Goals

The mission of the Microbial Engineering (MicE) Graduate Program is to offer students interdisciplinary training that spans biology and engineering, in preparation for careers at the intersection of biology and technology. Since its inception in 1986, biotechnology has expanded from a focus on antibody production and cell culture to include metabolic pathway design and biofuel development, and the MicE program continues to evolve to address these changes. MicE students may graduate with a research-based M.S. (Plan A) or a primarily coursework-based track (Plan B).

The graduate program was established to provide students with:

- interdisciplinary educational and research experiences not available in traditional biochemistry, microbiology, or chemical engineering programs,
- opportunities to conduct independent research and develop innovative combinations of skills, by drawing from faculty in over four different Colleges at the University
- opportunities to participate in the international biotechnology community through seminars, colloquia, and conferences.

The MicE program expects students to develop biological, quantitative, and computational skills allowing the synthesis of information in the life sciences, design of the next generation of biological catalysts, and communication of these discoveries.

Assessment of Goals

How does the program know that it is meeting its goals?

Evidence that the program collects and uses to evaluate success of the program include

- products of student work, such as publications, presentations, fellowships, and grants,
- student time to degree, and
- alumni employment histories.

Assessments of student satisfaction with the educational and research experiences provided by the program and suggestions for program improvement have been obtained through surveys, meetings between the Director of Graduate Studies and the graduate students, and with exit interviews of graduating students. Faculty and student engagement in the program, as shown by participation on committees, Seminar and Recruiting attendance, and willingness to train students is another measure of success of the program.

How well is the program currently meeting its goals?
1. Interdisciplinary educational and research experiences not available in traditional biochemistry, microbiology, or chemical engineering programs:

The interdisciplinary education of students starts with the design of an individualized coursework plan. What makes MicE unique is its flexibility; it is one of the few mechanisms allowing a student with an engineering background to gain training in biology, or a biology student to train in the processing of big data via courses in computer science. Students design a 20-credit series of courses that typically include aspects of biostatistics, microbial physiology, chemical engineering, and ecology. Students may take 5000-level courses (up to 9 credits) as well as 1000-4000 level courses with permission, although lower division courses can not count towards their 20-credit total. This flexibility remains one of the most popular features within MicE, and allows students to add new skills.

All new students also complete up to three laboratory rotations, providing opportunities to identify potential thesis research projects, advisors, or committee members as well as to gain exposure to a variety of research topics and techniques. When students choose a laboratory for their thesis research, they continue to shape their coursework plan in consultation with their advisor.

Students are required to attend the BTI seminar series throughout the year, thus providing further exposure to the breadth of biotechnology research topics. All MicE students are required to present a research seminar at the beginning of the second year in this seminar series. This provides a forum for sharing their research with others in the program, and prepares students for their defense, which is typically scheduled within the next six months.

To ensure students finish their degree within 2 years, students must choose a lab within their first semester, meet with the DGS and file a Graduate Degree Plan at the beginning of their second year, and provide a timeline for graduation by the end of their second year. Enforcement of these simple guidelines has reduced time to degree from an range of 3.1 - 4.2 years in the late 1990's to 2.3 - 2.7 years in more recent years, and our goal remains a full thesis defense within 2.0 years.

To help students navigate program and Graduate School requirements, the MicE student handbook was revised so that all policies, forms, and procedures are clearly organized in a single document.

2. Opportunities to conduct independent research to develop as innovative educators and scientists, by drawing from faculty in over four different Colleges at the University

In the past 10 years, a core group of 25 faculty have accounted for the majority of trained students. As over 45 faculty were listed as belonging to the program, offers were made to 20 of the most inactive faculty to withdraw or switch to non-training (committee-only) status, to clarify options for students. In general, we have seen a decline in students interested in chemical engineering-related disciplines, and an increase in environmental engineering, ecology, drug discovery, environmental microbiology and
synthetic biology. Students remain able to choose advisors from faculty who work on a wide range of topics in these areas. Program faculty are members of departments in the College of Food, Agricultural, Natural Resource Sciences, the College of Biological Sciences, College for Science and Engineering, and Academic Health Center.

Approximately 50% of MicE graduates enter PhD programs in fields such as Biochemistry or Microbiology after completing their degree, and due to their independent research experience are highly competitive. Students who enter the workforce immediately have been employed by companies as diverse as 3M, R&D Systems, Mascoma, Merck, and Lanzatech.

3. Opportunities to participate in the international biotechnology community through seminars, colloquia, and conferences.

Students develop skills necessary to work as independent researchers through classwork, workshops, rotations or visits to different laboratories, and as they complete their thesis research under the guidance of their advisor and advisory committee.

The program supports a dedicated seminar series (MICE8990), hosted by the Biotechnology Institute. Speakers from outside the University of Minnesota are the primary focus of this series, often with opportunities for students to meet with visiting faculty. Speakers from within the University, especially if they are applying for membership in BTI or the MicE program, also speak in this series, along with research seminars by MicE students.

**Review of Goals and Assessments**

Periodic review of program goals and progress towards those goals occurs as part of annual summaries in preparation for acceptance of new students, and quality metrics prepared for CBS.