

Section 1: Description of the Biochemistry and Molecular Biology Program

1.1 Mission, Vision, and Goals

The Biochemistry and Molecular Biology (BMB) Program at Gustavus Adolphus College was begun in 1990 as a joint venture of the Biology and Chemistry Departments. It has enjoyed a strong history of graduates, both numerically and qualitatively. The number of majors has ranged from 4 to 16, with an overall average of ~ 9/year. A majority of BMB graduates pursue either graduate or professional school, attending such institutions as Harvard, Stanford, and Northwestern Universities. The BMB Program is served primarily by two faculty (*i.e.* BMB faculty), both of whom hold joint appointments in the Biology and Chemistry Departments. The BMB faculty are the primary instructors for the BMB Program-specific courses (*i.e.* Biochemistry and Proteins) and also teach courses that support Biology and Chemistry, including Principles of Chemistry and Cell & Molecular Biology. The Program is also supported by resources, support staff, and faculty in Biology and Chemistry who teach core or elective courses that are required for the major.

Mission

The mission of the Biochemistry and Molecular Biology (BMB) Program is to stimulate and feed the intellectual curiosity of individuals seeking to pursue and advance understanding of the molecular basis of the living world. The BMB Program draws upon modes of thinking from biology and chemistry, as well as those that emerge in this pursuit, to both cultivate and exemplify an interdisciplinary approach to life-long learning.

Vision

The BMB Program endeavors to cultivate a learning community that is inclusive to all who wish to participate and is supportive of them as whole persons, including the development of capacities for leadership and a sense of vocation. The BMB Program aims to provide an exemplary curriculum that meets the highest standards of the profession. Thus, our approach pairs an emphasis on the fundamentals with significant engagement in the practice of the discipline. Our hope is that BMB majors are thoroughly knowledgeable of the fundamentals of the field, highly effective communicators, and exceedingly competent experimental scientists.

Goals

Goal 1: Foster BMB students' capacities in and awareness of their leadership skills and vocation

Goal 2: Enhance the communication skills and science information literacy of BMB students

Goal 3: Enhance student independence and sophistication as experimental scientists

Goal 4: Develop and enhance resources to support research in BMB fields

Goal 5: Empower BMB Program's ability to direct its development

Goal 6: Promote the support and professional development of Program faculty as whole persons and as teacher/scholars

1.2 Programs

The BMB Program and faculty contribute to and have long enjoyed the joint support of the Biology and Chemistry Departments. Significantly, Program faculty teach core courses in each department (BIO 201, CHE 107, CHE 141) in addition to Program courses (CHE 255), which support the majors of both Departments and the Program and non-majors preparing for admission to medical school and allied health fields. Contributions by Program faculty to other general education initiatives, such as the First Term Seminar or January term, are limited to those made as contributions as faculty members of the Biology and Chemistry Departments. Three introductory core courses and one advanced course from each department mutually benefit both Department and Program majors. Students then choose two electives from one or the other department to complete the BMB major. The BMB Program also enjoys the support of the Physics and Mathematics & Computer Science Departments, which provide two semesters of courses for the cognate requirements of the major. The Program faculty access administrative support through both Biology and Chemistry Departments, although Program expenses and teaching assignments are handled almost exclusively through the Chemistry Department, though in a cooperative fashion with Biology.

1.2 Support Relationships

The BMB Program relies on partnerships with many other support offices at Gustavus. We rely heavily on Gustavus Technology Services to support the technology used in our classrooms, computers in our laboratory, and instrument/computer software interfaces that are essential to our teaching and research. We partner with the library to ensure the quality of our library collections in the area of biomolecular science, including periodicals, scholarly texts, and appropriate literature databases. We work with Admissions to recruit high quality students to Gustavus. We collaborate with the Center for International and Cultural Education to support our students who are interested in studying abroad. We work closely with the office of Corporate and Foundation Relations when we seek external funding to support biochemical research and curricular development. Program faculty and students benefit from faculty development opportunities, student/faculty research programming and initiatives supported by the John S. Kendall Center for Engaged Learning.

Section 2: Strategic Review

2.1 Internal strengths

Begun in 1990, BMB is a well-established program that is deeply rooted in and supported by the Biology and Chemistry departments. None of our regional liberal arts counterparts, perhaps save one, have such a long-standing program, though many have (in recent years) added or are adding BMB-like programs. The Gustavus BMB Program has a rigorous, strong curriculum with a breadth of core and upper level courses in chemistry, biology, and biochemistry, a capstone experience, writing intensive courses, and research-like, investigative experiences in lab. Our commitment to ongoing curricular improvement is exemplified by focusing the students' research experiences and projects in the capstone course upon the further development of our model investigative laboratory curricula in the Biochemistry course. Thus, through the activity in and relationships between the capstone and Biochemistry courses, the laboratory program contains an internal cycle for ongoing development and enhancement.

The Program has benefited from dedicated and passionate Program faculty, as well as resource and strong faculty support from the Biology and Chemistry Departments. The presence of two Program faculty with joint appointments in Biology and Chemistry helps to maintain the strong connection of the Program to both departments and offers a positive cross-departmental line of communication. The BMB faculty are committed to teaching and service both within the Program and in the Biology and Chemistry Departments.

2.2 Internal weaknesses

While the BMB Program enjoys significant strengths, we admittedly struggle to offer students the education we wish for them and recognize several weaknesses in our Program. We receive students with a wide range of interests and preparations into Biochemistry, our first program-specific course. While we aspire to develop students writing skills and recognize our writing-intensive Program courses as a strength, the mixed preparation students have when they enroll in Biochemistry has limited the depth of writing instruction we would like to offer. In addition, while we have explicit and identifiable elements of Program curricula that develop science information literacy, this aspect of our curriculum has not received the attention it deserves due to time constraints. We recognize that we could develop and offer a more intentional, progressive and integrated approach to science literacy instruction. Similarly, we have only recently begun to consider a similarly developed approach to teaching scientific oral communication skills.

Another aspect of our Program that does not serve students as well as we would wish includes advising and mentoring. Presently, BMB Program faculty receive advisees from both the Biology and Chemistry Departments in addition to the Program (though admittedly, there are a number of Program-Department double majors). This itself is not problematic, rather there does not yet exist a system that insures Program faculty serve as advisors for all BMB majors as a first priority. A further complication is the delay students employ in declaring the BMB major. Thus, we have also come to recognize the need to more proactively engage interested students at a point before they enroll in the first Program specific course (usually as juniors).

We would also like to offer students a more robust preparation in modern experimental research in biomolecular science. The cost of reagents to conduct laboratory experiments in this field is admittedly significant, but inadequate and flat-lined laboratory course budgets (due to a flat-lined Chemistry Department budget) have limited the investigative projects in Biochemistry and the scope of research experiences we have been able to offer in the BMB capstone course. Outside of coursework, the lack of adequate time and reliable resources limits the independent research opportunities that can be offered and sustained by the two Program faculty. Some of the Program faculty's time is doubly-consumed due to the joint appointment, i.e. two department meetings, tenure-track searches in both departments (eight positions filled since the fall of 2002), contributing to and writing for three strategic plans, etc. A major point for resources in particular is the College's lack of any annual budgeting for major instrument replacement, repair and acquisition; this leaves the Program with outdated, decaying or non-functional equipment as well as no internal mechanism to advance our instrument repertoire. Not only does this limit students exposure to equipment that they will encounter in pursuit of scientific careers upon graduation, it requires an inordinate and ineffective use of faculty time to trouble-shoot and compensate for substandard instrument offerings, further compounding the issue of the time available to *engage* students in the practice of experimental investigation.

The ability to make improvements on the non-curricular matters above, in addition to some curricular matters not yet mentioned, is also limited by the lack of a certain degree of Program autonomy. While it is not the aspiration of the Program to become wholly independent of the supporting Departments of Biology and Chemistry, the Program is limited in its ability to direct its development, specifically in reference to matters of scheduling teaching assignments and budgeting for expenses. For example, the Program offers only two formal biochemistry courses within the major. If the Program faculty want to expand course offerings (*e.g.* another capstone course), presently there is not an efficient or coordinated mechanism to allow this expansion to occur due to the scheduling of Program faculty teaching assignments by the chairs of the Biology and Chemistry Department. Similar issues exist for matters of Program expenses, which are addressed administratively through the Chemistry Department and its budget. In addition to some level of structural or administrative autonomy, another limitation is the time required to address the administrative issues related to the Program. Presently, there is no course release support associated with Program administration. Combined with the invisible overload that comes with joint appointments, Program faculty are stretched thin and are unable to more effectively direct the advancement of the Program by addressing the weaknesses above or through pursuit of extramural funds to enhance curricular or instrumentation capabilities.

2.3 External Opportunities.

Over the past five years, BMB Program faculty at Gustavus and colleagues at Grinnell College have been collaborating to develop model laboratory curricula for biomolecular science. Both groups have worked 1) to develop parallel curriculum and pedagogy to achieve effective learning of biochemistry through the laboratory experience, 2) to assess the corresponding student learning outcomes, and 3) (presently) to evaluate the transferability of the curricula by exchanging them and assessing effectiveness. As the project is now in the final phase, the results will soon be prepared for publication. In addition, through contacts with colleagues at Grinnell College, Gustavus has been able to join a collaborative survey project entitled Classroom Undergraduate Research Experience (CURE) to assess the effectiveness of research-like experiences embedded in formal course instruction. The project is under the direction of Professor David Lopatto of Grinnell College and the collaborating institutions include Grinnell, Hampshire, Harvey Mudd, Hope, and Wellesley Colleges.

In addition to these curricular developments, the BMB Program and faculty have contributed significantly to the procurement of important and significant external funds. BMB faculty have been contributors, coordinators and active participants for each of two awards the College has received from the Merck/AAAS Undergraduate Science Research Program. In addition, the BMB Program, its curricular development project, and the success with Merck/AAAS were all featured as strengths to support the College's recent successful request to the Howard Hughes Medical Institute science education grant program. Since the start of the HHMI award, BMB Program faculty have stepped forward to assume leadership roles in the development of a peer mentoring program for first year biology and chemistry courses, to support the development of visualization and imaging resources for these departments, and to participate in the overall coordination of the initiatives of the HHMI-supported program. Additional opportunities to pursue extramural funding to support BMB-related curricula and research do exist (*i.e.* NIH R15, NSF RUI, and NSF CCLI), however due to their contributions in all of the aforementioned areas, Program faculty have been unable to take full advantage of these opportunities.

2.4 External Challenges.

Although Gustavus was the first liberal arts college within our immediate region to establish a BMB Program, our regional peer and aspirant institutions have all established (or are in the process of establishing) a biochemistry major in the past five to seven years. These same institutions, including Grinnell, St. Thomas, and St. John's/St. Benedict's, have also garnered resources for new science buildings and instrumentation to support their science programs, students, and faculty. While the BMB Program at Gustavus has appreciated and benefited from one of the more newly renovated spaces in Nobel Hall, in the absence of additional resources to support enhanced laboratory endeavors, expanded research opportunities, and acquisition of modern instrumentation, our Program will soon be overlooked by prospective students.

2.5 Barriers—internal

The major barriers that prevent the Gustavus BMB Program from becoming one of the programs of distinction in the nation have been described above in section 2.2, and can be distilled to inadequate budgetary resources and time.

Inadequacies in budgetary resources for equipment maintenance, replacement, and acquisition across the Natural Science and Mathematics division has resulted in antiquated equipment and instrumentation in our teaching labs that is unfriendly in terms of instrument/computer interfaces, is heavily used, and is frequently in need of maintenance.

Inadequacies in budgetary resources for the BMB laboratory program has reduced the scope of the investigative, research-like experiences that we can offer in Biochemistry and our capstone course and non-course based student/faculty research collaborations.

Although both the Program and the Biology and Chemistry Departments have benefited from BMB faculty that hold joint appointments and coordinate the Program, the time that is required to maintain an active and contributing presence to these bodies, along with other divisional and college-wide endeavors, is unsustainable. Formal acknowledgment of these contributions through course releases, laboratory support, or other means is appropriate.

The time and resource barriers described above have recently been compounded even further by higher than average enrollments across the Program. While historically we have averaged ~9 BMB majors/year, we currently have 46 declared majors (12 in the senior class, 20 in the junior class, 14 in the sophomore class), and a Biochemistry course that has supported 66 students in the 2008-2009 academic year, relative to an average of ~54 students/year over the past 5 years.

Section 3: Strategic Initiatives and Recommendations

Goal 1: Foster BMB students' capacities in and awareness of their leadership skills and vocation

Strategic Initiative 1.1: Develop and implement a vocationally reflective approach to advising for BMB students

Strategic Initiative 1.2: Develop and implement a plan to advance the leadership capacities of BMB students in alliance with the College's leadership formation initiative

- Recommendation: Partner with the Center for Vocational Reflection (CVR) for instruction and training to advise students in vocationally-reflective ways
- Recommendation: Consolidate BMB advising among BMB faculty
- Recommendation: Hold biannual advising sessions for currently declared and rising BMB majors
- Recommendation: Support diverse student populations considering and advancing in the major
- Recommendation: Generate and implement a laboratory and classroom model to foster the development of leadership skills in Program courses

Goal 2: Enhance the communication skills and science information literacy of BMB students

Strategic Initiative 2.1: Develop and implement a comprehensive plan to enhance oral and written communication skills in BMB students

Strategic Initiative 2.2: Develop and implement a comprehensive plan to enhance biomolecular information science literacy skills in BMB students

- Recommendation: Partner with the writing center, library, and faculty in Communication Studies to enhance instruction and evaluation of communication skills and information literacy in Program courses.
- Recommendation: Incorporate experiences in oral and written scientific communication and biomolecular science literacy that build upon the skills gained in the core and elective biology and chemistry courses
- Recommendation: Acquire resources to facilitate instruction and use of cutting edge biomolecular information tools
- Recommendation: Continue to offer small class sizes to have time to devote attention to students and provide formative feedback

Goal 3: Enhance student independence and sophistication as experimental scientists

Strategic Initiative 3.1: Continue to engage students in research-like laboratory experiences in Biochemistry

Strategic Initiative 3.2: Engage students in publication quality research in a capstone course

Strategic Initiative 3.3: Foster development of practical knowledge of modern instrumentation

Strategic Initiative 3.4: Establish necessary support for a more technically intensive curriculum

Strategic Initiative 3.5: Continue to engage students in non-course-based research experiences

- Recommendation: Continue to develop and enhance research-like, investigative lab curriculum
- Recommendation: Work within the administrative structure of Chemistry to define a Program budget and budget process
- Recommendation: Advocate for necessary Program budget increases from the administration to support high quality, laboratory experiences in Program courses
- Recommendation: Develop a system for capital equipment maintenance, replacement and acquisition
- Recommendation: Generate space to house new capital equipment/instrumentation for use by students and faculty across the division
- Recommendation: Hire laboratory support staff
- Recommendation: Develop an efficient, cooperative mechanism to address Program plans and needs in scheduling with Department chairs

Goal 4: Develop and enhance resources to support research in BMB fields

Strategic Initiative 4.1: Develop a sustainable plan for equipment acquisition, maintenance and replacement

Strategic Initiative 4.2: Develop a sustainable plan to support students conducting BMB-related research

Strategic Initiative 4.3: Develop a sustainable plan to support faculty conducting BMB-related research

- Recommendation: Hire an instrument technician
- Recommendation: Initiate a line within the Gustavus annual budget for capital equipment maintenance, replacement, and acquisition

- Recommendation: Generate space to house new capital equipment/instrumentation for use by students and faculty across the division
- Recommendation: Enhance library resources to expand access to biomolecular scientific journals and scholarly materials
- Recommendation: Grow the Langsjoen BMB research endowment for summer student stipends, research supplies, student and faculty travel to regional, national, and international research meetings
- Recommendation: Develop an acceptable and realistic accounting method for Program faculty FTE, which includes proper consideration of collaborative student/faculty research and grant writing

Goal 5: Empower BMB Program's ability to direct its development

Strategic Initiative 5.1: Develop a system to track and spend Program funds

Strategic Initiative 5.2: Develop a system to track and address Program needs

Strategic Initiative 5.3: Develop a system to consider Program plans in scheduling

Strategic Initiative 5.4: Develop support to more effectively use faculty time

Strategic Initiative 5.5: Acquire adequate time for Program administration

- Recommendation: Work within the administrative structure of Chemistry to define a Program budget and budget process
- Recommendation: Advocate for any necessary Program budget increases
- Recommendation: Develop a system for capital equipment maintenance, replacement and acquisition
- Recommendation: Develop an efficient, cooperative mechanism to address Program plans and needs in scheduling with Department chairs
- Recommendation: Hire laboratory support staff
- Recommendation: Develop an acceptable and realistic accounting method for Program faculty FTE, which includes consideration of administrative tasks

Goal 6: Promote the support and professional development of Program faculty as whole persons and as teacher/scholars

Strategic Initiative 6.1: Reduce the teaching load for Program faculty

Strategic Initiative 6.2: Develop mechanisms to more effectively use faculty time

Strategic Initiative 6.3: Increase Program-associated faculty and staff

- Recommendation: Develop an acceptable and realistic accounting method for Program faculty FTE, which includes proper consideration of joint appointment obligations, teaching, collaborative student/faculty research, administrative tasks, student advising, grant writing, etc.
- Recommendation: Hire laboratory support staff
- Recommendation: Hire instrument technician support staff (shared)
- Recommendation: Hire a molecular neuroscientist jointly with the neuroscience program to contribute to both Programs, increase flexibility in both Programs, and support connections across interdisciplinary boundaries

Section 4: Assessment

The proposed goals are set forth to allow us to strive to become an exemplary program that meets the highest standards of the profession. In order to monitor whether we are meeting the given goals, we propose the following plans for assessment.

Goal 1: Foster BMB students' capacities in and awareness of their leadership skills and vocation.

In order to demonstrate that we have achieved Goal 1, we will develop an assessment program which may include:

- monitoring the number of BMB majors with Program faculty as an advisor
- monitoring the number of BMB majors who take on a significant leadership experience during their Gustavus career
- development and use of a senior survey to track the expected post-baccalaureate education/career path and sense of student satisfaction with that life path
- development and use of a longitudinal survey to track the career, life vocation, leadership experiences, and perception of the impact of their Gustavus BMB education

Goal 2: To enhance communication skills and science information literacy in BMB students

In order to demonstrate that we have achieved Goal 2, we will develop an assessment program which may include:

- documentation of curricular changes and outcomes in areas of communication and literacy
- documentation of the number of students who present course and/or research materials in non-classroom environments (e.g. professional meetings)
- incorporation of communication portfolios (which may include class assignments, literature reviews, research proposals, etc.) as part of the BMB curriculum
- evaluation of the communication portfolios to assess student learning gains over the period of a course and entire Gustavus career

Goal 3: Enhance student independence and sophistication as experimental scientists

In order to demonstrate that we have achieved Goal 3, we will develop an assessment program which may include:

- tracking the number of students pursuing and/or engaged in non-course related research opportunities and careers
- tracking the level of sophistication in the investigative lab projects within the BMB courses laboratory curricula
- development and use of senior survey and longitudinal survey tools to track perception of laboratory independence and sophistication

Goal 4: Develop and enhance resources to support research in BMB fields

In order to demonstrate that we have achieved Goal 4, we will develop an assessment program which may include:

- tracking the number of students pursuing and/or engaged in non-course related research opportunities in BMB
- tracking the number of presentations of BMB research by students and/or faculty at regional, national, and international professional meetings
- monitoring the growth of the Langsjoen endowment for BMB research
- commitment to or the hiring of an instrument technician
- commitment to or incorporation of capital equipment line in the Gustavus annual budget
- generation or identification of a space to house new capital equipment/instrumentation
- tracking the number of research grants written by BMB faculty
- development of an acceptable and realistic accounting method for Program faculty FTE, which includes consideration of collaborative student/faculty research

Goal 5: Empower BMB Program's ability to direct its development

In order to demonstrate that we have achieved Goal 5, we will develop an assessment program which may include:

- establishment of a BMB Program budget line within the structure of the Chemistry Department budget
- commitment to or incorporation of capital equipment line in the Gustavus annual budget
- establishment of a collaborative plan and mechanism to determine teaching schedules of BMB Program faculty and courses
- monitoring of teaching loads/contact hours of BMB Program faculty
- commitment to or hiring of laboratory support staff that supports the BMB Program
- development of an accounting method for Program faculty FTE, which includes consideration of administrative tasks

Goal 6: Promote the support and professional development of Program faculty as whole persons and as teacher/scholars

In order to demonstrate that we have achieved Goal 6, we will develop an assessment program which may include:

- establishment of reliable funding that supports professional development of BMB Program faculty in research, teaching, and skill development endeavors.
- monitoring of the teaching load/contact hours of BMB Program faculty
- development of an acceptable and realistic accounting method for Program faculty FTE, which includes consideration of collaborative student/faculty research, administrative tasks, joint appointments, etc.
- commitment to or hiring of laboratory support staff that supports the BMB Program
- commitment to or hiring of an instrument technician that supports BMB and other science departments/programs
- commitment to or hiring of tenure-track faculty that can contribute to teaching and research in BMB

Final recommendations

- Partner with supporting departments and centers for assistance in student advising (CVR) and instruction/evaluation of communication skills and biomolecular science literacy (Communication Studies, Library, Writing Center). Addresses Goals 1 & 2.
- Generate and implement a laboratory and classroom model to foster the development of leadership skills in Program courses. Addresses Goal 1.
- Develop a strategy to incorporate experiences in a variety of communication styles and biomolecular science literacy that build upon the skills gained in core and elective biology and chemistry courses. Addresses Goals 2 & 3.
- Adopt a sustainable model for instrument acquisition, maintenance, and repair. Develop a modern complement of biomolecular instrumentation and tools to support high quality course and laboratory experiences and student/faculty collaborative research. Generate a space to house capital equipment/instrumentation. Addresses Goals 2, 3, 4, 5 & 6.
- Increase support of student/faculty research in BMB, through growth of the Langsjoen BMB research endowment or other endowed funds. Addresses Goals 2, 3, 4 & 6.
- Develop a mechanism and establish resources to foster collaboration and coordination of efforts in teaching, research, and administrative work between the Program and supporting Departments. Addresses Goal 2, 3, 4, 5 & 6.
- Develop an acceptable and realistic accounting method for Program faculty FTE, which includes consideration of joint appointment obligations and programmatic administrative tasks, such as one course release for a joint appointment and one course release for administrative tasks. Adjustments in FTE to account for teaching loads for science faculty and collaborative student/faculty research is a division-wide issue and needs to be addressed through division-wide conversations. Addresses Goal 4, 5 & 6.
- Continue to offer Program courses that are of a reasonable size to provide formative and constructive feedback to students. Addresses Goals 2, 3 & 6.
- Invest in additional faculty and staff to support Program needs in teaching, laboratory, and equipment maintenance, including an instrument technician, laboratory support staff, and tenure-line faculty (*e.g.* a molecular neuroscientist). Addresses Goals 3, 4 & 6.
- Develop a strategy to define a reasonable Program budget and process within the administrative structure of Chemistry. Addresses Goal 5.
- Develop an efficient and cooperative mechanism to address Program plans, enrollments, resources/budgets, and needs in scheduling between Program faculty, Department chairs, and administration. Addresses Goal 5.