

Contents

Contributors, x

Preface and Acknowledgements, xi

1 1 What is Biotechnology?, 1

I. J. HIGGINS

- 1.1 Introduction
- 1.2 Historical perspectives
- 1.3 Developments in the biotechnology industry since World War II
- 1.4 Future prospects for the development of biotechnology
 - 1.4.1 Medicine
 - 1.4.2 Energy
 - 1.4.3 Food and drink
 - 1.4.4 Chemicals
 - 1.4.5 Materials
 - 1.4.6 The environment
 - 1.4.7 Agriculture
- 1.5 Economic and business aspects of biotechnology
 - 1.5.1 Logistics of biotechnology development
 - 1.5.2 Protection of intellectual property in biotechnology
 - 1.5.3 Regulation of the safety of biotechnology procedures and products
- 1.6 Closing remarks
- 1.7 Recommended reading

2 2 Energy and Biotechnology, 24

D. O. HALL, J. COOMBS AND I. J. HIGGINS

- 2.1 Introduction
- 2.2 Biomass as a solar energy technology
 - 2.2.1 The resource base
- 2.3 Photosynthesis
 - 2.3.1 Photosynthetic efficiency
 - 2.3.2 Improving photosynthesis through biotechnology
- 2.4 Agriculture and forestry
 - 2.4.1 Energy ratios
 - 2.4.2 Forests and trees as a source of biomass fuels
 - 2.4.3 Algae and aquatic plants
 - 2.4.4 Oil plants
- 2.5 Conversion to fuels
 - 2.5.1 Feedstock preparation
 - 2.5.2 Fermentation
 - 2.5.3 Ethanol
 - 2.5.4 Energy balances
 - 2.5.5 Methane by anaerobic digestion
- 2.6 Cell free systems
 - 2.6.1 Combined systems for hydrogen production
 - 2.6.2 Electricity
- 2.7 Biofuel cells and other bioelectrochemical devices
- 2.8 Recommended reading

3 Food, Drink and Biotechnology, 73

G. A. BEECH, M. A. MELVIN AND J. TAGGART

3.1 Introduction

- 3.1.1 Microorganisms and food
- 3.1.2 The two scales of biotechnology
- 3.1.3 The scope of biotechnology in the food and drink industry

3.2 Dairy products

- 3.2.1 General points
- 3.2.2 Cheese
- 3.2.3 Yoghurt
- 3.2.4 Butter
- 3.2.5 Cultured butter-milk
- 3.2.6 Cultured sour cream
- 3.2.7 Novel products

3.3 Cereal products

- 3.3.1 Bread and baked goods
- 3.3.2 Starch hydrolysates

3.4 Brewing

- 3.4.1 Alcoholic beverage production
- 3.4.2 Beer
- 3.4.3 Wine
- 3.4.4 Spirits
- 3.4.5 Cider
- 3.4.6 Vinegar

3.5 Protein products

- 3.5.1 Traditional fermented foods
- 3.5.2 Single cell protein
- 3.5.3 MycoProtein

3.6 Food additives and ingredients

- 3.6.1 Acidulants
- 3.6.2 Amino acids
- 3.6.3 Vitamins and pigments
- 3.6.4 Flavourings
- 3.6.5 Oil and fats
- 3.6.6 Gums and thickeners

3.7 Fruit and vegetables

- 3.7.1 Preserved vegetables
- 3.7.2 Soya products
- 3.7.3 Fruit juices—application of enzymes

3.8 Overview

- 3.8.1 Short-term prospects
- 3.8.2 Long-term prospects

3.9 Recommended reading

4 Chemistry and Biotechnology, 111

D. J. BEST

4.1 Introduction

4.2 The development of current chemical biotechnology

- 4.2.1 The solvent fermentations
- 4.2.2 Organic acid production
- 4.2.3 Other organic acids
- 4.2.4 Amino acids

- 4.2.5 Antibiotics and steroids
- 4.2.6 The commercial exploitation of enzymes
- 4.3 The generation of chemicals from biomass
 - 4.3.1 Plant cell biotechnology
 - 4.3.2 Chemicals from biomass
- 4.4 Future prospects
 - 4.4.1 Reaction type
 - 4.4.2 Reactor configuration
 - 4.4.3 Future impact of biotechnology upon the chemical industry
- 4.5 Recommended reading

5 Materials and Biotechnology, 163

C. L. BRIERLEY, D. P. KELLY, K. J. SEAL AND D. J. BEST

- 5.1 Introduction
- 5.2 Microbial leaching
 - 5.2.1 The leaching microorganisms
 - 5.2.2 Commercial applications of bioextractive metallurgy
 - 5.2.3 Potential applications of bacterial leaching
- 5.3 Metal transformation, accumulation and immobilization by microorganisms
 - 5.3.1 Volatilization
 - 5.3.2 Extracellular precipitation
 - 5.3.3 Extracellular complexation
 - 5.3.4 Intracellular and extracellular accumulation of metals by microorganisms
- 5.4 Biopolymers
 - 5.4.1 Introduction
 - 5.4.2 Polysaccharides
 - 5.4.3 Polysaccharide production by fermentation
 - 5.4.4 Microbial polysaccharides: properties, applications and commercial potential
 - 5.4.5 Polysaccharide biosynthesis
 - 5.4.6 Approaches to the improvement of microbial polysaccharide production
 - 5.4.7 Poly- β -hydroxybutyrate
 - 5.4.8 Other microbially derived polymers
- 5.5 The biodeterioration of materials
 - 5.5.1 Introduction
 - 5.5.2 Definition of biodeterioration
 - 5.5.3 Classification of biodeterioration processes
 - 5.5.4 Materials subject to biodeterioration
- 5.6 Recommended reading

6 The Environment and Biotechnology, 213

D. J. BEST, J. JONES AND D. STAFFORD

- 6.1 Introduction
- 6.2 The processing of waste
 - 6.2.1 Aerobic processes: trickling/percolating filters, activated sludge, the fluidized bed
 - 6.2.2 The anaerobic digestion process
- 6.3 Biological control of microbial waste treatment systems
- 6.4 Pathogen control
- 6.5 Resource recovery
- 6.6 Biological processing of industrial waste
 - 6.6.1 Wastes from the dairy industry ... whey
 - 6.6.2 Wastes from the pulp industry
 - 6.6.3 Wastes from the dye industry

- 6.7 The degradation of xenobiotic compounds in the environment
 - 6.7.1 The involvement of microbial communities in the biodegradation of xenobiotics
 - 6.7.2 Chlorinated hydrocarbons
 - 6.7.3 Other substituted simple aromatic compounds
 - 6.7.4 Polyaromatic hydrocarbons
 - 6.7.5 Microbial treatment of oil pollution
 - 6.7.6 Pesticides
 - 6.7.7 Surfactants
- 6.8 Recommended reading

7 Genetics and Biotechnology, 257

K. G. HARDY AND S. G. OLIVER

- 7.1 Introduction
- 7.2 Conventional routes to strain improvement
 - 7.2.1 Mutagenesis and selection
 - 7.2.2 Hybridization by mating
- 7.3 *In vivo* genetic manipulation
 - 7.3.1 Plasmids
 - 7.3.2 Protoplast fusion
 - 7.3.3 Cell fusion
- 7.4 *In vitro* genetic manipulation
 - 7.4.1 Technology
 - 7.4.2 Expression of cloned genes
 - 7.4.3 Applications of genetic engineering
- 7.5 Summary and prospects
- 7.6 Recommended reading

8 Medicine and Biotechnology, 283

J. C. PICKUP

- 8.1 Introduction
- 8.2 Unmodified or mutant cells and their products
 - 8.2.1 Antibiotics
 - 8.2.2 Other cell cultures
 - 8.2.3 Bioconversions
- 8.3 Modified cells and their products
 - 8.3.1 Monoclonal antibodies
 - 8.3.2 Recombinant DNA technology
- 8.4 Application of the techniques of molecular genetics and recombinant DNA technology in diagnosis and pathology of human disease
 - 8.4.1 Prenatal diagnosis in inherited disease
 - 8.4.2 Genetic influences in disease pathology
- 8.5 Future prospects
- 8.6 Recommended reading

9 Agriculture and Biotechnology, 305

F. A. SKINNER

- 9.1 Introduction
- 9.2 The nutrient film technique
 - 9.2.1 Principle of the technique
 - 9.2.2 Basic requirements for a NFT installation
 - 9.2.3 Phytotoxicity
 - 9.2.4 NFT channel design

- 9.2.5 Supporting young plants
- 9.2.6 Disease
- 9.2.7 Prospects
- 9.3 Leguminous crops and symbiotic nitrogen fixation
 - 9.3.1 Historical introduction
 - 9.3.2 Inoculation with rhizobia
 - 9.3.3 Seed inoculation
 - 9.3.4 Modern solid-support inoculants
 - 9.3.5 Methods of inoculation
 - 9.3.6 Improving the legume-*Rhizobium* symbiosis
- 9.4 Vesicular-arbuscular mycorrhiza
 - 9.4.1 Significance of vesicular-arbuscular mycorrhiza
 - 9.4.2 Inoculation with the endophyte
 - 9.4.3 Inoculation techniques
- 9.5 Biological control
 - 9.5.1 Principles of biological control
 - 9.5.2 Examples of biological control
 - 9.5.3 Crown gall disease and its control
- 9.6 The aerobic treatment of agricultural wastes
 - 9.6.1 The problem of waste storage and disposal
 - 9.6.2 Aerobic treatment systems
- 9.7 Anaerobic digestion of agricultural wastes
 - 9.7.1 Essential features of the process
 - 9.7.2 Approach to agricultural waste treatment
 - 9.7.3 Microbiology of the process
 - 9.7.4 Modern developments
- 9.8 Plant breeding and protoplast techniques
 - 9.8.1 Vegetative propagation
 - 9.8.2 Regeneration of plants from protoplasts
 - 9.8.3 Protoplast fusion techniques
- 9.9 Recommended reading

10 Chemical Engineering and Biotechnology, 346

G. HAMER

- 10.1 Introduction
- 10.2 Microbial factors affecting process performance and economics
 - 10.2.1 Yield coefficients
 - 10.2.2 Growth and product formation kinetics
 - 10.2.3 Substrate affinity and microbial growth
 - 10.2.4 Fastidiousness and culture stability
- 10.3 Process engineering factors affecting process performance and economics
 - 10.3.1 Bioreactor classification and productivity
 - 10.3.2 Dimensional analysis and scale up
 - 10.3.3 Oxygen transfer
 - 10.3.4 Heat transfer and process cooling
 - 10.3.5 Conversion and recycle
 - 10.3.6 Characteristics of microbial and mycelial suspensions.
- 10.4 Ancillary unit operations in biotechnological processes
 - 10.4.1 Medium and air sterilization
- 10.5 Future developments in industrial biotechnological processes
- 10.6 Recommended reading