In this study, design and synthesis of ligands that can complex two different metals at two different sites are constructed. Larger ligand binding structures are attached to synthesized imidazoles. One imidazole nitrogen participates in binding the larger ligand to a first metal and the second imidazolate anion post-ionization acts as a bridge to bond to a second different metal species. The first metal bound to the larger ligand structure is a copper metal. Different transition metals, namely iron or zinc, are used as the second metal. The resulting binuclear complex acts as a biological mimic for the enzyme active site where the imidazole bridging action to metals is
analogous to Cu-Zn bovine erythrocyte superoxide dismutase enzyme-substrate binding.

Carboxylated copper phthalocyanine building blocks for hydrogen storage and CO₂ sequestering are non-toxic thermodynamically stable materials, for which exceptionally high dielectric constants have been reported, making them useful for electric components and possibly photovoltaic systems. Synthesis of several oligomers, especially the monomer and tetramer of the copper phthalocyanines is performed in a one pot synthetic route. Development of analytical methods using electro-spray ionization mass spectrometry to characterize the final products is carried out. Size exclusion methods for separation and silica gel columns for purification are utilized. Isolation of the tetramer in sufficient yield is attempted and determined to not be possible in bulk yield due to monomeric clusters formed upon synthesis. Based on this finding, its application as a molecular panel building block for the construction of metal organic frameworks having storage capabilities for molecules, such as hydrogen and carbon dioxide, is not possible as sought.

Investigation into the design of pyrrole copper oxidase catalysts and attempted synthesis of complexes is achieved in this study. Crystals of the complexes having water associated with open copper sites along with other solvents are obtained. These further the understanding of the idealized structure of such complexes for both in vitro and in vivo investigations for their applications in the medical field, as well as in industrial catalysis.