Understanding Metalloenzyme Function through Bio-inspired Inorganic Chemistry

Redox reactions in biological systems are frequently mediated by metal-containing enzymes (metalloenzymes). Manganese metalloenzymes play a particularly prominent role in biological redox reactions. For example, the enzyme manganese superoxide dismutase defends organisms, including humans, from the free radical superoxide, while photosystem II of all leafy plants contains a tetra-manganese cluster that converts water to molecular oxygen. These biologically important reactions typically involve manganese-peroxo and manganese-oxo species as central intermediates. However, these intermediates are very unstable, and it is challenging to understand their properties. In the Jackson lab, our goal is to develop structure-function relationships for these species, so we can understand what makes one intermediate well-suited for a particular biological reaction. To do this, we use synthetic inorganic chemistry to generate models of manganese-peroxo and manganese-oxo intermediates. We employ a variety of physical methods, such as UV-vis and electron paramagnetic resonance spectroscopies, to characterize these intermediates, and we perform kinetic studies to understand reaction orders and rates. Students working on this project will gain experience in synthesis (including the use of inert atmosphere techniques), spectroscopic characterization, and reaction kinetics.