ChE curriculum

AN OPTION IN APPLIED MICROBIOLOGY

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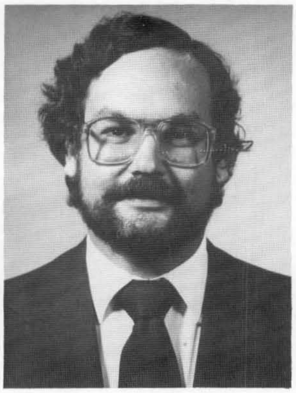
BIOTECHNOLOGY IS AN area which will continue to be incorporated into the chemical engineering curriculum to an increasing extent in the near future. Many departments currently include an undergraduate course on biochemical engineering. Beyond this, many faculties are wrestling with the problem of increasing the biotechnological component of the curriculum. The reasons for this have been documented in many articles appearing in the last two to three years. As an example, there has been speculation that as many as 25% of all practicing chemical engineers may become involved in various aspects of biotechnology within the next decade [1]. The AIChE is also aware of these kinds of projections [2]. Chemical engineering is an evolving discipline; there is nothing static about it, and this should also be true of the curriculum. Failure to recognize the evolutionary aspects of the discipline could lead to a serious crisis in the profession [3].

There are two extreme approaches that could be used to incorporate biotechnological topics into the curriculum. One extreme is to do it exclusively within the confines of the chemical engineering department (or, less radically, within the confines of engineering in general). The other extreme is to "farm it out" to other departments. There are weaknesses with both approaches. Engineers have one vital role in technology: the role of "technology transfer." That is, they have an important function in translating the bench-scale ideas of the researcher (in many cases, a chemist) to an industrial-scale process. Therefore, they should know something about the entire spectrum of technical activity. In regards to the chemical engineer in a biotechnological environment, this means that he or she should be able to function both as a biologist and as an engineer. Any curriculum should try to accomplish this by drawing upon the knowledge of both engineering and chemistry departments as well as the life sciences.



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USF's PROGRAM

The undergraduate program developed at the University of South Florida is illustrated in Table 1. The "applied microbiology" option is one of several options or areas of concentration which students can select upon admission to the department (typically at the end of the sophomore year). The program features a strong chemical engineering core along with a series of courses in life science. There is one required biochemical engineering class within chemical engineering which would normally be taken in the senior year. Students may take an additional elective course within engineering in areas such as fermentation which would count towards the degree. While most chemical engineers would take a course in physical chemistry as an advanced chemistry elective, this program requires biochemistry in its place. Finally, students have the option of taking a course in the biomaterials area in place of the normal introductory materials class which is offered by civil engineering on this campus. The total program requires 146 semester hours, which is slightly more than the 136 hour requirement of other engineering departments on this campus.

It should be mentioned that the chemical engineering curriculum in general has been recently over-

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hauled. For example, there were four required courses offered in previous years: "Transport Processes I" (momentum transport), "Transport Processes II" (heat transfer), "Mass Transfer," and "Separation Processes." They were each assigned 3 semester hours, for a total of 12 semester hours. We currently offer two courses in their place, titled simply "Transport Processes I & II," which address the unit operations aspects of momentum, heat, and mass transport. This freed up hours which could be devoted elsewhere. The general theme has been to make existing courses more reflective of chemical engineering as it is practiced today (and into the future), and to create more free elective hours where previously there had been few.

TABLE 1
Program for the Option in Applied Microbiology

	Sem. hrs in the area
A. GENERAL DISTRIBUTION	
Approved liberal arts courses	25
B. MATHEMATICS AND PHYSICS	
Engineering Calculus (3 semesters); Engineering Physics (2 semesters, including labs); Differential Equations, Statistics, System Dynamics, and Computer Programming (1 course)	29
C. CHEMISTRY	
General Chemistry (2 semesters, including labs); Organic Chemistry (2 semesters); Organic Chemistry Laboratory (1 semester); Biochemistry (1 semester)	20
D. ENGINEERING SCIENCE	
Statics, Thermodynamics I, Introduction to Electrical Systems I, and an approved course in the materials science area	12
E. CHEMICAL ENGINEERING	
Material & Energy Balances, Transport Processes I & II, Instrument Systems, Phase & Chemical Equilibrium, Automatic Controls I, Chemical Engineering Laboratory, Reacting Systems, Transport Phenomena, Environmental & Regulatory Aspects of Biotechnology, Theory & Design of Bioprocesses, Economics & Optimization, Plant Design, and an approved elective	41
F. BIOLOGY	
Fundamentals of Biology (with lab); Introduction to Microbiology; Cell Biology (with lab); and 2 of the following 3 courses: Applied Microbiology (with lab), Bacteriology (with lab), or Microbial Physiology (with lab)	19
TOTAL:	146

DISCUSSION

One of the goals of the program was to enable students to select from three possible career paths upon completion of the undergraduate degree: continued education within engineering, continued education within some branch of life science, or entrance into the industrial sector. The first path is possible since a strong chemical engineering foundation is provided, and the second path is possible because a sequence of classes is taken within the life science area. The engineering course in bioprocesses helps to put an engineering perspective on the biological knowledge base. Since engineering programs are practical and applied, students are always in a position to enter industry.

The program is described as "applied microbiology" rather than "biotechnology" because topics involving molecular biology (particularly genetic engineering) are not covered in depth. These topics are normally treated in graduate level courses. However, students coming out of this program could easily pursue advanced training in this area.

This is a rigorous program. Certainly it is more challenging than the "normal" chemical engineering program. Our experience is that better-than-average students are attracted to such a program. One note of caution must be mentioned to others thinking about such a program: it is important to get students into such a program early from an advising viewpoint in order to keep the residence time comparable to that of other engineering students. It is also important to have full support of the appropriate areas of the life sciences. In many cases, the interaction between the two groups has led to positive things both inside and outside the classroom.

REFERENCES

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3. Shinnar, R., "The Crisis in Chemical Engineering," *CEP* 83(6): 16-21, 1987.