Math, Science, and Technology Division Revised: 1996
Biotechnology Program

M.C.C. Academic Program Review

Section I: Data (information provided by the Institutional Research Office)

1. Please note important trends, patterns and issues that emerge through the **Enrollment, Academic Progress and Retention data:**

There are several issues concerning enrollment, academic progress, and retention that are not reflected in the data provided by the Institutional Research Office. It is more difficult to recruit students for biotechnology than it was in the early days of the program. This is probably a result of the improved local economy and a lower unemployment rate. Compounding that is the negative publicity that biotechnology has received in the last two years. The numbers in the data do not reflect a decrease but it has occurred. In 1990 and 1991, we had four or five applicants for every place in the program. We now have empty seats.

A look at the demographics of the enrollment shows a low percentage of minorities and very few traditional students. We are making efforts in these areas since these populations are a good source of students and are under served. We realize that improvements in this area are not immediate and evolve over time.

Retention in the certificate program has always been good. Actually, the success of the certificate program has hurt the retention rate of the associate degree program. After students complete the first year of the associate program, they are recruited for employment in the industry. Most choose to take these jobs as companies pay for them to continue their education. The result of this is fewer students in the second year day classes of the associate program. This trend has caused us to restructure the degree programs. We are choosing to discontinue the associate program during the day and increase the certificate offerings to respond to industry's immediate need for trained personnel.

2. Please comment on significant information that emerges from the **Student Transfer and Employment Follow-up data.**

No data was provided on the issues of student trasfer or employment follow-up. The program has had an exemplary record in placing students in industry. Virtually every graduate found employment in the industry and most are still employed.

Section II: Goals, Curriculum and Support (Information Provided by Program Faculty, Staff and, where appropriate, students)

Mission, Goals and Target Populations

1. Does the program have a **stated mission**? If so, please state it.

Guided by the tenets of the college itself, the biotechnology program at Middlesex Community College is dedicated to serving an academically, economically, and culturally diverse population by opening pathways for individuals to enter careers or continue to baccalaureate education and extending the resources of higher education to communities throughout the state. Responding to a changing economy through partnerships with business and industry, the biotechnology program offers certificate and associate degrees which provide opportunities for students to thrive in a global society. It is committed to providing excellence in education with challenging and innovative curriculum and to responding to the needs of industry with state-of-the-art classroom technology. The goal of the biotechnology program at Middlesex Community College is to be a vital educational and economic resource for the community it serves.

2. What is the **relationship of the program's mission to the overall mission** of the College as adopted by the Trustees and approved by the HECC?

The program's mission is representative and guided by the tenets of the mission of the college in the following ways:

_ it opens pathways for individuals to enter careers or pursue further degrees
_ it serves diverse populations with certificate and associate degrees
_ it partners with business and industry for job training and certification
_ it provides education and training for individuals in the community
_ it is a vital educational and economic resource for residents of the community

3. Does the program satisfy a **unique institutional goal**? If so, please explain.

The program satisfies several unique institutional goals:

- it provides response to a specific expressed industry need
- it provides rapid training in a field in which there is a serious labor shortage
- it propels the college into the forefront of education in advanced technological careers
- it generates partnership between the college and industry, high schools, and four year schools that lead to further collaborations.

4. Based on a review of other college catalogs, list the **colleges in our general area that have similar programs** and **comment on significant differences** from the program we currently offer.

Mass Bay Community College: (Associates 79 credits)

- requires two semesters of: Freshmen English, Principles of Biology, Principles of Chemistry
- requires one semester of: Critical Thinking Strategies, Organic Chemistry, College Physics, Precalculus
- does not require microbiology, QC/GMP
- Sequence entitled, "Introduction to Biotechnology and Laboratory, rotations I - V" encompass topics that we cover in "Methods", "Advanced Tech", and "Cell and Molecular"
- requires 9 credits of HU/SO electives

North Shore Community College: (Associates in Liberal Arts)

- requires two semesters of: English Composition, College Algebra, Biology, Introduction to Chemistry, Advanced Literature (electives)
- requires Introduction to Microbiology (catalog description indicates it to be Medical Micro)
- course entitled, "Introduction to the Cell" seems to be a hybrid of our "Micro for Biotech" and "Cell and Molecular"
- does not offer and internship/externship
- "Biotechnology Applications 1 & 2" are very similar to our "Methods" and "Advanced Techniques"
- "Biotechnology Seminar I & II" are similar to our "Special Topics"
- biotech lab space is limited to one room (share with Micro)
- equipment is new but limited (they have only one of many items)

New Hampshire Technical College: (Associates 65 credits, diploma 33 credits, certificate 10 credits)

- diploma and certificate do not require English, algebra, statistics, or HU/SO electives
- associates requires "Anatomy and Physiology I & II", "Organic Chemistry"
- "Laboratory Animal Science" and " Biotech Instrumentation" offered
- "Biotechnology Experience I: Research and Development" and "Biotechnology Experience II: Manufacturing and Production" are similar to our "Methods", "Advanced Techniques" and "Cell and Molecular" however BE II has a greater emphasis on scale up and large scale production than any of our offerings.
- BE II has a QC/GMP component which is not as extensive as our course.
- no internship is offered

Becker (Junior) College: (Associates 64 -65 credits)

- requires two semesters of Biology, Freshman English
- requires "Introduction to Biotechnology" and "Fermentation Technology" which we do not offer but are touched on in "Methods", Advanced Techniques" and "Microbiology for Biotech"
- their "Cell Culture" is similar to our "Methods", "Bioprocessing" is similar to our "Advanced Techniques", and "Research Lab Skills" is similar to our "Cell and Molecular Biology"
- "Quality Control" and "Practicum"(elective) are offered

North Essex Community College: (certificate 28 - 29 credits)

- offers "Seminar in Biotechnology", 1 credit and "Techniques in Biotechnology", 3 credits (1 hour lecture 4 hours lab per week). No other biotech courses offered.
- requires "Internship in Biotechnology", 1 credit, 47 hours of volunteer work. Required to generate list of learning objectives, keep a notebook, and attend on site conferences with NECC faculty.
- no QC/GMP offered.

Bunker Hill Community College: (certificate 29 credits)

- offers "Biotechnology Seminar" which is a survey of current biotech and biomedical advances with discussions involving ethical and social issues.
- offers "Issues and Regulations in Biotechnology" which is similar to our "QC/GMP"
- "Microbiology" has a clinical slant to service Health Careers
- offers "Biotech Lab methods I" which is similar to our "Biochemistry" and "Cell and Molecular"
- offers "Biotech Lab methods II" which is similar to our "Methods" and "Advanced Techniques"
- no internship offered

Boston University: (4 certificates, AS, BA, MA)

- the program is designed as post graduate biotech training, though BA/BS is not required.
- courses aimed at preparing students for positions in research and development
- very little overlap with our program
- our program might articulate well with the the programs offered here.

5. Is MCC's program intended to serve a **special population** or clientele? Please explain.

The program was not designed to serve a special population. Originally, the program was primarily attended by displaced or unemployed workers who wanted to get new employment as quickly as possible. The most recent groups of students are still interested

in the retraining aspect and getting employment quickly, but they are not necessarily unemployed while attending Middlesex.

6. Are there plans to target this program to any **new or different groups**? Please explain.

The biotechnology program has begun to target high school students seeking employment upon graduation. The program director has visited Lowell High School to present biotech as a career option. In December of 1995 and February of 1996, eight workshops were conducted for a group of twenty students from Lowell High School. Many of these students are minorities and speak English as a second language.
This summer, 1996, Middlesex Community College is hosting a two week workshop for middle and high school biology and chemistry teachers. The goal of this workshop is to demonstrate techniques in biotechnology and to relate the opportunities in the field of biotechnology to the teachers so they can impart this information to their students. The biotechnology program of Middlesex Community College also participated in a workshop of high school teachers at the Museum of Science in March.

7. Please describe mechanisms or procedures currently in place to **monitor changes in the job market** and **review the program's currency and "fit"** with the educational interests and needs in our region by:

a) relevant **external** parties, such as advisory groups or speakers, corporations/agencies. (If there is an advisory committee in place, please attach names of members and indicate frequency of meetings);

1. The advisory committee- participating members meet three times per year. Members include:
   MCC - Barry Werner, Mariluci Bladon, Paul Patev
   Minuteman - Jim Amarra, Ron Midgett
   WPI - Pam Weathers
   MBRI - Susan Moulton, Stacy Hill, Cianna Cooper
   Cambridge Schools - Melanie Barron, Larry Rosenstock, Kate Dollard
   EDC - John Wong, Judy Leff
   Umass Lowell - Dave Eberiel
   Biogen - Sean Quinn, Fiona Sibley
   WR Grace - Claudy Mullon
   Genetics Institute - Peter Lasky
   Charles River Labs - Tom Grace
   And other industry representatives
2. Job Shadowing for teachers - set up by MBRI - one or two visits per year by each instructor.

3. A biotech dinner is held yearly to gather interns, graduates, industry supervisors, and faculty.
4. An open house is held yearly for individuals interested in entering the program.

b) relevant **internal** groups or individuals;

The Biotech Dream Team meets monthly during the academic year. This team develops curriculum for the courses within the program.
The members are:

Barry Werner	Donna Duffy	Mariluci Bladon
Joan Kleinman	Jessie Klein	Paul Patev
Carol Hay	Maureen Woolhouse	Rick Doud
Mary Lee Underhill	Julien Farland	Sandi Albertson-Shea
Linda Young		

c) **other populations** (i.e., students, alumni, community members).

1. A yearly dinner/reunion
2. Students and alumni serve on the advisory committe
3. Student representatives for each class are chosen and report concerns to the instructors.

8. Are there plans to change or add to strategies currently in place to **assess the program's fit** with student interest and market demand?

The biotechnology program is constantly changing as business is changing. The advisory committee meets three times per year to discuss trends in industry. Some of the instructors in the biotechnology program are from industry and offer the students current industrial applications. Assessment for students is accomplished through surveys and other formative techniques at the discretion of the instructor. The curriculum is then revised or adjusted as necessary.

9. Are program faculty currently working with the Admission Department to **recruit students** into the program? What role(s) do they play?

Dr. Mariluci Bladon, biotechnology coordinator, and Ms. Claudia Lach, admissions work closely to contact and admit students to the program. Ms. Lach sends brochures to prospective students and refers the students to Dr. Bladon. The interview process is conducted by both Dr. Bladon and Ms. Lach.
Open houses to recruit students are planned and carried out by both Dr. Bladon and Ms. Lach. This year, there were open houses in February, April, and August.

10. Are there **additional recruitment efforts** in which program faculty would like to be involved? Please be as specific as possible.

The Biotechnology faculty are currently involved in a large number of non-traditional recruitment efforts. These are:

- MEOP - Last year Dr. Bladon gave a series of four biotechnology labs during the fall and four more in the sprint to MEOP students. Twenty-three attended the fall series and twelve the spring. They did hands-on activities including cell counting and DNA Fingerprinting.
- HCOP - Dr. Bladon has met with HCOP students to describe the career opportunities available in biotechnology.
- Project AWESOME - In the sprint, Dr. Bladon gave a series of three laboratories to approximately thirty students from Greater Lowell Regional Vocational Technical High School in association with Project AWESOME.
- Career Beginnings - Dr. Bladon conducted a Saturday hands-on laboratory for students participating in the Career Beginnings program. This summer she is supervising a student in an internship.
- Dr. Bladon and Professor Patev participated in displays for students at both the Lowell and Bedford campuses last spring. These were conduced in the vicinity of the cafeterias.
- Science faculty have described the program to students in science courses.
- Jessie Klein is coordinating a two week biotechnology workshop for regional high school and college teachers. The workshop will be conducted at Middlesex. Minuteman High School, and Worcester Polytechnic Institute. It is hoped that teachers who become familiar with our facilities and program will encourage students to pursue it.

Faculty will continue to be involved in these activities and in addition would like to:

- Develop the connection with MEOP. Lynne Osborn has been coordinating an effort to introduce Lowell High School students to our biotechnology, environment, and health programs. The program will encourage students to look into careers in these areas and assess their abilities to do college level work. In the senior year, students would be offered any developmental couses they would need in order to be prepared to take program courses in the first semester of their freshman year at the college.
- We have found some interest in the program from persons already employed in the industry. Faculty would like to go to companies and make presentations, possibly in the cafeteria at lunchtime or in any way that would be acceptable to the company.
- Visit high schools to describe the program to students.

Curriculum

11. Please indicate below the **major educational outcomes** for students enrolled in this program, **how each outcome is attained** (i.e., through a specific named course, activity, or project) and **how the attainment of each is assessed**. It is expected that between five and ten major programmatic outcomes will be listed. If there is nothing currently in place that is intended to provide for the attainment of a particular outcome or to assess the extent to which the outcome has been realized, please leave the appropriate space blank. The "blanks" will help to identify areas which need further development.

Student Outcome/Competency	**Strategies For Attainment**	**Assessment Criteria and Methods**
What should the student be able to do? (Performance/knowledge expectations for program graduates listed in **student outcome terms.)**	In what course or courses will the student be able to develop the competency? What activities/ assignments will enable the student to achieve it? (If the strategy is contained within a particular course, please list the course first, with the relevant activity or activities listed next to each course.)	How do the instructor and student know that the competency has been achieved? How is the student's performance judged?

Please attach additional pages as necessary

11. The biotechnology program at Middlesex emphasizes the following ten major educational outcomes for students enrolled. For each outcome, we list the courses and at least one strategy/activity for attainment of that outcome. We also include a technique used to assess the student's achievement of that competency. (Note: This is not an exhaustive list of every course, nor of every strategy within the courses listed.)

Competency #1:

Graduates of the biotechnology program should be able to follow a protocol.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	a. Write a protocol for hors d'oeuvres. b. Follow another student's protocol.	A comparison/contrast of two "chefs" following the same protocol.
BI 1111 Biology for Biotechnology	A lab exercise in which onion DNA is isolated	The DNA purity is determined spectrophotometrically
BI 2101 Methods of Biotechnology	A lab exercise to extract chromosomes form HELA cells	Analysis of chromosome spreads and karyotype
BI 2103 Cell & Molecular Biology	Restriction enzyme analysis	Analysis of the cleavage of plasmid DNA electrophoresis of cleavage products
BI 2123 Microbiology for Biotech	Each lab technique is explained in protocol form.	Lab results in the form of the lab report.
BI 2205 Advanced Methods of Biotechnology	Preparation of cell slides for immuno fluorescence Extraction of a specific enzyme from sweet potato	Detection of fluorescence in cells Summary of results and techniques required
BI 3101 Internship	Follow SOP given by biotech industry lab	Comparison of the student's results with the expected results.

Competency #2:

Graduates of the biotechnology program should be able to use laboratory equipment properly.

Course	Strategy for Attainment	Assessment Technique
BI 1111 Biology for Biotechnology	Exercise using the pH meter	Lab report with results
BI 2101 Methods of Biotechnology	Use of inverted and compound microscopes	Lab report with results and karyotype finished
BI 2103 Cell & Molecular Biology	Agarose gel electrophoresis apparatus & handling and disposal of ethidium bromide	Lab report with results Chemical assessment to determine proper disposal of ethidium bromide
BI 2123 Microbiology for Biotech	Aseptic technique. Autoclave, sterile filtration incubators, water baths, lab balance, innoculating loop, needle, spread rod	Quizzes, observations by instructor, sample of sterility of environment Autoclaved glassware is completely sterilized
BI 2205 Advanced Methods	Hot plates, knives, electrophoresis, reagents, pH meters, HPLC, centrifuge, and UV microscopes	Observations by instructor and proper use of UV microscopes shown in lab report results. Making buffers, running successful gels, using and programming HPLC
BI 3101 Internship	Various equipment use at companies	They retain their position with the company

Competency #3:

Graduates of the biotechnology program should be able to think critically.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	Position research paper. Controversial topics paper.	Student must take a position based on research. Paper counts 20% of course grade.
HU 5145 Bioethics	Critical analysis section on each exam	Exams Case studies
SO 2115 Economics & Management	Given problems, practice sets, and exams that require analytical skills	Exams Case studies
BI 1111 Biology for Biotechnology	Modified multiple choice. Students must explain their chosen response.	Exams Lab reports with interpretation of the results
BI 2101 Methods of Biotechnology	Student must explain the reason for each step in and SOP	Exams Lab reports with interpretation of the results Case studies discussions
BI 2103 Cell & Molecular Biology	Explain the reasoning behind each step of the SOP	Exams Lab reports with interpretation of the results Class discussions
BI 2121 Quality Control & GMP	Critical analysis section on each exam Case studies	Exams and cite the appropriate regulation Discussions of case studies
BI 2123 Microbiology for Biotech	Modules require students to formulate hypotheses and draw conclusions for formal lab reports	Hypotheses clear and testable conclusions relate to hypotheses.
BI 3101 Internship		

Competency #4:

Graduates of the biotechnology program should be able to use a computer for gathering data, processing information, and using computerized instrumentation.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	Encouraged on all papers but not required	
MA 2103 Computers for Technology	Lab reports are word processed, data is presented on spreadsheets, presentations, and access to the internet	Observations by instructor and completed assignments.
MA 3121 Math for Technology	Descriptive statistics, correlation, and regression analysis are done using a spreadsheet program.	Completed exercises and grading of student's statistical report.
BI courses	a. Lab reports are required. b. Students run the computerized instruments like the spectrophotometer, HPLC, and fermenter	a. Grading of lab reports b. Working the programs for HPLC purification. Program and check function of fermenter.

Competency #5:

Graduates of the biotechnology program should be able to work cooperatively as a member of a team.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	Collaborative letter writing assignment.	Team letters are graded for content and mechanics.
SO 2115 Economics & Management		
BI 1111 Biology for Biotechnology	Students work with lab partners.	Instructor observes team dynamics and encourages students to address problems.
BI 2101 Methods of Biotechnology	Students make solutions for each other and for the class.	Observation and feedback addressed in mid-term evaluations by instructor
BI 2103 Cell & Molecular Biology	Students always have lab partners.	Analysis of interaction among partners and sharing tasks within the lab.
BI 2123 Microbiology for Biotechnology	All tasks are to be performed as a team. Data is shared.	Lab reports are incomplete if students do not interact. Assigned tasks will take longer than time allotted for lab if done alone.
BI 2205 Advanced Methods	Tasks require students to work as a team in order to complete in allotted time.	Delegation of tasks with indication that all team members are informed.
BI 3101 Internship	Industry requires witness to verify every result	

Competency #6:

Graduates of the biotechnology program should be able to manage their time efficiently.

Course	Strategy for Attainment	Assessment Technique
BI 1111 Biology for Biotechnology	Lengthy lab activities.	Successful completion of the lab within the allotted time.
BI 2101 Methods of Biotechnology	Lab activities that require more than one lab period.	Successful completion of the lab within the allotted time.
BI 2103 Cell & Molecular Biology	Students allocate time to run and complete the DNA electrophoresis.	Successful completion of the lab within the allotted time.
BI 2123 Microbiology for Biotech	Modules span over weeks of lab activities.	Tasks must be completed in a timely manner. Data must be organized.
BI 2205 Advanced Methods	Exercises contain several steps which are often performed simultaneously.	Exercises completed. Little time wasted in waiting. Notebook entries are clear and organized.
BI 3101 Internship	Tasks must be done in the time allotted by the supervisor.	

Competency #7:

Graduates of the biotechnology program should be able to make appropriate decisions in a laboratory situation.

Course	Strategy for Attainment	Assessment Technique
BI 1111 Biology for Biotechnology	Lab on scientific method.	Students state hypothesis, test the hypothesis, and report the results and conclusion.
BI 2101 Methods of Biotechnology	Tissue on culture analysis.	Students decide if cells should be fed, trypsinized, or re-incubated.
BI 2103 Cell & Molecular Biology	Since time is crucial, students must decide at which steps it is safe to stop the procedure.	Results will be the indicator if correct decisions were made.
BI 2121 QC and GMP	Case studies and videos	Discussion and citing of appropriate regulations
BI 2123 Microbiology for Biotech	Students identify an unknown based upon results of testing and flow charts.	Identification of an unknown will be based on interpretation of the results.
BI 2205 Advanced Methods	Students must purify an enzyme and decide which pool to use in the next step.	Purification of β amylase.
BI 3101 Internship	Students must consult their supervisor when necessary.	Supervisor discusses issues with the student intern.

Competency #8:

Graduates of the biotechnology program should be able to interpret the results of their experiments.

Course	Strategy for Attainment	Assessment Technique
MA 3121 Math for Technology	Students must analyze the statistical results of their data and draw inferences.	Students responses and reasons for the conclusions they have drawn.
BI 1111 Biology for Biotechnology	Enzyme experiment	Results are interpreted as part of a lab report.
BI 2101 Methods of Biotechnology	Tissue culture analysis and chromosome analysis	Lab reports include results and conclusions.
BI 2103 Cell & Molecular Biology	DNA analysis of restriction enzyme	Results must be interpreted as part of the lab report.
BI 2121 Quality Control & GMP	Students respond to hypothetical situations.	Students graded on responses which consider good manufacturing practices.
BI 2123 Microbiology for Biotech	Culture plates must be innoculated weekly and assessed as to growth and metabolic requirements of organisms	Identification of an unknown. Constructing a profile of the organisms.
BI 2205 Advanced Methods	SDS-page, protein assay, enzyme assay, chromatograms, monitoring of fermentation batch	Assays must be interpreted in order to proceed to the next step.
BI 3101 Internship		

Competency #9:

Graduates of the biotechnology program should be able to communicate their results, decisions, and ideas to fellow workers and supervisors.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	Assigned compositions-summary writing, lab report writing, comparision & contrast writing, causal analysis	Graded papers and interaction of students as observed by the instructor.
HU 5145 Bioethics	Oral participation	Observed and encouraged by instructor.
SO 2115 Economics & Management	Written reports and exams. Class discussions.	Grading of assignments including essay questions.
BI 1111 Biology for Biotechnology	Lab reports and exams. Interaction with lab partner.	Reports, exams, and observed interactions.
BI 2101 Methods of Biotechnology	Lab reports, interaction with lab partner, and exams.	Reports, exams, and observed interactions.
BI 2103 Cell & Molecular Biology	Lab reports, interaction with lab partner, and exams.	Reports, exams, and observed interactions.
BI 2121 Quality Control & GMP	Class discussions.	Oral participation.
BI 2123 Microbiology for Biotech	Notebook entries, record sheet descriptions, hypothesis, conclusions, and interaction with lab partner.	Students must share information with their classmates and with the instructor.
BI 2205 Advanced Methods	Lab reports, interaction with lab partner, and exams.	Reports, exams, and observed interactions.
BI 3101 Internship	Oral and written interaction with co-workers and supervisor.	

Competency #10:

Graduates of the biotechnology program should be accountable for themselves and the materials they handle.

Course	Strategy for Attainment	Assessment Technique
EN 1103 English Composition	Paper deadlines throughout the course.	Grade is affected if deadline is not met.
HU 5145 Biotechics	Students must arrive to class on time and ready to learn..	Attendance and class discussions require student preparedness.
SO 2115 Economics & Management	Students must arrive to class on time and ready to learn..	Attendance and class discussions require student preparedness.
BI 1111 Biology for Biotechnology	Students must arrive to class and lab on time and ready to learn..	Attendance in lecture and lab and lab experiments require partners to collaborate.
BI 2101 Methods of Biotechnology	Students must arrive to class and lab on time and ready to learn..	Attendance in lecture and lab and lab experiments require partners to collaborate.
BI 2103 Cell & Molecular Biology	Students must arrive to class and lab on time and ready to learn..	Attendance in lecture and lab and lab experiments require partners to collaborate.
BI 2121 Quality Control - GMP	Students must arrive to class and lab on time and ready to learn..	Attendance and class discussions require student preparedness.
BI 2123 Microbiology for Biotech	Sanitation log, record sheets, maintain reference cultures.	Maintenance of logs and cultures.
BI 2205 Advanced Methods	Completing logs, notebook entries, witnessing notebooks.	Maintenance of logs. Entries made in "real time." Notebooks witnessed.
BI 3101 Internship	Students must arrive to work on time and ready to work.	

12. Is there a desire to introduce any new or revised student outcomes for this program? Please specify.

Proposed New or Revised Student Outcome/Competency	**Strategies for Attainment**	**Assessment Criteria**

Please attach additional pages as necessary.

Yes, there is a desire to incorporate the attributes as described in the bioscience skill standards. The problem is that we are not sure how to go about doing this at this time. We would like help in establishing strategies for attainment and in assessing these skills.

13. At present which courses within this program meet the following **core curriculum intensive value requirements** (please use specific course titles, where they can be identified)?

1. Multicultural perspective

2. Global understanding
   SO/BU 2115 Economics and Business in High Tech Industry

3. Written communication
   HU 5145 Introduction to Bioethics Julien Farland

4. Computer literacy
   MA 2103 Computers for Technology Carol Hay

5. Values, ethics, or social policy
   EN 1103 English Composition Sandi Albertson-Shea
   (position research paper - research at least two sides of a controversial biotech issue. Documentation of materials/opinions read and summarized/quoted. Position taken by student is based on the research.)

   HU 5145 Introduction to Bioethics Julien Farland

   SO/BU 2115 Economics & Management in High Tech
   Mary Lee Underhill
   Rick Dowd
   (Analysis and evaluation of economics and social policy and the role of government in:

1. use of society's scarce resources
2. business ethics as per spillover costs
3. product development
4. cost analysis
5. competition
6. prices
7. health care
8. human resources/wages)

6. Impact of technology, environmental issues, or health
   HU 5145 Introduction to Bioethics Julien Farland

14. Please describe any **interdisciplinary courses** which are provided as an integral part of this program.

SO/BU 2115 Economics and Management in High-Tech Industry
The course combines principles of economics and business to focus on today's rapidly changing contemporary organizations; particularly those involved in the development, manufacture, and/or distribution of technological products.

15. Please comment on **work-based learning** opportunities with the program (i.e., coop, internships, service learning). What percent of program students participate in each of these activities? Indicate any problem being faced in incorporating work-based learning.

100% of the students participate in the internship program. The experience to this date is a work experience, i.e. industry gets quality workers. Our students get the work experience. Our desire is to make this work experience more academic as well. Our contacts in industry do not share this desire. This is proving to be a challenge for us.

16. Please comment on the **scope and sequence** of courses now in place. Is the flow and relationship of courses to one another satisfactory? Are there changes indicated, based upon program objectives and/or new needs identified through the assessment process?

The scope of the material is extensive but the sequence of these courses sometimes varies. The current courses in place are:

<u>1st semester</u>

English Composition	Biology for Biotechnology
Math for Biotechnology	Chemistry for Biotechnology

Computers for Technology (1 cr.- certificate, 3 cr.- associate)

<u>2nd semester</u>

Methods of Biotechnology	Quality Control/Good Mfg. Practices

Microbiology for Biotechnology Biotech Internship
3rd semester
Advanced Techniques in Biotech Bioethics
Immunology Special Topics in Biotechnology
4th semester
Cell and Molecular Biology Biochemistry
Economics and Management of High Tech Industry

The NSF grant for curriculum development has aided in developing the connections of courses to one another. However, students are reluctant to take four or five courses per semester which makes the connections between courses less obvious. The flow or sequence of courses has glitches. The enrollment in the day, associate program is low and not all the courses run each semester. As a result, the sequence of courses student take varies greatly. The students who are admitted as a group in one semester scatter quickly depending upon the offerings and selections. Enrollment has not been a problem in the evening sections. Therefore, these students proceed through the biotechnology program in the same sequence and cohort group. Day students who wish to pursue an Associate Degree will feed into the evening A.S. program.

17. Please comment on the role of **developmental courses** in your program? Which ones are relied upon by significant numbers of students in the program, what conclusions are you able to draw about the impact of these courses on students' preparation levels?

The two developmental courses for students in the biotechnology programs are Algebra I and Basic Writing. The ability to solve simple equations is essential to balancing chemical equations and the ability to graph data is required in all sciences. Solid writing skills are fundamental to the preparation of clear laboratory reports for all the science classes.

18. Describe any plans to introduce **new methodologies** into required or elective courses.

The biotech program is currently funded by the National Science Foundation to develop new curricula. The modules that are being developed are from science, math, humanities, and social sciences. Some interdisciplinary units are being incorporated into the biotechnology classes. Much of the learning is experiential. The goal is to also include more computer technology in the classes as well. In addition, we hope to add cooperative learning and teamwork into courses as well as require projects.

19. Describe any new **student assessment methods** that have been implemented in any of the core program courses or in a general programmatic way. If you are able to assess the effectiveness of such methods, please do so.

The biotechnology program has created assessment tools for various phases of the program and the student's development. In March of 1996, a program evaluator, Valerie Crawford, was hired to assess and improve the program's assessment process. Below is a brief outline of the tools in place at this time (3/96):

	<u>to determine</u>
Curriculum:	
Pre-Course Questionnaire	attitudes about learning and content knowledge
Curriculum Surveys	effectiveness of module/lesson
Formative Tools	effectiveness of module/lesson
Post-Course Questionnaire	attitudes about learning and content knowledge
Student Development:	
Portfolios	educational growth in the program skill development development of attitudinal skills such as ethics, responsibility, team work, and decision making
Industry:	
Business Survey	quality of our program preparedness of our students appropriateness of the academic offerings
Graduates Survey	quality of our program preparedness to enter job market appropriateness of the academic offerings
Recruitment:	
High School Workshop Surveys	educate young people about biotechnology recruit minorities and under-represented groups into the biotechnology program
Teacher Training:	
Job Shadowing Survey	the effect of visits to industry had on faculty

Workshop Surveys	effectiveness of curriculum support, activities, and discussions about pedagogy

Instructional Support

20. Please discuss the adequacy of the **staffing level to teach and advise** for students enrolled in the program.

Staffing has been adequate in the biotechnology program. The Student teacher ratios for the day classes have averaged 12 students per instructor and the evening ratios for the certificate program have averaged 19:1.* The biotechnology program has employed scientists from industry to teach some of the courses. This is a win/win situation in that MCC learns the current practices in a rapidly changing industry and industry gains by participating in the training of prospective employees.
*The figures were derived from the enrollment for 94S through 96S for the following courses: BI 1111,2101,2103,2123,3101,3123,SC 2201,3137.
All biotech students are assigned one of two advisors, Mariluci Bladon or Paul Patev.

21. What specific **support services and activities** (i.e., tutoring, media, library, disabled student support, computer labs, service learning coordinator) does this program require? Please comment on the availability and adequacy of these services (be specific about any current deficiencies or projected needs).

Tutoring - The first year students often request tutors for biology and chemistry. This has been a problem for the evening certificate program in Bedford because the regular college science tutors are not available at night. In the past, graduates of the program have served as tutors but their availability was limited. In the Lowell day program, a chemistry tutor was unavailable until well into the second half of the semester. There is a need to have tutoring for the biotechnology program in place before classes begin.

Computers - There are several commercial computer programs available that are appropriate for the biotechnology program. Computer rooms in building 3 in Bedford and Lowell Talbot building are not adequate for use by an entire class. The rooms are too small and in the case of Lowell, there are only eight computers available. There is also a vast amount of information that pertains to biotechnology of the internet. A large number

of the computers should be on-line so that students can learn to access the internet and use this information.

22. How adequate and appropriate are **program facilities and equipment**? Please be specific about current deficiencies or projected needs.

1. Laboratory space - Much of the equipment is large and requires space around it for students to work. Talbot 308 is a reasonable size room but it is full of equipment and somewhat cramped. Talbot 306 is the microbiology lab which must be dedicated to microbiology classes only.
2. Stock space - The biotechnology stockroom is full. There is no room left for additional supplies.
3. Equipment room - This room is small and already full of equipment.
4. Both the biotech lab and the microbiology lab lack sufficient space for books and coats. This is especially a problem for the biotech lab since all the available wall space is covered by equipment.

Needed equipment -

1. Milli-Q RO water purifying system with storage tank for purifying water to adequate levels needed for biotech applications.
2. Conductivity meters (5)
3. Lyophylizer (freeze dryer)
4. 4_C refrigerator
5. Peristaltic pumps (5)
6. PC for fermenter
7. Fixed angle rotor for the ultracentrifuge
8. Beckman HPLC (a second one is needed)

23. Are there unmet **professional development needs** of program faculty or staff? If so, please describe.

1. We do not have someone on our full-time staff to teach Biochemistry or QC/GMP in the event no one in industry is available.
2. We need faculty to attend professional workshops to keep them current in biotech procedures.
3. More job shadowing.
4. Workshops for writing curricula.
5. Workshops for alternative teaching techniques.
6. Workshops to develop a computer savvy staff to work with the state of the art technology available in biotechnology and to access the volumes of information on the internet.
7. Workshops to provide explicit help in conducting alternative classroom assessments.

24. Describe the **program budget** if a specific one exists. How is it currently allocated among program expenditures?

Currently there is no specific budget for the program. The NSF grant pays for supplies, local travel, and extraordinary recruitment efforts such as conducting workshops for high school students and teachers. The expenditures anticipated for this year are:

Supplies	$15,000
Local travel	$ 500
H.S. workshops	$ 2,000

These costs will have to be absorbed by the division budget once the grant is completed.

25. Are there specific fiscal needs that have not been previously identified? If so, please specify them.

1. Service contract for maintenance and repair of equipment (Alert Scientific)
2. Supplies such as tissue flasks, pipettes, pipetmen, chromotography resin, cell culture media, clean room clothing, antibodies, enzymatic substrates, ELISA plates.
3. Biohazard waste and sharps disposal (Laidlaw)
4. Removal of antiquated equipment.

Additional Questions

Please list and address any **additional questions** that you consider important in assessing this program.

Section III: Program Evaluation Summary

This section should be completed based upon review and consideration of both the data supplied in **Section I** and the questions posed in **Section II.**

A. Major Program Strengths

1. 100% job placement rade in the industry
2. Strong faculty committment and cooperative effort
3. Responsive advisory committee
4. Program coordinator has strong connections with industry
5. Facilities are well equipped and maintained
6. Lab technician is a former biotech student
7. Student representatives speak on behalf of the group
8. Students form study groups on their own

B. Program Weaknesses or Needs for Improvement

1. Uncertain where future funds will come from when NSF grant expires in January, 1998
2. Enrollment is small and recruitment is problematic as unemployment decreases
3. Internship is not an academic experience
4. Transferrability of BI courses needs to be investigated
5. More articulation agreements with 4 year schools

C. Plans for improving or correcting identified weaknesses
(Please include proposed time lines where that is possible).

1. funding? - (NSF proposal to continue project)
2. More high school orientations
   Improve relationship with employment boards
3. Internship -
   Develop academic course with school based activities that connect with students work experience.

   These include:
   - journals to describe their work experience
   - research of companies where they are working and topics on which they are engaged
   - resume writing
   - interviewing skills
4. Further discussions with WPI, UML, BU, and Northeastern