SPECIAL REPORT

OF THE

ACADEMIC MATTERS COUNCIL

concerning a

REVISION OF THE
BIOCHEMISTRY AND MOLECULAR BIOLOGY
MAJOR (B.S.)
(#5295)

Presented at the
785th Regular Meeting of the Faculty Senate
March 7, 2019

COUNCIL MEMBERSHIP

Wesley Autio, Carol Barr, Carolyn Bassett, Bryan Beck, William Brown, Allison Butler, D. Anthony Butterfield, Marcy Clark, Colleen Coakley, Elizabeth Connor, Hayley Cotter, Sharon Domier, Morgan Donovan-Hall, Wei Fan, Diane Flaherty, Laura Francis, Mark Guerber, Jennifer Heuer, Maeve Howett, Chair, Patrick Kelly, Matthew Komer, Kathryn Lachman, Meredith Lind, Linda Lowry, Roberta Marvin, Ruthanne Paradise, Sarah Pfatteicher, Jennifer Randall, MJ Peterson, Patrick Sullivan, Jack Wileden, Rebecca Woodland, Kate Woodmansee

COUNCIL RECOMMENDATION

The Academic Matters Council recommends approval of this proposal.

Briefly describe the Proposal

Allow Independent study projects that meet defined criteria to substitute for a required biochemistry laboratory course (Biochem 426).

Please describe the existing program requirements, listing all required courses and available electives, as well as any additional requirements, and continuation or admissions policies.

- Bio 151, Bio 152, Bio 153
- Chem 111 and 112 (or Chem 121H and 122H)
- Math 131, Math 132 (or Math 127 and 128)
- Continuation policy: must earn a GPA 2.5 or above among these 4 courses: Chem111, Chem112, Math131, Math132 (or equivalents) by the end of the third semester.
- Biochem 275—must earn a grade of B- or better as prerequisite for other Biochem courses

Prerequisites: Bio 151 (C or better) AND Chem 112/122H (C - or better)
• Chem 261, Chem 262, Chem 269 (Lab)
• A third semester of Math/Statistics; Stat 240 or equivalent, Math 233 can be substituted
• Physics 131 and Physics 132 (or Physics 151 and 152)
• A grade of C- or better required for courses taken toward the major
• Biochem 390G (Prerequisite: Biochem 275, B- or better) or Biology 283 (Prerequisites: Biology 151/161H, C or better, Biology 152/162H, C or better)
• Biochem 276 (Prerequisite: Biochem 275, B- or better)
• Biochem 394RI (Prerequisite: Biochem 275) or NatSci 494I (Prerequisite: Biology 151 or Stockbridge 108)
• Biochem 423 (Prerequisites: Biochem 275, B- or better, Chem 261 and 262)
• Biochem 424 (Prerequisite: Biochem 423, C- or better, Chem 261 and 262)
• Biochem 426 (Prerequisite: Biochem 275, B- or better, Biochem 276, C- or better)
• Biochem 471 (Physical Chemistry) Spring only

Prerequisites: Chem 112 AND Physics 132/152 AND Math 128/132—ALL with a C- or better
• Biochem 430H (Prerequisites: Biochem 423, 424 or 426)
• Advanced Elective Requirements: minimum total of 8 CREDITS in science and math courses numbered 300 and above, not including courses required for the BMB major or Practica courses. Independent Study/Research credits may be counted as advanced elective credits.

Please describe the requirements that you are proposing, listing course requirements, elective options, as well as any additional requirements, and continuation or admissions policies.

Students may substitute Independent Study work at the 400-level or above, for the Biochem 426 requirement, if the Independent Study meets the following criteria:
• Applies to Biochemistry and Molecular Biology (BMB) majors who have plans for a rigorous Honors Thesis/Independent Study program in their senior year.
• Project must be BMB-related, specifically: It must involve elucidation of molecular or cellular mechanisms of life processes. Project must include "wet lab" laboratory experimentation and cannot be exclusively computational or theoretical.
• The research program must include 1) an original research project, 2) an oral presentation of the work, and 3) a final research manuscript that includes a literature review and includes drafts reviewed under guidance by the student’s research advisor.
• Projects approved for Biochem 499Y/T will generally satisfy these requirements. Students can request their approved Thesis Proposal be reviewed by BMB for substitution for the Biochem 426 requirement.
• Projects approved as {Dept}499Y/T (Honors Thesis) in another department, or as {Dept}496 (Independent Study) can also be submitted to BMB for consideration for substitution for the Biochem 426 requirement.
• When approved, 4 CR of the student’s Thesis/Independent Study credit will be applied toward the Biochem 426 requirement.
• Students using 4 CR of Thesis/Independent Study credit toward their Biochem 426 requirement may NOT also use these credits toward their Advanced Elective requirement in the BMB major.

Please provide the rationale for these revisions.

This revision is proposed because we have recently adapted Biochem 426 into a capstone research experience for our majors (see attached syllabus). As such, many of the Biochem 426 course objectives are now effectively redundant with the objectives of a rigorous
Honors/Independent Study research project.

This change in Biochem 426 has been made to ensure that all our majors have an authentic research experience by the time they graduate, and so those students who are already gaining comparable experience and competencies outside of this course should be considered to have completed this requirement.

Independent Study or Honors Thesis projects that fit our criteria (as determined by reviewing the student’s proposed work) will be allowed as substitutions. It is important to the Biochemistry and Molecular Biology faculty that this option for Biochem 426 substitution be open to all students, not only to members of the Commonwealth Honors College, so we will consider both Honors proposal and Independent Study proposals (see attached application for consideration of non-Honors Independent Study).

Attachments: [attachments appear on the following pages]
• Biochem 426 syllabus
• Application to request substitution for Biochem 426 from an Independent Study research project (non-thesis)

If this proposal requires no additional resources, say so and briefly explain why. If this proposal requires additional resources, explain how they will be paid for. For proposals involving instruction, indicate how many new enrollments are expected and whether the courses have room to accommodate them.

This proposal does not require any additional resources, because students are already conducting these independent study projects. The proposal provides more flexibility for students to meet BMB requirements for graduation within four years.

MOTION: That the Faculty Senate approve the Revision of the Biochemistry and Molecular Biology Major, as presented in Sen. Doc. No. 19-048.
Biochemistry 426-01:  
GENERAL BIOCHEMISTRY LABORATORY FOR MAJORS  
Spring 2018

COURSE INSTRUCTORS:  
Dr. Amy Springer, LGRT 918, 413-406-8837, aspringer@biochem.umass.edu  
Dr. Sergey Savinov, LSL N465, 413-577-0548, ssavinov@biochem.umass.edu  
Office hours: (see a Moodle course link for appointments)  
Dr. Springer: by appointment; Dr. Savinov: Tue 1–2pm, Thurs 9–10am and by appointment

Instructional Assistants:  
Lab technicians: Erica Light (elight@umass.edu)  
Undergraduate Assistants: Cole Burgess, Carolyn Huang, Devorai O’Connell, Matthew Vieira, Robert Yvon.

Contacting Instructors: In person during class or by email with “Biochem426” in the subject line to avoid confusion. Instructors will do their best to reply to emails within 48 hours.

Meeting Times: Mondays and Wednesdays 12:20 pm in Morr II 319, Lab in ISB 260 1:20-5:25pm.

Requirements:  

Prerequisites: Completion of the CW General Education requirements; BIOCHEM 275 with a grade of B- or better; and BIOCHEM 276 and BIOCHEM 423 with a grade of C- or better.

OBJECTIVES  
This course is designed to provide you with an opportunity to conduct original research in a biochemistry laboratory. You are expected to understand underlying physical, chemical and biological principles behind the experimental techniques you are employing. The pace of biochemical research is brisk and very competitive, and innovations and new techniques appear almost daily. We will begin with an introduction to many of the basic approaches used in the biochemistry laboratory, and then you will work on an independent project chosen by your group. In the course of working on this project, you will practice problem solving and analysis skills that are useful to any successful career, whether or not you expect to be performing laboratory science at the bench in the future.

Learning Outcomes: Upon completion of the course, students should be able to:  
- demonstrate knowledge of key biochemistry concepts and their relevance in the experimental project  
- develop a hypothesis-driven project that will address an unknown question.  
- demonstrate knowledge of their research project  
- develop technical expertise in equipment and methodologies used in biochemical laboratories  
- develop problem-solving skills and confidence associated with the design, preparation and analysis of experiments in the laboratory
- work effectively and safely in both individual and collaborative contexts
- improve presentation skills (oral communication needed for seminar and poster presentations)
- improve scientific writing abilities (written communication needed for written assignments)

**COURSE SCHEDULE:** A detailed schedule will be provided at the start of class.

**Weeks 1-4.** Introduction to course, Basics, Safety. Biochemistry “boot camp;” Development of research project prospectus.

**Weeks 5-12.** Prepare, conduct and analyze experiments for independent project.

**Week 13:** There will be a joint Poster session for all Biochem 426 sections to present results from independent project.

**Poster session (required):** Tuesday, May 15:30 PM in ILC.

**COURSE ORGANIZATION AND LOGISTICS**

This course will meet during the scheduled times and students will periodically be required to perform simple tasks such as checking plates, starting cultures, etc. outside of scheduled times. The required poster session is also outside of class time. All students are required to download, print, and read the lab manual prior to coming to lab.

Biochem 426 is divided into two modules – The first is intended to quickly bring all students up to speed on common biochemistry/molecular biology techniques and is referred to as “boot camp,” and will take place over the first four weeks. The second module involves original research projects chosen by groups (within certain guidelines set by the instructor), in which the choices of which experiments to perform and in what order is determined by each group.

In both modules, students will work in groups of four, all group members are required to participate in the planning, preparation, execution and graded assignments (details for these assignments will be provided in the “Written Report Requirements” and “Oral Presentation Requirements” handouts). Additionally, all students will be required to complete group participation evaluations periodically throughout the semester to ensure that everyone is doing their fair share of the work. Preliminary written assignments will be submitted by individuals, the final written proposal will be submitted one per group, requiring fair participation by each group member.

**Online course content: MOODLE:** ([https://moodle.umass.edu/](https://moodle.umass.edu/)) will be used to distribute course materials and make announcements. You should plan to visit the MOODLE page regularly to ensure that you are up-to-date on all course materials and issues.

The instructors will post files of lecture materials in advance of each class for your convenience. Revised/annotated material might also be made available after each lecture to aid in reviewing materials and studying for exams/homework.

**Laboratory notebooks and data recording**

A bound notebook or 3-ring binder is a good way to organize course notes and handouts (Relevant background information, experimental procedures, etc., handed out and available on the course Moodle website). You will need to record all of your data in a notebook that will be periodically graded for completeness. Students are expected to come to each laboratory period prepared, with the relevant information PRINTED and REVIEWED ahead of time so that time in the laboratory period is spent preparing or conducting experiments, or interpreting results and planning subsequent experiments, as appropriate. Recorded “data” for the notebook include not only raw quantitative values, but also protocols & modifications, identification of samples, and all observations. The recording and organization of a permanent record of laboratory observations is as important a technique to master as
any of the experimental methods taught in this course. Do not write on scraps of paper. Write everything down clearly. Remember, sometime later you (or someone else) might have to go back and rely on your notes to figure out what you did! Instructors will spot check or collect notebooks from all students at times throughout the semester and notebooks will be assessed for completeness and organization. Notebook grades will be calculated into your participation grade for the semester.

LABORATORY SAFETY
BMB laboratory courses are designed with safety in mind. All instructors, support staff, and students must take an active role to promote lab safety, this includes wearing appropriate personal protective equipment and proper disposal of hazardous material. Any student who has safety concerns, a medical condition, or other circumstances which might impact his/her participation in the labs is strongly encouraged to discuss these circumstances with the instructor as soon as possible.

ASSESSMENT:
Will be based on four “boot camp quizzes” (approx. 10%), several written reports - both draft and final versions (approx. 45%), presentations, attendance and participation (approx. 45%). Participation will be assessed based on activities, instructor and peer-evaluations, and will take into account adherence to laboratory conduct and safety policies.

Grading: Your final grade will be the average of the graded assignments listed above. Typical grading scale: >90%=A-, A, >80%=B-, B, B+, >70%=C-, C, C+. The instructor might opt to adjust the grading scale depending on the overall performance of the class.

Re-grading: Grade changes will only be made in cases where there was an obvious grading mistake. Requests for re-grading of graded works must be submitted in writing to the instructor within one week of the date the work was returned – no exceptions. Work submitted for regrading will be regraded in their entirety, points may be added or deducted as appropriate. Missed quizzes or presentations: See attendance policy below. Written work submitted after the deadline is subject to deduction.

ATTENDANCE
The class meets from 12:20 PM to 5:25 PM on Mondays AND Wednesdays as indicated in the syllabus. Because the lab schedule is tight, class begins promptly! Please be on time; latecomers will be deducted for attendance. All students are expected to remain in the laboratory to the conclusion of their group’s experiments and analysis, and must check out with the instructor/TA.

Attendance is mandatory.
There will be no opportunity to make up missed labs, exams or presentations. Points will be deducted for unexcused absences. Two unexcused absence is grounds for being dropped from the course. Serious, unavoidable conflicts (including religious observances) should be brought to the attention of the instructor one week prior to missing the laboratory period.
Extended absences due to illness, sports events, ROTC exercises may result in withdrawal. Any student requiring special accommodations MUST contact the instructor in the first two lab periods.

University Policies on Class Absence and Religious Observances:
http://www.umass.edu/registrar/students/policies-and-practices/class-absence-policy/
OTHER POLICIES

Policy on Snow days or other emergency closures: In general, material scheduled for days when campus is closed will be made up in some form. The information on changes to the schedule, including any changes to graded assignments or exams, will be sent to all students by email and also posted on the Moodle course within 24 hours of the announcement of campus closure.

Use of Cell Phones and Computers in Class: It is expected that cellular phones or other electronic communication devices will not be used during lecture periods unless directly related to the laboratory procedure. Other uses are distracting to the user and to others in the room; students using devices inappropriately may be asked to leave. Use of electronic communication devices during quizzes is strictly prohibited.

Academic dishonesty: No form of academic honesty will be tolerated in this course. Academic dishonesty includes but is not limited to: Cheating (the intentional use or attempted use of trickery or deception in one’s academic work); Plagiarism (knowingly representing the words or ideas of another as one’s own work, failure to provide a citation for data/information obtained from another source, directly quoting or closely paraphrasing a cited source without using quotation marks or citation, using the same or very similar wording as another student in the class); Facilitating dishonesty (knowingly helping or attempting to help another commit an act of academic dishonesty, signing in as another student, etc.). Any and all students who are suspected of dishonesty will be dealt with through the official honesty process as outlined by the Dean of Students. Academic Honesty Policy and Process: http://www.umass.edu/honesty/

Sharing of material posted or otherwise made available for Biochem 426 is not permitted (such as notes, manuals, assignments, protocols, data, quizzes, any answer keys). Some of this information is proprietary and protected by copyright so are only allowed for use pertaining to this class. Furthermore, since grades are determined based on such assignments, sharing these materials publicly or with sharing them with anyone other than enrolled students, instructors, tutors or teaching assistants, violates the Code of Student Conduct: http://www.umass.edu/dean_students/codeofconduct

Student Academic Regulations: For a description of academic policies, see http://www.umass.edu/registrar/sites/default/files/academicregs.pdf

Pronunciation, Names and Pronouns: The instructor’s intentions are that students should be referred to by appropriate names, pronunciations and gender pronouns. Please advise us of your name’s proper pronunciation, and any names or pronouns not reflected by the record in SPIRE.

Disability Student Learning Accommodations: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact the office of Disability Services on campus. http://www.umass.edu/disability/students.html. It is our intention that the course be accessible to all enrolled students, and if there are needed accommodations related to a documented disability, please communicate with us about how best to meet these.

LABORATORY CONDUCT

1. Much of the equipment used in this course is expensive and none of it is insured. If you have trouble with the operation of an instrument, do not hesitate to ask the instructor for help.

2. Never bring food or beverage into the laboratory. Do not dispose of food wrappers or beverage containers in the lab wastebaskets, even if the contents were not consumed in the lab.
3. **Work safely in the lab.** You are required to wear eye protection in the laboratory at all times. Wear proper eye protection before turning on any UV light. Place backpacks, coats, jackets and sweaters in the available shelf space to avoid fire and chemical spill hazards. Note the locations of First Aid kits, fire extinguishers, and drenching showers.

4. **Always think ahead.** Prepare for the next step in the procedure while waiting.

5. **Make sure you understand what you are doing.** If you do not, feel free to ask.

6. **Keep your bench area, balances and instruments clean and clutter-free.** Wash your hands before leaving the lab.

7. **Cell phones and music headsets** cannot be used during the laboratory unless specifically approved by the instructor.

8. **At the end of each laboratory period,** each group must “check-out” with one of the course instructor or the TA. The instructor/TA will inspect the station and drawers to ensure that waste is properly disposed of and that the lab space is neat and orderly.

**Additional note:** when an experimental procedure calls for addition of water, you should only be using sterile distilled water, provided in bottles.

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**Safety in Life Science Laboratories**

1. Eye protection is required in the laboratory at all times. It is especially critical to wear proper eye protection when there is potential for exposure to ultraviolet (UV) light, caustic chemicals, items under pressure, and where a broken/flying glass hazard exists.

2. Lab coats must be worn while in the laboratory.

3. Protective gloves of the proper type should be used when necessary.

4. Clothing choice is critical for maintaining personal protection. Shoes must be close-toed (no sandals, flip flops, etc.), and long pants must be worn in the laboratory. Shirts should have sleeves, and no dangling hair or jewelry is allowed.

5. To minimize cross-contamination and distraction, students should not use cell phones or iPods while in the laboratory room.

6. Maintaining a clean, clutter-free working environment promotes safety. All jackets, sweaters, backpacks, etc., as well as any materials not needed in the lab, should be placed in the cubbies at the entryway door. Lab benches should be wiped with 70% ethanol prior to and upon completion of experiments.

7. All students should wash their hands with antibacterial soap and warm water upon entering and leaving the laboratory room.

8. The laboratory contains several safety features that each student should note upon first entering the room. Each lab room has a drenching shower, eyewash station, first aid kit, and fire extinguisher.
9. All students should be familiar with the emergency exits (each lab room has two exits) and escape plan from their lab room and all common areas.

10. Never bring food or beverage into the laboratory or consume food or beverage in the laboratory. Additionally, do not dispose of food wrappers or beverage containers in the lab wastebaskets, even if the contents were not consumed in the lab. Inspectors conclude from such evidence that food or drink has been consumed in the lab room. Note that chewing gum counts as food under this rule.

11. All students should be familiar and comfortable with the proper operation of all instrumentation as well as the procedures to be performed in the lab. Students should be aware of the hazards that exist in the laboratory. Do not hesitate to ask the instructor or TAs for help. Report any instrument malfunction immediately to the teaching staff.

12. Label all bottles, flasks, test tubes, etc., that you use. A proper label should contain your name or initials, contents, concentration, course number, and date.

13. Never pipette by mouth. Remove only as much as you need for the experiment using the proper delivery method. Never return any excess to the reagent bottles, as it may cause contamination of a common supply.

14. You are responsible for safe handling and disposal of all chemicals, solutions, and equipment you use. Do not leave chemicals around common areas or your lab bench for labmates or the teaching staff to clean up. Proper disposal of laboratory materials is critical.
   a. The large gray trash bins are for paper towels, kimwipes, gloves, tape, and other general lab trash that is not sharp or contaminated. Do not put liquids, sharps, biohazards, broken glass, or pipets/tips in these trash barrels!
   b. Pipet tips and plastic pipets (along with microfuge tubes and empty conical tubes) should be deposited in the plastic beakers located on the benchtop. TAs will properly dispose of these items at the conclusion of each laboratory session.
   c. Broken glass must safely be deposited in the “glass waste disposal” cardboard boxes. Do not overfill these containers, and do not put items that do not belong into these containers (including gloves, plastic pipets, general lab trash, and liquids).
   d. Sharps such as razor blades and needles must be placed into the red “sharps” container.
   e. Each liquid hazardous waste will have a dedicated container in the fume hood for proper disposal. Consult with the teaching staff on the location of these containers.
   f. Biohazardous materials or items that require decontamination (i.e., bacterial growth plates/cultures, transgenic plants, etc.) will be collected by the teaching staff.

15. Our laboratory courses are designed with safety in mind. Any student who has safety concerns, a medical condition, or other circumstances which might impact his/her participation in the labs is strongly encouraged to discuss these circumstances with the instructor as soon as possible.

Summary: All instructors, support staff, and students must take an active role to promote and maintain a safe laboratory environment. Following the requirements and guidelines provided by the Environmental Health and Safety office (EH&S) and adhering to the above guidelines will maximize safety and enjoyment for everyone!
Application:
To request substitution for Biochem 426 from an Independent Study research project (non-thesis):

Please submit a proposal with the following sections:

1. Title of project and your name
2. Name of your research mentor, and of the BMB faculty member who will be a reader.
3. Describe your research project planned for the coming year
   - This should be a project in which you are working as an independent researcher.
   - Include goals and brief descriptions of methodology and evaluation procedures for the research.
4. Briefly describe how this work is in alignment with the BMB major (i.e. it must involve elucidation of molecular or cellular mechanism(s) of some life process).
5. Explain what type of oral poster presentation will be undertaken, when it will be completed, and criteria for evaluation of the presentation by your research mentor and BMB faculty reader.
   - This can be a short talk or poster presentation; and may be presented at a local Undergraduate poster session or at a regional or national meeting. You have the option of presenting your work at the BMB Biochem 426 Poster session in May.
6. Final report on your research and timeline for writing.
   - This must be a scholarly work that includes a literature review and is reviewed by your Research mentor and your BMB faculty reader.
   - Timeline for drafts of sections, and of the final report, to be submitted to your readers, and also when you plan to submit the complete revised report.
   - Please note that the final report must be completed no later than the last day of exams in your last semester, such that your Research mentor and BMB faculty reader can agree it is complete, and your mentor can submit a grade.
7. Criteria for evaluation of the project, agreed upon by you and your research mentor (and shared with your BMB faculty reader).

Due: No later than Sept 4, 2018: the first day of classes in Fall semester (may be submitted earlier)

Approval: Must be reviewed by the BMB Academic Affairs Committee, their decision to be provided no later than Sept 17, 2018, the last day to add/drop classes in Fall semester.

If approved, this proposal serves as a binding agreement between you and the BMB department in regards to work that will substitute for the Biochem 426 requirement of the BMB major. This means that 4 credits of your independent study credit will be put toward the Biochem 426 requirement, and cannot be used toward Advanced Electives in the major.

The approved proposal also protects you and your readers and the BMB Department from misunderstandings which could cause problems with gradings or delays in your graduation clearance.
The Biochem275/Biochem285 prerequisite in the BMB major—an evidence-based case for a student success marker

Summary
The Biochemistry and Molecular Biology (BMB) major currently requires achievement of B- or better in Biochem 275 or Biochem 285 as a prerequisite for upper division BMB courses. The choice of this prerequisite is based on student performance in the major and is intended to serve as a benchmark for students for likelihood of success in the major. Our data support that such mastery of intermediate-level biochemistry material is critical for students to be able to succeed in advanced biochemistry courses. This prerequisite is not intended to prevent students from majoring in BMB but rather, in combination with our Continuation Policy, to provide students with indicators of what level of performance they need to achieve to be successful. Students who do not achieve the minimum grade may re-take the course and thus become better prepared to complete the major. In some cases, we make exceptions to the minimum grade if we believe, based on performance in other courses and other extenuating circumstances, that the grade was not indicative of the student’s potential.

Historical course offerings
Originally, BMB offered only Biochem 285 (Cell and Molecular Biology) as a prerequisite course. A newer course Biochem 275 (Molecular Biology) was introduced in 2012, and in recent years only Biochem 275 has been offered. These courses have some overlap in content, but more importantly they both provide an intermediate level focus on Biochemistry content, and we consider them equivalent in terms of the preparation they provide, and so here present combined data from both courses.

Data on student performance in Biochem 275 and 285
We have compiled data on student performance in the major based on grades in Biochem 275 or 285, as shown below. We obtained SPIRE data from OIR on graduation rates and time to graduation based on grade in Biochem 275 or 285 from 2008-2016 (and graduation as of 2018). The students were declared BMB majors at the time of enrollment in Biochem 275 or 285, and Table 1 shows the percentage of these students who graduated with a BMB major, and the average time taken to graduate sorted by letter grade earned in Biochem 275 or 285.

Table 1: Data from SPIRE, showing number of students (and %) graduating with a BS in BMB, and average number of semesters to graduate, sorted by grade in Biochem 275 or 285. Bottom: grade categories are binned: B- and above, and C grades. Prerequisite (B-) is indicated by a gray line.

<table>
<thead>
<tr>
<th>Grade</th>
<th>N</th>
<th># grad in BMB</th>
<th>% grad in BMB</th>
<th># semesters to degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>184</td>
<td>165</td>
<td>90</td>
<td>8.1</td>
</tr>
<tr>
<td>A-</td>
<td>118</td>
<td>108</td>
<td>92</td>
<td>7.9</td>
</tr>
<tr>
<td>B+</td>
<td>119</td>
<td>103</td>
<td>87</td>
<td>8.2</td>
</tr>
<tr>
<td>B</td>
<td>105</td>
<td>92</td>
<td>88</td>
<td>7.9</td>
</tr>
<tr>
<td>B-</td>
<td>51</td>
<td>43</td>
<td>84</td>
<td>8.3</td>
</tr>
<tr>
<td>C+</td>
<td>38</td>
<td>22</td>
<td>58</td>
<td>8.8</td>
</tr>
<tr>
<td>C</td>
<td>29</td>
<td>17</td>
<td>59</td>
<td>8.7</td>
</tr>
<tr>
<td>C-</td>
<td>15</td>
<td>11</td>
<td>73</td>
<td>8.5</td>
</tr>
<tr>
<td>Below C-</td>
<td>69</td>
<td>13</td>
<td>19</td>
<td>9.1</td>
</tr>
</tbody>
</table>

Binned by grade:

| B- and above | 577 | 511 | 89 | 8.1 |
| C, C, C+     | 82  | 50  | 61 | 8.7 |
Based on these data, there is a significant reduction in percentage of students who graduate from the BMB major if they earn a grade below B-. Whereas 89% of students earning B- or above graduate in the program, only 61% of students earning a C grade do so (and many of these have repeated the course for a higher grade). Also, those students who earned B- or better graduated in an average of 8.1 semesters, while students who earned a C grade averaged 8.7 semesters. One datapoint for students earning a C had 73% graduation in the program, but this may not be statistically significant, as it represents only 15 students over a 10 year period. Overall these data indicate that grades below B- are not predictive of success and correlate with longer graduation times in the BMB major.

We also present data from a tool more readily available to departments, which is the predictive data from the EAB_SSC platform. These data present the percentage of students who graduate based on letter grade or grade point in Biochem 285, data compiled from 2000-2009. These data consider all students who enrolled in Biochem 285, not just those who were BMB majors at the time, and so includes students who may have never intended to graduate with a BMB major. This most likely explains why the percentage graduation rates are lower overall than in the SPIRE data shown above. The grades are also binned into A, B and C letter grades, not broken down into plus and minus designations.

Figure 1 and Table 2: Data from SSC predictive workbooks. BMB is the “Selected program,” Biochem 285 is the Course analyzed.

<table>
<thead>
<tr>
<th>Course Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
</tr>
<tr>
<td>Count</td>
</tr>
<tr>
<td>% of Total</td>
</tr>
<tr>
<td>Grad, Rate in Program</td>
</tr>
</tbody>
</table>

The table above provides a summary of students by grade achieved in a selected course. Please note that students who receive a D in their first attempt, who then achieve a B in their second attempt, before graduating in the major, will show up as a student who graduated after having achieved a D and as a student who graduated after having achieved a B.

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1 We should note that from this analysis we are unable to distinguish which of the graduates had repeated the course for a higher grade (and students with C- were more likely to have repeated the course since those with C or C+ are sometimes allowed to continue in the major without repeating). Overall, we do not believe this datapoint undermines the overall conclusion.
The trend from these data in Figure 1 and Table 2 show that students earning C grades have lower success that students earning B or A grades. While these data represent slightly different population from the date in Table 1, the trend is the same. Combined, a total of 70.1% of students in all majors earning a B or A grade (B- or above) graduated with a BMB degree, as compared to only 51% of students in all majors earning a C grade.

We conclude based on all of these data that there is a decrease in student success as grade in Biochem 275 or 285 decreases, and we believe that, in the interest of student success, we should advise our students to achieve grades that correspond to a high likelihood of graduating with a BMB degree. Given that our majors generally take this course in their second year, we would not want them to earn a grade that is predictive of a lower than 60% likelihood of graduating in the major, and for this reason we have set the prerequisite as B- for Biochem 275 or 285. This grade prerequisite enables us to identify students who have less than 60% likelihood of graduating with a BMB degree, and we can advise them to seriously consider changing their study habits or selecting a different major.

**Setting the grade minimum as prerequisite instead of a guideline for majors**

By making this grade a prerequisite rather than just a guideline, students need to come talk to an advisor before they can enroll in further courses. Students often do not come in for advising when they miss recommended benchmarks, or sometimes they do so only after a few more unsuccessful semesters. While some students do have extenuating circumstances for missing the grade minimum, we can only assess this if they meet with us to discuss their overall academic performance and other considerations as opposed to leaving this choice to the student alone.

We want to be very clear that the purpose of this prerequisite is to foster student success by providing a benchmark that indicates a statistical likelihood of success, and not to prevent students from choosing the major. Many students who miss the minimum grade in Biochem 275 or 285 opt to repeat the course for a higher grade and then go on to be successful in the major. We assume they use this opportunity to improve their study habits and thus are better prepared for success in subsequent courses. We believe that genuine student success means achieving good grades in their major classes, it should not be good enough to just continue a course of study, and possibly even graduate, with consistently poor grades. Poor grades not only pose a risk for even poorer grades and failure in upper level courses, but are also hard on self-esteem and overall sense of accomplishment.

One line of evidence that the prerequisite of a minimum grade in Biochem 275 or 285 does not delay graduation is the graduation rate in BMB. We have tracked the 4 and 6 year graduation rates for all BMB majors (not limited to those students who entered the University as declared BMB majors) over the past ten years. Figure 2 below shows the percentage of BMB graduates who completed their degrees in four and six years for each academic year shown below. The four year graduation rate in BMB has climbed over ten years from below 70% to above 90%.
Implementation of benchmarks in the BMB major

We let students know about the grade minimum in Biochem 275 or 285 when they attend NSO, or when meet with us to switch into the major. We also include it in our handouts on major courses (and information for majors posted on our website), and it is coded as a prerequisite for Biochem 276 and 423 in SPIRE. Our Biochem 275 instructors were pioneers using the SSC Early Alert program at UMass, this is a tool that we use to let students know early on if they are at risk of a grade below B-, and our data suggest it does motivate students to come in for advising when they get these notices. By letting students know what the benchmark is specifically, they have a better chance to see resources to help them achieve the required minimum grade. We use PERC checks in SPIRE before every semester to identify students who have enrolled in classes and subsequently not achieved the prerequisite grade, and then contact those students to tell them why they were removed from the class and ask them to come in for advising.

Advising students who do not achieve the B- in Biochem 275 or 285:

Most students take this course as Sophomores, most in their third semester of college. It is possible to take the course even into Junior year and still complete the major within four years. Thus, taking the course a second time does not actually put them off track to graduate on time, and the practice of retaking the course does prepare them for better success in more challenging upper level courses. We do look at the records of all majors who fail to make the minimum grade. Some of these students are experiencing challenges in other foundational science classes, and so it may be appropriate to advise them to explore other majors.

In some cases we do allow students who have not achieved a B- to go on in the major, but we do this on a case-by-case basis, taking into account each student’s performance in other courses and any extenuating circumstances that might have affected the one grade. We have had mixed success with
permitting students to continue in the major in this way, and tend to be very conservative about granting this permission.

The Continuation Policy recently approved for BMB provides us with an even earlier benchmark for students, one that we can use to track student performance as soon as their first semester at UMass. This policy stipulates that students must achieve a GPA of 2.5 over four courses: General Chemistry I and II and Calculus I and II, by the end of their third semester. We communicate the Continuation Policy to incoming majors just as we do for the Biochem 275 or 285 prerequisite, and it is coded in to the ARR for all students entering as of Fall 2017. We can use a query in SPIRE for Continuation Policy status after each semester, so that we are now identifying and reaching out to students after their first semester and first year, which is something we were never able to do in a comprehensive way before. We expect this will greatly help us to identify struggling students early, and in many cases to help them to stay in the major. We will track students over the next few semesters to see if the Continuation Policy implementation has an effect on the percentage who achieve the minimum grade required in Biochem 275 or 285. Since the Continuation Policy sets a benchmark for their first three semesters, and most students take Biochem 275 or 285 in their third or fourth semester, their performance in the four Continuation Policy courses as well as in Biochem 275 can inform them on how they are doing early on in the major, and also can inform us on how best to advise them toward the successful completion of a college degree.

Prepared by A. Springer and J. Normanly January, 2019