1.0 Introduction regarding multi-step sequential or cascade reactions

In the last two to three decades, multi-step sequential or cascade reactions are considered as a powerful tool to construct the fine chemicals and pharmaceuticals.\(^1\) The significant research has been focused on the development of new methodologies wherein two or more synthetic steps can be accomplished in one-pot multi-step sequential or cascade reactions. These reactions offer a number of advantages such as,

- operational simplicity,
- minimisation of waste, and
- use of lesser solvents.

These advantages are attractive for both environmental and economic reasons. The importance of these methods is clearly reflected by the number of publications and reviews came in this area in highly reputed peer-reviewed journals.

1.1 Transition-metals catalyzed cascade or sequential reactions

Metal catalysis have further revolutionised organic syntheses and also found considerable applications in the sphere of sequential reactions. Many transformations are known where transition-metal catalysts are used to construct more than one bond.\(^2\) Initially, most of such reactions are known with palladium metal only. One such reaction was developed by de Meijere, wherein palladium catalyzed two cross-coupling reactions have been carried out, the first coupling with vinyl triflate and the second with vinyl bromide (Scheme 1).\(^3\) This transformation is an example of a consecutive reaction, as the protocol requires both sequential addition of reagents and also a change in reaction conditions in order to affect the Heck coupling in the second step.
Scheme 1. Palladium catalyzed sequential reaction.

Transition-metal such as ruthenium catalyses two or more transformations that are fundamentally different in nature. In these cases, either addition of a new reagent or a change in the conditions, changes the catalytic nature of in such a way that it may no longer mediate the first reaction, but remains catalytically active as demanded for the next step. The examples of such reactions are Grubbs metathesis reaction, wherein Grubbs demonstrated that the use of either first or second generation metathesis catalysts mediated either ring-closing or cross-metathesis followed by hydrogenation (Scheme 2).

Scheme 2. Ruthenium catalyzed sequential reaction.

In addition to these, rhodium catalysis has also been successfully used for the multi-step sequential reactions and one of the finest examples being developed by Evans and Robinson, wherein rhodium(I) complexes were applied for first allylic alkylation and then Pauson-
Khand cyclo-addition reaction (PKR) in a one-pot process to construct bicyclic cyclopentenone (Scheme 3).

Scheme 3. Rhodium catalyzed sequential reaction.

Similarly, activated manganese has been extensively used for multi-step sequential reactions.\(^8\) One such example developed by Taylor et al.,\(^9\) involved the tandem oxidation-Wittig homologation in one-pot (Scheme 4), which circumvent the problems associated with the highly reactive bromoenal intermediate.

Scheme 4. Manganese catalyzed sequential reaction.

The use of manganese in tandem reactions has been exploited further for the synthesis of diverse range of products from activated primary alcohols via trapping of the intermediate aldehydes with various nucleophiles such as amines,\(^{10}\) heterocycles\(^{11}\) and cyclopropanes.\(^{12}\)

The application of these reactions in organic synthesis has attracted the attention of chemistry community, and number of such transformations are reported with various transition-metal catalysts. Moreover, the increasing understanding of mechanisms of transition-metal catalyzed reactions, will certainly lead to the involvement of multi-step sequential or cascade reactions for the synthesis of complex natural, bio-active and functional molecules. This multifunctional catalysis provide not only invaluable tool for increasing complexity but also associated with practical benefits.
1.2 Transition-metal catalyzed cascade or sequential reactions for the synthesis of heterocycles

Heterocycles are pervasive structural elements in natural products, medicines, agricultural chemicals, and functional materials.\textsuperscript{13} As a result, the construction and functionalization of these is a central focus in organic synthesis and the transition-metal catalyzed multi-step cascade or sequential reactions have provided an effective alternative way for the synthesis of five and six-membered heterocycles. Buchwald developed a strategy for the direct construction of benzimidazoles \textit{via} a regio- and chemo-selective cascade of palladium-catalyzed C–N bond-forming reactions, which involve a 2-chloroaryl sulfonate (or similar substrate) and two discrete nitrogen based nucleophiles that are added at the same time (Scheme 5).\textsuperscript{14} This method represents a potentially powerful alternative approach to heterocycle synthesis and provides modular access to a broad range of functionalized benzimidazoles with predictable and potentially selectable regio-control.

![Scheme 5. Palladium catalyzed cascade reaction for the synthesis of benzimidazoles.](image)

Bolm \textit{et al.} reported the iron-catalyzed domino Sonogashira/cycloisomerization reaction for the synthesis of a variety of benzofurans (Scheme 6).\textsuperscript{15}
Scheme 6. Iron catalyzed sequential synthesis of benzofurans.

Lautens developed palladium-catalyzed sequential alkylation-alkenylation reaction, which was used for the synthesis of substituted-benzoxepines (Scheme 7).\textsuperscript{16}

Scheme 7. Pd-catalyzed sequential synthesis of benzoxepines.

Subsequently, Lautens \textit{et al.} developed a norbornene-mediated palladium-catalyzed sequential reaction in which two alkyl–aryl bonds and one alkenyl–aryl bond are formed in one-pot (Scheme 8).\textsuperscript{17} A variety of symmetrical and unsymmetrical oxygen-, nitrogen-, silicon-, and sulfur-containing tricyclic heterocycles were synthesized from a Heck acceptor and an aryl iodide containing two tethered alkyl halides. This approach was further applied to the synthesis of a tricyclic mescaline analogue.
Scheme 8. Pd-catalyzed sequential synthesis of heterocycles.

Schmalz et al. developed Rh-catalyzed cascade reaction route for the synthesis of anti-mitotic alkaloids, such as (−)-colchicine and (−)-isocolchicine (Scheme 9), wherein Rh-catalyzed transformation of α-diazoketone into an oxatetrcyclic key intermediate through intramolecular [3 + 2]-cycloaddition of an in situ generated carbonyl ylide was carried out, which further underwent regio-selectively into a tropolone derivative.

Scheme 9. Rh-catalyzed cascade reaction for the synthesis of anti-mitotic alkaloids.
Takemoto et al. developed an efficient method for the stereoselective synthesis of various (E)-, (Z)-, and di-substituted-3-alkylideneoxindoles and 3-alkylidenebenzofuran-2-ones via palladium-catalyzed Heck/Suzuki–Miyaura, Heck/Heck, and Heck/carbonylation/Suzuki–Miyaura domino reactions (Scheme 10).\textsuperscript{19}

Scheme 10. Pd-catalyzed domino reaction for the synthesis of oxindoles/benzofuran-2-ones.

Jana et al. developed an iron-catalyzed domino isomerization/cyclodehydration sequences for the synthesis of substituted benzo[b]carbazoles. The substrates in turn were synthesized by Pd-catalyzed domino Heck–Suzuki coupling from 2-bromo-N-propargylanilide derivatives (Scheme 11).\textsuperscript{20}
Scheme 11. Fe-catalyzed domino reaction for the synthesis of benzo[b]carbazoles.

Arcadi et al. developed palladium-catalyzed cascade reaction of 1-(3-arylprop-2ynyloxy)-2-bromobenzene derivatives with organoboron compounds for the synthesis of benzofuran derivatives, wherein first cyclocarbopalladation reaction with readily available aryl-substituted propargylic aryl ethers occurs, followed by Suzuki–Miyaura coupling reactions with aryloboronic acid and potassium trans-β-styryltrifluoroborate lead to the synthesis of benzofuran derivatives (scheme 12). 21

Scheme 12. Pd-catalyzed cascade reaction for the synthesis of benzofuran derivatives.

Wang et al. developed an iron-catalyzed cascade reaction for the synthesis of 5H-benzo[b]carbazole derivatives, wherein first 5-exo-dig cyclization take place followed by
electrocyclization and then unprecedented [1,4]-tosyl migration from nitrogen to oxygen occurs leading to the formation of carbazole derivatives (Scheme 13).\textsuperscript{22}

![Scheme 13](image)

**Scheme 13.** Fe-catalyzed cascade reaction for the synthesis of 5\textit{H}-benzo[\textit{b}]carbazoles.

Gulea and Suffert have developed cascade reaction for the synthesis of sulfur heterocycles, wherein first cyclocarbopalladation followed by Stille or Suzuki–Miyaura cross-coupling was involved for the synthesis of sulphur heterocycles such as benzothiolane and isothiochromane with a stereodefined tetrasubstituted exocyclic double bond. The authors also demonstrated the application of this method by synthesizing a sulfur analogue of the anticancer agent tamoxifen (Scheme 14).\textsuperscript{23}

![Scheme 14](image)

**Scheme 14.** Pd-catalyzed cascade reaction for the synthesis of sulphur heterocycles.

Larock and co-workers developed a gold-catalyzed cascade reaction of 2-alkynylenones in the presence of external nucleophiles for the synthesis of heterocycles. The cascade reaction started with the activation of C–C triple bond followed by nucleophilic attack of the carbonyl function to produce a cyclic oxonium intermediate. An intermolecular nucleophilic addition of an external nucleophile at the activated enone moiety leads to a
furyl–[M] species which finally undergoes proto-deauration leading to furans and regenerates the catalyst (Scheme 15).

**Scheme 15.** Au-catalyzed cascade reaction for the synthesis of substituted furans.
Scheme 16. Au-catalyzed cascade reaction for the synthesis of substituted furans.

Wang and Zhang developed a gold catalyzed cascade reaction of 3-(1-alkynyl)-2-alken-1-ones for the synthesis of trisubstituted 2-acylfurans (Scheme 16). The gold-activated alkyne generate intermediate and its resonance form gold carbene. In the presence of H₂O₂, the gold carbene intermediate gives 2-acylfuran and regenerate the catalyst to finish the catalytic cycle.

Zhang et al. also reported the Au-catalyzed cascade synthesis of substituted pyrroles starting from oximes of 2-(1-alkynyl)-alk-2-en-1-ones (Scheme 17).

Scheme 17. Au-catalyzed cascade reaction for the synthesis of substituted pyrroles.

Wolfe has developed a Pd-catalyzed cascade reaction between aryl bromides and amines bearing pendant alkenes for the construction of nitrogen heterocycles (Scheme 18). The reaction proceed via intramolecular alkene aminopalladation of palladium(aryl)(amido) complex to yield intermediate, which undergoes reductive elimination to the substituted indolines.
Copper catalyzed cascade reactions for the synthesis of heterocycles

Copper being in-expensive and comparatively milder represents another efficient catalyst apart from expensive systems such as Pd, Ru, Rd etc. As catalytic cascade reactions have become one of the most active and burgeoning reactions in organic syntheses and also copper has been exploited in cascade reactions for synthesizing a wide range of heterocycles including valuable compounds such as drugs and natural products. Here, we are describing some of the literature reported copper catalyzed cascade reactions.

Copper catalyzed click chemistry for the cycloaddition reaction between alkyl or aryl azides and terminal alkynes is highly explored, wherein Cu(I) catalyst accelerate the Huisgen thermal reaction with perfect control of the mechanistic pathway to lead only to 1,4-disubstituted-1,2,3-triazoles. This reaction proceeds through the formation of a copper(I)–acetylide from the reaction of copper(I) catalyst with terminal alkyne, followed by cycloaddition with a copper(I)-bound azide to generate a triazolyl copper(I) complex, which is released by protonation of the Cu-C bond. In another prespective, recently, it was demonstrated that the CuAAC reaction of sulfonyl or phosphoryl azides with terminal alkynes could form reactive ketenimine species, which could be trapped by a range of nucleophiles. As a result, the copper catalyzed multicomponent reaction of azides, terminal alkynes, and nucleophiles have been formulated as shown in Scheme 19.28
Wang et al. first time applied this approach for the synthesis of heterocyclic compounds, wherein dual functionalized reagents (with both electron-rich and electron-deficient groups) were used to trap the in situ generated ketenimine intermediates, a cascade nucleophilic addition/annulation process could occur to afford heterocyclic compounds. The three-component reaction between terminal alkynes, sulfonyl azides, and salicylaldehydes or o-hydroxylacetophenones lead to the synthesis of substituted iminocoumarins (Scheme 20). The cascade process involves a nucleophilic addition of phenolic oxygen anion to the in situ generated ketenimine and subsequent intramolecular cyclization.
Scheme 20. Cu-catalyzed cascade reaction for the synthesis of iminocoumarins.

Cui et al. developed another copper catalyzed cascade reaction of in situ generated ketenimine with dual-functionalized reagents such as 2-acylaziridines. In this case, a three-component synthesis of 2-imino-5-arylidene-3-pyrrolines was successfully achieved (Scheme 21).30

Scheme 21. Cu-catalyzed cascade reaction for the synthesis of substituted pyrrolines.
Whiting and Fokin developed a cascade reaction which involves cycloaddition of ketenimine (Scheme 22).\textsuperscript{31} Here, copper-catalyzed reaction of imines with terminal alkynes and sulfonyl azides undergoes a [2+2] cycloaddition of imines to the \textit{in situ} generated ketenimine, producing \textit{N}-sulfonylazetidin-2-imines with both high regioselectivity and stereoselectivity in favor of the \textit{trans}-configuration.

\textbf{Scheme 22.} Cu-catalyzed cascade reaction for the synthesis of substituted azetidines.

Li \textit{et al.} developed a cascade reaction involving 1,3-dipolar cycloaddition of ketenimine with \textit{N'}-(2-alkynylbenzylidene)hydrazide to afford 2-amino-pyrazolo[5,1-\textit{a}] isoquinolines in good to excellent yields (Scheme 23).\textsuperscript{32}

\textbf{Scheme 23.} Cu-catalyzed cascade reaction for the synthesis of pyrazolo[5,1-\textit{a}] isoquinolines.
Ohno *et al.* developed Cu(I)-catalyzed three-component cascade coupling which involve coupling/cyclization reactions towards the synthesis of 2-(aminomethyl)indoles (Scheme 24). \(^{33}\)

![Scheme 24](image)

**Scheme 24.** Cu-catalyzed cascade reaction for the synthesis of substituted indoles.

Ohno *et al.* also developed Cu(I)-catalyzed domino three-component coupling/cyclization/N-arylation reaction, which provided a concise synthesis of indole-fused 1,4-diazepines (Scheme 25). \(^{34}\)

![Scheme 25](image)

**Scheme 25.** Cu-catalyzed cascade reaction for the synthesis of indole-fused 1,4-diazepines.
Zhou et al. reported copper-catalyzed cascade reaction of isocyanides with N-(2-haloaryl)propiolamides for the synthesis of pyrrolo[3,2-c]quinolin-4-ones, wherein α-cuprioisocynanide intermediate was first formed (Scheme 26).\(^{35}\)

**Scheme 26.** Cu-catalyzed cascade reaction for the synthesis of pyrrolo[3,2-c]quinolin-4-ones.

Cai et al. have developed copper-catalyzed cascade reaction of 1-(2-iodoaryl)-2-yn-1-ones with isocyanides for the synthesis of 4-oxo-indeno[1,2-b]pyrroles (Scheme 27).\(^{36}\) These reactions involve a formal [3+2] cycloaddtion/intramolecular coupling process.

**Scheme 27.** Cu-catalyzed cascade reaction for the synthesis of indeno[1,2-b]pyrroles.

Ma et al. developed a copper-catalyzed cascade condensation/S-arylation/heterocyclization for the three-component synthesis of 2-N-substituted
benzothiazoles from amines, carbon disulfide, and 2-haloanilines (Scheme 28). The first step involves the reaction between amine and carbon disulfide in the presence of base to form dithiocarbamate salt, which then undergoes Cu-catalyzed C-S coupling reaction with 2-haloanilines, followed by intramolecular condensation to produce benzothiazoles.

![Scheme 28. Cu-catalyzed cascade reaction for the synthesis of benzothiazoles.](image)

Similarly, Kim et al. developed a process involving Cu-catalyzed three-component coupling for the synthesis of benzimidazoles from 2-haloanilines, aldehydes, and NaN\(_3\) (Scheme 29).  

![Scheme 29. Cu-catalyzed cascade reaction for the synthesis of benzimidazoles.](image)
Barluenga et al. developed [Cu(CH$_3$CN)$_4$][BF$_4$]-catalyzed cascade reaction, wherein vinyl diazoacetates readily undergo a copper(I)-catalyzed cyclopropanation with another diazo compound, followed by copper(I)-catalyzed ring expansion of the cyclopropane intermediate to generate substituted cyclobutenes (Scheme 30).\(^{39}\)

**Scheme 30.** Cu-catalyzed cascade reaction for the synthesis of substituted cyclobutenes.

Barluenga further extended above method with iminoiodinanes, which lead to the generation of substituted 2-azetines (Scheme 31).\(^{40}\) The process is plausibly initiated by the aziridination of the C=C functionality by metal bound nitrene, which forms a key aziridinyldiazoacetate intermediate. The intermediate undergoes copper-catalyzed decomposition to copper-aziridinylcarbene, followed by selective [1,2]-amino rearrangement to give 2-azetines.

**Scheme 31.** Cu-catalyzed cascade reaction for the synthesis of substituted 2-azetines.

Peng et al. developed a copper catalyzed cascade reaction between propargyl containing $\alpha$-diazoesters and amine for the preparation of isoindoles (Scheme 32).\(^{41}\)
Scheme 32. Cu-catalyzed cascade reaction for the synthesis of isoindoles.

Wang’s group reported a copper-catalyzed three-component reaction of α-diazoketones with amines and nitroalkenes under aerobic conditions (Scheme 33). The cascade reaction follows a sequence of an N-H insertion, a copper-catalyzed oxidative dehydrogenation of amine, a [3+2] cycloaddition, and finally, an elimination of HNO₂/dehydrogenation, affording a variety of polysubstituted pyrroles.

Scheme 33. Cu-catalyzed cascade reaction for the synthesis of polysubstituted pyrroles.

Yang et al. have developed copper catalyzed cascade reaction of o-haloacetanilide with amidine hydrochlorides, wherein sequential coupling of o-haloacetanilide derivatives with amidines followed by hydrolysis (amides), and intramolecular cyclization with the loss of NH₃, yielded 2-substituted-1H-benzimidazoles (Scheme 34).
Scheme 34. Cu-catalyzed cascade reaction for the synthesis of substituted benzimidazoles.

Venkataraman *et al.* have reported the copper-catalyzed domino Sonogashira/cycloisomerization reaction for the synthesis of a variety of benzofurans (Scheme 35).\(^\text{44}\)

Scheme 35. Copper catalyzed sequential reaction for the synthesis of benzofurans.

Rolfe and Hanson developed a sequential one-pot protocol for the synthesis of benzothiadiazine-3-one-1,1-dioxides, utilizing a microwave-mediated copper-catalyzed \(N\)-arylation strategy (Scheme 36).\(^\text{45}\) The sulfonamides were reacted with three different amines using copper(I) iodide/1,10-phenanthroline as catalyst/ligand system.

Scheme 36. Copper catalyzed sequential reaction for the synthesis of benzothiadiazine-3-one-1,1-dioxides.
1.4 Mercury catalyzed cascade reactions for the synthesis of heterocycles

One of the most famous reactions of mercury salts is the solvomercuration-demercuration reaction which has been highly exploited for the synthesis of functionalized molecules. Mercury salts have some environmental-friendly issues, however, despite having those issues, still mercury salts are used in many important and useful organic transformations. Here, we are describing some of the literature reported mercury catalyzed cascade reactions.

Reddy et al. have developed a mercury catalyzed electrophilic cyclization (hydroxyl-assisted regioselective hydration) for the conversion of 4-bromo-3-yn-1-ols to γ-butyrolactones (Scheme 37).\(^{46}\) The various secondary and tertiary alcohols including benzylic systems were found to be equally reactive and gave moderate to excellent yields.

Kim et al. synthesized 3-alkylaminothiophenes from the reaction of ketene \(N,S\)-acetals with 1,3-dicarbonyl compounds in the presence of mercury(II) acetate (Scheme 38).\(^{47}\)

Marson and Campbell have developed a ring expansion method for the synthesis of thiophene-2-methanol from episulfide in the presence of catalytic amount of mercury(II) oxide in dilute sulfuric acid at room temperature (Scheme 39).\(^{48}\)

Tso and Tsay developed a cascade route for the synthesis of substituted furans by way of \([3+2]\) annulation of 3-methoxy-1-phenylthio-1-propyne with aldehydes (Scheme 40),\(^{49}\) wherein sequence of hydroxyalkylation/alkylation and mercury catalyzed cyclization take place in one-pot strategy.
Scheme 37. Mercury catalyzed synthesis of benzothiadiazine-3-one-1,1-dioxides.

Scheme 38. Mercury catalyzed synthesis of substituted benzo thiophenes.
Zhabanko and Maier developed a mercury catalyzed cascade spirocyclization reaction of 1,3-enynediols for the synthesis of highly useful [5,6]-spiroacetals (Scheme 41).^50
Scheme 41. Mercury catalyzed synthesis of [5,6]-spiroacetals.

Lin et al. have developed a mercury-catalyzed cyclization reaction to provide 3-benzoylbenzo[b]thiophenes in good yields by the treatment of 2-alkynylphenyl alkyl sulfoxides with mercury chloride and 2,3-dichloro-5,6-dicyano-1,4-benzoquinone (DDQ) in benzene at reflux temperature (Scheme 42). The proposed reaction mechanism is still not fully clear at this stage and further studies are needed to conclude the reaction mechanism.51

Scheme 42. Mercury catalyzed synthesis of benzoylbenzo[b]thiophenes.
Apart from these, the mercury catalyzed solvomercuration-demercuration of alkenes is considered as one of the most important synthetic method for the synthesis of important synthons. In this direction, several approaches have been performed towards the addition of different nucleophiles using mercury(II) salt followed by sodium borohydride reduction to give the corresponding functionalized compounds. These mercuration-demercuration process provides a new, convenient, and general method for the Markovnikov addition of diverse nucleophiles on carbon-carbon double bonds.

A significant progress has been made in the fields of transition-metal catalyzed cascade reactions. More importantly, these transition metal catalysts are critically important in numerous commercial chemical processes, particularly towards the synthesis of many biological, pharmaceutical and natural-occurring compounds. Discoveries of new cascade processes along with improvements in the known, low-yielding processes further increase the sustainability of these reactions. From the view point of practical applications, copper represent one of the most abundant metals on Earth and, consequently, inexpensive and environmentally friendly and therefore, the development and applications of copper-catalyzed cascade reactions are becoming a thriving area of organic synthesis chemistry. Based on these facts, the development of novel copper catalyzed methods for the synthesis of biologically active heterocycles has been presented in the thesis.

Moreover, inspite of toxic issues, the catalytic property of mercury salts couldn’t be ignored and one can find in the present thesis, how mercury salts has been exploited for the synthesis of medicinaly previledge structures, such as piperazines and morpholines.
Chapter 1

1.5 Aim and outline of the thesis

The thesis describes the chemistry regarding transition metal catalyzed cascade reactions for the synthesis of functionalized heterocyclic compounds of biological importance, and comprising of three chapters.

Chapter 1 describes the introduction regarding cascade or sequential reactions and metal catalyzed cascade reactions and their role in the synthesis of heterocycles. In addition to this, copper and mercury catalyzed cascade reactions and their role in the synthesis of heterocycles are discussed in depth.

Chapter 2 describes new copper catalyzed reactions for the synthesis of different biologically active heterocycles and further comprises of three sections:

In Section 2.1, a new copper-catalyzed method for the synthesis of 2,5-disubstituted furans has been described. Ligand-free, copper(II)acetate/TBHP catalyzed novel method has been developed from readily available terminal acetylenes, which works under open atmosphere. The present method works well with both aromatic and aliphatic terminal acetylenic compounds and number of aryl/heteroaryl/alkylsubstituted furans have been synthesized under the optimized conditions. The section is organized by starting with brief introduction about furan, biologically important furans containing compounds, available methods for their synthesis and present work along with experimental section and references.

In Section 2.2, we have reported new copper-catalyzed method for the synthesis of 2,5-disubstituted thiophenes. Ligand-free copper(II)acetate/TBHP catalyzed novel method has been developed from readily available terminal acetylenes and sodium sulphide, and works under open atmosphere. The readily and economical available Na₂S provide the source of sulphur atom for thiophenes. This method works well with both aromatic and aliphatic terminal acetylenic compounds and number of aryl/heteroaryl/alkylsubstituted thiophenes have been synthesized under the optimized conditions. The section is organized by starting with brief introduction about thiophenes, biologically important thiophene containing
compounds, available methods for their synthesis and present work along with experimental section and references.

In section 2.3, a mild, simple, and general method has been reported for the synthesis of biologically important phenazines by cross-coupling of benzoquinones with o-phenylenediamines. Benzoquinones and o-phenylenediamines react smoothly to give the corresponding cross-coupled products in good to excellent yields. 1,4-Naphthoquinone also undergoes coupling with o-phenylenediamines in the presence of copper acetate at 50 °C to give the corresponding benzo[a]phenazines. All the reactions were carried out under air atmosphere. The section is organized by starting with brief introduction about phenazines, biologically important phenazine containing compounds, available methods for their synthesis and present work along with experimental section and references.

Chapter 3 describes new mercury salt mediated reactions for the synthesis of biological active heterocycles and comprises of two sections:

In Section 3.1, a new mercuric salts mediated one-pot method for the synthesis of previdleged scaffold namely piperazines is described, wherein oxidative diamination of alkenes with suitable diamine has been optimized under mercuric salt conditions. Both mono-substituted and di-substituted alkenes were successfully employed for the coupling reaction. The section is organized by starting with brief introduction about piperazine, biologically impotant piperazine containing compounds, available methods for their synthesis and present work along with experimental section and references.

In Section 3.2, a new mercuric salts mediated one-pot method for the synthesis of another previdleged scaffolds namely morpholines is described via oxidative oxyamination of alkenes with N-protected ethanolamine. Both mono-substituted and di-substituted alkenes were successfully employed for the coupling reaction. Various substituted styrene bearing electron-donating and electron-withdrawing groups are also successfully used in the coupling reaction for the synthesis of substituted morpholines. The section is organized by starting with brief introduction about morpholines, biologically impotant morpohline
containing compounds, available methods for their synthesis and present work along with experimental section and references.
1.6 References:


