

# ARTIFICIAL INTELLIGENCE: A MULTIDISCIPLINARY APPROACH TOWARDS TEACHING AND LEARNING



Editors:

**Tahmeena Khan**

**Manisha Singh**

**Saman Raza**

**Bentham Books**

# **Artificial Intelligence: A Multidisciplinary Approach towards Teaching and Learning**

Edited By

**Tahmeena Khan**

*Department of Chemistry  
Integral University  
Lucknow, U.P., India*

**Manisha Singh**

*Department of Education  
Integral University  
Lucknow, U.P., India*

&

**Saman Raza**

*Department of Chemistry  
Isabella Thoburn College  
Lucknow, U.P., India*

## **Artificial Intelligence: A Multidisciplinary Approach towards Teaching and Learning**

Editors: Tahmeena Khan, Manisha Singh and Saman Raza

ISBN (Online): 978-981-5305-18-0

ISBN (Print): 978-981-5305-19-7

ISBN (Paperback): 978-981-5305-20-3

© 2024, Bentham Books imprint.

Published by Bentham Science Publishers Pte. Ltd. Singapore. All Rights Reserved.

First published in 2024.

## **BENTHAM SCIENCE PUBLISHERS LTD.**

### **End User License Agreement (for non-institutional, personal use)**

This is an agreement between you and Bentham Science Publishers Ltd. Please read this License Agreement carefully before using the ebook/echapter/ejournal (“**Work**”). Your use of the Work constitutes your agreement to the terms and conditions set forth in this License Agreement. If you do not agree to these terms and conditions then you should not use the Work.

Bentham Science Publishers agrees to grant you a non-exclusive, non-transferable limited license to use the Work subject to and in accordance with the following terms and conditions. This License Agreement is for non-library, personal use only. For a library / institutional / multi user license in respect of the Work, please contact: [permission@benthamscience.net](mailto:permission@benthamscience.net).

### **Usage Rules:**

1. All rights reserved: The Work is the subject of copyright and Bentham Science Publishers either owns the Work (and the copyright in it) or is licensed to distribute the Work. You shall not copy, reproduce, modify, remove, delete, augment, add to, publish, transmit, sell, resell, create derivative works from, or in any way exploit the Work or make the Work available for others to do any of the same, in any form or by any means, in whole or in part, in each case without the prior written permission of Bentham Science Publishers, unless stated otherwise in this License Agreement.
2. You may download a copy of the Work on one occasion to one personal computer (including tablet, laptop, desktop, or other such devices). You may make one back-up copy of the Work to avoid losing it.
3. The unauthorised use or distribution of copyrighted or other proprietary content is illegal and could subject you to liability for substantial money damages. You will be liable for any damage resulting from your misuse of the Work or any violation of this License Agreement, including any infringement by you of copyrights or proprietary rights.

### ***Disclaimer:***

Bentham Science Publishers does not guarantee that the information in the Work is error-free, or warrant that it will meet your requirements or that access to the Work will be uninterrupted or error-free. The Work is provided "as is" without warranty of any kind, either express or implied or statutory, including, without limitation, implied warranties of merchantability and fitness for a particular purpose. The entire risk as to the results and performance of the Work is assumed by you. No responsibility is assumed by Bentham Science Publishers, its staff, editors and/or authors for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products instruction, advertisements or ideas contained in the Work.

### ***Limitation of Liability:***

In no event will Bentham Science Publishers, its staff, editors and/or authors, be liable for any damages, including, without limitation, special, incidental and/or consequential damages and/or damages for lost data and/or profits arising out of (whether directly or indirectly) the use or inability to use the Work. The entire liability of Bentham Science Publishers shall be limited to the amount actually paid by you for the Work.

### **General:**

1. Any dispute or claim arising out of or in connection with this License Agreement or the Work (including non-contractual disputes or claims) will be governed by and construed in accordance with the laws of Singapore. Each party agrees that the courts of the state of Singapore shall have exclusive jurisdiction to settle any dispute or claim arising out of or in connection with this License Agreement or the Work (including non-contractual disputes or claims).
2. Your rights under this License Agreement will automatically terminate without notice and without the

need for a court order if at any point you breach any terms of this License Agreement. In no event will any delay or failure by Bentham Science Publishers in enforcing your compliance with this License Agreement constitute a waiver of any of its rights.

3. You acknowledge that you have read this License Agreement, and agree to be bound by its terms and conditions. To the extent that any other terms and conditions presented on any website of Bentham Science Publishers conflict with, or are inconsistent with, the terms and conditions set out in this License Agreement, you acknowledge that the terms and conditions set out in this License Agreement shall prevail.

**Bentham Science Publishers Pte. Ltd.**

80 Robinson Road #02-00

Singapore 068898

Singapore

Email: [subscriptions@benthamscience.net](mailto:subscriptions@benthamscience.net)



## CONTENTS

<b>FOREWORD I</b> .....	i
<b>FOREWORD II</b> .....	ii
<b>PREFACE</b> .....	iii
<b>LIST OF CONTRIBUTORS</b> .....	iv
<b>CHAPTER 1 THE EVOLUTION OF ARTIFICIAL INTELLIGENCE FROM PHILOSOPHY TO NEW FRONTIER</b> .....	1
<i>Manisha Singh, Arbind K. Jha, Tahmeena Khan and Saman Raza</i>	
<b>INTRODUCTION</b> .....	1
<b>THE HISTORY OF ARTIFICIAL INTELLIGENCE (AI)</b> .....	2
<b>PHILOSOPHY AND AI: A PHILOSOPHICAL JOURNEY</b> .....	4
<b>PHILOSOPHICAL CONSIDERATION OF AI</b> .....	5
Metaphysics and AI .....	5
Epistemology and AI .....	6
Axiology and AI .....	7
Framework of AI .....	9
<b>HUMAN-MACHINE TEAMING FRAMEWORK</b> .....	10
<b>FORMS OF AI</b> .....	11
Based on Capabilities .....	12
<i>Artificial Narrow Intelligence</i> .....	12
<i>Artificial General Intelligence</i> .....	12
<i>Artificial Super Intelligence</i> .....	12
<i>Generative AI</i> .....	13
Based on Functionality Artificial Intelligence .....	13
<i>Reactive Machines</i> .....	13
<i>Limited AI</i> .....	14
<i>Theory of Mind AI</i> .....	14
<i>Self-aware AI</i> .....	15
<i>Some other forms of AI</i> .....	15
<b>AI AND NEW FRONTIERS</b> .....	16
AI and Medical Science .....	17
AI and Life Science .....	17
AI and Mathematics .....	17
AI and Architecture .....	18
AI and Environmental Science .....	18
AI in Education .....	18
AI in Research .....	19
<i>ChatGPT/Perplexity/GoogleBard</i> .....	19
<i>PDFgear</i> .....	19
<i>Wordvice AI</i> .....	19
<i>Consensus</i> .....	20
<i>Trinka</i> .....	20
<i>QuillBot AI</i> .....	20
<i>Page.AI</i> .....	21
<i>Zotero, EndNote Online, Mendeley, RefWorks, etc</i> .....	21
<b>AI, HUMAN INTELLIGENCE AND HUMAN WISDOM</b> .....	21
<b>CONCLUDING REMARKS</b> .....	22
<b>REFERENCES</b> .....	22

<b>CHAPTER 2 ARTIFICIAL INTELLIGENCE AND BIOINFORMATICS: A POWERFUL SYNERGY FOR DRUG DESIGN AND DISCOVERY</b> .....	26
<i>Chanda Hemantha Manikumar Chakravarthi, Viswajit Mulpuru and Nidhi Mishra</i>	
<b>INTRODUCTION</b> .....	27
Overview of Machine Learning .....	27
<i>Supervised Learning</i> .....	27
<i>Unsupervised Learning</i> .....	27
<i>Reinforcement Learning</i> .....	27
Importance of Drug Design .....	27
<i>Challenges in Traditional Drug Discovery</i> .....	27
<b>DATA ANALYSIS AND PREPROCESSING</b> .....	28
Utilizing Biological Databases .....	28
<i>Omics Data Integration</i> .....	29
Data Cleaning and Feature Extraction .....	29
<i>Data Cleaning and Pre-processing</i> .....	29
<i>Feature Extraction Techniques</i> .....	30
Handling Imbalanced Datasets .....	30
<i>Oversampling and Undersampling</i> .....	30
<i>Advanced Algorithms for Imbalanced Data</i> .....	31
Addressing Batch Effects .....	31
<i>Definition of Batch Effects</i> .....	31
<i>Ensuring Consistency</i> .....	31
<b>PREDICTIVE MODELLING</b> .....	32
Classification Algorithms .....	32
<i>Support Vector Machines (SVM)</i> .....	32
<i>Random Forests</i> .....	33
<i>Neural Networks</i> .....	35
Regression Analysis .....	36
<i>Quantitative Structure-Activity Relationship (QSAR)</i> .....	36
<i>Predicting Molecular Properties</i> .....	38
<b>VIRTUAL SCREENING</b> .....	40
Target Identification and Validation .....	40
<i>Omics Data Integration</i> .....	40
<i>Disease Gene Prediction</i> .....	41
<i>Expression Profiling and Differential Analysis</i> .....	41
<i>Pharmacogenomics</i> .....	41
<i>Text Mining and Literature Analysis</i> .....	41
<i>Validation through High-Throughput Screening (HTS)</i> .....	41
<i>Integration of Structural Biology Data</i> .....	42
Ligand-Based Virtual Screening Techniques .....	42
<i>Molecular Descriptors and Fingerprints</i> .....	42
<i>Quantitative Structure-Activity Relationship (QSAR)</i> .....	43
<i>Machine Learning Classifiers</i> .....	43
<i>Pharmacophore Modeling</i> .....	43
<i>Chemical Similarity Networks</i> .....	43
<i>Ensemble Methods</i> .....	44
Structure-Based Virtual Screening .....	44
<i>Protein-Ligand Docking</i> .....	44
<i>Scoring Functions</i> .....	44
<i>Deep Learning in Binding Affinity Prediction</i> .....	45

<i>Machine Learning Filters</i> .....	45
<i>Consensus Scoring</i> .....	45
<i>Machine Learning for Binding Site Prediction</i> .....	45
<i>Fragment-Based Virtual Screening</i> .....	46
<b>DE NOVO DRUG DESIGN</b> .....	46
Generative Models in Drug Design .....	46
<i>Generative AI in bioinformatics</i> .....	46
<i>Generative AI in Drug Design</i> .....	46
<i>Generative AI revolutionizes Drug Discovery Processes</i> .....	47
<i>Variational Autoencoders (VAEs)</i> .....	47
<i>Generative Adversarial Networks (GANs)</i> .....	47
Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) Networks .....	48
<i>Transformer-Based Models</i> .....	48
<i>Graph Generative Models</i> .....	48
<i>Conditional Generative Models</i> .....	48
<i>Transfer Learning in Generative Models</i> .....	49
Reinforcement Learning for Molecule Generation .....	49
<i>Objective Function Definition</i> .....	49
<i>Policy Networks</i> .....	49
<i>Action Space Representation</i> .....	50
<i>Monte Carlo Tree Search (MCTS)</i> .....	50
<i>Actor-Critic Models</i> .....	50
<i>Exploration Strategies</i> .....	50
<i>Transfer Learning and Pre-training</i> .....	50
<b>DRUG REPURPOSING</b> .....	51
Identifying New Indications for Existing Drugs .....	51
<i>Biological Data Integration</i> .....	51
<i>Drug Similarity and Similarity Networks</i> .....	51
<i>Disease Similarity and Phenotype Matching</i> .....	52
<i>Text Mining and Literature Analysis</i> .....	52
<i>Predictive Modeling for Drug-Disease Associations</i> .....	52
<i>Network Propagation Algorithms</i> .....	52
<i>Electronic Health Records (EHR) Analysis</i> .....	52
<i>Multi-Omics Data Integration</i> .....	53
Utilizing Machine Learning for Drug Repositioning .....	53
<i>Data Integration and Representation</i> .....	53
<i>Feature Extraction and Engineering</i> .....	53
<i>Predictive Modelling for Drug-Disease Associations</i> .....	54
<i>Network-Based Approaches</i> .....	54
<i>Deep Learning Models</i> .....	54
<i>Text Mining and Literature Analysis</i> .....	54
<i>Clinical Data Mining</i> .....	55
<i>Ensemble Learning</i> .....	55
<b>PHARMACOPHORE MODELLING</b> .....	55
Molecular Interaction Understanding .....	55
Drug Design and Optimization .....	56
Virtual Screening .....	56
Lead Identification and Optimization .....	56
Polypharmacology Analysis .....	56
Structure-Activity Relationship (SAR) Analysis .....	56
Fragment-Based Drug Design .....	56

Target Druggability Assessment .....	56
Pharmacokinetic and Toxicity Prediction .....	56
Adverse Effects Mitigation .....	56
<i>Feature Selection and Descriptor Generation</i> .....	57
<i>Training Data Generation</i> .....	57
<i>Enhanced Pharmacophore Screening</i> .....	57
<i>Predictive Pharmacophore Modeling</i> .....	57
<i>Polypharmacology Prediction</i> .....	58
<i>Druggability Assessment</i> .....	58
<i>Hybrid Approaches</i> .....	58
<i>Pharmacophore Optimization</i> .....	58
<i>Data-Driven Drug Design</i> .....	58
<b>PERSONALIZED MEDICINE</b> .....	59
Tailoring Treatments Based on Individual Genetic Profiles .....	59
<i>Importance and Benefits</i> .....	59
<i>Application of Machine Learning</i> .....	60
<i>Examples of Personalized Medicine Applications</i> .....	60
<i>Ethical and Regulatory Considerations</i> .....	61
<i>Future Directions</i> .....	61
Machine Learning in Patient Stratification .....	61
<i>Key Components of Patient Stratification</i> .....	62
<i>Importance and Benefits</i> .....	62
<i>Applications of Machine Learning</i> .....	62
<i>Examples of Patient Stratification</i> .....	63
<i>Challenges and Considerations</i> .....	63
<i>Future Directions</i> .....	63
<b>CHALLENGES AND FUTURE DIRECTIONS</b> .....	64
Data Quality and Availability .....	64
<i>Data Quality Issues</i> .....	64
<i>Data Standardization and Integration</i> .....	64
<i>Limited Accessibility</i> .....	64
<i>Small Sample Sizes</i> .....	65
<i>Biological Variability</i> .....	65
<i>Ethical Considerations</i> .....	65
<i>Future Directions</i> .....	65
<i>Advancements in Personalized Medicine</i> .....	66
Ethical and Regulatory Considerations .....	66
<i>Patient Privacy and Informed Consent</i> .....	66
<i>Data Ownership and Sharing</i> .....	67
<i>Bias and Fairness in Models</i> .....	67
<i>Regulatory Compliance</i> .....	67
<i>Inclusivity in Research</i> .....	67
<i>Transparency in AI Decision-Making</i> .....	67
<i>Future Directions</i> .....	68
Emerging Technologies and Trends in Drug Design .....	69
<i>Artificial Intelligence (AI) and Machine Learning</i> .....	69
<i>Quantum Computing</i> .....	69
<i>Structural Biology Advancements</i> .....	69
<i>Immunotherapy and Personalized Medicine</i> .....	69
<i>CRISPR and Gene Editing</i> .....	70
<i>Nanotechnology in Drug Delivery</i> .....	70

<i>Data Integration and Systems Biology</i> .....	70
<i>3D Printing in Drug Manufacturing</i> .....	70
<i>Blockchain for Data Security</i> .....	70
<b>CONCLUDING REMARKS</b> .....	71
Artificial Intelligence (AI) and Machine Learning .....	72
<i>Quantum Computing</i> .....	72
<i>Immunoinformatics</i> .....	72
<i>CRISPR-Cas9 and Gene Editing</i> .....	72
<i>3D Bioprinting</i> .....	72
<i>Nanotechnology</i> .....	72
<i>RNA Therapeutics</i> .....	72
<i>Pharmacogenomics</i> .....	72
<i>Virtual Reality (VR) and Augmented Reality (AR)</i> .....	72
<i>Blockchain in Drug Development</i> .....	72
<i>Metabolomics and Systems Biology</i> .....	72
<i>Synthetic Biology</i> .....	73
Potential Impact on the Pharmaceutical Industry .....	73
<i>Acceleration of Drug Discovery</i> .....	73
<i>Revolutionizing Vaccine Development</i> .....	73
<i>Precision Medicine and Personalized Therapies</i> .....	73
<i>Efficient Drug Testing and Development</i> .....	74
<i>Targeted Drug Delivery and Formulation</i> .....	74
<i>Innovations in RNA Therapeutics</i> .....	74
<i>Optimizing Drug Responses</i> .....	74
<i>Immersive Research Environments</i> .....	74
<i>Ensuring Data Integrity and Compliance</i> .....	74
<i>Comprehensive Understanding of Drug Impact</i> .....	74
<i>Biosynthesis and Customized Biological Systems</i> .....	74
<b>REFERENCES</b> .....	75

**CHAPTER 3 ARTIFICIAL INTELLIGENCE ASSISTED TEACHING AND LEARNING AND RESEARCH OF ENVIRONMENTAL SCIENCES** .....

<i>Tahmeena Khan, Priya Mishra, Kulsum Hashmi, Saman Raza, Manisha Singh, Seema Joshi and Abdul Rahman Khan</i> .....	80
<b>INTRODUCTION</b> .....	81
Generative AI in Education .....	82
AI In Teaching, Learning and Academic Achievement .....	84
AI-Based Tools and Methodologies in Environmental/Geoscience Teaching .....	89
Different AI Techniques Used in Environment and Geosciences-Based Research .....	95
<i>Hazard Identification</i> .....	96
<i>Risk Assessment</i> .....	96
<i>Risk Evaluation</i> .....	97
<i>Decision Making</i> .....	97
<i>Earthquakes</i> .....	97
<i>Volcano</i> .....	97
<i>Landslide</i> .....	97
<i>Rainfall</i> .....	98
<i>Cyclones</i> .....	98
<i>Meteorological Drought</i> .....	98
<i>Wildfire</i> .....	98
<i>Dust storm</i> .....	99

<i>Anthropogenic Air Pollutants</i> .....	99
AI in Biosphere .....	99
Chat GP and Environmental Science .....	100
<b>CHALLENGES IN AI IN ENVIRONMENTAL SCIENCE BASED RESEARCH</b> .....	101
Choosing a Suitable Model .....	101
Training Optimization .....	101
Data Preparation .....	101
Ethical Issues .....	102
<b>CONCLUDING REMARKS</b> .....	102
<b>REFERENCES</b> .....	102
<b>CHAPTER 4 INTEGRATING AI APPROACHES IN TEACHING-LEARNING ASSOCIATED WITH THE MITIGATION OF AIR POLLUTION: A COMPREHENSIVE ANALYSIS</b> .....	115
<i>Rahila Rahman Khan, Ahmad Faiz Minai and Rushda Sharf</i>	
<b>INTRODUCTION</b> .....	115
<b>OVERVIEW OF THE CURRENT STATE OF AIR POLLUTION AND ITS IMPACT</b> .....	116
<b>APPLICATIONS OF AI IN ENVIRONMENTAL CHALLENGES</b> .....	116
Environmental Monitoring .....	117
Climate Modeling .....	117
Biodiversity Conservation .....	117
Renewable Energy .....	118
<b>POTENTIAL OF AI IN ADDRESSING AIR POLLUTION</b> .....	118
Data Analysis and Prediction .....	118
Source Identification .....	118
Early Warning Systems .....	118
Policy Formulation .....	118
<b>PROBLEMS WITH CONVENTIONAL AIR QUALITY MONITORING TECHNIQUES</b> .....	120
Restricted Coverage .....	120
Temporal Limitations .....	120
High Installation and Maintenance Costs .....	120
Data Timeliness .....	120
<b>AI-BASED AIR QUALITY MONITORING</b> .....	120
Remote Sensing and Satellite Technology .....	120
Integration of Satellite Data .....	121
AI Algorithms for Data Analysis and Interpretation .....	121
Sensor Networks and IoT Devices .....	121
Deployment of Smart Sensors .....	121
Machine Learning for Sensor Data Analysis .....	121
<b>UTILIZING AI FOR TIMELY INFORMATION</b> .....	121
<b>AI TECHNIQUES FOR IDENTIFYING AND QUANTIFYING POLLUTION SOURCES</b> .....	122
Data Fusion and Integration .....	122
Chemical Mass Balance Models .....	122
Source Separation Algorithms .....	122
<b>INCORPORATING AI INSIGHTS INTO CITY PLANNING FOR POLLUTION CONTROL</b> .....	122
Zoning and Land Use Planning .....	122
Traffic Management .....	123
Emission Reduction Strategies .....	123
<b>AI AND POLICY IMPLEMENTATION</b> .....	123
<b>OVERCOMING CHALLENGES IN POLICY IMPLEMENTATION</b> .....	123
<b>PUBLIC AWARENESS AND ENGAGEMENT</b> .....	123

<b>FUTURE INNOVATIONS AND RESEARCH DIRECTIONS</b> .....	124
<b>CONCLUDING REMARKS</b> .....	124
<b>REFERENCES</b> .....	125
<b>CHAPTER 5 APPLICATIONS OF NEURAL NETWORK IN PHYSICS: COSMOLOGY AND MOLECULAR DYNAMICS</b> .....	128
<i>Vivekanand Mohapatra, Dhruv Agrawal and Shubhamshree Avishek</i>	
<b>INTRODUCTION TO ML AND NEURAL NETWORK</b> .....	128
<b>MACHINE LEARNING IN 21-CM COSMOLOGY</b> .....	132
Differential Brightness Temperature .....	134
Challenges in Observational Cosmology .....	136
Modelling the Foreground Signal .....	136
Modeling the Differential Brightness Temperature .....	136
Application of ANN in Cosmology .....	138
<i>Basic Architecture of ANN</i> .....	138
<i>Parameter Estimation using ANN</i> .....	139
<b>INTRODUCTION TO MOLECULAR DYNAMICS SIMULATIONS</b> .....	140
Recurrent Neural Networks .....	141
<i>Understanding Sequential Data Processing in RNNs</i> .....	142
<i>Integration of RNNs with Physics</i> .....	142
<b>CONCLUDING REMARKS</b> .....	144
<b>REFERENCES</b> .....	145
<b>CHAPTER 6 ROLE OF ARTIFICIAL INTELLIGENCE IN TEACHING AND LEARNING CHEMICAL SCIENCES</b> .....	148
<i>Shahla Tanveer, Mariyam Tanveer and Ayesha Tanveer</i>	
<b>INTRODUCTION</b> .....	149
<b>CHEMICAL REPRESENTATION OF ATOMS AND MOLECULES IN COMPUTER-UNDERSTANDABLE FORMAT</b> .....	150
Molecular Graph Representation .....	150
Simplified Molecular Input Line Entry System (SMILES) .....	151
InChi .....	152
<b>APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN CHEMICAL SCIENCES</b> .....	153
Retrosynthesis .....	153
<i>Reactant Selection</i> .....	153
<i>Template Selection</i> .....	154
Prediction of Reaction Outcomes .....	156
Molecular Designing .....	157
<i>Simulator</i> .....	158
<i>Evaluator</i> .....	158
<i>Constraints</i> .....	158
<i>Specifications</i> .....	158
<i>GP (Genetic Programming)</i> .....	158
<i>Visualizer</i> .....	159
<i>Control Interface</i> .....	159
<i>Properties for Electronic Data</i> .....	159
<i>Pharmaceutical Applications</i> .....	159
<i>Reactive Properties and Catalyst Optimization</i> .....	159
<i>Structure and Docking Ability</i> .....	160
Molecular Property Prediction .....	160
<b>ROLE OF GENERATIVE AI IN CHEMICAL SCIENCES</b> .....	161
Benefits of Integrating Generative AI in Chemistry Learning and Teaching .....	162

<i>Enhanced Student Involvement</i> .....	162
<i>Instantaneous Answers and Assistance</i> .....	162
<i>Customised Learning</i> .....	162
<i>Promotion of Critical Thinking</i> .....	162
<i>Access to Extra Learning Resources</i> .....	162
<i>Facilitation of Continuous Learning</i> .....	163
<i>Reinforcement of Essential Knowledge</i> .....	163
<i>Supplementing Limited Resources</i> .....	163
Role of ChatGPT in Promoting Student Engagement and Active Learning .....	163
<i>Interactive Conversations</i> .....	163
<i>Instant Response and Feedback</i> .....	163
<i>Scaffolded Learning</i> .....	163
<i>Fostering Curiosity and Inquiry</i> .....	163
<i>Exploratory Learning</i> .....	164
<i>Adaptable Learning Environments</i> .....	164
<i>Active Problem-Solving</i> .....	164
<i>Fostering Discussion and Collaboration</i> .....	164
<b>CHALLENGES AND LIMITATIONS</b> .....	164
Underdeveloped Technologies .....	164
Lack of AI Skills .....	164
Inadequate Data .....	164
Trust and Transparency Concerns .....	165
Uncertain ROI .....	165
Data Bias .....	165
Limited Generalisation .....	165
High Computing Requirements .....	165
Ethical Concerns .....	165
Integration Challenges .....	165
<b>FUTURE PROSPECTS</b> .....	165
Accelerated Medication Discovery .....	166
Precision Medicine .....	166
Green Chemistry .....	166
Material Design and Discovery .....	166
Automation and Robots .....	166
Integration of Big Data .....	166
<b>CONCLUDING REMARKS</b> .....	166
<b>REFERENCES</b> .....	167
<b>CHAPTER 7 AI TOOLS FOR TEACHING-LEARNING CHEMISTRY</b> .....	173
<i>Saman Raza, Satya, Tahmeena Khan and Manisha Singh</i>	
<b>INTRODUCTION</b> .....	173
<b>TYPES OF AI</b> .....	174
<b>GENERATIVE AI</b> .....	176
<b>APPLICATIONS OF AI IN CHEMISTRY</b> .....	176
Prediction of Chemical Reactions .....	176
Drug Design .....	178
Material Design .....	180
Others .....	182
<b>AI POWERED TOOLS AND APPLICATIONS FOR TEACHING AND LEARNING CHEMISTRY</b> .....	182
Tutoring Systems using AI .....	183

Interactive Learning Platforms .....	183
ChatGPT .....	184
Smodin Chemistry Homework Solver .....	185
HyperWrite's Chemistry Assistant .....	185
SorSor .....	185
FormuTodo .....	186
<b>STUDIES TO DETERMINE THE INFLUENCE OF AI IN LEARNING CHEMISTRY .....</b>	<b>186</b>
<b>THE BENEFITS OF USING AI FOR CHEMISTRY EDUCATION .....</b>	<b>188</b>
<b>DRAWBACKS AND CHALLENGES .....</b>	<b>188</b>
<b>CONCLUDING REMARKS .....</b>	<b>189</b>
<b>REFERENCES .....</b>	<b>189</b>
<b>CHAPTER 8 TRANSFORMATION IN THE WORLD OF COMMERCE AND ECONOMICS THROUGH AI .....</b>	<b>194</b>
<i>Umang Tandon, Apoorva Tandon and Tarang Mehrotra</i>	
<b>INTRODUCTION .....</b>	<b>195</b>
Predictive Analytics .....	196
Operational Decision-Making .....	196
Strategic Integration .....	196
Operational Efficiency .....	197
Risk Mitigation .....	197
Ethical Imperatives .....	197
<b>OBJECTIVE .....</b>	<b>197</b>
Identifying and Synthesizing Key Findings from Existing Research .....	197
Addressing Gaps in Understanding AI's Impact on Commerce and Economics .....	198
<b>AI IN ANALYTICS AND DECISION-MAKING .....</b>	<b>198</b>
Predictive Analysis .....	198
Descriptive Analytics .....	201
Decision-Making Processes .....	203
<b>ECONOMIC IMPLICATIONS OF AI .....</b>	<b>205</b>
<b>RISK MITIGATION .....</b>	<b>206</b>
Productivity Enhancement .....	207
Labour Dynamics .....	208
<b>ADDRESSING INHERENT BIASES IN AI MODELS .....</b>	<b>209</b>
Gender Bias .....	209
Racial Bias .....	210
Market Bias .....	210
Biases in Labor Markets .....	210
Policy Bias .....	210
<b>RECTIFICATION PROCESSES .....</b>	<b>211</b>
Data Diversification for Holistic Representation .....	212
Algorithmic Transparency: Unveiling the Black Box .....	212
Continuous Model Evaluation: The Lifeline of Bias Rectification .....	212
Stakeholder Collaboration: A Collective Approach .....	212
<b>CONCLUDING REMARKS .....</b>	<b>213</b>
<b>REFERENCES .....</b>	<b>214</b>
<b>CHAPTER 9 TRANSFORMING ENGLISH PEDAGOGY WITH ARTIFICIAL INTELLIGENCE: ENROUTE TO ENHANCED LANGUAGE LEARNING .....</b>	<b>216</b>
<i>Leena Rajak, Sangeeta Chauhan and Sonu Bara</i>	
<b>INTRODUCTION .....</b>	<b>217</b>
What is Artificial Intelligence (AI)? .....	217

<b>GENERATIVE ARTIFICIAL INTELLIGENCE (GAI)</b> .....	218
<b>EVOLUTION PROCURED BY GENERATIVE AI IN THE FIELD OF EDUCATION</b> .....	219
English Language Education .....	220
Technology in Language Teaching .....	221
<i>Online Language Learning Platforms</i> .....	221
<i>Language Learning Apps</i> .....	222
<i>Virtual Reality (VR) and Augmented Reality (AR)</i> .....	224
<i>Online Tutoring and Video Conferencing</i> .....	225
<i>Digital Language Resources</i> .....	225
<i>Interactive Whiteboards and Smartboards</i> .....	226
<b>LANGUAGE LEARNING MANAGEMENT SYSTEMS (LMS)</b> .....	226
Speech Recognition Technology .....	227
Educational Software and Apps .....	227
Social Media and Online Communities .....	228
Virtual Assistants for Language Learning .....	228
Intelligent Tutoring Systems .....	229
Natural Language Processing .....	229
Gamification and Interactive Learning .....	229
Accessibility and Inclusivity .....	230
The Role of Teachers .....	231
The Future of English Language Education .....	232
<b>ROLE OF AI IN ENGLISH AND LANGUAGE LEARNING</b> .....	232
Personalized Learning .....	233
Immediate Feedback .....	233
Enhanced Engagement .....	233
Accessibility .....	233
Language Analysis .....	233
Natural Language Processing (NLP) .....	233
Adaptive Assessment .....	234
24/7 Availability .....	234
Data-Driven Insights .....	234
Language Generation .....	234
<b>CHALLENGES IN THE IMPLEMENTATION OF AI TECHNOLOGY IN LANGUAGE LEARNING</b> .....	234
Access and Equity .....	234
Quality of Content .....	235
Data Privacy and Security .....	235
Lack of Personalization Understanding .....	235
Integration with Traditional Pedagogy .....	235
Ethical Considerations .....	235
User Engagement and Motivation .....	236
Cost of Implementation .....	236
Adaptability and Continuous Improvement .....	236
Overreliance on Technology .....	236
<b>FUTURE SCOPE</b> .....	237
<b>CONCLUDING REMARKS</b> .....	238
<b>REFERENCES</b> .....	239

**CHAPTER 10 REVOLUTIONIZING LEARNING LANDSCAPES: UNLEASHING THE POTENTIAL OF AI IN THE REALM OF ACADEMIC RESEARCH** ..... 242

*Waseem Zahra and Gunjan Rautela*

<b>INTRODUCTION</b> .....	243
<b>ACADEMIC RESEARCH</b> .....	243
<b>THE ADVANCEMENT OF AI IN ACADEMIC RESEARCH IN THE 21<sup>ST</sup> CENTURY</b> ....	244
<b>ROLE OF AI IN REVOLUTIONIZING ACADEMIC RESEARCH</b> .....	245
Using AI Techniques to Review the Literature and Gain Research Knowledge .....	246
AI in Writing Research Hypothesis .....	246
AI in Academic Writing .....	246
Applying AI to Data Analysis .....	247
Recommendation System .....	247
<b>NAVIGATING THE RESEARCH JOURNEY WITH ARTIFICIAL INTELLIGENCE:</b>	
<b>ESSENTIAL STEPS</b> .....	247
Define Research Objectives .....	247
Literature Review .....	248
Formulate Research Hypotheses or Questions .....	249
Data Collection .....	249
Data Preprocessing .....	249
Feature Engineering .....	249
Model Selection .....	249
Training and Validation .....	249
Evaluation .....	249
Analysis and Interpretation .....	249
Documentation and Reporting .....	250
Peer Review and Feedback .....	250
<b>GENERATIVE AI (GENAI) IN ACADEMIC RESEARCH</b> .....	250
<b>KEY ARTIFICIAL INTELLIGENCE TECHNIQUES EMPLOYED IN DATA ANALYSIS AND ANALYTICS</b> .....	252
Natural Language Processing (NLP) .....	254
Machine Learning .....	254
Computer Vision .....	254
Deep Learning .....	254
Predictive Analytics .....	255
Reinforcement Learning .....	255
Clustering and Classification .....	255
Blockchain for Research Integrity .....	255
<b>DIVERSE AI TOOLS FOR EMPOWERING ACADEMIC RESEARCH</b> .....	255
NLTK (Natural Language Toolkit) .....	256
SpaCy .....	256
ChatGPT and GPT-3 .....	256
TensorFlow and PyTorch .....	257
Scikit-learn .....	257
Zotero and Mendeley .....	257
Slack and Microsoft Teams .....	257
Matplotlib and Seaborn .....	257
Google Scholar .....	257
<b>EXPLORING THE ADVANTAGES OF AI IN ACADEMIC RESEARCH</b> .....	257
Data Analysis and Pattern Recognition .....	258
Accelerated Hypothesis Generation .....	258
Automation of Repetitive Tasks .....	258
Predictive Modelling and Forecasting .....	258
<i>Enhancing Personalized Learning</i> .....	258
<i>Improving Educational Outcomes</i> .....	259

<i>Addressing Educational Inequality</i> .....	259
<b>A COMPREHENSIVE EXAMINATION OF CHALLENGES IN INTEGRATING ARTIFICIAL INTELLIGENCE INTO ACADEMIC RESEARCH</b> .....	260
Data Quality and Availability .....	260
Interpretability .....	260
High Computational Costs .....	260
Lack of Standardization .....	260
Lack of Technical Expertise .....	261
Ethical Considerations in Using AI in Academic Research .....	261
Data Privacy .....	261
Algorithmic Bias .....	261
Equity and Access .....	261
<b>CONCLUDING REMARKS</b> .....	262
<b>REFERENCES</b> .....	262
<b>CHAPTER 11 FUTURE TRENDS AND INNOVATIONS IN ARTIFICIAL INTELLIGENCE</b> .....	265
<i>Samiya Farooq and Pooja Mishra</i>	
<b>INTRODUCTION</b> .....	265
Stages of Artificial Intelligence .....	268
<b>THEORETICAL BACKGROUND</b> .....	268
AI and Education .....	268
Education for Understanding AI .....	268
The Use of AI in Education .....	269
Model Framework of Educational Landscape .....	269
<b>REASONS TO ADDRESS ARTIFICIAL INTELLIGENCE IN EDUCATION</b> .....	271
<b>E-LEARNING TRENDS</b> .....	272
Google Classroom .....	273
Collaborative Learning .....	273
MOOCs .....	273
Blended Learning .....	274
Gamification .....	274
<b>TECHNOLOGIES WITH AI</b> .....	274
Chatbots .....	274
Virtual Reality .....	274
Learning Management System .....	275
<b>FUTURE TRENDS OF AI</b> .....	275
Personalized Learning .....	275
Adaptive Learning Systems .....	276
Chatbots and Virtual Assistants .....	276
Gamification and AI .....	276
AI in Grading and Assessment .....	276
Predictive Analytics for Student Success .....	276
<b>AI AS A PROMISING TECHNOLOGY TO SUPPORT THE EDUCATIONAL PROCESS</b> .....	276
<b>POLICIES FOR AI IN EDUCATION</b> .....	277
<b>AI ENABLES ADAPTIVITY IN LEARNING</b> .....	279
<b>INDIAN EDUCATION SYSTEM AND ARTIFICIAL INTELLIGENCE</b> .....	280
<b>ARTIFICIAL INTELLIGENCE: PROMISING APPLICATIONS AND POTENTIAL EFFECTIVENESS</b> .....	281
Personalized Learning Opportunity .....	281
Delivery of Quality Content .....	282
Remote Learning .....	282

Curriculum Upgradation .....	283
Droupouts Management .....	283
Assessment Grading .....	283
Research Activities .....	283
<b>CONCLUDING REMARKS</b> .....	283
<b>REFERENCES</b> .....	284
<b>SUBJECT INDEX</b> .....	288

## Artificial Intelligence Assisted Teaching and Learning and Research of Environmental Sciences

Tahmeena Khan<sup>1,\*</sup>, Priya Mishra<sup>2</sup>, Kulsum Hashmi<sup>2</sup>, Saman Raza<sup>2</sup>, Manisha Singh<sup>3</sup>, Seema Joshi<sup>2</sup> and Abdul Rahman Khan<sup>1</sup>

<sup>1</sup> Department of Chemistry, Integral University, Lucknow, U.P., India

<sup>2</sup> Department of Chemistry, Isabella Thoburn College, Lucknow, U.P., India

<sup>3</sup> Department of Education, Integral University, Lucknow, U.P., India

**Abstract:** Artificial intelligence (AI) has become the latest tool in facilitating the computer-assisted teaching-learning process. The AI-based teaching system is viewed as a personalized one-on-one student-teacher interaction. AI in education is becoming more common and has received a lot of attention recently. This growing interest is likely to have a big impact on higher education. Many educators and educational authorities are considering integrating AI topics into K-12 curricula, to provide school students with insights into these evolving technologies. Recent studies on AI curricula have mostly concentrated on identifying which AI tools are better for student learning and what subject matter knowledge and abilities need to be taught. Since the goal of these studies was to promote information, they designed their curriculum with appropriate content, effective delivery methods, and strategies to increase students' competency levels. Environmental education seeks to explore natural processes and foster the development of skills and attitudes geared towards sustainability and the protection of the environment. Recently, AI has been widely used in geological, environmental, and related research. It can also assist in the exploration of energy resources and minerals. The use of AI in education teaching-learning and academic achievement has been elucidated in this chapter. This chapter also aims to explore the role of AI-assisted teaching of environmental sciences and how it impacts the overall learning experience. Understanding the role of AI in environmental sciences is very important as it can address crucial problems like climate change, early prediction of natural disasters, and many others. Currently, there is a need to develop accurate models at an affordable time and cost. Other than research, the implementation of AI in environmental education can lead to a change in students' aptitude and interest and can help in the development of sensitivity towards environmental protection.

**Keywords:** AI, Biosphere, Cyclones, Earthquakes, Teaching-learning, Environmental education, Landslides.

---

\* Corresponding author Tahmeena Khan: Department of Chemistry, Integral University, Lucknow, U.P., India; E-mail: tahminakhan30@yahoo.com