Summary

This proposed faculty research and development project aims to develop open-source neuroscience tools through innovation and international collaboration. The innovative and cost-effective open-source tools developed will be designed for the model system *Caenorhabditis elegans* (*C. elegans*) and built in a collaborator's laboratory in Brazil. The proposed project has the following specific objectives:

1. To build open-source neuroscience tools for experiments using *C. elegans*.
2. To test the role of the ATP binding cassette subfamily A member 7 (ABCA7) gene variant in neurodegeneration, learning, and memory in *C. elegans*, using open neuroscience tools for tracking, microscopy, and analyses.

Funding requested is primarily for Fall 2026 but necessitates starting in July 2026 to plan final logistics and purchase materials needed before traveling to Brazil. Travel to Brazil may exceed the individual travel funds per CBA, so this project is a combined travel and faculty development project. The ultimate goal of the project is to advance scientific discovery and teaching effectiveness at Lincoln University.

Background and Specific Objectives

C. elegans is a simple yet robust invertebrate model system that lends itself well to undergraduate research and teaching. *C. elegans* worms are microscopic and, interestingly, transparent. *C. elegans* only has 302 neurons compared to billions in humans. *C. elegans* strains are inexpensive; however, commercially available video tracking systems and other instrumentation used for *C. elegans* are quite expensive. Cost-effective open neuroscience tools are ideal. In addition to saving money, the beauty of open neuroscience is that it is freely accessible, is innovative, stimulates collaboration, accelerates discovery, and removes barriers. Thus, knowledge is more readily attainable.

Creating open neuroscience tools for the tiny *C. elegans* is creative and will allow us to afford instrumentation to gain a deeper understanding of the mechanisms of ABCA7 dysfunction in neurodegeneration and cognitive decline. The ABCA7 gene variant is of great interest because it is a risk factor for Alzheimer's disease, especially in African Americans (Reitz et al., 2013; see "Other Supporting Documents" for reference list). *C. elegans* worms show neurodegenerative changes and can learn (Gourgou et al., 2021) and have an orthologue of ABCA7 (Basu et al., 2017). The **goal** of the proposed research is to develop such innovative open-source tools that will allow me to delineate the mechanisms of ACA7 dysfunction more readily and to impart this knowledge to Lincoln students in the research laboratory and classroom. To reach my goal, I will need to visit the research laboratory of a collaborator in Brazil. The goal of my project will be accomplished with the following **specific objectives**:

Objective 1. To build open-source neuroscience tools for experiments using *C. elegans*.
Rationale and How Outcomes Will Be Measured. To understand ABCA7's role in learning impairments, I have designed a 3D-printed T-maze for learning and memory of *C. elegans* models of Alzheimer's disease. The T-maze works well, but there needs to be more stability in the 3D-printed apparatus that I used to help visualize *C. elegans* as they navigate the T-maze. For two weeks in August 2026 (the last two weeks if sabbatical is awarded), I plan to visit the laboratory of my collaborator, Dr. Andre Maia Chagas, at Pontifical Catholic University of Campinas (PUC-Campinas) in Brazil. Dr. Chagas is a former faculty member at the University of Sussex in the United Kingdom and is an expert in open neuroscience tools. He will help me build a stable open-source and cost-effective microscope (up to 1000x magnification) and video tracking system for *C. elegans*. The **rationale** is that the development of a more stable open neuroscience tool will allow me (and my students) more readily to visualize and track *C. elegans* as they learn and generate more publishable data. Dr. Chagas will instruct me on how to use the open-source

Bonsai video acquisition software to analyze the videos. While visiting Dr. Chagas' lab, I will also build a mechanical stimulator for *C. elegans* experiments using open-source tools. A two-week visit should be ample time to build the tools since I was able to make two open-source tools (electronic "neuron" called Spikeling and one of my 3D-printed T-mazes) in a 1-week open neuroscience course that Dr. Chagas facilitated at Stony Brook University (Chagas et al., 2023). If necessary, I can make some items at Lincoln with my 3D printer. Once data are published, the codes of the open-source tools will be shared and tracked for their usage. Engagement of the tools in lab and class at Lincoln will be measured as well.

Objective 2. To test the role of the ABCA7 gene variant in neurodegeneration, learning, and memory in *C. elegans*, using open neuroscience tools for tracking, microscopy, and analyses.
Rationale and How Outcomes Will Be Measured. The orthologue of ABCA7 in *C. elegans* has a loss of function of *ced-7*. Ced-7 helps degenerated axons to fuse and promotes neuronal plasticity. My research students have begun imaging degenerated neurons in *ced-7 C. elegans* strains and testing their learning in the 3D-printed T-mazes. The open-source tools developed in the project will facilitate analysis of neuronal images and track the *C. elegans* in the 3D-printed T-mazes, measuring distances traveled. The **rationale** is that obtaining more detailed analyses of neurodegeneration, learning, and memory data will enable me to have sufficient preliminary results to begin writing a grant proposal for additional funding.

Enhancement of Research and Teaching at Lincoln University

The outcomes of the proposed project will greatly benefit Lincoln University. The project is focused on innovative technologies and cutting-edge research. This alone bolsters the research advancement of the University and provides a high level of engagement for our students at Lincoln. Training in my collaborator's lab will foster faculty development. Open-source neuroscience tools save money for the University. Open-source technology enhances teaching. My students have shown much enthusiasm using Spikeling in BIO-4012 Neuroscience and 3D-printed T-mazes in research; students should be quite impressed with the new open-source tools built. Furthermore, *C. elegans* strains are inexpensive – one reason why I have used them in my research. There will be new opportunities for student internships at PUC-Campinas and University of Sussex. Faculty-led study abroad and international research are already in the talks. The proposed project could also benefit faculty-faculty collaborations within Lincoln. Thus, research and teaching at Lincoln University will be enhanced from the proposed activities.

Timeline

Objective	**Summer 2026**	**August 2026**	**September 2026**	**October 2026**	**November 2026**	**December 2026**
Objective 1	Final preparations for visit.	Visit Dr. Chagas lab in Brazil to develop open neuroscience tools.	3D-print any remaining parts of tools at Lincoln.	Inform Dr. Chagas on how the tools are working.		
Objective 2	3D-print more T-mazes.		Order more ced-7 strains of *C. elegans* (or use frozen stocks).	Test learning of ced-7 *C. elegans*, using tools built.	Continue learning experiments and analyze images.	Begin writing grant proposal and a manuscript.

Dissemination of Project's Outcomes

The project's outcomes will be disseminated widely. The outcomes will be presented at the Faculty Research Symposium in Spring 2027 and at the Society for Neuroscience Annual Meeting in Fall 2027. Journal articles will be written. In class, students will learn how to use the open-source neuroscience tools and *C. elegans*. Codes for the open-source tools will be shared with the scientific community.