

Review of the Department of Chemistry and Biochemistry, University of Regina: The Reviewers' Report

External Reviewers:

Dr. Jed Harrison, Professor of Chemistry, University of Alberta

Dr. Masoud Jelokhani-Niaraki, Professor of Chemistry and Biochemistry, Wilfrid Laurier University

Internal Reviewer:

Dr. Amr Henni, Professor of Industrial and Process Systems Engineering, University of Regina

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Executive Summary

The Department of Chemistry and Biochemistry of the University of Regina is a modestly-sized department in Canada, which offers two undergraduate programs in Chemistry and Biochemistry, as well as Masters and Doctoral degrees with a focus on different sub-disciplines of Chemistry and Biochemistry. The Department has formidable undergraduate programs and a strong research productivity and a very good potential for growth. The recent focus on Proteomics and Systems Biology has attracted substantial research funding, students and senior research scientists to the department. In spite of its modest number of research faculty and their substantial service load, the department maintains its commitment to graduate education and undergraduate teaching.

Undergraduate Teaching and Learning

- ❖ The Department of Chemistry and Biochemistry offers BSc and BSc Honours undergraduate degrees in both Chemistry and Biochemistry. These are programs with substance that is of comparable content and quality to programs across the country.
- ❖ Undergraduate students are offered hands-on research experience through several options, in alignment with trends across Canada. Undergraduate laboratories provide a vibrant undergraduate laboratory experience.
- ❖ There has been a substantial growth in the number of students in service courses over the past 5 years (20 %), and even more (over 200 %) during the past 10 years. This is an

extraordinarily high service load for a department of a modest size and the impact of this growth needs to be addressed.

- ❖ Due to high teaching load dedicated to 1st and 2nd year courses, the department has limitations in offering senior courses on a regular basis. This is a notable disadvantage for undergraduate students.

Graduate Teaching and Learning

- ❖ The Chemistry and Biochemistry Department has a small Graduate student program, which is the basis of their research productivity, and is a mainstay of the ability to deliver the undergraduate program, through Teaching Assistantships. Both MSc and PhD programs are offered in Chemistry and in Biochemistry.
- ❖ Graduate programs have a rigorous structure comparable to other universities across Canada. The research opportunities available to graduate students cover a broad range, from theoretical, to organic, inorganic, biochemistry, proteomics to environmental chemistry.
- ❖ A number of key individual labs form a major component of the research infrastructure, many funded through successful CFI grants in the past ~15 years.
- ❖ In order to maintain research productivity, the department and Faculty of Science should consider growth in the graduate programs. Increased graduate student support through Teaching Assistantships would be helpful for both graduate and undergraduate programs.

Research

- ❖ Considering the number of faculty and the relatively small size of the department, and the fact that it includes two major disciplines of natural sciences (chemistry and biochemistry), the research productivity is strong.
- ❖ In the past few years, research strength has been especially visible in the areas proteomics and metabolomics. The research quality of the faculty is reflected in the diversity of publications in many highly cited journals.
- ❖ To support the research strength of the department, it is essential to increase the success rate of external funding by attracting high quality graduate students, as well as maintaining, updating and expanding the existing research infrastructure.

Service

- ❖ Considering the size of the department, its contribution to service, both inside and outside University, is significant.

Staffing

- ❖ Regarding the current size of the Department of Chemistry and Biochemistry, any

reduction in its size can severely damage its teaching and research ability.

Financial Resources

- ❖ The Budget for the department appears relatively low compared to the number of students being taught and has not shown a growth commensurate with the increasing number of students in the past 5 years. The department has taken a number of steps to accommodate the increased teaching workload, but it appears that the demands on staff are high and the available resources are stretched to the limit.

Role in Meeting the University's Strategic Plan

- ❖ The department is actively contributing to the objectives of the University of Regina Strategic plan. The department has placed a strong focus on student success, and contributes to the concept of sustainability through research activity in Energy and the Environment. It is contributing substantive and diverse outreach activities. The department is also developing closer interactions with indigenous communities and introducing indigenous cultures to the public, by offering an online course on Medicinal Plants and Culture, and by incorporating traditional knowledge through Elders.

Introductory Remarks

The Review Committee for the Department of Chemistry and Biochemistry of the University of Regina consisted of two external reviewers: Professor Jed Harrison (University of Alberta) and Professor Masoud Jelokhani-Niaraki (Wilfrid Laurier University). The internal reviewer was Professor Amr Henni, Associate Dean of Engineering and Applied Sciences. The Review Committee was provided with a Self-Study Report from the Department of Chemistry and Biochemistry, giving details of the unit's undergraduate and graduate programs, research profile, as well as the academic CV's of the department members. The dates of the site visit of the department were March 22 and 23, 2018. The site visit included meetings with academic administrators of the University, Faculty of Science, as well as Faculty of Graduate Studies and Research. In the department, the Review Committee met with Department Head, faculty, laboratory instructors and support staff, Science Library liaison (from the Library), as well as undergraduates, graduate students, and past graduates. The committee also had a tour of instructional lab facilities, research facilities and research labs.

The Review Committee members would like to express their gratitude to all for answering the committee's questions and explaining the operation of the department within the University. We further thank Dr. Renata Raina-Fulton (Head of the Department of Chemistry and Biochemistry) for hosting the Review Committee. The agenda for the Review Committee's site visit can be found in Appendix I.

Report Content and Format

The Review Committee's Report contains the following sections:

- Undergraduate Teaching and Learning
- Graduate Teaching and Learning
- Research
- Staffing
- Service
- Financial Resources
- Role in the University's Strategic Plan

Areas defined by the University of Regina Academic Review Policy were emphasized in these sections, when applicable. The areas in the Review Policy include:

- The priorities and aspirations of each unit and the extent to which they are being realized
- The challenges and opportunities faced by the unit
- The structure and quality of undergraduate and graduate programs and instruction
- The contribution of each program to related disciplines and fields of study
- The scope and significance of research being pursued
- The degree to which academic programs meet students' learning needs and goals
- The characteristics of staffing complements
- The degree to which the unit is meeting its internal and external service responsibilities
- The role the unit plays in meeting the University's vision, mission, goals and priorities
- The financial resources of the unit

This report also includes incorporated "Observations" and "Recommendations" sections. Observations are the committee's direct impressions summarizing its view on specific aspects of site visit. Recommendations are the formal views of the committee.

Undergraduate Teaching and Learning

Structure

The department currently offers BSc Major and BSc Honours programs in Chemistry and BSc Major and BSc Honours programs in Biochemistry, as well as a Co-Op program option and minors in both Chemistry and Biochemistry. Combined BSc in both Chemistry and Biochemistry or Biology and Biochemistry program options are being phased out as existing students graduate, due to relatively low enrollments. The department offers experiential research-based courses for Majors and Honours, with a faculty research supervisor. There is a substantive service course component including CHEM100, CHEM104, or CHEM140, offered through the department and at the First Nations University or off-campus locations. Other

major courses that also service other departments include BIOC220/221 and CHEM105, which are only available from the department. In the first year courses for 2016-17, the vast majority being service courses, they instructed 5,382 students in Chemistry, and 1794 students in Biochemistry. These are extraordinarily high service numbers for a department of 11 faculty, and have been growing over the past 5 years (20 %), and even more substantially over the past 10 years (over 200 %).

Quality of Program

The Chemistry and Biochemistry undergraduate programs are comparable in course content to similar offerings at other Canadian universities. The Review Committee assesses that the selection of courses offered represents a program (BSc and BSc Honours) with substance that is of comparable content and quality to programs across the country. The Introductory Chemistry course program is strong, as is the Introductory Organic Chemistry program. The department is working hard to ensure these courses are taught by a large fraction of tenure track faculty, in addition to Sessional Instructors, for which they are to be commended. Undergraduate students are offered hands-on research experience through several options, in alignment with trends across Canada.

The senior management personnel who met with the Review Committee all expressed very strong positive opinions regarding the Chemistry and Biochemistry Department. These included the Dean of Science, and Associate Deans of Science (Research and Academic). The Dean of Science expressed strong support for continued development of teaching equipment and infrastructure. The Dean's Office confirmed their appreciation of the commitment of the department to quality undergraduate teaching, and to running a sound program, with a good history of very few academic complaints or problems.

Undergraduate Lab Experience

A tour of the undergraduate laboratories and meetings with the lab instructional staff evidence a vibrant undergraduate laboratory experience, showing well-managed labs. The strong effort of the lab coordinators and technical staff has been invaluable in keeping aging equipment running. They have ensured that the methods and concepts these old instruments are used to teach are current and up to date. It is clear their contributions are critical to the department's success in maintaining the lab functions and advancing the teaching environment.

The present effort to replace some of the teaching lab equipment, and to expand the range of instrumental methods that students are being taught is important. The self-study report identifies creative and well thought out efforts to improve the lab equipment resources. Nevertheless, the tour also revealed a substantial amount of the instrumentation and equipment, such as UV-vis spectrometers, gas chromatographs, pH meters and other items, is very old and is in need of replacement. Modern equipment is needed in order to teach the

methods used in the laboratory today in industrial, government, and research labs. The Dean of Science expressed strong support for continued development of teaching equipment and infrastructure. The Review Committee notes the high impact of the equipment replacement and infrastructure development budget of the Dean of Science, and strongly recommends this funding program be continued.

A number of teaching labs have been renovated, and others moved to the newest Science building, providing a needed upgrade in the lab environment. Fume hoods in other labs remain original and are showing serious signs of age, such as poorly working window sashes, plumbing and surfaces, making them unusable by students in the lab. A continued effort to complete teaching lab renewal is recommended. The department self-study identifies multiple steps the department has undertaken to optimize the use of teaching lab space through all available terms. The self-study also mentions the challenge of sharing a teaching lab with a Biology course, and Review Committee meetings with the lab staff confirm these challenges. The magnitude of effort required to move equipment in and out for specific labs, and specific teaching terms, is significant, and impairs delivery of the courses according to the lab instructors. If the lab were fully available to Chemistry and Biochemistry courses it would increase the potential for enrollment in the entry level service courses, through reorganization of lab utilization. A reevaluation of sharing the lab in question is recommended.

Meeting students' learning needs and goals

The instructional program is sound, and well delivered, meeting the expectations of a quality BSc for Chemistry and Biochemistry. The department endeavours to deliver quality instruction across all years of the program, to student's benefit. A research experience is available to students in all of the programs, which is a strength. The senior courses cover a large breadth, but the department needs to look at how to better manage students' expectations of subjects that may be available each year. The teaching lab space has undergone renovations, and some labs moved to a new building a few years ago, modernizing a portion of the student teaching space. Faculty and staff have maintained and developed equipment necessary to offer a strong modern laboratory experience, which is critical for training of chemists, but more modern equipment will be needed.

Observations

The Provost and Dean identified University strategies to continue to increase the number of international students within the undergraduate program. The Department faculty indicated they have had some difficulties with the preparedness of such students, and the Dean's Office expressed some concerns related to preparedness. The Review Committee recommends the Provost's and Dean's offices examine the practices being adopted at other Canadian Universities, to enhance success and retention of international undergraduates. For

example, Simon Fraser University has teamed up with a BC college to provide a summer preparation school for incoming students, at the student's cost. The University of Alberta, Faculty of Science, has implemented a pilot program to monitor the performance of international students in the first 8 weeks of their introductory courses, to identify those that may need academic guidance or support of some kind. Other models exist as well, recognizing the need to support the success of students attracted from other countries. The Review Committee notes that a previously implemented Support Instruction (SI) program was a very positive element in the eyes of faculty members, and that its loss is keenly felt. A program of this type may represent a viable option for concerns related to success of international students.

The Review Committee enquired about training of students in the use of library resources, and was not made aware of any specific, course-based instruction. We recommend the department take advantage of training lectures on literature searching that are offered by the Library, and other library resources, as part of the curriculum within at least one course, perhaps further motivated by a graded assignment in that course. The Review Committee learned that the undergraduate and/or graduate student organizations have been supporting training of this type on their own, confirming that students see the need.

A number of parties commented pointedly on the large number of senior undergraduate courses the department has on the books, compared to the number of senior courses actually offered and the frequency of those offerings. Meetings with current and past undergraduates showed that this issue has been ongoing across multiple generations of undergraduate classes. Students past and present expressed disappointment that they could not take courses that appeared very interesting to them, because they were not offered during their senior year. Faculty members were unhappy to miss the chance to teach a senior course more frequently. Other faculty raised the concern that the current number of senior course offerings made it very hard for students to complete an Honours degree within 4 years, reducing enrollment. The issue seems to not just be the number of courses offered, but the variability in the scheduling of subject areas from year to year, which can make it hard to build the required pre-requisite courses into a student's schedule. Finally, the Chair explained that sabbaticals, other forms of leave, and the heavy teaching demands of the Introductory courses made it hard to develop a robust senior course cycle.

The Review Committee recommends that the department take a deep look at their senior course programming and consider structural changes, as the issue has clearly persisted over an extended time frame of many years of graduating classes. We recommend they reduce the number of courses on the books and focus on ensuring those that are available are regularly offered. Further, we recommend that approaches to blending or mixing senior subject material into these fewer courses be developed, so that topics the department considers core to a graduating chemist are always available to students. We suggest the department undertake this challenge by first establishing the desired student learning

outcomes: identifying learning outcomes for the program, then working back through the courses offered and setting their curriculum. Working towards meeting these learning outcomes will provide a valuable tool in working through the competing interests of faculty in presenting individual sub-disciplines of Chemistry. The learning outcome formulation is becoming widespread, with an expectation it will be required at the University of Regina in the future, so this would be an opportune time and use of the methodology. Some faculty indicated an interest in having more department meetings to increase communication, and others an interest in holding a retreat to develop departmental directions. This recommended significant evaluation of senior courses could be facilitated through both such activities.

As discussed in more detail in the staffing section, the ability of the department to deliver the current service program and to better structure the delivery senior courses would be greatly enhanced by the addition of more TA'ships and raising the total faculty complement to 12, from the current 11.

Recommendations:

- The University, through Dean and Provost's Offices, explore means to enhance retention of international undergraduate students, evaluating approaches being utilized at other Canadian schools.
- The current size of the faculty should grow rather than decrease, in order to deliver the full program of service courses, and Majors and Honours in Chemistry and Biochemistry.
- Increased support for graduate teaching assistantships should be provided to support the undergraduate teaching program.
- The department should take advantage of training lectures on searching the literature offered by the Library, such as those that can be delivered in class, and other library resources, as part of the curriculum within at least one course, perhaps further motivated by a graded assignment in that course.
- The department should examine their senior course programming and consider structural changes, to reduce the variability of senior courses available to each graduating class. Using the learning outcome formulation would assist in this restructuring, and this represents an opportune time and use of the methodology.
- The Review Committee notes the high impact of the teaching equipment replacement and infrastructure development budget of the Dean of Science, and strongly recommends this funding program be continued (Note: this funding is also linked to research equipment.).
- A continued effort to complete teaching lab renewal is recommended.
- A reevaluation of sharing the lab LB-320 with the Biology undergraduate teaching program is recommended.

Graduate Teaching and Learning

Structure

The department has a small Graduate student (GS) program, currently 17 students, which is the basis of their research productivity, and is a mainstay of the ability to deliver the undergraduate program, through Teaching Assistantships. MSc and PhD programs are offered in Chemistry and in Biochemistry. Senior undergraduate courses are structured to provide graduate education as well, with a few graduate specific courses also on offer. The number of Post-Doctoral Fellows and visiting scientists is more than 50% the number of graduate students, which is quite healthy, and provides a good resource for the GS program. Maintaining and increasing these GS numbers is a key issue for the department.

The PhD program has a number of rigorous steps involved in preparation and training of students, including a proposal writing course, two department seminars, three progress reports and a literature review course. The research opportunities available to graduate students cover a broad range, from theoretical, to organic, inorganic, biochemistry, proteomics to environmental chemistry.

Quality of Program

The program quality is intrinsically linked to the research program of the faculty, which is discussed in detail in the Research section. Many students have the opportunity to publish in high quality journals, and develop a strong resume of publication, though there is a range of achievements. Students receive a high quality preparation through the required course and training steps. The weight and balance of these steps could be adjusted to reduce time to completion.

Meeting students' learning needs and goals

The research lab space has undergone renovations, and many labs moved to a new building a few years ago, providing good quality research space for many research teams. A number of key individual labs form a major component of the research infrastructure, many funded through successful CFI grants in the past ~15 years. The remaining research infrastructure depends to a great extent on campus facilities within the Faculties of Science and Engineering, as well as instrumentation operated by the department for teaching and research. The research infrastructure is currently sufficient to support major research efforts by graduate students in a number of research areas of chemistry and biochemistry. However the infrastructure is aging, and will require continued investment by the University and through NSERC RTI, CFI and other grant applications.

Graduate students in the program would benefit from an increased number of students, creating more course demand, and more mutual support within the research laboratories. Overall time to completion is an issue that should receive some attention, in part to make the

program more attractive, and in part to enhance the students' resumes through showing a timely graduation.

Observations

The Review Committee was surprised to learn there are very few specific graduate courses offered. Instead, the department is judicious in its use of faculty instructors, co-teaching senior undergraduate and GS in the same classroom, with enhanced learning exercises for the GS. This is efficient for department course workload, but GS may benefit from some graduate specific courses being on offer, and this should be evaluated. The Review Committee also noted that the department could be more pro-active in developing elements of Professional Training for GS, although there is a clear effort existing in the literature review and proposal writing courses. Several opportunities are available through the Faculty of Graduate Studies. The review committee recommends the department formalize requirements for students to participate in such training, such as the Graduate Student Conference, or some specified number of the MITACS workshops.

Several GS expressed some concerns with the program, focused on the length of time to degree for both the MSc and the PhD. A review of the faculty CV's in the self-study report identifies a 9-year PhD, several 6 to 7-year PhD, and multiple MSc of 3 or more years in length. The students believe there are a number of incidences of 4-year MSc degrees and 7 to 9-year PhD degrees. Department statistics may well show the average times are somewhat shorter, in the range of 3 and 6 years, respectively, and the committee recognizes there can be occasional students whose program times are long. Nonetheless, overly long degrees can reduce the value of a student's degree, and the perception that degrees take too long is damaging to recruitment of GS from within the University and from a broader catchment. Universities across Canada, the US and Europe have become engaged in the topic of time to completion for GS, and many are actively addressing means to control the length of study. The Review Committee strongly recommends the department examine current practices across Canada, and develop a strategy directed at reducing the average time to completion. In the Committee member's experience, reductions will occur when there is a commitment by the leadership of Deans, Chairs and Associate Chairs within a Faculty to address the issue, and to make it part of the student and faculty annual evaluation processes. Concrete goals and strategies need to be in place.

The Review Committee suggests that the requirements on GS throughout the program be examined, with an eye to streamlining the number of literature, proposal, and presentation exercises required. These appear to have become quite time consuming for GS, and it is feasible to reduce the number or the expectations of these requirements.

Graduate students also believe that the small size of the program makes it more difficult to complete a degree in a timely fashion, and recommend action be taken by the department

and Faculty to help grow the program. Increased GS support through TA'ships would be of assistance. The Faculty of Graduate Studies and Research (FGSR) expressed that funding for GS may be more stable than department faculty perceive, and that they should explore more aggressive options in recruiting students and increasing GS numbers. The Review Committee recommends the department pursue this perspective with FGSR.

Faculty expressed concerns with their ability to evaluate applications of international graduate students and predict success, as a means to increasing enrollment. The department should consult with Graduate Admissions committees in other departments at the University of Regina, and other Chemistry departments in Canada, in order to develop reference points for interpreting different grading scales, reference letter styles, and the quality of schools the applicants attended.

The department self-study mentions ideas to introduce students to research within the department in a deliberate fashion in first year courses, as a means to recruit both departmental Majors/Honours and future graduate students. The Review Committee encourages all approaches to increase program enrollment in these categories.

Recommendations:

- Multiple strategies for increasing graduate student enrollment need to be developed, including, but not limited to, those discussed above.
- The department should explore the possibilities of using more aggressive options in recruiting graduate students, in concert with the Dean of FGSR.
- Increased support for graduate teaching assistantships should be provided not only to support the undergraduate teaching program, but also to bolster enrollment opportunities in graduate school.
- Regarding international graduate student admissions, the department should consult with Graduate Admissions committees in other departments at the University of Regina, and other Chemistry/Biochemistry departments in Canada, in order to develop reference points for interpreting different grading scales, reference letter styles, and the quality of schools the applicants attended.
- The review committee recommends the department formalize requirements for students to participate in professional training opportunities, such as those offered by FGSR.
- The Review Committee strongly recommends the department develop a strategy directed at reducing the average time to degree completion, examining current practices across Canada, that the Dean be engaged in the process through annual faculty evaluation, and that the requirements of the program be streamlined.
- The graduate program may benefit from some graduate specific courses being on offer, and this should be evaluated.

Research

Historically, the Chemistry and Biochemistry Department has chosen the strategy of covering all areas of chemistry and biochemistry, and does not follow thematic research in one or a few select areas. This choice is reflected in the research activity of faculty, which encompasses a broad range from experimental and theoretical chemistry to biochemistry, biophysics, as well as bioinformatics. This approach enables the department to fulfill the theoretical and technical expertise required for offering undergraduate and graduate programs in chemistry and biochemistry. It is worthwhile mentioning that despite this broadness in research themes, the research in the department is aligned with the research strategies of the university in *Energy and Environment, Health, and Informatics*.

Considering the number of faculty and the relatively small size of the department, and the fact that it includes two major disciplines of natural sciences (chemistry and biochemistry), the research productivity is generally strong. In the past few years, this research strength has been especially visible in the areas of proteomics and metabolomics. The research strength of the faculty is also reflected in the diversity and good quality of the publications in many highly cited journals. Several faculty have active research collaborations throughout North America and Europe, which can further strengthen their research productivity. The department has also shown a very good ability in acquiring research instrumentation from national grant agencies. To support the research strength of the department, it is essential to increase the success rate of stable external funding by attracting high quality graduate students, as well as maintaining, updating and expanding the existing research infrastructure (please, also see the section on Graduate Teaching and Learning).

Observations

The Review Committee visited several research labs and found many state-of-the-art instruments utilized for research. The instruments were mostly maintained by technical staff, postdoctoral fellows and graduate students. The existing strong research infrastructure in the department, as well as interesting and exciting collaborative research projects, can definitely provide an excellent opportunity for training students and young researchers.

The Review Committee interviewed several senior researchers, postdoctoral fellows and graduate students and found them enthusiastic about their work. Very few undergraduates involved in research were evident to the committee, however, the CV of faculty show that undergraduates are being supervised in research. The experiential undergraduate courses in research also provide an opportunity for undergraduates. Nevertheless, some faculty indicated they believe the department could engage undergraduates to a greater extent. Notably, undergraduate research is considered as an HQP contribution in grant applications.

Using teaching equipment to support research has been a long-standing strategy in academics, and investment by the Dean and department in the undergraduate lab experience

will benefit the research program as well. Research oriented instrumentation is also a major need for the faculty and their programs. In particular, NMR equipment is essential to any Chemistry program. Such instruments provide critical insights, and are routinely used to monitor the course of development within any synthetic chemistry research program. There is really no alternative to having high performance NMR available on site for analyses, and the 300 MHz instrument is a minimum capacity, while a 400 MHz would give better performance, better data quality and shorter analysis times. These instruments are expensive enough they can not be secured through NSERC RTI grants alone. The lead time in delivery is long, so that planning for new instrumentation to replace existing units must take place well in advance. The Review Committee wishes to emphasize that this instrumentation is crucial to the research programs of a majority within the department, and that University and Faculty support for its replacement in a timely fashion is critical. The Dean of Science expressed strong support for continued development of research equipment and infrastructure.

The Review Committee also noticed a collegial environment and close collaboration between the members of department (faculty and staff) and between the department and other academic units. The overall morale within the department seemed very high. Regarding the size of the department and the resource limitations, this positive work environment is essential for productive interdisciplinary collaborative research within the department and with other academic units, including Department of Biology and Faculty of Engineering.

Recommendations:

- Attracting good quality graduate students is extremely important to maintain and improve the research productivity of the department. The department should develop strategies to move in this direction.
- The department should also consider means to strengthen undergraduate research as a resource for attracting future graduate students, and for contributing to published research output.
- The department should consider joint interdisciplinary research projects with other academic units, such as Faculty of Engineering, which can increase the success rate of funding opportunities.
- The Review Committee notes the high impact of the equipment replacement and infrastructure development budget of the Dean of Science, and strongly recommends this funding program be continued (Note: this funding is also linked to teaching equipment.). Also noted is the critical need for University and Faculty support for replacement of the 300 MHz NMR in a timely fashion.
- In consultation with the Dean of Science the department should consider approaches to long-term maintenance of the existing research infrastructure.

Service

The department self-study report identifies a large range of service the department provides to the University and the community. In addition to active participation in committee work within the University, the department's faculty and staff contribute to several outreach activities, such as the Science Rendezvous (a Faculty of Science Annual Open House), Regina Science Fairs, University of Regina Summer Camps, Transition from High School to University Committee, faculty liaison to department's Student Association (BCSA), Recruitment and Retention Committee, and Lifelong Learning Centre at the Centre for Continuing Education Committee. There is substantial support for education in the community, with the department supporting course offerings in Introductory Chemistry at college campuses across the province. These are substantive contributions for a department of this size, with the significant service teaching they also perform.

Community outreach, and support of the teaching and learning endeavor could benefit from the creation of a Visiting Committee consisting of former graduates of the program, and current and potential employers of program graduates.

Staffing

The Department of Chemistry and Biochemistry currently has 7 chemistry faculty members, 4 biochemistry faculty, 4 laboratory instructors (with one additional term laboratory instructor), one technician, and one administrative assistant. The Review Committee notes the considerable increase in undergraduate students over the past 6-year period, and commends the department on their ability to absorb this increase and deliver a strong core undergraduate program.

In the past decade new lab instructor positions have been added to adapt to the ~200 % increase in students in service courses. As discussed under Undergraduate Teaching, the lab instructors and technician play a key role in delivering and modernizing the laboratory experience, in maintaining and operating old instrumentation, and in implementing novel strategies to upgrade instrumentation. All of these positions are critical to continued delivery of a large service role in teaching.

The current faculty staffing levels are marginal. The Chair identified significant challenges in delivering both service courses and senior courses. The challenge is exacerbated by leaves such as sabbaticals, wherein an average of ~1.5 faculty members is entitled to sabbatical every year. The most recent faculty hire, who has done very well in developing a strong research program, and has been well supported by the University in this endeavor, was brought in over 5 years ago, in a time period when the department grew from 9 to 11 faculty (one of which is not a base funded, continuing position). It is likely there will be several faculty retirements within the next few years.

Observations

The increasing number of students being taught at the undergraduate level (in both service and senior courses) has put strain on the department members. The hiring of an additional faculty member would help address this strain and advance the program. The participation of faculty in team grants such as CFI and NSERC RTI applications would be greatly bolstered by the addition of faculty members. Continued support for refreshing equipment infrastructure for teaching and research will also aid in addressing the increasing workload for staff.

The Review Committee sees it as critical that any positions vacated through retirement or attrition be returned to the department for faculty hiring, and that an existing non-base faculty position be converted into a base position in the department upon being vacated due to retirement or attrition. We also strongly recommend that another tenure-track faculty position be established within the department. A new position will assist in addressing the continuing challenge of offering senior courses and specific graduate courses on a regularized basis, and will enhance the Graduate Program and research outcomes of the department.

The Dean indicated strong interest in supporting the continued expansion of research activities within the department, through hiring of junior faculty. This opinion was evidenced in part through his commitment to development of a Chemistry and Biochemistry CRC application, which unfortunately was not successful.

There are some clear differences in hiring strategy expressed by the Dean and by the department, and it would be useful for the department to work to align with the Dean to secure positions and to enhance the success rate of new faculty. The department has followed a model common throughout North America for Chemistry Departments, not specializing in subsets of the discipline, but rather hiring broadly across all of the sub-disciplines. With a small department this may no longer be a wise strategy, if they are to make a research impact. The need to teach many areas of Chemistry/Biochemistry can be used as an argument to support this breadth, but other disciplines, such as Physics, Geology or Computing Science have shown they can operate a broad undergraduate program while hiring in a narrowed, more focused selection of research areas. The Review Committee recommends the department consider and discuss this option together, perhaps in a retreat-style setting. They need to consider how to build on existing strength, and later work with the Dean to see their vision through. The department is in need of the development and support the Dean expressed in order to meet their undergraduate teaching mission, and to grow and better position their research and graduate student instructional capabilities. Given the cost of hiring faculty and the research equipment needs, the Dean must also garner support from senior Administration.

Recommendations:

- Any positions vacated through retirement or attrition should be returned to the department for faculty hiring.
- An existing non-base faculty position should be converted into a base position in the department upon being vacated by retirement or attrition.
- Strongly recommend that another tenure-track faculty position be established within the department to raise the complement to 12 tenure track faculty.
- Strongly encourage the department identify areas of strength in which to focus future faculty hiring, perhaps starting with a retreat.
- Strongly encourage the department work to align their hiring vision with the Dean.

Financial Resources

The Review committee notes the considerable increase in undergraduate enrollment over the past decade and commends the department on their ability to absorb this increase and deliver a strong core undergraduate program. The Budget for the department appears relatively low compared to the number of students being taught, and has not shown a growth commensurate with the increasing number of students in the past 5 years. The department self-study identifies a number of steps taken to accommodate the increased teaching workload in terms of optimizing lab utilization, instrumentation development, obtaining additional lab instructor staff positions over time, an increase in faculty over 5 years ago, and careful utilization of sessional instructors. Nonetheless, it appears that the demands on staff are high and that the current strategy within the available resources is stretched to the limit. This strong growth has created a need for more Teaching Assistantships, and more Faculty members than are currently available to the department, if the increased workload is to be sustained.

The Dean of Science expressed strong support for continued development of teaching and research equipment and infrastructure. He also indicated a strong interest in supporting the continued expansion of research activities within the department, through hiring of junior faculty. The department is in need of the development and support the Dean expressed in order to meet their undergraduate teaching mission, and to grow and better position their research and graduate student instructional capabilities. The associated recommendations are outlined in the undergraduate, graduate and staffing sections of this report.

Recommendations:

- There are a number of financially related recommendations made in the Undergraduate, Graduate and Staffing sections, related to TA'ships, faculty staffing levels, and support of teaching and research infrastructure, notably for instrumentation.

Role in meeting University's Strategic Plan

The University of Regina's current Strategic Plan has three emphases: Student Success, Research Impact and Commitment to our Communities, with Sustainability and Indigenization as overarching themes.

Student Success

The department has placed a strong focus on serving service course students well, with a major effort made to adapt and adjust to the steadily increasing student numbers. There is also a focus on ensuring that students in Introductory courses, which are team taught across several sections, include a significant fraction of tenure track faculty instructors. The Academic Associate Dean of Science commented specifically on the strong performance by the department in undergraduate teaching as viewed from his perspective. In the area of graduate education, the Review Committee believes the department should examine ways to offer more graduate specific courses, and should develop strategies to reduce the time to completion for graduate degrees. Recommendations were presented in the undergraduate and graduate sections.

Research Impact

The research fields of Chemistry and Biochemistry contribute to several of the targeted research themes defined within the University Strategic Plan, Energy and the Environment; Health; and Informatics. In comparison to its size, the department research impact is strong, as elaborated in the Research section of this document.

Commitment to our Communities

The Chemistry and Biochemistry Department is strongly committed to community activities by contributing to the diverse outreach activities of the Faculty of Science and Canada-wide Science Fairs. The department is also aiming at closer interaction with indigenous communities and introducing indigenous cultures to the public, by offering an online course on Medicinal Plants and Culture through the University of Regina and First Nations University of Canada campuses. One of the attractive and important features of this course is the incorporation of traditional knowledge through Elders. In another effort the department is in the process of developing a lab-based course (to be taught from fall 2018), which will incorporate indigenous traditional knowledge of food preparation. These activities emphasize the creative efforts of the department to public education of chemical sciences and are commended.

Sustainability and Indigenization

The department is very actively contributing to providing opportunities for indigenous students to take chemistry courses that are needed to meet many Faculty of Science and pre-professional course requirements. The extensive development of Introductory Chemistry courses and lab experiences that can be delivered at campuses across the province, including the First Nations School, represents a major contribution to creating opportunities.

The sustainability concept is inherently related to chemistry and biochemistry; and also corresponds to some of the main research themes of the University Strategic Plan, specifically Energy and the Environment. Many chemistry departments across the country have developed Environmental Chemistry courses or UG programs in Environmental Science. Developing one or more courses in Environmental Chemistry and/or a research program with Energy and Environment focus (this can be considered in a future faculty hiring) can attract new students (including engineering and natural sciences students) to the department and further contribute to the University Strategic Plan emphasis on Sustainability and Indigenization.

Recommendations:

- The department should consider developing a plan of action for its future development in teaching and research that is based upon the University Strategic Plan, as a means to motivate a new faculty position and justify it from a budget perspective.

Summary of Recommendations

(In order of appearance in the text)

1. The University, through Dean and Provost's Offices, explore means to enhance retention of international undergraduate students, evaluating approaches being utilized at other Canadian schools.
2. The current size of the faculty should grow rather than decrease, in order to deliver the full program of service courses, and Majors and Honours in Chemistry and Biochemistry.
3. Increased support for graduate teaching assistantships should be provided to support the undergraduate teaching program.
4. The department should take advantage of training lectures on searching the literature offered by the Library, such as those that can be delivered in class, and other library resources, as part of the curriculum within at least one course, perhaps further motivated by a graded assignment in that course.
5. The department should examine their senior course programming and consider structural changes, to reduce the variability of senior courses available to each graduating class. Using the learning outcome formulation would assist in this

restructuring, and this represents an opportune time and use of the methodology.

6. The Review Committee notes the high impact of the teaching equipment replacement and infrastructure development budget of the Dean of Science, and strongly recommends this funding program be continued (Note: this funding is also linked to research equipment.).
7. A continued effort to complete teaching lab renewal is recommended.
8. A reevaluation of sharing the lab LB-320 with the Biology undergraduate teaching program is recommended.
9. Multiple strategies for increasing graduate student enrollment need to be developed, including, but not limited to, those discussed above.
10. The department should explore the possibilities of using more aggressive options in recruiting graduate students, in concert with the Dean of FGSR.
11. Increased support for graduate teaching assistantships should be provided not only to support the undergraduate teaching program, but also to bolster enrollment opportunities in graduate school.
12. Regarding international graduate student admissions, the department should consult with Graduate Admissions committees in other departments at the University of Regina, and other Chemistry/Biochemistry departments in Canada, in order to develop reference points for interpreting different grading scales, reference letter styles, and the quality of schools the applicants attended.
13. The review committee recommends the department formalize requirements for students to participate in professional training opportunities, such as those offered by FGSR.
14. The Review Committee strongly recommends the department develop a strategy directed at reducing the average time to degree completion, examining current practices across Canada, that the Dean be engaged in the process through annual faculty evaluation, and that the requirements of the program be streamlined.
15. The graduate program may benefit from some graduate specific courses being on offer, and this should be evaluated.
16. Attracting good quality graduate students is extremely important to maintain and improve the research productivity of the department. The department should develop strategies to move in this direction.
17. The department should also consider means to strengthen undergraduate research as a resource for attracting future graduate students, and for contributing to published research output.
18. The department should consider joint interdisciplinary research projects with other academic units, such as Faculty of Engineering, which can increase the success rate of funding opportunities.

19. The Review Committee notes the high impact of the equipment replacement and infrastructure development budget of the Dean of Science, and strongly recommends this funding program be continued (Note: this funding is also linked to teaching equipment.). Also noted is the critical need for University and Faculty support for replacement of the 300 MHz NMR in a timely fashion.
20. In consultation with the Dean of Science the department should consider approaches to long-term maintenance of the existing research infrastructure.
21. Any positions vacated through retirement or attrition should be returned to the department for faculty hiring.
22. An existing non-base faculty position should be converted into a base position in the department upon being vacated by retirement or attrition.
23. Strongly recommend that another tenure-track faculty position be established within the department to raise the complement to 12 tenure track faculty.
24. Strongly encourage the department identify areas of strength in which to focus future faculty hiring, perhaps starting with a retreat.
25. Strongly encourage the department work to align their hiring vision with the Dean.
26. There are a number of financially related recommendations made in the Undergraduate, Graduate and Staffing sections, related to TA'ships, faculty staffing levels, and support of teaching and research infrastructure, notably for instrumentation.
27. The department should consider developing a plan of action for its future development in teaching and research that is based upon the University Strategic Plan, as a means to motivate a new faculty position and justify it from a budget perspective.