INTEGRATING FIRST YEAR STUDENTS IN PRIMARY BIOLOGICAL RESEARCH: A FEASIBILITY STUDY

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INTRODUCTION:

The level I Biology course (Biology 1A03) is a course that serves over 1200 students each year. The students are introduced to fundamental concepts in Molecular and Cell Biology that they will need in all programs under the Life Sciences umbrella. These students will go on to programs in Biology, Biochemistry, Psychology, Life Sciences, and many others. In this course, the students are also introduced to some essential laboratory skills and tools.

We would like to engage our students in a real research question as they learn the skills required in a biology lab. The question is, what is the association between enzyme activity, gene copy number, and gene evolution (Meisler and Tang, 1993)? Students will collect samples of their own amylase enzyme from saliva and their own DNA from cheek cells. Simple tests will assay for protein activity and DNA sequences. The most exciting part for the students is that their data will contribute to a collection of data from the whole class on an annual basis. Across these thousands of samples, we can analyze the association between cultural background, diet, protein activities, and gene evolution (Tang, 2007).

This restructuring would encourage students to think about biology concepts and laboratory skills in the context of a contemporary question in the life sciences. It will also introduce students to an interdisciplinary approach to scientific research. Students will see that biological questions cannot be neatly slotted into subfields, but that researchers from many fields contribute information that in its aggregate tells us something about our selves and our world. This will also allow the Department to illustrate the role of basic biological research in addressing questions of importance to human health.

A central element of this project will be to teach students elements of research ethics and design, especially in the context of the use of human subjects in research.

This proposal seeks funding to determine the feasibility of the project on the scale of over a thousand students per year across three terms. The funds include reagents for development and a one-term pilot. If the pilot is successful, this would be a part of Biology 1A03 and would be funded with the resources currently devoted to the lab component of this course.

STUDENT OUTCOMES:

1) Introduction to essential scientific skills
- Scientific literacy including an understanding of scientific concepts and mechanisms
- Laboratory skills and techniques including the ability to analyze and interpret data
- An understanding of the interdisciplinary nature of scientific inquiry

2) Bringing learning out of the lecture into an active research project
- Students would be contributing their time and data to a large-scale research project.

PROJECT OUTCOMES:

This research question is not part of a single lab in the Department of Biology. It is a project that would be owned by the students the first year Biology course. Data could be published in two formats: i) publication in a pedagogical journal to illustrate a novel approach to undergraduate research; ii) possible publication of aggregate data in a scientific journal.

PROJECT IMPLEMENTATION:

Timeline: The project could be introduced as a pilot in May 2014 to the cohort of students taking the course in the spring term, approximately 100 students. This would be followed by incorporating the lab into the course in Fall and Winter 2014/15 to over 1000 students.

Structure of labs and supporting activities: The lab experience would cover a single story: the evolution of the amylase gene family in humans. Students will be studying: protein synthesis, enzyme activity, the processing of carbohydrates, the gene to protein relationship, the polymerase chain reaction (PCR), genome studies and gene evolution, and human microbiomes.

The laboratory component would alternate between wet-lab experiments and online tutorials.

Lasb: 1) obtaining and preparing saliva sample; 2) amylase enzyme assay; 3) obtaining cheek cell DNA sample; 4) amplification of DNA using PCR.

Four laboratory video presentations would be made that demonstrate the techniques to be used in the lab. These would be available to the students before and after the lab to review, but importantly would be in the lab on a display as the students step through the activities. Students can pause, rewind, and review each technique as it is performed.

Tutorials: 1) Research ethics and design; 2) Protein structure; 3) Carbohydrate structure; 4) Gene structure; 5) Preparing for a PCR experiment; 6) Data analysis; 7) Communicating and disseminating scientific results; 8) Reading and interpreting published papers.

Online tutorials would be followed by quizzes that test for the ability to perform calculations and interpret data, and assess the students' understanding of the underlying concepts.

In addition, we would like to introduce students to the use of a **digital lab notebook**. These lab notebooks would be available to the course instructors for periodic review and evaluation and would teach students the skill of appropriate note-taking in the lab (Giles, 2012)

PHASE 1: DEVELOPMENT OF LABORATORY RESOURCES, SUMMER AND FALL 2013

OVERVIEW: The four lab techniques described have been published. We need to test whether they can be easily scaled up to over 1000 students per year. Upper year biology students will test out the protocols, develop the online tutorial materials, record the laboratory video presentations, and test the application of online or digital lab notebooks. These students will be completing these tasks and the evaluation of project as part of either a thesis project (Biology4F06) or as a research placement (Biology3EP3).

BUDGET: $2400 for 1000 student samples in the pilot project. This funding is requested because it is above the current cost of running the labs. If the lab module becomes a part of the level 1 course, the costs will be integrated annually into the lab budget.

PHASE 2: EVALUATION OF THE LABORATORY EXPERIENCE

OVERVIEW: We anticipate publication of the new laboratory description in a pedagogical journal and would like to begin collecting data on the student experience. We propose that this can occur primarily through students with an interest in pedagogical research. These students can accumulate and analyze data that comes from student evaluations as part of a fourth year Honors thesis project.

IMPLEMENTATION: Student evaluations would need to be developed in the months prior to the project initiation, but the thesis project could run in 2014/2015.

BUDGET: No monetary needs are tied to this.

CONCLUSION: This lab structure is significantly different form the standard three-hour per week lab. Students have the opportunity to repeat sample collection at different points if necessary. There is no "right" answer; students are contributing data to a larger set that they will analyze.

TOTAL FUNDING REQUESTED: The total funding request is for $2400. This would provide the funds to set up the lab and run the pilot. If successful, future lab resources would come from the Department of Biology.

REFERENCES

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