Department of Chemistry and Biochemistry

California State University, Fullerton

Program Performance Review

Self- Study

2017-2018

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I. Department Mission, Goals and Environment

A. Mission and Goals since previous PPR

In preparation for our 2009 Program Performance Review, the Department elected to hold a series of retreats that resulted in a comprehensive strategic vision for the Department, with associated goals. In preparation for the current Program Performance Review and in response to the College strategic planning process, the Department reviewed and updated its mission, vision, and goals in a series of meetings and retreats every year. The Vision Statements crafted by the Department in 2009 were specifically designed to provide broad strategic direction to the Department; as such they have not changed in the short time since our last review. However, the Department's specific goals have evolved significantly in response to the changing environment in the university and our own progress towards meeting our goals.

Department Mission Statement

The Department of Chemistry and Biochemistry will strive to create a collegial, collaborative, and supportive environment that nurtures professional relationships, enrich teaching and learning, develop and strengthen scholarship, and encourage professional service. We strive to be a leader in undergraduate and graduate level research. We offer a rigorous and contemporary curriculum that is responsive to future developments, reflecting the interdisciplinary nature and diversity of the chemical sciences, thus enabling students to become successful professionals, scholars, scientifically literate citizens and leaders. We will make significant contributions and have a major impact on chemical education, teacher preparation, and professional development in the region. We promote excellence in service to the department, university and community as well as cultivating ties with local and regional industry and academic institutions.

This mission statement is unchanged from the one that was adopted in 2009.

Department Goals - The Department annually reviews and updates its Goals in a series of faculty meetings. The 2009 PPR listed a number of goals that are aligned with the 4 main University Goals:

1. Create a collegial, collaborative, supportive environment and departmental structure that nurture professional relationships, enrich teaching and learning, develop and strengthen scholarship, and encourage professional service.
2. Be a leader in undergraduate and master's level research.
3. Offer a rigorous and contemporary curriculum that is responsive to future developments, reflects the interdisciplinary nature and diversity of the chemical sciences, and enables students to become successful professionals, scholars, scientifically literate citizens and leaders.
4. Make significant contributions to and have major/notable impact on chemical education, teacher preparation and professional development in the region.
5. Promote excellence in service to the department, university and community, and cultivate ties with local and regional industry and academic institutions.

To more closely mirror the university strategic planning process, we have consolidated many of the earlier objectives under larger goals. The Department's integrated goals, strategies, and outcomes are shown in Section 1.C and further discussed in section VII (Long-Term Plans).

The previous PPR listed a number of key issues that the Department was facing and needed to deal with; all of these are also directly related to the Department goals as listed above.

1. The mandatory student-faculty research component of the curriculum is noteworthy, but it creates a significant workload for the faculty as a result of the increasing number of majors.
2. The department should consider reviewing the curriculum with the intent of decreasing the time required to complete both bachelors and master's degrees.

3. A key issue for the department is to review its retention, tenure and promotion policies.
4. The department has made progress in developing an environment for the assessment of student learning including development of indicators of departmental quality but should consider adding to the list of indicators, that might include graduation rates, graduate/professional school enrollment rates.
5. The department should address issues of morale in the current economic climate? And a related question how can the department maintain the quality of its programs and sustain them in the present economic climate?

Many of these issues are ongoing and regular topics of discussion. The Department is planning several mini retreats to deal with curriculum (undergraduate and graduate) issues in the coming years. Main goals include revamping the graduate program to provide a faster pathway to the MA and MS degrees. The undergraduate degrees were recently evaluated and adjusted but additional changes (e.g. fewer electives, research requirement) can be considered. The Department Personnel Committee previously had presented a new RTP document to the Department, which was approved. However, the Dean required that more specific metrics be included, after which the document stalled. The Department recognizes the need for an updated and modern document and will continue the task this fall. Much progress has been made in assessment, however, the task continues, and better methods are being developed and implemented every semester. A major goal (as indicated above) is to look more carefully at graduation rates as well as details on graduate/professional school enrollments and employment (industry/government/etc.) Over the past several years, the moral in the department has improved dramatically. We have brought in energetic faculty, and better hiring practices and mentoring have avoided the pitfalls encountered previously. A Handbook for Faculty was developed and is updated every year (Appendix IV). The Department leadership has a major goal of achieving a friendly environment where faculty, staff and students can all be successful.

B. Changes in the Discipline and Department Response

1. Employment Prospects for Students

The chemical sciences are experiencing a period of high student demand nationwide. This can be attributed to a number of factors, including the increasing public awareness of global climate change and its impacts, a growing need for and understanding of pharmaceutical and medicinal chemistry, the increasing national and regional strain on water resources, ongoing and expanding environmental remediation efforts driven by both public demand and tighter regulation, and a continued strong interest in health-related professions. A recent employment outlook from the Bureau of Labor Statistics (US Department of Labor) predicts a healthy growth and replacement rate for the next decade (Appendix V).

The 2014 Comprehensive Salary and Employment Survey by the American Chemical Society (ACS) shows that unemployment numbers for chemists went down by almost 50% between 2011 and 2014. The workforce is dominated by jobs in industry (40%) and academia (39%). Salaries of full-time employed chemists depend on specific areas and are considered competitive and attractive (Appendix V).

A 2015 survey by Chemical & Engineering News (a weekly news magazine published by the American Chemical Society) reported salaries for graduates with different degrees who had full-time employment. The data showed strong salaries for graduates with Bachelor's degrees, especially in the Pacific region (Appendix V)

In a recent survey (December 2015), the College of NSM in collaboration with the CSUF Career Center polled alumni regarding employment history, with 58 responses from Chemistry and Biochemistry majors (Appendix V). Since graduating, 90% of the respondents indicated that they were employed in a chemistry/biochemistry related field or closely related field and 88% after obtaining their undergraduate degree; for graduate students this was 100% of respondents. More than 40% of respondents indicated an annual salary of over $100,000 with an undergraduate degree; for graduate degrees this was 50%. The majority of the graduates work in scientific research and development, pharmaceutical industry, higher education, as a healthcare practitioner. Graduate students tend to find employment in higher education or the pharmaceutical industry. In summary, the Department does a very good job preparing its graduates for jobs in different areas of the discipline and the overwhelming majority of our students get chemistry and biochemistry related jobs.

2. Preparation and recruitment of prospective students

As shown above, growth in the chemistry and biochemistry disciplines is strong and expected to continue into the next decade. Salaries are consistently competitive for most job sectors and the recent growth in the major (see Table 1-A, Appendix) is therefore not surprising. Together with the fact that the majority of our majors find well-paying jobs within the discipline, continued growth is expected to continue. Until now the Department has put little emphasis on recruitment of prospective students and simply depends on incoming students admitted by the University. With increasing entrance requirements at the University level, it seems that the quality of incoming majors is increasing accordingly. Traditionally, students in our major struggle with the first-year Math and Chemistry courses. Having to repeat these courses often increases the time to graduation. Data (Appendix VI) suggests that over the period of Fall 2008 – Fall 2016 an average of 19% of incoming Chemistry and Biochemistry majors enrolled in MATH 150A in their first semester at CSUF. Although this number is low, it is encouraging to see that the number has increased from below 10% (Fall 2008 – Fall 2011) to more than 30% (fall 2015 and 2016). Similarly, the number of incoming Chemistry and Biochemistry majors exempt from Math remediation has increased from 56% (Fall 2008) to 73% (Fall 2016). Also, over this same period there is a clear trend of more students who did remediation if needed. For example, in Fall 2008, 19 students (out of 72 incoming majors) failed to demonstrate entry-level competence in Math but only 1 student actually did remediation. In Fall 2016, 7 students (out of 117 incoming majors) failed to demonstrate competency but a total of 14 students chose to do remediation.

For incoming Chemistry and Biochemistry majors enrolling in CHEM 120A in their first semester, the numbers are surprisingly constant over that same period, although there were some fluctuations (Appendix VI). For example, in Fall 2008, 28% of incoming majors enrolled in CHEM 120A, which is slightly above the average (27%) for the entire period. However, Fall 2010 saw a very low number (8%) whereas Fall 2014 and 2015 saw higher than average numbers (52% and 46% respectively). It is clear that in order to improve graduation rates, a first step will be to have more of the incoming majors start in MATH 150A and 120A in their first semester.

Despite the very limited recruiting efforts, the Department has seen continued and robust growth of new majors since 2009. Applications and admittance of first-time freshmen (FTF) and upper-division transfer (UDT) students has grown steadily in the past 5 years and are very strong (Appendix I - Tables 1A and 1B). Due to impaction and higher entrance standards, the percentage of admitted students has gone down for both FTF and UDT students in that same timeframe. Interestingly, the numbers for enrolled FTF and UDT students in the past 5 years have also declined somewhat. Although the exact reasons are unclear, it is possible that better awareness of rigorous standards and preparation for the degree have something to do with this. Alternatively, it is likely that the numbers are affected by students changing their major. Data for the period of 2008-2016 show that as many as 50% of incoming majors eventually change their major (Appendix VII; see discussion further below). It would be easy to assume that the majority of these students had come in thinking of becoming health providers but not being prepared for the challenging subject matter, however, there is no clear trend to support that idea (although a significant number of students change their major from Chemistry or Biochemistry to Health Science). These numbers suggest that even though enrollments are healthy, a more targeted approach through outreach will likely have a positive impact on the Department and possibly help students choose the correct major early on.

3. Changes in the discipline

Many of the innovative changes that have occurred in the past 50 years have in large part been due to IT. Although changes will continue to happen, most of these innovations are expected to be over. However, the next area where great innovations are expected to be made is chemistry and advances in chemistry and biochemistry will be needed for the next generation of advances. Examples of areas where innovation is needed include fuel cells (batteries), Fischer-Tropsch technology (to turn natural gas into liquid), C—H bond activation (requires the development of specific and selective catalysts) and DNA computing (dependent on advances in biochemistry).[1] Chemistry is traditionally divided into several basic areas (analytical, inorganic, organic, physical, and biochemistry) but many advances occur through interdisciplinary collaborations. The need for teaching the fundamental areas of chemistry will remain but faculty hiring should have a more explicit focus on interdisciplinary research areas that will allow us to better prepare our graduates for the challenges of the near future. The Department of Chemistry and Biochemistry has made good progress and recent hires have brought a variety of multidisciplinary areas to campus, including biomedical and materials science, which has already lead to increased collaborative projects. In addition, chemical education faculty collaborate extensively with all other faculty in the different disciplines, often to provide a form of assessment to the project but also to better understand how our students learn, both in the classroom and in the research laboratory. Expanding our chemical education caucus is therefore considered one of the top priorities. Funding from external agencies also often requires an interdisciplinary approach and therefore the Department will continue its hiring plan to identify and hire individuals who meet these expectations. These hires will ensure that the Department remains relevant as the field continues to evolve. For the Department to be successful and have its new faculty be successful, it is essential that along with new faculty appointments there also are additional staff appointments. The Department recently underwent a successful evaluation by the American Chemical Society and earned approval for its program (see Appendix VIII for letter), however, the committee made the following suggestions for the continued development of the chemistry program:

Support staff. According to Item 3.5b of the periodic report, budget cuts and hiring freezes have prevented the department from hiring new staff to perform stockroom management and instrument maintenance. The department has previously addressed this issue by employing students to complete these duties. The Committee encourages you to work with the administration and identify a mechanism to fund more permanent staff positions to ensure that instruments are properly maintained and faculty are relieved of these responsibilities.

The Department will continue to respond to the changes and trends in the discipline. Together with the need for improved graduation rates and student success, our focus will be on:

a) Re-evaluating the need for a mandatory research project for all majors;
b) Developing integrated laboratory experiences for undergraduate students to expose them to modern interdisciplinary research projects and remove capstone bottlenecks;
c) Developing a pre-professional degree pathway for students interested in pursuing medical, dental, pharmacy careers;
d) Re-assessment of the American Chemical Society guidelines for certified degrees in chemistry and biochemistry.

C. Priorities for the future.

The Department recently set a number of goals as well as strategies and measurements/benchmarks. The goals were set up to align with the College and University goals and were identified as either priority 1 (focus on year 1-2), priority 2 (focus on year 2-5) and priority 3 (focus on 2025). The goals will be reviewed annually and adjusted as necessary. Specific attention is given to student success and issues the Department plans to focus on specifically (through a series of Departmental retreats) are:

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[1] http://observer.com/2016/03/the-most-promising-disruptive-innovations-for-the-decade-2011-2020/

a) Student preparation
   - Improving the quality of incoming students in terms of math and chemistry skills;

b) Undergraduate research and alternatives as a High Impact Practice
   - Increasing graduation rates while maintaining the undergraduate research requirement;

c) Infrastructure and Personnel
   - Improving the current infrastructure (lab space, office space, classrooms, equipment, etc.) to attract and hire talented educators and increase graduation rates. These improvements must be accompanied by the appointment of additional technical staff.

The Department's goals and priorities are identified below. The strategies and outcomes for the general goals are described in Appendix VI. Details of the priorities for each goal, along with metrics of accomplishment are in section VII.

Goal 1. Improve Student Success.

1. *Develop and use advising surveys and exit interviews to improve programs and track student career choices (priority 1).*
2. *Allow for completion of capstone experience in summer (priority 1).*
3. *Continue to develop partnerships with industry to leverage research opportunities and career pathways for our students (priority 1).*
4. *Develop a pathway for professional school careers to promote faster time to graduation (priority 1).*
5. *Shorten time to degree by pinpointing bottlenecks in degree programs (priority 2).*
6. *Create ways to better screen, inform and prepare incoming FTF (priority 2).*
7. *Recruit high quality faculty dedicated to working with and mentoring our students in the classroom and the research laboratory (priority 2).*
8. *Improve the time to degree for MA and MS students (priority 2).*
9. *Give release time to faculty with significant advising workloads. Develop a College-based Advising Center where specific advisors from each department have office hours (priority 3).*
10. *Make more effective use of existing space by increasing shared and flexible lecture and lab spaces to better serve students and faculty (priority 3).*
11. *Work towards a Research-Based Curriculum (integration of teaching-research) - enhance integration of teaching and research in lab courses and other activities to provide meaningful exposure for freshman and sophomores (priority 3).*

Goal 2. Support Student-Faculty Research

1. *Continue providing support for faculty with active research programs and student involvement from OE (priority 1).*
2. *Promote early entrance into research labs for interested students (priority 1).*
3. *Formalize more internships and research opportunities for our students in local industry and other university partners--including Western, KGI, and Marshall B Ketchum U, etc. (priority 1).*
4. *Develop integrated lab courses to expand capstone experience opportunities and support faculty research activities (priority 2).*
5. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, collaborations, and career pathways for our students (priority 2).*
6. *Integration of teaching and research – involve faculty research projects in lab classes (priority 3).*
7. *Look for alternative methods to provide funds for new equipment used in teaching and research (priority 3).*
8. *Increase number of graduate students for MS and MA programs (priority 3).*

<u>Goal 3. Actively Support External Fundraising</u>

1. *Encourage and support faculty to write grants, travel to relevant meetings and high quality sabbatical requests (priority 1).*
2. *Promote opportunities for junior faculty in first two years to participate in grant writing workshops offered by CUR (priority 1).*
3. *Continue to hold alumni events to friend raise and fundraise (priority 1).*
4. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, and collaborations (priority 2).*
5. *Expand Department publicity (social media, pictures, stories, etc.) (priority 2).*
6. *Hire full-time lecturers or tenure-track teaching faculty to provide more time for research activities for research active faculty through integrated science courses (priority 3).*

D. Special session and self-support courses.

The Department offers up to thirteen course sections in self-support summer sessions. These courses often are GE courses (CHEM100, 100L, 102, 120A) and are mostly in-person. We recently started offering online sections of CHEM100 and 100L during the summer session; both have proven to be popular with students. Other recent additions to our summer offerings include CHEM 316 (a bottleneck course) and CHEM 421. Demand for these two courses is expected to remain high. Although the Department hasn't offered intersession courses, it is something we will be looking into in the coming years as it may provide an opportunity for students to stay on track towards graduation. However, most of our courses are not appropriate for timeframes that are shorter than 5 weeks; a longer intersession would be beneficial to achieve this goal. Other future developments for summer session include offering courses that can be used to meet the capstone research requirement for the degrees. Examples include CHEM 495 (senior research) and integrated laboratory courses where an intensive research experience will be beneficial for students. In addition, it will allow students with little time to commit to these experiences during the regular semester (often a multi-semester commitment) and complete it within an 8-10 week period promoting faster graduation rates. We plan to work with UEE to allow more affordable fees as well as to receive funding to support the faculty offering these courses by providing funds for supplies.

<u>II. Department Description and Analysis</u>

A. Curricular Changes

Since the last PPR in 2009, we have added two new courses to our undergraduate curriculum:

- CHEM 410 Computational Chemistry
- CHEM 429 Medicinal Chemistry

These courses are upper-division elective courses for either the B.A. or B.S. degrees. These can be part of the 9-unit (max) 400-level course collection for graduate study plans. The new courses were developed to complement faculty strengths in those subject fields and fill high-profile holes in our elective curriculum. CHEM 410 was a replacement of the previously established four 1-unit courses (CHEM 410A-D). Due to changes in the field and the degree requirements, those 1-unit courses no longer made sense and were replace with a 3 unit course that combined many of the topics previously taught in 410A-D. CHEM 429 is a first step towards establishing a Center for Medicinal Chemistry in our College (potentially together with the existing Center for Applied Biotechnology Studies). Additional courses that will eventually be part of this "emphasis" include Bioorganic Chemistry and Medicinal Chemistry Laboratory (course proposals were submitted). The latter will be an example of an integrated laboratory course (modeled after CHEM 472B) that can be used by students as a capstone.

In addition, one of our faculty members proposed a course CHEM 492 – Sustainability in collaboration with the Environmental Studies program (the course is also offered as ENST 492). This course introduces students to a variety of sustainability issues and students work in group format on different projects throughout the semester and present the outcomes of their studies. The course exposes students not only to sustainability issues but also to a variety of interdisciplinary concepts and requires our students to work closely together with students from other (often non-science) disciplines. The course has grown in popularity in recent semesters and is also allowed as a capstone experience for Chemistry and Biochemistry majors.

We retired several courses that were no longer offered due to the fact that they were specialty courses taught by experts that are no longer in the Department. In addition to the previously mentioned CHEM 410A-D courses, also retired were 340 (Writing for the Chemical Sciences), 411E (Radiochemistry – 1 unit), 437 (Environmental Water Chemistry), 477 (Advances in Biotechnology), and 539 (Chemistry of Natural Products). CHEM 340 was never successful and few faculty were interested in teaching the course. In addition, some professional schools would not recognize it as an upper division writing courses. Currently students can take ENGL 301, 360 or 363 to meet the upper division writing requirement. CHEM 411E was not taught for many years and the person who had taught it took a different position within the University and could no longer teach the course. This course was one of several 1-unit instrumentation courses, however, a new course (CHEM 411D – Electrochemistry) was added to make up for the retired course, giving students the same number of options. CHEM 411A,B,C,D,G can be used as electives by Chemistry and Biochemistry majors (see also below in changes to degree programs). CHEM 437 was also taught by a single faculty member who retired in 2001. Due to the lack of expertise in this area the course was retired. CHEM 477 was a required course for Biochemistry majors for a short period of time. The content of the course changed dramatically within a few years and instead of a lecture course it became more of a seminar format that, although interesting and useful, did not meet the standards of the curriculum. This course was replaced by an elective course in the B.S. Biochemistry degree program, giving students greater flexibility. CHEM 539 was a course taught by only a single faculty member who retired in 2002. The course was unique and intended for a specialized audience. To broaden the appeal of this course it is currently being reconfigured into a 400-level course (Bioorganic Chemistry) targeted at both chemistry and biochemistry majors as well as biology majors. An initial offering of the course was successful and a course proposal is currently going through Curriculog.

The unit load for CHEM 316 was increased from 1 to 2 by adding a 1 hour lecture component to the lab course. Previously, both the pre-lab lecture and the actual lab component had to be completed in 3 hours, which often led to students not finishing experiments and instructors trying to rush students, all of which diminish the learning experience in this very instrumental laboratory course (taken by all Chemistry and Biochemistry majors). Adding an additional unit to allow for a better lecture experience also aligns the course better with similar courses at other institutions. The increase in units did not result in more units needed for the degree as a unit was removed from elective courses or by removal of a previously retired 1-unit course (CHEM 210) from the degree programs.

In Fall 2016, we submitted changes for the B.A. in Chemistry, which were approved in Spring 2017. Instead of requiring students to take 3 CHEM 411 courses (chosen from 411A, B, C, D, or G), the new program requires 3 elective unit (upper division CHEM). The CHEM 411 courses are very popular and give students an outstanding training in the use of modern analytical instrumentation, however, these courses only have limited seating capacity due to their hands-on nature. This created a small bottleneck and by allowing 3 units of electives, it gives students more flexibility. Other minor changes included the removal of courses that were no longer offered (e.g. CHEM 210, 410A-D) as well as removal of ENGL 301 or CHEM 340 as part of the CHEM core courses. The unit load for the capstone requirement was increased from 2 to 3 units. Overall, these changes did not change the number of units for the degree.

In Summer 2017, changes were submitted for the B.S. Chemistry and B.S. Biochemistry degrees. Both were approved in the Fall of 2017. For the B.S. Biochemistry degree, a few minor changes were submitted. As a result of the change in courses offered by the Department of Biological Science, the supporting courses changed from

BIOL 171 and 273 to BIOL 151 and BIOL 251. This also caused a change in units (from 10 to 7), which is easily compensated because most students choosing this degree take a number of supplemental courses to prepare themselves for either professional or graduate school. An additional change was the removal of courses that no longer existed (CHEM 210, 340, 410A-D, and 477) and the addition of several elective courses (MATH 338, BIOL 303, HESC 401). The upper division writing requirement was removed from the degree requirements section; students can now choose from ENGL 301, 360 or 363 to meet the University requirement. Overall, these changes did not change the number of units for the degree.

Changes for the B.S. Chemistry degree included the removal of courses that no longer exist (CHEM 210, 410A-D, 340), changing courses from “required” to “elective” (CHEM 411A-G, MATH 338), and removing the upper division writing requirement from the degree requirements section; students can now choose from ENGL 301, 360 or 363 to meet the University requirement. The Upper Division Elective and Career Breadth sections were simplified to “Upper Division Electives” (9 units); students can now choose from a variety of courses from different Departments to meet the requirement, allowing more flexibility and an easier path towards graduation. Overall, these changes did not change the number of units for the degree.

In the Fall of 2015 and 2016, all CHEM courses in the B.1, B.3 and B.5 categories of General Education were evaluated and adjusted as necessary in order to remain certified. All courses in these categories (CHEM 100, 100L, 102, 105, 111, 120A, 303ABC, and 313ABC) were approved and recertified.

B. Structure of Degree Programs

Undergraduate Program

Our undergraduate program has three majors: (1) B.A. in Chemistry, (2) B.S. in Chemistry and (3) B.S. in Biochemistry along with a Minor in Chemistry. The B.A. in Chemistry is a contemporary curriculum, reflecting the interdisciplinary nature and diversity of the chemical sciences and providing a hands-on approach where students learn by doing. Special emphasis is placed on an authentic research experience, preparing our students for scientific careers, science education, graduate studies, or professional programs. The B.S. in Chemistry is a rigorous, contemporary, and calculus-based curriculum enabling students to become successful professionals, scholars, scientifically literate citizens and leaders. The hands-on curriculum provides an authentic research experience, preparing our students for scientific careers, graduate studies, or professional programs. This degree is approved by the American Chemical Society and ideal for students who desire an advanced degree (M.S., Ph.D.) in chemistry. The B.S. in Biochemistry is an interdisciplinary curriculum that provides a hands-on approach through a variety of laboratory courses. Special emphasis is placed on the importance of chemistry in biological science and the degree is capped by an authentic research experience. The similarities in chemistry core and electives courses for the three majors are shown in Table 1 below. Because of the significant overlap between the three degree programs, the SLO’s for each are the same.

TABLE 1 – General chemistry course comparison B.A. in Chemistry, B.S. Chemistry and B.S. in Biochemistry.

	BA CHEM		BS CHEM		BS BCHM	
Course	Required	Elective[1]	Required	Elective[2]	Required	Elective[3]
120A (5)	X		X		X	
120B (5)	X		X		X	
301A (3)	X		X		X	
301B (3)	X		X		X	
302 (2)					X	
306A (2)	X		X			
306B (2)	X		X			
315 (3)	X		X		X	
316 (2)	X		X		X	
325 (3)	X		X			
355 (3)			X			
361A (3)	X				X	
361B (3)	X				X	
371A (3)			X			
371B (3)			X			
410 (3)		X		X		X
411A (1)		X		X		X
411B (1)		X		X		X
411C (1)		X		X		X
411D (1)		X		X		X
411G (1)		X		X		X
421 (3)	X[1]			X		
422 (2)				X	X	
423A (3)	X[1]			X	X	
423B (3)				X	X	
425 (3)		X		X		X
429 (3)		X		X		X
431 (3)		X		X		X
435 (3)		X		X		X
436 (3)		X		X		X
438 (3)		X		X		X
445 (3)		X		X		X
472A (3)						X
472B (3)						X
473 (3)						X
480T (3)		X		X		X
Capstone[4] (3)	X		X		X	

[1] BA CHEM degree requires 3 elective units as well as CHEM 421 or 423A; [2] BS CHEM degree requires 9 units of electives (non-CHEM options are available as well); [3] BS BCHM degree requires 6 units of electives (non-CHEM options are available as well); [4] Capstone normally met by CHEM 495; other options include 472B, 490, 492, or 499.

B.A. in Chemistry: The B.A. in Chemistry is a rigorous and contemporary curriculum that is responsive to future developments, reflecting the interdisciplinary nature and diversity of the chemical sciences, thus enabling students to become successful professionals, scholars, scientifically literate citizens and leaders. The curriculum provides a hands-on approach where students learn by doing, preparing them for scientific careers, science education, graduate studies, or professional programs. This degree is designed to provide chemistry-educated professionals (policy makers/politicians, business leaders, lawyers, and journalists) that will need to understand the importance of chemistry in a variety of globally important fields such as resources, pollution, and other environmental issues. In addition, this degree will be pursued by students interested in pursuing careers in industry or teaching. Thus, the curriculum is a traditional chemistry curriculum with a significant laboratory component (Appendix IX). The degree requires a total of 120 units, of which 44 are chemistry core or elective courses and 16 are related courses (Math and Physics). The core chemistry courses cover the spectrum of fundamental chemistry topics including one semester (minimum) of biological chemistry or biochemistry. The degree is less Math-focused and the physical chemistry and Physics courses are algebra-based rather than calculus-based. Due to changes in the curriculum, including unit changes in some courses, the B.A. Chemistry degree now offers an elective course, which is something the Department had intended to do for quite some time. The removal of the requirement for B.A. Chemistry students to take three CHEM 411 courses (replaced with the 3-unit elective) also helped remove a significant bottleneck (there is very limited seating in all of the specialized 411 courses). These electives provide breadth in the chemistry curriculum and selection of courses depends on the interests and career goals of the student.

All B.A. Chemistry majors complete a 3 unit capstone research course experience where majors work one-on-one with a faculty adviser to do original research. This requirement can be taken as three 1-unit courses over a three-semester time span and is typically met by completing a research project in a research lab (CHEM 495) that results in a poster presentation and written report in the style of an ACS journal. Discussion within the Department on whether these students benefit from the research experience have led to the introduction of other ways to meet the capstone experience. Students now can also choose to do library research (CHEM 499), a project in sustainability (CHEM 492), or an internship (CHEM 490). These additional options give students greater flexibility in meeting the capstone requirement and provides them with options that are more geared towards their career plans as well as shorter graduation times. In future years we will continue to discuss additional options for B.A. Chemistry majors and consider adding integrated laboratory courses as a capstone experience.

For related fields science courses, students are required to take at least 16 units, with two semesters each of college level calculus (MATH 150A and 150B) and physics with lab (PHYS 211/L and 212/L). Students are also advised to take a semester of statistics (MATH 338 – upper division GE) although it is not a requirement for the degree.

Students can qualify for the Emphasis in Environmental Chemistry by taking 13 – 16 additional units. Although these additional courses provide a useful background for students interested in careers related to environmental issues (industry, government, etc.), the emphasis has not generated much interest in recent years. All courses are offered regularly, however, some are considered bottleneck courses (CHEM 411A/C/G) whereas others are on a 2-year rotation, which may be a limiting factor for many students. The Department will have to review the Emphasis and make changes accordingly.

Students may combine a B.A. in chemistry with a minor in Business Administration to qualify to enroll in and complete an MBA degree at CSUF in one additional year (33 units), provided all entrance requirements for the MBA program have been met. Theoretically, this program would be expected to be popular with students anticipating to pursue administrative careers in industry, however, there is no evidence of any students taking advantage of this pathway in recent years. A lack of information and support for this pathway are the most likely reasons for why it is not used more often. The Department should review the option, clarify the requirements, and promote it to students during mandatory advising sessions.

The Student Learning Outcomes (SLOs) for the B.A. in Chemistry are given below and the SLOs are mapped onto the curriculum in Table 2. The SLOs are introduced (I) in beginning courses, developed (D) in most of the core and elective courses and practiced at a high level (mastered; M) in at least one course. It is important to note that M level is obtained for all SLOs in the capstone undergraduate research (CHEM 495); hence, we use this undergraduate capstone course as the assessment vehicle for assessing our B.A. in Chemistry program.

Concepts

- Recognize that all matter is composed of atoms whose inherent periodic properties determine their interactions and combinations into compounds with specific molecular structure, chemical function and physical properties. (Atoms)
- Explain the various ways that chemists represent and test chemical knowledge in models, theories, mathematical relationships and symbolic notations. (Reps)
- Illustrate the principles of safe practices and ethical use of scientific knowledge, materials and procedures, and explain their impact on a diverse society. (Ethics)
- Demonstrate literacy in concepts underlying fundamental analytical instrumentation and instrumentation techniques used in chemistry and biochemistry. (Instrm)
- Discriminate between equilibrium and nonequilibrium systems using fundamental thermodynamic laws and kinetics. (EqNeq)

Skills and Processes

- Demonstrate the ability to generate and collect data and information through designing and safely implementing hypothesis-driven experiments using contemporary methods and techniques. (Hyp)
- Analyze, interpret, and retrieve data and appropriate literature, to develop critical thinking and problem solving skills. (SciKnl)
- Work effectively, independently and cooperatively to communicate data, concepts, skills and processes to experts and nonexperts in the field. (Comm)

<u>*B.S. in Chemistry*</u>: The Bachelor of Science in Chemistry is designed to be a rigorous, contemporary, and calculus-based curriculum that is responsive to future developments, reflecting the interdisciplinary nature and diversity of the chemical sciences, thus enabling students to become successful professionals, scholars, scientifically literate citizens and leaders. The curriculum provides a hands-on approach where students learn by doing. Special emphasis is placed on an authentic research experience, preparing our students for scientific careers, graduate studies, or professional programs. This degree is approved by the American Chemical Society (certain courses must be taken) and ideal for students who desire an advanced degree (M.S., Ph.D.) in chemistry. It also provides excellent preparation for those individuals in pre-professional programs (e.g., medicine, dentistry, forensic science, business administration, or law) or those interested in teaching careers. The degree requires a total of 120 units, of which 50 are chemistry core (41) or elective (9) courses and 25 are related (Math and Physics) courses (Appendix IX). The core chemistry courses cover the spectrum of fundamental chemistry topics including one semester of physical chemistry laboratory. Biological chemistry or biochemistry can be chosen as elective courses for an ACS-approved degree (together with Advanced Inorganic Chemistry (CHEM 425) and 3 units of instrumentation (411) courses). The calculus-based degree requires 4 semesters of Math as well as the calculus-based physical chemistry and Physics courses. A recent change in the curriculum has cleared up some issue with the degree, including the removal of courses that are no longer offered. In addition, the Upper Division Writing requirement was removed from the list degree courses and the number of electives was changed from 12 units to 9 units. In addition, the Department has approved a larger variety of Upper Division (UD) courses that can be used to meet the UD elective requirement, including courses from other departments

(BIOL, CRJU, EDSC, EGCE, EGME, GEOG, GEOL, MATH, and PHYS). Students are allowed to use certain courses taken for the minor in MATH, PHYS, or CRJU as UD electives, helping them graduate faster. These electives provide breadth in the chemistry curriculum and selection of courses depends on the interests and career goals of the student.

For related fields science courses, students are required to take at least 25 units, with four semesters of college level calculus (MATH 150A, 150B, 250A, and 250B) and two semesters of calculus-based physics with lab (PHYS 225/L and 226/L) as well as 1 unit (Optics) of the third semester (PHYS 227). Students are often advised to take a semester of statistics (MATH338 – upper division GE) although it is not a requirement for the degree (it counts as an upper division elective as well as upper division GE).

All B.S. Chemistry majors complete a 3 unit capstone research course experience where majors work one-on-one with a faculty adviser to do original research. This requirement can be taken as three 1-unit courses over a three-semester time span and is typically met by completing a research project in a research lab (CHEM 495) that results in a poster presentation and written report in the style of an ACS journal. Many B.S. Chemistry students are interested in careers involving a research component and therefore often start earlier with research activities (CHEM 295 or 395). Students can also choose to do library research (CHEM 499), a project in sustainability (CHEM 492), or an internship (CHEM 490) in place of the research experience, however, traditionally most B.S. Chemistry students take CHEM 495 as their capstone. These additional options do give students greater flexibility in meeting the capstone requirement and provides them with options that are sometimes more geared towards their career plans as well as shorter graduation times. In future years we will consider adding integrated laboratory courses as a capstone experience for B.S. Chemistry majors as well.

Similar to the B.A. Chemistry majors, B.S. Chemistry majors can qualify for the Emphasis in Environmental Chemistry by taking 13 – 16 additional units. Because many of these units can also be used as electives for the B.S. Chemistry degree, the actual unit count is usual lower.

The B.S. Chemistry degree is approved by the American Chemical Society (ACS) and in order for a student to earn this distinction, they need to take at least one semester of biochemistry (CHEM 421 or 423A) as well as advanced inorganic chemistry (CHEM 425) and three units of instrumental analysis courses (CHEM 411A-G). Very few students have taken this option, which may be due to poor advertising, limited space in CHEM 411, limited offering of CHEM 425 (once every two years), or a general unclarity of the benefits of the ACS certified degree.

The Student Learning Outcomes (SLOs) for the B.S. in Chemistry are given above and the SLOs are mapped onto the curriculum in Table 2. The SLOs are introduced (I) in beginning courses, developed (D) in most of the core and elective courses and practiced at a high level (mastered; M) in at least one course. It is important to note that M level is obtained for all SLOs in the capstone undergraduate research (CHEM 495); hence, we use this undergraduate capstone course as the assessment vehicle for assessing our B.S. in Chemistry program.

B.S. in Biochemistry: The B.S. in Biochemistry is a rigorous and contemporary curriculum that is responsive to future developments, reflecting the interdisciplinary nature and diversity of the chemical sciences, thus enabling students to become successful professionals, scholars, scientifically literate citizens and leaders. The curriculum provides a hands-on approach where students learn by doing. Special emphasis is placed on the importance of chemistry in biological science and the degree is capped by an authentic research experience, preparing our students for scientific careers, graduate studies, or professional programs. Students preparing for health-related fields (e.g., medicine, dentistry, veterinary medicine) or those who desire an advanced degree (M.S., Ph.D.) in biochemistry, biology, or the health sciences receive excellent preparation from this degree program. The degree requires a total of 120 units, of which 47 are chemistry core or elective courses and 23 are related (Biology, Math and Physics) courses (Appendix IX). The core chemistry courses cover the spectrum of fundamental chemistry topics (general, organic, analytical, and physical) as well as a two-semester of biochemistry with laboratory. The degree is less Math-focused and the physical chemistry and Physics courses are algebra-based rather than calculus-based. Due to changes in the curriculum, including the removal of courses that no longer exist and unit changes in some courses, the B.S. Biochemistry degree now requires 6 units of electives. Students can choose from several CHEM, BIOL, MATH and HESC courses, some of which are useful (required) for students pursuing acceptance to professional schools. These electives provide breadth in the chemistry curriculum and selection of courses depends on the interests and career goals of the student.

All B.S. Biochemistry majors complete a 3 unit capstone research course experience where majors work one-on-one with a faculty adviser to do original research. This requirement can be taken as three 1-unit courses over a three-semester time span and is typically met by completing a research project in a research lab (CHEM 495) that results in a poster presentation and written report in the style of an ACS journal. Discussion within the Department on whether these students benefit from the research experience have led to the introduction of other ways to meet the capstone experience. Similar to our B.A. Chemistry and B.S Chemistry majors, B.S. Biochemistry majors can also choose to do library research (CHEM 499), a project in sustainability (CHEM 492), or an internship (CHEM 490). An additional option for biochemistry majors is the use of CHEM 472B as the capstone requirement. This course is a research-intensive experience with both lecture and lab components. The lab component is less structured than a regular lab course and the overall experience gives the students an outstanding research experience that is related to the research interests of the faculty member teaching the course. Students participating in this particular experience also write a formal lab report (thesis) and present a poster to the Department. These additional options give students greater flexibility in meeting the capstone requirement and provides them with options that are more geared towards their career plans as well as shorter graduation times. In future years we will continue to discuss additional options for B.S. Biochemistry majors and consider adding integrated laboratory courses as a capstone experience.

For related fields science courses, students are required to take at least 24 units, with two semesters of college biology (BIOL 151 and 251) as well as two semesters each of college level calculus (MATH 150A and 150B) and physics with lab (PHYS 211/L and 212/L). Students are also advised to take a semester of statistics (MATH 338 – upper division GE) although it is not a requirement for the degree.

Students can qualify for the Emphasis in Biotechnology by taking 12 additional units. These additional courses provide a useful background for students interested in careers related to biotechnology (industry, government, etc.), but some of the courses have one or more pre-requisites, which results in an increased workload. Very few students have expressed an interest and the Department will have to review the Emphasis and make changes accordingly in collaboration with the Department of Biological Science.

The Student Learning Outcomes (SLOs) for the B.S. in Biochemistry are given above and the SLOs are mapped onto the curriculum in Table 2. The SLOs are introduced (I) in beginning courses, developed (D) in most of the core and elective courses and practiced at a high level (mastered; M) in at least one course. It is important to note that M level is obtained for all SLOs in the capstone undergraduate research (CHEM 495); hence, we use this undergraduate capstone course as the assessment vehicle for assessing our B.S. in Biochemistry program.

Minor in Chemistry: The Chemistry minor is appropriate for students majoring in Biological Science, Geological Science, Physics, or Science Education. It is also appropriate for students who have interest in Art Restoration, Environmental Science, Forensic Science, Business Administration, Medical Technology, Patent or Environmental Law, or Science Writing. A minor in Chemistry requires a minimum of 24 acceptable units of chemistry, including General Chemistry (CHEM 120A,B), Organic Chemistry (CHEM 301A,B), Quantitative Chemistry (CHEM 315) plus 11 units of additional upper-division chemistry courses. Each course must be completed with a grade of “C” or better. Prospective minors should make an appointment with the Department undergraduate adviser in order to select courses that most closely match their educational goals.

TABLE 2. Chemistry Curriculum Map.

Course	C1 Atoms	C2 Reps	C3 Ethics	C4 Instrm	C5 EqNeq	SP1 Hyp	SP2 SciKnl
120AB	I,D	I,D	I	I	I	I	I
190			D				
301AB	I,D,M	I,D	I	I,D	I	I	
302/306AB	I,D	I,D	I,D	I,D		I	I,D
315	D	D,M	D	D			I,D
316			I,D	D,M		D	D
325	D,M	D,M			I,D		D
361AB		D,M			D,M		
371AB		D,M			D,M		
355	D	D,M	D	D,M		D,M	D,M
410	D	D,M		D		D	D
411A-G			M	D,M		D,M	
421	I,D,M	D,M			D,M		
422			I,D	D		D	
423AB	I,D,M	D,M			D,M		D,M
490/495/499			D,M	D,M		D,M	D,M
Biochem Electives 445/472B/473	D,M	D,M	D,M			D,M (472B)	D,M
Org/InorgElectives 425/429/431/435	D,M	D,M	D,M (435)				D,M
Anl/Envr Elective 436/438	D,M	D,M	D,M	D,M			D,M

Graduate Program

We offer a Master of Science in Chemistry, as well as a Master of Arts in Chemistry, which began in Fall 2010. The MS degree is a research-based degree where students spend a major part of their time in a research laboratory working on an independent research project. They will carry out sophisticated experiments and gain valuable critical thinking skills by analyzing their data and planning the next steps in their project. The degree culminates in a written thesis and a public oral defense of the thesis. The skills students learn in our program will prepare them very well for a career in teaching, industry or graduate school. The MA degree is primarily a course work-based degree, which means that during the degree program students spend a major part of their time taking advanced level classes. In addition, they will analyze literature in their selected area and work on a project that will provide a venue for bolstering their critical thinking skills by analyzing literature data and, if appropriate, proposing the next steps in a research project. The degree culminates in a written proposal and a public oral defense of the proposal. The skills learned in this program prepare students well for a career in teaching, industry or health professions.

The M.S. degree requires 30 units of which 21 must be at graduate level (500 level). All students take the Seminar in Chemistry (CHEM 505A,B – 2 units) courses, Thesis (CHEM 598 – 2-4 units), Independent Graduate Research (CHEM 599 – 3-6 units), as well as Core (9 units) and Elective (9-12 units) courses. Core courses are taken in an area of specialization (Analytical, Biochemistry, Inorganic, Organic, or Physical). Students must take 9-12 elective chemistry and/or related fields courses, which are approved on the required study plans. A public, oral defense of the thesis is required. The Student Learning Outcomes (SLOs) for the M.S. in Chemistry are given below. All of the SLOs are practiced at a high level, as evidenced by students:

- Completing advanced courses within their discipline;
- Attending and interacting in research seminars at CSUF and other local institutions and societies;
- Presenting research at regional and international professional conferences;
- Conducting independent research that includes:
  a) writing of a research proposal;
  b) production of a written thesis that describes the problem, methodology, and results of the student's research;
  c) dissemination of the results through publication in peer-reviewed journals and/or presentations at regional and/or international conferences;
  d) a public oral defense of the thesis.

The aim of the Master of Science (MS) Program in the Department of Chemistry and Biochemistry is to provide a dynamic learning environment in which graduate students can:

- Develop the skills, experiences and mastery required to enter and succeed in diverse careers in the chemical or biochemical sciences or academic and professional programs;
- Investigate and solve a problem with good scholarship and modern research approaches that lead to new knowledge in chemistry and biochemistry;
- Become ethical professionals able to (i) perform scientific and computational literature searches, and (ii) understand and communicate the role of chemistry, biochemistry, and research in their professional practice.

The following goals and learning outcomes have been established for students pursuing a M.S. degree in chemistry:

Concepts

1. Demonstrate in-depth knowledge and an understanding of scientific questions in a primary area of expertise in the chemical and biochemical sciences and place the thesis research in the context of the current state of knowledge of the field. (C1)
2. Appropriately employ models, theories, mathematical relationships and symbolic notations that are used to represent and test knowledge in the chemical and biochemical sciences. (C2)
3. Demonstrate an awareness of the diversity and interdisciplinary nature of the chemical and biochemical sciences and a competent understanding of the fundamental principles in related disciplinary fields through participation in coursework, seminars and group meetings. (C3)
4. Employ the principles of safe practices and ethical use of scientific knowledge, materials and procedures. (C4)
5. Demonstrate mastery of fundamental and advanced instrumentation and techniques used in his/her disciplinary field of chemistry and biochemistry. (C5)

Skills and Processes

1. Analyze, interpret, and retrieve data from the primary and review literature, to develop critical thinking and problem solving skills for raising and addressing scientific question(s). (SP1)
2. Demonstrate the ability to generate and collect data and information through designing and safely testing original hypothesis using contemporary methods and techniques. (SP2)
3. Work independently and cooperatively on an original research project to collect, interpret, analyze, organize, and present high quality data for an original thesis. (SP3)
4. Effectively communicate ideas, concepts, results and conclusions from the original research project in a written thesis, oral defense and poster presentations. (SP4)

The M.A. degree requires 30 units of which 21 must be at graduate level (500 level). All students take the Seminar in Chemistry (CHEM 505A,B – 2 units) courses, Original Research Proposal Project (CHEM 597 – 3 units), as well as 400- or 500-level laboratory courses (4 units) and Elective (21 units) lecture courses, at least fifteen units of which must be lecture courses at the 500 level. Although courses from the Chemistry and Biochemistry department are preferred, a student may also use coursework from other Departments (e.g., Biological Science, Physics, Science Education, Business, etc.) if it can be demonstrated that these courses are useful for the student's career. The use of such coursework on the MA study plan is limited to 9 units and must be approved by the Project Advisor and the Graduate Program Advisor. The degree's culminating experience, CHEM 597, is a "significant undertaking appropriate to the field" in all areas of chemistry. As part of this culminating experience students will demonstrate the ability to conduct independent literature research, collect, analyze, and interpret information using contemporary methods, and communicate results of research using oral and written formats to experts and non-experts in the field. The written project will be defended orally.

The Student Learning Outcomes (SLOs) for the M.A. in Chemistry are given below. Although similar to those for the M.S. degree, the original research project refers to a project that involves an extensive review of the literature or an original research proposal rather than laboratory-based research. Students graduating with the MA degree in Chemistry are expected to demonstrate an awareness of the dynamic nature of scientific knowledge, have an awareness of the broader impact of research and practice in the chemical sciences and pursue career objectives that make use of the graduate degree.

The aim of the Master of Arts (MA) Program in the Department of Chemistry and Biochemistry is to provide a dynamic learning environment in which graduate students can:

- Develop the skills, experiences and mastery required to enter and succeed in diverse careers in the chemical or biochemical sciences or academic and professional programs;
- Demonstrate literacy in concepts underlying fundamental and advanced analytical instrumentation and instrumentation techniques used in chemistry and biochemistry.
- Demonstrate mastery of key elements of research and study design and apply them to an independent research project.

The following goals and learning outcomes have been established for students pursuing a M.A. degree in chemistry:

Concepts

1. Demonstrate in-depth knowledge and an understanding of scientific questions in a primary area of expertise in the chemical and biochemical sciences and place the thesis research in the context of the current state of knowledge of the field. (C1)
2. Appropriately employ models, theories, mathematical relationships and symbolic notations that are used to represent and test knowledge in the chemical and biochemical sciences. (C2)
3. Demonstrate an awareness of the diversity and interdisciplinary nature of the chemical and biochemical sciences and a competent understanding of the fundamental principles in related disciplinary fields through participation in coursework, seminars and group meetings. (C3)
4. Employ the principles of safe practices and ethical use of scientific knowledge, materials and procedures. (C4)
5. Demonstrate knowledge of fundamental and advanced instrumentation and techniques used in his/her disciplinary field of chemistry and biochemistry. (C5)

Skills and Processes

1. Analyze, interpret, and retrieve data from the primary and review literature, to develop critical thinking and problem solving skills for raising and addressing scientific question(s). (SP1)
2. Demonstrate the ability to collect data and information through literature research and designing

original hypothesis. (**SP2**)

3. Work independently and cooperatively on an original research project to collect, interpret, analyze, organize, and present high quality data for an original thesis. (**SP3**)
4. Effectively communicate ideas, concepts, results and conclusions from the original research project in a written thesis, oral defense and poster presentations. (**SP4**)

C. Student Demand

Student demand for the degrees has remained strong and growth has continued since the last PPR with a small decline in the most recent semesters (Appendix I, Table 1-A). Since 2012, first-time freshmen (FTF) applications have gone up 44%, but the percent admitted has dropped from 17.6% to 10.1%. A significant drop occurred in 2013-14, after which the numbers stabilized. It is not clear what the reason was for this drop. For several semesters, the B.S. Biochemistry program was impacted but that occurred in 2014-15. The percent enrolled numbers seem to correlate with the percent admitted numbers, which also have dropped over the same period (from 87.7% to 69.2%). This could be a result of stricter admission criteria. Nevertheless, the degree programs remain popular and we see approximately 100 new FTF each year. Although the data in Table 1-A does not specify this, the ratio of Biochemistry to Chemistry has changed in recent years from approximately 3:1 (FA11) to 2:1 (FA17). This change in student population has had an effect on our course demands and offerings.

Graduation rates for FTF as reported in Table 3-A (Appendix I) include all students who started as chemistry or biochemistry majors, including those who changed their major. The 4-year graduation rate is between 1 and 10%, whereas the 6-year graduation rate is between 14 and 30%. These numbers are quite low, but they are in part due to the fact that many students change their major. From Figure 1 below it can be seen that 50% or more of incoming CHEM and BCHM FTF eventually change their major. In some cases, this happens quite late; for example, the 2014 cohort of FTF was 137 and after two years 84 (61%) had not changed their major. Assuming that trends for this cohort will be the same as those for earlier cohorts, this data suggests that some students change their major as late as year 3 or 4. A more accurate graduation rate can be obtained when we look at students graduating with a degree in CHEM or BCHM, independent of their starting major. Data for the 4-year graduation rate is available for 2010, 2011 and 2012:

Cohort	Cohort size	4 Year Grad. Rate
Fall 2012 FTF	149	12.1%
Fall 2011 FTF	148	12.2%
Fall 2010 FTF	110	9.1%

For example, for the fall of 2012, the cohort size was 149 FTF and the 4 year graduation rate was 12.1% (slightly up from 2010). Compared to the data shown in Table 3-A (4.4% for Fall 2012), this is significantly better (and more realistic). Similar data is available for the 6 year graduation date, which also shows a significant improvement over the comparable data in Table 3-A. The recent improvements are encouraging:

Cohort	Cohort size	6 Year Grad. Rate
Fall 2010 FTF	110	50.0%
Fall 2009 FTF	91	57.1%
Fall 2008 FTF	62	32.3%

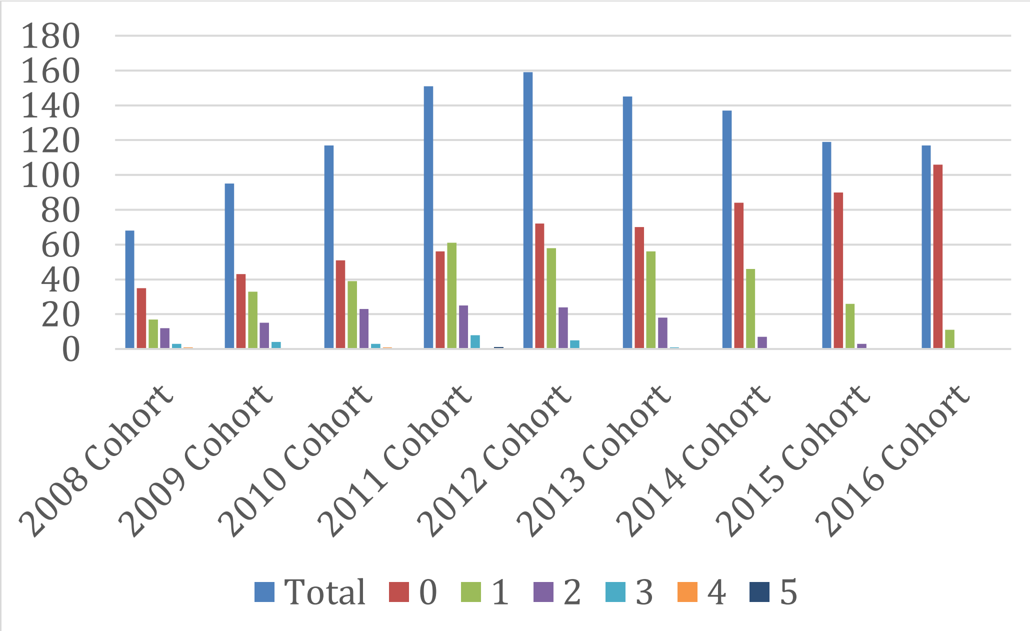


Figure 1. Number of students starting out as CHEM or BCHM major and number of major changes. The red bar indicates the number of students that remained in the major after 4 or more years.

Applications for upper division transfer (UTD) students increased by 43% between 2012-13 and 2016-17. The biggest increase was seen in 2013-14 (362 applications relative to 255 in 2012-13) and after that the number has remained constant. The percent admitted students dropped significantly from 2012-13 (81.2%) to 2014-15 (38.2%) but since then it has gone back up (58% in 2016-17). The number of enrolled students has consistently grown (27% overall) and transfer students now make up approximately 40% of our major population (up from 25% in 2012). The opposite trends seen for FTF and UTD could be related; as fewer students enroll at CSUF, perhaps they enroll at a community college instead and then transfer after several years, leading to increased enrollment numbers.

The data from Table 3-B (Appendix I) for UDT indicates a 2 year graduation rate of 0-16% and a 4 year graduation rate of 35-54%. These numbers are not significantly different from the data shown below, which only takes into account students who graduated with a degree in CHEM or BCHM. As expected, very few UDT students who come in as CHEM or BCHM majors change their major after transferring to CSUF.

Cohort	Cohort size	2 Year Grad. Rate
Fall 14 Transfer	31	3.2%
Fall 13 Transfer	63	6.3%
Fall 12 Transfer	59	1.7%

Cohort	Cohort size	4 Year Grad. Rate
Fall 12 Transfer	59	50.8%
Fall 11 Transfer	50	46.0%
Fall 10 Transfer	43	65.1%

The low graduation rates (mostly for FTF but to some extent also for UDT) can be attributed to a number of sources, including students not being prepared for the rigorous subject matter (MATH and CHEM). Math is a fundamental part of chemistry and many students enter CSUF with a poor foundation in basic math skills, which often means they have to do remediation before starting Calculus I. Having to do so will put students back at least one semester. The number of CHEM/BCHM majors who enroll in MATH 150A in their first semester on campus varies between 6 and 34% (data from Fall 2008 through Fall 2016; Appendix VI).

The data show a clear trend that more of our majors tend to enroll in the appropriate math course in their first semester, however, 70% of FTF do not start math in their first semester. Similarly, many of our majors are not prepared to start the first semester of general chemistry (CHEM 120A) in their first semester. The number of majors who enroll in CHEM 120A in their first semester is between 8 and 52% (data from Fall 2008 through Fall 2016). It is interesting to note that higher percentages were seen in Fall 2014 (52%) and Fall 2015 (46%) when the program was impacted, suggesting that higher admissions criteria could contribute to better graduation rates. Higher percentages were also seen for majors enrolling in MATH 150A in the first semester during the impaction.

A recent CSUF survey asked students about bottlenecks that have limited their ability to graduate in 4 years. Data for students from NSM suggested the main bottleneck was class availability (55%). Several bottleneck courses have been identified in our department, all for different reasons. For example, for several semesters, CHEM 316, Quantitative Chemistry Laboratory, was a major bottleneck, however as a result of an effective hiring strategy, the department is now able to offer additional sections allowing students to enroll in this required course more effectively. The organic chemistry courses (CHEM 301A and 301B) are often indicated by students as bottlenecks and with the support of Student Success Initiative funds we have been able to offer additional sections as well as classes at non-traditional days and times and classes at the Irvine campus. Additional sections at the Fullerton campus at normal days and times remain popular but non-traditional days as well as classes at the Irvine campus have not been effective. More recently, CHEM 301A was also identified as a major bottleneck in the sense that it has some of the highest repeatable rates in the College (37%). The highest rates are seen for CHEM and BCHM majors (34% each), followed closely by BIOL majors (30%). Other majors who often take this course include Health Science, Kinesiology and Psychology; the repeatable rates for these students were significantly lower (23%, 15%, and 16% respectively), which is likely because these are highly motivated pre-professional students preparing to enter professional schools for which organic chemistry is still considered an important indicator.

Major	*Total Enrollment*	*DFW*	*%*
BCHM	521	176	34%
BIOL	1313	397	30%
CHEM	231	79	34%
HLTHSCI	179	42	23%
KNES	53	8	15%
PSYCH	32	5	16%

Data (grades, major, class size, and day/time) for CHEM 301A sections of the past 5 years were analyzed to see if there were any clues to what might be important contributors to these high repeatable rates. The data do not show any clear trends, although it seems that on average lower repeatable rates are seen in smaller sections. The day and time of a given section might contribute but there was not enough data to conclude this. Funds were awarded to the department for a proposal to remodel one of our existing computer classrooms to an active learning classroom. There is substantial support for the idea that an active learning environment together with a flipped classroom approach can have a positive influence on student learning. We plan to remodel MH-

536 in the summer of 2018 to change it into an active learning classroom. The CHEM 301A sections will be offered mostly in the new classroom and faculty will be encouraged to use a flipped classroom model when teaching the course (some of our instructors have shown an interest in doing this). Some instructors in other courses have used a similar approach so we have some in-house experience. By being able to control the room, instructor, as well as the day and time of the class, we hope to learn more about what it takes to have students be successful in CHEM 301A and reduce the repeatable rate. Nevertheless, it has previously been noted that many of the students who start off in our major eventually change their major and a good portion of these students do that after year 2, so it is entirely possible that students try to stay in the major, repeating the freshmen and sophomore courses before realizing that a different major might be a better option for them. As such, it is reasonable to assume that students will continue to struggle in the 301A course. Another option to be considered is to follow the recommendation of the American Chemical Society to use the first semester of a two-semester course as a survey of the topic (less specific) and the second semester to introduce more specifics and details. This would require a significant change and effort, but it is certainly possible. However, it would put our course at odds with the organic chemistry courses offered at other institutions creating potential difficulties for transfer students. Although there are significant discussions about student success in courses such as organic chemistry, it is certainly possible that the numbers seen at CSUF are no different from those at other institutions nationwide, raising the question whether the observed trends are normal rather than unusual. Although this would not mean that more emphasis should be put on having students be successful, it could act as a more realistic view and guide proposed measures accordingly. The Department plans to look at national numbers for the first semester organic chemistry course and act accordingly.

From Table 5 (Appendix II) It can be seen that the number of applicants to the graduate programs (MS and MA) increased by 43% and the number of admitted students increased from 18 to 22 (percent admitted decreased from 64% to 55%). The number of enrolled students each year has been relatively constant (~10), however the FTES generated by the graduate program has dropped from 8.9 to 5.4 (40% decrease), similar to the headcount enrollment (30% decrease), suggesting that in addition to having fewer students in the program, these students also take fewer units (i.e., there are more part-time students). This is also reflected in the graduation rates, which show zero graduations within 2 years, 1-2 students in 3 years and an additional 2-3 students in 4 years. The decrease in percent admitted students is due in part to greater selectivity of our program, which was put in place several years ago when it was noticed that many admitted students were struggling early on (often with remedial undergraduate coursework) and could not successfully complete the first-year requirements.

The low graduation rates can be attributed to many of the students being part-time students. In addition, some of the coursework that is required for certain specialization tracks may not always be offered, and the amount of coursework needed for the degree is possibly too much for a research-based degree. Efforts are underway to make changes to the MS and MA programs to allow students to graduate faster. The acceptance standards will be reviewed and adjusted if necessary and plans to increase the TA financial support and attract more high quality, full-time graduate students into our program are being evaluated. Despite the recent decrease in graduate student enrollments, we are confident that this is simply a short-term issue and we expect to see the enrollments and graduation rates increase substantially over the next several years.

D. Enrollment Trends

The Chemistry and Biochemistry Department total FTES (undergraduate) have continued to increase from the previous PPR. In 2008-09 the FTES was 479.9 and since then it has increased to a high of 755 in 2014-2015 (+57%) and 651.9 in 2016-17 (an increase of 36%) (Appendix I; Table 2-A). Over the same time period our total undergraduate majors (annual headcount) have grown from 408 (in 2008-09) to a maximum of 688.5 in 2014-15 (an increase of 68%) and dropping off to 638 (+56%) in 2016-17, signaling a stabilization, although this may be a temporary effect as a result of the impaction. The growth of the major in the last 15 years has been very significant; the previous PPR indicated a growth of 60% and that same growth has continued through the period for this PPR. Clearly, this has put a strain on our department and resources. In 2009, a total of 48 bachelors degrees were awarded. In 2012 this had increased to 62 and in 2016-17 it reached 91. This data is consistent with the strong growth the department has seen over the same period and we expect the number of undergraduate degrees to continue to be around 80-100 annually for the foreseeable future.

The total headcount for MA and MS in Chemistry graduate students increased to a maximum of 34 in 2013-2014, but has since decreased to 21 at Fall 2016 census (Appendix Table 6). Typically, our graduate courses have 4 to 8 graduate students enrolled, and some graduate students take 400-level courses of which they can use up to 9 units toward their study plans. Though the number of students in the graduate courses is not high, it is still sufficient to maintain a community of scholars in the program. Nevertheless, efforts are underway to grow the program and bring it back to previous levels of 30-40 students. As described earlier (and below) we have plans to modify the program in terms of required courses to make it more attractive to potential students and allow them to graduate faster. To create more of a community for our graduate students we have created a designated space for them to have their office hours and we hope to add an area where TAs can have a desk space as well as an area to interact with other graduate students. The TA's in our department earn less than those in other departments in the College and we will continue to work with the College to rectify this situation so that there is equity between all graduate students in the College. This may also make it more attractive for our students to become TAs. The average number of graduate degrees awarded each year dropped from 7 (previous PPR) to 5.2. This is consistent with the lower enrollments; our goal for the future is to bring this back up to 7 – 10 degrees per year.

The number of tenured and tenure track faculty (16-19) has remained fairly constant compared to the previous PPR (14-18). Despite the continued growth in the major, the number of faculty has reached a status quo, mostly because of a lack of office and research space. Faculty are replaced upon retirement or resignation but despite the potential to hire new faculty, the lack of space (as indicated above) and limited start-up funds often make this a non-issue. To deal with the continued growth in majors and other students taking our courses, the department has instead increased the number of lecturers. Our FTEF (Full Time Equivalent Faculty = number of faculty each teaching 15 weighted teaching units [WTU]) allocation has continued to increase from 27.7 to 31.4 in 2016-17. This increase is significantly less than that observed in the previous PPR (from 21.3 to 28.2) despite a similar growth in the major (Appendix Table 9). Over the 2012-13 to 2016-17 time period the Chemistry and Biochemistry Student:Faculty ratio (SFR = FTES/FTEF) has varied between 18.9 and 24.5, which is significantly higher than that reported in the previous PPR (15.2-16.0) but the average (22.0) is above the College number (20.74) used by the current New Program Cost Analysis Form.

E. Plans for Curricular Changes

<u>Short-term Curriculum Plans.</u> In the short term (next 1-3 years), we plan to add or modify several undergraduate courses. We also plan to revise the requirements for the M.S. in Chemistry degree and make small adjustments to the M.A. degree in Chemistry. The course and degree additions and/or modifications are mostly geared towards creating more flexible and faster pathways towards graduation. The new courses or modifications and rationale for each are listed below.

CHEM 195 – Introduction to Research in Chemistry and Biochemistry. This course will provide an introduction to research for freshmen. Engaging students in research activities earlier on has been shown to promote interest in the subject material and therefore promote student success. Students will also be able to transition more easily into a capstone research project and thereby increasing graduation time. The pre-requisite for the course will be completion of CHEM 190. Students will be selected based on self-identified interest in research in CHEM 190 (most commonly the previous semester) or CNSM 101.

CHEM 430 – Bioorganic Chemistry. This 3-unit lecture course will cover topics related to the interface of biology and organic chemistry, focusing on biological processes. Chemical reactions and mechanisms will be studied to understand how nature creates complex molecules with specific biological roles. The courses will also explore how organic chemistry can be utilized to synthesize a variety of molecules to probe biological systems and principles. This course will be an integral part (together with the previously approved Medicinal Chemistry (CHEM 429) course and the Medicinal Chemistry Laboratory (CHEM 467) course) of the Emphasis in Medicinal Chemistry that we hope to establish in the coming years. The course can also be used by graduate students on their study plan.

CHEM 467 – Medicinal Chemistry Laboratory. This research-based course introduces students to medical chemistry research focusing on organic synthesis, enzymatic assays and molecular modeling with the overall goal of discovering novel therapeutic agents. The course will consist of 1 hour of lecture and 6 hours of laboratory each week. Students will complete laboratory modules in organic synthesis, enzymatic assays and molecular modeling. Once students have completed the three modules they will be provided with a drug discovery project to complete during the rest of the course. Utilizing the tools, they have learned the students will synthesize novel molecules, screen the molecules for inhibitor activity and study the molecules by computational molecular modeling. Overall, the course will provide students with a complete laboratory experience that will benefit them in future careers. This course can be used as a capstone experience (to replace CHEM 495).

Other plans include decoupling the laboratory from the CHEM 120A course (a 5 unit course that includes lecture (3), activity (1) and lab (1) components). We also plan to decouple the lab portion from the CHEM 120B course to create separate lecture (3 units) and lab (2 units) components. The rational for this is that the current setup restricts many students from choosing a convenient combination of lecture (or lecture/activity) and laboratory, which may often result in students postponing taking the course and therefore potentially increasing time to graduation.

To further improve student success in organic chemistry I (CHEM 301A) we plan to take the current lab course (CHEM 302; 2 units, taken together with the second semester lecture) and split it into 2 separate sections (306A and 306B). CHEM 306A will be taken together with CHEM 301A and 306B together with 301B, which will allow us the emphasize and support the material taught in the lecture course. All majors will take the CHEM 306A,B series and the courses will be set up similar to CHEM 316 (1 hour lecture followed by 3 hours of lab). The additional hour of lecture will be used to review material from the lecture course and link it to the work the students are doing in the lab course. The Department will also develop an advanced organic chemistry lab course that can be used as an elective course by all majors. There will be no increase in units for any of the majors.

Integrated laboratory courses. All students in our department must complete a capstone project, which is most commonly achieved by students enrolling in CHEM 495 and carrying out research in the laboratory of a faculty member in the department. Due to the significant growth in the major, many students experience difficulty finding a research lab to complete their capstone experience in a reasonable amount of time. Several alternatives are already available, but the department is looking to eventually offer several (hopefully 4) integrated laboratory courses that will allow students to complete the capstone research requirement in one semester. These high-intensity research experiences will be modeled after our successful CHEM 472B course, which has been operated that way for several semesters. A second course focusing on Biochemistry and Biotechnology will be established in the near future and the above mentioned Medicinal Chemistry Laboratory course will also fall in this category. The fourth course will likely be one in the area of Analytical/Physical Chemistry where the department has a significant expertise in the area of atmospheric chemistry.

Establishing a Professional degree pathway. Many of our majors are headed to professional school, which requires them to take additional courses and increases their time to graduation. Our department will explore the possibility of establishing a degree pathway that includes all required courses for entry into a professional program. The B.S. Biochemistry degree will be used as the starting point as it already includes many of the required courses.

Long-term Curriculum Plans. Our long-term curricular plans revolve around Department growth and subject deficiencies in our curriculum. In addition, student success and improving graduation rates while maintaining a research-intensive capstone experience remain important factors in our decisions. The main areas for long-term are in line with the short-term plans:

- Review all the laboratory courses and adjust and update (modernize) them as appropriate to make the material in line with the corresponding lecture course. Also take steps to improve the interconnectivity between different lab courses;
- Work towards a research-based curriculum by integrating research projects into laboratory courses (at all levels);
- Establish an Emphasis in Medicinal Chemistry; the growth in interest from our students in medicinal chemistry and related topics such as pharmacy, pharmaceutical science and pharmacology makes establishing a medicinal chemistry emphasis a logical choice. Completing the required courses for the emphasis is easily achieved by B.S. Chemistry majors without adding additional units to the degree. We also aim to establish a collaboration with faculty at Marshall B. Ketchum University to allow students to do projects focused on pharmaceutical science.
- Develop additional CHEM 411 (1 unit instrumentation based) courses focusing on instrumentation and techniques used in molecular biology and biotechnology.

III. Documentation of Student Academic Achievement and Assessment of Student Learning Outcomes

Assessment in the Department of Chemistry and Biochemistry occurs at all levels, most commonly at the course level in the form of exams, quizzes, presentations, etc. In some courses, for example, the one-year General Chemistry sequence CHEM 120A/B, all students are assessed by a standardized exam, which allows for student learning to be compared from one year to another as well as compared to that of students at other institutions across the country. In some courses a common final exam is being considered as an option to further assess student learning in that particular course. At the Department (Program) level, we developed detailed programmatic student learning outcomes (SLOs) covering all our undergraduate degree programs and means for their assessment in the areas of concepts, skills and processes, as well as attitudes, in 2007 and 2008. The faculty agreed that program assessment would be most meaningful by looking at data from the capstone experience (undergraduate research), which is required for all students. The capstone course involves an individual research project for each student as well as an oral (poster presentation) and written report (thesis). The poster abstract and thesis have been used for assessment purposes in the past several years according to our initially developed assessment plan. The most recent assessment focused on Communication Skills. The outcomes of the assessment were generally positive although the stated objectives were not met in all cases. The details of the assessment, as well as the discussion can be found in Appendix X.

Based on the traditional course assessments we have been using so far, a significant percentage of students entering our degree programs have difficulties passing our courses with a required grade of “C” or better. We noted earlier that we lose majors particularly in the first couple of years, when they are going through CHEM 120A,B and also CHEM 301A,B. Many of our students have to repeat these courses as they go along, putting them behind and making them reconsider their major. An unofficial survey suggests that many of the students who change their major from chemistry or biochemistry end up as Kinesiology or Health Science majors. Earlier we already hinted at some of the underlying problems we believe are responsible, namely poor preparation in Math and Chemistry. The Department is actively looking at solutions for these issues, however, there is little control over admission standards. Performance in the first-year general chemistry sequence (CHEM 120A,B) is monitored by administering standardized exams in both semesters. The results show that the average performance in these courses remains fairly constant and is just below the national average. A program currently underway is focusing on better preparing our students for these courses. Many students start by taking the CHEM 115 course, which is designed for students who have not taken general chemistry for a while, or those students who did not pass the Chemistry Placement Exam. The course is currently tested in an online format and if the move is made to a system where placement exams or courses that do not provide credit towards the degree are no longer allowed, the entire course will be changed in to a self-study module that students can complete prior to starting the general chemistry course.

For the organic chemistry sequence, a number of changes are being considered to promote student success. One of our computer classrooms will be modified and changed into an active learning room, which will be designed such that there is lots of opportunity for activity-based work, a flipped classroom model can be used (if desired), etc. Students will be encouraged to actively participate in the lecture by working out problems in small groups on whiteboards that are all around the classroom. Many of the CHEM 301A sections will be offered in this room. If the approach is successful, the CHEM 301B course may be offered in the same format eventually. Some faculty are exploring the use of the flipped classroom model for organic chemistry, which has seen significant success at other institutions. As described above, the proposed change in the organic laboratory lab courses is also expected to contribute to student success in organic chemistry as a whole.

Better educating our majors about the expectations and demands for the major is important and will be better incorporated into our CHEM 190 course, which most students take early on in their college career. In addition, we are developing the CHEM 195 course which will allow a select group (cohort) of students to start participating in research activities early on, which has also been shown to be beneficial for student success and retention.

Despite these problems, our number of graduating majors is increasing every year (also a result of the fact that we had increasing numbers of majors). In addition, our students are generally happy with their progress towards graduation. In a Fall 2017 survey (523 students participated), 57% of the students indicated they had originally planned to graduate in 4 years and 45% of all students indicated they thought they were on track. More importantly, 73% of all students were happy with their progress towards graduation. Finally, based upon the performance of our students in the capstone experience for the degrees (which involves research as well as oral and written reports provided or submitted for evaluation to faculty outside the mentor's laboratory), our students generally graduate with a decent grounding in the theory and practice of chemistry and/or biochemistry, and the advantage of practical laboratory research experience, as well as safety training and practice.

IV. Faculty

A. Changes in FTEF since last PPR

Since the last PPR in 2008 the Department has seen a dramatic shift in faculty. Retirements and resignations account for the loss of 11 faculty over the time period of 2008-1017. Over the same period the department has aggressively hired new faculty; a total of 14 new faculty were hired but 3 of these new hires have since resigned for various reasons, giving a net zero change. The department currently has ten tenured faculty members (6 full and 4 associate professors), nine tenure-track faculty members (8 assistant and 1 associate professor) and one full time lecturer, for a total of 20 full-time faculty. Considering the fact that these numbers are only slightly higher than 15 years ago, together with the fact that the number of majors has more than doubled in that same timeframe and the number of students in our courses has grown even more (as other majors have also grown), the department is still well below where it should be in terms of full-time faculty. The difference is compensated for by hiring a significant number of part-time instructors (from as low as 5 in 2003-04 to more than 20 in 2016-

17). Our FTEF allocation has changed from 15.5 to 31.4 to keep the SFR in line with that of the College and University.

For the first time in many years, the Department was able to create a full-time lecturer position. For quite some time, the Department had discussed the need to have in place a full-time lecturer whose main task would be to coordinate the undergraduate laboratory classes. After having the position approved, we hired Beena Matthew (formerly our chemical stockroom manager) to fill this position. Beena coordinates and teaches CHEM 100, 100L, 120AL, and 120BL courses. The CHEM 120AL courses are coordinated together with Dr. Barbara Gonzalez but it is expected that Beena will take over this role in the coming years. This position has been quite successful, and the Department is considering a second coordinator position that focuses on upper-division laboratory courses. The Department has regularly created and updated its long-term (usually 5 year) faculty hiring plan, however, often there are deviations as a result of unexpected retirements or resignations. For example, Michael Bridges was hired in 2011 but resigned in 2015 for personal reasons. Phil Janowicz was hired in 2010 but resigned in 2016 to pursue a different career. Alexandra Orchard was hired in 2014 but resigned in 2017 to start medical school. Chris Meyer left CSUF in 2017 to become the Dean of the College of Natural Science at Fresno State. The recent year was especially challenging because we had a total of five faculty retire (Christina Goode, Hal Rogers, and Richard Deming) or resign (Chris Meyer, Alexandra Orchard). Christina Goode had been in an early retirement program and Richard Deming had been in FERP for the past 5 years, so these retirements were expected but Hal Rogers' retirement was unexpected (he announced it in late summer).

The Department has been very successful in hiring new faculty members. At least one faculty member was hired every year of the past five years. Niroshika Keppetipola (2013) was effectively a replacement for Chandra Srinivasan who had decided to change her career track to a more administrative role (she eventually left in 2015 to become the Faculty Director for Research Development at CSU Dominguez Hills). In 2014 we hired two organic chemists (Alexandra Orchard and Amanda Evans) to cover (in part) the loss of Chris Hyland who had officially left CSUF in 2012 to purse his career in Australia. Allyson Fry-Petit was hired in 2015 to compensate for Richard Deming's FERP and the need for additional faculty in analytical chemistry. In 2016 the Department was very successful and hired two computational physical chemists (Andrew Petit and Michael Groves) and a chemical education faculty (Sachel Villafane) in an effort to strengthen those areas as well as bring in faculty who can teach in the general chemistry area. In 2017 the Department again hired three new faculty. Kelvin Billingsley is an organic chemist and basically replaces Alexandra Orchard. Daniel Curtis is an analytical chemist who moved to CSUF from CSU Northridge where he had been a tenured associate professor; He was hired as an associate professor (without tenure) to bring more expertise to the analytical chemistry caucus to allow Allyson Fry-Petit to focus more on her area of expertise (inorganic chemistry). Marcos Ortega is a biochemist who effectively replaced Chris Meyer. Because of the very strong pool in the biochemistry search ion 2016-17, we were allowed to make a fourth hire with the stipulation that this person would start in 2018. Stevan Pecic is a bioorganic chemist who will be joining our faculty in the fall of 2018. His addition to the faculty will somewhat compensate for the unexpected retirement of Hal Rogers. Although most of these recent hires were planned in advance, many of them (especially those in the last two years) effectively became replacements for faculty members who retired or resigned. Overall, the Department has done an exceptional job planning and executing its hiring plans taking into account the many potential changes, which make this a difficult exercise. In addition to finding people for the right areas of chemistry, it is also clear that we have hired the right people in terms of personality. Much effort has gone into carefully screening the applicants and making sure they are a good fit with the department and this has clearly paid off. The Department as a whole is much stronger now and willing to work together, creating a very positive atmosphere despite the numerous challenges we face.

As mentioned above, the Department has been able to compensate for many of the losses of full time faculty however, but some impacts remain at this point:

- Phil Janowicz was involved in organic chemistry and chemical education. The hire of Sachel Villafane had been planned to expand our chemical education caucus but it became an effective replacement. The Department remains committed to growing our chemical education caucus.
- The unexpected retirement of Hal Rogers, together with Alexandra Orchard's resignation (as well as Phil Janowicz' resignation), has left the Department with a significant hole in its organic chemistry (lecture) offerings. The loss in the area of organic chemistry (teaching) has so far been compensated by the hiring of Kelvin Billingsley as well as additional part-time lecturers. Unfortunately, one of the best PTL who taught organic chemistry very successfully in our Department recently left to be a stay-at-home mom and the Department faces an urgent need in the area of organic chemistry.

Additionally, the net-zero change in full-time tenure/tenure track faculty members together with growing enrollments has led to increasing numbers of part-time instructors teaching greater numbers of units every semester. Details of this are given below in section IV.C.

B. Priorities for additional hires

Although the Department has regularly prepared 5 year hiring plans, often these plans had to be changed due to unexpected retirements, resignations, changes in physical space, etc. The most important factor typically is teaching need and even though the focus often is on one of the traditional areas of chemistry (analytical, inorganic, organic, physical) or biochemistry, our recent hires have been much more interdisciplinary. We feel that this trend is likely to continue and will guide us in the future. Although the need for additional full-time faculty is clear, the major limitations in hiring new faculty are space (office and lab), and startup funding. Other factors that we have less control over include cost of living and housing issues, both of which make Southern California a less attractive destination. Due to the lack of office and research space (as well as a below average startup funds) the Department did not engage in a faculty candidate search for the 2017-18 year. Although the Department has a plan and a vision for its future hires, uncertainty about retirements, departures, etc. may change these plans.

Currently, the greatest needs in the Department of Chemistry and Biochemistry are in the areas of Inorganic/Materials Chemistry and Organic Chemistry. For Inorganic Chemistry, the Department has a single faculty member (Allyson Fry-Petit) who teaches all courses in that area and in her absence (leave, sabbatical, other commitments such as SI, CNSM 101, etc.) certain core courses cannot be taught since there is no expertise in that area present among the current faculty. One of the courses she teaches is a required course for the ACS-certified degree. In addition, the new faculty member would also be expected to teach core courses in general chemistry, which is always an area in demand. The area of experimental Inorganic Chemistry is very broad and can range from bioinorganic chemistry to organometallic chemistry materials chemistry. The laboratory demands can vary based on the exact area, however, with impending changes, the Department is confident it can find appropriate lab space for the new hire. In order to provide a reasonable office space, renovations will be necessary to existing space in MH (details are given below).

A second area of significant need is in organic chemistry (as described above). Because of the lack of available research space, an interdisciplinary hire would be a better alternative. An interesting option might be to hire a theoretical organic chemist. This person could interact closely with our other theoretical chemists (all physical chemists) as well as become part of CCAM. There would also be numerous opportunities for collaborative work with current faculty members in Chemistry, Biochemistry and Biological Science. A path forward with such a hire would require significant modifications to existing areas in MH, however, it would make available both a research space and an office space (details are given below). An alternative would be to hire a Chemistry Education person with an interest in organic chemistry. The ideal research space would be in MH-531, which is currently occupied by Catalyst and CCAM, however, by swapping spaces (MH-459) this can be achieved. Both of these strategies are in line with our desire to grow the areas of Theoretical chemistry and Chemistry education.

In fact, our vision is to establish two showcase areas, one for each (see below). Additional hires would include inorganic chemistry (to create a cluster for inorganic chemistry and/or material science), and a water/marine chemist, which ties in with our existing interests in environmental chemistry and sustainability. Given the growing importance of water issues in Southern California as well as the possibility to become involved in the existing Ocean Studies Institute (OSI) and its potential research/outreach center in the Port of Los Angeles make this an attractive option. One could also see collaborative interactions with people in biology and geology.

The main limiting factor is the lack of appropriate research space. Converting existing space in MH to lab space is expensive but if the general chemistry teaching labs can be moved to MH, it would open up significant opportunities for interdisciplinary laboratory courses and research areas. Currently, most of the available space in DBH is available in the Biochemistry research laboratories. Many of these research spaces are in areas that were originally designed as teaching labs and therefore are very large. Sharing or remodeling these spaces is the only reasonable way to move forward. Technically there is space to house 7 research faculty and currently there are only 4 using that space. Stevan Pecic, our new hire who will start in fall of 2018, will have one organic chemistry laboratory (DBH-181) as well as a bench area in DBH-145, which will be shared by Marcos Ortega. Future hires may have to be accommodated in a similar way and the nature of the proposed research of the candidate will likely influence the hiring itself. The lack of suitable office space is an additional limiting factor, however, there are several opportunities to improve this situation, all of which require renovation. Details are described below and if the Department wants to grow and be at its appropriate size in terms of FTEF, funds will need to made available to create these spaces.

Hiring additional full-time lecturers and laboratory coordinators can help with reaching the desired FTEF numbers, however, they would also require office space. The proposed general chemistry laboratory space on the 5th floor of MH also creates 4 office spaces that could serve that purpose. Competition from the Community Colleges for talented instructors is fierce and one would need an enticing package as an offer for a motivated instructor. An interesting development at UC (and other R1 institutions) is to see the hiring of tenure-track teaching faculty. Although at that level, some education research is expected, at the CSU this could possibly be different and truly be a tenure-track teaching faculty position with no research expectation.

C. Role of full-time and part-time faculty and student teaching assistants

In general, our full-time faculty are involved in teaching all levels of the curriculum, including large and small beginning, mid and senior level core and elective courses, and graduate lecture and laboratory courses. Because the number of students we are teaching has grown 60% since the last review and more than doubled since the early 2000's, and the number of full time faculty has remained the same, we have had to hire more part time faculty than before to cover our courses. Currently we have 19 part-time and full-time lecturers teaching 100-400 level courses and laboratories (154.8 WTUs); teaching assistants (graduate students) are covering 98.5 WTUs (laboratory courses); and full-time faculty the rest (162.5 WTUs). The latter includes units devoted to supervising undergraduate and graduate students in research courses (CHEM 295, 395 and 495 or 499 or 490) required for undergraduate degrees, or for the master's degree (CHEM 599, 598 or 590). Our faculty are supposed to receive 0.33 units of credit for every unit (6 hours per week) of undergraduate research supervision, and 0.50 units of credit for every master's student. Because research is a fundamental and required part of the degree for our undergraduate students, we greatly value these Supervisory units as recognition for the faculty's teaching and mentoring activities. Furthermore, similar to providing funds to operate teaching laboratories, the Department also provides a small amount of money for each faculty to operate their research labs. Although not nearly enough to maintain continuous operations, it will allow faculty to continue their research activities with students during times when external funding is not available. Nevertheless, the ever-increasing workload and expectations for faculty is worrisome, especially considering the fact that besides the supervisory units there is little credit available for research or scholarly activities. With the number of majors having increased dramatically over the past 10 years but the number of research faculty stagnant, it becomes increasingly difficult to provide quality experiences and mentorship to students.

In general, the part time faculty have been PhDs, or have master's degrees (often from our own department) and have been hired to teach general education courses (100, 105, 111, 311) as well as most of the activities and/or laboratories associated with the general chemistry (115, 120A and B) and organic chemistry (302) curriculum. Our graduate students have been a major resource for teaching the lower level laboratories and activities and the 302 (core organic) laboratories. Some of the complex upper division laboratories, where enrollments have been at a maximum (but limited to 16 or 24 students for space and safety reasons), such as the core biochemistry laboratory (422), the physical chemistry laboratory and sometimes also the analytical lab course, as well as in some instrumentation modules (411 courses), occasionally require the help of a graduate assistant. Graduate assistants also help with grading assignments and tests in large enrollment courses; in some cases, talented undergraduates are used as graders. The number of graduate students has declined in recent years and as a result the number of teaching assistants has also dropped significantly. In recent semesters, we have had to depend heavily on part-time lecturers to cover many of the undergraduate laboratory sections. Without growth in full-time (tenure/tenure-track) faculty, we expect that part-time faculty and TA's will be responsible for covering 60-70% of the total number of sections and WTUs offered by the Department. This was noted as an area of concern in the most recent comprehensive program review by the American Chemical Society (Appendix VIII):

The Committee made the following suggestions for the continued development of the chemistry program.
Part-time faculty. According to Table 3.1, several part-time faculty teach courses leading to student certification. The Committee encourages you to work with the administration and identify a plan to ensure that such courses are taught by fulltime, permanent faculty.

V. Student Support and Advising

A. Describe how Department advises its majors, minors, and graduate students

Undergraduate Student Advising. Our undergraduate B.S. and B.A. majors must be advised upon declaring the major or when they transfer to CSUF, and they have mandatory advising every semester thereafter. All students have a hold placed that is removed after they have met with an advisor. Mandatory advising usually takes place in a three-week window at about mid-semester and just after the next semester's schedule is released. All undergraduates are notified by email and postings about the need to see a specific faculty member for advisement at the start of the second half of each semester. A few years ago, one faculty member (Dr. Paula Hudson) became the official undergraduate advisor for the Department and since then some significant changes have been made to our advising activities.

- All freshmen are advised in small groups by the undergraduate advisor (they are required to register for an advising session and can choose from up to 10 different days and times).
- For the past year, the Department Chair has focused on meeting with students who have applied for graduation in the following semester, which allows for a pre-grad check to be completed and an "exit" interview to be done.
- Incoming freshman are advised during college orientations; new transfer students are usually advised by the department chair.
- Students declaring a chemistry minor are generally seen by the vice chair. All other students are advised by the faculty in the Department.
- In recent semesters, the undergraduate advisor and department chair have set up several advising tutorials for the faculty, to highlight changes, common issues, etc. and to inform new faculty of proper advising procedures. This tutorial will be done every semester and has become an event where faculty discuss experiences and exchange advise on how to deal best with certain situations.

- Advised students are permitted to register through a faculty-signed form brought to one of our department office staff members, who clear the hold. Students who fail to obtain advisement during the three-week designated periods are sometimes advised by the vice chair or chair, or they will have their hold removed three weeks prior to the start of the semester.
- Prior to advisement, students are asked to fill out some forms to help them plan their next semester but also to list the courses they have failed (worst and best semester at CSUF), the number of repeat units they have used up, etc. to help them understand the situation they are in.
- To further learn about student road blocks, the undergraduate advisor has also initiated a program that targets students who had GPAs of below 2.0 for the past semester (but who are not necessarily on probation).

During advisement, specific forms (listing all requirements) are reviewed with the student, and plans are made for the next semester(s). Notes are made online (electronically on the TDA) so that they can be seen by other advisors. Undergraduate students are counseled particularly on the importance of sufficient study time, integrating outside work and their academics, and taking courses in the most efficient sequence, and with pre-requisites. Examples of advising materials and forms are available in Appendix XI.

Graduate Student Advising. Graduate Advisor: (All graduate students) Upon admittance, all new graduate students are contacted by the Department Graduate Advisor with a list of important sites/links/handbooks. This information includes the Department Graduate Handbook (see Appendix XII), the University Graduate Studies webpage, and the Department webpage, where they can access important forms required to begin their journey. Within the first month of their arrival, new graduate students are required to attend an advising session with the Department Graduate Advisor where they are provided with information about important deadlines, protocols for success, and how to manage their study plan. Graduate student progress is evaluated every semester and students with problems are counseled about how to proceed and about their options, both personally and in writing, with copies going to the faculty mentors. The Graduate Committee also reviews problems and gives feedback to the Graduate Advisor on how to proceed. The Graduate Advisor's role includes also study plan management, graduate checks, and other issues that require the Graduate Advisor's signature. Finally, the Graduate Advisor acts as the liaison between the Department of Graduate Studies and the Department of Chemistry and Biochemistry for issues that pertain to the graduate student.

Graduate students offered a TA position attend a mandatory safety and orientation session with laboratory coordinators during the first week before classes. This TA orientation focuses on the TA's responsibilities, teaching advice, and other pedagogical material aimed at preparing the TA for their teaching responsibilities. Within the first few weeks of the semester, new TA's are also required to attend a campus session on Unit 11 (union) compliance where they learn about their TA rights and privileges. Upon completion of the Unit 11 advisement, the TA's report the date and time of their attendance to the Department administrative support assistant to insure Unit 11 compliance.

Project Advisor: (All graduate students) All Department graduate students must find a Project Advisor. The Project Advisor is the student's mentor with whom the student should have the most contact. The Project Advisor is expected to help the graduate student succeed in the program by providing the project direction, study plan, goals, resources, and timeline. Although not required, the Project Advisor is encouraged to meet with their graduate students regularly as commensurate with student's needs and the project's development.

B. Student access to research opportunities, internships, outreach, and student assistant teaching opportunities.

Student research opportunities: Doing research with faculty is integral to all our current degree programs. Undergraduates are required to carry out at least 3 units of senior, independent laboratory (CHEM 495) or library (CHEM 499) research for their degrees, but at least half do considerably more and start earlier (CHEM 295, 395), spending 2 or more years with a given faculty member. This is the major capstone experience for our undergraduates. Probably about 1-2% of our undergraduates opt for the library versus laboratory-based research experience (499 versus 495). All the research activities are supported by (i) research funds obtained by individual faculty through extramural and intramural grants; (ii) funds from federal (NIH, NSF) and private (Howard Hughes Medical Institute) grants supporting students doing research (rather than working to support themselves), during the school year and also during summers; (iii) up to $3,500 per year per faculty member from department funds ($150 per student per research unit per semester); (iv) WTU from the department (0.33 units per undergraduate, 0.5 units per graduate student, for up to 3.0 units per semester) for the degree coursework in research they are providing (CHEM 295, 395, 495, 499, 490, 599, 598), as already indicated. Virtually all the faculty are participating in these student-faculty research activities to some degree. Students doing research and presenting their results at meetings generally pursue travel funding from the Associated Students Interclub Council. Our students strive to be involved with the ASC-ICC.

Integrated Laboratories: In recent years we have seen increased demand for the capstone requirement because the number of majors has grown so much and so fast, whereas the number of research active faculty has remained the same. To allow all students to have a research-intensive capstone experience, we have set out to introduce additional ways for students to meet this requirement for graduation. For several semesters we have offered the Advances in Biotechnology Laboratory course (CHEM 472B) where students work on a biotechnology-related research project under the guidance of a research faculty member (Dr. Madeline Rasche or Dr. Niroshika Keppetipola). In this course the students are introduced to biotechnology related issues and bring together lab skills learned in other courses. A second course that will follow a similar pathway is Medicinal Chemistry Laboratory, which is currently undergoing approval. The Department hopes to add a third such course and possible a fourth over time. These courses, over a two-year period (one per semester) will allow up to 24 students to complete their capstone requirement each year (approximately 25-30% of a typical graduating class).

Internships: For the last several years we have worked to invigorate an internship program (CHEM 490) that had previously supported 1-2 students per year. With significant input and effort by Drs. John Haan and Nicholas Salzameda the program now supports up to 10 students every semester and in some cases more positions are available than we have students. Some of the internships are paid, providing an incentive to the students. Some of the students have found permanent employment with the company after completing the internship and the degree. Due to the different nature of the research at the companies, students in CHEM 490 no longer present a poster to the faculty at the end of the semester, but rather give an oral presentation (open to all faculty and students). All students participating in the internship program are expected to complete a written report, similar in length and quality to that of the senior research students.

Chemistry and Biochemistry Club: Our Department has a very active student-run club that is part of the Associated Students Interclub Council. Officers are elected annually and there are typically 20+ students active in the club. The club sponsors student events that foster social interactions and promotes student research. Student club is very involved in outreach efforts such as interacting with potential chemistry and biochemistry majors visiting our Department or at Welcome to Cal State Fullerton Day.

Seminar series: We have a bi-weekly seminar series whereby professionals are invited to give talks and interact with students and faculty. Speakers are invited to spend most of the day on campus in order for them to interact with faculty and students. Typically, visiting scientists have lunch (pizza) with students and dinner with faculty following the seminar.

Participation in professional meetings: Our students regularly attend and participate in national and regional professional society meetings (ACS, ASBMB, CSUPERB) and in local professional organizations such as the Orange County Section of the American Chemical Society. Students (with their mentors) have made hundreds of research presentations at regional, national and international meetings, and uncountable numbers (literally hundreds) of research presentations at local and CSU-wide conferences. Students at these organization meetings are engaged in chemistry and biochemistry discussions and have opportunities to network with potential graduate schools and with chemistry and biochemistry company employers – many make graduate school or job connections at these meetings.

From this information, it should be apparent that the Department has a well-established research “culture” that involves all our undergraduate majors, as well as our graduate students, in research. We are proud of this culture and know that it provides our undergraduates advantages with regard to obtaining technical jobs in industry (and at other institutions) and entering graduate or professional training programs. Our graduates (with bachelor’s or master’s degrees) are a significant portion of the technical workforce in the local pharmaceutical, biotech and other industries. In our master’s program, we have a particularly good track record in developing (or rehabilitating) bright but disadvantaged students who either did not perform so well as undergraduates or had not yet figured out the nature of their life and career interests upon completing their bachelor’s degrees. Those of our students who obtain master’s degrees do very well not only in industry positions but in rigorous doctoral and professional programs. The same is true of many of our undergraduates.

Aspects of our research culture that stimulate the interest of our students in the practice of chemistry and biochemistry include not just the fact that they must take research courses requiring them to apprentice with faculty on research projects (theoretical or actual) as part of their requirements for the undergraduate (or graduate) degree, but also that research and scholarly activities are a constant thing in our department. Some students and faculty can be found in their laboratories almost all the time, including evenings and sometimes at night, year-round, on weekends and during the week, whether or not classes are in session – as is the case at “Research-1” institutions. Adding to that, and making it more likely and robust, are our strong summer research and student research support programs, which include financial support for students engaging in research, year-round (MARC, LSAMP, McNair and (until recently) the Howard Hughes Medical Institute grant programs) and during the summer (Project RAISE, REU, International REU, and others). These grants do a great deal to stimulate our students to immerse themselves in practicing and learning chemistry and biochemistry, allowing them to be paid to do this rather than having to work elsewhere in non-science jobs; also providing research “manpower” (and a little money for supplies) to the faculty. Almost all publications from the department are based on student work and have students as co-authors. Over the last 7 years, the faculty we currently have (and while at CSUF) with their students have published more than 100 peer-reviewed articles with student co-authors.

It is also noteworthy that many of our faculty have received internal as well as external awards recognizing them as outstanding teachers, outstanding researchers, or rendering outstanding service (see Appendix VIII). Thus, since the last PPR, Fu-Ming Tao was recognized by the College of NSM for outstanding research; Barbara Gonzalez for promoting student success; and John Haan for being the outstanding untenured faculty member. In addition, Maria Linder received the inaugural L. Donald Shields Award for Excellence in Scholarly and Creative Activity (2013) from California State University, Fullerton and in 2015 she was named an American Association for the Advancement of Science Fellow for her distinguished research discoveries on how copper and iron function in the body.

VI. Resources and Facilities

A. State and non-state resources

Appendix XIII shows the breakdown of state and non-state resources received since 2012-13. The numbers within a certain category, vary significantly because of year-to-year changes of items that are considered to be part of these categories. For example, in some years, start-up funds were part of the OEE category whereas in other years they were not. In general, our total budget has increased by about 6.7% but this increase was merely the result of an increase in staff and faculty salaries and in effect the budget to support courses and research has decreased. The PTF blanket has been covered by Dean and VPAA funds to meet required course needs and includes salary for all part-time lecturers, state-funded graduate assistants, teaching assistants (TA), and Instructional Support Assistants (ISA). The increase in PTF blanket expenses between 2012-13 and 2016-17 reflects the increase in number of sections taught by PT faculty.

The OEE has varied significantly as a result of the inclusion of start-up and other costs in some years, but the last 3 years give a somewhat normal overview that suggests a stabilizing yet decreasing number of support. Much of these funds, as well as the Miscellaneous Course Fees are used for maintaining day-to-day operations of the Department and are therefore absolutely essential.

Our faculty have been successful in obtaining grants and contracts. The external grant amounts include large grants from DOD and NSF for state-of-the-art instrumentation. Some of the grants and contracts provide resources as release time and indirect cost (IDC) money. Our faculty obtained intramural grants at a rate of $15,000 to $35,000 per year in total. All of these grants provide valuable resources for allowing faculty to work with students on research projects that are expensive due to travel, field, lab, and/or analytical costs inherent in our discipline. One of our priorities (section VII) is to increase grant submittals.

Our donations to the Department vary from about $15K to about $50,000 per year over the last 5 years. The 2013-14 and 2014-15 donations total are skewed by gift to set up the Wegner Family Scholarship (2013-14) and the Eric and Alyse Streitberger Science Education Endowed Scholarship (2015-16). Most of the rest of the donations are as gifts of up to $1000. One of our long-term goals is to work with University Advancement to increase donor giving. The Department has established ASPIRE (Alumni Supporting Programs In Research and Education) to raise funding for undergraduate research to supplement (or replace) the OEE funds used by the Department.

B. Identify any special facilities/equipment used by the program/Department such as laboratories, computers, large classrooms, or performance spaces. Identify changes over last five years and prioritize needs for the future.
The Department of Chemistry and Biochemistry includes classrooms, offices, and research labs that are located in the basement, 2nd, 4th, and 5th floors of McCarthy Hall (MH) as well as the 1st and 2nd floors of Dan Black Hall (DBH).

In DBH, the department has numerous teaching laboratories to accommodate large numbers of sections of its laboratory courses in general (244, 261, and 263), organic (212 and 213), analytical (166), physical (166), biochemistry (161), biotechnology (161) and nursing chemistry (261). Each research-active faculty member (which is almost everyone) also has a research laboratory in which undergraduate and graduate students, as well as some post-doctoral fellows and research associates/technicians carry out research. Many of these research laboratories contain highly sophisticated and specialized equipment that was either constructed from parts or directly purchased, with funds obtained through grants or startup funds (new faculty), or imported from elsewhere when the faculty member came to CSUF. The chemical stockroom that provides chemicals, solutions, etc. for our teaching and research labs is also located in DBH.

We have several special pieces of equipment that were obtained through NSF instrumentation grants over the last few years, and for which renovations were needed to house them in the basement of McCarthy Hall: a 400 MHz NMR from Bruker particularly essential to our organic chemists; and a research grade, EMXplus EPR spectrometer (Bruker-Biospin) that allows UV-Vis spectroscopy while simultaneously observing magnetic resonance behavior. The NMR and EPR are fundamental to the research of several faculty and some of our classes (411 and 306B) and were critical for hiring several faculty members at the time. Very recently we obtained funding from the Department of Defense and from NSF to purchase two LC/MS instruments, which are forming the core of our medicinal chemistry focus. Both will soon be housed in DBH-166B, which is undergoing some renovations. This past year we were also able to acquire an LC instrument with UV detection (funds were provided by the Provost) which is used in CHEM 316 and 411C as well as several smaller pieces of equipment (electrochemistry setup and bomb calorimeter) to replace aging equipment in the Physical Chemistry laboratory (CHEM 355). In addition, the organic chemistry lab spaces were upgraded with projectors and screens (to replace old whiteboards), the general chemistry labs were upgraded with new stir plates and other small items and the biochemistry teaching lab (CHEM 422) received a new GelDoc system. Many of these instruments are also heavily used for research activities.

In MH the Department has numerous classrooms and other facilities. As mentioned above, the basement houses our NMR and EPR spectrometers. Recently, space was swapped with Physics (MH-501B went to Physics; MH-10 went to Chemistry) with the idea to house our newly acquired LC/MS instrument in the basement. Unfortunately, the space was not adequate to house any equipment so an alternative plan was thought up for DBH. MH-10 will most likely be changed into a space for TA's to have office hours. On the 2nd floor of MH we have our equipment stockroom (MH-277) and the back end of this area (MH-228) was cleaned up to provide space for TA's to have office hours. This area may be converted into a space for TA's to have desks (cubicles) to follow the designs of Math, Geology and Biology of spaces for their TA's. The 4th floor of MH has one area dedicated to our IT staff person (MH-459) but the majority of the Department space is on the 5th floor of MH (with the Department office and most of the faculty offices). Special facilities include our studio classrooms (MH 587/536), which have been centers for teaching the beginning chemistry courses and associated activity sessions. These rooms were originally designed as computer classrooms, however, changes in technology and approaches to learning have led us to think about converting the spaces into active learning rooms. The incentive was to focus on improving the high failure rates in the first semester of organic chemistry (CHEM 301A), which we believe can be done by using smaller classrooms (48 seats) and an active learning approach (for example, the flipped classroom). A proposal was written and funded by the Provost office for GI2025. The renovation of MH-536 will occur in the summer of 2018. If successful, MH-587 may undergo a similar renovation in a few years. The added benefit is that the computers in these classrooms (48 desktop computers) no longer will need to be updated every two or three years, saving a significant amount of money. Computational aspects for our curriculum remain a high priority, however, there are now better ways to accomplish this (most commonly by having laptops available for students who do not own a computer). To make better use of the rooms, efforts have been made to teach the CHEM 120A course in MH-536 or 587. We also make good use of MH-468, which also holds 48 students. Although the Department does not own this room, it uses it frequently throughout the week. Until recently, the virtual lab component of CHEM 120B was held in MH-587. However, each section only used half the seats in the room, making for a poor occupancy rate. A decision was made to move the CHEM 120B virtual labs to MH-564 so that additional lecture and activity courses could be scheduled in MH-587.

MH-564 was remodeled several years ago to make it a showcase lab for Chemical Education. The main course taught in that room was CHEM 102 (previously also PHYS 102), as well as two EDSC courses. By reorganizing the schedules we were able to house most of the CHEM 120B virtual labs in MH-564.

Several faculty have research space in MH; these are the Chemistry Education faculty (Drs. Barbara Gonzalez and Sachel Villafane) and the Theoretical Chemistry faculty (Drs. Michael Groves, Andrew Petit, and Fu-Ming Tao). One potential long-term vision involves the creation of two unique spaces on the 5th floor that center around Chemistry and Science Education (including Catalyst) and Computational Chemistry (as part of CCAM). Both are modeled after GWPAC and details for this vision are given below.

A few years ago, one area (formerly housing the Department IT staff member) was converted into an SI room (mostly for Chemistry but also used for other subjects), filling a long-standing need.

Future priorities:

Maintaining existing infrastructure by hiring additional technical staff. The huge growth in the major and the number of students in our service courses has resulted in a dramatic increase in the use of our teaching laboratories, equipment, etc. No additional staff has been hired and our current staff members are pushed well beyond the limit and currently they can only focus on the most urgent issues. The Department of Chemistry needs to hire one or two additional technical staff in order to keep up with maintenance and repair of existing equipment including hiring experts at dealing with equipment and computer interfaces. In addition, some of the modern equipment (e.g., the NMR and the LC/MS) are being maintained by faculty members (together with staff), which is not a good use of their time. An additional option that must be considered is to hire one or more experienced instrument technicians that will maintain the equipment, run samples (standardized) for both teaching labs and research labs, and teach classes related to the equipment. The Department offers several instrumentation classes every semester and it makes sense to have a person with significant experience in this area in charge. A flexible hiring policy would go a long way in providing a better future for the Department, its infrastructure, faculty, staff and students.

Upgrading infrastructure in DBH and MH. The DBH and MH buildings have a number of shortcomings that severely affect the instrumentation in those buildings, as well as the people (faculty, staff, students) working with those instruments. This is most noticeable during a power outage (planned or unplanned). Although DBH has emergency power, many of these outlets are in a location where there is no use for them (for example there are multiple emergency power outlets in the DBH-212 and 213 teaching laboratories that are all unused). As a result of research faculty acquiring more equipment, the need for emergency outlets in other areas of the building is beyond critical. For a planned power outage, faculty and staff spend many hours locating outlets and hooking up equipment with extension cords. This is a logistical nightmare that can be avoided by moving emergency power outlets to locations where they are needed most. Alternatively, the University should invest in a system where a large generator can be brought to the building and plugged in directly, to power the entire building for the duration of a planned power outage. Improving the reliability of the power to the buildings is also important. Unexpected power outages have caused major damage to equipment and computers, which then becomes a problem for the Department to cover. The situation in MH is worse, since there is no emergency power. Similar to DBH, the University should invest in a system where the entire building can be powered by an outside generator via a simple plugin connection. Although this does not help with unexpected power outages, it will help getting through planned power outages more conveniently. Because of the very different power needs for the MH and DBH buildings (with millions of dollars of sophisticated research instrumentation), the University may also consider providing separate power to these buildings so that in case of a planned power outage, the MH and DBH buildings are not affected.

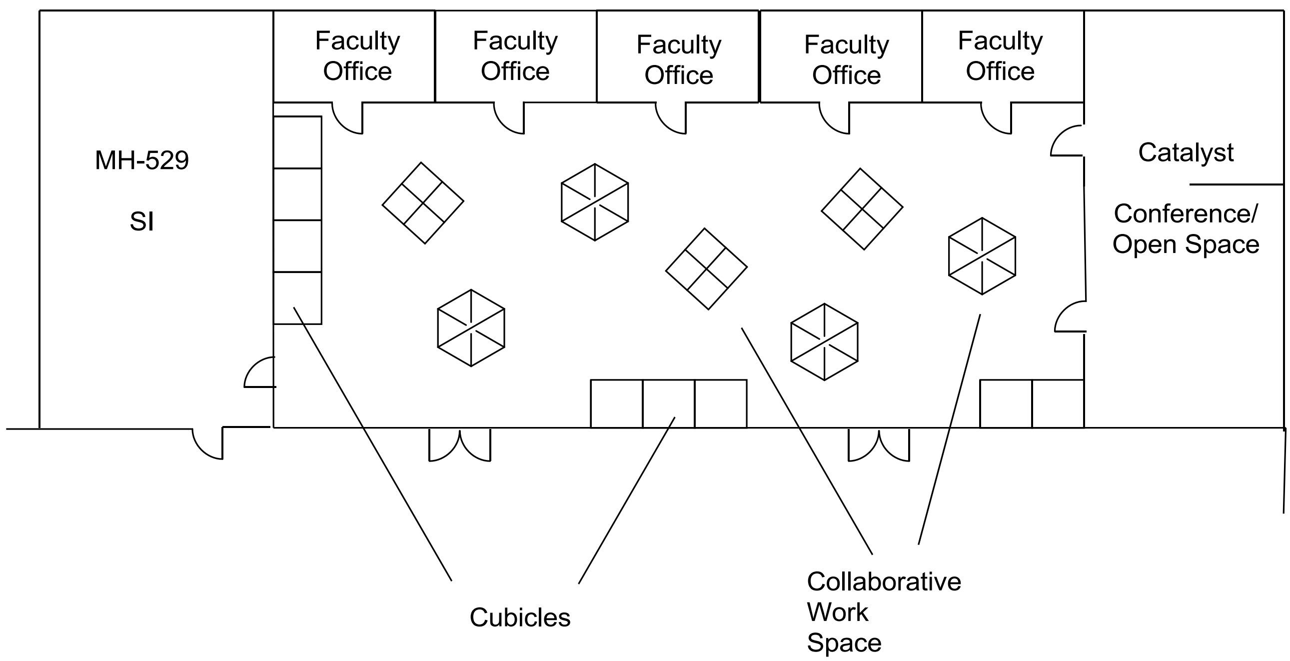
Upgrading teaching and research equipment. The aging infrastructure remains one of the biggest issues the Department is facing. In addition to a lack of suitable space (office or research), the detrimental state of some of our equipment (despite the recent upgrades and purchases) is troublesome and eventually may lead to us not being able to teach the classes we need to teach. Chemistry is an experimental science and to best prepare our students and make them competitive for the workforce or advanced studies, we must be able to introduce them to sophisticated equipment. Since the state does not provide more than a fraction of the funds needed to keep our course and research laboratory facilities going, we will make additional concrete efforts to submit additional grant proposals to NSF (and probably also NIH) for groups of "workhorse" instruments that are getting quite old, and for which replacement parts may be difficult to obtain in the future. These include a nanopure water system (although really part of our infrastructure that should be refurbished by the university), gamma counter, ultracentrifuge and rotors, and shakers for biochemistry, as well as gas chromatography-mass spectrometry systems, and atomic absorption, UV-Vis, and IR spectrometers, and GC-FID instruments for the analytical, organic and biochemistry laboratories. Many of the ultra-low freezers used by a variety of experimental chemists and biochemists are nearing the end of their lifetime and will need to be replaced in the next couple of years.

Newer models that are currently on the market provide a number of advantages (e.g., lower power usage, flexible power outlet use (208 or 110 V), longer lifetime, etc.) Although more expensive, the advantages will make up for that difference over time. Another option that will be explored is to set up agreements with companies to lease equipment or to establish a partnership that allows for special discounts for a suite of instruments in return for name recognition or special naming rights. Finally, carrying forward funds would allow the Department to save enough money to make bigger purchases when needed.

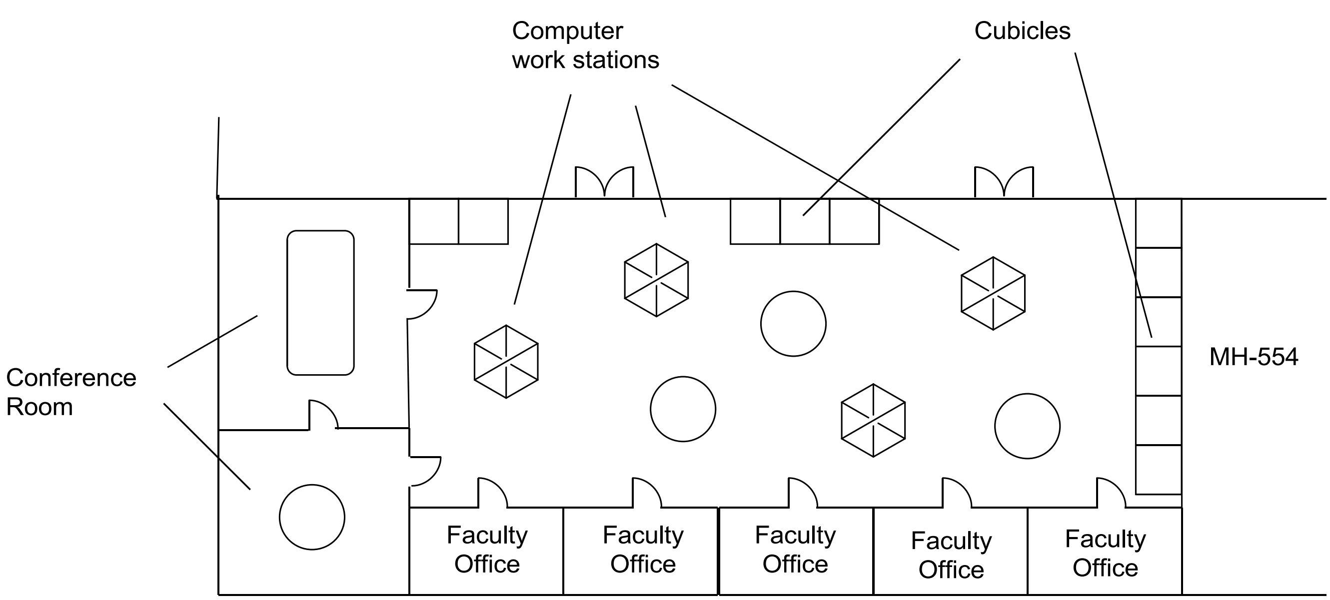
Creating office and research space. A severe lack of space is a major issue for the Department. Over the past several years, the Department has lost access to numerous areas in MH and DBH. For example, after the retirement of Dr. Patrick Wegner, his former space (MH-553, 553D, and 504B) was taken over by Math. MH-501 was taken over by the Dean's office and Geology has taken over office and lab spaces on the 4th and 5th floors of MH as well as DBH-175. Hiring additional faculty is urgent (3-4 more are currently needed as mentioned above) but without appropriate renovations, this is not possible. Below, a short-term plan is proposed that will allow for two new faculty members to be hired and provide each with appropriate office and research space in MH. Additional office spaces can be created to facilitate additional hires, however, research space in DBH would require additional work. A long-term plan is more difficult to aim for given the uncertainty of the building and its potential renovation. However, the College goal is to establish showcase areas for both wet and dry laboratory spaces and with that vision I mind, some chemistry-focused areas are proposed below.

1. Create office and lab space in MH for two hires. A short-term plan that involves some renovation of an existing space and swapping space with Math (CCAM) would allow for two new faculty to be hired and given office and research space. Convert MH-501A from a lab space to an office space (remove benches and fumehood) and convert the MH-504A/512A area into a computational lab space (focus on theoretical organic chemistry). Swap MH-531/531A (currently used by Catalyst and CCAM) with MH-457. The MH-531 area fits perfectly with the existing Chemistry Education spaces and the SI area (MH-529). The space in MH-457 is appropriate for a new hire, however, they would be isolated on the 4th floor away from the Computational or Chemistry Education clusters. Math already has several areas on the 4th floor, making it a better place for CCAM. Catalyst can become part of the visionary Education space as detailed below. Additional modifications can be made to create further office spaces. The IT staff member can be housed in MH-585 (currently a faculty office) and a door can be created between MH-585 and 536B, which will be used for the IT staff member's items. MH-582F can be modified and changed into two office spaces; it will require the removal of a fumehood and the installation of a wall and an additional door. The faculty member whose office is in MH-582A can be moved to MH-570 (currently used as a research space together with 570A) if the proposed research space (MH-570A/564E) can be isolated from the MH-564 teaching lab. This can be accomplished by opening up the north wall of 564E with a door and adding a wall with a door to allow entrance into MH-564. Removal of a fumehood in MH-570A would complete the project. Removal of a fumehood in MH-536A would allow for better use of the research space (computational chemistry; does not require a fumehood). Details are shown in the drawing in Appendix XIV with changes shown in red.

2a. Long-term vision: Education and Computational showcases for dry laboratories. Modern research spaces often consist of large open spaces with a general usage area surrounding office spaces. The GWPAC space at CSUF is an example of such a multiuse space. The Department of Chemistry and Biochemistry has established priorities for expertise and clusters in education and computational chemistry, both of which are ideal candidates for such a multiuse space. For the education area, we envision changing the existing area comprised of MH-531, 535, 539, and 543 to a single area with office spaces along the outer (North) wall. The open area will be furnished with modular items (desks, tables, chairs) as well as movable partitions to allow for designated spaces to be created as needed. A meeting area will be available for group meetings, review sessions, etc. Ideally, the chemistry education center is a bright area with glass walls to the hallway and inside to the Catalyst and Conference space. It will be located conveniently next door to the SI room. Alternatively, this area can also be at the northwest corner of the 5th floor (the complex containing MH-501A, 501B, 501C, 503, 503A, 501, 511, 513, 513A, and 513B) opposite of the new general chemistry laboratories (see below) to allow for more direct interaction between research and teaching laboratories. An alternative layout with faculty office lining the side (east and west) walls of the space would allow for a brighter space with floor-to-ceiling windows on the inside and outside walls allowing one to see from one end of the building to the other side (and beyond).



A similar space (in terms of layout) can be envisioned for the computational chemistry center. The existing area of MH570, 564, and 556 will be converted into a large open space with faculty offices on the outer (South) wall of the building. A conference room (shared with CCAM) will be at the south-west corner of the complex and the open space will contain multiple computer stations in different configurations, surrounded by glass walls wherever possible. Locating the faculty offices on the side (east/west) walls would again allow for an even more-open space with views extending well beyond the MH exterior walls.



2b. Long-term vision: General Chemistry teaching laboratories. To provide students with a better opportunity to relate chemistry in the practical sense with what is learned in the classroom, a better integration of the laboratory component is needed. One way to do this is to make the laboratory space more integrated with the lecture spaces in the MH building. Currently, all our large laboratory teaching spaces are housed in DBH, however, moving the general chemistry teaching laboratories to MH would have several benefits. Students who walk by the lab can see chemistry in action for themselves and they do not need to go to another building that feels "foreign" to get that experience. The lab spaces can be designed such that they are attractive from the outside (hallways) and create interest from students passing by. Students who take CHEM 120A or 120B in MH-536/587 can walk down the hall to the lab. Because the new labs will be close to the Computational and Educational research lab areas, there will be an opportunity to connect the work done in a teaching laboratory to that in a research laboratory. The proposed teaching laboratories are similar to those found on the 3rd floor of MH (Biology teaching labs); 4 teaching laboratories (housing 24 students each) together with prep spaces and office space for staff and laboratory coordinators. In this model, MH-563 and 565 would be replaced by one lab; MH-512/514, MH-502/504, and MH-553 would be replaced by the other 3 labs spaces. The areas between those 4 lab spaces would be changed to provide support (lab prep) and office spaces (lab coordinators). Each lab would have 4 student work stations (6 students each) in an open setting. Along two of the walls are benches and fumehoods. Along one wall there will be the instructor station (computer) and a large display screen for presenting pre-laboratory information. The walls facing the hallways are envisioned to be mostly see-through to provide a more open space and also allows passers-by to see inside activities. A schematic of the proposed space is given in Appendix XV. One could imagine a visionary space in MH where the teaching labs and research labs are located together with floor-to-ceiling glass walls allowing for stunning outside views from almost anywhere in the area.

VII. Long-term Plans

A. Summary of long-term plan, priorities, and outcomes metrics

The Department recently outlined a number of goals as well as strategies and measurements/benchmarks. The goals were set up to align with the College and University goals and were identified as either priority 1 (focus on year 1-2), priority 2 (focus on year 2-5) and priority 3 (focus on 2025). The goals will be reviewed annually and adjusted as necessary. Specific attention is given to student success and issues the Department plans to focus on specifically (through a series of Departmental retreats) are:

1. Student preparation
    a. Improving the quality of incoming students in terms of math and chemistry skills;
2. Undergraduate research and alternatives as a High Impact Practice
    a. Increasing graduation rates while maintaining the undergraduate research requirement;
3. Infrastructure and Personnel
    a. Improving the current infrastructure (lab space, office space, classrooms, equipment, etc.) to attract and hire talented educators and increase graduation rates
    b. Increase technical support by hiring additional technical staff members for day-to-day instrument operation and maintenance
    c. Rising costs of general use items (gases, cryogenics)

Although these items are addressed in one or more of the Department goals listed below, it is important to emphasize a few items. The recession, budget deficits, and decline in overall state funding taking place over the last several years have made it difficult to maintain and improve our large and complex program which requires funding for high impact practices such as advanced laboratory courses and research. Because research is a required component for all of our degrees and involves faculty mentoring students, the Department continues to fund faculty members who actively involve students in their research programs. Nevertheless, the budget does not allow significant amounts to be used for this important purpose. One of the biggest issues has been dealing with the uncertainty of FTES targets and budget cuts. We have had to be quite innovative in saving costs without sacrificing quality. Limitations in space and the ability to efficiently renovate existing space (which is critical for student centered research and "learning by doing") and funding for needed equipment and infrastructure (vital for modern STEM training) remain very significant challenges. In fact, keeping the current equipment (both for teaching and research labs) in operational shape is presenting itself as one of the biggest challenges and this is a situation that seems to be getting worse every year. Some of our teaching labs are in danger of being cancelled if no funds are provided for replacement equipment. In recent years, we have been fortunate to secure significant equipment donations from the Drug Enforcement Agency, Allergan and Southern California Edison which has allowed us to modernize some of our programs. We are working toward developing scalable and sustainable research projects which meaningfully engage our students beginning at the freshman level in courses that feature the integration of teaching and research, but these efforts will only be successful if we can introduce students to modern instrumentation that is properly maintained.

The Department has been very successful in hiring several new faculty members over the past couple of years, however the Department continues to face challenges in terms of staffing. Additional faculty are needed to appropriately serve our growing student body. With a lack of research laboratory space, there is a solid argument to be made for hiring full-time lecturers who will buy in to the Department vision and become active participants at all levels. In addition, the Chair has brought up the possibility of hiring "teaching tenure-track faculty" in conversations with the Interim Dean and the Provost and he will continue to do this as it is a potentially very efficient way of better meeting the teaching demand and at the same time allow research active faculty to focus more of their efforts on integrating (more) students in their research programs as well as develop integrated research experiences in some of our courses.

Although the Department has been successful in hiring new faculty members, a greater need possibly exists in the area of staff. Despite huge growth in the major (and as a result the number and use of our teaching laboratories, equipment, etc.) no additional staff has been hired (in fact, at least one position was lost) and our current staff members are pushed well beyond the limit. It is absolutely essential that the University will address this issue and be more flexible in letting Departments and Colleges decide to hire in the area of greatest needs. If given the choice, the Department of Chemistry would hire one or two additional technical staff in order to keep up with maintenance and repair of existing equipment including hiring experts at dealing with equipment and computer interfaces. In addition, some of the modern equipment (e.g., the NMR and the LC/MS) are being maintained by faculty members (together with staff), which is not a good use of their time. An additional option that must be considered is to hire one or more experienced instrument technicians that will maintain the equipment, run samples (standardized) for both teaching labs and research labs, and teach classes related to the equipment. The Department offers several instrumentation classes every semester and it makes sense to have a person with significant experience in this area in charge. A flexible hiring policy would go a long way in providing a better future for the Department, its faculty, staff and students.

The Department's goals and priorities along with general metrics of accomplishment are identified below.

<u>Goal 1. Improve Student Success.</u>

a. *Develop and use advising surveys and exit interviews to improve programs and track student career choices (priority 1).*
   We have started the process by asking graduating seniors about their career plans; we send regular email notifications to graduating seniors (e.g., job opportunities). The Department Chair has started advising the students who have applied for graduation the following semester to speed up graduation checks and any exceptions that need to be made. This process will also allow us to implement a "formal" exit interview to

learn more about how we can better serve our students. In the fall of 2017 a survey was conducted to poll students about graduation rates, roadblocks, and success. The results are being analyzed and will lay the foundation for future surveys (more detailed) as well as strategies for improving student success.
Metric: Improve surveys and exit interviews. Start tracking students in CHEM 190.

b. *Allow for completion of capstone experience in summer (priority 1).*
All majors in our Department must complete a capstone experience. Most commonly this is met by participating in a research project under the mentorship of a faculty member. Several issues have arisen in recent years, including limited opportunities because of the increase in the number of majors. Students often have to wait until the end of their degree program to find a lab that is willing to take them. A rewarding lab experience often takes as long as two or three semesters and these issues combined can lead to students postponing graduation. Although the benefits of participating in a multi-semester research experience are plentiful, there are good arguments to be made for allowing students to complete this requirement in a shorter period of time. One obvious solution would be to have students complete the requirement in the summer. Until recently this was not possible due to logistics, however, working together with UEE we were able to reach an agreement to offer CHEM 495 (capstone research experience) in the summer of 2018 as a pilot. The agreement is set up such that students will pay a reduced fee (they only pay for the units they take rather than paying for 6 units) and part of the fees will come back to the Department to support the research advisor (supplies).
Metric: Identify students who qualify for summer capstone. Promote program and grow it to allow up to 10 students to complete the capstone in the summer.

c. *Continue to develop partnerships with industry to leverage research opportunities and career pathways for our students (priority 1).*
We have established better connections with the career center on campus via our former college career specialist (Michelle Levy). In addition, our CHEM 190 course has been very successful in bringing in speakers and visitors from local institutions. Our internship program is growing slowly to help with the increase in demand on our senior research program. Two faculty members (John Haan and Nicholas Salzameda) applied to the University for funding to get a formal internship established. Several efforts are being developed to create partnerships with nearby institutions such as KGI, Western, MBKU for partnerships, collaborations, or internships. We hope to connect with Western (through former CSUF faculty member Christina Goode) to formalize a research experience or internships for students interested in health professions. A similar effort will be undertaken with MBKU for opportunities in pharmaceutical sciences. We also plan to promote the internship program at academic and industrial institutions to our students in order to make this a competitive process.
Metric: Increase the number of internships to approximately 20 per year over a 5 year period.

d. *Develop a pathway for professional school careers to promote faster time to graduation (priority 1).*
Students interested in pursuing a career in the health professions end up taking numerous courses beyond those are needed for any of the existing degree programs. Most commonly students will be BS Biochemistry majors but that degree does not cover all the pre-requisites for entry into a professional program. We plan to investigate the possibility of developing a degree program that would cover all the required pre-requisites for the most common professional programs. Establishing such a program would allow students to move towards graduation faster. We will work with other Departments to determine programmatic needs and opportunities for a cohort setup. We will also work with the Health Professions Advising Office, which previously established a minor in Health Professions.
Metric: Investigate a potential 4 year pre-professional degree program (courses/study plan); complete study by end of summer 2019.

e. *Shorten time to degree by pinpointing bottlenecks in degree programs (priority 2).*
The information gained from the survey (Goal 1.a) will be used to start pinpointing potential bottlenecks in our degree programs. The initial survey provided interesting information but more detailed surveys are needed to get better information. The surveys will be done once a year (Fall semester) during the mandatory advising period. Students must complete the survey before meeting with an advisor. To prevent survey "burn out", the surveys and the questions will be kept short. The CHEM 190 class will be used as a testing ground for the survey. Each spring semester, an improved version of the survey from the previous fall will be made a mandatory assignment for the CHEM 190 students. The Department also plans to then follow the CHEM 190 students as they progress through the curriculum and obtain information from them directly (as a cohort).
Metric: Use survey to pinpoint bottlenecks each semester.

f. *Create ways to better screen, inform and prepare incoming FTF (priority 2).*
As discussed above, many students struggle in our program because of poor preparation in Math and Chemistry. Not being able to start in the appropriate courses sets students back immediately. Many students also have to repeat the classes when they do not pass them, creating more roadblocks. A great deal of these students eventually will change their major. Better preparation in Math and Chemistry would be desirable, however, out of our control unless we can work with the University to set entrance standards for our program or create a pre-Chemistry major where students must pass certain courses within a given timeframe to continue on as a Chemistry or Biochemistry major. A simpler option would be to set and strictly enforce Math pre-requisites for the lower division Chemistry courses (CHEM 120A/B). Because Math is an essential component of Chemistry, students who cannot complete the Math should not be able to continue in the major. Better educating our majors about the requirements and rigor of the degrees is also important. The best place to do this is in CHEM 190, which is a course taken by all students (it should be taken as a freshman or first year transfer student). The new CNSM 101 course will also play an essential role in this education aspect.
Metric: Evaluation of Math pre-requisite enforcement. Determine whether pre-chemistry degree pathway is possible (University).

g. *Recruit high quality faculty dedicated to working with and mentoring our students in the classroom and the research laboratory (priority 2).*
A critical issue for the Department in the next six years will be faculty recruitment. Strong growth in chemistry and biochemistry majors and overall FTES during current and previous review periods has not resulted in an overall increase in the number of faculty – see sections II.D. and IV.A. In general, each year at least one faculty member will be on sabbatical or difference in pay leave, which negatively impacts our ability to offer key courses for our undergraduate majors and staff important committees. The limited number of faculty available to supervise and mentor undergraduate students in the laboratory combined with the increase in majors, there has been a near doubling in the annual number of research students per faculty research lab to keep up with undergraduate student demand. The demand for research mentoring has overburdened not only faculty workload, but also the capacity of our physical lab facilities. Given the current enrollments (650 FTES) and existing Student Faculty Ratio (SFR) of 20.74, the Department should increase to 23.5 tenure-track faculty to fill the academic and discipline needs, assuming the Department allocates 75% of its FTEF to tenure-track faculty. With Dr. Stevan Pecic coming on board in the fall of 2018, the Department will be at 20 tenure-track and tenured faculty, leaving 3.5 positions available. Because of a severe lack of office and research space, the Chair also continues to make the case for hiring more full-time lecturers.
Faculty recruitment will be targeted to strengthen the Department's presence in existing and planned interdisciplinary research centers within the college and university. Collaborative, interdisciplinary, and even transdisciplinary approaches are now critical to making progress in important research areas (including

energy, climate change, and medicine). Many of our faculty have active collaborations and new faculty are encouraged to develop similar collaborative projects. Establishing formal working relationships with nearby research-intensive universities such as UC Riverside and UC Irvine would have several advantages for both parties including economical access to expensive and specialized equipment, training for students, faculty, and staff, and student recruitment from a diverse population. Particularly with respect to costly equipment, it makes good sense to share resources and avoid unnecessary duplication in area schools. The Department Chair has started attending the CSU Chemistry Chair's meeting and will use these connections effectively. In terms of hiring future faculty, this is especially a useful avenue since our graduates are familiar with the CSU system. Several of the CSU's have a large diverse pool of graduates that we can access through these connections.
Metric: Hire 3-5 new faculty members as outlined in section IV.

h. *Improve the time to degree for MS students (priority 2).*
Currently, many of our graduate students take significantly longer than 2 years to obtain their degree. There are numerous reasons for this, but one contributing component is the significant number of classes a student has to take for the research-based degree (MS). The Department is looking to modify the MS program such that all students take more generic classes (together to create a cohort) and fewer elective classes. The generic classes will be designed such that they can be taught by multiple faculty allowing for more regular offerings. Creating a research community for graduate students will also include providing graduate students (especially TAs) with a designated space for course prep work and office hours. We are currently investigating the use of an area in the basement as designated office hour space and a space in MH to set up cubicles for TAs to study and/or do course prep work.
Metric: Produce new MS and MA study plans. Propose new graduate courses.

i. *Give release time to faculty with significant advising workloads. Develop a College-based Advising Center where specific advisors from each department have office hours (priority 3).*
Mandatory advising of all our majors every semester has become a very significant undertaking that presents a significant workload for faculty members. Although many faculty members are excellent and dedicated advisors, it would be better to have a smaller number of dedicated advisors for all our majors. It is very important for students to get a consistent message, which is more easily accomplished when there is a set group of faculty advisors. It is essential to have faculty advisors because of the intricacies of the curriculum as well as the knowledge of potential careers and the appropriate pathways those require. Rather than having a 3- or 4-week period where advising takes place, under the new model it would be more of a semester-round event where students can walk in or they can set up an appointment. All students must still be advised every semester. With the current number of majors (and assuming there will only be very modest growth), it is estimated that a total of 5 advisors are needed (each advising 8 hours per week throughout the semester).
Metric: Identify motivated and talented faculty interested in advising students. Obtain release time from University or College for faculty advisors.

j. *Make more effective use of existing space by increasing shared and flexible lecture and lab spaces to better serve students and faculty (priority 3).*
Space issues are ongoing as we continue to hire new faculty and need to provide office and research space for them. For the past two years we were successful in bringing 3 new faculty members (6 total) on board, however, most of these were replacements and our space options are now very limited. Future goals and plans are limited because of the uncertainty with respect to the future renovation plans for the MH building. In section VI.B (page 37) above, we outlined our plans to create more office space in MH, as well as to convert some existing space into a computational chemistry or chemistry education space. Some opportunities exist in DBH where existing space can be modified to create additional space for new faculty

members, but none are enough to fill the need, nor are the spaces convenient for all areas of chemistry. Most of our teaching labs are housed in the DBH building; renovating MH to move and house the teaching labs there would free up significant space in DBH that can be converted to research areas. In fact, enough space could be freed up to allow other Departments to benefit from this as well.
Metric: Refurbish existing room into an active learning room. Purchase laptop computers to replace desktop computers. Schedule activity sections directly following lecture sections.

k. *Work towards a Research-Based Curriculum (integration of teaching-research) - enhance integration of teaching and research in lab courses and other activities to provide meaningful exposure for freshman and sophomores (priority 3).*
Research is a very important (and required) part of our curriculum which has proven to be beneficial for students in terms of retention and graduation rates. Having student involved in research activities earlier on will allow students to do better in their classes but will also provide opportunities for them to join a research lab sooner and complete the senior capstone in a more reasonable timeframe. The Department goal is to implement research-based experiments in our undergraduate lab courses. Faculty will be invited to contribute to these experiments and have them linked to their research programs to attract interested students. The ultimate (long-term) goal is to develop labs that build better on one another and are better connected to the lecture material as well as the development of integrated research projects to be carried out at the end of a semester lab course (to give students a better idea of research early on in the curriculum). To further encourage early participation in research, the Department is developing CHEM 195, which will introduce freshmen to research activities in a formal class setting. Students will be selected in CHEM 190 based on interest. In CHEM 195 they will be taught the basics of research, literature searches, notebook keeping, ethics and lab etiquette. They will also do formal rotations through research lab, writing up their experiences as an assignment. The goal is to get students excited about research early on so that they can join a research lab sooner, and work towards completing their capstone faster.
Metric: Develop research-based experiments with faculty input for undergraduate laboratory courses.

Goal 2. Support Student-Faculty Research

a. *Continue providing support for faculty with active research programs and student involvement from OE (priority 1).*
One of the Department's greatest strengths has been a strong emphasis on student-faculty research; all our degree programs are distinctive as some of the only undergraduate programs in the university to require all majors to complete a full undergraduate thesis based on original research. However, increasing numbers of majors and decreasing FT faculty places significant time and resource constraints on our faculty. A main part of the CSUF strategic plan is to enhance HIPs such as undergraduate research.
Metric – All majors complete thesis project. Develop research-based course alternatives to meet the capstone requirement.

b. *Promote early entrance into research labs for interested students (priority 1).*
Student retention and graduation rates are positively affected by research experiences and a major goal of the department is to giving real hands-on research experiences to our students at an earlier time in their academic career. This particular goal goes hand-in-hand with our desire to transform our curriculum to integrate teaching and research. As described above, our first attempts will be made in the near future by incorporating research-based experiments in our teaching labs. Other options include participating in programs specifically designed for incoming freshman such as the CHEM 195 course that will be developed.
Metric: Prepare CHEM 195 course proposal. Identify research cohort in CHEM 190.

c. *Formalize more internships and research opportunities for our students in local industry and other university partners--including Western, KGI, and Marshall B Ketchum U, etc. (priority 1).*

As a result of increasing demand (growing number of majors), additional ways to meet the capstone research requirement are needed. Our internship program is growing slowly to help with the increase in demand on our senior research program. In addition, several efforts are being developed to create partnerships with nearby institutions such as KGI, Western, MBKU for partnerships, collaborations, or internships. We hope to connect with Western (through former CSUF faculty member Christina Goode) to formalize a research experience or internships for students interested in health professions. A similar effort will be undertaken with MBKU for opportunities in pharmaceutical sciences. We also plan to promote the internship program at academic and industrial institutions to our students in order to make this a competitive process.
Metric: Establish connections with Western University of Health Sciences and Marshall B Ketchum University.

d. *Develop integrated lab courses to expand capstone experience opportunities and support faculty research activities (priority 2).*
Similar to Goal 2.c, another way to provide additional ways to meet the capstone requirement is to have students participate in a research-intensive integrated lab course. For several years we have offered CHEM 472B (Advances in Biotechnology Laboratory) as such a course. As part of a proposed emphasis in medicinal chemistry we are looking to develop a Medicinal Chemistry Laboratory course, which can be used as the capstone experience. Planning of this emphasis is in the initial stages. We have obtained grant support from Allergan and the Department of Defense (equipment).
Metric: Implementation of the proposed lab course; identification of appropriate lab space to house the new equipment.

e. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, collaborations, and career pathways for our students (priority 2).*
This goal is tightly connected to goals 1.c and 3.d but the emphasis is on collaborations and sponsorships. We hope that by establishing new partnerships, some funds or equipment donations will be made to the Department.
Metric: Establish connections with Western University of Health Sciences and Marshall B Ketchum University.

f. *Integration of teaching and research – involve faculty research projects in lab classes (priority 3).*
This goal is tightly connected to goals 1.k and 2.d but the emphasis is on the faculty research component.
Metric: Develop research-based experiments with faculty input for undergraduate laboratory courses.

g. *Look for alternative methods to provide funds for new equipment used in teaching and research (priority 3).*
The existing infrastructure of the equipment in our teaching and research laboratories is very poor and getting worse every year. No significant influx of funds is expected from the State and grant opportunities alone are not sufficient to change the pattern. Without State support, other ways need to be found to maintain our current equipment and to acquire new equipment. To provide better maintenance and support, additional technical staff is an absolute must. The College must work with the University administration to allow more technical staff to be hired. Our College is inherently dependent on technical staff for all our teaching and research needs, yet we are critically understaffed, and the current staff is overworked. We will explore obtaining new equipment in a variety of ways. If the Department is allowed to carry forward funds, it is possible to save up enough funds to make larger purchases that are deemed absolutely essential. In addition, we will explore potential partnerships with equipment companies such as Shimadzu and Agilent. Specifically, we will investigate the possibility of leasing scientific equipment agreements rather than purchasing it. Another option would be to establish a named (sponsor) center that consists of equipment donations.

Metric: Identify and contact potential equipment suppliers. Learn about equipment leasing opportunities. Invite Internship providers to poster sessions.

h. *Increase number of graduate students for MS and MA programs (priority 3).*
The graduate program has significantly decreased in size compared to several years ago. A healthy program should have 40-50 students with approximately 10-5 students graduating each year. A potential reason for the lower numbers could be reputation. Many of our students take a long time to graduate and combined with the relatively high entrance barrier, students may likely go elsewhere. An additional problem is the relatively low TA salary we offer in our Department (significantly less than other Departments in the College). To make the program more attractive to potential students, we will need to improve in all these areas – review the entrance requirements, a shorter pathway to graduation (2-3 years); more competitive TA support (funding); and better recruitment. Another option is to explore potential partnerships with local UC's where our MS program is considered a guaranteed pathway towards entry into the PhD program.
Metric: Produce new MS and MA study plans. Propose new graduate courses. Establish equal pay for all TAs in the College. Reach out to local UCs to discuss pathway opportunities. Renovate space for TA offices.

Goal 3. Actively Support External Fundraising

a. *Encourage and support faculty to write grants, travel to relevant meetings and high quality sabbatical requests (priority 1).*
Given the State budget crisis and the costs of research supplies, equipment, and training of students, it is absolutely essential that the faculty aggressively pursue additional support from external sources, including federal and private sources. The department has had a successful history of obtaining research and student training grants from both the NSF and NIH and more recently from HHMI and a number of faculty members (both new and more experienced) should be well poised to compete for more State and Federal funding; we also plan to work with Development Director Michael Karg to identify and apply for additional support from private foundations and donors. Recent successes include a grant from Allergan (for our soon to be established medicinal chemistry emphasis), a funded proposal from the Department of Defense for equipment, and a NSF Major Research Instrumentation award. Faculty are also successful in obtaining funding for teaching activities (e.g., introducing technology in the classroom; use of high impact practices; etc.) The level of grant activity in the department is fairly high (19 grants in 2015-16 for a total of $700,000), however, a continued level of activity is absolutely necessary. Small intramural grants are good sources for small amounts and provide useful grant writing experiences. The success rate for our department for these grants is very high (100% in 2015-16; well above 75% in previous years). While we realize that achieving substantial increases in funding will take time, it must remain a high priority. The Department continues to support research active faculty to continue their research and travel (faculty and students) to conferences. Other areas where the department and college provide support is for attending grant writing seminars and visits with program officers. The University also offers several internal grants to support research and travel (for faculty and students). We always strongly encourage faculty and students to apply for these opportunities. Finally, the department is a strong supporter of sabbatical leaves and has been successful in obtaining these.
Metric: Establish Research Committee to identify grant opportunities (together with Research Office). Promote formation of Departmental research grant writing support group.

b. *Promote opportunities for junior faculty in first two years to participate in grant writing workshops offered by CUR (priority 1).*
For the past two years we have supported faculty members attending the grant writing workshop offered by the Council for Undergraduate Research (CUR). Although the Department and College have supported other grant writing workshops and seminars, this particular workshop is more beneficial for our faculty because it is geared towards faculty from PUIs. The faculty who have attended the workshop have been very positive

about their experience and we expect to see positive results from these efforts in the coming years. The Department will continue to offer travel funds to new faculty in their first two years to attend CUR workshop. Ideally, this will become part of the contract for new faculty members and funded/supported by the University Administration.
Metric: Create line item in budget for grant writing workshops. Obtain University or College support for funding.

c. *Continue to hold alumni events to friend raise and fundraise (priority 1).*
In April of 2015 we organized our first alumni day. It was a great success for which we received lots of positive feedback and attention in the media. It was followed by our second alumni day in April of 2016 at which we presented our first alumni award (to Dr. Eric Streitberger). Again, the feedback from the attendees was overwhelmingly positive. In October of 2017 we organized our first Alumni Dinner, which was held at Bootlegger's Brewery in downtown Fullerton. The event was very well attended, and the Department plans to continue this format for the coming years. We aim to continue organizing annual events to maintain and improve the connections with our alumni and our focus is on the more recent graduates (last 10-15 years). We have also created a better social media presence (improved website; Facebook page) and plan to continue further in that direction. Over time we will focus more on the fundraising aspects to obtain funds to support our undergraduate research program.
Metric: Establish alumni relations committee to organize alumni events. Aim to raise $10K per year in 5 years

d. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, and collaborations (priority 2).*
As indicated above, we have been fortunate to receive several pieces of equipment from local laboratories, however, this is not a long-term solution to keep our curriculum and facilities in good shape. In addition to obtaining funding from external sources (federal agencies, private foundations), we will need to continue looking for other opportunities to improve and modernize our laboratories. A curriculum that is focused on integration of teaching and research is the likely way forward as it will allow us to pursue state-of–the-art equipment and teach our students how to use it properly making them better candidates for graduate schools and industrial positions. We hope to keep making new connections (in part through our new internship program and maybe through our alumni) to increase these opportunities. The internship program will also be instrumental in forging better ties with local companies. In order to achieve these goals, it is essential that we improve our alumni database and better track our students. Having exit interviews with graduating seniors is one step in this entire process. Continuing our alumni day and advertising other department events and successes is also important. We hope to identify alumni and other leaders in the local industry and alert them to gifts-in-kind as ways to donate to and support the Department; this way we plan to seek support for undergraduate research, internships, seminar program, and graduate scholarships.
Metric: Identify partners in industry, alumni, internships, etc. and reach out to promote the idea of equipment donations and other in-kind gifts.

e. *Expand Department publicity (social media, pictures, stories, etc.) (priority 2).*
Many of the goals listed above involve our alumni. Continuing our alumni day and advertising other department events and successes is important and social media play an increasingly important role. To stay in touch with alumni, it is essential that we improve our alumni database and better track our students. Our website is being updated and the Department also needs to review its current social media accounts. Access is currently restricted, and we need to find a way to allow faculty to post items regularly. We aim to establish a Newsletter soon and work on ways to get quick feedback from our alumni on pressing issues.
Metric: Create or update social media pages with access for multiple faculty. Publish a newsletter once a year for now and twice a year in 3-5 years.

f. *Hire full-time lecturers or tenure-track teaching faculty to provide more time for research activities for research active faculty through integrated science courses (priority 3).*
Part-time lecturers (adjunct faculty) play an important role in educating our students. Although the majority is involved in teaching GE courses, some do also teach our majors in important fundamental courses. As discussed earlier, the number of part-time instructors has gone up dramatically in recent years as a result of a growth in the major as well as growing numbers of other majors who take our classes. Because the number of full-time faculty (tenured or tenure-track) has remained the same, the only way for us to offer enough classes is by hiring part-time instructors. Most part-time instructors have obligations at multiple institutions, which is less beneficial for CSUF and our students. Hiring full-time instructors with specific responsibilities in the Department (including service) could potentially generate a community of instructors "loyal" to CSUF. At the UCs it is now common to hire "teaching-track" faculty; this is a model the CSU should consider as well. Although this would require a different RTP model (no or different Scholarly and Creative Activities), it seems a feasible and attractive alternative for bringing in talented instructors.
Metric: Hire 2-3 full-time instructors.

B. Long-term budget in support of long-term plan and priorities.

Below we outline the expected cost estimates for new "budget" items in our long-term priority list. Decreased budgets due to limited state, University, and College resources over the last 10 years has severely limited general operating expenses (excluding equipment and service expenses for new faculty start-up packages) and has led to the decline of maintenance and/or replacement of Department teaching equipment. Likewise, staff are working continuously to repair and maintain the existing equipment but are overworked because no additional staff members can be hired. New CSUF strategic plan-driven mandates will mean that considerable time be given to assessment and advising duties. The cost estimates below are fiscally modest but reflect some of the needs to meet our priorities – however as our Department keeps growing in terms of majors, our basic operating expenses will likewise increase, especially in terms of meeting part-time faculty blanket for part-time instructors and TAs to assist in teaching lecture, activity and laboratory courses.

Goal 1. Improve Student Success.

a. *Develop and use advising surveys and exit interviews to improve programs and track student career choices (priority 1).*
No anticipated extra costs

b. *Allow for completion of capstone experience in summer (priority 1).*
Up to $500 allocation per student for faculty research support; $5,000 maximum (10 students) per year.

c. *Continue to develop partnerships with industry to leverage research opportunities and career pathways for our students (priority 1).*
No anticipated extra costs

d. *Develop a pathway for professional school careers to promote faster time to graduation (priority 1).*
No anticipated extra costs

e. *Shorten time to degree by pinpointing bottlenecks in degree programs (priority 2).*
No anticipated extra costs

f. *Create ways to better screen, inform and prepare incoming FTF (priority 2).*
No anticipated extra costs

g. *Recruit high quality faculty dedicated to working with and mentoring our students in the classroom and the research laboratory (priority 2).*

Start-up, new faculty release time: costs vary. We plan to hire 4-5 new faculty over the next six years. Each of these will have associated start-up costs depending on discipline. Current start-up costs are about $100,000 per new faculty in Chemistry and Biochemistry, excluding lab remodel costs.
Office space remodel: costs vary depending on amount of remodel (for example, removing a fumehood from a room). Up to $40,000 per space.
Faculty search costs: $5000/search. Includes advertising and interview costs.

h. *Improve the time to degree for MS students (priority 2).*

No anticipated extra costs

i. *Give release time to faculty with significant advising workloads. Develop a College-based Advising Center where specific advisors from each department have office hours (priority 3).*

Assigned time: 30 WTU/year = $142,000/year. Up to 5 faculty members will be given release time each semester to act as dedicated advisors throughout the academic year. Advising every student once per year would cut the cost in half.

j. *Make more effective use of existing space by increasing shared and flexible lecture and lab spaces to better serve students and faculty (priority 3).*

Classroom remodel: $40,000 (new furniture for active learning; whiteboards around the room; multiple displays in the room with computer access. Laptop computers (25) to replace desktop computers: $12,500.

k. *Work towards a Research-Based Curriculum (integration of teaching-research) - enhance integration of teaching and research in lab courses and other activities to provide meaningful exposure for freshman and sophomores (priority 3).*

Promotion of research activities: up to $3,000 per year once established.

<u>Goal 2. Support Student-Faculty Research</u>

a. *Continue providing support for faculty with active research programs and student involvement from OE (priority 1).*

Support research-based courses for capstone requirement: up to $3,000 per course per year.

b. *Promote early entrance into research labs for interested students (priority 1).*

No anticipated extra costs

c. *Formalize more internships and research opportunities for our students in local industry and other university partners--including Western, KGI, and Marshall B Ketchum U, etc. (priority 1).*

No anticipated extra costs

d. *Develop integrated lab courses to expand capstone experience opportunities and support faculty research activities (priority 2).*

Support research-based courses for capstone requirement: up to $3,000 per course per year.

e. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, collaborations, and career pathways for our students (priority 2).*

No anticipated extra costs

f. *Integration of teaching and research – involve faculty research projects in lab classes (priority 3).*

Promotion of research activities: up to $3,000 per year once established.

g. Look for alternative methods to provide funds for new equipment used in teaching and research (priority 3).
Leasing equipment, if possible, could cost as much as $20,000 per year for a significant number of instruments.

h. Increase number of graduate students for MS and MA programs (priority 3).
No anticipated extra costs for program development (new courses, study plan modifications).
Renovation cost for TA office space: $20,000 (cubicles, IT infrastructure (wireless or wired connections)).

Goal 3. Actively Support External Fundraising

a. Encourage and support faculty to write grants, travel to relevant meetings and high quality sabbatical requests (priority 1).
No anticipated additional cost.

b. Promote opportunities for junior faculty in first two years to participate in grant writing workshops offered by CUR (priority 1).
No anticipated additional cost. Line item would be approximately $2,000 per year for every faculty member.

c. Continue to hold alumni events to friend raise and fundraise (priority 1).
No anticipated costs to Department. We will utilize philanthropic and IDC funds for alumni outreach efforts.

d. *Continue to develop partnerships with industry to leverage sponsorships, equipment donations, and collaborations (priority 2).*
No anticipated additional cost.

e. Expand Department publicity (social media, pictures, stories, etc.) (priority 2).
No anticipated additional cost.

f. Hire full-time lecturers or tenure-track teaching faculty to provide more time for research activities for research active faculty through integrated science courses (priority 3).
Faculty salaries; no start-up cost anticipated. Professional development costs: $2,000 per faculty member (once every 3 years).
Office space remodel: costs vary depending on amount of remodel (for example, removing a fumehood from a room). Up to $40,000 per space.
Faculty search costs: $5000/search. Includes advertising and interview costs.

VIII. Appendices Connected to the Self-study

Attached PDF files