

Submission date: 2/10/2020

Program/s in this review: Chemistry, BS _____

Specialized accrediting agency (if applicable): NA _____

Campuses where the program is delivered: Anchorage, main campus _____

Members of the program review committee:

- Colin McGill, Associate Professor and Chair, ANC
- Pat Tomco, Assistant Professor, ANC

1. Centrality of Program Mission and Supporting Role

Relevancy of the program. Chemistry is central to intellectual and technological advances in many areas of science. The traditional boundaries between chemistry subdisciplines are blurring, and chemistry increasingly overlaps with other professions. An important goal of chemistry is to provide students with the tools to solve problems. Students are taught how to define problems clearly, develop testable hypotheses, design and execute experiments, analyze data, understand fundamental uncertainties, and draw appropriate conclusions. Throughout the curriculum, students are challenged to apply their understanding of chemistry and use appropriate laboratory skills and instrumentation to solve problems. UAA chemistry has taken the opportunity to design innovative curricula that meets the needs and interests of its students and community.

Role the program plays in supporting other academic programs. Based on the current UAA catalog, 15 Bachelor's degrees programs require at least one lower division chemistry course, and 3 Bachelor's degree programs require at least one upper division chemistry course. A large number of students who take chemistry courses are NODS, taking classes required to apply for medical school and other programs. Over the last 7 years the UAA Chemistry program has delivered the 5th most SCHs by a CAS program. This is primarily in support of (1) lower division Tier II GER courses and (2) upper-division credit requirements. Chemistry supports a wide range of other academic programs; between Fall 2017 and Fall 2019, 95 different majors took a chemistry course offered by CAS at the UAA main campus. The distribution of these majors and their relative percent of total CHEM enrollments for the 10 most enrolled programs are:

• BIOS	N=1056, 19.0% of total
• PMNS	N= 711, 12.8% of total
• NSCI	N=546, 9.8% of total
• MECH	N=424, 7.6% of total
• PMHS	N=383, 6.9% of total
• NODS	N=382, 6.9% of total
• CIVL	N=280, 5.0% of total
• CHEM	N=186, 3.3% of total
• PMDH	N=137, 2.5% of total
• EXPM	N=135, 2.4% of total
Sum of top 10:	N=4240, 76.3% of total

UAA Chemistry clearly supports Natural Sciences, Health Sciences, and Engineering programs. Outside of the top 10, 85 other majors accounted for the remaining CHEM enrollments, which is considerable support with both depth (large number of STEM programs) and breadth (large diversity of programs served).

Partnerships with outside agencies, businesses, or organizations. Among several partnerships, we wish to highlight one with the Alaska State Crime Lab. This group provides subject matter experts for student research projects, developed collaboratively with UAA faculty, and executed at UAA. The primary aim is to develop new analytical

procedures that can be implemented routinely into future Crime Lab operations. A paid student internship program builds forensic chemistry skills to provide a pathway to employment in their lab, which has a continuing labor demand.

Specific workforce development and employment opportunities relevant to the program. UAA Chemistry strongly supports priority programs in health and engineering via delivery of required courses. UAA chemistry graduates routinely enter health fields. A survey of upper division chemistry majors at UAA indicates 90% intend to pursue a health profession. Our goal is to provide a foundation on which our graduates can build their personal and professional goals, whether working as a chemist or using the degree as a platform to pursue other goals.

Sources of extramural support and funding for the program. The chemistry department has two tenure-track faculty that support a combined \$1M in research awards, grants, and contracts. Externally funded research programs in Chemistry are provided by federal sources (NSF, NIH, Dept. of Homeland Security, and USDA) that focus on an array of applied, multidisciplinary efforts. This enables collaborative partnerships with the US Coast Guard, Department of Environmental Conservation, Dept of Fish & Game, and others. These research efforts more than cover the research time CAS allocates to these faculty's workloads, support graduate students/postdocs, and provide high-impact learning opportunities for undergraduates. We hope to convert the NMR and mass spectrometer in ASET to 'recharge center' status to fund maintenance and provide external support of Chemistry's upper division laboratories and undergraduate research.

Any high demand job designation for the program. Among several high-demand designations for a degree in chemistry, we wish to highlight the 6:1 ratio of pharmacy jobs to pharmacists in Alaska, among the highest in the nation.

2. Program Demand (including service to other programs), Efficiency, and Productivity

Seven year degree award trend and major enrollment trend. As of January 2020, BANNER indicates 60 actively enrolled Chemistry majors. Since program suspension in 2014 and reactivation in 2017, we have seen a significant upward trend in both majors and graduates over the past 3 years. The distribution of active majors by academic class currently indicate:

- Freshman 28
- Sophomores 7
- Juniors 10
- Seniors 15

The students with senior status have increased significantly as a result of re-activation in 2017, indicating a recovery of the program. Our first new cohort is on track to graduate next year. It is reasonable to expect a 4-6 year lag in graduates following the reactivation of a program due to the time inherent in delivering a degree and the challenges associated with recruiting new majors following a recent suspension of admission. Therefore, the degree and major enrollment trend over the past 7 years cannot be accurately explained with a simple trendline. Consideration of the impact of suspension/re-activation must be given. We point to the following timeline to support this statement:

2012:	The chemistry curriculum was comprehensively revised to reduce perceived graduation barriers.
2012-2014:	The number of chemistry majors increased by 70 students in two years, peaking at 108 in 2014. Nearly all selected 'Biochemistry' emphasis over 'classical chemistry'.
2014:	Prioritization leads to suspension of admissions and initiates a 'teach-out' of existing majors. A majority of newly admitted majors opt into other degree programs or leave UAA
2014-2016:	Multiple faculty retirements and faculty attrition occur. An all-time high of contingent: tenure-track faculty ratio (11:2) is reached in Spring 2016.
2017:	Admission is reactivated for chemistry (biochemistry emphasis) following three new tenure-track hires and retention of one faculty who rescinded a resignation notice.
2018:	Curriculum is revised to broaden acceptability of elective requirements, decrease credit load, and eliminate mandate of independent research credits.

2019-2020: Three students are awarded chemistry degrees during F19, two more file for graduation in Spring 2020 (5 graduates total in AY 19-20)

The data clearly indicates that the decline in graduates over the review period was caused by the suspension of admission to the program and the time inherent in progressing a new cohort of majors through the curriculum following its reactivation. Through this period, we have evidence for the effectiveness of the updated Chemistry curriculum at attracting majors and promoting an effective path to graduation. Graduation rates nearly doubled following the 2012 curriculum revision when compared with longitudinal historical data from 1980 to present. *Of the Chemistry graduates during the 40-year historical period, nearly 1 out of 3 of those Chemistry graduates obtained their degree in the last 7 years.* Our further revisions from 2018 are expected to continue this trend.

Credit per degree. The mean credits per degree for baccalaureate degrees at UAA over the review period was 120.2 credits. For Chemistry, Biological Sciences, Geological Sciences, and Natural Sciences the mean is 130.5 credits. Chemistry is slightly higher at 135.8 credits, which is surprising since our recent program revisions of 2012 and 2018 decreased the minimum credit requirement to 124 and 120, respectively. We suspect that students who were caught in the ‘teach-out’ and ‘transition’ periods of 2015-2019 can explain instances of larger credit load. Those who switched away from chemistry at a late stage in their degree path, then switched back to chemistry when it became available again after accumulating credits in a different degree had larger credit loads than needed. Our post-reactivation cohorts should graduate with a significantly lower number of credits. This information may not be apparent by an assessment of the data over the review period due to the intermittent degree suspension.

Course pass rates. Chemistry is a genuinely challenging topic and deals with concepts that have perceived limited intuition. Success in chemistry courses requires students to interpret problems, identify appropriate models to address problems, and correctly predict solutions. Which, requires a sound foundation in reading, critical thinking, mathematics, sound time management, and studying skills. Because of this, DFW rates in Chemistry are higher than average for UAA and CAS in general for both lower- and upper- division courses. Developmental chemistry courses are comparable with other developmental courses at CAS (41.9% vs 39.2% DFW, respectively). Lower division CAS Chemistry courses had a DFW rate over the review period at 31.8%, which is comparable to other physical sciences e.g. Physics at 32.9%.

Chemistry has received commendations from CAS Assessment leads each year over the past 3 years for their commitments to addressing DFW rates at all levels of instruction. With a new focus on assessment practices and analytics since re-activation, the chemistry program has taken several recent steps to reduce DFW ratios in our courses:

- Mathematics prerequisites have been increased. Math skills are the single strongest predictor for success in chemistry nationally.
- A new learning platform, ALEKS, was adopted for 100-level courses which continuously assesses students’ level of skill and concept mastery, then tailors their practice to provide extra content in weaker areas.
- We encouraged new instructional efforts to align classroom examples, practice problems, and assessment problems.
- We are piloting a model of Peer Learning Assistants, upper division students who work with the course instructors to deliver extra contact time for students outside of class.

Internal demand. A majority of students who take 100-299 and 300-499 level chemistry courses do so “In Major,” at 71.18% and 81.99%, respectively. This is a noticeably different trend than what is typical of CAS as a whole, with only 41.4% of 100-299 level courses and 71.63% of 300-499 level course taken “In Major.” The data indicates that, although Chemistry delivers the 5th most SCH within CAS, not many students casually take chemistry courses. This indicates that of the SCH delivered a substantial majority are required for the students’ degree paths.

SCH. Over the last 7 years, the chemistry program has delivered the 5th most SCH among CAS programs. Over that time period enrollments have steadily declined. UAA-wide annual SCH production decreased from 381,009 in 2013 to 304,502 in 2019, a 20.1% reduction. In CAS annual SCH decreased from 148,126 in 2013 to 105,222 in 2019, a 28.9% reduction. Chemistry courses taught within CAS produced 7,262 SCH in 2013 and declined to 6,478 SCH in 2019, a decrease of 10.8%. Despite the decrease in SCH delivered, the Chemistry program is exhibiting significantly less attrition

than CAS or UAA as a whole. This is likely due to a combination of Chemistry supporting high demand degrees which require chemistry courses.

SCH/FTEF. Within CAS the Chemistry program is the 5th most efficient at delivering its SCH, based on SCH/FTEF ratio. The only program which both delivers more SCH and does so more efficiently is Biology. Chemistry has spent the last several years evaluating course sizes, frequency of offerings, and staffing to improve efficiency while delivering course offerings which meet student needs and maintain pedagogical priorities.

Class size, Cost/SCH, (80% tuition – institutional cost). In 2019, the mean class sizes for UAA and CAS were 16.4 and 18.2, respectively. The Chemistry program has class sizes well above average, at 24.2, despite the high volume of instructional laboratories. Over the period of review, the mean Cost/SCH for UAA and CAS were 210.8 and 187.7, respectively. The Chemistry Cost/SCH over the same timeline was 133.6. The reduced Cost/SCH was realized through carefully managing course offerings and lab sections, increasing class sizes in face-to-face and online sections, and using term and adjunct faculty for a majority of lab instruction. Chemistry brings in more 80% tuition revenue than our institutional cost, averaging 21.7% more revenue than cost over the review period. In AY19-20 Chemistry courses brought in \$848,977 in 80% tuition with salary and benefits of \$607,779, putting the program revenue-positive \$241,198 (39.7% over cost).

External demand. The skills and knowledge obtained by chemistry undergraduates allows students to pursue a large variety of career paths. Many choose to obtain additional education to fulfill the growing need for chemists in healthcare and manufacturing. The sustained growth chemistry-dependent sectors will continue to drive the demand for undergraduate chemists, especially biochemists who can perform well in both sectors. National trends of recent chemistry graduates who went pursued an advanced degree showed the top 3 options were graduate school (31.0%), followed closely by those going into medicine (27.7%) and pharmacy (12.9%).

3. Program Quality, Improvement and Student Success

Currency of the Curriculum and Innovative Program Design. UAA Chemistry comprehensively updated its curriculum in 2017. We have taken the opportunity to design innovative curricula that meets the needs and interests of our students and community by defining a biochemistry concentration. The curriculum of the UAA chemistry program provides both a broad background in chemical principles and in-depth study of biochemistry. Highlights of the program strengths that differentiate it from other courses of study at UAA include the following:

- Biochemistry is a 3 course, two semester sequence that builds depth competencies in lecture and laboratory.
- Biological emphases are incorporated into Inorganic, Physical, and Analytical Chemistry courses.
- Seminar contact was recently increased to 2 semesters. This has shown an improvement in student outcomes in communication, awareness of career opportunities, and an arena that allows students to articulate their goals and receive feedback in a supportive group setting.
- Experiential learning models were adopted for Analytical chemistry, Instrumental Analysis, and Seminar.
- Mathematics requirements were adjusted and a statistics requirement was added.
- Accepted upper division electives were broadened, allowing for multiple paths to graduation

The Chemistry program obtained a major upgrade with a 400 MHz NMR following support from a combination of financial sources, which significantly upgraded the Organic laboratory. All students that take upper division chemistry labs utilize the modern analytical tools in ASET. Students become proficient in the use of chemical instrumentation to study the complex issues relevant to modern scientific inquiries. The NMR was installed in 2018 and is consistently and positively noted in student surveys.

Availability and indications of quality of distance offerings. UAA Chemistry recognizes the need for quality distance options, particularly for GER courses. We currently offer online options in ChemA054/055, A103, A104, A105, and A106. The faculty who deliver online courses have been given stable workload assignments to refine these courses. One bipartite faculty member has moved to 100% online to facilitate this specialization. Consistency is key for ensuring our faculty can deliver the best online course possible; the setup of an online course takes significant resources. The less online teacher turnover we experience, the better student experiences

are. Online chemistry faculty have credentials which include a Master's in Education, Quality Matters Certifications, and other continued education regarding effective online instruction and implementation of our adopted educational platforms. The department is iteratively evaluating and updating its approach to online education using data-driven analytics. Evidence of success in delivering 100-299 level chemistry is clear. The DFW rate for our online courses is 33.7%, comparable to our face-to-face offerings at 31.4%.

Program Student Learning Outcomes assessment. Since our program is still (but nearly complete) in rebuilding, we primarily point to the increased student enrollment in the biochemistry emphasis degree as the strongest evidence that we are doing things well. We have developed a program that matches the interests of our students with the programs and workforce opportunities they wish to pursue. Considering that most of our majors do not intent to become chemists and thus can choose any program for their undergraduate degree, the fact that they chose chemistry demonstrates an intrinsic value in the major. The student's self-selection is evident.

In addition to metrics of program recovery, DFW/pass rate trends, and enrollment trends, UAA Chemistry widely implements the nationally standardized ACS exam as a tool for comparing our educational outcomes to those on a national scale. Chemistry students at UAA routinely score at or above the national average on ACS exams in General, Analytical, Organic, and Biochemistry. This is particularly impressive considering our open-enrollment designation. Future program revisions will require the use of these exams to provide more comprehensive data and to correlate course grade distributions to a nationally-held standard.

Notable changes we have made to the way we administer the program to improve student success include:

- Decreasing the credits required for the degree to 120.
- Increasing the minimum Math prerequisite for entrance into 100-level chemistry but allowing a substitution of sufficient ALEKS math score to facilitate transfer students.
- Adopting experiential learning practices in numerous courses.
- Facilitating undergraduate research through imbedding students in funded projects and encouraging them to write Undergraduate Research Proposals to the UAA Honors College and Office of Undergraduate Research and Scholarship.
- Collaborating with the AK State Crime Lab and AK Dept of Fish & Game.
- Adopting OER texts and materials.
- Integrating 100-level laboratory course manuals into Blackboard, now free to students.
- Eliminating fees when possible.
- Encouraging faculty specialization in online delivery of GER chemistry.
- Incorporating an adaptive learning platform to individualize student learning experiences.
- Developing Chemistry A054 to specifically address essential skills associated with success in 100-level chemistry.
- Piloting Peer Learning Assistants (PLA) in courses with high DFW rates to provide students with increased contact time and peer mentorship.
- Enhancing the ACS student chapter engagement in significant community outreach.
- Initiating a search for a bipartite tenure track faculty to bring specific expertise in face-to-face and online chemistry instruction and outreach.

The chemistry department remains focused on improving D, F, and W rates, especially in first-semester general chemistry courses. This is a complex issue and our many conversations are inclusive of term and adjunct faculty, who perform the majority of our instructional duties at these levels. These conversations have lead to us evaluating (and re-evaluating) the utility of course prep remediation materials. A recurring theme brought up by Chem 103 and 105 instructors was students exhibiting poor performances on the first exam of the semester, stemming from lack of preparation and/or prerequisite chemistry knowledge. We began assessing the utility and implementation of ALEKS ChemPrep, a third-party assessment and remediation platform for students wishing to enroll in Chem 103 and 105. Our hope was that when implemented, ALEKS would allow students to track through their degree programs without spending excessive amounts of time taking remedial coursework. After implementation, we have not noticed any significant changes to our D,F, and W rates. We are currently assessing

whether this is due to ALEKS not having been a required component of the course (simply offered as a supplemental tool), or whether the ALEKS module itself is perceived by students as a barrier instead of a gateway. Our prior assessment efforts have indicated that ACS scores normalize to national averages when ACS exams are administered not as a supplement, extra credit, or option, but as a recorded grade with significant weight on the student's course performance. So, we assume that a change in implementation would affect DFW rates. However, our student surveys indicate "buy-in" is particularly low with this platform, and that there may be other more streamlined options that are less costly to students.

Excellence in outreach. Building community within a student body is an essential aspect of growing and sustaining a program. Students, like all people, need community and support for each other as well as purpose and opportunity to share with others. Over the past three years, we have developed innovative new outreach opportunities for chemistry majors to collaborate with National, Local, and University sections of the American Chemical Society (ACS), National Institute for Informal STEM Education, and local outlets such as the Anchorage Museum and Girls Scouts of America. This has resulted in several national awards from the American Chemical Society (ChemLuminary national competition) for outreach programs that connect chemistry undergraduates with young (and old) learners from all across the state of Alaska. During this time, 79 UAA undergraduate students have received formal outreach and protection-of-minors training. They have brought the joy of topics such as fluorescent slime, moving molecules, colorful chemistry, and many other activities to over 9600 community members across Alaska during 12 annual outreach events. The most well-attended events included UAA STEM Day in early October, National Chemistry Week in late October, UAA STEM Expo in April, and several Girl Scout STEM events. In recognition for these activities, the chemistry department and affiliated student club has been awarded several local and national awards, including National ACS CHEMLuminary award for "outstanding outreach event organized by a student chapter" in 2019, National and Local ACS Outreach Volunteer Award in 2018, National ACS recognition for outstanding student chapter in 2016-2019, and National Institute for Informal STEM education chemistry outreach award in 2018.

Undergraduate research is at an all-time high despite no longer being required. An interesting development since re-activation has been that despite removing Chem 498 as a required course, we have an all-time high in students who request to take Chem 498. We believe students are seeing the value of undergraduate research opportunities and being proactive in building their own self-perceived needed skillsets. We think this ties in with our other findings that despite having a litany of options at UAA to pursue their professional interests, many students choose chemistry because they are adamant that biochemistry is the most-suited option for obtaining their desired skillsets.

4. Program Duplication / Distinctiveness

The B.S. program at UAA is a degree in Chemistry with a concentration in biochemistry. UAF offers a B.S. program in Chemistry, with the vast majority of their majors electing to declare either "classical" or "environmental" concentrations, with very few "biochemistry" majors. UAS does not offer a degree in chemistry. Particularly important to this discussion is the unique niches and state-needs each campus fulfills within their respective mission. Given UAA's strong emphasis on the teaching of Health Professions, UAA's ***biochemistry*** program as an exclusive option fits well within this niche; most of our students plan to enter health and biomedical professions after graduation. All (60 out of 60) of our majors study biochemistry, which is a very different situation compared to UAF, where only 19% (8 out of 43) of their majors concentrate in biochemistry. We do not have a functional redundancy with UAF's offering of biochemistry.

This is an excellent example of programs at different campuses adapting to and addressing the specific needs of their respective communities and academic cultures. In 2012, UAA performed a curriculum restructure to match the increasing student demand for health and biomedical science degree pathways. Consistent with ACS guidelines, UAA's curriculum evolved a series of biologically-focused sub discipline courses (e.g. **bio**-inorganic and **biophysical** chemistry) and requires majors to complete multiple semesters of upper-division biochemistry. UAF requires students to complete multiple semesters of traditional inorganic and physical chemistry with labs and a single general biochemistry course. In light of the unique foci of our respective curricula, UAA and UAF have

worked together in the past and continue to work together to share courses to facilitate degree completion in chemistry.

5. Summary Analysis

The UAA chemistry program is experiencing a successful rebound from suspension that occurred in December 2014. The program was re-activated in September 2017, and in this short time frame has attained 60 majors. Many students choose to study chemistry at UAA due to the relevance of the subject matter to the health and biomedical fields; this integrates seamlessly into the mission of UAA. The value of the chemistry program to students and the community is evident and can be seen by the rapid growth in majors following reactivation. We will graduate our first post-suspension cohort in AY 21. It is reasonable to expect that the headcount of declared majors has not plateaued, since there is another year of freshmen recruitment until all classes are represented. As the chemistry department continues to rebuild, we will continue to deliver the degree efficiently and profitably while maintaining student success and research.

The culture of chemistry at UAA has changed dramatically since suspension; we are one of the most efficient units in CAS in delivering student credit hours and have one faculty that has attained several national recognitions for an early investigator, establishing prominence for UAA to conduct research on spilled oil and environmental toxicology in the Arctic and Subarctic. The chemistry department took over responsibility for ASET laboratory in 2017, since then the culture and mission has changed dramatically, becoming a shared facility that provides access to state-of-the-art instrumentation, including NMR and mass spectrometry. With the support of several funded grants and laboratory fees, the chemistry department has stabilized the finances of this lab and hopes to build on its successes.

Among several ideas we have for the future of the program, one idea would be to comprehensively re-assess the minimum qualifications of the common state, federal, and industry workforce requirements that our majors segue into, to ensure that minimum qualifications are not a barrier to entry into the workforce. This stems from recent discussions with the State Crime Lab, who has recently brought to light an issue that prevents UAA graduates from transitioning into their workforce as forensic scientists. There are specific requirements for coursework if you want to work in an accredited laboratory, and many Alaska residents do not satisfy minimum qualifications because their transcripts do not show that they took the required classes. We can easily procure a list of these required courses, not just for the crime lab but for several career trajectories such as pharmacy, medicine, dental school, graduate school, etc., identify which UAA courses best align, and outline "tracks" that guide our students with a list of elective courses that will achieve these targeted minimum requirements. We have just learned about this and see an exciting opportunity to ensure the minimum qualifications of our graduates fit the needs of our community workforce.

Chemistry is a central science, and in particular, biochemistry is a central science to the health and biomedical fields. The UAA biochemistry degree program is an essential component of the UA system.