Outcomes Assessment of a Program for Undergraduate Biomedical Science Research

College of Veterinary Medicine and Biomedical Sciences

PI: Christopher Quick, Ph.D., Assistant Professor, Veterinary Pharmacology and Physiology. cquick@cvm.tamu.edu; 845-7261

Co-PI: Evelyn Tiffany-Castiglioni, Ph.D., Associate Dean for Undergraduate Programs, College of Veterinary Medicine & Biomedical Sciences; ecastiglioni@cvm.tamu.edu; 458-2828

Co-PI: Charles Farnsworth, Ph.D., Coordinator of Instructional Design, Educational & Communication Resources. cfarnsworth@cvm.tamu.edu; 862-1226

Abstract

The purpose of the Biomedical Sciences Program at Texas A&M University is to prepare undergraduate students for careers in the biomedical sciences. While many of the students in the program are seeking entry into professional programs, a significant number use the BIMS degree to prepare for research careers in the biomedical sciences. One of the best ways to accomplish the task of preparing students for research careers in the biomedical sciences is by engaging them in undergraduate research experiences. In this proposal we will describe two programs designed to work together to encourage and prepare BIMS students for research careers in the biomedical sciences: The eBat Research Intensive Community (RIC) and the Three-week Biomedical Sciences Summer Academy.

The *eBat Research Intensive Community* provides undergraduates with the opportunity to study blood and blood vessels by noninvasive means. As a part of this effort, the Cardiovascular Systems Dynamics Lab (CSDL) has developed the sole, extant, chronic colony of Pallid bats used in the study of cardiovascular science. The thin, non-pigmented, nearly translucent wing membranes of the Pallid bats allows the microvasculature to be viewed in vivo through a microscope as researchers manipulate such variables as blood pressure, vascular occlusion, wing and body temperature and light stimulation during experimental procedures.

The CSDL has developed a number of unique resources to leverage the assets of the lab. Prominent among theses resources, is an experiential learning/research management system to efficiently train and utilize undergraduate students as partners in the advancement of cardiovascular research. The effectiveness of this management system is such that it is not only beneficial to the productivity of the research scientist but also serves as a valuable learning opportunity for students. Another important CSDL resource is a web-based tool for asynchronous research collaboration and remote control of experiments called eBat. The eBat website is multifunctional; it allows remote experimentation, synchronous and asynchronous communication, and centralized access to manuscripts and ideas being developed by members of the research community. Collectively, the resources developed by the CSDL allow undergraduates to participate in an experiential learning opportunity known as the eBat Research Intensive Community.

The *Three-week Biomedical Sciences Summer Academy* will be offered to students transferring into our program from one of the eleven community colleges who share 2+2 agreements with BIMS. The academy will be not-for-credit and non-graded and will be offered in the College of Veterinary Medicine during the last two weeks of May and first week of June. During this 3-week period, transfer students will tour various TAMU research facilities, complete web-based mini classes on world diseases and writing for scientific publication and participate in research lab rotations. The purpose of this program is to provide an immersion experience at TAMU that will acquaint these students with the campus and other 2+2 students and fuel their interest in biomedical science research.

Summer Academy Workshops will also include instruction on:

- Medical Sciences Library use (including on-line resources)
- Ethics in research workshop (2 sessions)

Summer Academy Tours will be selected from:

- Comparative Medicine Program facility: provides support services for animal research and teaching programs at TAMU; includes specialized housing for genetically engineered mice, pathogen free mice, and the one of the only research colonies of *Monodelphis* (short-tailed opossum) in North America.

- Texas Veterinary Medical Diagnostic Laboratory: TVMDL performs diagnostic testing, such as for infectious disease outbreaks and exposures to toxic plants and chemicals, for thousands of veterinary hospitals and clinics in Texas and throughout the country.

- Wildlife and Exotic Animal Center: a facility of the CVM housing ostriches, African hoofstock, and the world's first cloned deer.

- Image Analysis Laboratory: state-of-the-art facility for the imaging of biochemical and physiologic processes in live cells and in real time; this facility has been externally evaluated multiple times by NIH reviewers as one of the best in the world.

The purpose of this proposal is to provide funding to develop assessment tools to document the experiential learning outcomes acquired by students participating in the eBat Research Intensive Community and the Summer Academy. Funding of these two programs will generate a synergistic benefit to efforts to encourage and assess undergraduate research in the BIMS program. The Summer Academy will expose greater numbers of students to opportunities to participate in undergraduate research and the eBat program will provide a model for encouraging more faculty to provide research opportunities for undergraduates. We anticipate that this model for undergraduate research and the assessment tools developed in this project will facilitate the growth of undergraduate research at this university and others.

Learning Outcomes

The goal of the eBat Research Intensive Community is to help students accomplish the following learning outcomes: (1) understand and apply the scientific method; (2) develop a working knowledge of the anatomical and physiological concepts related to the study of blood and blood vessels of mammals; (3) proper and safe use of laboratory equipment; (4) proper experimental procedures in the laboratory; (5) proper use of the modeling software, STELLA, for communicating results of experimental procedures; (6) teamwork skills; (7) interdisciplinary skills in translating quantitative theory into experimental analysis and (8) skills in communicating experimental results for publication. To understand what students participating in RIC are learning, data will be gathered via a system of online submission and online grading. Dr. Farnsworth will coordinate development and administration of rubrics designed to allow graders to uniformly apply standardized descriptions of various levels of student performance. Pre-test/post-test administration of these assessment tools will provide direct measures of improvements made in students' written communication skills and other research-related performances.

1. Understand and apply the scientific method – students will be able to formulate hypotheses and carry out experimental procedures using the scientific method.

Assessment – weekly evaluations of students' laboratory work by graduate assistant group leaders.

2. Develop a working knowledge of the anatomical and physiological concepts related to the study of blood and blood vessels of mammals – students will be able to apply these concepts clearly and in their proper context as they communicate the results of their experiments.

Assessment – graduate assistant group leader use of a performance rubrics and comments to evaluate student manuscripts at their various stages of development and students' production of peer reviewed publications.

3. Proper use of laboratory equipment – students will be able to demonstrate proper and safe use of laboratory equipment.

Assessment – weekly evaluations of students' laboratory work by graduate assistant group leaders.

4. Proper experimental procedures in the laboratory – students will be able to demonstrate the proper laboratory procedures for testing hypotheses.

Assessment – weekly evaluations of students' laboratory work by graduate assistant group leaders.

5. Proper use of the modeling software, STELLA, for communicating results of experimental procedures – students will be able to use STELLA to develop graphic representations of mathematical models of theoretical concepts.

Assessment – (formative) use of a performance rubric and comments to evaluate students' use of STELLA to develop graphic representations of mathematical models of theoretical concepts in scientific manuscripts at their various stages of development and (summative) production of figures to communicate results in peer reviewed publications.

6. Teamwork skills – students will be able to demonstrate the ability to work productively and cooperatively in small groups and as a member of the entire research community.

Assessment – ethnographic analysis of electronic communications conducted between group members and other members of the research community and weekly evaluations of students' laboratory work by graduate student group leaders.

7. Interdisciplinary skills in translating quantitative theory into experimental analysis – students will be able to develop sound experimental hypotheses after careful reading of relevant, peer reviewed, scientific literature.

Assessment – weekly evaluations of students' work by graduate assistant group leaders, graduate assistant group leader use of a performance rubrics and comments to evaluate student manuscripts at their various stages of development and students' production of peer reviewed publications.

8. Skills in communicating experimental results for publication – students will be able to produce scientific manuscripts communicating the results of their experiments that are worthy of publication.

Assessment – graduate assistant group leader use of a performance rubrics and comments to evaluate student manuscripts at their various stages of development and students' production of peer reviewed publications.

The programmatic goal of the Three-week Biomedical Sciences Summer Academy is to increase the number of transfer students from 2+2 community colleges who enroll in undergraduate research courses in the BIMS program at Texas A&M University. This goal will be measured by

tracking the number of students from 2+2 community colleges that engage in research. The learning outcomes expected for this program are the same for the eBat RIC and with the exception of an the addition of an assessment of knowledge gains from the "Great Diseases" learning module, will be assessed in the same manner.

Use of Assessment Feedback for Improvement

Assessment data will be analyzed each semester to gauge the effectiveness of the eBat Research Intensive Community and the Three-week Biomedical Sciences Summer Academy in reaching their goals. These data will also be used to discover new ways to improve the programs. If the data indicate that the programs are successful in achieving their goals then we will seek to publish the data as a means for improving other undergraduate research programs.

Sustainability

Some of the programs described in this proposal are already being implemented. This proposal will allow us to implement the remainder of the programs and to develop the assessment tools that will allow us to use the learning outcomes to make further improvement in the programs. Also, we have applied for funding from the NIH Bridges to the Baccalaureate Program to provide additional funding to help sustain these programs.

Impact of the Proposal

Approximately 120 students are currently participating in the eBat Research Intensive Community and we plan to have at least 12 transfer students participate in the Summer Academy. Researchers at the College of Veterinary Medicine and Biomedical Sciences have recently completed a proposal for a NIH Bridges to the Baccalaureate grant. If successful, this proposal will serve to bring in additional students that would be added to these numbers. Finally, there is potential to add even larger numbers of students as other researchers from our college adopt this model for undergraduate research. Developing measures of student performance that are practical, valid and reliable will allow the program to be more readily adopted by faculty and supported by the university's effort to expand undergraduate research. Based on current growth rates for the program and increased faculty adoption rates anticipated through funding of this proposal, we estimate having 1,300 *new* undergraduate STEM students per year participating in authentic research at the end of five years.

Budget

Development of web-based assessment tools	
- Web database programming to implement assessment instrument design (100 hours @ $45.00/hr.)	$4500.00
Development of scientific writing instructional module and assessment tools	$2500.00
Development of "Great Diseases" instructional module and assessment tools	$3000.00
Total	**$10,000.00**