Converging Chemical and Biological Sciences for a Sustainable Era

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Converging Chemical and Biological Sciences for a Sustainable Era

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Preface

In an era defined by complex global challenges, the need for innovative and integrated solutions has never been more persistent. This book entitled “Converging Chemical and Biological Sciences for a Sustainable Era”, delves into the critical intersection of chemistry and biology, showcasing interdisciplinary fusion is essential in addressing the multifaceted sustainability issues confronting our planet. From pioneering green technologies to advancements in environmental protection and healthcare, the book explores the transformative power of scientific integration in fostering a truly sustainable future.

The first article explores the kinetic behavior of Chromium (VI) oxidation in the presence of micellar systems, offering a detailed comparative analysis of various kinetic models. It emphasises the role of micelles in modulating redox reactions, which has implications for environmental chemistry and biochemical applications. By examining substrate-specific responses and surfactant interactions, the study contributes valuable insights into micellar catalysis and the mechanisms underpinning electron transfer in heterogeneous systems.

The article by Amit Kumar Dutta presents an innovative approach to the green synthesis of metal and metal oxide nanoparticles using blue flower extract, a beverage rich in antioxidants. Highlighting its significant antibacterial and anticancer potential, the study demonstrates eco-friendly routes to nanoparticle development. The work offers valuable insight into sustainable nanotechnology and opens new avenues for biomedical and therapeutic applications rooted in plant-based green chemistry.

Metal-Free and Sustainable Strategies in the Synthesis of Substituted Furans by Harisadhan Ghosh and Anupam Jana, offers a comprehensive review of recent eco-friendly synthetic methodologies. Emphasizing green chemistry principles, this work highlights metal-free catalytic, multicomponent, and cycloaddition approaches. The study serves as a vital resource for researchers pursuing sustainable solutions in organic synthesis and showcases the growing relevance of environmentally benign pathways in chemical science.

Sucheta Das's *Clerodendrum – One Useful Beneficial Phytomedicinal Plant* offers a comprehensive review of the therapeutic potential of various Clerodendrum species. Highlighting their traditional uses, phytochemical composition, and diverse pharmacological effects, this work underscores the genus's significance in ethnomedicine and modern drug discovery. It serves as a valuable resource for researchers in herbal medicine, pharmacology, and botanical sciences.

Anirudha Mondal *et al*. in their article explore innovative materials for green hydrogen generation, focusing on the potential and challenges in biological hydrogen production. The study examines key biomaterials, catalytic systems, and environmental considerations critical to advancing sustainable hydrogen technologies. This research offers valuable insights for scientists and engineers working toward eco-friendly energy solutions and contributes to the growing discourse on renewable and bio-based hydrogen production.

Another article by Shrabani Sen investigates the dynamic transition between micelles

and vesicles in surfactant systems, emphasizing the role of pH oscillators. Using a two-state model and numerical simulations, the study explores the rhythmic interconversion of self-assembled structures. The research offers valuable insights into the mechanisms governing surfactant phase behavior and contributes to advancements in drug delivery and nanostructure design.

Pritha Mondal in her article explores the antioxidant properties of breast milk and the critical role of maternal diet in enhancing its protective function. Highlighting key enzymes like CAT, SOD, and GPx, the study emphasises how nutrients, trace elements, and lifestyle factors influence infant development. The work underscores the importance of tailored maternal nutrition during lactation for optimal oxidative stress defence in newborns.

The article by Piu Dhal presents a detailed investigation into the synthesis, structure, and magnetic properties of a 1D polymeric copper complex. Employing copper-catalysed hemiacetal synthesis, the study explores zigzag chain coordination and antiferromagnetic interactions through alkoxo and thiocyanato bridges. Combining spectroscopic, electrochemical, and magnetic analyses, the work contributes significantly to the field of coordination chemistry and offers insights into designing novel metal-organic frameworks.

This article by Ganesh Chandra Midya explores the KOtBu-promoted transformation of nitriles into amides, offering a mild, efficient, and environmentally friendly synthetic approach. The study highlights the mechanistic aspects and broad substrate applicability of this base-mediated conversion. Contributing to the development of sustainable organic synthesis, this work provides valuable insight for researchers in synthetic chemistry seeking greener and more versatile methods for functional group transformations.

The study by Biswanath Bhowmik shows the association of insect fauna with the flowers of *Zea mays* (sweet corn variety AKSH4) in southern West Bengal. Highlighting both diurnal and nocturnal pollinators, the work insect-plant interactions, particularly in relation to environmental factors like temperature and humidity. As a pioneering effort in the Indian context, this research offers essential baseline data on insect-mediated pollination in maize and underscores its ecological and agricultural importance.

The article, *Multireference Perturbation Based Quantum Chemical Investigation on Isomerisation Alley of Diphosphorous Compounds* by Suvonil Sinha Ray, presents an in-depth study using IVO-SSMRPT methodology to explore isomerisation pathways in P=P bonded systems. Emphasizing computational efficiency and accuracy, the research bridges theoretical chemistry with practical insight into molecular behavior. It offers significant contributions to multireference electronic structure theory and is a valuable resource for researchers in quantum chemistry and phosphorus-based molecular systems.

The article *Non-Adiabatic Escape Rate of a Quantum Dissipative System from a Rapidly Oscillating Periodic Potential* explores quantum tunnelling phenomena in non-equilibrium conditions. Focusing on the non-adiabatic escape dynamics, it examines the periodic potentials and dissipation influence particle transitions. This study adds valuable theoretical insights to quantum mechanics, particularly in the fields of quantum transport,

condensed matter physics, and the modelling of dynamic quantum systems under time-dependent perturbations.

The article, *Exploring the Catalytic Potential of Ionanofluids in Green Chemistry*, presents a comprehensive evaluation of ionanofluids as efficient and sustainable catalysts. Highlighting their unique physicochemical properties and environmentally friendly nature, the study emphasises their applications in promoting greener chemical processes. This work contributes significantly to the advancement of eco-conscious catalysis, aligning with global efforts toward cleaner production technologies and sustainable chemical innovation.

The article by Sugata Samanta provides a comprehensive review of the spectroscopic studies on the binding interactions between serum albumins and quercetin. Highlighting fluorescence quenching, energy transfer, and time-resolved emission techniques, the study reveals critical insights into protein-flavonoid interactions. The work contributes significantly to understanding the therapeutic potential of quercetin and its molecular association with serum albumins in biomedical and pharmaceutical contexts.

Another article, *Advancing Sustainable Chemical Processes through the Use of Green Solvents and Reaction Media*, emphasises the critical role of environmentally benign solvents in modern chemical synthesis. It explores emerging green alternatives, their benefits, and practical applications in sustainable chemistry. This work contributes to the global shift toward eco-friendly practices, offering valuable insights for researchers and industries focused on reducing the environmental impact of chemical processes.

This article, authored by Shib Shankar Biswas and colleagues, explores cutting-edge advancements in nano-engineered materials for defence applications. It provides a comprehensive review of processing methods, integration challenges, and transformative applications in stealth, armour, and energy systems. Emphasizing interdisciplinary innovation, the work highlights nanotechnology's critical role in enhancing operational efficiency, resilience, and protective capabilities in modern defence systems.

The diverse articles compiled in Converging Chemical and Biological Sciences for a Sustainable Era collectively underscore the immense power of interdisciplinary collaboration in tackling the complex challenges of our time. Each article highlights innovative solutions linking chemistry and biology. This volume serves as a powerful testament to the transformative potential of combining chemical and biological insights, offering valuable resources for researchers, practitioners, and students committed to building a sustainable era. Ultimately, Converging Chemical and Biological Sciences for a Sustainable Era it is a testament to the power of collaborative science. We hope this book inspires interdisciplinary approaches, fostering a new generation of solutions that will pave the way for a healthier planet and a more sustainable tomorrow.

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