

Contents

List of Contributors

ix

Preface

xi

1 Biological and Agricultural Systems: An Overview

David O. Hall

I. Introduction	1
II. Impending Liquid Fuel Problem	2
III. Energy Available from Photosynthesis	3
IV. Efficiency of Photosynthesis	3
V. Areas Required for Solar Power	5
VI. Complete Crop Utilization	8
VII. Energy Farming	10
VIII. Cellulose	12
IX. Waste Disposal and Algae	13
X. Plant Selection and Breeding	15
XI. Regulation of Plant Reactions and Selected End Products	16
XII. Controlled Environments	18
XIII. Nitrogen Fixation	19
XIV. Biocatalytic Hydrogen Production Systems	20
XV. Carbon Reduction	21
XVI. Artificial Chlorophyll Membranes	22
XVII. Bacteriorhodopsin Membranes	22
XVIII. Concluding Remarks	23
References	24

2 Marine Biomass Production through Seaweed Aquaculture

George A. Jackson

I. Introduction	31
II. Seaweed Growth	33
III. Impact of Advective-Convective Processes on Oceanic Culture	52
IV. Conclusions	54
References	56

3 Algal-Bacterial Systems*William J. Oswald and John R. Benemann*

I. Introduction	59
II. Elements of Algal-Bacterial Systems	63
III. Conclusions	77
References	79

4 Fuels and Organic Chemicals via Anaerobic Fermentation of Residues and Biomass*Donald L. Wise*

I. Introduction	81
II. Perspective of Economic Impact	83
III. Temperature Effect	85
IV. New Processing Concepts	90
V. Fermenter Functioning	99
VI. Biomass Sources	104
VII. Summary	111
References	112

5 Biological Nitrogen Fixation with an Emphasis on the Legumes*D. W. Emerich and H. J. Evans*

I. Introduction	118
II. Biological Nitrogen-Fixation Systems	118
III. The Symbiotic Association in Legumes	120
IV. Asymbiotic Fixation by Rhizobia	123
V. The Enzymology of Nitrogen Fixation	124
VI. Energy Requirements for Nitrogen Fixation	131
VII. Increasing Biological Nitrogen Fixation	135
References	141

6 Energy Crops (Energy Farming)*James A. Bassham*

I. Introduction	147
II. Why Is Efficiency Important?	149
III. Advantages of Energy Farming	150
IV. Efficiencies of Solar Energy Conversion by Plants	151
V. Calculated Maximum Biomass Production and Reported High Yields	155
VI. C-4 Metabolism and Photorespiration and Effects of CO ₂ Enrichment	156
VII. Energy Content of Biomass	159
VIII. Types of Energy Farms	159

IX. Crops Requiring Moderate Rainfall or Irrigation	160
X. Energy Crops in Semi-Arid and Arid Regions	163
XI. Ponds and Fresh-Water or Brackish-Water Bodies	167
XII. Marine: Giant Kelp	169
XIII. Biomass Residues from Agriculture and Forestry	170
XIV. Summary	170
XV. Epilogue	171
References	172

7 The O₂/CO₂ Cycle: Development and Atmospheric Consequences*Peter Böger*

I. Rise of Atmospheric Oxygen	175
II. Distribution of Biogenic Carbon and Oxygen	180
III. Stability of Atmospheric Oxygen Content	183
IV. Increase of Carbon Dioxide—The "Greenhouse" Effect	184
References	188

8 Glycerol Production in the Alga *Dunaliella**Ami Ben-Amotz*

I. Introduction	191
II. Growth of <i>Dunaliella</i> under Measurable and Controlled Conditions	194
III. Glycerol Production in <i>Dunaliella</i>	199
IV. Bioengineering Approach	203
V. Economic Appraisal	205
VI. Conclusion	206
References	206

9 Energy Considerations of Biofuels Production*C. W. Lewis*

I. Energy Analysis	209
II. Solar Energy	213
III. Fuels from Biomass	214
IV. Conclusion	224
References	224

Index