

The **AI** REVOLUTION in **LIFE SCIENCES:**

Technologies, Applications,
and Future Directions



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The AI Revolution in Life Sciences: Technologies, Applications, and Future Directions



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Preface

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, and its influence on the life sciences is growing at an unprecedented pace. The convergence of AI with biology, medicine, biotechnology, genomics, pharmaceuticals, agriculture, and other life-science disciplines is creating new possibilities for research, discovery, diagnosis, prediction, and innovation. The AI Revolution in Life Sciences: Technologies, Applications, and Future Directions has been developed to provide a comprehensive overview of this rapidly evolving landscape.

The increasing availability of large and complex datasets, advances in machine learning and deep learning, improvements in computational infrastructure, and the development of generative AI have significantly changed how scientific and biological problems are approached. AI systems can identify patterns within vast datasets, support the interpretation of complex biological information, accelerate drug discovery, assist in disease prediction, enable personalised healthcare, and contribute to more efficient and sustainable biological and agricultural systems.

This book explores the fundamental technologies underlying AI and examines their applications across diverse areas of the life sciences. It highlights how machine learning, deep learning, natural language processing, computer vision, predictive analytics, and emerging AI approaches are being integrated into scientific and healthcare workflows. Particular attention is given to applications such as drug discovery and target identification, disease diagnosis and prediction, precision medicine, genomics, biotechnology, bioengineering, agriculture, and other emerging areas.

Beyond current applications, the book also considers the challenges associated with the growing use of AI in life sciences. Issues related to data quality, privacy, security, algorithmic bias, interpretability, ethical decision-making, regulatory frameworks, and responsible AI adoption are increasingly important as AI systems become part of critical scientific and healthcare environments. Understanding these challenges is essential for ensuring that technological progress remains scientifically reliable, ethically responsible, and socially beneficial.

The book also looks towards the future, considering emerging developments such as generative AI, AI-driven biological discovery, digital twins,

autonomous laboratories, advanced computational biology, and the potential convergence of AI with quantum computing. These developments may further accelerate scientific discovery and open new pathways for addressing some of the most complex challenges in human health, biotechnology, food security, and biological research.

This volume is intended for undergraduate and postgraduate students, researchers, academicians, healthcare professionals, biotechnology practitioners, and professionals seeking to understand the role of AI in modern life sciences. It may also serve as a reference for readers who wish to explore the opportunities and limitations of AI-enabled scientific innovation without requiring highly specialised knowledge of every underlying computational technique.

The objective of this book is not merely to present Artificial Intelligence as a technological advancement, but to examine it as an evolving scientific tool that is reshaping the way knowledge is generated, interpreted, and applied in the life sciences. By bringing together technological foundations, practical applications, emerging trends, and future directions, this book aims to encourage informed discussion and further research in this interdisciplinary field.

As AI continues to evolve, its greatest potential may lie not in replacing scientific expertise, but in augmenting human capabilities and enabling researchers and professionals to address problems that were previously difficult, time-consuming, or impossible to solve. The responsible integration of human knowledge with computational intelligence will therefore remain central to the future of life-science innovation.

We hope this book provides readers with a useful foundation for understanding the present state of AI in life sciences while inspiring further exploration, research, and innovation in the years ahead.

Acknowledgement

The authors would like to express their sincere gratitude to all those who contributed, directly or indirectly, to the development of this book, *The AI Revolution in Life Sciences: Technologies, Applications, and Future Directions*.

The rapid advancement of Artificial Intelligence has created remarkable opportunities across life sciences, transforming the way biological data are analysed, diseases are diagnosed, drugs are discovered, and healthcare and biotechnology are delivered. Bringing together these developments into a coherent and accessible volume has been possible through the support, encouragement, and intellectual contributions of numerous individuals and institutions.

We are deeply thankful to our colleagues, researchers, educators, healthcare professionals, scientists, and students whose discussions, insights, and continuing work in Artificial Intelligence and life sciences have enriched our understanding of this rapidly evolving field. Their dedication to research and innovation continues to inspire new approaches to solving complex challenges in biology, medicine, biotechnology, agriculture, and related disciplines.

We also acknowledge the valuable contributions of the wider scientific and academic community whose research, publications, datasets, technological developments, and scholarly discussions have provided the foundation for many of the concepts presented in this book.

Our sincere appreciation goes to our families, friends, colleagues, and well-wishers for their patience, encouragement, and constant support throughout the preparation of this work. Their understanding and motivation played an important role in bringing this book to completion.

Finally, we extend our gratitude to the publishing and editorial team for their cooperation and assistance in shaping this work into its present form.

We hope that this book will serve as a useful resource for students, researchers, academicians, healthcare professionals, biotechnology practitioners, and all those interested in understanding the transformative potential of Artificial Intelligence in life sciences.

About the Authors



Dr. Prabhavati is an Assistant Professor in the Department of Zoology at K.L.E. Society's S. Nijalingappa College, Rajajinagar, Bengaluru, Karnataka, India. She received her Ph.D. in Zoology from Gulbarga University, Kalaburagi in 2019, with a dissertation named "Hydrobiological Studies of Kamalavati River of Sedam Taluka, Kalaburagi District," which focused on limnology, ecotoxicology and aquatic biodiversity. Prior to her current position, she worked as an Assistant Professor for eight years of teaching both undergraduate and postgraduate courses, actively contributing to academic curriculum development and guiding numerous student research projects. Her main research and teaching interests include Ecology, Biodiversity Assessment, Wildlife Management, Ethology, Genetics and Molecular Biology, Anatomy, Physiology and Reproductive Biology. Dr. Prabhavati, has published six research papers, serves as a peer reviewer for academic journals, develops undergraduate instruction and laboratory manuals and has presented at national and international conferences. She has been honoured with the Women Icon Award (2025).



Dr. Soumya M. Hegde is an Assistant Professor in the Department of Botany at KLE Society's S. Nijalingappa College, Rajajinagar, Bengaluru, Karnataka, India. She completed her Ph.D. in Botany from Sahyadri Science College, Kuvempu University, Shivamogga in 2024 with the research title "Diversity and Biology of Terrestrial Orchids in Shivamogga District, Karnataka." Her doctoral work focused on terrestrial orchid diversity, distribution, phenology, reproductive Biology, mycorrhizal associations, and conservation in the Western Ghats of Karnataka.

Her areas of teaching and research interest include Plant Taxonomy, Orchid Biology, Plant Ecology, Biodiversity Assessment, Plant Conservation, Mycorrhizal Associations, Plant Anatomy, Phytochemistry, Ethnobotany, Medicinal Plants, and Plant Secondary Metabolites. She has conducted extensive field surveys across the Western Ghats, documented orchid diversity, carried out anatomical and ecological studies, and contributed to

biodiversity conservation research.

Dr. Hegde has published 18 research papers in the areas of orchid diversity, phenology, plant anatomy, and biodiversity of the Western Ghats. She is actively involved in undergraduate teaching, laboratory instruction, curriculum development, preparation of practical manuals, question banks, and academic mentoring. She has also served as a reviewer for graduate research synopses.

She has presented research papers at several national and international conferences and participated in numerous workshops, seminars, and training programmes related to biodiversity, orchid conservation, plant taxonomy, ecology, and research methodology.

Dr. Hegde is a life member of The Orchid Society of India and a member of the International Society for Horticultural Science (ISHS). She is committed to promoting scientific research, biodiversity conservation, and quality higher education through field-based learning, innovative teaching, and interdisciplinary research



Dr. Jagadevi Shivaputrappa is a Guest Lecturer in the department of Botany, Gulbarga University, Kalaburagi, Karnataka, India. Her areas of interest in teaching and research include Medicinal plants, Agricultural biotechnology, Plant breeding, molecular biology, microbiology and genetic engineering. She published 5 research articles in reputed national and international journals and a book chapter in Cambridge scholars publishing house, UK and presented her research work in several national and international conferences.

She is actively involved in curricular and co-curricular enrichment activities. She is an active member of MycoAsia and institutional botanical society. She aspires to make a significant contribution to research and education.



Dr. Mahesh Vilas Tanwade is an Assistant Professor in the Department of Postgraduate Studies and Research in Zoology at Sharnbasva University, Kalaburagi, Karnataka, India. With over four years of academic and research experience, he actively mentors postgraduate and doctoral scholars, currently supervising three research students. He holds a Ph.D. and an M.Sc. in Zoology from Sharnbasva University and obtained his undergraduate studies from Sharnbasveshwar College of Science, Kalaburagi affiliated to Gulbarga University, Kalaburagi.

Dr. Mahesh Vilas Tanwade's core research expertise lies at the intersection of endocrinology, reproductive biology, and ecotoxicology. Utilizing rodent animal models, his work explores male fertility, the neuroendocrine regulation of copulatory behaviors—including mounting, intromission, and ejaculation—and the adverse physiological impacts of endocrine-disrupting chemicals (EDCs). His research integrates standard toxicological and endocrine assays, such as the Hershberger, uterotrophic, and repeated-dose toxicity tests, alongside comprehensive semen analysis, to advance strategies in reproductive healthcare and environmental risk assessment.

Dr. Mahesh Vilas Tanwade is an active contributor to the scientific community and has published several research papers in peer-reviewed International Journals, including Comparative Clinical Pathology, Biological Trace Element Research, and the Journal of Molecular Structure. He has presented his scholarly findings at leading institutions, such as Dr. B. Lal Institute of Biotechnology, Jaipur, and Banaras Hindu University (BHU), Varanasi. Dr. Mahesh Vilas Tanwade holds life memberships in several professional organizations, including the Indian Society for the Study of Reproduction and Fertility (ISSRF), the Laboratory Animal Scientists Association (LASA), India, and the Society of Clinical Research and Medical Professionals (SCRMP), USA.

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ABOUT THE BOOK

The AI Revolution in Life Sciences: Technologies, Applications, and Future Directions explores the transformative role of Artificial Intelligence (AI) in life-science research, healthcare, biotechnology, agriculture, and biological engineering. The book provides a concise and accessible overview of AI technologies, applications, opportunities, and challenges shaping this rapidly evolving field.

It introduces key concepts such as machine learning, deep learning, natural language processing, computer vision, predictive analytics, and generative AI, highlighting their ability to process complex datasets, identify patterns, improve prediction, and support scientific decision-making.

The book examines important applications of AI in drug discovery, disease diagnosis, precision medicine, genomics, biotechnology, bioengineering, and precision agriculture. These applications demonstrate how AI can accelerate research, improve healthcare outcomes, enhance biological analysis, and support more efficient and sustainable systems.

It also addresses responsible AI adoption through discussions of data privacy, cybersecurity, algorithmic bias, transparency, explainability, ethics, and regulatory challenges. Looking ahead, the book explores emerging areas such as generative AI, autonomous laboratories, digital biology, AI-driven biological discovery, and AI-quantum computing integration.

Designed for students, researchers, academicians, healthcare professionals, biotechnology specialists, and life-science practitioners, the book provides a foundation for understanding both the current capabilities and future possibilities of AI. Ultimately, the book presents AI as a powerful enabling force capable of reshaping scientific discovery, healthcare, biotechnology, agriculture, and sustainable development, while emphasising the ethical and practical responsibilities that accompany its adoption.



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