

Design of microbial fuel cells for practical application: a review and analysis of scale-up studies

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Anthony Janicek, Yanzen Fan & Hong Liu*

There has been substantial progress towards scale-up and practical application of microbial fuel cell (MFC) technology in the last decade. Studies regarding this progress have been reported ranging from 1 to 1000 L, consisting of short-term laboratory-scale experiments, to long-term in situ pilot-scale investigations. Despite this fact, a successful demonstration has yet to be shown. This suggests that advances made at the milliliter-scale have not been translated, or are not transferable, to larger scales, implying a lack of understanding on how to progress from the milliliter-scale to larger scales. This review compiles 18 separate studies, the majority of scale-up efforts (liter-scale and greater) to date, thoroughly reviewing and analyzing aspects of design in relation to performance and the potential for success. Key factors affecting the MFC performance are highlighted. A future perspective on scaling-up MFCs for practical wastewater treatment is also provided.

As the global population increases, the demand for water also increases. In the last century, water use has been growing at a rate more than double that of population increase [1]. This increase in water use has led to an increase in wastewater generated and, ultimately, an increase in the demand for treatment. As a result, current wastewater treatment technologies presently consume approximately 3% of the electricity generated in developed countries [2,3]. With an ever-increasing population and a finite supply of water, finding more efficient and cost-effective means of treating wastewater has become extremely important. Developing new treatment technologies that will offset this high-energy cost is necessary to maintain both water and energy security.

Microbial fuel cell (MFC) technology has the potential to revolutionize wastewater treatment in both industrialized and developing nations by becoming a net energy producer [4,5]. Through the use of electrogenic bacteria, MFC technology releases the energy contained in wastewater while simultaneously treating it. This process occurs when bacteria growing on the anode oxidize organic matter contained in the wastewater and transfer the electrons to the anode. A current is produced when electrons flow from the anode to the cathode through an

external circuit. At the cathode, the electrons reduce an electron acceptor, typically oxygen, ultimately forming a reduced compound such as water.

In order for practical applications to be realized, MFCs need to have the capability to treat large quantities of wastewater. Many MFC systems have been developed with liquid volumes of a few milliliters to several hundred milliliters. Recent advances in materials as well as reactor configurations have led to a growing number of scale-up studies, ranging from 1 to several hundred liters, with a few attempts at pilot-scale MFC systems. Moving this technology from the laboratory-scale to pilot scale brings it one step closer to the realization of practical application.

There are several recent reviews that have focused on electrodes summarizing materials, performance, cost, application range and surface modification methods [6–8]. Recent advances in separator materials comparing performance based on oxygen, substrate and proton transfer efficiencies, as well as the effect on *internal resistance*, power density and coulombic efficiency, have also been examined [9]. Another recent review has provided a brief overview of scale-up efforts ranging from the milliliter to the liter scale, and detailed the impacts of operational

Biology at Biological Engineering Design State University of Colorado, CO 80538 USA.
*Author for correspondence: Tel.: +1 303 733 6000 E-mail: hliu@engr.ucsd.edu

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Advanced Techniques in Diagnostic Microbiology Yi-Wei Tang, Charles W. Stratton, 2018-11-09 In recent years advanced molecular techniques in diagnostic microbiology have been revolutionizing the practice of clinical microbiology in the hospital setting Molecular diagnostic testing in general and nucleic acid based amplification methods in particular have been heralded as diagnostic tools for the new millennium This third edition covers not only the most recent updates and advances but details newly invented omic techniques such as next generation sequencing It is divided into two distinct volumes with Volume 1 describing the techniques and Volume 2 addressing their applications in the field In addition both volumes focus more so on the clinical relevance of the test results generated by these techniques than previous editions

Exercises for the Microbiology Laboratory, Fifth Edition Michael J Leboffe, Burton E Pierce, 2021-01-01 This inexpensive exercise manual provides a straightforward step by step concise alternative to large microbiology laboratory manuals It can be used by itself as a required lab text and is also designed to be used in conjunction with A Photographic Atlas for the Microbiology Laboratory Fifth Edition by Leboffe Pierce with exercises keyed to specific images **Diagnostic Immunohistochemistry E-Book** David J Dabbs, 2013-10-11 Diagnostic Immunohistochemistry presents the latest information and most reliable guidance on immunohistological diagnoses in surgical pathology David J Dabbs MD and other leading experts bring you state of the art coverage on genomic and theranostic applications molecular anatomic pathology immunocytology Non Hodgkin s lymphoma and more Additional features such as tables discussing antibody specifications differential diagnosis boxes ancillary anatomic molecular diagnostics and full color histological images ensure user friendly coverage that makes key information easy to find and apply This concise and complete resource is today s indispensable guide to the effective use of immunohistochemical diagnosis Discusses diagnostic pitfalls through immunohistologic differential diagnosis wherever appropriate so you can provide the most accurate diagnoses Presents chapters arranged by organ system for comprehensive coverage of all relevant information in a convenient and intuitive organization Provides quick reference graphs for antibodies throughout the text that illustrate the frequency of immunostaining for a variety of antibodies in tumors Includes Key Diagnostic Points boxes in every chapter for a quick summary of text areas that are of particular importance Features an expert author for each chapter to ensure coverage of the current state of the art

Textbook of Diagnostic Microbiology - E-Book Connie R. Mahon, Donald C. Lehman, George Manuselis, 2014-04-11 Providing a solid introduction to the essentials of diagnostic microbiology this accessible full color text helps you develop the problem solving skills necessary for success in the clinical setting A reader friendly building block approach to microbiology moves progressively from basic concepts to advanced understanding guiding you through the systematic identification of etiologic agents of infectious diseases Building block approach encourages recall of previously learned information enhancing your critical and problem solving skills Case in Point feature introduces case studies at the beginning of each

chapter Issues to Consider encourages you to analyze and comprehend the case in point Key Terms provide a list of the most important and relevant terms in each chapter Objectives give a measurable outcome to achieve by completing the material Points to Remember summarize and help clearly identify key concepts covered in each chapter Learning assessment questions evaluate how well you have mastered the material New content addresses bone and joint infections genital tract infections and nosocomial infections Significantly updated chapter includes current information on molecular biology and highlights content on multidrug resistant bacteria Reorganized chapters accent the most relevant information about viruses and parasites that are also transmissible to humans Case studies on the Evolve site let you apply the information that you learn to realistic scenarios encountered in the laboratory *Essentials of Practical Microbiology* Apurba Sankar Sastry,Bhat Sandhya K,2017-08-20 **Practical Handbook of Microbiology** Lorrence H Green,Emanuel Goldman,2021-05-04

Practical Handbook of Microbiology 4th edition provides basic clear and concise knowledge and practical information about working with microorganisms Useful to anyone interested in microbes the book is intended to especially benefit four groups trained microbiologists working within one specific area of microbiology people with training in other disciplines and use microorganisms as a tool or chemical reagent business people evaluating investments in microbiology focused companies and an emerging group people in occupations and trades that might have limited training in microbiology but who require specific practical information Key Features Provides a comprehensive compendium of basic information on microorganisms from classical microbiology to genomics Includes coverage of disease causing bacteria bacterial viruses phage and the use of phage for treating diseases and added coverage of extremophiles Features comprehensive coverage of antimicrobial agents including chapters on anti fungi and anti virals Covers the Microbiome gene editing with CRISPR Parasites Fungi and Animal Viruses Adds numerous chapters especially intended for professionals such as healthcare and industrial professionals environmental scientists and ecologists teachers and businesspeople Includes comprehensive survey table of Clinical Commercial and Research Model bacteria The Open Access version of this book available at <http://www.taylorfrancis.com> has been made available under a Creative Commons Attribution Non Commercial No Derivatives 4.0 license Chapter 21 Archaea of this book is freely available as a downloadable Open Access PDF under a Creative Commons Attribution Non Commercial No Derivatives 4.0 license available at <http://www.taylorfrancis.com> See Emanuel Goldman's Open Access article Lamarck redux and other false arguments against SARS CoV 2 vaccination <https://www.embopress.org/doi/full/10.15252/embr.202254675> [Introduction to Diagnostic Microbiology for the Laboratory Sciences](#) Maria Dannessa Delost,2015

Introduction to Diagnostic Microbiology for the Laboratory Sciences provides a foundation in microbiology that is essential for a career as a medical laboratory technologist technician MLT A key text for students and a helpful reference for practitioners it reviews the microorganisms most commonly encountered in clinical settings and clearly explains basic laboratory procedures This text provides a concise overview of topics and facilitates comprehension with learning objectives

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Rapid Methods and Automation in Microbiology and Immunology K.-O. Habermehl, 2012-12-06 Rapid progress in molecular biology genetic engineering and basic research in immunology has opened up new possibilities for application to diagnostic procedures and to clinical research In a short period a new era of diagnosis dawned covering nearly all fields of microbiology immunology and food technology In consequence of this rapid development scientists of many disciplines are involved studying infections of humans animals and plants or working in technical microbiology The application of the newest findings of basic research to diagnostic work and to clinical research covers nearly all fields of microbiology and immunology Moreover it underlines the close relationship between diagnosis therapy and epidemiology An outstanding example of these connections is given by the recent development of hepatitis B vaccine The discovery and identification of a non cultivable agent by physicochemical and immunological methods were the heralds of a new era in the prevention of infectious diseases This book provides an up to date comprehensive review of developments and future aspects in various fields I am convinced that the authors have succeeded in furnishing a large variety of new ideas and possibilities K O HABERMEHL Contents Time Realities in the Evaluation of Vaccines for Safety and Efficacy The Evaluation of Vaccines M R HILLEMANN *Technical Manual* United States. War Department, 1975-06 Serum Diagnosis by Complement-fixation John Albert Kolmer, 1928

Practical Pulmonary Pathology: A Diagnostic Approach E-Book Kevin O. Leslie, Mark R. Wick, 2017-10-27 Part of the in depth and practical Pattern Recognition series Practical Pulmonary Pathology 3rd Edition helps you accurately identify and interpret neoplastic and non neoplastic diseases of the lungs by using a pattern based approach Leading diagnosticians in pulmonary pathology guide you from a histological pattern through the appropriate work up around the pitfalls and to the best diagnosis Superb full color illustrations capture key pathological patterns for a full range of common and rare conditions and a visual index at the beginning of the book directs you to the exact location of in depth diagnostic guidance A user friendly design

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The Newer Knowledge of Bacteriology and Immunology Edwin Oakes Jordan, Isidore Sydney Falk, 1928

Textbook of Microbiology and Immunology Subhash Chandra Parija, 2023-03-16 The fourth edition of Textbook of Microbiology and Immunology is an extensively revised edition a healthy mixture of the old and the new contents Many of the old traditional chapters have been retained with addition of new information along with the inclusion of new chapters more in line with the on going changes in the syllabus and concepts in Medical Microbiology While doing so this book has blended the traditional organism based learning and a syndrome based approach to infectious disease together with the introduction of

new and modified chapters incorporating the latest information in this field The book provides an extensive coverage of fundamental topics in general and medical microbiology The book also lays due emphasis on clinical microbiology with special focus on syndrome based approach to infectious diseases It includes the basic concepts of microbiology as well as the recent updates and developments in the field of medical microbiology All the topics have been incorporated in seven major sections General microbiology Immunology Bacteriology Virology Mycology and Applied and Clinical Microbiology The dynamic nature of medical sciences with new guidelines and new diagnostic methods coming into the arena necessitates the incorporation of new information in each new edition of a book This facet has been addressed with the inclusion of recent information on the various aspects of microbiology infectious diseases and immunology in the fourth edition of the Textbook of Microbiology and Immunology which makes it one of the most authoritative and informative textbooks in medical microbiology The book is an effort to inform and engage a wide spectrum of readers including medical students both undergraduates and postgraduates and residents and faculty It aims to be a must have companion book for graduate and advanced undergraduate as well as postgraduate students of medical microbiology general and allied microbiology and of immunology

Textbook of Microbiology & Immunology Parija, 2009 This book provides an up to date information on microbial diseases which is an emerging health problem world over This book presents a comprehensive coverage of basic and clinical microbiology including immunology bacteriology virology and mycology in a clear and succinct manner The text includes morphological features and identification of each organism along with the pathogenesis of diseases clinical manifestations diagnostic laboratory tests treatment and prevention and control of resulting infections along with most recent advances in the field About the Author Subhash Chandra Parija MD PhD DSc FRCPath is Director Professor and Head Department of Microbiology Jawaharlal Institute of Postgraduate Medical Education and Research JIPMER Pondicherry India Professor Parija author of more than 200 research publications and 5 textbooks is the recipient of more than 20 National and International Awards including the most prestigious Dr BC Roy National Award of the Medical Council of India for his immense contribution in the field of Medical Microbiology

Microbiology: Laboratory Theory and Application, Brief Michael J. Leboffe, Burton E. Pierce, 2016-01-01 This brief version of the best selling laboratory manual Microbiology Laboratory Theory and Application is intended for majors or non majors in introductory microbiology laboratory courses This full color manual is appropriate for courses populated primarily by allied health students and courses with a preference for an abbreviated number of experiments

Medical microbiology, virology and immunology T. V. Andrianova, V. V. Bobyr, V. V. Danyleichenko, 2019-01-01 The textbook was compiled in accordance with officially approved teaching programs for microbiology virology and immunology in all faculties of higher medical schools Questions of general microbiology basic methods of studying microorganisms morphology structure and classification of bacteria their physiology the influence of physical chemical and biological factors on microorganisms microbial genetics and biotechnology antimicrobials and the

concept of infection and special microbiology morphology physiology pathogenic properties of pathogens of many infectious diseases modern methods of their diagnostics specific prevention and therapy The textbook also contains sections on virology protozoology mycology and helminthology which examine the basic biological properties of the causative agents and the diseases they cause A significant part of the textbook is devoted to questions of immunology nonspecific resistance of the organism the doctrine of antigens the immune system of the body immune response immunity reactions allergy and other types of immune responses immunodiagnostics and immunocorrection immunoprophylaxis and immunotherapy The textbook contains sections on clinical and sanitary microbiology examines the ecology of microorganisms the normal microbiota of the human body and the effect of microorganisms on the fetus Separate sections are devoted to the microbiota of the oral cavity and microbiological research in stomatological and pharmaceutical fields The textbook is intended for students of medical universities relevant departments of higher education of doctors interns and microbiologists of all specialties

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