CHAPTER – I

Introduction and

Literature Survey
Over the past four decades, chemistry of coordination compounds has expanded and diversified considerably. The progress in the studies of metal complex chemistry was rapid, perhaps partly because of the utility and economic importance of metals and also because of an intrinsic interest in many of the compounds and the intellectual challenge of the structural problems to be solved. The backing of excellent theoretical approaches and modern sophisticated instrumental techniques facilitated this growth. Currently, the advent of computers exemplified by internet communication dramatically changed the style of research in this area. The overlapping of coordination chemistry and biological science is one where exciting and significant developments are taking place. Although most of the coordination compounds originally studied were purely inorganic in nature, the field has grown so greatly since then, the study of coordination compounds now includes a large area of organic chemistry and some domains of biochemistry as well.

The nature of coordination compound depends on the metal ion, the donor atom, the structure of the ligands and the metal-ligand interaction [1]. One of the most important problems in the coordination chemistry has been the nature and strength of metal-ligand bond. Normally, a metal ion does not form bonds of equal strength with two different donor atoms. Similarly, a particular donor atom does not form bonds of the same strength with different metal ions [2].

The coordination chemists are interested mainly in stereo chemical, thermodynamic, kinetic, spectral and magnetic properties of coordination compounds. Apart from these, there has been a growing interest in the role of the metal ions and their complexes in biological systems. It is a well known fact that, about six metals are vary much essential for human life even though they are present in ultra trace quantities. Alkali and alkaline earth metal complexes of crown ethers and cyclic ligands play an important role in the biological systems. The complexes of copper and iron are involved in biological systems as oxygen carriers; there is a growing interest in
understanding the mechanism of oxygen binding, structure of oxygen containing compounds and to develop synthetic oxygen carriers [3-5]. Similarly, involvement of molybdenum in nitrogenous enzymes leads to nitrogen carrying compounds that might be used in nitrogen fixation [6].

Recently, many applications have been developed, most important being in the field of catalysis and analytical chemistry. Iron complex [Fe₄(CO)₁₀NSiMe₄] used for the hydrogenation of methacrylate, 2,4-dimethylbutadiene, cyclobutene [7] etc. The complex [RhCl (PPh₄)₄] known as Wilkinson's catalyst is largely used in the homogeneous hydrogenation. It is highly active catalyst for the hydrogenation of alkenes [8]. Wilkinson et al have shown that, the complex [RhCl (PPh₄)₄] and complexes derived from it can be used for the preferential and related complexes have been used on the partial hydrogenation of soybean oil [9]. Molybdenum(VI) and Tungsten(VI) dioxo complexes have been used in the epoxidation of alkenes [10, 11].

Coordination chemistry has played major role in medicine and coordination compounds have been used in the treatment or diagnosis of diseases. In some cases, coordination compounds can be formed in the body to handle dysfunction due to metal poisoning. There are many principal areas for the use of transition metal complexes in medicine.

Many metal complexes of azo, formazan, azomethine, nitroso, anthraquinone and phthalocyanine ligands find an important application in the field of photography, catalysis and some modern high technology industries such as electronics. Some complexes are used as pigments and dyestuffs in textile and paper industry [3]. Recently, several phthalocynides have found new applications in electronics, piezoelectric and electrochemical devices, xerography, laser disc memory, photovoltaic cells and chemical sensors [6].

Hydrogen production using bi and polynuclear complexes of metalloporphyrins and metallophthalocyanides in the presence of visible light is attracted much interest as photo sensitizers for photo reduction of hydrogen from water [3]. The application of metal complexes in photolytic
decomposition for the production of hydrogen which stimulated the research for regenerating non-polluting fuel, that can be the ultimate solution to the future energy crisis faced throughout the world due to imminent exhaustion of the fossil fuels.

Coordination chemistry has also its greatest application in the field of hydrometallurgy. Use of carboxylic acid extractant to remove Fe(III) from solution of the earth metals has been reported. Versatic acid has been used for the production of pure Eu(III), La(III) and Y(III) oxides. Development of new water soluble chelating agents and their use as extracting agents via solvent extraction or ion exchange methods has tremendously helped the isolation of lanthanides and actinides and also separation of individual elements.

“The ever increasing application of metal complexes in various fields of science is the driving force for the research and development in coordination chemistry”.

**Triazoles**

1,2,4-Triazole display biological activity such as inhibition of cholinesterase, interference with mitosis and reversible denaturation of serum proteins [12] and its derivatives have become very useful compounds in medicine, agriculture and in many fields of technology [13]. The metal complexes of substituted 1,2,4-triazole derivatives have been extensively investigated in previous reports [14-16]. Recently, several complexes of various transition and inner transition metals with substituted 1,2,4-triazole ligands have been reported from our laboratory [17-20]. There is growing interest in the studies on the metal complexes of Schiff bases derived from substituted triazoles which are well known bactericides [21], pesticides [22], insecticides [23] and potential fungicides [24].

**Coumarins**

Coumarin (2H-1-benzopyran-2-one), a naturally occurring plant constituent, has been used in the treatment of cancer [25] and oedemas [26].
Many of its derivatives are known to possess anti-microbial activity and to act as scavengers of reactive oxygen species, such as hydroxyl, hypochlorous, or superoxide radicals. These properties enable coumarin derivatives and their metal complexes to play an important role in the development of new metal-based antibacterial and antifungal drugs, as well as Superoxide Dismutase (SOD) mimetics.

Schiff base complexes of transition metals are well known [27]. The structures of the Schiff-base ligands and their metal complexes were confirmed using spectroscopic methods (1H-NMR, 13C-NMR, IR, UV, magnetic, FAB-Mass and TGA) and elemental analyses.

A number of substituted coumarins were synthesised by the von Pechman reaction [28]. Isolation of suitable coumarins allowed the formation of Schiff bases via condensation with a number of aromatic aldehydes and amines. The Schiff base ligands were then reacted with a number of metal salts.

Thiazoles

Thiazole and substituted thiazoles possess interesting biological activity probably conferred to them by the strong aromaticity of their ring system [29] and also very interesting class of compounds because of their wide applications as antimicrobial [30], anti-inflammatory [31], anti-degenerative [32] and anti-HIV [33] activities. When diverse functional groups that interact with biological receptors are attached to this ring, compounds possessing outstanding properties could be obtained [34].

Macrocyclic Compounds

The field of coordination chemistry of macrocyclic complexes has undergone spectacular growth during the past few decades. This enormous growth is due to the synthesis of a large number and variety of synthetic macrocycles, which behave as coordinating agents for metal ions [35, 36]. Template reactions have been widely used as the synthetic routes for the macrocyclic complexes [37-39]. Nitrogen containing macrocycles have a
strong tendency to form stable complexes with transition metals [40]. Some macrocyclic complexes have been reported to exhibit antibacterial and antifungal activities [41, 42]. Macrocyclic nickel complexes find use in DNA recognition and oxidation [43], whereas macrocyclic copper complexes find use in DNA binding and cleavage [44].

Survey of the Previous Work

As the work embodied in the thesis mainly deals with the metal complexes of Schiff bases derived from triazoles, thiocarboxydrzone, 2-amino-4-phenyl-1,3-thiazole, coumarin and macrocyclic compounds, here, the discussion is confined to metal complexes of above mentioned compounds and their derivatives.

The tridentate Schiff bases with heterocyclic amines containing ONS donor sequence have been tried for complexation with transition metals such as Co(II), Ni(II), Cu(II), Zn(II) and Cd(II). Of these Cu(II) complexes, the ligand shows bivalent tridentate behavior and forms dimeric complexes, this has been substantiated by the subnormal magnetic moments and electronic spectra [45-48].

Garg et al., [49] have synthesized Co(II), Ni(II) and Cu(II) complexes of 5-mercapto-1,2,4-triazoles and they have assigned distorted octahedral geometry for these complexes.

Gadag and Gajendragad [50] have been prepared the nickel(II) and copper(II) complexes with 3-methyl and 3-ethyl derivatives of 4-amino-5-mercapto-1,2,4-triazole and they have high spin octahedral type configuration.

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Literature also records the complexing ability of 3-aryloxymethyl-4-aryl-5-mercapto-1,2,4-triazoles with bivalent metal ions [51]. In this case, x-ray studies reveal that, the complexes possess cubic structure and fungi toxicity of the complexes and the free ligands have been evaluated against *H. Oryzae*.

Pannu *et al*, [52] have been reported Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) complexes of 4n-butyl-4H-1,2,4-triazole, in which ligand shows bidentate behavior in all the complexes except those of Cd(II) and Hg(II).

Badiger and Patil *et al*, [53] have been reported the complexes of Co(II), Ni(II) and Cu(II) with 3-substituted-4-(4'-substituted-salicyldeneimino)-5-mercapto-1,2,4-triazoles and they have assigned the tetrahedral configuration for Co(II) and Ni(II) complexes on the basis of magnetic and spectral data. In case of Cu(II) complexes the ligand shows bivalent tridentate behavior involving O, N, S-donor system. All the complexes are four coordinated and polymeric nature.

Zaydoun *et al*, [54] have been reported the Mn(II), Fe(II), Co(II), Ni(II) and Cu(II) halide complexes with 1,2,4-triazoles. Their structures were discussed on the basis of electronic and magnetic data and they have assigned the pseudo-octahedral geometry for all the complexes. The complexes are polymeric and metallic ions are bridged by triazoles and halogens. The compounds studied generally exhibit antiferromagnetic coupling.
Jia-Cheng Liu and coworkers [55] have reported Cu(II) complexes with 1,2,4-triazole and end-on azido bridging ligands. They have assigned the Cu(II) ions are strongly antiferromagnetic nature on the basis of their magnetic and crystal structures.

Depree et al., [56] have been studied the Pb(II) and Cu(II) complexes with macrocyclic Schiff bases derived from [2+2] cyclisation reaction of 3,5-diacetyl-\(H^-\)-1,2,4-triazole and 1,3-diaminopropane using Pb(II) template ions. The macrocycle provides four nitrogen atoms, two imine and two triazolate donors as equatorial donor atoms to each of the two metal ions in the macrocycle. The Cu(II) complexes have been structurally characterized by X-Ray diffraction and three different structural types can be distinguished: monomeric, trimeric and polymeric.

Chohan et al., [57] used 1,1'-disubstituted ferrocenes have been prepared and used as chelating ligands in the preparation of Cu(II) compounds with a variety of anions such as nitrate, sulfate, oxalate, and acetate. These compounds have been characterized by physical, spectral, and analytical methods. Screening of these derivatives against pathogenic bacterial such as \(S.\) \(aureus\), \(E.\) \(coli\), \(P.\) \(aeruginosa\), and \(K.\) \(pneumonia\) showed all of them to possess varied bactericidal activity. The Cu(II) complexes were found to be consistent with the proposed square planar structure of the Cu(II) complexes.
Wesley R. Browne and coworkers [58] have reported the Ru(II) complexes with Schiff bases derived from 2,2'-bipyridine and H₂(Metr)₂ 2,5-bis(5'-methyl-4'H-[1,2,4]triaz-3'-yl)pyrazine. All these complexes have been characterized by various physico-chemical techniques. They have been very well explained about photoluminescence and photochemical reaction of above said complexes.

Recently Bhat et al., [59] have been studied the Ag(I), Tl(I), Zn(II), Hg(II), Cd(II), Pd(II), Co(II), and Ni(II) with 4-[(4-dimethylamino-benzylidene)-amino]-5-ethyl-2,4-dihydro-[1,2,4]triazoles-3-thione and 4-[(benzylidene)amino]-6-(t-butyl)-4H-[1,2,4-triazene-3-thione-5-one and they have been assigned the octahedral structures for the Co(II) and Ni(II), tetrahedral for the Zn(II), Hg(II), Cd(II) complexes, linear polymeric structures for the Ag(I), Tl(I) complexes and a square-planer structure for the Pd(II) complex.
Recently Liang Shen and co-workers have studied [60] the crystal structure of centrosymmetric dinuclear complex of [\(\mu\)-2,10,15,23-tetramethyl-3,6,9,12,13,16,19,22,25,26,27,28-dodecaazatricyclo[22.2.1]hexacosa-1(26),2,911(28),13,15,22,24(27)-octaene-12,25-diido-\(k^5\)N\(^{13}\),N\(^{16}\),N\(^{19}\),N\(^{22}\),N\(^{25}\):2\(k^5\)N\(^{3}\),N\(^{6}\)N\(^{9}\)N\(^{12}\),N\(^{26}\)-bis[diaquomanganese(II)]dichloride hexahydrate. They have assigned the Mn(II) centre is an approximately pentagonal-bipyramidal environment.

\[
\begin{align*}
\text{[I]} & \quad \text{[II]}
\end{align*}
\]

Alexander Eisenwiener et al., [61] have studied the Cu(II) and Pt(II) complexes with a series of pyrazole and triazole based dinucleating ligands have been synthesized and their complexation potential for metal ions, which exhibit square planar coordination geometry has been studied. In the case of Cu\(^{2+}\) the complexation equilibria in solution have been determined using pH titrations. Species with 1:1 stoichiometry [CuLH\(n\)] 2:1 stoichiometry [Cu\(_2\)L\(Hm\)], and of dimeric nature [Cu\(_2\)L\(_2\)Hp], have been detected and their overall stability constants have been measured.

\[
\begin{align*}
\text{[I]} & \quad \text{[II]}
\end{align*}
\]
Recently K. Singh et al., [62] have studied the Co(II), Ni(II) and Zn(II) complexes with Schiff bases synthesized by the reaction of p-nitrobenzaldehyde, o-nitrobenzaldehyde and p-toluylaldehyde with 4-amino-5-mercapto-1,2,4-triazole. Which are characterized by Physico-chemical studies suggest an octahedral geometry for the cobalt(II), nickel(II) and zinc(II) complexes.

These complexes have been screened for their antibacterial activity against three Gram-positive (S. aureus, S. epidermidis and B. subtilis) and two Gram-negative (S. typhi and P. aeruginosa) bacterial strains, and results were compared with the activity of the free ligands. The results shown that, metal complexes were found to be more potent against one or more bacterial strains than the free ligands.

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Very recently, Nali et al., [63] synthesized the pentacoordinated Cu(II) complex, \([\text{Cu}(\text{H}_2\text{O})(\text{L}_1)(\text{L}_2)(\text{NO}_3)](\text{NO}_3)(\text{H}_2\text{O})\) (1; \(\text{L}_1=1,2,4\)-triazole-5-one, \(\text{L}_2=1,10\)-phenanthroline) and characterized. An X-ray structure analysis of 1 revealed that, the Cu(II) centre has a distorted square pyramidal environment with a second weakly bonded nitrate (Cu–O 2.550Å) giving rise to a pseudo-octahedral coordination geometry. Weak interactions such as \(\pi-\pi\) stacking and hydrogen bonding (especially C–H–O hydrogen bonds) have significant effects in configuring the 3D packing of the complex.
Recently David Olea et al. [64] have been studied Nanoprocessability of a one-dimensional oxalato-bridged cobalt(II) complex with 1,2,4-triazole. The polymer \( \{[\text{Co(ox)(Htr)2} 2\text{H}_2\text{O}]n \) (ox = oxalate dianion; Htr = 1,2,4-triazole) (1) has been synthesized and characterized by FT-IR spectroscopy, thermal analysis, variable-temperature magnetic measurements and X-ray diffraction methods. They studied its processability, as nano-rings, fibres and single chains which has been achieved by scission of part of the metal–ligand bonds with ultrasound and posterior re-organization of the oligomers on surface. A new feature is the observation for the first time of circular structures of a coordination polymer that is linear in the solid state. Reaction formation of this polymer at low concentration of the reactants has been also shown as a suitable way for the isolation of nano-fibres on HOPG (Highly Oriented Pyrolytic Graphite).

\[
\begin{align*}
\text{L} = \text{rigid N-containing ligands such as Pyridines, Triazoles derivatives or Purine bases}
\end{align*}
\]

Patil et al. [65] have synthesized Ni(II) complexes with Schiff bases derived from thiocarbohydrazide and substituted salicylaldehydes and thiocarbohydrazide and benzoin. Which are characterized by elemental
analyses, magnetic, conductance and spectral data and suggested a square planer configuration for these complexes.

Patil et al., [66] have also reported tin(IV) complexes with nickel(II) thiocarbohydrazones and they have demonstrated that Ni(II) complexes of thiocarbohydrazones having square planar configuration react with tin(IV) chloride and as a result of this square planar Ni(II) complexes got change their configuration to octahedral. The complexes were identified by the elemental analyses and characterized by spectral and magnetic data.

*N. M. El-Metwally and A. A. El-Asmy* [67] have reported that, the bis(diacetylmonoxime)thiocarbohydrazone is a strong chelating agent coordinating to metal ions as a polydentate ligands, with different tautomeric forms. The VO$^{2+}$, Co(II), Ni(II), Cu(II) and Pt(IV) complexes have been characterized and their molecular weights evaluated from mass spectra. The Cu(II) complex was square pyramidal while the rest were octahedral. The ligand introduced as an analytical reagents for weak acid-weak base titration.
Very recently, Avaji et al., [68] have studied La(III) and Th(IV) complexes with Schiff base derived by the condensation of thiocarbohydrazide and thiophene-2-aldehyde have been reported from this laboratory. These complexes have been characterized on the basis of elemental analyses, spectral, magnetic and thermal studies.

\[ \text{La(III) complex} \]

\[ \text{Th(IV) complex} \]

Zahid H. Chohan [69] have studied the Ni (II), Cu (II) and Zn (II) Metal Chelates with some thiazole derived Schiff bases and characterized by elemental analyses, spectral and conductance data. The biological study shows that the activity of the Schiff bases became more pronounced when coordinated with the metals.

\[ \text{Ni(II) complex} \]

\[ \text{Cu(II) complex} \]

\[ \text{Zn(II) complex} \]

R= H, CH\(_3\), OCH\(_3\), NO\(_2\) and Cl
M= Ni(II), Cu(II) and Zn(II)

Very recently Anwar Usman et al., [70] have studied very recently the Diacetatobis(2-aminobenzothiazole)zinc(II) complex. In which the Zn(II)
complex is four-coordinated by one N atom from each of two 2-
aminobenzothiazole ligands and one O atom from each of two monodentate acetate ions. This ZnO₂N₂ coordination forms a distorted tetrahedral geometry. The two Zn-N bond lengths (2.034 Å and 2.039 Å) are similar, and agree with that in another zinc(II)-thiazole complex (2.061Å; McCleverty et al., 1980). The Zn-O bond distances are slightly shorter than those in another zinc acetate complex (1.981 Å; Razak et al., 2001), and consistent with the interpretation of the coordination as monodentate.

\[ \text{Zn} \quad \text{N} \quad \text{O} \quad \text{C} \quad \text{H}_3 \]

\[ \text{I} \]

Luminita Oprean et al., [71] have studied Cu(II) and Ni(II) complexes with 2-hydrazino-4-R-thiazole derivatives. The ligands act as tridentate and the complexes have a distorted tetrahedral geometry. The complexes are characterized by standard physico-chemical techniques and also studied their antibacterial, antifungal activities.

\[ \text{R=Cl and COOC}_2\text{H}_5 \]

\[ \text{M= Cu(II) and Ni(II)} \]

INTRODUCTION
P. P. Hankare et al., [72] have reported Mn(II), Co(II), Ni(II), Cu(II) and Zn(II) complexes with azo coumarins. In which the ligands act as natural bidentate and their metal(II) complexes appear to be octahedral geometry. The complexes are characterized by elemental analysis, magnetic, molar conductance, TGA and spectral studies. The complexes have \([M(L)_2(H_2O)_2]\). X H_2O where L is a deprotonated ligand.

\[
\text{M} = \text{Mn(II), Co(II) Ni(II), Cu(II) and Zn(II)}
\]

S. Srihari et al., [73] have studied VO(IV), Co(II), Ni(II), Cu(II) and Pd(II) complexes of some coumarin based Schiff bases. The ligand is uninegative, bidentate coordinating with metal ions through phenolic oxygen and azomethine nitrogen. The geometry and the bonding characteristics of the complexes have been arrived at from the electronic and ESR spectral data.

\[
\text{Were M= VO, Co, Ni, Cu and Pd}
\]

\[
X = - \text{H}_2\text{O} \text{H}_2\text{O} -
\]

INTRODUCTION
S. A. Zabin and C. R. Jejurkar [74] have synthesized macrocyclic quadridentate organic Schiff base and their Cu(II), Ni(II) and Zn(II) complexes. The complexes have been characterized by elemental analysis, magnetic and spectral data. The X-ray diffraction studies show the number of molecules per cell n=6, indicating that metal atom is inside the macrocyclic structure and coordinated by N₂N₂ sites. The magnetic measurement shows tetrahedral structure of the complexes.

Very recently, R. V. Sing et al., [75] have the studied macrocyclic complexes and were characterized by elemental analyses, molecular weight determinations, infrared and ¹H-NMR spectral analyses. The elemental analyses are consistent with the formation of complexes [Sn(Macn)Cl2] where, n = 1–5 and Mac represents a macrocyclic ligand moiety.
Very recently, Avaji et al., [76] have studied the La(III) and Th(IV) complexes, in which, the complex having the stoichiometry of the type \(\text{[La}^{IV}\text{L}_{1}^{IV}\text{(NO}_3\text{)}\text{(H}_2\text{O})_2\text{]}.3\text{H}_2\text{O}\) and \(\text{[Th}^{IV}\text{L}_{1}^{IV}\text{(NO}_3\text{)}_2\text{(H}_2\text{O})_2\text{]}.3\text{H}_2\text{O}\). These are characterized by spectral, magnetic, TGA, molar conductance and FAB-Mass studies.
AIM OF THE PRESENT RESEARCH WORK

In recent years, there has been lot of interest shown in the synthesis and physico-chemical properties of transition metal complexes with substituted 1,2,4-triazoles. Triazoles and their derivatives have been proved to be effective bactericides [77], pesticides [78], fungicides [79, 80] and insecticides [81, 82]. Many Schiff bases derived from either heterocyclic amines or aldehydes have been studied for their ability to form complexes with the transition metals [83-92].

The metal complexes of Schiff bases have been widely investigated because of their structural features, unusual properties and their relevance to biological processes. The metal complexes of 4n-butyl-4H-1,2,4-triazole have been reported to act as a systemic protectant, fungicide against leaf rust for both spring and winter wheat. Mercapto derivatives of triazoles have great antiviral and antiinflammatory activities [93, 94]. The Schiff bases are known to possess tuberculostic [95], fungicidal [96], bacteriostatic [97] activities. Patil and Coworkers studied the antimicrobial activities of triazole derivatives [98]. They have exhibited promising results. Besides their pharmaceutical and agricultural uses, triazole derivatives have been used in the field of polymers [99] and for making photographic chemicals and dyestuffs [100]. Benzaldehyde derivatives of 3-methyl-4-amino5-mercapto-1,2,4-triazole has been evaluated for its coordinating abilities [101]. This ligand exists in the thiol form and it is reported that, Cu(II) undergoes reduction to Cu(I) while forming the complexes with this ligand.

In biological front, Coumarins have long been recognized to possess anti-inflammatory [102], antioxidant [103], antithrombtic [104], antiallergic [105], hepatoprotective [103], antiviral [105] and anticarcinogenic [106] activities. The hydroxycoumarins are typical phenolic compounds and therefore, used as potent metal chelators and free radical scavengers. They are powerful chain-breaking antioxidants [107]. The coumarins display a remarkable array of biochemical and pharmacological actions [102-105], the
antitumor effects of coumarin and its major metabolite, 7-hydroxycoumarin, were tested in several human tumor cell lines [111]. Furthermore, cytotoxic effects of complexes of coumarin derivatives were examined on several neuronal cell lines [108].

A survey of the literature aroused our interest in synthesizing and elucidating the structures of transition [Co(II), Ni(II) and Cu(II)] and innertransition [La(III) and Th(IV)] metal complexes with the following new triazole, thiacarbohydrazone and thiazole Schiff bases (Figures 1-6).

1. Schiff bases derived from 3-substituted-4-amino-5-hydrazino-1,2,4-triazole and 8-formyl-7-hydroxy-4-methylcoumarin (Figure-1).
2. Schiff base derived from thiacarbohydrazone and 8-formyl-7-hydroxy-4-methylcoumarin (Figure-2).
3. Schiff bases derived from 3-substituted-4-amino-5-mercapto-1,2,4-triazoles and 8-formyl-7-hydroxy-4-methylcoumarin (Figure-3).
4. Schiff base derived from 2-amino-4-phenyl-l,3-thiazole with 8-formyl-7-hydroxy-4-methylcoumarin (Figure-4).
5. Schiff bases derived 3-substituted-4-amino-5-hydrazino-1,2,4-triazole and Orthophthalaldehyde (Figure-5).

All the complexes have been characterized on the basis of various physico-chemical techniques.

Because of the biological properties associated with the triazoles, thiazole and coumarin moieties, we have evaluated some Schiff bases and their metal complexes for their antibacterial against E. coli, S. aureus, S. pyogenes and P. aeruginosa) and antifungal activities against Aspergillus niger, Aspergillus flavus and cladosporium by MIC method. The brine shrimp bioassay was also carried out to study their invitro cytotoxic properties.
LIGANDS USED IN THE PRESENT INVESTIGATION

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

INTRODUCTION
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