Dedicated

To

My Beloved Parents

&

Siblings

DECLARATION

I hereby declare that the thesis entitled **"Transformative Reactions Involving Carbon-Hetero and Carbon-Carbon Bond Formations"** has been prepared by me with the guidance of Professor Pranab Ghosh, from the Chemistry Department at the University of North Bengal. None of the content in this thesis has been previously used to obtain any degree or fellowship.

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CERTIFICATE

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Thank You.

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PREFACE

Carbon-hetero and Carbon-Carbon bond formation reactions are widely used in the synthesis of various biological and pharmaceutically important compounds. These reactions are also valuable in agrochemical industries. They are powerful tools for the synthesis of naturally occurring biologically active compounds such as amino acids, glycosides, and heterocyclic compounds.

This work describes methodologies for the synthesis of a vast range of bioactive molecules containing carbon-hetero and carbon-carbon bonds. The thesis begins with **Chapter I,** which provides a brief review of various approaches to the reaction methodology for carbon-hetero and carbon-carbon bond formation.

Chapter II presents an efficient, green, and bio-compatible reaction medium for the metal-free synthesis of functionalized 1,4-benzothiazine derivatives from 2-amino thiophenol and 1,3-diketone derivatives in a one-pot, two-component pathway.

Chapter III demonstrates a methodology for solvent and metal catalyst-free molecular iodine-catalyzed C(Sp^2)-H sulfenylation of biologically active enaminone compounds under mechanochemical conditions, as well as studies on their biological activity, including molecular docking and DFT.

Chapter IV is divided into three sections**.** **Section A** illustrates synthesis of biologically active diaryl sulfide, **Section B** provides the method of formation for biologically active propargylamine derivatives and **Section C** Studies of diaryl sulfide and propargylamine derivatives on their biocidal activity including molecular docking and DFT studies for anti-diabetic activity.

Finally, **Chapter V** illustrates the synthesis of pharmaceutical and biologically active polyhydroquinoline derivatives using a newly synthesized Cu-Schiff base complex.

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LIST OF APPENDICES

APPENDIX A

List of Research Publications

APPENDIX B

Poster Presentations

APPENDIX A

List of Research Publications (Related to thesis work)

1. One pot three component tandem annulation of 4-hydroxycoumarine with aldehyde and aromatic amines using graphene oxide as an efficient catalyst, Rabindranath Singha, **Aminul Islam** & Pranab Ghosh*, *Scientific Reports*, 2021,11,19891.
2. Polyethylene Glycol (PEG-200): An Efficient, Green and Biocompatible Reaction Medium for the Metal-Free Synthesis of Functionalized 1, 4-Benzothiazines, **Aminul Islam**, Rabindranath Singha & Pranab Ghosh*, *ChemistrySelect*, 2023, 8, e202203780.
3. Molecular iodine catalyzed C(sp2)–H sulfenylation of biologically active enaminone compounds under mechanochemical conditions and studies on their biocidal activity including molecular docking and DFT, **Aminul Islam**, Prasun Choudhury, Kaushik Sarkar, Rajesh Kumar Das, Malay Bhattacharya and Pranab Ghosh*, *Molecular Diversity*, 2023,https://doi.org/10.1007/s11030-023-10677-9.

List of Research work(communicated)

1. CoFeLDH for enhancement of catalytic activity for the formation of biologically active diaryl sulfide and propargylamine derivatives and studies on their biocidal activity including molecular docking and DFT studies for anti-diabetic activity, **Aminul Islam,** Rabindranath Singha, Susanta Kumar Saha, Kaushik Sarkar, Rajesh Kumar Das, Sudeshna Nandi, Tania Baishya, Ranabir Sahu, Malay Bhattacharya, Mayukh Deb and Pranab Ghosh*. Communicated to OBC, (*RSC*), Manuscript ID: OB-ART-07-2023-001131
2. Synthesis of biologically active polyhydroquinolines derivatives using newly synthesized Cu-Schiff base complex, **Aminul Islam**, Kakoli Malakar, Marappan Velusamy and Pranab Ghosh*. Communicated to *ACS Catalysis*, Manuscript ID: cs-202400634a

APPENDIX B

Poster Presentations

1. Novel Greener protocol for one-pot three-component tandem annulation of 4-hydroxycoumarine with aldehyde and aromatic amines using Graphene oxide as an efficient catalyst, Held on Department of Chemistry, University of North Bengal, International seminar on "*Frontiers in Chemistry & Prof. C. N. Rao Endowment Lecture-2023*".
2. Novel Greener protocol for one pot synthesis of biologically potent 1,4-Benzothiazines, Organized by Institution's Innovation council (IIC), University of North Bengal on "*Global Science for Global wellbeing*-2023"
3. Greener approach for the synthesis of diaryl sulfide, Held on Department of Chemistry, University of North Bengal, National seminar on "*Frontiers in Chemistry-2019*"

ABBREVIATION

AChE	acetylcholinesterase
AChEI	acetylcholinesterase inhibitor
AD	Alzheimer's disease
[bmim][OTf]	1-Butyl-3-methyl-imidazolium-trifluoromethanesulphonate
BBB	blood-brain barrier
Bipy	2,2′-Bipyridine
BnCl	Benzoyl chloride
Boc	tert-butyl oxycarbonyl
Bs	Benzothiazine
CAS	catalytic active site
Cbz	benzyl chlorocarbonate
CFLs	Compact fluorescent lamps
ChE	cholinesterase
cm	centimeter
d	doublet
DABCO	1,4-diazabicyclo[2.2. 2]octane
DAT	dopamine transporter
DCE	1, 2 dichloroethane
DCM	Dichloromethane
DFT	Density functional theory
DiPPF	1,1'-bis(diisopropylphosphino)ferrocene
DMAc	Dimethylacetamide
DMEDA	N, N-dimethyl ethylenediamine
DMF	Dimethylformamide
DMPAO	2-(2,6-dimethylphenylamino)-2-oxoacetic acid
DMSO	Dimethyl sulfoxide
DPEphos	Bis[(2-diphenylphosphino)phenyl] ether
DPPH	2,2-Diphenyl-1-picrylhydrazyl

EL	ethyl lactate
Equiv	Equivalent
EWD	electron withdrawing group
Fmoc	fluorenylmethoxycarbonyl
FT-IR	Fourier-transform infrared spectroscopy
g	gram/grams
GI	Gastrointestinal
h	hour/hours
HIA	human intestinal absorbance
HIV	Human immunodeficiency virus
HOMO	Highest occupied molecular orbital
HPA	heteropoly acids
HPLC	High-performance/pressure liquid chromatography
HRMS	High-resolution mass spectrometry
HSVM	high-speed vibration mill
IPA	Isopropyl alcohol
IL	Ionic liquid
LDA	Lithium diisopropylamide
LDHs	Layered double hydroxides
L-DOPA	levodopa and l-3,4-dihydroxyphenylalanine
LED	Light-emitting diode
LUMO	Least unoccupied molecular orbital
m	multiplet
MAO	monoamine oxidase
MCR	multi component reaction
MeCN	methyl cyanide
mg	miligram
MH	Mueller-Hinton
MHz	Megahertz
MIC	Minimum inhibitory concentrations

min	minute/minutes
mL	millilitre
mm	millimeter
MM	mechanical milling
mmol	millimole
µM	micrometer
MNPs	Magnetic nanoparticles
MP	Melting point
MW	microwave
NET	norepinephrine transporter
NHPI	N-hydroxyphthalimide
nm	nanometer
NMP	N-Methylpyrrolidone
NMR	Nuclear Magnetic Resonance
NPs	nanoparticles
°C	degrees Celsius
PAS	peripheral anionic site
PCM	phase change materials
PD	Parkinson's disease
PEG	Polyethylene glycol
PHQ	Polyhydroquinoline
PMA	phosphomolybdic acid
PPA	polyphosphoric acid
PPh_3	triphenylphosphine
RB	Rose Bengal
RMSD	Root mean square deviation
rpm	rotations per minute
rt	room temperature
s	singlet
SEM	Scanning electron microscopy

SERT	serotonin transporter
SDS	Sodium dodecyl sulfate
SRL	Sisco Research Laboratories
SSA	solid-supported acid
t	triplet
^{t}BuONa	Sodium tert-butoxide
TBHP	tert-Butyl Hydroperoxide
TCI	Tokyo Chemical Industry
TEM	Transmission electron microscopy
TEMPO	2, 2, 6, 6-tetramethyl-1-piperidinyloxy
TFA	Trifluoroacetic acid
THF	tetrahydrofuran
TLC	thin-layer chromatography
TMS	tetramethylsilane
TMSCN	Trimethylsilyl cyanide
TON	Turnover Number
TPSA	topological polar surface area
TR	trypanothione reductase
TSIL	task-specific ionic liquid
UNCA	urethane-protected α-amino acid N-carboxyanhydride
V	Voltage
VSM	Vibrating sample magnetometry
W	watts
XRD	X-ray diffraction