

## Preface

In the present era, chemical and biological sciences are progressing rapidly and contributing significantly to the understanding and solution of various scientific, environmental, and societal challenges. Continuous developments in research methods, technologies, and interdisciplinary approaches have opened new possibilities in areas such as sustainable chemistry, biomedical sciences, nanotechnology, environmental protection, and analytical science. This book, *Contemporary Developments in Chemical and Biological Sciences*, aims to present recent research trends and innovative scientific approaches while promoting a better understanding of emerging developments and their applications in addressing contemporary challenges.

The chapter "Balancing Static and Dynamic Correlation in Diradicals: A Low-Cost Multireference Perturbative Strategy" explores the theoretical challenges of describing diradicals and open-shell systems, where near-degenerate electronic states demand a balanced treatment of static and dynamic correlation. It highlights state-specific multireference perturbation theory combined with improved virtual orbitals as a computationally efficient strategy for achieving reliable electronic-state descriptions, energy gaps, and chemically meaningful insights with modest cost.

The review "Fluorescence sensing mechanism and hydrazide moiety" explores the growing significance of hydrazide-based fluorescent chemosensors in detecting environmentally and biologically important ions. It summarizes recent developments in sensor design, fluorescence sensing mechanisms, selectivity, and practical applications. Particular attention is given to their potential in environmental monitoring, biological imaging, food safety, and future analytical technologies.

This study, authored by Abhradeep Basu and Anamika Basu, presents a physiologically based pharmacokinetic modelling approach to predict the plasma concentration profile of chrysin derived from *Mangifera indica*. Using PK-Sim® software, the model evaluates chrysin pharmacokinetics in rats, humans, and liver disease populations, providing valuable information about its absorption, metabolism, bioavailability, and potential therapeutic applications.

The chapter "Temperature compensation of Circadian Oscillations" provides a theoretical perspective on temperature compensation in circadian oscillations and chemical oscillatory systems. It examines how activation energy distributions influence reaction kinetics and explains why circadian rhythms remain relatively stable despite temperature variations, offering insight into the relationship between stochastic kinetics, biochemical regulation, and temperature-dependent oscillatory behaviour.

The chapter titled "Towards the Synthesis of Polymeric Ladderphanes from Cyclopropene Monomers: A Model Study" presents Biswajit Panda's exploration of strained cyclopropene monomers as promising precursors for ladderphane synthesis. Emphasizing ROMP polymerization, ring strain, and structural design, the chapter offers valuable insights into advanced polymeric architectures and their potential applications in organic synthesis and materials science.

Chandan Kumar, in his study, explores the preparation, characterization, and antimicrobial potential of heterobinuclear complexes derived from copper and nickel Schiff bases with alkali metal salts. The work highlights their structural features, spectral behavior, bonding characteristics, and promising antibacterial and antifungal activities, contributing to the growing importance of Schiff base metal complexes.

The chapter titled "Oxidation of Hydroxylamine by a Tetranuclear Manganese Complex in Aqueous Acidic Medium–Proton Coupled Electron Transfer" presents Suranjana Chatterjee's study on hydroxylamine oxidation using a stable tetranuclear manganese complex. Emphasizing kinetics, isotope effects, and hydrogen atom transfer, the chapter offers insight into proton-coupled electron transfer processes and manganese-based models relevant to biological oxidation systems.

The chapter by Usha Mandi describes chromium(VI)-immobilized mesoporous polyaniline (Cr-PANI) as a highly efficient heterogeneous catalyst for selective oxidation of alkanes and alkenes under mild reaction conditions. Highlighting catalyst characterization, selectivity, recyclability, and the use of hydrogen peroxide as a green oxidant, the chapter emphasizes sustainable approaches to valuable organic transformations.

The chapter titled “Recent Developments on the Synthesis of Colorless Polyimides” presents Pradip Kumar Tapaswi's review of advanced CPI materials for transparent and flexible electronic applications. It highlights recent monomer design strategies, suppression of charge-transfer interactions, and improvements in optical transparency, thermal stability, and mechanical performance for next-generation optoelectronic devices.

Debarati Dey's chapter provides a comprehensive review of the importance of zinc in human health, highlighting its essential roles in metabolism, immunity, growth, reproduction, enzyme function, and cellular repair. It discusses dietary sources, bioavailability, deficiency-related disorders, and preventive measures, offering valuable insight into zinc's significance as a vital trace element for maintaining human physiological balance.

Prasenjit Mandal and Sk Imran Ali present this work on the experimental characterization of carbon allotropes and nanocomposite materials using advanced analytical techniques. This research demonstrates the necessity of systematic material analysis to understand structural, morphological, chemical, and optical properties, supporting the development of efficient nanomaterials for diverse technological applications.

Together, these chapters showcase the diverse and interdisciplinary progress in chemical and biological sciences. The research contributions highlight innovative methodologies, sustainable technologies, and emerging scientific insights that address challenges in healthcare, materials science, environmental protection, and fundamental biological understanding, paving the way for future advancements.

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