UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

Purchase of an Incubator and a Shaker for Biochemistry Laboratory Courses

Drs. Wu Xu and Yu Wang
Name of Submitter
(Faculty or Staff Only)

Department of Chemistry
Organization
ABSTRACT:

There is no graduate program in the Department of Chemistry and our faculty members focus on undergraduate teaching and research. Our faculty typically teach three to four courses, and often have one to two lab courses each semester. Students learn basic and advanced chemical skills in the chemistry courses including making buffers, titrations, synthesis and separation of small to large molecules, and characterization of compounds and molecules by a variety of spectroscopic and electrophoresis techniques. Nearly all chemical reactions are affected by temperature and strength of sample mixing process. In addition, biomolecule preparation and purification by students requires an incubator at specific temperature and a shaker at specific speed. Incubators and shakers are very common instruments in chemistry labs. Although no graduate program in the department, our chemistry faculty published ~20 papers every year and many undergraduates are the co-authors of the publications. Chemistry labs including biochemistry lab, and undergraduate research labs need an incubator and a small shaker in order for our faculty to efficiently prepare solutions and samples for chemistry lab courses, and for students in chemistry labs to perform certain chemical reactions and culture microorganisms. We feel that a STEP technology fee application is the most sensible way to attempt to address our instrumental deficiencies. This situation compels us to submit this proposal for university support.
Purchase of an Incubator and a Shaker for Chemistry Laboratory Courses

A. Purpose of grant and impact to student body as a whole

Because there is no graduate program in the Department of Chemistry, the department’s mission is focused on undergraduate teaching and training. Currently, the Department of Chemistry offers ten lab courses: CHEM 112 (General Chemistry for Education Majors), CHEM 115 (General Chemistry), CHEM 222 (Analytical), CHEM 252 and 452 (Inorganic), CHEM 233 (Organic I), CHEM 234 (Organic II), CHEM 311 (Physical I), CHEM 312 (Physical II), CHEM 319 (Biochemistry) and CHEM 362/462 (Undergraduate Research I/II) for the students of the Colleges of Science, Engineering, and Education, as well as courses designed for those interested in non-technical fields.

Drs. Xu and Wang along with many faculty members in the Department of Chemistry teach CHEM 115. CHEM 115 (General Chemistry Lab) is designed to reinforce concepts learned in lectures of general chemistry (CHEM 107 and CHEM 108) and provides an introduction into basic laboratory techniques, the experimental methods, and the presentation of scientific data, as well as direct experiences with chemical principles and the properties and reactions of substances and molecules. This lab is a required course for undergraduates majoring in biology, chemistry, physics, chemical engineering, civil engineering, petroleum engineering, and kinesiology. The department typically offers eight sections of CHEM 115 in fall semesters and nine sections in spring semesters. There are also four to five summer sections of CHEM 115, although the number of sections is somewhat variable. Each section has ~25 students (American Chemical Society (ACS) limits number of students in any chemistry lab to 25), and every section is typically full, and has a substantial wait list. It is estimated that approximately 500 students take this lab every year.

Table 1. List of undergraduate majors which require CHEM 115 for graduation

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<th>CHEM 115 General Chemistry</th>
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<td>Biology</td>
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<td>Kinesiology</td>
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Chemistry is one of traditional and fundamental fields. Its applications are to address the challenges facing the world by combating diseases, providing clean water and safe food, developing new sources of energy, developing new materials, and confronting climate changes through interdisciplinary nature of chemistry. To obtain skills in solving world challenges, it requires an appropriate suite of modern chemical instrumentation and specialized lab apparatus to analyze chemical properties of small and large molecules to support undergraduate instructional and research missions. All chemistry labs need a certain type of equipment for students to learn lab skills and collect data. An incubator with a range of temperature from 4°C to 80°C and a small scale shaker are very common equipment. A lab incubator is a cooled or heated insulated instrument used to grow microorganisms or to perform a certain chemical reactions that require specific temperatures. A shaker is a piece of lab equipment used to mix, blend, or to agitate
substances in tube(s) or flask(s) by shaking them, which is mainly used in the fields of chemistry and biology.

There is no shaker even a small scale shaker in any of teaching labs in the Department of Chemistry. There are ovens in all chemistry teaching labs. Ovens are used to control temperature for certain type of chemical reactions. However, the oven cannot precisely control the temperature. It often give 5-20% errors in temperature. In addition, ovens are not right equipment for culturing microorganisms. The main purpose of the proposal is to purchase an incubator and a shaker with its accessories for CHEM 317, CHEM 417, CHEM 319 lab, CHEM 115 lab, CHEM 362/462 lab and CHEM 261. Dr. Xu along with other faculty members who teach those lecture and lab courses. Faculty members and students in our department always share our resources including all equipment. The incubator and shaker will be used in other chemistry labs as well. This situation requires us to initiate this STEP proposal, seeking support from our university. Students will benefit in the following ways:

(i) Both incubator and shaker have been used on daily basis in biochemistry teaching and research labs for last ten years. The objective of Experiments 3-6 is to purify lysozyme from egg white and to characterize the enzyme by enzymatic reaction. Experiments 3-6 involve (1) isolation of proteins from egg white by size exclusion and ion exchange chromatography; (2) protein content analysis by Bradford, Folin-Lowry and UV-Vis methods; (3) separation of the purified proteins by SDS-PAGE. An incubator and a shaker are required to prepare samples for the experiments (Figure 1). In addition to protein purification from egg white, students will isolate cytoplasmic proteins, nuclear proteins and whole cell proteins from mammalian cell cultures, and resolve proteins in SDS-PAGE based on our published methods to characterize proteins. Experiments 9-11 were designed based on Dr. Xu’s EMBO J paper. Four endogenous genes were dependent on the physical interactions between CREB and CBP in response to cAMP signaling. The endogenous cAMP responsible genes were verified by luciferase reporter assay. Two of the constructed reporter genes: cfos and Areg, were used in experiments 9-11. The objective of these three labs is to identify plasmids using two independent methods: enzyme digestion and polymerase chain reactions. These three labs include (1) isolation of plasmid DNAs: cfos and Areg luciferase reporter constructs; (2) enzyme digestion of the plasmids and gel electrophoresis; (3) PCR and gel electrophoresis. Culturing bacterial cells require an incubator and a shaker (Figures 2 and 3). The objectives of Experiments 13-14 are to learn mammalian cell culture, to isolate and to characterize signaling-dependent mRNAs. Experiments 13-14 include (1) mammalian cell culture and cell treatment by anti-cancer drugs [60] and cAMP activator; (2) RNA isolation and reverse transcriptase reaction; (3) semi-quantification of RNA by RT-PCR. An incubator and a shaker are needed to prepare RNA samples (Figure 4);

(ii) CHEM 261 Introduction to Polymer Science: This is a planned new course which will take place in the fall of 2017. In Chapter 7, Characterization of Polymers, determination of molecular weight and polymer microstructures will be discussed. Matyjaszewski and co-workers have recently demonstrated that
modern polymer synthesis methodologies can be implemented within the classical chemistry undergraduate curriculum with ease by providing two examples for undergraduate lab experiments at the nexus of polymer synthesis. An incubator and a shaker will be introduced to integrate synthetic polymers with biopolymers;

(iii) CHEM 115 is designed to reinforce concepts learned in lectures of general chemistry and provides an introduction into basic lab techniques, the experimental methods, and the presentation of scientific data, as well as direct experiences with chemical and/or biochemical principles and the properties and reactions of substances and molecules. An incubator is essential equipment for faculty members to prepare certain solutions for students;

(iv) CHEM 362 and CHEM 462: Research quality is an important indicator of success of an academic program since high quality research will better prepare students to pursue intellectual inquiry. The faculty members have been able to obtain funding to enhance their research activities. Dr. Xu has obtained support from ITRS program, an NSF EPSCoR award, and a RCS award. A number of independent and collaborative projects have been developed by our faculty members. We are very proud of our undergraduates. Dr. Wang is our new faculty and his research focused on kinetics and mechanism of controlled radical polymerization, a method which was widely used for macromolecular architecture design. He has acquired the experiences on polymer architecture design and molecular weight characterizations with size exclusion chromatography, light scattering and MALTI-TOF during his PhD training at Department of Chemistry at Carnegie Mellon University (US) and postdoctoral training at Max-Planck Institute for Polymer Research (Germany) and Centre national de la recherche scientifique (France). In his PhD study, Dr. Wang developed new catalysts for controlled radical polymerization and investigated the factors which influence the quality of the polymers synthesized via controlled radical polymerizations. Equipped with those knowledge he continued his postdoctoral research on the application of polymeric materials with well defined molecular structures in nano medicine and organic electronics. The proposed instruments are essential for undergraduate research. One important objective for requesting funding is to encourage students to be exposed to research and advanced instrumentation early in their education. Many undergraduates are bright, highly motivated, and determined to succeed, but lack academic prepa-
ration and essential lab skills to work at a higher cognitive level and/or research environment. Students with hands-on experience obtained from lab courses or research experience tend to perform better in their course study. Dr. Xu has been conducting surveys on undergraduate research with the goal of integration of research with teaching. Students are interested in learning lab techniques (Figure 5). As a result, the students are more likely to pursue an occupation in science or other professional fields. Research will provide students with a group-based work environment. The interaction with other students (from biology and engineering backgrounds at undergraduate and graduate levels) allows the growth of interpersonal, organizational, and teamwork skills that will better prepare all involved students for their future careers.

B. Projected lifetime of enhancement

The incubator and shaker should be in a good working condition in the laboratory for ten years, only requiring regular basic maintenance.

C. Person(s) responsible for

Implementation: Wu Xu
Installation: Wu Xu
Maintenance: Departmental committee made of up faculty member: Wu Xu
Operation: Faculty of Chemistry Department
Training: Wu Xu will conduct training for faculty members, following their training by the manufacturer

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<th>Budget Proposal</th>
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2. Software       $0.00

No software is required.

3. Supplies        $0.00

4. Maintenance     $0.00

Routine maintenance will be covered by department.

5. Personnel       $0.00

No personnel required

6. Other           $0.00

None
TOTAL: $8,768.30

D. Other relevant information

None

E. Previous STEP projects

Drs. Xu successfully authored a STEP proposals “Smart Classrooms in Chemistry”, funded in 2014 or 2015.