

2006-758: ENCOURAGING NON-BME ENGINEERING MAJORS TO STUDY BIOLOGY

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Encouraging non-BME Engineering Majors to Study Biology

Abstract

Recognizing the need for more engineers to learn biology and considering the relatively small number of undergraduate engineering majors (outside of Biomedical Engineering) at the University of Wisconsin who study a significant amount of (or any) biology, the Biomedical Engineering Department made a goal to provide a mechanism that would stimulate non-BME students to study biology as well as the synergistic relationships between engineering and biology. Subsequently a multidisciplinary engineering faculty committee defined the Biology in Engineering Certificate, a program of study that a student can complete to receive a special designation on his/her transcript. To receive this certificate, a student must be enrolled in an engineering degree program and complete at least 15 semester credits including courses on basic and advanced biology, the combination of biology and engineering (e.g., biomaterials, tissue engineering), and a course called Biology in Engineering Seminar that introduces the student to research at the boundary of engineering and biology across the various disciplines of engineering.

Problem Statement

There is a growing need for engineers in all disciplines to be educated about recent advances and remaining challenges in modern biology. Not only does limited biology education impoverish our engineering students' education and their potential contributions to engineering, but it also limits their potential contributions to the exciting and new frontiers in biology. For example, advances in functional genomics, molecular evolution, intracellular and dynamic imaging, and the system-level integration of signal transduction and regulatory mechanisms require an ever increasing number of biologists to seek collaborations with engineers, mathematicians and physical scientists^{1,2}. Those trained in the more traditional disciplines of mechanical, electrical, chemical, civil and industrial engineering have much to contribute to these frontier areas, but will be hindered from doing so without at least an introductory exposure to biology and the interface of biology and engineering.

Students in biomedical engineering are typically required to take both chemistry and biology as undergraduates and as such are well poised to make important contributions to modern biology. However, most BME programs have limited enrollment and cannot accommodate student interest. Considering the relatively small number of undergraduate engineering majors outside of BME at our institution who study a significant amount of (or any) biology, the Biomedical Engineering Department sought to establish a mechanism by which non-BME students would be encouraged to study biology, learn about exciting developments at the interface between engineering and biology, and be recognized for doing so.

Approach

In order to encourage non-BME students to study biology and learn about recent advances and challenges in modern biology, we chose to develop a Biology in Engineering Certificate. Much like a minor, a certificate recognizes the fulfillment of a program of study in a defined

knowledge area and is listed on a student's undergraduate transcript. In our College of Engineering, for example, we have existing programs of study such as the Technical Communications Certificate, the Technical Japanese Certificate, and the International Engineering Certificate. The Business School offers the Business Certificate for non-business majors, and other certificate programs are offered across the campus.

In order to develop the requirements for this program of study, a multidisciplinary committee was convened that consisted of faculty from the various engineering departments that have faculty who do research with biological applications. The committee included representatives of the Departments of Biomedical Engineering (the authors), Electrical and Computer Engineering, Chemical and Biological Engineering, Mechanical Engineering, Industrial and Systems Engineering, Biological Systems Engineering, and Civil and Environmental Engineering.

The certificate requirements are as follows³:

Prerequisites: A student must be enrolled in an engineering degree program.

Requirements: A student must complete at least 15 semester credits of courses including:

- 1) a basic biology course with lab (typically at least 5 credits)
- 2) at least 6 credits of advanced biology courses (e.g., physiology, cell biology, neurobiology)
- 3) at least one 3-credit course that substantially combines biology and engineering (e.g., biomaterials, tissue engineering), and
- 4) a required 1-credit seminar course called Biology in Engineering Seminar, which introduces the student to research at the boundary of engineering and biology across the various disciplines of engineering.

Results

The Biology in Engineering Certificate program began admitting students in the Fall of 2005. Thirty-three students enrolled in the Biology in Engineering Seminar class, 20 of whom were either enrolled in the certificate program or planned to enroll. Of those students, all were undergraduates majoring in BME. Graduate students and non-BME undergraduates also took the course (6/33) but were not enrolled in or planning to enroll in the certificate program.

The value of the certificate program cannot be evaluated at this time. However, the value of the seminar course, which was designed to be the capstone for the program, may provide some insight into the value of the certificate program. Course evaluations demonstrated that the seminar course was quite valuable to students (4.0 ± 0.6 out of 5). When asked to rank the ways in which the course was most valuable, most students replied that it exposed them to research areas that they are excited about (Table 1).

Table 1. Survey responses from 30 students enrolled in the Biology in Engineering seminar course. Students were asked “In what ways was this course most valuable (rate the following from most (5) to least (1))?” Mean and standard deviation of responses shown.

Showed me research areas I’m excited about	4.0 ± 1.0
Pure intellectual interest	3.8 ± 1.3
Helped me narrow down my future interests	2.8 ± 1.4
Motivated me to learn more biology	2.8 ± 1.2
Motivated me to learn more engineering	2.7 ± 1.1

Preliminary Conclusions

The Biology in Engineering Seminar course provides the only formal opportunity for BME undergraduates as well as students in other majors to learn about biomedical engineering research across all the disciplines of engineering. Clearly, the seminar course was valuable to BME majors but we would caution against extrapolating from BME students’ interests to non-BME students’ interests. The value of the Biology and Engineering Certificate to non-BME majors cannot be evaluated at this time. BME majors can receive the certificate with no credit penalty if they are careful to select an advanced biology course from a preapproved list of courses. The certificate is popular among BME majors, in part, due to the extra credential it adds to their transcript. No other engineering majors can fit all the certificate courses into their curricula, so extra course credits are necessary. Since many engineering students elect to take four and one-half years to complete an engineering degree, our thought is that those who are interested in learning biology or who are premedical students might elect to complete a certificate as part of a five-year program.

Our main conclusion is that while the faculty may recognize that more engineers in all disciplines would benefit from better exposure to and education in modern biology, students not enrolled in the BME department need explicit encouragement to pursue studies in biology. Establishing the certificate program may be an important first step, but faculty in all non-BME departments must promote the program to their students and promote the inclusion of biology in the program of study for non-biomedical engineers.

Bibliography

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