
THE COLLEGE OF
WOOSTER
MEMORANDUM

To: Thomas Falkner, Dean of Faculty, and the Educational Policy Committee

From: Dean Fraga, Department of Biology
Charles L. Borders, Jr., Department of Chemistry

Subject: REVISED Proposal to change the existing **Biochemistry** major, administered by the Department of Chemistry, to **Biochemistry and Molecular Biology**, administered jointly by the Departments of Biology and Chemistry

Date: October 5, 2001

On behalf of the Departments of Biology and Chemistry we are resubmitting this proposal to revise the Biochemistry major so that it is jointly run by both departments and better reflects its nature as an interdisciplinary major. Both departments have reviewed this document and the chairs of both departments have indicated their support in accompanying letters. We would like to call the revised major **Biochemistry and Molecular Biology** to highlight that the major will be jointly administered by the Departments of Biology and Chemistry. It does not represent a totally new major, simply an exciting change in some of the offerings and in how the program is administered.

The italicized headings below are derived from a conversation one of us had with the Dean of Faculty regarding what should be included in this proposal.

I. Rationale for change in the Program

The existing **Biochemistry** major was first proposed by the Department of Chemistry and approved by EPC in the spring of 1994. Montie Borders was one of the main architects of that program. At the time, he and the Department of Chemistry engaged in a discussion with the Department of Biology of an alternative program in "**Biochemistry and Molecular Biology**" which was conceptually different than the one being proposed today. The idea discussed at that time was that the program would have two different tracks. A student could major in **Biochemistry**, with a major track in the Department of Chemistry, or major in **Molecular Biology**, with a major track in the Department of Biology. Students majoring in Biochemistry would normally have done their Senior I. S. with an advisor from Chemistry, while Molecular Biology majors would have had a member of the Biology faculty as an advisor. The members of the Department of Biology decided at that time they did not want to have two different majors in their department, so the Department of Chemistry proceeded with its proposed Biochemistry major, which has now been in place for the past six years.

Some members of the Departments of Chemistry and Biology have maintained an open dialog in recent years about the possibility of a true interdepartmental major in Biochemistry. In the fall of 1998, the College of Wooster sent a team of five people to the first Project Kaleidoscope (PKAL) workshop on the nature of Biochemistry. The workshop, entitled "Biochemistry: Is It Biology or Chemistry?", was held at Rice University in Houston and the Wooster team consisted of Dean of Faculty, Susan Figge, Dean Fraga and Bill Morgan from Biology, and Montie Borders and Paul Edmiston from Chemistry. We all found the workshop to be very stimulating and exciting; we came home with a renewed determination to create a true interdepartmental major at Wooster. The proposal we are sending today is a culmination of our actions over the past two years.

Overall we feel this innovative program will make Wooster more attractive to students interested in the biomolecular sciences. It is a field of increasing interest to students and similar majors are seen in the top Liberal Arts Colleges. For example, institutions such as Grinnell, Bates, and Creighton afford their students the opportunity to major in this field through jointly administered programs. We feel that the field of Biochemistry and Molecular Biology is interdisciplinary and can provide students with a broad education in science but still provides them with sufficient depth to be competitive after graduation.

Jointly administering this major makes sense because the fields of biochemistry and molecular biology represent the two sides of the boundary between biology and chemistry. Biochemists and molecular biologists both ask how the multitude of molecules found in biological systems interact to confer the amazing properties of living organisms. The disciplines of chemistry and biology continue to grow and draw inspiration from each other as scientists at this boundary learn more about how molecules in the cell interact to convert energy, build complex structures, maintain order, and convey information spatially and over time.

II. A new description of the program such as it might appear in the Catalogue (as requested this includes the courses that will be considered BMB courses)

Biochemistry and Molecular Biology

Borders, Edmiston, Fraga and Morgan

Biochemists and molecular biologists both ask how the multitude of molecules found in biological systems interact to confer the amazing properties of living organisms. In fact the disciplines of biochemistry and molecular biology are really the two sides of the boundary between the classical disciplines of biology and chemistry. Both chemistry and biology continue to grow and draw inspiration from each other as workers in this boundary continue to learn more about how molecules interact to convert energy, build complex structures, maintain order, and convey information spatially and over time. The requirements for a Biochemistry and Molecular Biology major are listed below.

Biochemistry and Molecular Biology requirements

Biochemistry and Molecular Biology: 303, 331, 332

Chemistry: 101, 102, 211, 212

Biology: 210, 220, 305, 306.

Mathematics: 111

Physics: 203 (or 101)

Independent Study: 401, 451, 452

Strongly suggested courses:

Chemistry: 215, 318

Biology: One other upper level biology course

Physics: 204 (or 102)

Mathematics: 112

The "required courses" listed above represent a minimum major. Students interested in going to graduate school in chemistry, biochemistry, pharmacology, molecular biology, and related fields should also plan to include the "strongly suggested" courses in their schedules. A student who majors in Biochemistry and Molecular Biology and takes all of the strongly suggested courses will meet all of the requirements, including the research component, that are recommended by the American Society of Biochemistry and Molecular Biology in its guidelines for a Biochemistry major. Students who are more interested in meeting requirements for graduate work in a department with a strong biological emphasis (such as a Molecular, Cellular, Developmental, Physiological, or Biology department) are advised to take additional biology courses that reflect their specific interests, such as Evolution, Development, Neurobiology, Plant Biology or Microbiology.

The major is administered by a committee composed of equal numbers of faculty from the Departments of Biology and Chemistry, of whom one is the chair for purposes of administration. Interested students should direct any questions about the major to the chair or their designee. A double major in either Biology or Chemistry and Biochemistry and Molecular Biology is not an option; neither is a minor offered in Biochemistry and Molecular Biology. Distribution credit in the natural sciences and mathematics is noted in the individual department listings.

Chem 101 General Chemistry I see Chemistry for full description

Chem 102 General Chemistry II see Chemistry for full description

Chem 211 Organic Chemistry I see Chemistry for full description

Chem 212 Organic Chemistry II see Chemistry for full description

Bio 210 Introduction to the Biology of Organisms see Biology for full description

Bio 220 Introduction to the Biology of Cells see Biology for full description

BMB 303 Techniques in Biochemistry and Molecular Biology. This course will cover basic techniques in biochemistry and molecular biology. It is organized around a semester-long project in which students use molecular biological techniques to genetically engineer a protein and then purify that protein to determine the biochemical effects of those changes. The course is cross-listed as Bio/Chem 303 so that Biology and Chemistry majors can take the course for credit as well. Prerequisites: Chemistry 102 and Biology 220. It is encouraged that BMB majors have prior or concurrent enrollment in BMB 331. Offered annually in the Fall.

Bio 305 Cell Physiology see Biology for full description

Bio 306 Genetics see Biology for full description

BMB 331 Biochemistry I. (Formerly Chem 333). The structure and function of proteins, carbohydrates, lipids, nucleic acids, and membranes are emphasized. An introduction to oxidative metabolism is also provided. This course is cross-listed as Bio/Chem 331. Prerequisite: Chem 212. Suggested previous courses: Chem 318 and/or BIO 220. Offered annually in the Fall.

BMB 332 Biochemistry II. (Formerly Chem 334). Bioenergetics and cellular respiration are emphasized from a molecular and mechanistic perspective. Various aspects of oxidative metabolism, biosynthesis, and recombinant DNA methodology are presented. This course is cross-listed as Bio/Chem 332. Prerequisite: Chem 331 and Bio 220 or permission of the instructor. Offered annually in the Spring.

BMB 401 Introduction to Independent Study This will be a new Junior I.S. course and will be an introduction to the techniques and practices of modern biochemical and molecular biological research. The course will focus on scientific writing, experimental design, and informational retrieval systems, including accessing the growing collection of molecular databases. Exploration of the literature related to the proposed I.S. thesis will be accomplished through a series of structured writing assignments. The final major paper will be a detailed proposal for a senior research project. Offered annually in the Spring semester.

BMB 451/452 Senior Independent Study Thesis. An original investigation is conducted, culminating in a thesis and oral defense of the thesis. During the year each student will give at least one research seminar on his or her Independent Study research topic to either the Chemistry or Biology departments. Normally a student will have one research advisor and the thesis will be read by the research advisor and one other professor. The evaluation of the thesis will be determined by these two readers in consultation with the other members of the BMB committee. Prerequisite BMB 401

III. Proposals for new or revised courses.

The changes we propose would create two new courses in Biochemistry and Molecular Biology (BMB), **BMB 303 Techniques in Biochemistry and Molecular Biology**, and **BMB 401 Introduction to Independent Study**. In addition, **BMB 451 & 452 Independent Study Thesis** would give majors an equal opportunity to choose a Senior I.S. advisor from either the Biology or Chemistry Departments. It is our intention that both BMB 303 and BMB 401 will be taught jointly by one faculty member from Biology and one from Chemistry. BMB 303 will be designed as a laboratory intensive course and will combine the best of the techniques currently taught in **Bio 309 Topics in Molecular Biology** and the laboratory portion of **Chem 333, Biochemistry I**.

New courses

BMB 303 Techniques in Biochemistry and Molecular Biology. An introduction to modern techniques in biochemistry and molecular biology. This class will be primarily a laboratory course complemented with weekly seminars in which students will present and discuss papers from the primary literature. There will be a strong emphasis on a combination of

classic biochemical and molecular biology techniques to carry out a full-term project. The course will be cross-listed as BIO/CHEM 303 so that Biology and Chemistry majors can take the course for credit as well. Prerequisites: Chemistry 102 and Biology 220. It is encouraged that BMB majors have prior or concurrent enrollment in BMB 331. Offered annually in the Fall.

BMB 401 Introduction to Independent Study This will be a new Junior I.S. course and will be an introduction to the techniques and practices of modern biochemical and molecular biological research. The course will focus on scientific writing, experimental design, and informational retrieval systems, including accessing the growing collection of molecular databases. Exploration of the literature related to the proposed I.S. thesis will be accomplished through a series of structured writing assignments. The final major paper will be a detailed proposal for a senior research project. Offered annually in the Spring semester.

BMB 451/452 Senior Independent Study Thesis. An original investigation is conducted, culminating in a thesis and oral defense of the thesis. During the year each student will give at least one research seminar on his or her Independent Study research topic to either the Chemistry or Biology departments. Normally a student will have one research advisor and the thesis will be read by the research advisor and one other professor. The evaluation of the thesis will be determined by these two readers in consultation with the other members of the BMB committee. Prerequisite BMB 401

Revised and renumbered courses

BMB 331 Biochemistry I. (Formerly CHEM 333.) This course will be somewhat modified in content from the current CHEM 333 to reflect a more biological perspective. A Hewlett Mellon grant has been gratefully received from the college to make this a reality. The laboratory portion will be dropped in favor of requiring the new course BMB 303 of all majors. This course will be cross-listed as **BIO/CHEM 331**. This will allow Biology majors to take a course that emphasizes biochemical approaches without being a biochemistry major, and will allow Chemistry majors to include the course in their required courses. Prerequisite: CHEM 212. Suggested previous courses: CHEM 318 and/or BIO 220. Offered annually in the Fall.

BMB 332 Biochemistry II. (Formerly CHEM 334). This course will be modified in content somewhat to reflect a more biological perspective. This course will be cross-listed as **Bio/Chem 332**. Prerequisite: CHEM 331 and BIO 220 or permission of the instructor. Offered annually in the Spring.

Deleted courses

Bio 302 Metabolism and Biosynthesis. This course will be eliminated because the courses BMB 331 (currently CHEM 333) and BMB 332 (currently CHEM 334) will be cross-listed so that Biology students can take these two courses and receive credit towards the Biology major. This action will actually expand the number of options available for biology majors.

Bio 309 Topics in Molecular Biology. This course will be dropped in favor of the new course BMB 303. The lecture topics covered in this course are covered in Cell Physiology, Biochemistry I and II, and Genetics. Certain portions will be covered in the redesigned Biochemistry courses. The laboratory portion will be continued and expanded in the new course BMB 303.

IV. A description of the proposed administration of the program

The major will be jointly administered by Biology and Chemistry through a committee composed of two faculty members from each department. This committee will have the responsibility for the day-to-day operation of the program. The chair of the committee will be appointed by the VPAA and approved by TS&T, and the candidates for Chair will come from the four faculty who serve on the committee. The committee will have the following responsibilities:

- Setting and/or revising the course requirements for the major (subject to EPC guidelines)
- Reviewing and approving the content of BMB 331/332 and BMB 303
- Reviewing and approving the program description in the course catalog
- Advising declared Biochemistry and Molecular Biology majors
- Administering, scheduling, and staffing, with the approval of the Chairs of Biology and Chemistry, BMB 401 and BMB 303
- Pairing senior BMB majors with advisors for their Independent Study thesis project
- Setting requirements for attendance at either Biology or Chemistry Senior I. S. seminars
- Meet on a regular basis to discuss the major and any questions that may arise
- Make recommendations to the Chemistry and Biology departments with regard to any equipment purchases for courses

We expect that since this revised major is built upon an existing structure of courses currently supported by the two departments, that support for chemical purchases, I. S. projects, and the like will continue to come from both departments in an equitable fashion. We anticipate that there will be some start-up costs associated with implementing the new courses as we try to develop courses that integrate the two disciplinary approaches. For these expenses, we will be seeking competitive external (NSF, Beckman) and internal funding.

V. Other relevant information

Impact on the Department of Biology. Below is a tentative outline for a two-year sequence of courses that might be taught by Dean Fraga and Bill Morgan once the BMB major is in place. The nonmajor's course can alternate with First Year Seminar as needed. This schedule indicates that this new structure would not impinge significantly upon course offerings in Biology (Please be advised that this schedule is for comparison purposes only). In the appendix is a complete comparison of Drs. Fraga and Morgan's course offerings with and without the BMB major in place.

Year 1

<u>Faculty</u>	<u>Fall schedule</u>		<u>Spring schedule</u>	
Bill Morgan	BIO 220	1.0	BIO 220	1.0
	BIO 307	1.5	BMB 401	0.4
			BIO 306	1.5
Dean Fraga	BIO 220	1.0	BIO 220	1.0
	NONMJRs	1.0	BMB 401	0.4
	BMB 303	0.5	BIO 305	1.5

Year 2

Bill Morgan	BIO 220	1.0	BIO 220	1.0
	NONMJRs	1.0	BMB 401	0.4
	BMB 303	0.5	BIO 306	1.5
Dean Fraga	BIO 220	1.0	BIO 220	1.0
	BIO 380	1.5	BMB 401	0.4
			BIO 305	1.5

BIO 305 Cell Physiology
BIO 306 Genetics
BIO 307 Development
BMB 401 Biochemistry Junior IS

BIO 220 Introduction to the Biology of Cells
BMB 303 Techniques in Biochemistry and Molecular Biology
BIO 380 Neurobiology
NONMJRs Nonmajors course such as Human Genetics or FYS

Notes about Biology schedule:

During the past five years there have been 49 students who have or will (in May) graduate with a Biochemistry major, an average of 9.8 per year (lets say 10 so that it doesn't get messy). We estimate that another six Biology majors each year would have either opted for the major if it had been Biochemistry and Molecular Biology or will want to pursue a related project that would be best served by having Drs. Morgan or Fraga as an advisor. For simplicities sake, we will assume approximately 16 students who will be advised in a 401 course by Drs. Borders, Edmiston, Fraga, or Morgan. Most of these students will be BMB majors, but some will be biology majors. The assignment of teaching duties for Drs. Morgan and Fraga results in a teaching load of 5.4 teaching credits per year for each of them. This is 0.4 more than their current load. If they both supervise approximately 4 Senior I.S. students each year on average (16/4), then they will each have a total teaching load of 6.2 for each year (5.4 + 0.8 = 6.2). To keep teaching loads among BMB faculty in balance, we will adjust Junior IS responsibilities (i.e., the 401 course and advising).

Regarding BIO 401 teaching credit calculations. The method of calculation we used here was to count 0.1 teaching credit per student. Since we will be advising about 4 students this comes out to 0.4 credits. Chemistry handles 401 differently but the numbers are the same.

Impact on the Department of Chemistry. Below is a tentative outline for a two-year sequence of courses that might be taught by Montie Borders and Paul Edmiston once the BMB major is in place. It should be noted that Chemistry typically has three faculty members involved in CHEM 401 to handle a total of 26 to 33 students. Once BMB 401 is in place, Chemistry would then have only two faculty teaching CHEM 401 with 16 to 23 Chemistry majors each spring. This schedule indicates that this new structure would not significantly alter course offerings in Chemistry (Please be advised that this schedule is for comparison purposes only).

Year 1

<u>Faculty</u>	<u>Fall schedule₁</u>		<u>Spring schedule₁</u>	
Montie Borders	BMB 331	1.0	BMB 332	1.0
	CHEM 211	1.5	BMB 401	0.8
			CHEM 212	0.5
Paul Edmiston	CHEM 215	2.0	CHEM 102	1.0
	BMB 303	0.5	CHEM 316	1.5

Year 2

Montie Borders	BMB 331	1.0	BMB 332	1.0
	BMB 303	0.5	CHEM 212	1.5
	CHEM 215	1.0		
Paul Edmiston	CHEM 215	2.0	CHEM 102	1.5
	CHEM 200	1.0	BMB 401	0.8

₁CHEM 102 General Chemistry I

CHEM 211 Organic Chemistry I

CHEM 215 Analytical Chemistry

CHEM 200 Chemistry for Non-Science majors

CHEM 212 Organic Chemistry II

CHEM 316 Instrumental Analysis

Notes on the Chemistry schedule:

During the past five years there have been 49 who have or will graduate with a Biochemistry major, or an average of 9.8 per year. We estimate that another six Biology majors each year would have opted for the major if it had been Biochemistry and Molecular Biology. We thus assume, for the purposes of calculation, 1.6 total teaching credits each year for BMB 401. The teaching credits for both Borders and Edmiston come out to 4.8 to 5.3 per year (not including IS advisees). If they both supervise 4 Senior I.S. students each year on average, then they will each have a total teaching load of 5.6 to 6.1 per year. We have chosen to show a tentative schedule in which one chemistry faculty member teaches BMB401 and thus will receive all of the BMB 401 teaching credits for that year.

Appendix A. Comparing a typical 2-year schedule for Fraga and Morgan Year 1

Faculty	Current schedule (w/o BMB)			Proposed schedule (w/ BMB)			
Bill Morgan	<u>Fall</u>	BIO 220	1.0	BIO 220	1.0		
		BIO 306	1.5	BIO 307	1.5		
	<u>Spring</u>	BIO 220	1.0	BIO 306	1.5		
		BIO 307	1.5	BIO 220	1.0		
		BIO 401	0.2	BMB 401	0.4		
		451/452	0.8 (approx.)	451/452	0.8 (est.)		
		Total	6.0	Total	6.2		
	Dean Fraga	<u>Fall</u>	BIO 220	1.0	BIO 220	1.0	
			BIO 305	1.5	BIO 303	0.5	
					NONMJRs	1.0	
<u>Spring</u>		BIO 220	1.0	BIO 220	1.0		
		NONMJRs	1.0	BMB 401	0.4		
		BIO 401	0.2	BIO 305	1.5		
		451/452	0.8 (approx.)	451/452	0.8 (est.)		
		Total	5.5	Total	6.2		
Year 2							
Bill Morgan		<u>Fall</u>	Bio 220	1.0	BIO 220	1.0	
	Bio 306		1.5	NONMJRs	1.0		
				BMB 303	0.5		
	<u>Spring</u>	Bio 220	1.0	BIO 220	1.0		
		Bio 309	1.5	BIO 306	1.5		
		Bio 401	0.2	BMB 401	0.4		
		451/452	0.8 (approx.)	451/452	0.8 (est.)		
		Total	6.0	Total	6.2		
	Dean Fraga	<u>Fall</u>	BIO 220	1.0	BIO 220	1.0	
			BIO 305	1.5	BIO 380	1.5	
<u>Spring</u>		BIO 220	1.0	BIO 220	1.0		
		BIO 380	1.5	BIO 305	1.5		
		BIO401	0.2	BMB 401	0.4		
		451/452	0.8 (approx.)	451/452	0.8 (est.)		
		Total	6.0	Total	6.2		

The major change will be in offering what are currently Spring courses in the Fall and vice versa. This actually would make it easier for us to contribute to FYS.