Evaluation of Laboratory Exercises for a New Biochemistry Laboratory Course

Proposal for IUSB Curriculum Development Grant
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for
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This proposal requests $2400 to hire a student during the summer to test a set of laboratory experiments for a new course, Biochemistry Laboratory C486, to be offered yearly, beginning Spring 2000.

In response to student suggestions the Chemistry Department at IUSB is expanding our biochemistry program to provide our students with an undergraduate biochemistry laboratory course. We recently redesigned our biochemistry offerings to include a 2 semester sequence of biochemistry courses (C484 and C485). The addition of a laboratory course, C486, will complete a well-rounded biochemistry program. Together with our other biology and chemistry course offerings, this biochemistry sequence should fully qualify our students for graduate studies in biochemistry, genetic engineering, biophysical chemistry, drug design, medical research, and plant biochemistry as well as other fields in chemistry and biology.

To ensure a positive learning environment, the experiments chosen for this new laboratory course should be thoroughly field tested and any experimental or logistical problems should be identified and solved before the students do these experiments. Since this is a new course, all the experiments will be new to IUSB, and all of them need to be ready for the Spring 2000 course. This proposal asks for funds to hire a student during the summer to troubleshoot all the planned laboratory experiments.

What activities are planned?

A chemistry, biology, or secondary education major will be hired to test a series of laboratory experiments (see attached tentative syllabus). A student who is unfamiliar with biochemistry techniques but skilled in other laboratory skills is preferred. In this way the novice student will closely match the experiences of students likely to enroll in the C486 course. The hired student will thus be providing me information on realistic time expectations and where problems in techniques and misconceptions are likely to arise. I will work closely with the student to show him/her the salient biochemistry techniques and to troubleshoot the problems that are bound to occur.

The student will gather appropriate chemicals and instruments, and prepare the stock solutions required for the experiment. Careful documentation will provide me with a protocol for reagents preparation for the lab class so that in future years, I will be able to quickly prepare the reagents necessary for the students to begin the lab. This summer the hired student will also perform each experiment as if it were being done in a 3 hour laboratory period. As in any new laboratory experiments, technical difficulties are inevitable, and I will work closely with the student to determine solutions to the problems that arise.

The student hired from funds from this proposal will test all equipment to be used in the laboratory course. The chemistry department has obtained several fraction collectors and micropipettors from Bayer Corp when it relocated some of its divisions. These pieces of equipment have not yet been tested or calibrated. The student will clean and test each piece of apparatus to be sure the equipment functions well before the
laboratory class begins. The student will also calibrate all the Pipetmen (micropipettors) and change filters, plunger tips, etc. as necessary.

As the student does each planned laboratory experiment, he/she will also be keeping track of time to be sure that novice students will be able to complete the experiments in the time allotted for the class. Because techniques in biochemistry differ considerably from laboratory techniques used in other chemistry courses, I expect that students enrolled in the course will require extra time than those students who have participated in an undergraduate research project and considerably more time than if I tested the labs myself. By testing the lab experiments, a novice student will provide me with an indication of labs that will be problematic in terms of time, and which steps are most time consuming of confusing to students with little background.

One exciting experiment that will require considerable adaptation is one in which the catalytic activity of RNA (ribozymes) will be demonstrated. This is a new and exciting field of biochemistry which is being explored for use in AIDS treatments, cancer, crop engineering and many other fields. The protocol as written requires the use of radioactivity to label and detect the nucleotides. Although some undergraduate laboratories use $^{32}$P radioactivity, there are inherent risks, especially for pregnant women. To avoid these risks (and associated regulations from the Nuclear Regulatory Commission), I would like to try to adapt this experiment to our needs by substituting biotin conjugation to the RNA and subsequent detection of RNA fragments with enzyme-labeled anti-biotin antibodies. The hired student and I will develop and test a protocol for this. If the developed protocol ends up being significantly different than the established $^{32}$P protocol, this may form a basis for a publication in a journal such as the *Journal of Chemical Education*.

This project will be mutually beneficial to everyone concerned. The hired student will learn classic biochemistry techniques and will be introduced to how experiments for educational purposes are designed and implements. The student will also be introduced to research in developing and adapting new detection methods for biomolecules. Students enrolled in the C486 laboratory course will have a much more positive experience and will be able to learn without the frustration of experiments that "don't work." This course will also increase the chances of our students being accepted to graduate programs in biochemistry and related fields. I will be able to continue with my biochemistry research with arsenite oxidase, and still be able to include undergraduates in biochemistry research. The Chemistry Department will benefit by being able to offer an upper level laboratory course for chemistry majors (currently our majors are not able to have a laboratory course for at least 2 semesters of their undergraduate studies because of limited course offerings). The Biology Department will benefit from a upper level lab elective for their students interested in biochemistry and molecular biology. The biotechnology community will benefit from a pool of graduates from IUSB who are familiar with techniques likely to be directly applicable to entry position jobs.

I plan to use 12 experiments for C486, each of which will be tested this summer by the hired student. I expect that the student will be able to complete this project by working 40 hours a week for 10 weeks. I am assuming that some of the experiments will be relatively straightforward and require little adjustment, while others will require more
time and effort to adapt for a smooth and satisfying experience for the students enrolled in the laboratory course.

**What qualifications do you bring to the position as grant director?**

As grant director, I will be working closely with the student involved in this project. I will explain background theory, demonstrate techniques, and carefully monitor the safety and progress of the project. The student will be working in my research laboratory so that I will have constant contact with the student, and be readily available to help the student as required. I expect this will take about 2-4 hours of my time daily. I will be working on my own research project at the same time and in the same laboratory, so I will be in continual contact with the student.

As a biochemist, I am familiar with the theory behind these experiments and most of the protocols. Because the field of biochemistry advances rapidly, there are some protocols which I have not done previously, but I do not expect insurmountable technical challenges. Since I will be teaching the course, this will also be an opportunity for me to become thoroughly acquainted with the experiment and projected pitfalls.

**What previous IUSB awards have you received, what resulted from those projects?**

I have received several IUSB grants, both for teaching and for research. A publication in the *Journal of Chemical Education* was a direct result of two previous curriculum development grants (see attached reprint and highlighted acknowledgement at the end of the paper.)

The following is a list of Curriculum Development, Grant-in-Aid, and Summer Faculty Fellowships and the results from these projects:

1. (1997) Grant-In-Aid and Summer Faculty Fellowship  
"Cloning the Gene for Arsenite Oxidase" This grant and fellowship supported my research with arsenite oxidase. This project is still on-going, and I am now engaged in a research collaboration with Simon Silver's lab at the University of Illinois at Chicago to continue the cloning and sequencing efforts. I and another IUSB undergraduate student will be continuing work on this project this summer.

"Reagent Preparation for Practical Applications of Organic and Biochemistry" This grant was awarded to hire a student part-time to prepare reagents and organize equipment and supplies associated with the restructured C122 laboratory course.

   **Results:** This project contributed to a manuscript, "Enzyme-Linked Antibodies: A Laboratory Introduction to the ELISA Assay" Gretchen L. Anderson and Leo A. McNellis, *Journal of Chemical Education* **75**, 1275-1277 (1997). The manuscript is co-authored with a student who worked with me on this project. In addition, a complete set of reagent preparation instructions was prepared for this course, as well as a well-run laboratory experience for our health science majors.

"Workshop for Techniques in Capillary Electrophoresis; Preparation for NSF Equipment Grant Proposal" This grant (together with travel funds from the Division of Liberal Arts and Sciences) allowed me to attend a two day workshop on capillary electrophoresis.

Results: This gave me the background necessary for writing an NSF grant for a capillary electrophoresis instrument for use in teaching and research. As a result of subsequent restructuring in our department, I no longer teach the laboratory courses in which this technique would be logically introduced. However, I may be able to incorporate capillary electrophoresis into the new biochemistry course.


"Testing and Evaluation of Proposed Organic and Biochemistry Experiments for the Nursing and Allied Health Science Student" This grant was awarded for development of new laboratory experiments for C122, Elementary Chemistry II. The grant covers expenses for an advanced student to test new experiments and help write and draw figures for a laboratory manual for this course.

Results: A publication resulted from this grant: "Enzyme-Linked Antibodies: A Laboratory Introduction to the ELISA Assay" Gretchen L. Anderson and Leo A. McNellis, Journal of Chemical Education 75, 1275-1277 (1997). This journal is the single most widely subscribed education journal in chemistry. The manuscript was co-authored by a student who worked with me on this project.

5. (1994) Classroom Technology Grant

Funding of this grant proposal allowed the Chemistry Department to acquire the HyperChem software. This chemical modeling program is used extensively in many of our chemistry courses, including C100, C102, C122, C105, C106, C483, C341 and C342.

The grant was co-authored by myself and Dr. William Feighery.

Results: The HyperChem software has become a central teaching tool in our department. It is used in virtually every course we teach, from non-majors chemistry to senior level advanced courses. The software has been so useful that our department has obtained twelve copies of the student version with which our chemistry majors can manipulate molecules and understand bonding and chemical theory.

6. (1994) Grant-in-Aid of Research

"Identification of Arsenite Binding Sites in Arsenite Oxidase" awarded April 1994 for part-time summer research wages for David Fingerhut.

Results: This project was the initial work that led to the eventual publication of the manuscript, "Redox State-Dependent Inactivation of Arsenite
Oxidase" by Leo A. McNellis and Gretchen L. Anderson in the *Journal of Inorganic Biochemistry* 69, 253-257 (1997). In addition, David Fingerhut (an undergraduate student) presented his research at the *American Chemical Society Regional Meeting* in Ann Arbor, 1994.

7. (1993) Grant-in-Aid of Research
   Awarded April 1993 for wages for a part-time summer student (Kris Notestine) and matching money for wages for an Intercampus Undergraduate Summer Research Grant for Matthew Martin

8. (1993) Entrepreneurship Grant
   An internal grant to provide myself summer salary and benefits to prepare grant proposals.

9. (1992) Summer Faculty Fellowship
   "Identification of Molybdenum Binding Sites in Arsenite Oxidase and Nitrate Reductase" This grant provided my summer salary for summer research.
   *Results:* This work initiated my research program at IUSB. This research indicated appropriate research directions to pursue for most probable and most immediate results. Although I cannot point directly to publications that evolved directly from this research, the project lay the foundation for all my research projects on arsenite oxidase.

In addition to the above grants for research, I helped students receive 15 grants from the SMART program (formerly the Undergraduate Research Initiative). Most of these students presented research at various regional undergraduate research conferences.
What efforts are underway to obtain additional funding for this purpose?

Since the student will be developing a new, non-radiolabeled detection protocol for one of the experiments, the student will write a SMART proposal to offset the costs of reagents needed for this part of the project.

Agdia, a local agricultural biotechnology company, will provide ELISA kits on a yearly basis for this course, including the development of experiments.

Bayer Corp, a local medical diagnostics company, has donated several fraction collectors, pipettors, columns, rockers, and other ancillary equipment which will be used in this course.

I will loan various pieces of equipment which I have obtained for my biochemistry research projects from external grants and startup funds. These include numerous items, including pipettors, microcentrifuges, Vortexer, quartz cuvettes, assorted glassware, constant temperature freezer boxes, a test-tube rocker, electrophoresis equipment, spectrophotometer, circulating water bath, heat sealer, etc.

The chemistry department funds will supply all other reagents and supplies for this project. The Division of Liberal Arts and Science has also provided extra funds for start-up for this course. The costs of replacing reagents and expendables and equipment maintenance will be absorbed by the chemistry department in future years.
BUDGET

Student salary @ $6.00 per hour, 40 hours/week for 10 weeks $2400

This grant asks only for student summer salary. All supplies, reagents and equipment will be obtained from other sources.