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Research Article

INTERACTIONS OF METAL WITH NUCLEIC ACID STUDIES: A SHORT REVIEW

Mohd.Washid Khan*., Chandan Singh Ahirwar., Rahul Nayak and Priyanshu Verma

Department of P.G. Studies and Research in Chemistry & Pharmacy Rani Durgavati University, Jabalpur M.P

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A B S T R A C T

Nucleic acids (DNA and RNA) are actually salts (or structures) of iron ions from the chemical spectrum. Therefore, it is difficult, if not impossible, to distinguish the function of DNA and RNA in their function with the metals. This progress has been largely due to major advances in nucleic-acid technology. We can now decompose, process, and synthesize nucleic acids in the same sequence, just as we would with other chemical molecules that we are testing. In addition, these heavy metals disrupt metalloululatory proteins and thus disrupt genetic expression. We need to understand the function of natural metalloregulators in genes and we need to design new metal-related ligands, which, like proteins themselves, take heavy metals before their damage is done. This review explains the interaction of iron in the context of nucleic acid electrostatics, and then provides examples of iron sites in various types of DNA and RNA. It is also useful to study the interaction of nucleic acid compounds to provide scientific information regarding the manufacture and construction of iron ore.

INTRODUCTION

The bioinorganic community in the field of iron / nucleic-acid interactions has emerged in the last decade. Bioinorganic chemistry itself has gone from being a field focused on defining metal centers in biology into something that involves the use of uncommon chemicals to test properties and function. Nucleic acids (DNA and RNA) are actually salts (or structures) of iron ions from the chemical spectrum. Therefore, it is difficult, if not impossible, to distinguish the function of DNA and RNA in their function with the metals. We must also pay attention to water molecules that are specially bound because they tend to interact between polynucleotides and ion ions. [1-2]. In recent decades it has become clear that nucleic acids, which are organized, efficient and notable in terms of catalysis, play an important and varied role in the Environment. This progress has been largely due to the tremendous advances in nuclear technology. We can now decompose, process, and synthesize nucleic acids in the same sequence, just as we would with other chemical molecules that we are testing. In addition, these heavy metals disrupt metalloregulatory proteins and thus disrupt genetic expression. We need to understand the function of natural metalloregulators in genes and we need to design new metal-related ligands, which, like proteins themselves, take heavy metals before their damage is done.

The combination of heavy metal with nucleic acid actually provided the basis for the effective use of cisplatin and its availability as anticancer chemotherapeutic agents. Transition-metal chemistry, both in the cell and in the pharmacy testing tube, provides an important tool for creating and testing these processes. There are also many practical reasons for research into how complex iron and ions interact with nucleic acids. The toxicity of most iron in our environment comes as part of a composite compound of iron ions containing nucleic acids. One deoxyribo nucleotide and four different nucleicacid bases. As can be seen, each mononucleotide near the nucleic-acid polymer contains a variety of contact areas with metals, from electrostatic contact with anionic phosphate to nucleophilic contact with purine heterocycle. The various nucleic-acid bases further provide a range of energy and electricity that you can use. The combination of the metal structure with the N7 nitrogen purine atom, for example, may place other ligands attached to the nucleus of the hydrogen atomic nucleus and the 06 oxygen atom, but may lead to conflicts with the amine hydrogen atom of adenine. Monomeric units are grouped together in polynucleotide in addition to providing multiple polymer conformers. Figure 1 shows three crystallographically shaped structures of DNA Oligonucleotides with a double helical. [3-5]

Corresponding author:* **Mohd.Washid Khan
Department Dept of P.G. Studies and Research in Chemistry & Pharmacy Rani Durgavati University, Jabalpur M.P

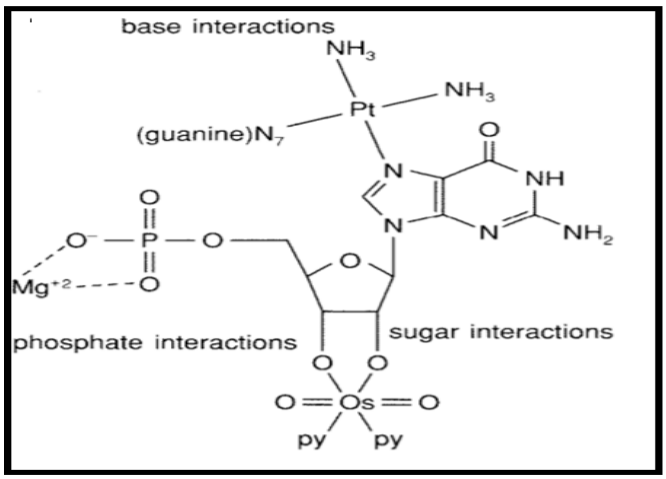

Fig 1 shows three crystallographically characterized structures of double-helical DNA oligonucleotides.

There are two extremes in such communication. First, among biologists and molecular biologists, the properties of iron remain relatively stable compared with the structures of nucleic acid (possibly due to their small size); and on the other hand, they are common among rare chemicals, which take nucleic acids as major organic ligands. In fact, both nucleic acids and ionic ions exhibit significant difficulties in their function, and such interactions can affect the chemical and chemical properties of both compounds.

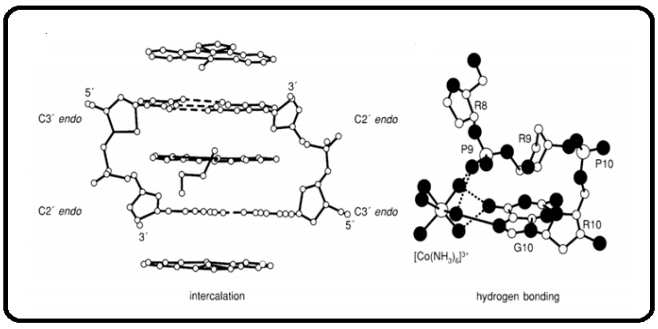

Fig 2 Covalent and noncovalent binding modes of metal complexes with DNA

Involvement of iron-containing species in acid-dependent processes, including nucleotide biochemistry; the storage and transfer of genetic information, as well as gene control (Mg^{2+}) [5-7] mutagenesis (e.g. Mn^{2+}, Cu^{2+}, Co^{2+}, and Ni^{2+}) [8-10] abnormal chromosomal (e.g. Be^{2+} and Hg^{2+}); [11,12] and carcinogenesis (e.g. Ni^{2+}, Cd^{2+}, Cu^{2+}, Co^{2+}, Fe^{3+}, and Be^{2+}) [13-16] are well documented. There are only a few processes that make it clear that nucleic acid is the most important factor in iron function.

Fundamental Interactions with Nucleic Acids

Iron and complex ions combine DNA and RNA in a variety of ways, Both strong bonds and weak non-valentatic structures are recognized. [17] Each can show significant disruption of nucleic acid and / or may be exploited for site-specific response. Depending on the rules of chemical communication, which can help to plan this interaction. The most common among DNA-binding structures are those that involve interactions between soft metal ions and nucleophilic sites at bases. The structure of cis- (NH3hPt-dGpG is an example: its platinum base is similar to the N7 base of guanine foundations. Intrastrand crosslink between neighboring guanine residues in the fiber. N7 position of adenine, N3 position in cytosine, and N3 position dissolved in thymine and uracil. [18, 19].

Nucleic acid properties with metal binding

The chemical structure of nucleic acids [20] provides a variety of binding centers that can be involved in ionic formation, bonding (receptor-receptor), hydrogen (H-), and covalent bond. The term 'nucleic acid' is often used to refer to polynucleotides. The monomeric unit (nucleotide) contains one heterocyclic nucleobase, either purine (adenine or guanine) or pyrimidine (cytosine, uracil, or thymine), attached to N Glycosyl bond to pentose sugar (nucleoside), attached to phosphate is a phosphodiester bond at 5- or 3-terminus. Nucleotides (NMP, where N= adenosine, A; guanosine, G; inosine, I; cytidine, C; thymidine, T; or uridine, U) can be synthesized using 5.3 phosphodiester bonds to produce oligonucleotides direct (usually 100 nt), or combined with additional phosphate groups to form nucleoside di- and triphosphates (NDP and NTPs, respectively). Phosphate groups can be incorporated into the nucleoside using groups of 5 - and 3 - hydroxyl pentose rings.

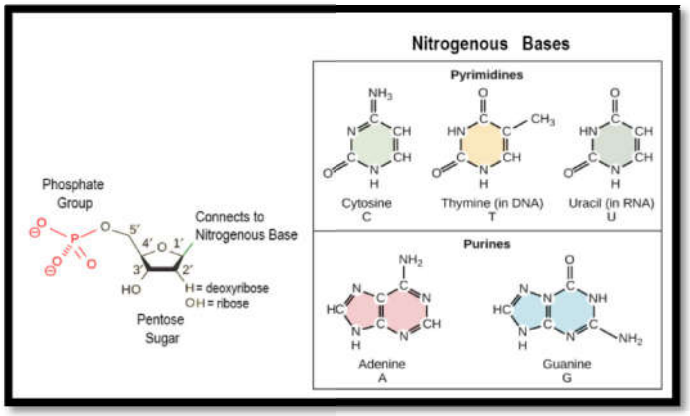

Fig 2 Structures of the nucleic acids and their constituents

Nucleic acid residues are concentrated in aqueous solutions and crystals: two H2Os with diesel phosphate and six bases containing DNA and RNA [21,22]. There are at least two different types of water molecules bound to nucleic acids. The first includes a highly ordered hydration shell, which is a layer of H-bond water molecules mainly composed of hydrogen bond suppliers and groups to obtain nucleic acid residues. These water molecules play important roles in internal and external molecules between nucleic acid residues and iron-nucleic acid combinations that require the compound (both nucleic acid and iron ions) to be stabilized (inside - of sphere) bonds or bonds in ways that a water molecule (outersphere) can form. [23-28]. The water layer is slowly ordered and weakly bound to nucleic acids (using secondary H-bonds or dipole interactions - dipoles) facilitating the exchange of large amounts of water molecules and iron ions. The dissolution of water molecules can reduce electrostatic interactions between nucleic acids and ion ions

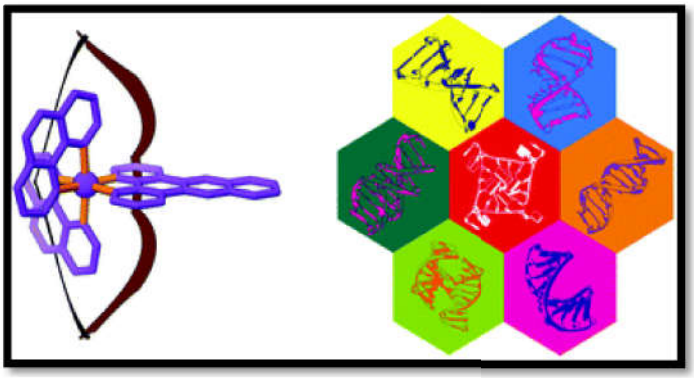

Fig 3 electrostatic interactions between nucleic acids and metal ions.

Nature's use of metal/nucleic-acid interactions

Materials in iron iron in the formation of metalloproteins, nucleic-acid compounds, and micro-organisms that contain iron ions that combine with DNA and RNA. We understand the basic interactions and reactions of iron-containing iron-containing elements, and in comparison to how chemists have used this compound to test nucleic acids.

The role of the construction center

The iron ions used in these proteins appear to explain the formation or pattern of the peptide domain that binds directly to nucleic acid. It would be wise to select a structure that will help direct the formation of iron in specific areas of DNA. It can perform the functions of iron-defining metals in biological systems with their ability to provide a built-in center to control protein binding. Metalloproteins that bind to DNA have received as much attention recently as "protein-finger" proteins. Treatment with zinc zinc ion, or in recent studies with high concentrations of Co2 +, has restored some binding capacity. Therefore, zinc ion has been shown to be important in the functioning of these eukaryotic regulatory proteins. Berg proposed a three-dimensional structure of the zinc finger, which is illustrated by the system in Figure 4 [29]. The proposed structure consisted of a tetrahedral zinc compound with two cysteine residues and histidine below the finger and a helical circuit acting approximately the length of the domain.

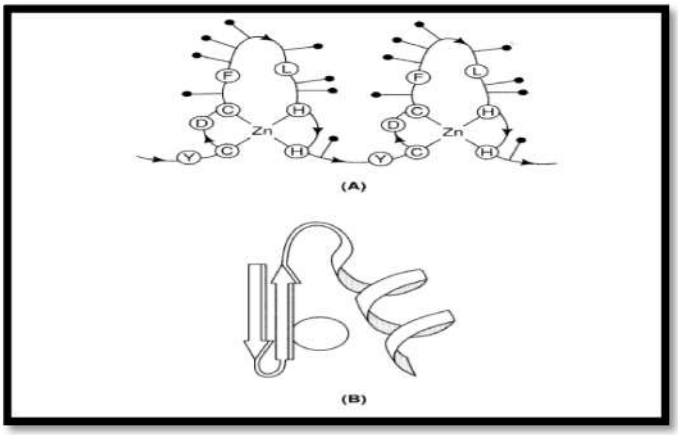

Fig 4 (A) A schematic of a zinc-finger peptide domain.
(B) The proposed schematic structure of a zinc-finger domain

The role of director

It is a biological process that must respond to changes in the concentration of iron within cells. At high concentrations ion ions become harmful to the cell; therefore, a complete protein program must be developed that will chew and return toxins in a metal-bound pool. But at the same time, DNA itself must be protected from high concentrations of iron ions. The need for these metalloregulatory proteins, therefore, binds to DNA in the absence of iron, which often suppresses writing, but in the presence of iron ions binds ions firmly and directly, and as a result improves the recording. System models are also being developed to test the metal flexibility of DNA binding. One scheme involves the fusion of two dipeptides composed of acyclic metal-binding polyether ligand, and Fe (EDTA) -2 bound to another boundary marker boundary [30].

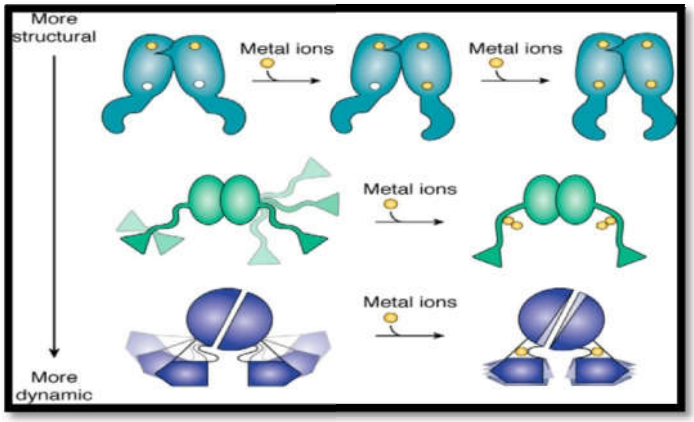

Fig 5 Allosteric control of metal-responsive transcriptional regulators

Role in Pharmaceuticals

Many drugs used as DNA binders were initially classified as natural products derived from bacteria, fungi, plants or other organisms. They mainly represent complex substances, including peptide and / or saccharide synthesis, and often have different variants, such as ene-diyne to calichimycin. These natural products bind DNA by force, through intercalation, groove binding, or a mixture thereof. Often the action of these antimicrobials is caused by subsequent alkylation or reactions of DNA strand-cleavage that damage the DNA. The various natural products used in the clinic as an antitumor antibiotic are bleomycins, a family of glycopeptide-derived species isolated from Streptomyces cultures [31]. Hanif and Hartinger began the issue by explaining the misconceptions of cisplatin, and discussed the steps taken to correct these problems [32]. Advanced medical advances have brought new ways of diagnosing cancer cells, and researchers have recently experimented with using metallodrugs to induce the body's response to cancer. Yang then proposed a simple strategy to create functional metallodrugs, providing examples based on platinum and vanadium [33]. He suggests that metallodrugs work by imitating metal-controlled systems through signal transmission, and that drugs should incorporate ‘enhancer’ and ‘antidote’ properties, which promote signaling while inhibiting metal toxicity. Koide and colleagues described their initial work to develop metallodrug carboplatin. Koide's team has begun to incorporate arginine-rich helical peptide motif into problem [34]. A good structural charge can facilitate cell mobility, releasing platinum under the conditions found in the target area. Cyclodextrin is an example of a structure of interest because of its hydrophobic compound, which can be used to improve the availability of small lipophilic molecules.

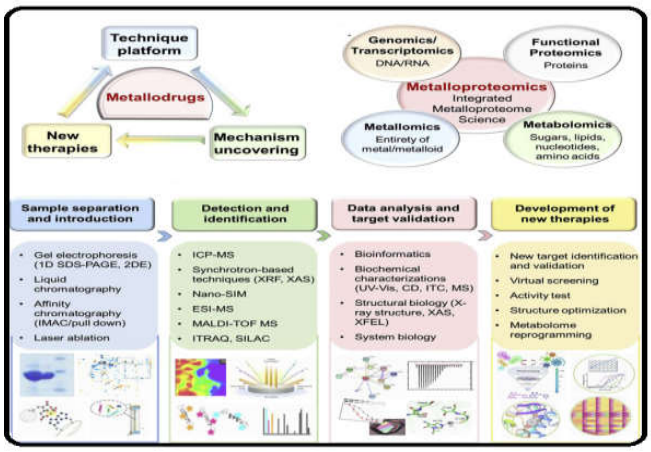

Fig 6 A pharmaceutical application of metallodrugs/metalloproteomics

In his review of collaborations with Oliveri, Vecchio highlights recent efforts to incorporate cyclodextrin into metal systems for the development of therapeutic, diagnostic, and therapeutic drugs [35]. As understanding of cell acceptance progresses, scientists are beginning to build structures to mimic the action of essential enzymes and biomolecules. Indeed, while the therapeutic use of metal structures has seen clinical success, metals have certain important medical positions. Gadolinium is the key to MRI procedures and Chang discusses the formation of new agents, their key features and complications [36]. Comparative MRI agents, such as cardolite, are now easily taken for granted; This is how their effects on medication and diagnosis can be made. Many structures designed for you allow for erroneous thinking, respond to a variety of situations, and the review focuses on blood clotting factors, allowing for binding to certain organs or identifying certain diseases. In their work, Lui *et al*. see the future of iron therapy, which is geared towards new stages of disease [37]. Alzheimer's disease appears to be in the form of amyloid-β peptide synthesis, forming plaques in and around dendritic neurons. It is hoped that metal chelators can be used therapeutically, interacting with Cu (II), Zn (II) and Fe (III) residues in the peptide structure to prevent or reverse coagulation. Screws that attach to these metal sheets can also aid in the imagination of plates, which combine both structures for theranostic purposes. However complete studies in structural chemistry are one of the nucleic acid components of solidification and state solutions. These studies focus mainly on dielectric, electrical, potentiometric energy and temperature [38 - 42.]

CONCLUSION

The purpose of this review is to provide information on the behavior of iron-coating nucleic acid. Facilitate study and interaction with hydrogen bond and DNA or RNA element. Many architectural designs allow for greater imagery, responsiveness to a variety of topics, and revisions focus on blood thinners, which allow for binding to specific organs or identifying specific diseases. It is also useful to assemble these metal particles and can aid in the imagination of plates, assembling both structures for theranostic purposes..

Conflict of Interest

The authors declared that they have no conflicts of interest.

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Reference

1. V. A. Buckin, B. I. Kankiya, D. Rentzeperis, and L. A. Marky, J. Am. Chem. Soc., 1994, 116, 9423.
2. E. Westh of, Annu. Rev. Biophys. Chem., 2001, 17, 125.
3. M. McCall, T. Brown, and O. Kennard, 1. Mol. Bioi. 183 (1985), 385.
4. R. Wing *et al*., Nature 287 (1980), 755.
5. A. H.-J. Wang *et al*., Nature 282 (1979), 680.
6. G. L. Eichhorn, Met. Ions Biol. Syst., 1980, 10, 1.
7. M. Grunberg-Manago, G. H. B. Hoa, P. Douzou, and A. Wishina, in 'Metal Ions in Genetic Information Transfer', eds. G. L. Eichhorn and L. G. Marzilli, Elsevier/NorthHolland, New York, 1981,193.
8. A. S. Mildvan and L. A. Loeb, in 'Metal Ions in Genetic Information Transfer', eds. G. L. Eichhorn and L. G. Marzilli, Elsevier/North-Holland, New York, 1981, 103.
9. I. Bertini, L. Messori, and M. S. Viezzoli, Coord. Chem. Rev., 1992, 120, 163.
10. T. V. O'Halloran, Science, 1993, 261, 715.
11. M. A. Sirover and L. A. Loeb, Science, 1976, 194, 1434.
12. K. M. Downey and A. G. So, Met. Ions Biol. Syst., 1989, 25, 1.
13. V. G. Bregadze, Met. Ions Biol. Syst., 1996, 32, 419.
14. I. Sissoeff, J. Grisvard, and E. Guill ¨ e,´ Prog. Biophys. Mol. Biol., 1976, 31, 165.
15. N. T. Christie and M. Costa, Biol. Trace Elem. Res., 1983, 5, 55.
16. E. L. Andronikashvili and L. M. Mosulishvily, Met. Ions Biol. Syst., 1980, 10, 167.
17. C. P. Flessel, A. Furst, and S. B. Radding, Met. Ions Biol. Syst., 1980, 10, 23.
18. H. J. Issaq, Met. Ions Biol. Syst., 1980, 10, 55. J. Anastassopoulou and T. Theophanides, Crit. Rev. Oncol. Hematol., 2002, 42, 79
19. J. Anastassopoulou and T. Theophanides, Crit. Rev. Oncol. Hematol., 2002, 42, 79.
20. C. S. Chow and J. K. Barton, Meth. Enzym. 212 (1992), 219.
21. S. E. Sherman *et al*., Science 230 (1985), 412.
22. D. Hodgson, Prog. Inarg. Chem. 23 (1977), 211.
23. N. K. Kochetkov and E. I. Budovskii, 'Organic Chemistry of Nucleic Acids', Plenum Press, New York, 1972, Part B, 496
24. H. Eisenberg, in 'Basic Principles in Nucleic Acid Chemistry', ed. P. O. P. Ts'o, Academic Press, New York, 1974, 3,171.
25. W. Saenger, Annu. Rev. Biophys. Biophys. Chem., 1987, 16, 93
26. W. Saenger, Annu. Rev. Biophys. Biophys. Chem., 1987, 16, 93.
27. I. D. Kuntz, T. S. Brassfield, G. D. Law, and G. V. Purcell, Science, 1969, 163, 1329.
28. T. Lundback and T. Hard, Proc. Natl. Acad. Sci. U.S.A., 1996, 93, 4754.

29. C. Mundoma and N. L. Greenbaum, Biopolymers, 2003, 69, 100.
30. J. A. Subirana and M. Soler-Lopez, Annu. Rev. Biophys. Biomol. Struct., 2003, 32, 27.
31. D. E. Draper, RNA, 2004, 10, 335.
32. J. M. Berg, Proc. Nat!. Acad. Sci. USA 85 (1988), 99.
33. J. H. Griffin and P. B. Dervan, J. Am. Chem. Soc. 109 (1987),6840.
34. J. Stubbe and J. W. Kozarich, Chem. Rev. 87 (1987),1107
35. Hanif M, Hartinger C. Metallodrug research: where is the new cisplatin? Future Med. Chem. 10(6), 615–617 (2018).
36. 36. Yang X. Regulating cellular stress responses: an emerging strategy for rational metallodrug design. Future Med. Chem. 10(6), 611–614 (2018).
37. Masuda R, Hayashi R, Nose H *et al*. Development of a carboplatin derivative conjugated with a collagen-like triple-helical peptide. Future Med. Chem. 10(6), 619–629 (2018).
38. Oliveri V, Vecchio G. Metallocyclodextrins in medicinal chemistry. Future Med. Chem. 10(6),663–677(2018).
39. Chang Y, Kim H, Gang H. Gadolinium as an MRI contrast agent. Future Med. Chem. 10(6), 639–661 (2018).
40. Liu H, Qu Y, Wang X. Amyloid β-targeted metal complexes for potential applications in Alzheimer's disease. Future Med. Chem. 10(6), 679–701 (2018).
41. M S Masoud, M F Fathalla, R H A Mohamed, M S Hassan (2019) Asian J of Chem 31(3): 733.
42. M S Masoud, A S El-Kholany, M F El-Shahat (2019) *J of Chemical, Pharmaceutical Research* 11(12): 45.

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