

Faculty Development Project Report

Funding for Summer 2024 Research

Title of project: Investigating Hemoglobin's Roles in Nitroso Compound Interactions and Implications for Human Health

Name of the Applicant: Viridiana E. Herrera, PhD

Rank of the Applicant: Assistant Professor

Expertise Area: Biochemistry, Structural Biology, Synthetic (Protein) Chemistry

Proposal Submission Term: Summer 2024

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- 1. Project Overview** This project aimed to investigate the interactions between hemoglobin (Hb) and nitroso compounds (RNOs), exploring their implications for human health. Given hemoglobin's crucial role in oxygen transport, understanding its interactions with non-traditional ligands like RNOs can provide insights into physiological and pathological processes. The study aimed to evaluate how ligand size affects Hb-RNO binding, assess structural changes in hemoglobin upon ligand interaction, and determine the biochemical significance of these changes.

2. Key Outcomes and Achievements

2.1 Investigation of Ligand Size on Hemoglobin Binding

- UV-Vis spectroscopy was utilized to monitor binding interactions between Hb and various RNO ligands.
- Preliminary findings indicated that larger RNO ligands resulted in decreased active site occupancy, leading to slower reaction rates.
- These results align with previous observations, reinforcing the hypothesis that steric effects influence hemoglobin's ligand-binding capacity.

2.2 Structural Analysis through X-ray Crystallography

- Crystallization efforts focused on Hb-RNO complexes to elucidate structural changes upon ligand binding.
- Preliminary structural data obtained from previous work (Hb-MeNO complex) revealed ligand-induced displacement of oxygen-binding sites.
- Further crystallization studies are ongoing, with expectations to obtain diffraction-quality crystals by Summer 2025.

2.3 Student Involvement and Research Training

- A full-time post-baccalaureate researcher was onboarded through NSF PRELS funding, enhancing the lab's research capacity.
- Undergraduate students actively participated in data collection, including spectroscopic analysis and crystallization efforts.
- Students presented preliminary findings at local and national conferences, including Lincoln University's Science Fair and the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) Annual Meeting in Orlando, FL, 2024.

3. Impact on Research and Teaching

3.1 Contribution to NSF RIA Grant Proposal

- The preliminary data collected through this funding mechanism was instrumental in supporting a larger NSF Research Initiation Award (RIA) grant proposal (\$411,000), currently in its first year of implementation.
- Research findings are expected to contribute to further external grant applications, strengthening Lincoln University's research portfolio.

3.2 Integration into Chemistry Curriculum

- Experimental methodologies and findings from this study have been incorporated into Biochemistry (CHE303/304) and Advanced Inorganic Chemistry (CHE403) courses.
- Students engaged in hands-on learning experiences involving protein ligand-binding studies, and structural characterization techniques.

4. Dissemination of Findings

- Research findings have been presented at multiple local and national conferences, demonstrating the broad impact and engagement of this study.
- **NSF Division of Chemistry Early Career Investigator Workshop, National Science Foundation, Alexandria, VA (May 7, 2024):**
 - Influence of Ligand Sterics on the Binding of Alkyl Nitroso Compounds to Hemoglobin, presented by Viridiana E. Herrera.
- **NOBCChE 2024 Conference, Orlando, FL (September 9-13, 2024):**
 - Impact of Nitroisopropane Interactions with Hemoglobin, presented by Da'Veyanna Bivens, Kevin Carver, Rachel Brown, Leonard Thomas, George Richter-Addo, and Viridiana E. Herrera.
 - Investigating Hemoglobin's Roles in Nitroso Compound Interactions and Implications for Human Health, presented by Rachel Brown, Kevin Carver, Da'Veyanna Bivens, Leonard Thomas, George Richter-Addo, and Viridiana E. Herrera.
- **ABRCMS 2024 Conference:**
 - Investigating Hemoglobin's Roles in Nitroso Compound Interactions and Implications for Human Health, presented by Rachel Brown, Kevin Carver, Da'Veyanna Bivens, Leonard Thomas, George Richter-Addo, and Viridiana E. Herrera.
- Findings will also be shared at Lincoln University's Faculty Research and Development Symposium April 10th.

5. Future Directions

- Continued efforts in crystallization and structural analysis of Hb-RNO complexes.
- Expansion of research to investigate the physiological relevance of Hb-RNO interactions in cellular models.
- Application for additional funding to support further biochemical and biophysical investigations.

6. Conclusion

This mini proposal successfully advanced our understanding of hemoglobin's interactions with nitroso compounds, providing critical progress and data for a larger NSF-funded project. The research has not only contributed to the field of structural biochemistry but has also enhanced student training and engagement in research at Lincoln University. The findings will support future funding applications and contribute to scientific literature, further solidifying Lincoln University's research capabilities in the field of protein chemistry.