

Algal Systems for Resource Recovery from Waste and Wastewater

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Edited by

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Preface

In the past few decades, our planet has witnessed an unprecedented surge in population, carbon emissions, and the demand for essential resources, particularly energy and water. This exponential growth has come at a cost: a staggering increase in waste and wastewater, presenting formidable challenges to our environment and sustainability. Faced with this urgent dilemma, the imperative to develop innovative technologies for resource recovery has never been more critical. Amidst this challenge, algae, tiny yet extraordinary photosynthetic organisms, have emerged as potent microbiota in the quest for environmental solutions. In this context, this book *Algal Systems for Resource Recovery from Waste and Wastewater* testifies to the pivotal role algae can play in addressing some of the world's most pressing issues.

In recent years, algae-based wastewater treatment has made significant strides. Rigorous research validated the integration of specific algae strains into existing treatment plants, elevating their efficiency. Cutting-edge technologies, such as advanced photobioreactors and real-time monitoring systems, empowered precise control and seamless automation. Symbiotic systems and the dual-purpose utilization of harvested algae for biofuel production bolstered economic viability. Scalable implementations and widespread commercialization swiftly followed successful pilot programs. Ongoing cutting-edge research continues to sharpen the focus on efficiency enhancements, new strain exploration, and integration of other modern technologies such as anaerobic digestion and bioelectrochemical systems, promising an unwavering and sustainable technical solution to the pressing issue of wastewater pollution.

Within this book, we embark on a profound exploration of various algae-based systems, unveiling their transformative potential and transition from laboratory trials to real world solutions. Wastewaters, rich in resources like phosphorus, demand efficient nutrient removal for the development of a circular bioeconomy. Algae-based treatment systems achieve both wastewater clean-up and valuable biomass production. Algae have a unique ability to absorb pollutants or transform them into sustainable bioproducts. Their capacity to convert wastewater into valuable biomass and value-added commodities opens doors to a multitude of applications, ranging from the production of sustainable biofuels to the creation of nutrient-rich animal feed and fertilizers. This book chronicles the remarkable journeys of scientists and researchers from around the globe to unlock the potential of these tiny organisms. It presents the current status, major challenges and recent scientific innovations in algae-based technologies for waste remediation and nutrient recovery.

Authored by experts and researchers at the forefront of algal biology, bioprocess engineering, and environmental science, this comprehensive volume aims to provide an authoritative resource for academics, researchers, industry professionals, and policymakers. Its pages will empower readers with knowledge about the latest advancements, challenges, and breakthroughs in the use of algae for wastewater treatment and energy recovery. Each contributed chapter is presented on a stand-alone basis, so that the reader will find it helpful to consider only the theme of each chapter. There are nevertheless many connections between what may at first seem to be quite different topics. As in all the books of the *Integrated Environmental Technology* series, one of our purposes was to draw out and emphasize these interdisciplinary links. For this reason, a comprehensive index is included to facilitate cross-referencing. We hope that the work described in this book will inspire those working in the field and will encourage those who are beginning to investigate it.

We wish to thank all contributors to this book for their valuable contributions by sharing their expertise in the various chapters. We also thank all past and present co-workers as well as all collaborators who joined in unravelling different areas of the application of algae in environmental technology as described in this book, especially those at National University Ireland Galway and UNESCO-IHE. We would also like to thank all the reviewers who put a lot of effort into improving the quality of this book. In addition, the national and international granting agencies who supported our work on various aspects of algal based pollutant removal and resource recovery over the years are gratefully acknowledged, in particular the Science Foundation Ireland (SFI), who financially supported the open access publication of this book through the SFI Research Professorship Programme *Innovative Energy Technologies for Biofuels, Bioenergy and a Sustainable Irish Bioeconomy* (IETS BIO³; grant number 15/RP/2763) and the Department of Foreign Affairs (DFA) under the SDG Challenge project *Floating Treatment Wetland* (grant number SFI/21/FIP/SDG/9933). We are also grateful to the editorial team of IWA Publishing, in particular Mark Hammond, Andrew Peart and Katharine Allenby for their help and editorial support in realizing this book.

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