



2016-2017 Cyclical Program Review of Chemistry and Biochemistry

PROGRAMS:

- Honours BSc Chemistry
- Honours BSc Chemistry with Thesis
- Honours BSc Biochemistry & Biotechnology
- Honours BSc Biochemistry & Biotechnology with Thesis
- Honours BSc Biochemistry & Biotechnology Combined with Conestoga College Biotechnology Technician Diploma
- Honours BSc Biochemistry & Biotechnology with Thesis Combined with Conestoga College Biotechnology Technician Diploma
- Honours BSc Chemistry and Biology
- Honours BSc Chemistry with Environmental Science Option
- Honours BSc Chemistry with Thesis and Environmental Science Option
- Honours BSc Chemistry and Mathematics
- Master of Science in Chemistry and Biochemistry

Final Assessment Report

Submitted by: Dr. Pam Bryden, Dean, Faculty of Science; Dr. Tamas Dobozy, Dean, Faculty of Graduate and Postdoctoral Studies; Dr. Kathryn Carter, Associate Vice-President: Teaching and Learning; Dr. Paul Jessop, Vice-President: Academic
Date: September 12, 2017

PART ONE: EXECUTIVE RESPONSE

A) SUMMARY OF REVIEW DOCUMENTS

Summary of Self-Study

- The self-study describes the evolution of the undergraduate and graduate Chemistry and Biochemistry programs. The relationship between the programs is clearly articulated and both the MSc and the PhD programs build on faculty expertise and on the undergraduate program. Recommendations from the previous review are listed and the department's action on each is noted. The program asked reviewers to respond to questions regarding attrition, progression requirements, pursuing further accreditation, and recruitment for the MSc program.
- The document articulates the program-level learning outcomes and describes the process by which they were developed. It outlines accreditation standards and identifies which programs are accredited currently, noting that there is no CSC accreditation for graduate programs. Admission requirements are consistent with Laurier averages and the document describes alternate admission requirements.
- Curriculum of the Chemistry and Biochemistry programs is structured to introduce, reinforce, and provide mastery of knowledge and skills as students move through the program; at the graduate level, some mastery occurs through research-based theses. Program learning outcomes have been developed and adopted in the context of degree level expectations from the Ontario Council of Academic Vice-Presidents, the American Chemical Society, and the current Ontario high school science learning outcomes.
- Enrolment has generally been increasing in the undergraduate program and the department has been able to keep graduate class sizes small while accommodating a higher number of undergraduates. The undergraduate program's service teaching contribution is substantial. Courses are delivered through lecture, lab, and tutorials, and the programs utilize high impact practices such as the flipped classroom, undergraduate research, collaborative assignments and projects, capstone courses and projects, active learning, and green labs. Students are assessed through laboratory assignments and reports, tests and examinations, and learning portfolios.
- The program has made excellent use of existing resources and has even managed to grow enrolment with limited laboratory instructor resources. Space is currently adequate in the Science building and there is a planned expansion of the undergraduate teaching lab space described in the self-study. Scientific instruments are refreshed with the help of special grants through external and internal funding sources.
- The department's administrative and decision-making and committee structures are clearly outlined and support units are identified and their contributions described. Faculty are consistently successful in their research funding and regularly obtain grants from both external and internal sources and collaborate with researchers at other institutions. Faculty are active in their engagement with scholarly and research activities and publish regularly in notable journals in their fields. Faculty expertise is diverse and covers

key areas of the programs in the department, and has showed and increased commitments to innovative and evidence-based high impact teaching practices. Course evaluations typically meet or exceed faculty and university averages and indicate a high degree of satisfaction with the program. Employment rates are consistently higher than the overall Laurier averages. Alumni indicate a high degree of satisfaction with the program and provided useful feedback on areas of growth such as earlier academic advising opportunities and additional career guidance.

- The department states that the overall goal of their strategic plan is “providing excellent instruction of undergraduate and graduate students and to advance scholarly research in the chemical sciences.” Their key priorities for the next five years includes: improving student learning outcomes and ensuring student success; experiential learning opportunities for undergraduate students; and enhancing research activity. Current areas of concern are undergraduate student recruitment and retention, support for laboratory teaching, and sustainability of graduate course offerings. The conclusion to the self-study reiterates the department’s commitment to teaching and research excellence, and its prioritizing of student recruitment, retention and success.

External Reviewers’ Report

The external reviewers for the Chemistry and Biochemistry cyclical review were Dr. Pam Bryden from the Department of Kinesiology at Wilfrid Laurier University, Dr. James Gauld from the Department of Chemistry at the University of Windsor, Dr. Robert Singer from the Department of Chemistry at Saint Mary’s University, and Dr. Brian Wagner from the Department of Chemistry at the University of Prince Edward Island. The site visit took place on December 5th and 6th, 2016 at Wilfrid Laurier.

Executive Summary

The Department of Chemistry and Biochemistry at Wilfrid Laurier University provides strong undergraduate Honours Bachelor of Science and Masters of Science programs. The Faculty is engaged, hard-working, and concerned about student success. Teaching in the Department is one of its strengths, and faculty are dedicated to providing students with an excellent learning experience and environment. Research and scholarly work in the Department is also strong, with significant external funding overall, and good publication rates. One area of concern is availability of lab (both teaching and research) space; this needs to be addressed through a combination of construction of a new Science Building, and becoming involved with the new potential Laurier campus in Milton, ON. The other significant concern is undergraduate student attrition. This must be addressed, and the numbers of majors in upper years needs to be increased. This needs to be done through a combination of revisions to the curriculum (including removal of the requirement for the Linear Algebra math course), and enhancement of the undergraduate student experience (including through increased opportunities for and access to research experience for undergraduate students. This may also be partially addressed by a concerted, strategic effort to recruit more international students, at both the undergraduate and graduate levels. The Department should also work towards increasing the lab contact hours for those not doing an Honours thesis, to meet CSC accreditation requirements for such students.

List of Recommendations

2a-1. The Department should endeavour to have additional programs offered, including non-thesis based programs, accredited by the Canadian Society for Chemistry (CSC).

2a-2. The Department should develop its own strategic academic plan that is consistent with that of the University and the Faculty of Science. A clear mission statement for the Department should be included in this document.

2a-3. The Department requires adequate teaching laboratory space to deliver its plethora of programs that can continue to meet and align with the University's SAP. Currently there is woefully inadequate lab space in which to further develop and evolve one of the Department's strengths – experiential learning.

2b-1. Admission requirements should be maintained for entrance standards directly from high school while progression standards for continuation in the various programs should be revised.

2c-1. Math requirements for undergraduate programs need to be revised both at the university entry level and within program curricula. The Department should revise math requirement to be more consistent with what is typically offered at other Canadian Chemistry and Biochemistry Departments and with CSC criteria.

2c-2. The Department should develop lab components for courses where students receive lab hours prescribed by CSC Accreditation. This will require adequate teaching lab space to be made available.

2c-3. The Department should develop stand-alone graduate level courses for M.Sc. level students. Where senior undergraduate level courses must be cross-listed, separate evaluation tools (i.e. Assignments, tests, examinations, etc.) distinct from those of the undergraduate level should be developed.

2c-4. The Department should simplify the seminar series of graduate courses into 1 course, which runs the full year. Within the course the same benchmarks could be met, and provide increased flexibility for those that start or finish outside of the usual dates.

2c-5. The Department should work with the Faculty of Graduate and Postdoctoral Studies to provide ASPIRE workshops at alternative times that are more suited to the other demands upon the department's graduate students.

2c-6. Provision of a word template for the MSc thesis would help ensure that theses meet the rigorous standards and requirements for such documents.

2d-1. The department should continue to explore and implement innovative assessment methodologies, which assess higher cognitive skills and abilities, and are relevant to various types of learners.

2d-2. The department should designate one of the faculty to serve as undergraduate program coordinator, to act as a resource person for undergrads, and a liaison between students and the Department Chair.

2d-3. Current lab assessment approaches should be re-evaluated, to make sure that lab skills and theory are being assessed appropriately.

2d-4. Ensure in cross-listed courses that the different undergraduate and graduate learning outcomes are clearly communicated and assessed.

2e-1. Establishment of a Science Resource Centre, or other central resource where CAS and TA's may hold office hours or otherwise be available to undergraduate students.

2e-2. Investigate the possibility of developing a new Biotechnology or other program within the Department of Chemistry to be established at the new Milton campus.

2e-3. The Department should investigate ways of accessing required resources to allow for an increase in the number of lab contact hours for non-thesis students to meet accreditation requirements.

2e-4. The Department should ensure that it takes advantage and makes full use of all available funding programs, both internal and external, to increase the numbers of undergraduate and graduate students working in the research labs.

2e-5. The Department should investigate ways to leverage a new Analytical Chemistry faculty position, at least with a partial appointment, for example through a cross appointment with another department (such as Environmental Studies).

2e-6. The Department should prioritize the acquisition of a new part time lab coordinator/technician, to help reduce the strains on the current lab staff, and to help work towards increasing lab contact hours for non-thesis students.

2e7. The Department should make better use of their students as teaching and research resources.

2f-1. Strategic recruitment of an additional faculty member(s) would reduce the dependence on availability of sessional instructors. It could also increase the department's ability to further grow their research MSc program, and deliver appropriate graduate courses.

2f-2. For faculty supervising graduate students, recognition of all grad students they supervise through having the thesis/dissertation courses count as 1 teaching credit may help to recognise the time and effort required of such endeavours while simultaneously ensuring the ongoing competitive research productivity of the department.

2g-1. Remove the Linear Algebra math course requirement, and revisit overall the math and other non-departmental requirements of the Honours programs.

2g-2. Need to engage outstanding or promising undergraduate students early in their careers in research groups of faculty, perhaps through an Outstanding Student award only available to those in the relevant program.

2g-3. Increase opportunities for co-op or internship placements in the undergraduate curriculum.

2g-4. Develop new programs that are well matched to student interests and career goals, such as Biotechnology.

2g-5. Work with University recruiters to expand the area of recruitment of undergraduate students, including the development of a Departmental International Student Recruitment Strategy.

2h-1. The research and graduate profile of the department could be raised by requiring or providing financial support to graduate students to attend at least one national/international level conference within Canada (e.g.,

the annual Canadian Society for Chemistry Conference). This in turn would aid recruitment efforts by showcasing graduate research at Wilfrid Laurier University.

2h-2. Industry personnel and alumni could be invited to give Departmental seminars, either formal or informal.

2i-1. Enhance the opportunities provided by the CH390 course through incorporating relevant hands-on research aspects, and/or strengthening its professional development relevance.

2i-2. Introduction of a co-op or internship option(s) would provide opportunities for students to connect and reinforce classroom material via enhanced experiential learning with real-world applications.

Unit Response

The Unit Response was authored several faculty members in the Department of Chemistry and Biochemistry, including Department Chair Dr. Ian Hamilton, Dr. Louise Dawe, Dr. Lilian DeBruin, Dr. Geoff Horsman, Dr. Stephen MacNeil, and Dr. Ken Maly. The response thanks the reviewers for the time and effort put into the review and notes that the review report was thoughtful and the recommendations useful.

The department classified the reviewers' recommendations into three themes: increasing resources for experiential learning; increasing research intensity and profiles; and strategic planning and faculty recruitment. One correction to the reviewers' report was noted, which impacted the department's response to that recommendation.

For each recommendation, the department indicated if they agreed with it or not, gave detailed examples of any actions already taken place toward implementation, future steps that could or would be taken, and noted where the implementation of a recommendation required collaboration with the Faculty of Science. The Unit Response concludes by reiterating the usefulness of the reviewers' report and recommendations and indicates that they the department looks forward to working with the Faculty of Science and the University as a whole in prioritizing and implementing recommendations that support the strategic goals of the department and improve students' learning experience.

B) IDENTIFICATION OF PROGRAM STRENGTHS

Acting Dean FOS: The Department of Chemistry and Biochemistry has a strong record of excellence in teaching at the undergraduate level coupled with a very strong research productivity. They should be praised on their effective use of existing resources while managing to grow enrolment. The Department's key priorities for the next five years are sound, including improving student learning outcomes and ensuring student success, experiential learning opportunities for undergraduate students, and enhancing research activity.

Acting Dean FGPS: The Department of Chemistry and Biochemistry is to be commended for its active research profile, commitment to graduate student teaching, mentoring and professionalization. As well, faculty have been consistent in financially supporting graduate students through research grants. Their partnering with Biology in

creating a PhD program is likewise an innovative development, and one that increases Laurier's profile as a comprehensive university.

C) OPPORTUNITIES FOR PROGRAM IMPROVEMENT AND ENHANCEMENT

Acting Dean FOS: The reviewers emphasize 1) undergraduate student attrition; 2) revisions to the curriculum, and 3) enhancement of the undergraduate student experience as areas for program improvement and enhancement. In particular, I would strongly suggest that the Department continue to consider ways to revise their undergraduate curriculum to remove barriers to success and engage students in their program.

Acting Dean FGPS: The reviewers draw attention to three significant issues for graduate students: 1) Recruitment; 2) Program-specific courses; 3) Lab space and equipment. I would urge the department to focus on these three elements and make them a priority for attracting more students, and, in particular, retaining undergraduate students for the Masters program, and Masters students for the PhD. In this regard, the program is well served by considering not only entrance requirements, but progression requirements at all levels.

D) PRIORITIZATION OF RECOMMENDATIONS APPROVED FOR IMPLEMENTATION

Acting Dean Faculty of Science

Recommendation 2a-2: It should be relatively straightforward for the Department to complete, as the Faculty of Science has completed its strategic planning exercise and the document has been approved at Divisional Council.

Undergraduate Curriculum-related Recommendations

Math requirements (Recommendation 2c-1; 2g-1): The Department has already begun to address the math requirements for their undergraduate programs by the removal of MA122. Continued work with the Math Department must be done to create possible replacement courses that cover relevant mathematical skills for chemists. In addition, the Department should continue to monitor their students' progress in required math courses.

Laboratory hours (Recommendations 2a-1; 2c-2; 2e-3): The Department may not be able to add the appropriate number of lab hours to the honours non-thesis streams of the program, but they should plan how this could be achieved for a larger number of students for the future, without large resource implications.

Learning assessment methodologies (Recommendations 2d-1; 2d-3): The Department has created the Chemistry Education Committee which is examining innovative assessment methodologies. The work of this committee is essential and they are encouraged to continue their efforts. It will be important to consider how to implement new assessment techniques as a next step. As part of Recommendation 2d-3, the committee should also evaluate assessment techniques in the laboratory portions of courses.

New program in Biotechnology (Recommendation 2e-2; 2g-4): The Department should consider, with the Faculty of Science, what programs should be developed at Milton, or enhanced at the Waterloo campus. This is part of long-term planning in the Faculty.

Addition of co-op programing (Recommendation 2g-3): The Faculty of Science is working to add co-op education to more of its programs, as outlined in the new Strategic Plan. Discussions concerning co-op will take place over the next year.

Recruitment and Retention Recommendations

Admission/progression requirements (Recommendation 2b-1): At this point in time, admission and progression requirements should remain as articulated in the calendar. The Department should first consider changes to the curriculum (such as the removal of MA122) to determine how this influences the success of their students before attempting to change admission or progression requirements.

Recruitment (Recommendation 2g-5): As part of the new Strategic Plan, the Faculty of Science is in the process of revamping its Recruitment and Admissions Committee. All departments will have representation on this committee. The goal of the committee is to enhance our recruitment strategies at the Faculty level.

Graduate Program Recommendations

Graduate curriculum (Recommendations 2c-3; 2c-4; 2d-4). I concur with the reviewers that cross-listed undergraduate/graduate courses should be kept to a minimum. Alternative course structures, curriculum development should be considered. In addition, for those courses that are cross-listed explicit and clear learning objectives must be articulated for graduate students. The graduate-level course must also examine the material in more depth than the cross-listed undergraduate level course. As for changes to the graduate seminar series, the argument for disagreeing with the reviewers makes sense. Finally, as for the scheduling of ASPIRE workshops, the graduate coordinator in the Department should offer possible suggestions for additional ASPIRE program offerings. In addition, offering Science specific orientation/training sessions to graduate studies should be considered.

Use of graduate students in teaching and research (Recommendation 2e-7): The Department, while considering changes to their curriculum, learning assessment methods, and laboratory assessment methods, should reflect on the use of teaching assistants in their courses. Involving laboratory coordinators in this discussion would be helpful.

Funding of research and undergraduate/graduate students (Recommendations 2e-4; 2g-2; 2h-1): As part of its new Strategic Plan, the Faculty of Science will be working on ways to leverage funds to help researchers, undergraduate, and graduate students engage in research. Committees are currently being determined to reach the goals of a) promoting and celebrating research opportunities and success and b) identifying and securing funding to establish award programs for students

Graduate student success (Recommendation 2c-5; 2c-6): The Faculty of Science is considering some Science specific orientation/training sessions to graduate studies which might aid the Department in boosting student attendance in the ASPIRE workshops. The Department should ensure that a template for theses is readily available for all students.

Other Recommendations

Recommendation 2h-2: Adding alumni and industry partners to the Departmental Seminar Series is a good idea. Additionally, the Strategic Plan in the Faculty of Science has articulated greater development of alumni relations and community outreach/engagement.

Recommendation 2d-2: The unit response is appropriate as there is already an undergraduate program coordinator in the Department. Nonetheless, this might be an excellent time for the Department to review and outline the duties of the undergraduate advisor.

Recommendation 2e-1: The Faculty of Science is looking into creating a central resource area within the Bricker Academic Building.

Recommendation 2i-1: The Department has made a solid case for disagreeing with the reviewers in altering the CH390 course. However, some consideration might be made for how to provide additional professional development activities to other courses, or to outside class workshops/events.

Recommendations with Resource Implications

Recommendation 2a-3: Undergraduate Chemistry labs are currently being renovated which will alleviate some of the space constraints felt by the Department. Addition of laboratory teaching space is not possible at this time given the space constraints that the Faculty of Science currently experiences.

Recommendation 2e-5; 2f-1: The addition of a faculty position is part of ongoing budget constraints.

Recommendation 2f-2: Such credit for supervising is regulated under the collective agreement.

Acting Dean Faculty of Graduate and Postdoctoral Studies

Recommendation 2c-3 & 2d-4: this is especially critical; graduate students should not be assessed in the same manner as undergraduate students, even if they are taking courses with senior BSc. Students. Normally, in such cases an entirely different syllabus, with similar but lengthier and more intensive requirements, are provided to differentiate graduate progression requirements and learning outcomes from those of undergrads. Where possible, however, the department should seek to offer all graduate students one or more courses exclusive to graduate students. I would urge them to discuss the possibilities in this regard with their program chair and dean of science. Report back: May 2018.

Recommendation 2c-4: The rationale for disagreeing here makes sense to me; students should have the greatest flexibility in completing degrees, and if this process aids in this regard, then it should continue.

Recommendation 2c-5: Keep up the good work, though it might be a good idea to offer suggestions for additional spring and summer ASPIRE program, and also to consider online courses now in development by ASPIRE partners. Report back: May 2019.

Recommendation 2c-6: Again, I think a concise document, for quick reference on the part of students, would be helpful. However, I wonder about its placement on MyLS, rather than the part of the dept. website detailing the graduate program. At the very least it should be posted in both places. Report back: May 2018.

Recommendation 2e-1: It is important for the professionalization of students, especially TAs, that they have an appropriate space in which to work on their duties and to meet with students. I encourage the program to discuss this with the dean of science and to request help from the FGPS capital fund where possible.

Recommendation 2e-2: I would encourage the dept. to think about the ways in which graduate programs in some aspect of Chemistry would be suitable for the Milton campus, once the nature of that campus is full determined.

Recommendation 2e-4: I would recommend that the department create (if it's not doing so already) an inventory of grants awarded to faculty and its impact on HQP (especially at the grad. level), which would aid future assessors in determining the faculties' commitment to research. Report back: May 2018.

Recommendation 2e-7: I encourage the faculty to continue thinking of ways in which to improve and vary the experience of graduate TAs, including their place as potential mentors for senior undergraduate TAs. Report back: May 2019.

Recommendation 2f-2: I think it's important to note, historically, that when Laurier went from a 3/2 to a 2/2 teaching load, the understanding was that this was a form of remuneration for graduate level supervision outside of regular class teaching (in those depts. where grad teaching counts for load). I am surprised that the external reviewers where either not apprised of this, or willing to comment on it. I therefore do not agree either with this recommendation, nor the response.

Recommendation 2g-2: I agree with this recommendation, and feel that it would also aid in retaining promising undergraduate students for graduate programs. Report back: May 2019.

Recommendation 2h-1: I strongly encourage the department to look into additional travel opportunities for their graduate students, and to contact FGPS and Development and Alumni Relations for help in this regard. Report back: May 2019

SIGNATURES

Pam Bryden	September 11, 2017	
Tamas Dobozy	April 13, 2017	
Kathryn Carter	September 12, 2017	
Paul Jessop	July 5, 2017	

PART TWO: IMPLEMENTATION PLAN

Recommendation to be Implemented	Responsibility for Implementation	Anticipated Completion Date	Additional Notes
Recommendation 2a-2: Development of Strategic Plan for Department.	Department	September 2018	
Recommendation 2c-1; 2g-1: Math Requirements	Department, in consultation with Mathematics	May 2018	
Recommendations 2a-1; 2c-2; 2e-3: Laboratory hours and CSC Accreditation.	Department	May 2019	The Department may not be able to add the appropriate number of lab hours to the honours non-thesis streams of the program, but they should plan how this could be achieved for a larger number of students for the future, without large resource implications.
Recommendations 2d-1; 2d-3: Learning assessment methodologies.	Department	May 2019	
Recommendation 2g-3: Addition of co-op programming.	Department, in consultation with Dean and Co-Operative	September 2018	Discussions concerning co-op will take place over the next year.

	Education		
Recommendation 2c-3 & 2d-4: Cross-listed courses	Department	May 2018	
Recommendation 2c-5: ASPIRE program offerings.		May 2019	
Recommendation 2c-6: MSc Thesis template.	Department	May 2018	
Recommendation 2e-1: Space for CAS and TAs to hold office hours.	Department, Dean of Science	May 2018	Discuss this with the dean of science and to request help from the FGPS capital fund where possible.
Recommendation 2e-2, 2g-4: Investigate possibility of graduate program offerings at Milton site.	Department, Dean of Science, Dean of FGPS	May 2018	
Recommendation 2e-4: Increase number of students working in research labs.	Department	May 2018	The department could create an inventory of grants awarded to faculty and its impact on HQP.
Recommendation 2e-7: Better use of students as teaching and research resources.	Department	May 2019	
Recommendation 2g-2: Engage promising undergraduate students.	Department	May 2019	

Recommendation 2h-1: Financial support for graduate students to attend conferences.	Department	May 2019	
Recommendation 2h-2: Inviting industry personnel and alumni to departmental seminars.	Department	May 2018	