

Microbial Biotechnology

An Interdisciplinary Approach



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Microbial Biotechnology

An Interdisciplinary Approach

Pratyoosh Shukla



CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

© 2017 by Taylor & Francis Group, LLC
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed on acid-free paper
Version Date: 20161019

International Standard Book Number-13: 978-1-4987-5677-8 (Hardback)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access www.copyright.com (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

Visit the Taylor & Francis Web site at
<http://www.taylorandfrancis.com>

and the CRC Press Web site at
<http://www.crcpress.com>

Contents

Foreword, vii

Preface, ix

Contributors, xi

CHAPTER 1 ■ Bacterial Exopolysaccharides: Major Types and Future Prospects 1

APARNA BANERJEE AND RAJIB BANDOPADHYAY

CHAPTER 2 ■ Bioremediation: A Novel Green Technology to Clean Up the Highly Contaminated Chromites Mining Sites of Odisha 21

SWATI SUCHARITA PANDA AND NABIN KUMAR DHAL

CHAPTER 3 ■ Recent Developments in Food Biotechnology to Improve Human Health with Probiotics with Special Emphasis on Lowering Cholesterol 35

RENU AGRAWAL

CHAPTER 4 ■ Molecular Characterization and Quantification of Microbial Communities in Wastewater Treatment Systems 59

JASHAN GOKAL, OLUYEMI OLATUNJI AWOLUSI, ABIMBOLA MOTUNRAYO ENITAN, SHEENA KUMARI, AND FAIZAL BUX

CHAPTER 5 ■ Thermostable Enzymes and Their Industrial Applications 115

SANTHOSH KUMAR, NANTHAKUMAR ARUMUGAM, KUGENTHIREN PERMAUL, AND SUREN SINGH

CHAPTER 6 ■ Microbial Enzymes for Pulp and Paper Industry: Prospects and Developments	163
---	-----

PUNEET PATHAK, PRABHJOT KAUR, AND NISHI K. BHARDWAJ

CHAPTER 7 ■ Rhizobacteria: Tools for the Management of Plant Abiotic Stresses	241
---	-----

ANJALI SINGH, AJAY SHANKAR, VIJAI KUMAR GUPTA, AND VISHAL PRASAD

CHAPTER 8 ■ Betulin Biotransformation toward Its Antitumor Activities: A Brief Overview	263
---	-----

DHIRENDRA KUMAR AND KASHYAP KUMAR DUBEY

CHAPTER 9 ■ Optimizing the Performance of Wastewater Treatment Plants and Effluent Quality Using Evolutionary Algorithms	287
--	-----

ABIMBOLA MOTUNRAYO ENITAN, JOSIAH ADEYEMO, GULSHAN SINGH, AND FOLASADE ADEYEMO

CHAPTER 10 ■ Production of Fructooligosaccharides as Ingredients of Probiotic Applications: Future Scope and Trends	311
---	-----

RUBY YADAV, PUNEET KUMAR SINGH, AND PRATYOOSH SHUKLA

CHAPTER 11 ■ Avenues in Ophthalmic Optical Coherence Tomography in Medical Biotechnology: Prospects and Future Trends	325
---	-----

RAJU PODDAR, VINOD AGGARWAL, VARUN GOGIA, MAYANK BANSAL, SHIKA GUPTA, ROHAN CHAWLA, AND PRADEEP VENKATESH

INDEX	349
-------	-----

Foreword

THE BOOK *Microbial Biotechnology: An Interdisciplinary Approach*, edited by Dr. Pratyosh Shukla, covers some of the latest applications of microorganisms from a practical point of view. The field of microbial biotechnology, in the context of the so-called cell factories, is of great interest and the number of groups involved in such projects is growing exponentially.

Although the book chapters cover different aspects of microbial biotechnology, I want to highlight two of them. The first refers to the field of functional foods; several chapters deal with the production of probiotics and prebiotics, and their effect on gastrointestinal health. The second topic is microbial bioremediation, which is exemplified in this book by the use of microbes to clean up mining sites and by the optimization of wastewater treatments. Other issues having a significant impact are also addressed in the book: for example, the use of microbial enzymes in pulp and paper industries, the different applications of exopolysaccharides, or the latest developments in medical biotechnology, among others.

In summary, there is no doubt about the interest of the contents displayed in this book. I am sure that the book *Microbial Biotechnology: An Interdisciplinary Approach* will provide the scientific community with great benefits for the coming years.

Francisco Plou

Research Scientist at Spanish CSIC

Honorary Professor at Autonomous University of Madrid

Madrid, April 4, 2016



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Preface

THE BOOK DESCRIBES THE INTERDISCIPLINARY SCOPE OF BIOTECHNOLOGY and discoveries thereof. This book briefs the reader on various novel and innovative ideas of emerging biotechnology. The key features are described below to highlight the important contents of the book:

1. The book envisages the recent ideas of novel findings in microbiology.
2. It also provides insights into various interdisciplinary research avenues.
3. There are very few books available covering the diversity of topics described in this book.
4. Some key areas of modern biotechnology are also covered in this book, which are not available in any such books in the market.
5. Enhanced and simplified descriptions are the key components of this book, which provide unique benefits to its readers.

This book will also act as an important means of information on researchers working in interdisciplinary areas of research. The chapters outlined in this book cater to the needs of researchers working in the areas of bacterial exopolysaccharides, microalgal proteomics, applications of microbial L-asparaginases, novel aspects of bioremediation, probiotics and their impact on society, microbial community analysis in wastewater treatment techniques, etc. The book focuses on describing the above-mentioned aspects and on diversifying the understanding of microbial biotechnology to an expanded level.

This book will be a valuable resource to senior undergraduate and graduate students, researchers, professionals, and other interested individuals or groups working in the areas mentioned in the book.

Pratyosh Shukla, PhD

December 2016

Rohtak, India

Contributors

Folasade Adeyemo

Institute for Water and Wastewater
Technology (IWWT)
Durban University of
Technology
Durban, South Africa

Josiah Adeyemo

Department of Civil and
Structural Engineering
Masinde Muliro University of
Science and Technology
Kakamega, Kenya

Vinod Aggarwal

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Renu Agrawal

CSIR-CFTRI and Rural
Development Programme
Mysore, India

Nanthakumar Arumugam

Department of Biotechnology
and Food Technology
Durban University of Technology
Durban, South Africa

Oluyemi Olatunji Awolusi

Institute for Water and Wastewater
Technology
Durban University of Technology
Durban, South Africa

Rajib Bandopadhyay

Department of Botany
The University of Burdwan
Burdwan, West Bengal, India

Aparna Banerjee

Department of Botany
The University of Burdwan
Burdwan, West Bengal, India

Mayank Bansal

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Nishi K. Bhardwaj

Avantha Centre for Industrial
Research & Development
Yamuna Nagar, Haryana, India

Faizal Bux

Institute for Water and Wastewater
Technology (IWWT)
Durban University of Technology
Durban, South Africa

Rohan Chawla

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Nabin Kumar Dhal

Environment and Sustainability
Department
CSIR-IMMT
Bhubaneswar, India

Kashyap Kumar Dubey

University Institute of
Engineering and Technology
(UIET)
Maharshi Dayanand University
Rohtak, Haryana, India

Abimbola Motunrayo Enitan

Institute for Water and Wastewater
Technology (IWWT)
Durban University of Technology
Durban, South Africa

Varun Gogia

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Jashan Gokal

Institute for Water and Wastewater
Technology
Durban University of Technology
Durban, South Africa

Shika Gupta

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Vijai Kumar Gupta

School of Natural Sciences
NUI Galway
Galway, Ireland

Prabhjot Kaur

Avantha Centre for
Industrial Research &
Development
Yamuna Nagar, Haryana, India

Dhirendra Kumar

Department of Biotechnology
University Institute of
Engineering and Technology
(UIET)
Maharshi Dayanand University
Rohtak, Haryana, India

Santhosh Kumar

Department of Biotechnology and
Food Technology
Durban University of Technology
Durban, South Africa

Sheena Kumari

Institute for Water and Wastewater
Technology (IWWT)
Durban University of Technology
Durban, South Africa

Swati Sucharita Panda

Environment and Sustainability
Department
CSIR-IMMT
Bhubaneswar, India

Puneet Pathak

Avantha Centre for Industrial
Research & Development
Yamuna Nagar, Haryana, India

Kugenthiren Permaul

Department of Biotechnology and
Food Technology
Durban University of Technology
Durban, South Africa

Raju Poddar

Department of Bioengineering
Birla Institute of Technology
Ranchi, India

Vishal Prasad

Institute of Environment and
Sustainable Development
Banaras Hindu University
Varanasi, India

Ajay Shankar

Institute of Environment and
Sustainable Development
Banaras Hindu University
Varanasi, India

Pratyoosh Shukla

Department of Microbiology
Maharshi Dayanand University
Rohtak, Haryana, India

Anjali Singh

Institute of Environment and
Sustainable Development
Banaras Hindu University
Varanasi, India

Gulshan Singh

Institute for Water and Wastewater
Technology (IWWT)
Durban University of
Technology
Durban, South Africa

Puneet Kumar Singh

Department of Microbiology
Maharshi Dayanand University
Rohtak, Haryana, India

Suren Singh

Department of Biotechnology and
Food Technology
Durban University of
Technology
Durban, South Africa

Pradeep Venkatesh

Dr. Rajendra Prasad Centre for
Ophthalmic Sciences
A.I.I.M.S.
New Delhi, India

Ruby Yadav

Department of Microbiology
Maharshi Dayanand University
Rohtak, Haryana, India



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Bacterial Exopolysaccharides

Major Types and Future Prospects

Aparna Banerjee and Rajib Bandopadhyay

CONTENTS

Abstract.....	2
Introduction.....	2
EPS Producing Bacteria: Major Types.....	4
Soil Inhabitants.....	4
Lactic Acid Bacteria.....	4
Halophiles.....	4
Thermophiles.....	8
Psychrophiles.....	8
EPS from Pathogenic Bacteria.....	8
Regulation of EPS Production.....	9
Present Studies on Bacterial EPS.....	10
Heteropolysaccharides.....	10
Homopolysaccharides.....	12
Future Prospects of Bacterial EPSs.....	13
Food Industry.....	13
Pharmaceutical Industry.....	13
Biomedical Application.....	14
Bioremediation and Wastewater Treatment.....	14
Patenting in the Field of Bacterial EPS.....	14
Conclusion.....	16
Acknowledgment.....	17
References.....	17