Advances in Heterocyclic Chemistry: Structures, Reactivity, and Applications in Metal Complexes

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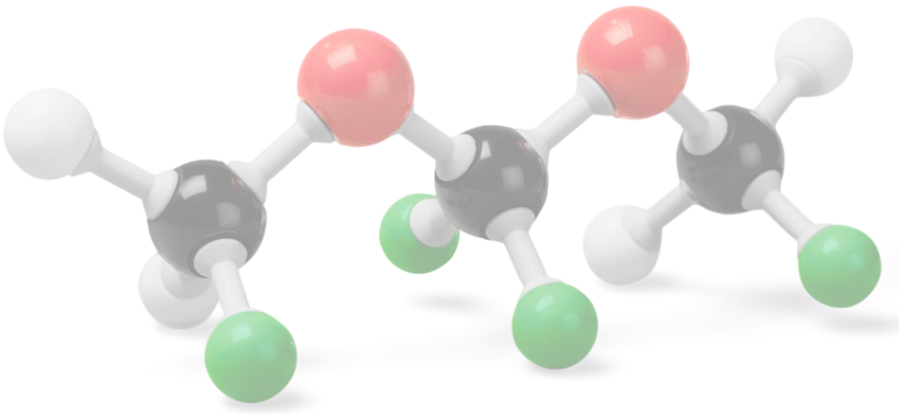

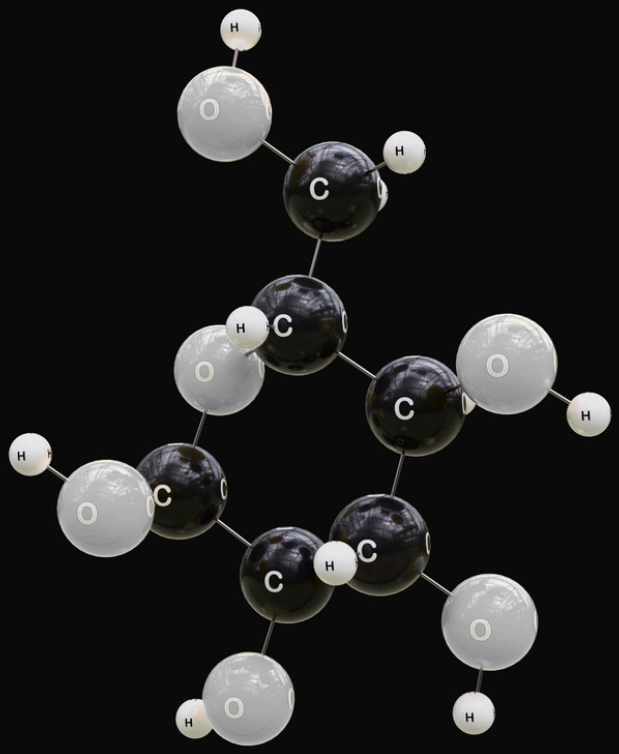

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Preface

The field of heterocyclic chemistry continues to be one of the most dynamic and intellectually stimulating areas of chemical science, bridging the disciplines of organic, inorganic, medicinal, and materials chemistry. Heterocycles constitute the backbone of countless biologically active molecules, advanced functional materials, and catalytic systems. In recent decades, their integration into metal complexes has provided transformative opportunities in catalysis, sensing, materials design, and therapeutic applications. Recognizing the importance of this expanding field, this volume—"**Advances in Heterocyclic Chemistry: Structures, Reactivity, and Applications in Metal Complexes**"—brings together diverse perspectives to provide a comprehensive overview of the structures, reactivity patterns, and multifaceted applications of heterocyclic compounds and their metal complexes.

The book is organized into thematic chapters, each devoted to a specific class of heterocycles or their role in metal coordination chemistry. The initial chapters focus on **nitrogen-containing heterocyclic compounds**, emphasizing their versatile coordination chemistry, rich reactivity, and significant contributions to pharmaceuticals and catalysis. Building upon this, the book examines **sulfur-containing heterocyclic systems**, highlighting their unique electron-donating properties, redox activity, and promising applications in materials science and environmental remediation. are also extensively discussed, particularly with regard to their structural diversity, hydrogen-bonding capability, and essential roles in bioinorganic chemistry.

Recognizing that the interplay between multiple heteroatoms often leads to novel properties, special attention is **given to mixed heteroatom systems**, including nitrogen–sulfur, nitrogen–oxygen, and oxygen–sulfur heterocycles. These chapters explore their synthetic strategies, structural features, and practical applications, underscoring the synergistic effects of multiple heteroatoms in fine-tuning chemical behavior and metal-binding affinities.

The later chapters broaden the scope by examining the **importance of heterocyclic compounds in coordination with transition metals, lanthanides, and actinides**. These sections highlight how heterocycles influence the stability, geometry, and reactivity of metal complexes, and how such systems are finding applications in catalysis, luminescence, magnetism, energy storage, and biomedical research. The final chapter emphasizes the **importance of heterocycles in inorganic chemistry at large**, providing a holistic perspective that situates heterocyclic compounds as central building blocks across multiple subfields of chemical research.

This volume is designed to serve as a reference for researchers, academicians, and students who are engaged in heterocyclic chemistry, organometallic chemistry, coordination chemistry, and related interdisciplinary areas. By compiling state-of-the-art knowledge, the book aims not only to provide a clear understanding of established concepts but also to inspire further exploration into emerging applications and future directions.

It is my sincere hope that "**Advances in Heterocyclic Chemistry: Structures, Reactivity, and Applications in Metal Complexes**" will stimulate new ideas, foster interdisciplinary collaborations, and serve as a valuable resource for the scientific community engaged in advancing this fascinating field.

About the Editors

Dr. Jayashree Shailesh Patil is an Assistant Professor at J.S.M. College, Alibag, Raigad. She obtained her M.Sc. degree in 1997 from the University of Mumbai (Kalina Campus), followed by an M.Phil. in 2008 from Madurai Kamaraj University, and a Ph.D. in 2014 from Jaipur National University, Jaipur. With a rich academic experience spanning 27 years, Dr. Patil has contributed extensively to the field through the publication of over 30 research papers and 20 conference presentations. Her research interests encompass diverse areas of chemistry, reflecting her commitment to advancing scientific knowledge and education.

Mr. Mandar D. Medhi, M.Sc. (Distn), SET, is currently serving as the Head and Associate Professor in the Department of Chemistry at Ramniranjan Jhunjhunwala College, Ghatkopar (W), Mumbai. With an impressive teaching career spanning 28 years, he has made significant contributions to higher education in the field of chemistry. His academic specialization lies in Organic Chemistry, while his research expertise focuses on the emerging areas of Nano Science and Nano Chemistry. He continues to inspire students and researchers through his dedication to teaching, mentoring, and advancing scientific knowledge.

Dr. Leena Manik Khadke holds an M.Sc., B.Ed., and Ph.D. in Chemistry. She is currently serving at Government Polytechnic, Thane, located at Phadke Pada, Khardi Gaon, Diva (East) – 400612. With 13 years of teaching and research experience, Dr. Khadke has made notable academic contributions, having published nine research papers in reputed journals and presented eight papers at national and international conferences. Her research interests lie in the areas of inorganic chemistry, coordination compounds, and applied chemical sciences.

Dr. Gajanan C. Upadhye serves as an Assistant Professor in the Chemistry Department at Konkan Gyanpeeth Karjat College of A.S.C., Karjat, Raigad, Maharashtra, an institution affiliated with the University of Mumbai. With over 28 years of teaching experience in degree colleges, he has contributed more than 45 research publications to internationally recognized journals. Dr. Upadhye has presented his research findings at numerous conferences and holds four national-level patents to his name.

Dr. Sandip Subhashrao Nandre, an Associate Professor, earned his Bachelor's and Master's degrees from K.B.C. North Maharashtra University, Maharashtra, India, and a Master's in Philosophy from Madurai Kamaraj University, Madurai, Tamil Nadu. He completed his Ph.D. in Physical Chemistry at K.B.C. North Maharashtra University, Jalgaon. Dr. Nandre began his academic career as an Assistant Professor in 2009 at Late Annasaheb R. D. Deore Arts and Science College, Mhasadi, Tal. Sakri, Dist. Dhule, Maharashtra, and was promoted to Associate Professor in 2022. Since joining, he has been actively involved in teaching, research, and extension activities, with a specialization in Solution Chemistry and Inorganic Chemistry. He has served as the Head of the Chemistry Department at the same college for approximately 16 years. Dr. Nandre has published around 25 peer-reviewed research articles in reputable journals and presented his work at 12 national and international conferences. Recognized as a Ph.D. guide and Postgraduate Teacher by K.B.C. North Maharashtra University, Jalgaon, he is currently mentoring three doctoral candidates in their research.

Dr. Sandesh Jaybhaye earned his B.Sc., B.Ed., and M.Sc. degrees in Chemistry from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra, India, and completed his Ph.D. at Dr. Babasaheb Ambedkar Technological University, Lonere, Dist. Raigad, Maharashtra. He also pursued an Indo-Italian Post-Doctoral Fellowship at the University of Genova, Italy. With over 25 years of teaching experience in the Chemistry Department at B.K. Birla College, Kalyan, Dr. Jaybhaye specializes in the synthesis and applications of Carbon Nanomaterials (CNTs and CNFs) and Metal Nanoparticles. He has published 100 research papers in peer-reviewed international journals indexed in SCI/Scopus/Web of Science and presented at conferences, secured 4 Indian patents, authored 3 books, and completed 3 Major Research Projects (funded by UGC, BRNS, and NRB), 6 Minor Research Projects, and 4 consultancy projects. He has guided 3 Ph.D. students to completion, with 5 currently under his supervision, and mentored over 100 M.Sc. research projects in Chemistry, Biotechnology, and Environmental Science. Dr. Jaybhaye has organized numerous national conferences, seminars, workshops, and science exhibitions for students. He serves as a reviewer and editorial board member for several prestigious journals, including the International Journal of Applied Science (IJAS), International Journal of Pharmaceuticals, Green Chemistry & Technology Letters, International Journal of Applied Clay Science (Elsevier), and International Journal of Research in Chemistry and Environment. He is actively involved with scientific organizations such as the Society of Materials Science, American Nano Society, Indian Carbon Society, National Science Congress, and Association of Chemistry Teachers. Dr. Jaybhaye has delivered numerous talks on nanotechnology at seminars, conferences, and All India Radio-Mumbai. His accolades include the National Level "Young Scientist Award–2006," State Level "Gururbrahama Award–2005," "Shivajirao Shendge Award–2005," "Shikshak Bhushan Award–2003," IIIP Awards 2022 for societal contributions, Late Shri Hariram Chimandas Punjabi NSS Karmaveer Award–2022, Best Citizens of India–2013, and JMF Silver Jubilee Adarsh Shikshavid Puraskar 2025. He has

undertaken international research visits to Italy, Monaco, Switzerland, Austria, Slovakia, Germany, and France for research exposure.

Dr. Niranjan Kumar Mandal obtained his Ph.D. in Environmental Chemistry from Sido Kanhu Murmu University, Dumka, Jharkhand, and holds an M.Sc. in Chemistry (First Class) from Lalit Narayan Mithila University, Darbhanga, Bihar. He has been serving as a Lecturer in the University Department of Chemistry, Sido Kanhu Murmu University, Dumka, since 2008, where he has also contributed as a B.Ed. Coordinator for three years.

Dr. Mandal has made significant scholarly contributions with over 35 research papers published in reputed national and international journals, and he has actively participated in more than 60 national and international seminars. His academic involvement extends to authoring and contributing to scholarly literature, including three book chapters in Environmental Chemistry and a textbook titled “Engineering Chemistry.”

Dr. Pradeep A. Shimpi serves as Associate Professor and Head of the Chemistry Department at B.N.N. College of Arts, Science, Commerce & SFC, Bhiwandi, Dist. Thane is an institution accredited with an 'A' grade by NAAC. He earned his Ph.D. from the University of Mumbai under the supervision of Dr. R. G. Deshmukh, focusing on “Study of the Metal Complexes of Oximo Hydrazone Derived from Diacetylmonoxime.” With 33 years of teaching experience, he has delivered numerous guest lectures at various colleges. Dr. Shimpi has published several research papers in national and international journals, specializing in metal complexes, and has presented his work at multiple national and international conferences. He has served as Chairperson for the T.Y.B.Sc. practical examinations at the University of Mumbai and has been a member of the syllabus committee for both undergraduate and postgraduate levels at the same university. Additionally, he has guided

numerous M.Sc. students in their research projects and completed a Minor Research Project.

Dr. Ganga Shivaji Gore is an Assistant Professor of Chemistry at Dapoli Urban Bank Senior Science College, Dapoli, where she has been serving since 1999. She holds an M.Sc. in Physical Chemistry, an M.Phil. in Chemistry from Madurai Kamaraj University, a B.Ed., the M.S.CIT certification, and an N.C.C. "C" Certificate, and is Dapoli Urban Bank Senior Science College, Dapoli

Her research interests include Spectroscopy, Thermodynamics, Solvent Extraction, Chemical Kinetics, Solid-State Chemistry, Phase Rule, and Nuclear Chemistry. She has presented papers at national conferences, participated in several workshops and seminars, and completed a Minor Research Project funded by the University of Mumbai.

With over 14 years of undergraduate and 7 years of postgraduate teaching experience, Dr. Gore is a recognized postgraduate teacher of the University of Mumbai. She has guided M.Sc. students in research projects and actively contributes to academic and institutional development through her roles in DLLE, IQAC, NAAC committees, and various co-curricular initiatives.

Mr. Vijay Ashok Tarate is working as an Assistant Professor at G.M. Vedak College of Science, Tala, Raigad. He has been actively engaged in teaching and research, contributing to the academic development of students in the field of science.

He has carried out his work under the able guidance of Dr. Ganga S. Gore, Assistant Professor at Dapoli Urban Bank Senior Science College, Dapoli, whose expertise and mentorship have been instrumental in shaping his academic pursuits.

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