

# Contents

|          |                                                                                                                   |           |
|----------|-------------------------------------------------------------------------------------------------------------------|-----------|
| <b>1</b> | <b>Introduction</b>                                                                                               | <b>1</b>  |
| <b>2</b> | <b>Microbial CO Metabolism</b>                                                                                    | <b>5</b>  |
| <b>3</b> | <b>CO-oxidizing Microorganisms</b>                                                                                | <b>11</b> |
| 3.1      | CO-utilizing Hydrogenogenic Bacteria and Archaea                                                                  | 12        |
| 3.1.1    | CO-utilizing Facultatively Anaerobic Bacteria                                                                     | 15        |
| 3.1.2    | CO-utilizing Obligately Anaerobic Bacteria<br>and Archaea                                                         | 17        |
| 3.2      | CO-utilizing Sulfate-Reducing Bacteria and Archaea                                                                | 19        |
| 3.3      | CO-utilizing Sulfur-Reducing Archaea                                                                              | 22        |
| 3.4      | CO-utilizing Acetogenic Bacteria                                                                                  | 22        |
| 3.5      | CO-utilizing Methanogenic Archaea                                                                                 | 23        |
| 3.6      | CO-utilizing Iron-Reducing Bacteria and Archaea                                                                   | 26        |
| <b>4</b> | <b>Biotechnological Applications of Thermophilic<br/>Carboxydrotrophs</b>                                         | <b>29</b> |
| 4.1      | Electricity Production from CO/Syngas-fed Microbial<br>Fuel Cell                                                  | 31        |
| 4.1.1    | Overview of Microbial Fuel Cells (MFCs)                                                                           | 31        |
| 4.1.2    | CO/Syngas as Substrates for Microbial Fuel<br>Cells (MFCs)                                                        | 38        |
| 4.1.3    | Thermophilic Carboxydrotrophs in CO/Syngas-fed<br>Microbial Fuel Cells (MFCs)                                     | 41        |
| 4.1.4    | Design Considerations of MFCs Operating<br>at Thermophilic Temperatures                                           | 48        |
| 4.2      | Biofuel and Organic Acid Production by Thermophilic<br>Carboxydrotrophs from Synthesis Gas (Syngas) Fermentation  | 50        |
| 4.2.1    | Microbiology of Carboxydrotrophic Microorganisms<br>Capable of Converting Syngas to Biofuels and Organic<br>Acids | 57        |

|          |                                                                                                                                                                                                       |            |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| 4.2.2    | Biochemistry of Syngas Fermentation . . . . .                                                                                                                                                         | 67         |
| 4.2.3    | Products of Syngas Fermentation. . . . .                                                                                                                                                              | 72         |
| 4.2.4    | Potential Improvements . . . . .                                                                                                                                                                      | 77         |
| 4.3      | Bioremediation of Toxic Compounds with Thermophilic<br>Carboxydotrophs . . . . .                                                                                                                      | 81         |
| 4.3.1    | Reductive Dehalogenation of Trichloroethylene<br>by <i>Methanosarcina Thermophila</i> . . . . .                                                                                                       | 83         |
| 4.3.2    | Reductive/Substitutive Dechlorination of<br>Tetrachloromethane (CCl <sub>4</sub> ) by <i>Clostridium</i><br><i>Thermoaceticum</i> and <i>Methanobacterium</i><br><i>Thermoautotrophicum</i> . . . . . | 85         |
| 4.3.3    | Transformation of 2,4,6,-trinitrotoluene (TNT)<br>by a Carboxydotrophic Sulfate-reducing Anaerobe. . . . .                                                                                            | 87         |
| 4.4      | Thermophilic Carboxydotrophs as Biosensors for CO<br>Detection . . . . .                                                                                                                              | 88         |
| 4.4.1    | Mediators . . . . .                                                                                                                                                                                   | 92         |
| 4.4.2    | Enzyme Electrodes . . . . .                                                                                                                                                                           | 92         |
| 4.4.3    | Gas Biosensors . . . . .                                                                                                                                                                              | 93         |
| 4.4.4    | Detection of CO from the Environment . . . . .                                                                                                                                                        | 94         |
| <b>5</b> | <b>Conclusions . . . . .</b>                                                                                                                                                                          | <b>103</b> |
|          | <b>References. . . . .</b>                                                                                                                                                                            | <b>105</b> |

Thermophilic Carboxydotrophs and their Applications in  
Biotechnology

Tiquia-Arashiro, S.M.

2014, IX, 131 p. 35 illus., 13 illus. in color., Softcover

ISBN: 978-3-319-11872-7