DESIGN, SYNTHESIS, ION-BINDING AND SELF-ASSEMBLING BEHAVIOR OF TRIAZOLE-BASED MOLECULES

by

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Submitted

In fulfillment of requirement of degree of

DOCTOR OF PHILOSOPHY

to the

Indian Institute of Technology Delhi

December 2011

Dedicated to my dear sir Dr. Mukul Roy

and to my family

CERTIFICATE

This is to certify that the thesis entitled, **"Design, Synthesis, Ion-binding and Self-Assembling Behavior of Triazole-Based Molecules"**, being submitted by **Mr. Srikanta Sahu**, to the Indian Institute of Technology, Delhi, for the award of degree of '**Doctor of philosophy in Chemistry**', is a record of bonafide research work carried out by him. **Mr. Srikanta Sahu** has worked under my guidance and supervision and has fulfilled all the requirements for the submission of this thesis, which to my knowledge has reached the requisite standard. The results embodied in this thesis have not been submitted in part or in full, to any other University or Institute for award of any degree or diploma.

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ACKNOWLEDGEMENT

It's my great pleasure to pay my deepest gratitude and respect to my supervisor, **Dr. V. Haridas**, Associate Professor, Department of Chemistry, I.I.T. Delhi, who has been of constant inspiration to me throughout the realization of this work not only through the groves of research, but also through the jungles of reality. I did have the opportunity to imbibe a lot from his persona, and enjoyed *sans facon* criticisms of his during all of our research and non-research discussions.

My sincere thank to the erstwhile and the present Head of the Department of Chemistry Prof. A. K. Singh, Prof. B. Jayaram, and Late Prof. U. K. Nadir for providing the necessary facilities for carrying out my research. I am also greatly indebt to Dr. N. D. Kurur, Dr. Siddharth Pandey, and Dr. N. G. Ramesh, for their constant encouragement and useful discussions.

I wish to thank everybody with whom I have shared experiences in life. From the people who first persuaded me and got me interested into the study of Chemistry, specially those who also played a significant role in my life, to those who with the gift of their company made my days more enjoyable and worth living.

I would like to thank my lab mates Dr. Sarala Naik, Dr. Yogesh Sharma, Kiran Kumar, Kasmirilal, Harinder, Ram Prakash, Bharat, Sandhya, Bijesh, Praveen, Appu, Gopal, Isanki, Tauseef, Tusita and Sakhi for their moral support, well wishes and inhibited help from time to time. I would also like to thank, Kamala, Naba, Satya, Soroj, Purnedu, Dipak, Monoj, Papu, Saubhagya, Nem, Vinod, Dharmendra, Amit, Arbind, Prodhumn, Archana, Gita, Neeru, Monali, Chetna, Nibedita, Usha, Majlee, and Sruti for their encouragement, affection and support.

I gratefully acknowledge Mr. Munna Lal, Mr. Keshav, Mr. Aggarwal, Mr. J. P. Sharma and Mrs. Shanta and other technical staff of the Chemistry Department for their help during data acquisition.

Last but not least, I thank my family members for their unconditional love, support and encouragement to pursue my interests, even when the interests went beyond boundaries of language, field and geography. I express my sincere appreciation to my brothers Pravat Sahu, Prasanta Sahu, and Rajkishore Sahu for affection and support.

Final support from Council of Scientific and Industrial Research, India in the form of research fellowship is gratefully acknowledged.

I would like to express my gratitude towards almighty for giving me strength, courage and perseverance.

Srikanta Sahu

ABSTRACT

This thesis, **"Design, Synthesis, Ion-binding and Self-Assembling Behavior of Triazole-Based Molecules"** deals with the design and synthesis of various acyclic and cyclic triazole-based molecules. We have demonstrated the utility of these molecules for binding of anions and as new self-assembling systems. Molecular recognition of cations, anions and neutral molecules play a significant role in biology and chemistry. However, a rigorous attention has been paid for recognition of cations but recognition of anions received little attention. Anions are everywhere in the living systems and play pivotal role in carrying out many biochemical operation for sustaining life. Anions such as chloride, phosphate, and sulfate regulate the flux of key metabolites into and out of cells while maintaining osmotic balance. Among all anions, anion receptors specific for chloride and fluoride has attracted growing interest because of their role in chemistry, biology and medicine.

Chapter 1 covers a detailed overview of anion recognition properties of various synthetic anion receptors, namely: polyammonium, quaternary ammonium, amide, urea and thiourea, guanidinium, pyrrole, imidazolium, and triazole containing molecules. **Chapter 2** describes the design and synthesis of various cyclic and acyclic triazole-based molecules and their binding behavior towards halide ions. Experimental results showed that placing triazole moieties on different positions of an aromatic scaffold can change the binding affinity towards anions. Various receptor designs described in this chapter emphasize that simple triazole moiety is a potential CH hydrogen bond donor for binding anions and for designing self-assembling systems.

Chapter 3 addresses a design strategy for anion binding that illustrated the use of amide-linked triazole on an aromatic scaffold. In conclusion, we have demonstrated that the amide-linked triazole is an excellent motif for anion recognition. It can be considered a

mimic of constrained dipeptide linkage and could be used efficiently for binding guest molecules. We also designed and synthesized a triazole-based receptor that can change color upon binding, providing a useful tool for the visual detection of anions.

Chapter 4 reports cystine-based macrocyclic compounds showing very unique self-assembling behavior. 24-membered disulfide macrocycle **D3** shows a helical and tubular organization and also forms an insoluble plaque that is birefringent with congo red dye. 52-membered macrocycle **D4** shows a vesicle-like assembly. This is a rare example, wherein helices, tubes and vesicles are formed from cystine-based macrocycles. These disulfide macrocycles, with amyloid-like self-assembly, will serve as excellent model systems for studying the mechanism and the inhibition of amyloid-like disorders. The vesicles from disulfide macrocycles are useful as container molecules for various guest molecules.

Chapter 5 deals with the design and synthesis of various macrocyclic compounds with an aim to bind cations. The results from the binding studies showed that these macrocycles are not strong binders of cations, indicating that the orientation of triazole nitrogen is a crucial factor. Even the acyclic compounds **E27**, **E28**, **E30** and **E31** did not show very strong binding affinity, emphasizing the importance of correct orientation of triazole units for metal ion binding. Therefore, the present methodology can be further utilized for the generation of macrocycles containing metal ion binding units on the linker regions. The conformationally restricted macrocycles, by the correct choice of linkers, may provide macrocycles with high binding affinity similar to porphyrins.

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