Organic Matter *545*
17.2 Basic Knowledge of Methane Fermentation of Organic Wastes *546*
17.3 Conventional Methane Fermentation Process *549*
17.4 Advanced Methane Fermentation Processes *551*
17.4.1 Methane Fermentation of Organic Wastes with High Salinity *551*
17.4.2 Methane Fermentation of Nitrogen-Rich Organic Wastes with High Ammonia *552*
17.5 Hydrogen Production from Organic Wastes *555*
17.5.1 Hydrogen Production Combining Methane Fermentation *555*
17.5.2 Hydrogen Production by Various Anaerobic Bacteria *556*

17.5.3 Feasible Substrates for Hydrogen Production *558*
17.5.4 Bioreactor for High-Rate Hydrogen Production *559*
17.6 Upgrading of Biogas from Organic Wastes Based on Biological Syngas Platform *561*
17.6.1 Bioduel Production from Syngas by Acetogens *562*
17.6.2 Development of Genetic Engineering Tools of Acetogens *563*
17.7 Conclusions *564*
References *565*

18 Microbial Removal and Recovery of Metals from Wastewater *573*
Michihiko Ike, Mitsuo Yamashita, and Masashi Kuroda
18.1 Microbial Reactions Available for Metal Removal/Recovery *574*
18.1.1 Bioprecipitation/Biomineralization *575*
18.1.2 Biovolatilization *577*
18.1.3 Biosorption *578*
18.1.4 Bioleaching *581*
18.2 Selenium Recovery by *Pseudomonas stutzeri* NT-I *583*
18.2.1 *Pseudomonas stutzeri* NT-I as a Versatile Tool for Selenium Recovery *583*
18.2.2 Selenium Recovery by Bioprecipitation *585*
18.2.3 Selenium Recovery by Biovolatilization *586*
18.3 Future Prospects *587*
18.3.1 Toward Environmental Conservation and Solutions to Resource Depletion *587*
18.3.2 Development of Removal and Recovery Strategies for Other Elements *589*
18.3.3 Potential for Practical Application *589*
18.4 Conclusions *590*
References *590*

19 Sustainable Use of Phosphorus Through Bio-Based Recycling *597*
Hisao Ohtake
19.1 Introduction *597*
19.2 Microbiological Basis *598*
19.2.1 P_i Acquisition in Bacteria *598*
19.2.2 Bacterial polyP Accumulation *599*
19.3 Bio-Based P Recycling *600*
19.3.1 Biological P Removal *600*
19.3.2 P_i Release from polyP-Rich Sludge *601*
19.3.3 P_i Recovery from Aqueous Solution *602*
19.4 Other Options for P Recycling *604*
19.4.1 Land Application of Biosolids *604*
19.4.2 Animal Manure Management *605*
19.4.3 Biosolubilization of Immobilized P_i *606*

19.4.4 Industrial P Recycling *606*
19.5 Conclusions *607*
References *609*

Index *613*

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1 Introduction

Toshiomi Yoshida

1.1 Introduction

The European Federation of Biotechnology proposed a definition of biotechnology as “The integration of natural science and organisms, cells, parts thereof and molecular analogs for products and services.” The Concise Oxford English Dictionary states “biotechnology is the exploitation of biological processes for industrial and other purposes especially the genetic manipulation of microorganisms for the production of antibiotics, hormone, and so on” [1].

Biochemical engineering has developed as a branch of chemical engineering, and deals with the design and construction of unit processes that involve biological molecules or organisms. Biochemical engineering is often taught as a supplementary option to students of chemical engineering or biological engineering courses because of the overlap in the curriculum and similarities in problem-solving techniques used in both professions. Its contribution is widely found in the food, feed, pharmaceutical, and biotechnological industries, and in water treatment plants.

Biological engineering or bioengineering is the application of the concepts, principles, and methods of biology to solve real-world problems using engineering methodologies and also its traditional sensitivity to the cost advantage and practicality. In this context, while traditional engineering applies physical and mathematical sciences to analyze, design, and manufacture inanimate tools, structures, and processes, biological engineering primarily utilizes knowledge of molecular biology to study, investigate, and develop applications of living organisms. In summary, biological engineers principally focus on applying engineering principles and the knowledge of molecular biology to study and enhance biological systems for varied applications.

Referring to the above review and brief discussion, it is proposed to have a section titled “Applied Bioengineering” be included in the Wiley Biotechnology Series. This section will deal with recent progress in all subjects closely related to “engineering and technologies” in the field of biotechnology; widening the coverage beyond conventional biochemical engineering and bioprocess engineering

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to include other biology-based engineering disciplines. The topics involved were selected specifically from the perspective of practical applications.

The volume "Applied Bioengineering" comprises five topics: enzyme technology, microbial process engineering, plant cell culture, animal cell culture, and environmental bioengineering. Each topic is figured in several chapters, though with more chapters pertaining to environmental bioengineering. This field has seen an increase in active research as mentioned below because of growing awareness and concern about conservation, remediation, and improvement of the environment.

The later part of this chapter provides a brief overview on the developments in bioengineering, referring to recent highly cited research.

1.2 Enzyme Technology

Recently, several attempts have been made to screen organic-solvent-tolerant enzymes from various microorganisms [2]. The ligninolytic oxidoreductases are being improved utilizing protein engineering by the application of different "omics" technologies. Enzymatic delignification will soon come into practical use in pulp mills [3]. Enzyme stabilization has been attempted using various approaches such as protein engineering, chemical modification, and immobilization [4].

Microbial glucose oxidase has garnered considerable interest because of its wide applications in chemical, pharmaceutical, food, beverage, clinical chemistry, biotechnology, and other industries. Novel applications of glucose oxidase in biosensors have further increased its demand [5]. Numerous oxidative biotransformation studies have demonstrated that enzymes have diverse characteristics and wide range of potential, and established applications [6]. Multienzymatic cascade reactions used in the asymmetric synthesis of chiral alcohols, amines, and amino acids, as well as for C–C bond formation, have been extensively studied [7].

1.3 Microbial Process Engineering

1.3.1 Bioreactor Development

Stirred-tank bioreactors are used in a large variety of bioprocesses because of their high rates of mass and heat transfer and excellent mixing. Theoretical predictions of the volumetric mass transfer coefficient have been recently proposed, and different criteria for bioreactor scale-up have been reported [8].