

Form SE**Sponsoring Institution: University of Missouri-St. Louis****Program Title: Master's of Science in Biochemistry and Biotechnology****STUDENT ENROLLMENT PROJECTIONS****Projections Based on Market and Student Demand**

YEAR	1	2	3	4	5
FULL-TIME	2	4	5	6	6
PART-TIME	3	6	10	14	15
TOTAL	5	10	15	20	21

Note: We anticipate that in the first two years of the program all students would be those who would otherwise have enrolled in Biology or Chemistry and thus would not represent additional student enrollment on this campus. In year 3 we estimate that 50% of the students would be new students attracted specifically to this program. In year 4 and thereafter, we anticipate that 70% of the students would be new students attracted specifically to this program.

Enrollment at the end of Year 5 for the program to be Financially and Academically Viable

YEAR	5
FULL-TIME	3
PART-TIME	10
TOTAL	13

2. Need**A. Student Demand**

Over the last ten years the Departments of Biology and Chemistry have attempted to satisfy student demand for more specialized education in biochemistry and biotechnology by offering a graduate certificate program in biotechnology within the M.S. degree in biology and a specialization in biochemistry within the Ph.D. degree in chemistry. This does not really address the needs of potential M.S. students who want a degree focussed specifically in their area of interest. The Biochemistry and Biotechnology Committee has met over the last 5 years to address the problem that many potential students are not adequately served by certificates or specializations within existing degree programs. The answer has been apparent for some time: in order to better serve the needs of graduate students we must develop a new degree program that allows students to specialize in the areas of biochemistry and biotechnology. While each of these is a specific discipline, the areas of biochemistry and biotechnology are complementary and thus fit together well in a comprehensive graduate educational program.

B. Market Demand

In the last 10 years St. Louis has become a focus for the establishment of life science research and development. In addition to the major companies such as Monsanto, Mallinckrodt and Sigma-Aldrich that have long contributed to the scientific base of industry in the St. Louis region, a large number of smaller companies and research institutions have chosen St. Louis as their home. Among the newer, smaller institutions with a major focus in the areas of life science technology are the Donald Danforth Plant Science Center, Nidus Center for Scientific Enterprise, the Center for Emerging Technology, Missouri Technology Park, Technology Gateway Alliance, and the World Agricultural Forum. According to an article in the Post Dispatch (Dec. 31, 2000) by Robert Calcaterra, CEO of the Nidus Center for Scientific Enterprise in St. Louis, the life science component of St. Louis industry represents about 5% of the region's private sector payroll. With both the large industrial base in life science research and development and the universities in the St. Louis area involved in life science research (including UM-St. Louis), St. Louis is poised to be a leader in life science research.

Business incubators that provide space, facilities and services for start-up technology-based companies have developed and flourished in St. Louis over the last decade. St. Louis Commerce Magazine featured incubators in a cover story in February, 2000. The article described four incubators in the St. Louis region (Nidus Center for Scientific Enterprise, Center for Emerging Technologies, Economic Development Center of St. Charles County, and the St. Louis Enterprise Centers) that each support 10-30 fledgling businesses. Two of these incubators focus on life science-based technologies while the others support a variety of businesses. Occupants of these incubators are expected not only to require additional workers in order to develop their businesses, but as they grow and develop into independent companies they will depend on a trained work force.

One aspect of life science research that dominates in both industrial and academic institutions is technology. The application of life science principles to practical issues in medicine and agriculture typically involves both biotechnology and biochemistry. Thus, we see a clear need for expanded programs in the rapidly growing areas of biotechnology and biochemistry. According to Calcaterra, "Two areas of weakness in St. Louis involve physical infrastructure and availability of an adequately trained and experienced work force." In another article (St. Louis Post-Dispatch April 23, 2000) on the growing biotechnology industry in St. Louis, David Nicklaus of the Post-Dispatch says, "A growing industry needs more than just biologists with doctorates. ... In today's economy, a trained work force is the most precious resource for any industry."

UM-St. Louis is particularly well suited to address this critical need. We attract local students who typically remain in the St. Louis community after graduation as part of the work force. In order to attract and retain students interested in careers in the life sciences, particularly in areas of technology, students must have access to high quality education that will prepare them for careers in the expanding field of life science technology. Most of the current M.S. students in the Departments of Biology and Chemistry work full time in the St. Louis area. They return to graduate school in order to change careers or to advance in their current position. These students can help to provide for the workforce needs of the St Louis region.

We propose to develop a M.S. degree program in biochemistry and biotechnology that encompasses both the basic principles and the technological applications of life sciences. The aim is to attract well-qualified students from the greater St. Louis region who will obtain a high quality graduate education that will prepare them for life science technology jobs in the greater St. Louis metropolitan area. A well-trained work force will help to attract new industry to the St. Louis region and those new industries will in turn provide incentives for local students to seek education in a program that will lead to high paying jobs.

C. Societal Need

Technological advances in the life sciences are rapidly changing the lives of most Americans. Recombinant DNA technology has allowed the development of safer and more effective drugs such as human insulin and clotting factor VIII. As the technology has led to changes in food production, such as bovine growth hormone to increase milk production, controversy has followed. Currently, the biotech agricultural community is in chaos as farmers are attempting to determine whether consumers will accept genetically modified foods. The human genome project is nearly complete and will lead to a wealth of new information that must be considered in terms of both health and medical ethics. Clearly we are in a period of history in which the advances in life science research are contributing to major changes in our society.

In order to better understand the changes to our society that result from technology we need a well-educated public. This begins with solid educational programs at the undergraduate and graduate level. The program we are proposing will provide the education that all students need not only to become members of a well-trained work force, but also more importantly, well educated citizens who will in the long term determine the future direction for life science research and its impact on society.

D. Methodology used to determine "B" and "C" above

As noted above the documentation of student and market demand comes from numerous publications from outside of UM-St. Louis that attest to the growth of the companies and research institutions that require a workforce trained in the area of life science technology.

3. Duplication and Collaboration

The chemistry department offers a specialization in biochemistry within the chemistry Ph.D. program while the biology department offers a graduate certificate in biotechnology. Over the last few years it has become clear that a combined program in biochemistry and biotechnology would better serve the needs of potential master's students. The two disciplines are complementary and a good education in biotechnology depends on a solid background in biochemistry. Similarly, students interested in biochemistry benefit by understanding the applications of biochemistry in the field of biotechnology. Therefore, it seemed reasonable to develop a new M.S. program in biochemistry and in biotechnology.

Biochemistry has been a well recognized discipline for decades while the technological aspects of biology that comprise biotechnology have only been recognized as a discipline over the last 10 years. The proposed M.S. degree in biochemistry and biotechnology differs from a traditional biochemistry degree because it has a stronger biological component. The Department of Biochemistry at UM-Columbia offers a M.S. degree as does the Department of Molecular Biology and Microbiology; however, these programs cannot serve place-bound students from the St. Louis region. In St. Louis, Washington University Medical School offers a Ph.D. in Biochemistry and Molecular Biophysics, and St. Louis University Medical School offers a Ph.D. in Biochemistry and Molecular Biology. Neither institution offers a M.S. and neither university accepts part-time or evening students. University College, the evening college program at Washington University, does not offer a M.S. in biochemistry, molecular biology, or biotechnology. We are not aware of any other programs in the state that offer a M.S. in biochemistry and biotechnology.

There is no collaboration with any other institution for this program. The Departments of Chemistry and Biology will be equal partners in the continued development and the implementation of the program. Currently four faculty members from each department have been involved in the development of the new degree program; however, we anticipate adding at least one additional new faculty member from each

department in the Fall of 2001, assuming that current searches for new faculty in each department are successful. This group of faculty will continue to develop the graduate program by recruiting new students and developing the courses for the program. The faculty will work together to organize a seminar series, bringing in outside speakers whose research is focussed in the areas of biochemistry and biotechnology. The joint program is designed to foster close interactions among the faculty in the Biochemistry and Biotechnology Program, encouraging the exchange of ideas and the development of collaborations in research that can attract new research funding.

4. Relevance of the degree program to the University of Missouri-St. Louis Strategic Plan.

The M.S. in Biochemistry and Biotechnology is designed to correspond to the needs, goals, objectives and action steps set out in the University of Missouri-St. Louis Strategic Plan. The most relevant sections of the Strategic Plan that are central to the new degree program are directly quoted below.

Page 4 – Regional Needs

Recently, business and elected leaders have focused on work-force development. Studies by the St. Louis Regional Chamber and Growth Association, the East-West Gateway Coordinating Council and the Regional Business Council have pinpointed several areas experiencing worker shortages due to growth and retirements. The Missouri Department of Economic Development projects that there will be nearly 18,000 regional job openings over the next six years in the areas of information technology and finance, health and life sciences and K-12 education.

Page 5 – Regional Needs

State and local leaders want to know what investments need to be made to fill these jobs and keep the region's economy strong. Increased investment in the University of Missouri-St. Louis is a large part of the answer in responding to the needs of the metropolitan area. UM-St. Louis is the largest producer of college-educated workers who enter the St. Louis-area job market each year. More than 80 percent of its 60,000 graduates live and work in the St. Louis region. No other institution can respond to the region's needs as effectively or efficiently as the University of Missouri-St. Louis.

Page 7 - Strategic Goal

Expand and enhance programs, student body and facilities as appropriate for the University of Missouri campus located in the state's largest metropolitan area.

Page 7 –Most Relevant Objectives

- Acquire a significant role in the revitalization of the St. Louis region with a focus on work-force development and on research, development and education in the life sciences.
- Expand programs that engage the University with the community.
- Enhance student development in the areas of leadership, professional skills and teamwork.
- Provide superior learning opportunities for a diverse student population of undergraduate, graduate and professional students; traditional and non-traditional students; international students; and credit and non-credit students, in full-time and part-time programs.
- Increase the size, diversity and quality of the student body.

Page 8-11 –Most Relevant Action Steps

- Expand program offerings in areas that utilize strengths of the region and contribute to the economic and cultural health and growth of the region such as information sciences and technology, transportation and logistics, biotechnology, financial services, advanced manufacturing and health care.

- Offer new masters and doctoral programs in areas with greatest demand and that are critical to the region's competitive position in the world economy.
- Develop further partnerships with St. Louis business enterprises.
- Expand cooperative programs and internships with St. Louis businesses, schools, health-care providers, cultural institutions and governmental agencies and integrate such experiences, where possible, into the academic curriculum.
 - Increase emphasis on student career opportunities during their educational experience at UM-St. Louis and advertise the University as directly benefiting future career opportunities.
 - Enhance the quality of the degree programs within academic departments so that students majoring in those programs can experience curricula that are comprehensive and reflect the latest scholarship and, where appropriate, technology.
 - Encourage collaborative research with external organizations in the public and private sectors.
 - Increase recruitment of graduate students.

FORM PS**4. Program Structure**

	Nonthesis	Thesis
A. Total credit hours for graduation: At least half must be at 400 level.	36	30
B. Residency requirements:	24	20
C. General education credits:	NA	NA
D. Major requirements:	36	30
Biochem/Biotech Core	15	15
Advanced Biochemistry		
Bio 376 <u>or</u> Topics in Biochemistry (3)		
Chem 372 Advanced Biochemistry (3)		
Biotech/Mol. Bio. Lab		
Bio 327 <u>or</u> Intro. to Biotechnology (4)		
Bio 428 Adv. Techniques in Molecular Bio. (4)		
Advanced Gene Expression		
Bio 426 <u>or</u> Adv. Gene Expression in Eukaryotes (3)		
Bio 438 Adv. Gene Expression in Prokaryotes (3)		
Chem. & Bio Informatics		
Chem xxx* Cheminformatics and Bioinformatics (3)		
Graduate Seminar		
Bio 489 Graduate Seminar (2)		
Biochem/Biotech Electives	21	15
Chem 373 Biochemical Techniques (2)		
Chem 376 Interdisciplinary Topics Biochem. (3)		
Chem 377 Physical Biochemistry (3)		
Bio 317 Immunobiology (3)		
Bio 426 ¹ Adv. Gene Expression in Eukaryotes (3)		
Bio 438 ¹ Adv. Gene Expression in Prokaryotes (3)		
Bio 428 ¹ Adv. Techniques in Molecular Bio. (4)		
Bio 433 Adv. Nucleic Acid Structure/Function (3)		
Bio 434 Adv. Virology (3)		
Bio 435 Adv. Molecular Cell Biology (3)		
Bio 439 Adv. Plant Molecular Biology (3)		
Bio 417 Adv. Immunology (3)		
Chem 478 Problem Seminar in Biochemistry (3)		
Chem 479 Special Topics in Biochemistry (3) (4 courses)		
Inorganic Biochemistry		
Applications in Bioanalytical Chem.		
Bioorganic Chem. of Enzymatic Catalysis		
Computer Aided Chemistry		
Bio 489 Graduate Seminar (2)		
Bio 406 Topics in Mol., Cell. & Dev. Bio. (1)		
Bio 431 Graduate Internship in Biotech. (1-4)		
Bio/Chem 490 Graduate Research	(5 or less)	(12 or less)

*New courses.

¹If not taken as part of the core curriculum.

E. Free elective credits: not applicable

F. Requirements for thesis, internship, or other capstone experience:

Students selecting the nonthesis option will be strongly encouraged to participate in research with a member of the Biochemistry and Biotechnology faculty (Bio 490 or Chem 490) or to complete an internship (Bio 431) in a company or research institute that will allow the student to obtain work experience in the field of biochemistry and biotechnology.

G. Any unique features such as interdepartmental cooperation:

As explained in the section on cooperation, this program is a cooperative effort between the Departments of Biology and Chemistry. Graduate students will interact extensively with faculty and other students in both departments, gaining a better understanding of the importance of both areas of science in the fields of biochemistry and biotechnology. In addition, the joint biochemistry and biotechnology seminar program will expose faculty and graduate students in biology and chemistry to emerging fields in life science technology.

Form FP - Master's of Science in Biochemistry and Biotechnology**5. Financial Projections**

1. Expenditures

A. One-Time

	Year 1	Year 2	Year 3	Year 4	Year 5
New/Renovated space					
Equipment					
Library					
Consultants					
Other					
Total One-Time	0	0	0	0	0

B. Recurring

	Year 1	Year 2	Year 3	Year 4	Year 5
Faculty					
Staff					
Graduate Stipends					
Benefits					
Equipment					
Supplies ^a	5,000	5,200	5,408	5,624	5,849
Library ^b	250	260	270	280	292
Total Recurring	5,250	5,460	5,678	5,904	6,141
Total (A + B)	5,250	5,460	5,678	5,904	6,141

2. Revenues

	Year 1	Year 2	Year 3	Year 4	Year 5
State Aid					
Tuition/Fees ^c	12,228	25,190	37,066	49,631	53,086
Institutional					
Total Revenues^d	0	0	7,413	20,998	31,458
Revenue minus Expenditures	-5,250	-5,460	1,735	15,094	25,317^e

Budget Footnotes

^aThis degree will be offered by a newly established Program in Biochemistry and Biotechnology, not by either the Chemistry Department or the Biology Department. Thus a nominal supply budget is requested to cover such necessary Program costs as photocopying, long distance charges, postage, and student recruitment. The requested funds will be used to pay only for expenses associated exclusively with the new Program.

^bAs per institutional policy, funds equal to 5% of the total recurring expenditures are requested for the University Library budget.

^cA more detailed description of the expected fee income is given below in Table 2. These calculations assume that educational fees will start at the current level and increase by 3% per year for each of the first five years of the program. Part-time students have been counted as 0.5 FTE per student.

Table 2
Calculation of Expected Fee Income

	Student FTE	SCH per FTE	Charge per SCH	Fee Income	Adjusted Income
Year 1	3.5	18	\$194.10	\$12,228	0
Year 2	7.0	18	\$199.92	\$25,190	0
Year 3	10	18	\$205.92	\$37,066	\$7,413
Year 4	13	18	\$212.10	\$49,631	\$20,998
Year 5	13.5	18	\$218.46	\$53,086	\$31,458

^dThe total fee income has been adjusted based on estimates of the percentage of “new” students, defined as those students who would not have chosen to enroll at U.M.-St. Louis in either the Chemistry or Biology programs had the new program in Biochemistry and Biotechnology not become available. We estimate that for the first two years, all the students in the Biochemistry and Biotechnology program will come from Chemistry or Biology. In subsequent years the percentage of new students increases to about 70% of the total enrollment.

^eThis Master’s Degree program and an B.S. program in Biochemistry and Biotechnology are being proposed simultaneously. The projected fees from the B.S. program would add approximately \$118,000 per year to the net income shown above for year 5 in the budget.

FORM PG

6. PROGRAM CHARACTERISTICS AND PERFORMANCE GOALS

A. Student preparation

1. Admission procedures and student qualifications.

Students must have an undergraduate degree in biology or chemistry with undergraduate courses in genetics and biochemistry. The program will require a minimum GPA of 3.0 and three letters of recommendation. Applications will be reviewed by at least four faculty members of the Biochemistry and Biotechnology Program to determine eligibility.

2. Characteristic of specific population to be served

The program will serve full-time and part-time students from the St. Louis region who are interested in advancing their careers in life science technology or in changing careers. This is a rapidly growing field in the St. Louis region that is anticipated to provide a large number of jobs in the next decade. Working students are expected to comprise most of the students in this program.

B. Faculty characteristics

Four members each from the biology and the chemistry faculty currently comprise the faculty of the Biochemistry and Biotechnology Program. All the faculty hold Ph.D. degrees, have research laboratories and publish in the top journals in their fields. The faculty currently have or have had external funding for their research programs, and most of the faculty currently have both undergraduate and graduate students involved in laboratory-based research projects. The faculty in this program currently teach all the courses that comprise the biochemistry and biotechnology core and will develop any new courses that are required for the program.

C. Percentage of credit hours to be taught by full-time faculty

All the courses in this program will be taught by full-time faculty.

D. Expectations for professional activities, special student contact, teaching/learning innovation

All students in the Biochemistry and Biotechnology Program will have a faculty member of the program who will serve as an advisor and mentor. Students will be encouraged to attend and participate in seminars and, whenever possible, to become involved in research either in the laboratories of faculty or in local industries.

E. Enrollment projections

The program is expected to enroll 2 full-time students per year for the first two years and to level off at six full-time students in year 3. In addition, the program is expected to enroll 5 part-time students in the first year, and to enroll 7 additional part-time students per year until it reaches a steady-state enrollment of 28 part-time students in year 5.

F. Student and program outcomes

1. Number of graduates per annum

The number of graduates expected per year is shown below. These estimates are based on a 36 credit hour M.S. program, assuming that a full-time student will take 18 SCH per year and that a part-time student will take 9 SCH per year.

	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Graduates	0	2	2	7	10

2. Special skills specific to the program

This program is particularly designed to provide technology skills in the fields of biochemistry and biotechnology. The program includes laboratory courses designed to insure that students are prepared for positions in high technology fields when they graduate.

3. Proportion of students who will achieve licensing, certification, or registration

Not applicable.

4. Performance on national and/or local assessments

Not applicable.

5. Placement rates in related fields, in other fields, unemployed

We estimate that 80% of graduates will find employment in their field of study or a related field while about 20% will pursue a Ph.D. or professional degree in their field of study or a closely related field. If projections for workforce needs are accurate, it appears likely that few graduates will be unemployed.

6. Transfer rates

Since no other institutions in the area offer a program in biochemistry and biotechnology, it is unlikely that a significant number of students will transfer to other institutions.

G. Program accreditation

Not applicable. There is no state or national accreditation agency that is appropriate for this program.

H. Alumni and employer survey of satisfaction

The program will be reviewed every five years and will include a survey of all graduates as part of the review. We anticipate that most of the graduates will be employed or in a Ph.D. or professional degree program and therefore will likely be satisfied with the program. We will periodically survey major employers of our students to determine their level of satisfaction with graduates of the program; however, long term employment of graduates will also be used as a measure of employer satisfaction.

7. Accreditation

All degree programs offered by UM-St. Louis are accredited degree programs. As explained above, there is no specific accreditation that is associated with this particular program

8. Institutional Characteristics

UM-St. Louis is particularly well suited to offer this degree program for the following reasons:

- The St. Louis region is a center for life science technology research.
- Fields of science that require knowledge and experience in biochemistry and biotechnology are rapidly expanding.
- The St. Louis region will require large numbers of well-trained M.S.-level scientists to help in the development of life science technology-based research and industry in the region.
- About 95% of UM-St. Louis students come from the St. Louis region.
- UM-St. Louis is the largest provider of college educated workers in the region.
- About 80% of UM-St. Louis graduates live and work in the St. Louis region.
- UM-St. Louis offers opportunities for part-time and evening students to pursue graduate degree programs while they are employed.