CONTENTS

VOLUME I

Biotechnology

Edgar J. DaSilva, International Scientific Council for Island Development, France Horst Werner Doelle, MIRCEN-Biotechnology, Australia

- 1. Historical Development
- 2. Present Development
 - 2.1 Fundamentals in Biotechnology
 - 2.2 Agriculture
 - 2.3 Medicine
 - 2.4 Industry
 - 2.5 Environment
 - 2.6 Social aspects
- 3. Future Development

Fundamentals in Biotechnology

Edgar J. DaSilva, International Scientific Council for Island Development, France Horst Werner Doelle, MIRCEN-Biotechnology, Australia

- 1. Introduction
- 2. Cell Characteristics
- 3. Cell Cultivation
- 4. Chemical Functions
- 5. Mutation and Gene Technology
- 6. Biosafety

Microbial Cell Culture

Horst Werner Doelle, MIRCEN-Biotechnology, Australia

- 1. Introduction
- 2. Nutrition
 - 2.1 Macronutrients
 - 2.1.1 Carbon Source
 - 2.1.2 Nitrogen Source
 - 2.1.3 Sulfur Source
 - 2.1.4 Phosphorous Source
 - 2.1.5 Others
 - 2.2 Micronutrients
 - 2.2.1 Tracer elements
 - 2.2.2 Iron
 - 2.3 Growth Factors
 - 2.4 Medium Composition
- 3. Growth
 - 3.1 Measurement
 - 3.1.1 Dry Weight
 - 3.1.2 Optical Measurement
 - 3.1.3 Cell Count
 - 3.1.4 Cell Constituents
 - 3.1.5 Optimization
- 4. Cultivation Systems
 - 4.1 Batch Cultivation

34

21

1

i

- 4.2 Continuous Cultivation
- 4.3 Fed-Batch Cultivation
- 4.4 Recycling Cultivation
- 4.5 Inoculum Cascading
- 4.6 Solid-state and Solid-substrate Cultivation
 - 4.6.1 Principles
 - 4.6.2 Inoculum
 - 4.6.3 Bioreactor Design
 - 4.6.4 Application

Algal Cell Culture

Peter A. Thompson, University of Tasmania, Australia

- 1. Introduction
- 2. Cell culture characteristics
 - 2.1 General considerations
 - 2.1.1 Morphology
 - 2.1.2 Physiology
 - 2.1.3 Reproduction
 - 2.2 Habitats
 - 2.3 Isolation
 - 2.4 Culture purification
 - 2.5 Sampling and counting algal cells
 - 2.6 Aseptic culture transfers
- 3. Growth and nutrition
 - 3.1 General remarks
 - 3.2 Artificial media
 - 3.3 Enriched natural waters
 - 3.4 Water supply and processing
 - 3.5 Illumination
 - 3.6 Preparation and use of glassware and other materials
- 4. Cultivation techniques
 - 4.1 General considerations
 - 4.2 Stock cultures
 - 4.3 Batch cultivation
 - 4.3.1 Lag phase
 - 4.3.2 Exponential phase
 - 4.3.3 Declining growth
 - 4.3.4 Stationary phase
 - 4.3.5 Death phase
 - 4.4 Semicontinuous cultivation
 - 4.5 Continuous cultivation
 - 4.5.1 Chemostats
 - 4.5.2 Turbidostats
 - 4.5.3 Cyclostats
 - 4.6 Final remarks on culture systems
- 5. Selected organisms
 - 5.1 Cyanobacteria
 - 5.2 Dunaliella salina
 - 5.3 Some other aquaculture species
- 6. Scale-up considerations
 - 6.1 Light
 - 6.2 Nutrient inputs
 - 6.3 Waste products
 - 6.4 Contamination
 - 6.4.1 Other algal species
 - 6.4.2 Pests

- 6.4.3 Predators
- 7. Production system classified by product type
 - 7.1 High value, low volume, intensive culture
 - 7.2 Lower value, greater volume
 - 7.3 Live feeds
- 8. Scale-up technology
 - 8.1 Harvesting
 - 8.2 Drying
- 9. Molecular algal biotechnology

Plant Cell Culture

Mary Bridget Taylor, South Pacific Commission, Fiji

- 1. Introduction
- 2. The Basics of Plant Cell Culture
- 3. Propagation of Plant Material
 - 3.1 Micropropagation
 - 3.2 Somatic Embryogenesis
- 4. Plant Improvement
 - 4.1 Callus and Suspension Cultures
 - 4.2 Protoplast Fusion
 - 4.3 Haploid Culture
 - 4.4 Embryo Rescue
- 5. Conservation
 - 5.1 Embryo Culture
 - 5.2 Germplasm Storage In Vitro
- 6. Utilization of Plant Germplasm
 - 6.1 Germplasm Exchange
 - 6.2 Production of Secondary Metabolites

Mammalian Cell Culture

Christopher P. Marquis, The University of New South Wales, Australia

- 1. Introduction
- 2. A brief history of mammalian cell culture
- 3. Primary and continuous cultures
 - 3.1 Primary Cultures
 - 3.2 Continuous Cell Lines
 - 3.3 Organ culture
 - 3.4 Some useful cell lines
 - 3.4.1 CHO Cells
 - 3.4.2 VERO cells
 - 3.4.3 Sp2/0 myelomas
- 4. Methods in mammalian cell culture
 - 4.1 Media and environment
 - 4.1.1 Media
 - 4.1.2 Environment
 - 4.2 Bioreactor design
 - 4.2.1 Anchorage-dependence
 - 4.2.2 Surfaces for tissue culture growth
 - 4.2.3 Bioreactor Types
- 5. Applications of cell culture in virus production
- 5.1 Viral Vectors for Gene Therapy
 - 5.2 Key areas for future development of cell culture related to gene therapy
- 6. Application of cell culture in biopharmaceutical production
- 6.1 Antibodies for human therapy

126

iii

- 7. Tissue engineering and cell culture
 - 7.1 Bone and Cartilage
 - 7.2 Hepatic cell culture
 - 7.3 Haematopoietic stem cell culture

Cell Thermodynamics and Energy Metabolism

Horst Werner Doelle, MIRCEN-Biotechnology, Australia

- 1. Introduction
- 2. Concepts of Thermodynamics
 - 2.1 First Law of Thermodynamics
 - 2.2 Second Law of Thermodynamics
 - 2.3 Free Energy
- 3. Concepts of Energy Production and Conservation
 - 3.1 Principles of Electron Transfer and Transport
 - 3.2 Proton-translocating Electron Transport Chain
 - 3.3 Proton-translocating ATPase Complex
- 4. Concepts of Membrane and Solute Transport
 - 4.1 Passive Diffusion
 - 4.2 Facilitated Diffusion
 - 4.3 Active Transport
 - 4.4 Group Translocation
- 5. Concepts of Energy Metabolism
 - 5.1 Photosynthesis
 - 5.2 Aerobic Respiration
 - 5.3 Anaerobic Respiration
 - 5.4 Fermentation
- 6. Concept of Enzyme Catalysis

Basic Strategies of Cell Metabolism

Horst Werner Doelle, MIRCEN-Biotechnology, Australia

- 1. Introduction
- 2. Polymer hydrolysis
 - 2.1 Starch hydrolysis to glucose
 - 2.2 Cellulose
 - 2.3 Proteins
 - 2.4 Fats
- 3. Aerobic catabolism
 - 3.1 Carbohydrates
 - 3.2 Amino Acids
 - 3.3 Fatty Acids
 - 3.4 Hydrocarbon
 - 3.5 Single Carbon Compounds
- 4. Anaerobic catabolism
 - 4.1 Carbohydrates
 - 4.1.1 Ethanol formation
 - 4.1.2 Acetate, Butyrate, Acetone and butanol formation
 - 4.1.3 Organic acid formation
 - 4.1.3.1 Propionic and succinic acid formation
 - 4.1.3.2 Malo-lactic fermentation
 - 4.1.3.3 Diacetyl, acetoin and butanediol formation
 - 4.2 Proteins and amino acids
 - 4.2.1 Single Amino Acids
 - 4.2.2 Pairs of amino acids
 - 4.2.3 Single amino acids in combination with keto acids
 - 4.3 Fatty acids

178

5.

4.4 Methane formation

5.2 Protein biosynthesis

5.4 Lipid formation5.5 Cell Wall Formation6. Metabolic Regulation

6.1.1

6.1.2 6.1.3

6.2.1

6.2.2

6.2.3

6.2.4

Anabolism (biosynthesis) of cellular components

Substrate availability

Cofactor availability

Constitutive enzymes

Catabolite repression

5.3 Ribonucleic acid [RNA] and Deoxyribonucleic acid [DNA]

Product removal and Feedback inhibition

The Importance of Microbial Culture Collections and Gene Banks in Biotechnology

Repression of enzyme synthesis

Induction of enzyme synthesis

5.1 Autotrophic carbon assimilation

6.1 Enzyme Activity Regulation

6.2 Enzyme Synthesis Regulation

- Lourdes M. Mahilum-Tapay, University of the Philippines, Philippines
- 1. Introduction
- 2. Microbial Resources
 - 2.1 Establishment of Culture Collections
 - 2.2 Kinds of Culture Collections
 - 2.3 Current Status of Culture Collections in the World
- 3. Plant Genetic Resources
- 4. Culture Collections, Gene Banks and Biotechnology
 - 4.1 Repository of Strains and/or Genetic Materials
 - 4.2 Provider of Materials/Information and Services
 - 4.3 Patent Depository
 - 4.4 Information Center
- 5. Future Programs

Biosafety in Biotechnology

Bernadette Van Vaerenbergh, Institute of Public Health, Belgium Ellen Van Haver, Institute of Public Health, Belgium Myriam Sneyers, Institute of Public Health, Belgium Suzy Renckens, Institute of Public Health, Belgium Didier Breyer, Institute of Public Health, Belgium Jean-Marc Collard, Institute of Public Health, Belgium William Moens, Institute of Public Health, Belgium

- 1. Introduction
- 2. General Principles of Risk Assessment
 - 2.1 Classification of Natural Organisms on the Basis of Hazard
 - 2.2 Assessing the potential risks of genetically modified organisms
- 3. Contained Use
- 4. Deliberate Release of Transgenic Plants: Testing in the Environment and Placing on the (World) Market
- 5. Food and Feed as, or Derived from, Transgenic Crops
 - 5.1 Safety Assessment of GM food for Humans
 - 5.2 Safety Assessment of GM Feed for Animals
 - 5.3 Novel Food/Feed Acceptance
- 6. Medicinal Products
- 7. Framing Biosafety in An International Context

v

227

8. Conclusions

Bioinformatics

Bojana Boh, University of Ljubljana, Slovenia

- 1. Introduction
- 2. Levels of information processing
- 3. Traditional information support in biosciences: bibliographic databases
- 4. Value added processing of databases
- 5. Factual databases in biosciences
- 6. Nucleic Acid Research and Genomics
- 7. Protein Research and Proteomics
- 8. Higher levels of information processing

Microbial Chemistry

Horst W. Doelle and Monica Wilkinson, MIRCEN-Biotechnology Brisbane and Pacific Regional Network, Brisbane, Australia

- 1. Introduction
- 2. General Consideration
- 3. Metabolism
 - 3.1. Thermodynamics
 - 3.2. Aerobic Metabolism
 - 3.3. Anaerobic Metabolism
 - 3.4. Anabolism (biosynthesis) of cellular components
 - 3.5. MetabolicRegulation
- 4. Microbial Chemistry in Nature
 - 4.1. Carbon
 - 4.2. Nitrogen
 - 4.2.1. Nitrogen Fixation
 - 4.2.2. Symbiotic Nitrogen Fixation
 - 4.2.3. Ammonification
 - 4.2.4. Nitrification
 - 4.2.5. Denitrification
 - 4.3. Sulfur Cycle
 - 4.3.1. Oxidative Sulfur Transformation
 - 4.3.2. Reductive Sulfur Transformation
 - 4.4. Phosphorous Cycle
 - 4.5. Iron Cycle
- 5. Microbial Interactions
 - 5.1. Interactions Amongst Microorganisms
 - 5.1.1. Synergism
 - 5.1.2. Mutualism or symbiosis
 - 5.2. Microorganism-Plant Interactions
 - 5.2.1. Beneficial Interactions. Symbiotic Nitrogen Fixation
 - 5.2.2. Rhizosphere
 - 5.2.3. Mycorrhiza
 - 5.2.4. Detrimental Interactions
 - 5.3. Microorganism Animal Interactions
- 6. Human and Microbial Chemistry
- 7. Biotechnology Applications

Index

321

325

About EOLSS

261