

## **Proposal for FWI Funding: Faculty Development**

### **The Applied Learning Laboratory for Undergraduate Research Excellence (ALLURE) in the Department of Biology**

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Department of Biology, Faculty of Science

#### **BACKGROUND**

In the Globe and Mail's 2013 Canadian University Report, McMaster University was ranked highest amongst student satisfaction in the large university category for undergraduate research opportunities<sup>1</sup>. In tandem with McMaster's renowned reputation for innovation in education and research, the Department of Biology emphasizes a curriculum with active learning and robust research opportunities. It is this emphasis on engaging students in scientific research that we wish to build upon.

The undergraduate experience can be greatly enhanced by engaging students in research opportunities<sup>2</sup>. These opportunities may be broadly classified into course-based labs, inquiry- or project-based labs, and authentic research experiences. Authentic research experiences are those in which students are working directly in a research lab and contributing to novel research and discovery. Engaging students in authentic research is regarded as the most effective way of encouraging students to stay in and succeed in careers in science, technology, engineering, and mathematics (STEM)<sup>3,4</sup>. With increasing numbers of undergraduate students, it is unfortunate that space, resources, and importantly faculty time, limit student access to an authentic experience in a research lab. At McMaster University, even as there is an increase in research opportunities in specialized programs, the majority of students, who are not in such programs, struggle to obtain equivalent placements. This means that a vital complement of skills and attitudes that essential to careers in science – critical yet creative thinking, experimental design, data analysis - are experienced by the minority of our graduating students. We have gone well beyond the apprenticeship model of undergraduate research. Engaging in research as an undergraduate not only informs a student's choice about graduate research, but also fosters critical thinking skills that are essential to successful careers in the fields that the majority of our graduates pursue including health care, environmental response, science policy, and scientific communication.

The Department of Biology currently has 3 teaching-track professors (Kim Dej, Lovaye Kajiura and Chad Harvey) and a contractually limited teaching-track professor (Rosa da Silva) that are actively engaged in the mentoring and supervision of the research projects of undergraduate science students at McMaster across many programs including Biology, iSci, Origins, and Life Sciences. These projects are in the fields of genetics and molecular biology, cellular and systemic physiology, ecological, and pedagogical research projects. As teaching professors, we define our educational leadership to include the active engagement in discipline-specific scientific research with undergraduate students, with the clear aim of imparting vital research and communication skills to our students. Students have the opportunity to engage in undergraduate research opportunities in levels 2, 3, and 4 only if they are able to secure an independent position in a research lab. This is facilitated through courses such as LifeSci2AP3, Bio3I03, MGB3I03, LifeSci3RP3, Bio4F06 and 4C09, and LifeSci 4A03, 4B06, and 4C09. While the opportunity exists in theory, the reality is that many students cannot seize the opportunity, due to limited lab space and supervisors. Hundreds of requests for laboratory placements are turned down.

#### **PROPOSAL**

Over the last 8 years, Dr. Dej has mentored undergraduate thesis students in projects using *Drosophila* and nematodes as model systems to study cell biological and genetic questions. These projects have engaged between 6 and 12 students in research projects on an annual basis, a total of over 65 students. Dr. da Silva joined the Department in Summer 2014 and she is establishing undergraduate research projects with an emphasis on cellular and systemic physiology. Together, we would like to develop an undergraduate

research lab space, the Applied Learning Laboratory for Undergraduate Research Excellence (ALLURE) in the Department of Biology. Dr. Roger Jacobs, Chair of the Department of Biology, has agreed to designate space for ALLURE. This is undergraduate laboratory space in Burke Science Building (BSB201) that is occasionally used for lab courses. This space will be used more intensively through the Fall, Winter and Spring/Summer terms as dedicated undergraduate independent research space. ALLURE will have specific emphasis on discipline-related undergraduate research excellence, mentoring, and scientific literacy.

Students at ALLURE will be involved in team-projects focused on genetics, cellular and molecular biology, cellular physiology, and systemic physiology. While projects may relate directly to the research strengths of Drs. da Silva and Dej, Research Faculty will be invited annually to propose collaborative projects that can be mentored by the Teaching Professors. The scientific direction would be proposed in collaboration with research faculty and the mentoring of skills, critical thinking, and research methods would come from the Teaching Professors. In addition, we would make this centre a prominent feature in the Burke Science Building. This will be a significant focal point for undergraduate recruitment during Fall Preview and May@Mac events.

This Forward with Integrity Proposal seeks to fund the establishment of ALLURE in which up to 24 undergraduate research students per academic year may engage in independent research. The requested funds are for resources required to establish the ALLURE centre. In subsequent years, funding will be possible through collaborations with research groups, and other internal and external opportunities. The ALLURE lab will also provide a fertile environment for the Teaching Professors to engage in the design and testing of innovative and exciting new undergraduate laboratories and modules that are directly linked to courses in Biology and Life Sciences.

### **PROJECT OUTCOMES**

- 1) Providing support, resources, and mentoring to increase the capacity for independent undergraduate research opportunities in the Department of Biology.
- 2) Providing a permanent space for the innovation and development of laboratory research projects that can be implemented in larger course-based modules.
- 3) Engaging undergraduate students in the fundamental research objectives of the Department of Biology.

### **Professional development:**

- As teaching professors, we believe that actively engaging in undergraduate research informs our teaching and creativity in the classroom.
- Presentation and publication of undergraduate research projects and laboratory modules developed in the space will allow us to contribute resources to the international community.
- Undergraduate-research projects in collaboration with faculty outside of Biology encourage interdisciplinary teaching in the classroom.
- Fostering an undergraduate research community for Teaching Professors in the Faculty of Science.
- Ensuring that there is not a line severing teaching from the practice of science.

### **Student outcomes:**

- Creating the understanding that knowledge is not just learned, but discovered.
- Fostering an appreciation for basic research in undergraduate students.
- Establishing a strong sense of teamwork, leadership, and communication.
- Fostering of the critical thinking skills essential to student learning outcomes and future career success.
- Building self-confidence in a student's abilities as a scholar.
- Engagement of undergraduate students in publishable research such as the publications with undergraduate student authors who were co-supervised by Dr. Dej or Dr. da Silva <sup>5, 6, 7, 8, 9</sup>.

**EVALUATING OUTCOMES:**

ALLURE creates a positive environment that will encourage the professional development of Teaching Professors in the Department of Biology. Over the next two years, the success of the centre will be evidenced through the publication and presentation of the approaches and resources developed for undergraduate research. Presentations at professional meetings including the American Society of Cell Biology, Canadian Society of Zoology and the Insect Biotech Conference will be targeted towards the increasing number of workshops on education and undergraduate research that we see at these discipline-specific conferences. Success will also be monitored by tracking the implementation of our approaches at other Universities as our resources for undergraduate research that will be freely shared with the international community. Finally, vital to our professional development is evidence that ALLURE has had an impact on our undergraduate students. We will be evaluating the effects of these independent research opportunities on learning outcomes including scientific, literacy, communication, and critical thinking through collaborations with MIIETL.

**ANTICIPATED DATE OF COMPLETION**

ALLURE will be set up in Fall 2014. In the first year we will have a cohort of approximately 12 students complete independent projects. In year two, we will be closer to carrying capacity with 24 students working in the facility across three terms.

**RESOURCES REQUIRED FOR ALLURE CENTRE IMPLEMENTATION:**Permanent Lab Resources:

- refrigerator/freezer (\$500)
- glassware, cell culture dishes, slides and cover slips, pipettes, petri dishes (\$500)
- fine dissecting tools (4 forceps-\$200, spring scissor (\$200), Extra fine Bonn scissors (\$200), Blade holder scalpel and breakable blades (\$450)
- serological pipettes (\$200), pipette aids (p2, p1000)- \$600
- A sign for the hallway that alerts students and visitors to the ALLURE facility (\$500)

Short-term Resources:

- primary and secondary antibodies (histone, Cy3, Cy5, phalloidin, propidium iodide, DAPI, histone proteins, neurobiotin, tubulin) -\$500
- Western blot products and reagents (Protein ladders-\$160, Western ECL substrate, \$150, -Acrylamide, SDS solutions and TEMED solutions (\$64) nitrocellulose membranes (\$300)
- Other reagents: Bovine Serum Albumin (\$80), TRIS(hydroxymethyl) aminomethane (\$200), Ammonium Persulfate (\$50)

**Total funds requested: \$4854**

**References:**

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  3. Russell, S.H. Hancock, M.P., and McCullough, J. (2007). Benefits of Undergraduate Research Experiences. *Science*, 316: 548-549.
  4. Seymour, E., Hunter, A.-B., Laursen, S.L., and DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education*, 88(4): 493-534.
  5. Lee D, Taufique H, da Silva R & AB Lange. (2012) An unusual myosuppressin from the blood-feeding bug *Rhodnius prolixus*. *J Exp Biol*. 215(Pt 12):2088-95.
  6. da Silva R, da Silva SR & AB Lange. (2012) The regulation of cardiac activity by nitric oxide (NO) in the Vietnamese stick insect, *Baculum extrudentatum*. *Cell Signal*. 24(6):1344-50.
  7. da Silva S, da Silva R & AB Lange. (2011) Effects of crustacean cardioactive peptide on the hearts of two Orthopteran insects, and the demonstration of a Frank-Starling-like effect. *Gen Comp Endocrinol*. 171(2):218-24.
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  9. Dej, K., Ahn C and Orr-Weaver, TL. 2004. Mutations in the *Drosophila* condensin dCAP-G: defining the role for chromosome condensation in mitosis and gene expression in interphase. *Genetics* 16(2): 895-906.
- (Undergraduate students indicated in bold.)

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This proposal is endorsed by:

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Dr. Robert Baker  
Dean, Faculty of Science

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Date

*(attached)*

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Dr. Roger Jacobs  
Chair, Department of Biology

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Date



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2014-05-02

Selection Committee  
Forward With Integrity Faculty Development

Selection Committee,

I am writing to provide my full support for the ALLURE Centre FWI proposal authored by Drs. Kim Dej and Rosa daSilva. From a faculty development perspective this is a strong proposal because it engages our teaching professors in more hands- on research interaction with students and adds breadth to their pedagogical skills development. The Department of Biology has identified the enhancement of the quality and accessibility of hands-on research experience as its highest undergraduate training priority. This proposal adds momentum to Biology's efforts to provide inquiry directed wet-lab research experience to a broader population of students, in alignment with Departmental priorities.

This application leverages the commitment from the Provost to expand Cell Biology lab infrastructure in the Faculty of Science. This new equipment, and consumables funded by FWI will jumpstart project development and use of the facility by a larger number of students.

Sincerely,

A handwritten signature in black ink, appearing to read "Roger Jacobs". The signature is fluid and cursive, with the first name "Roger" being more prominent than the last name "Jacobs".

Roger Jacobs  
Chair, Department of Biology