

## **2006-1162: NEW PATHWAYS TO EDUCATE FUTURE TRANSLATIONAL RESEARCHERS IN MEDICINE**

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# **New Pathways to Educate Future Translational Researchers in Medicine**

## **Abstract**

We have developed a novel summer clinical medical and research internship targeted at undergraduate biomedical engineering majors in their junior year to train and encourage them to pursue careers in translational medical research. The goal of translational research is to accelerate the transfer of findings from the laboratory to clinical application for the detection, diagnosis, treatment, or prevention of diseases leading to the prolongation and enhancement of life. The course is designed to prepare students for careers in translational research by way of MD, PhD, or combined MD/PhD programs. Goals of the program included exposure to clinical medicine and the relevant vocabulary, research experiences that emphasize the creation and application of new scientific knowledge, and entrepreneurial experience and its attendant vocabulary. The ten-week summer course also emphasizes development of skills in leadership, communication, ethics, and team building.

The typical day for the internship students begins with ninety minutes of lectures and exercises about ethics, communication skills, entrepreneurship, and leadership. Students attend a full-day human cadaver-based anatomy course for the first two weeks of the course. Lectures, dissection, and special projects comprise this course of instruction in the anatomy, physiology, and pathophysiology of the major organ systems. The students spend four days learning physical examination procedure through lectures and clinical sessions. During the second eight-week period of the internship, students attend morning rotations in internal medicine, pediatrics, obstetrics and gynecology, surgery, intensive care, and the emergency room. Students are assigned to a clinical mentor, and observe their mentor interacting with patients, performing clinical procedures, analyzing test results, and developing treatment plans. Students keep a weekly journal in which they describe their experiences in the clinical rotations. Afternoons in the latter eight weeks of the internship are spent working on independent research supervised by a faculty mentor. Students write a short proposal at the beginning of this period and present a poster of their project at the end of the summer.

Faculty from the University of Texas at Austin, M. D. Anderson Cancer Center, the University of Texas Health Science Center-Houston, and Rice University have participated in this program. Students from the University of Texas (summers of 2004, 2005) and Rice University (summer of 2005) have participated in the program. The program evaluations showed an increase in student interest in translational research careers. We believe programs of this kind will create an undergraduate experience that is well suited to develop a new generation of translational researchers in medicine and biomedical engineering.

## **Motivation**

The NIH Roadmap Initiative identified opportunities in biomedical research and education that would make the biggest impact on future progress of medical research. A major outcome of the Roadmap was a call for programs that prepare biomedical scientists and engineers to work in

interdisciplinary teams and to pursue careers in translational research. The goal of translational research is to accelerate the transfer of findings from the laboratory to clinical application for the detection, diagnosis, treatment, or prevention of diseases leading to the prolongation and enhancement of life.

In addition to the NIH Roadmap Initiative, the creation of the internship program was motivated by many calls for reform of undergraduate science, math, engineering, and technology (SMET) education at research universities. Growing evidence shows that hands-on discovery experience is more effective at teaching complex concepts than traditional lectures.<sup>1</sup> The National Academy of Sciences issued a call for SMET courses that enable students to “understand science, mathematics, and engineering as processes of investigation – as ways of knowing; to have hands-on experiences with investigations and to discover the joy and satisfaction of discovery.”<sup>1</sup> We believe programs of this kind will create undergraduate students who are prepared to become the new generation of translational researchers. By reinforcing their abilities to think critically, to work in teams, and to appreciate the value of multidisciplinary research, we believe we will create future graduate and medical students capable of performing at a higher level in their chosen fields. We have reason to hope that adding context to process-based instruction may increase the representation of women pursuing careers in translational research.<sup>2</sup>

A program such as this can work in concert with other programs targeted at post-baccalaureate students to increase their interest in translational research.<sup>3-6</sup> These programs include: 1) extended research experience in medical school that combines clinical and scientific skills, 2) joint MD/PhD degree programs, 3) post-doctoral research training programs for physicians, 4) loan repayment programs for medical doctors pursuing research careers to help offset the financial burden of medical school, and 5) increased NIH and private foundation funding for translational research. While existing programs have shown some success in the training at the post-baccalaureate and post-doctorate levels, our approach is to target undergraduate students as they are preparing to make important career choices

## **Program Description**

We designed a unique Clinical Medical/Clinical Research Internship course targeted at undergraduate bioengineering majors in their junior year. The course is designed to motivate and prepare students for interdisciplinary careers in translational research, leading to bioengineers who can integrate advances in basic research and clinical medicine to develop new diagnostic and therapeutic technologies. In this summer internship, bioengineering undergraduates from Rice University and the University of Texas at Austin (UT) participate in a clinical internship offered at the University of Texas MD Anderson Cancer Center located in Houston TX. Students at both universities receive six hours of credit for completing the courses. Dr. Richards-Kortum (Rice University) and Dr. Michele Follen (UT MD Anderson) teach the course.

Our internship is based on the assumption that bioengineers interested in translational research need a new set of research tools, and that they must be exposed to these tools from the very beginning of their studies. They need exposure to clinical medicine and the relevant vocabulary, research experiences that emphasize the creation and application of new scientific knowledge, and refined communication and leadership skills. The ten-week summer course also emphasizes

development of skills in entrepreneurial experience and its attendant vocabulary, ethics, and team building. We recently submitted a paper describing the course to the peer-reviewed literature.<sup>7</sup>

The schedule for the students is a mix of lecture and exercises, clinical rotations, and translational research. Table 1 gives an overview of the ten-week summer course.

Table 1: Program schedule overview.

	6:30 am - 8:00 am	8:00 am - 12 noon	12 noon - 6:00 pm
Weeks 1-2	Lecture series	Anatomy lab	Anatomy lab
Weeks 3-10		Clinical rotations, including Internal Medicine, Pediatrics, OBGYN, Surgery, ICU, ER	Research

The day begins at 6:30 am with one and one half hour of lecture and/or exercises. Topics include clinical medicine, communication skills, entrepreneurship and leadership (Table 2).

Table 2: Topics covered in morning lecture series.

<b>Clinical Medicine</b>	Physical Examination (5 lectures) Clinical Etiquette (1 lecture) Ethics of Research Involving Human Subjects (3 lectures)
<b>Communication Skills</b>	Library searching (1 lecture) Writing a manuscript (1 lecture) Writing a good abstract (1 lecture) Making a poster (1 lecture) Giving a good presentation (1 lecture) Writing a grant (1 lecture) Conflict management (2 lectures)
<b>Entrepreneurship</b>	Basic managerial finance (3 lectures) Overview of American legal system (2 lectures) Business ethics (1 lecture) Business plans (2 lectures) Grants, contracts and research funding mechanisms (1 lecture) NIH grant review process (1 lecture)
<b>Leadership</b>	Organizational culture (1 lecture) Traditional organizational structure (1 lecture) Time management (1 lecture) Project management (1 lecture) Problem solving and decision making (1 lecture) Emotional intelligence (1 lecture) Leadership vs. Management (1 lecture) Leadership at different levels (1 lecture) Leading high performance teams (1 lecture) Leading change (2 lectures)

Active learning is emphasized in the morning lecture series. For example, students write an abstract, present a poster and give an oral presentation describing their research project. A

second project is to formulate a product or process that can be commercialized from a university laboratory and write a business plan for a start up company. Students receive critical feedback on all assignments.

Following the morning lecture series, students attend a full day human cadaver-based anatomy course for the first two weeks of the course. A mix of lectures, dissection, and special projects emphasize the anatomy, physiology and pathophysiology of the major organ systems.

For the remaining eight weeks of the course, students spend the mornings learning clinical medicine, attending rotations in Internal Medicine, Pediatrics, Obstetrics and Gynecology, Surgery, ICU, and the ER. Each rotation is approximately one week in length. Students are assigned to a clinical mentor, and observe the mentor interacting with patients, performing clinical procedures, analyzing test results and developing treatment plans. Clinical mentors are chosen from faculty at the MD Anderson Cancer Center and the UT Health Science Center-Houston who have established teaching accolades. Students keep a weekly journal in which they describe their clinical encounters and interactions.

Also during the latter eight weeks of the course, students spend afternoons carrying out an independent research project, under the supervision of a faculty mentor. Research mentors include physician-scientists and biomedical scientists involved in translational or clinical research at the MD Anderson Cancer Center or the UT Health Science Center-Houston. Students write a short proposal at the beginning of this period, reviewing the background motivation for their research and articulating their hypotheses and research goals for the summer. Students met at least weekly with advisors to review research progress. On the last day of the course, each student presents a poster and gives a ten-minute oral presentation describing his/her research. All presentations are attended by research and clinical mentors, who provide encouragement and critical feedback.

### **Program Assessment**

The course was offered for the first time in summer 2004; sixteen students from UT enrolled. Students were required to live in a dormitory at Rice University. At the start of the program, two of the sixteen students indicated in their journal entries that they might attend medical school. At the conclusion of the program fifteen students participated in the Survey of Undergraduate Research Experience (SURE) sponsored by the HHMI. In the survey, six responded that they would apply to MD/PhD programs, three would pursue a PhD, five planned to pursue an MD with a focus on patient-oriented research, and one student wished to pursue law school. Students were asked to rate whether the program clarified their career interests on a 1-5 Likert scale with 1=no gain and 5=very large gain. The average rating of the 15 students was 4.06. Thus, the program increased the interest of students in translational research careers.

The course was offered again in summer 2005 and was expanded to include bioengineering students from two institutions, Rice University and UT; enrollment increased to 26 students. At the conclusion of the program fifteen students participated in the SURE survey. Six responded that they would apply to MD/PhD programs, three would pursue a PhD, four planned to pursue an MD, and two students wished to pursue different options. The following items about learning

gains received a response greater than or equal to 4.0 on a 1-5 Likert scale: tolerance for obstacles faced in the research process (4.1); readiness for more demanding research (4.0); understanding the research process (4.0); skill in how to give an effective oral presentation (4.4); learning to work independently (4.1). Students also had very favorable comments about their faculty mentors. Some students acted as peer mentors. One student reflected, “I was placed in charge of a college freshman and a high school freshman. I found this to be extremely challenging because I had to manage my time between doing my own work, assigning work to my mentees, ensuring they understood what they were doing and did a good job, and teaching them when needed. All in all, this summer was extremely rewarding in that I helped two people gain a better understanding of science and research and that helped me become a better leader.”

Students write in their journals based on their experiences during the clinical rotations. The journals were filled with their wonder at the birth of a baby, their sadness at death, their compassion toward and empathy with patients, and an enthusiasm for medicine. Most expressed a feeling of being exceptionally privileged—a feeling that they must return to medicine.

In the summer 2005, advanced internships were designed to accommodate the first group of “internship graduates”. Eleven students returned, some to pursue clinical rotations with translational research; others returned for pure research internships. Having gained the vocabulary and experience, they were able to enhance knowledge in a specific discipline.

## **Conclusions and Acknowledgments**

Overall, we feel that this course meets the objectives of prepare students for careers in translational research by way of MD, PhD, or combined MD/PhD programs. Details of the course can be viewed at <http://www.engr.utexas.edu/bme/faculty/richards-kortum/BME377/mission/mission.htm>, along with a short video documentary following students through the course.

This clinical medical/clinical research internship program has been supported by private donors, the Howard Hughes Medical Institute, the Dr. Scholl Foundation, and the Whitaker Foundation. In addition, UT, MD Anderson and Rice have made substantial commitments to continue the internship. MD Anderson provides salary for a full-time educational coordinator. In addition, UT and Rice are working together to raise donor support to sustain the undergraduate stipend and housing costs.

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