

#### No-Cost Extension Request

Grant Title: "Development and evaluation of StarCellBio: a cell biology experiment simulator for science education"

Grant Number: NSF DUE-1122616

OSP Account: 6924322

PI: Graham Walker

Dear Laureen Horton,

I am contacting you because we would like to request a no-cost extension for our TUES StarCellBio Grant #1122616 (OSP Account # 6924322). As of August 31<sup>st</sup>, 2014, we project having approximately [REDACTED] (total costs) in remaining funds, which we are requesting to utilize over the no-cost extension period to meet the grant's goals.

### REASONS FOR UNEXPECTED FUNDS

During the past academic year, we have prioritized the development of the StarCellBio tool itself over its assessment and dissemination. In addition, we have engaged in several outside funded initiatives that have resulted in the conservation of grant funds.

First, during the past three funding years, our group made the decision to focus on the development of StarCellBio to be implemented in online and blended courses, thereby postponing its assessment and dissemination and conserving anticipated conference travel and workshops-associated costs. In addition, feedback obtained from initial prototypes of StarCellBio at the end of the first funding year, indicated the need for a clear, user-friendly user interface, which led us to work with a user interface designer, a development stage for which we had not initially planned. While the final results of this work are readily apparent for students and instructors using this tool, the incorporation of a user interface design stage, followed by a subsequent rendering of a clean and user-friendly design, has led to the overall development of StarCellBio taking longer than originally anticipated and a delay in the assessment and dissemination stages.

Second, Lourdes Alemán and Alison Brauneis, who are both integral contributors to this project and whose salaries are paid in part through this grant, have been active participants in two outside funded initiatives, the MIT-Haiti Initiative (<http://haiti.mit.edu/>) and an Education Development Center (EDC)-USAID-funded project. With the MIT-Haiti Initiative, we designed and led three different workshops in Port-au-Prince, Haiti over the last 18 months. With the EDC project, we developed and implemented a new online course, called *Best Practices for Teaching and Learning*, for science faculty in Pakistan.

### ACTIVITIES PLANNED FOR NO-COST EXTENSION PERIOD

During the last year, we have built the third experimental technique, microscopy, which will be included in the first version of StarCellBio available for public launch. In addition, we successfully implemented StarCellBio in MIT's cell biology course (course 7.06) this spring, gathered student feedback in the form of feedback surveys and interviews, conducted usability testing of the flow cytometry and microscopy experimental techniques, and initiated work on animation and visualization resources that will be available in StarCellBio. While StarCellBio is currently in the final stages of development prior to its worldwide public launch, we have much left to do to finalize the development, assessment, and dissemination of this new tool. We propose to work on the following aspects of StarCellBio in the no-cost extension term:

#### Development

Although we have been able to design and implement the core functionalities of this experiment simulator in the past three funding years, the following important features remain to be developed:

*i. Assignment Builder.* The development of an assignment builder was proposed in our NSF grant, but has been delayed due to the longer development time of StarCellBio's core functionalities, which also includes the user

interface and graphic design work previously mentioned, than was originally anticipated. In the Assignment Builder, an instructor will be able to create and customize their own StarCellBio experiments, which represents the most instrumental functionality for StarCellBio's dissemination and use by instructors all over the world. We have already defined all the user interface components necessary this functionality and have commenced work on the design of paper prototypes of its user interface. During the next academic year, we will work with a graphic designer to render the graphic design in a similar style as the rest of the program before building and implementing this feature in StarCellBio. Following implementation of the Assignment Builder functionality and user interface in StarCellBio, we will conduct usability and accessibility testing with MIT's Usability and Accessibility Laboratory to ensure that this new feature is accessible and usable by its target population, instructors. Following usability and accessibility testing, we will then assess the effectiveness and ease of use of this new feature through feedback surveys and focus groups. The feedback obtained will then be implemented and tested along with the addition of video tutorials designed to guide instructors on how to use the Assignment Builder for their courses.

*ii. Lab Notebook.* The Lab Notebook feature was not originally proposed in our grant proposal to NSF, but instead emerged as an important feature to consider developing through focus group's and students' feedback. In the Lab Notebook, students will be able to compile and annotate their experimental findings generated within StarCellBio as well as provide additional analyses of their findings before submitting their assignment report to their instructor. In a response to our last progress report, our NSF Program Officer Terry Woodin encouraged us to include this new functionality within the program before the end of our grant, stating that she thought this would be an important feature of the program. We have already defined all the user interface components necessary for this functionality and have commenced work on the design of paper prototypes of its user interface. As with the Assignment Builder functionality, during the next academic year, we will work with a graphic designer to render the graphic design of this feature before implementing it in StarCellBio. Following implementation of the Lab Notebook functionality and user interface in StarCellBio, we will conduct usability and accessibility testing with MIT's Usability and Accessibility Laboratory to ensure that this new feature is accessible and usable by students. We will then assess the effectiveness and ease of use of this new feature through feedback surveys and interviews.

*iii. Modularization & Integration in the MITx/edX Platform.* StarCellBio's development occurred in the midst of the announcement and subsequent development of the MITx/edX platform. We have implemented the tool within this platform this past spring within MIT's cell biology course (course 7.06), but as a separate application that students access on the platform through a web hyperlink. Student feedback on this implementation effort (feedback survey and student interviews) indicated that they wished to access StarCellBio directly within the actual online course platform. This will require separating StarCellBio's experimental components (experimental setup and each of the techniques provided within the tool) into small widgets that can be easily embedded within any online course platform. We believe this to be an important functionality for the ease of implementation of StarCellBio in future online courses and would like to commence its development after the assignment builder and the lab notebook features have been completed.

*iv. Animations and Visualizations.* In our last progress report, we reported that we procured funding from MIT's Alumni Class Fund to create visualizations and animations explaining complex cell and molecular biology concepts, experimental processes and techniques. During the last funding year, we have started to work with an animator with a Ph.D. in Biology to develop animations on flow cytometry and fluorescence, an experimental technique and important concept encountered within StarCellBio. During the next year, we propose to develop three more 2-5 minute animations on western blotting, antibodies, and microscopy in collaboration with the animator. In addition, we will make illustrations and other visualizations of these same processes and concepts for use in StarCellBio's reference library. We will then implement the animations and visualizations in relevant areas within StarCellBio to enhance student understanding of the concepts as well as the experimental techniques and processes contained within the program. Once all of the animations and visualizations have been developed and implemented within StarCellBio, we will gather feedback from students in MIT's cell biology course (course 7.06) on the effectiveness of the animations and visualizations on enhancing their understanding of the experimental techniques, processes, and concepts included within StarCellBio.

## Assessment

One of our key objectives is to assess the effectiveness of StarCellBio at enhancing student understanding of experimental data analysis, experimental design, and proper control selection. This component of the StarCellBio project is a longer-term project that will extend for at least an additional academic year and possibly longer. Last year, we reported that we had developed an open-ended concept quiz to assess student understanding of experimental design, experimental setup, and data interpretation. To develop a quiz for large-scale use, we realized the need to develop and validate a multiple-choice quiz. In the next year, we will develop a new quiz to directly assess students' understanding of experimental data analysis, experimental design and proper control selection. The quiz will be developed using an iterative approach to draft the questions, gather student and instructor feedback, and then revise the questions repeatedly until a clear, validated multiple-choice quiz has been developed. We will then implement the quiz before and after student use of StarCellBio in MIT's cell biology course (course 7.06) during springs 2015 and 2016. Since MIT's cell biology course with which we are associated is only held in the spring semester, our assessment of the effectiveness of StarCellBio is limited to those semesters. Student interviews will also serve to complement the findings from the quiz. In addition, we will also assess the students' StarCellBio user experience by gathering student feedback data and conducting student interviews. Following collection of all forms of data, we will analyze and disseminate the findings through a publication. The assessment of StarCellBio has depended on the development of the tool, as is expected, but also on its utilization in MIT's cell biology course (course 7.06), which is offered during the spring semester. Therefore, assessment and data collection take place on a yearly cycle, which prevents our ability to do rapid cycles of implementation, evaluation, and revisions of assessment tools.

## Dissemination

In the past three years, we have prioritized the development of the tool over its dissemination, to ensure the completion of a functional product that could be implemented in our own MIT courses before the end of the funding period. We strongly believe outreach to be a crucial component of any educational project and will utilize the additional time to disseminate the tool and related findings through the following means:

*i. Freely-available curriculum to accompany StarCellBio.* One of our goals for StarCellBio is to widely disseminate the tool along with example exercises for instructors to implement in their own classrooms. During the next year, we propose to develop and implement 3-5 cell and molecular biology exercises to accompany StarCellBio. The exercises will cover each of the three experimental techniques: western blotting, flow cytometry and microscopy included within StarCellBio as well as important experimental concepts such as the selection of proper positive and negative controls. Following their integration into the program and use by instructors and students, we propose to gather feedback from instructors on the exercises and their applicability within their own cell and molecular biology curricula.

*ii. Publications and presentations.* To widely disseminate StarCellBio and its accompanying curriculum, we propose to publish an article on the StarCellBio tool during the next year and the results of our StarCellBio assessment project in the year following that. The first paper will focus on the development of the program itself, including the iterative, multi-step process used to develop a usable, effective program for biology education. The second paper will focus on the assessment of the effectiveness of StarCellBio at enhancing student understanding of experimental design, data analysis, and control selection. In addition to the public launch of StarCellBio on its website, these papers will further serve to disseminate the new cell and molecular biology experiment simulator to a worldwide audience. In addition, we will disseminate the tool itself and our results through talks and workshops in relevant biology and education conferences.

## PROPOSED PLAN FOR THE FUNDS

During the no-cost extension term, the funds will be used to pay for a larger portion of Alison Brauneis' salary, a postdoctoral researcher who will support and spearhead all of the activities described above. Lourdes Alemán, a research scientist, is anticipated to transition to 100% full-time effort with the Office of Digital Learning as of October 4th, 2014. However, I hope to negotiate a portion of her time and pay for it with NSF funds for her continued involvement in the activities proposed above.

In addition to supporting the initiatives mentioned above, we anticipate the following costs, including (1) new technology (computer) costs, (2) graphic design costs for the Assignment Builder and Lab Notebook user interfaces, (3) compensation for student volunteers participating in the assessment of StarCellBio, (4) interview transcription costs, and (5) travel costs to attend conferences.

Please do not hesitate to contact me if you have any further questions,

Best wishes,

A handwritten signature in black ink, reading "Graham Walker". The signature is fluid and cursive, with the first name "Graham" and last name "Walker" clearly distinguishable.

**Graham Walker**

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