CSU San Marcos Degree Program Proposal Template[1]

1. Program Type (Please specify any from the list below that apply—delete the others)

a. State-Support

g. New Program

2. Program Identification

a. Campus: **California State University San Marcos**

b. Full and exact degree designation and title: **Master of Science in Chemistry**

c. Date the Board of Trustees approved adding this program projection to the campus Academic Plan.[2]: **1993**

d. Term and academic year of intended implementation: **Fall 2019**

e. Total number of units required for graduation. This will include all requirements (and campus-specific graduation requirements), not just major requirements: **30 Units**

f. Name of the department(s), division, or other unit of the campus that would offer the proposed degree major program. Please identify the unit that will have primary responsibility: **Department of Chemistry & Biochemistry**

g. Name, title, and rank of the individual(s) primarily responsible for drafting the proposed degree major program: **Jacqueline A. Trischman, Professor of Chemistry & Biochemistry (Chemistry Option); Sajith Jayasinghe Associate Professor of Chemistry & Biochemistry (Biochemistry Option); Kambiz Hamadani Assistant Professor of Chemistry and Biochemistry**

h. Statement from the appropriate campus administrative authority that the addition of this program supports the campus mission and will not impede the successful operation and growth of existing academic programs.

i. Any other campus approval documents that may apply (e.g. curriculum committee approvals).[3] The campus may submit a copy of the WASC Sub-Change proposal in lieu of this CSU proposal format. If campuses choose to submit the WASC Substantive Change Proposal, they will also be required to submit a program assessment plan using the format found in the CSU program proposal template.

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[1] When beginning to fill out this form, contact Academic Programs for general guidance and for samples of recent program proposals. It is recommended that program proposers start to fill out the template with the catalog description.

[2] The "campus Academic Plan" is called the University Academic Master Plan (UAMP) at CSU San Marcos. Contact Academic Programs for this date.

[3] Proposers do not need to supply this item. As the proposal goes through the approval process, memos from curriculum committees are obtained. These will be collected and added to the proposal by Academic Programs as a response for this item.

j. Please specify whether this proposed program is subject to WASC Substantive Change review.[4]
This proposed program is NOT subject to WASC Substantive Change review.

k. Optional: Proposed Classification of Instructional Programs (CIP) Code and CSU Degree Program Code [5]:

CSU Degree Program Code for Chemistry: 19051

CIP Code: 40.0501

Campuses are invited to suggest one CSU degree program code and one corresponding CIP code. If an appropriate CSU code does not appear on the system wide list at: http://www.calstate.edu/app/documents/HEGIS-CIP2000_102406.xls , you can search CIP 2000 at http://nces.ed.gov/pubs2002/cip2000/ to identify the code that best matches the proposed degree program. The Classification of Instructional Programs (CIP) is a National Center for Education Statistics (NCES) publication that provides a numerical classification and standard terminology for secondary and postsecondary instructional programs. The CSU degree program code (based on old HEGIS codes) and CIP code will be assigned when the program is approved by the Chancellor.

3. Program Overview and Rationale

a. Provide a rationale, including a brief description of the program, its purpose and strengths, fit with institutional mission, and a justification for offering the program at this time. A comprehensive rationale also explains the relationship between the program philosophy, design, target population, and any distinctive pedagogical methods.

Program Description, Purpose, and Strengths:

The purpose of this graduate program is to offer an experiential, research-intensive, cost-effective, and customizable Master of Science graduate degree program in Chemistry with concentrations in both Biochemistry and Chemistry, which caters to students pursuing careers in both academia and industry. The primary objectives of this program are to teach graduate students how to think independently, how to pursue targeted research objectives (initially those of their advisors/mentors but ultimately those which they set for themselves), how to make well-founded scientific arguments based on experimental data, and how to convey those arguments in written and oral presentations and publications to further their career goals. Research may be performed in a laboratory on campus, in an industrial laboratory, or, for a focus on chemical education, in the classroom. Our program will be distinguished from other Chemistry or Biochemistry graduate programs in the region in the following ways: a flexible schedule with full-time and part-time options as well as some evening classes, which will be attractive to working students; a hands-on research-intensive curriculum; and the option to carry out a collaborative industrial-academic project as a culminating experience for students interested in research careers in industry.

[4] Generally this refers to a degree offered at a new level (e.g., a doctorate). To be certain that a WASC Substantive Change review is not necessary, contact the Associate Vice President Academic Programs.
[5] Contact Academic Programs for assistance in proposing CIP and Program (formerly HEGIS) codes.

Program Goals: The Master of Science in Chemistry produces graduates who:

1. are scholars and professionals in the their chosen field.
2. are proficient problem solvers who employ critical thinking and sound scientific reasoning.
3. are able to leverage their expertise and skills to advance the fundamental understanding of their field and to communicate what they have learned to others.

Program Student Learning Outcomes (SLOs): Students graduating with a MS in Chemistry will be proficient and knowledgeable scientists in their area of specialization, who are able to:

1. communicate scientific information in a clear and concise manner.
2. critically read and evaluate scientific literature.
3. design and carry out experiments using proper laboratory procedures.
4. explore new areas of research, and demonstrate an in-depth understanding of a specialized subject area.

Fit with Institutional Mission:

Our institutional mission statement is given below. The text in bold indicates synergy with the goals and student learning outcomes of our proposed graduate program. A detailed rationale for the synergy between CSUSM's institutional mission and our graduate degree program goals are also given below.

Institutional Mission Statement: "California State University San Marcos focuses on the student as an **active participant in the learning process**. As a Carnegie classified **"community engaged" university**, CSUSM **students work closely with a faculty** whose commitment to sustained **excellence in teaching, research, and community partnership** enhances student learning. The university offers rigorous undergraduate and **graduate programs distinguished by exemplary teaching, innovative curricula, and the application of new technologies**. CSUSM provides a range of **services that respond to the needs of a student body with diverse backgrounds, expanding student access to an excellent and affordable education**. As a public university, CSUSM grounds its mission in the public trust, **alignment with regional needs**, and sustained **enrichment of the intellectual, civic, economic, and cultural life of our region and state**."

Rational for synergy between Institutional Mission and Program Goals/SLOS: Our research-intensive graduate degree program inherently requires "active participation (of students) in the learning process" since research is an active-learning pedagogical practice. CSUSM's classification as a "community-engaged university" also harmonizes with multiple aspects of our proposed graduate degree program. Among the various options offered by our program is a thesis-based chemical education option designed to provide students with the skills and expertise necessary to become highly-successful and pedagogically-informed high-school science teachers. Since the chemical education research to be carried out through our program is likely to involve current science teachers at regional K-12 schools, our graduates will be primed to play well-informed catalytic roles in our regions K-12 educational system. Similarly, the chemical education research option within our program synergizes well with our campus' existing Math and Science Teacher Initiative program.

The proposed graduate program will make possible an entirely new tier of highly-engaged, one-on-one, and otherwise "close" mentor-mentee interactions between our departmental faculty and their graduate student researchers. Such mutually beneficial interactions are a natural extension of the interactions which faculty in our department already engage in with their undergraduate student researchers. They are also a natural extension (at the graduate-level in the fields of chemistry and biochemistry) of CSUSM's mission to expand student access to an excellent and affordable education.

As with other graduate programs at CSUSM, our proposed M.S. graduate degree in Chemistry will be "distinguished by exemplary teaching, innovative curricula, and the application of new technologies" and will therefore also enhance our campus' mission in these respects. For example, a wide range of additional courses that are proposed in the program will be made accessible to qualified undergraduate and graduate students across a wide spectrum of disciplines. The graduate program will also make it possible to extend the types of research undertaken by faculty, well beyond what is currently possible with only undergraduate student researchers, thereby again advancing the mission of CSUSM.

Justification for offering the program at this time:

The Employment Development Department of the State of California reports that between 2012 and 2022 the demand for research-experienced life scientists, biochemists, and biophysicists within the research and development (R&D) sectors in San Diego County will increase by about 571 jobs/yr and that the demand for physical scientists and chemists will increase by about 361jobs/yr (including both new positions as well as replacement hires)[6]. In 2015 San Diego North Economic Development Council (SDNEDC) reported[7] that within Northern San Diego County *alone*, highly-skilled jobs within the biotechnology and biomedical devices industry grew at a rate of about 538 jobs/yr between 2010 and 2014, whereas those in the clean technology industry grew at a rate of 368 jobs/yr. Importantly, this same report concluded that while the number of STEM degrees conferred by North County's postsecondary institutions (CSUSM, MiraCosta College, and Palomar College) has steadily increased by 110% from 2009 to 2013 (~121 additional degrees awarded/yr), this increase is woefully inadequate to meet Northern San Diego County's workforce demand for B.S.-level STEM degrees. Furthermore this increase is not expected to meet the growing regional demand for STEM graduates at higher skill levels (i.e. M.S. or Ph.D. -level).

In alignment with these datasets and forecasts, BIOCOM - southern California's largest life science trade association which currently represents over 650 member companies, service providers, and research institutions in the region –has highlighted "talent and professional development" as a major strategic goal as well as a key determinant for future economic growth not only for San Diego County but for all of southern California[8]. Importantly, the San Diego Association of Governments (SANDAG) has also reported that while the biomedical, biotechnology, and pharmaceutical sectors in San Diego have attracted many billions of dollars in venture capital funding to our region in recent years,

[6] http://www.labormarketinfo.edd.ca.gov/

[7] 2015 SDNEDC State of the Region Report

[8] BIOCOM Strategic Plan 2013-2015: https://biocom.org/about_us/publications/

worker salaries have not kept up with the growth in these sectors[9]. This suggests a lack of career or professional advancement/development opportunities for workers in these sectors and reinforces BIOCOM's assertion that new routes to talent and professional development are urgently needed for continued growth.

Three major universities located within San Diego County are equipped in various ways to meet the needs detailed above for regional research-based graduate programs in chemistry and biochemistry: the University of California San Diego (UCSD), San Diego State University (SDSU), and California State University San Marcos (CSUSM). Over the past 6 years these universities have conferred ~320 M.S. or Ph.D. degrees/year in the life sciences and ~290 M.S. or Ph.D. degrees/year in the physical sciences. Even if every graduate stayed in the San Diego region, only 67% of the total current workforce demand in these sectors would be met.

Currently the University of California San Diego (UCSD), and San Diego State University (SDSU) both offer masters degrees in chemistry. However, their masters programs are not ideally suited to meet regional demand in all of its various forms and neither campus offers master's-level programs in biochemistry that would be analogous to the proposed Biochemistry Concentration. The UCSD M.S. program is by default a single-year coursework-only program designed as a brief (24 semester units) extension of the undergraduate degree program. M.S. students may petition to switch to a more research-intensive thesis-based option (involving a second year of study), however this option seems to serve primarily as a stepping-stone for the Ph.D. program. The UCSD M.S. program is also a full-time program without evening classes, and students must petition to be allowed to take classes on a part-time basis. Similarly, SDSU offers a coursework-only M.A. degree in Chemistry (30 units total with a maximum of 3 units of required hands-on research training), a thesis-based M.S. degree in Chemistry (30 units total with a minimum of 3 units of required research training), and - in collaboration with UCSD - a joint Ph.D program in Chemistry. Though a few courses are taught in the evening, the majority are taught during the morning and early afternoon. No biochemistry courses are taught in the evening. Much like the analogous program at UCSD, the M.S. program at SDSU appears to be designed as a stepping-stone to the joint SDSU/UCSD Ph.D. program.

Given these considerations we maintain that the time is right to offer a program that caters to working students interested in a research intensive master of chemistry degree with concentrations in chemistry or biochemistry. CSUSM's recognized commitment to community-engagement and in particular its dedication to meeting the regional needs of northern SD County makes our campus an ideal place to offer such a program. While the Biotechnology Professional Science Masters (PSM) program at CSUSM has grown rapidly since its inception in 2011, this program provides little hands-on research exposure, is cost-prohibitive to most students served by the CSU-system, and has a significant business-managerial training component. In short, the focus is entirely different in terms of training offered and students it attracts.

[9] SANDAC 2008 San Diego Regional Economic Prosperity Strategy: http://www.sandag.org/index.asp?projectid=107&fuseaction=projects.detail

b. Provide the proposed catalog description, including program description, degree requirements, and admission requirements. For master's degrees, please also include catalog copy describing the culminating experience requirement(s).[10]

MASTER OF SCIENCE IN CHEMISTRY

Program Description

The fields of biochemistry and chemistry aim to increase our molecular understanding of the organization of matter in natural and artificial systems and thereby provide solutions to problems of great importance to society. The primary goal of the M.S. Program in Chemistry is to produce experienced, motivated, and highly-independent researchers with the critical thinking skills required for industrial research positions, careers in chemical education, or entry into Ph.D. programs. Faculty research interests within our program span a wide range of topics, in the broad categories of organic chemistry, inorganic chemistry, analytical chemistry, physical chemistry, biochemistry, and chemical education. Our program provides students with both the freedom to explore diverse topics as well as a highly-structured "hands-on" research training environment where they can work one-on-one with faculty to systematically learn how to effectively and efficiently develop, plan, test, and present scientific hypotheses, investigations, and results. Through these explorations, students gain exposure to, and mastery of, a wide range of advanced techniques, such as nuclear magnetic resonance spectroscopy, single molecule fluorescence spectroscopy, circular dichroism spectroscopy, fluorescence spectroscopy and laser-based polarimetery, and experience with high-end instrumentation including a Bruker Avance 400MHz Nuclear Magnetic Resonance instrument; Fourier Transform Infrared spectrometers; Ultra Violet and Visible spectrophotometers; Gas Chromatography systems; High Performance and Fast Performance Liquid Chromatography systems; an Liquid Chromatography mass spectrometer; a Gas Chromatography mass spectrometer; an atomic absorption spectrometer; a circular dichroism spectropolarimeter; a fully-equipped machine shop; a Rigaku Miniflex X-ray diffractometer; three Fluoromax Fluorimeters; and a broad spectrum of molecular biology instrumentation.

The M.S. program in Chemistry is distinguished by the flexibility it offers students to select courses of study which align best with their individual interest (see concentrations below), and major career objectives (see culminating experience options below).

Program Student Learning Outcomes

Students graduating with a MS in Chemistry will be proficient and knowledgeable scientists in their area of specialization. These students will be able to:

- communicate scientific information in a clear and concise manner.
- critically read and evaluate scientific literature.
- design and carry out experiments using proper laboratory procedures.

[10] Use the format found in the most recent General Catalog.

- explore new areas of research and demonstrate an in-depth understanding of a specialized subject area.

Admission Process and Application

Applicants must meet the following qualifications to be considered for program admission:

1. Applicants must meet the general requirements for admission to graduate studies at California State University, San Marcos. These are described in this catalog under Graduate Studies in the section titled "Admission Requirements for Graduates and Post-Baccalaureate Students".
2. The applicant must have earned a bachelor's degree with a major in chemistry, biochemistry, biology, biotechnology, or related field. Students with majors in other areas may also be accepted contingent upon their satisfactory demonstration of competence in either chemistry or biochemistry depending on which option they intend to pursue (see below).
3. The applicant must have maintained a minimum overall GPA of 2.8 and a minimum major GPA of 3.0. Conditional admission may be granted to applicants who do not meet this requirement.
4. The applicant must have completed the following prerequisite courses (or their equivalent): one year of Calculus, CHEM 202L, CHEM 275, CHEM 401. In addition, applicants who wish to pursue the chemistry options should have completed CHEM 402, 404, and CHEM 416, and those who wish to pursue the biochemistry option should have completed BIOL 210 and CHEM 351 (or CHEM 341). Applicants who either received their bachelor's degrees two or more years prior to their expected entry into the program, or who received a grade of less than B in any of the prerequisite courses listed above, may be accepted to the program contingent on their demonstration of competence within each sub-field by passing the appropriate ACS placement exams or GRE subject tests either before or during their first semester in the program. Students failing to show competence in this manner will be required to take and pass (with a minimum grade of B) an appropriate undergraduate-level course.
5. All applicants, regardless of citizenship, who do not possess a bachelor's degree from a post-secondary institution where English is the principal language of instruction must satisfy the English language proficiency requirement as described in this catalog under Graduate Studies in the section titled "English Language Admission Requirements for Graduate and Post-Baccalaureate Applicants".
6. All applicants are required to complete the general test of the Graduate Record Examination (GRE). GRE subject tests in either Biochemistry, Cell & Molecular Biology, or Chemistry are recommended but not required.

Applicants must submit the following items to the CSUSM Graduate Admissions Office:

1. A university application (completed through the system-wide CSU-Mentor web portal).
2. The application fee (~$55).
3. One set of official transcripts from all colleges/universities attended with indication of graduation.

Applicants must also submit the following items directly to the Dept. of Chemistry & Biochemistry:

1. A completed departmental application for the M.S. program in Chemistry.
2. One set of official transcripts from all colleges/universities attended with indication of graduation (if not in English, certified English translations must be included).
3. Official transcripts of GRE and, if applicable, TOEFL results.
4. Three letters of recommendation acknowledging the applicant's academic capabilities. Two of these letters should come from individuals capable of commenting on the applicant's potential for graduate-level research in chemistry/biochemistry. The last letter can be from an individual outside the applicants chosen field of study.

Application materials to be sent directly to the Department should be sent to:

Administrative Coordinator
Department of Chemistry and Biochemistry
California State University San Marcos
San Marcos, CA 92096-0001

Application Deadline:
Complete applications, including test scores, and recommendation letters, should be received in the program office by March 15th for admission into the fall semester. However, applications will be accepted as long as space allows until June 30th. There is no Spring admission.

Review and Acceptance:
All files received by the March 15 deadline will be reviewed by the Graduate Studies Committee for potential acceptance. Applicants who meet all CSUSM and prerequisites set by the Department of Chemistry and Biochemistry (see above) will be admitted as classified graduate students. In addition, promising applicants, who have deficiencies in specific admission criteria (i.e. missing one or more preparatory courses or minor GPA deficiencies) that can be remedied by additional preparation or coursework (see above), may be considered for admittance with conditional classification status. The procedure for removing the acceptance conditions will be detailed by the committee in the acceptance letter. Please contact the Graduate Advisor for more information.

Degree Requirements

The following requirements must be met within five years to earn the degree of Master of Science in Chemistry at California State University San Marcos:

1. Advancement to candidacy. In order to be considered for advancement, graduate students must have a) obtained approval of their program of study by their advisor, b) developed a thesis or project proposal, and c) present the proposal to their thesis or project committee. On approval of their thesis/project proposals, classified graduate students will be advanced to candidacy for the Master of Science degree.
2. A completed program of study. This program requires at least 30 units of graduate-level work including the following subsets of course requirements: core courses (10 units);

additional seminars, colloquia, teaching experience and/or research (13 or 12 units for the thesis and project options respectively; and electives (7 or 8 units for the thesis and project options respectively). Students must complete the selected set of courses with a 3.0 GPA, and earn at least a grade of C in each course.

3. A final defense of the thesis or project. Students in the "thesis-based" culminating experience option must publicly defend their thesis through an oral presentation to the faculty and students of the Department of Chemistry and Biochemistry. Students in the "project-based" culminating experience will orally present the results of their research to an audience, which, at a minimum, must include their project committee members as well as at least two individuals from the collaborating industry organization.

Program of Study

The Master of Science Degree in Chemistry requires a minimum of (30) semester units of study. Students must complete the selected set of courses with a 3.0 GPA, and earn at least a grade of C in each course. Students must complete the required semester units in accordance with the specific requirements of the chosen culminating experience option.

Students may select from among two culminating experience options:

Thesis based option: The traditional "thesis-based" option involves the preparation and publication of a master's thesis detailing scholarly research resulting in one or more original and unique contributions to the fields of chemistry, biochemistry, or chemical education.

Project option: The "project-based" option is most appropriate for students interested in industry research careers and who wish to carry out collaborative academia-industry research projects.

Master of Science in Chemistry

	Units
Required core courses for the degree (10 units)	
Select two from CHEM 501, 502, 504	6
CHEM 690	2
CHEM 691	2
Required courses for the Thesis Option (13 units)	
students participating in the Thesis Option will take the following courses:	
CHEM 680	1
CHEM 697	6
CHEM 698	6

Required courses for the Project Option (12 units)
students participating in the Project Option will take the following courses:

CHEM 696	12

Electives (7-8 units)
Students should, in consultation with the graduate advisor, select elective courses, from the list below (except those that are taken as part of the required core courses), to gain an in-depth knowledge in the concentration of their choosing. With consent of the graduate advisor students may use up to five units of course work at the 400 level towards their degree and may also use up to three (3) units of course work from outside the department.

CHEM 402*	3
CHEM 404*	4
CHEM 416*	5
CHEM 450*	3
CHEM 501	3
CHEM 502	3
CHEM 504	3
CHEM 511	2
CHEM 514	3
CHEM 521	2
CHEM 531	2
CHEM 532	2
CHEM 533	2
CHEM 534	2
CHEM 550	3
CHEM 551	3
CHEM 552	2
CHEM 553	2
CHEM 555	2
CHEM 556	2
CHEM 590	1-2

* Students are expected to have completed the pre-requisites for these course as part of their undergraduate degree.

Master's Student Graduate Writing Assessment Requirement

All students must fulfill the Master's Student Graduate Writing Assessment Requirement, before advancing to candidacy. Please refer to page 110 for more information regarding this requirement.

Advancement to Candidacy

To be eligible for advancement to candidacy for the Master of Science degree, a graduate student must fulfill all acceptance conditions to attain classified status, constitute their thesis or project committee, obtain approval from the graduate advisor for their program of study, and present their thesis or project proposal to their committee. Each student must initially obtain the permission of a tenured or tenure-track faculty member in the department of Chemistry and Biochemistry to serve as the chair of his or her thesis or project committee. The thesis/project committee chair and student will then recommend two additional members for the thesis/project committee. A student's research supervisor need not be a member of the faculty in the department of Chemistry and Biochemistry, but must be a member of the thesis/project committee. The Chemistry Graduate Studies Committee must approve the composition of the student's committee. The thesis/project committee chair will assist the student in establishing a program of study and in developing a research proposal. A formal written proposal will be orally presented to the thesis/project committee no later than the beginning of the second year of full-time study, or after twelve (12) units of graduate coursework have been completed. A classified student will be advanced to candidacy after the official program of study has been approved by their committee, their written thesis or project proposal has been presented to their committee, and their thesis committee has approved the proposal.

Continuation

Graduate students must maintain an overall GPA of 3.0 and earn at least a C (2.0) in each course. Students who are conditionally classified because of GPA deficiencies may not earn less than a B (3.0) in the courses on their approved program of study. Any student whose overall GPA falls below 3.0 for two semesters, or who receives more than three grades of C (2.0) or lower, will be dropped from the program. A full-time graduate student should be enrolled in at least nine (9) units per semester. Full-time students serving as teaching assistants or graduate assistants should be enrolled in at least six (6) units during the semester of service. In addition, except in unusual circumstances, a completed thesis must be submitted and defended not later than eight semesters following advancement to candidacy, and not later than five years after entry into the program. The student must be registered in CHEM 696, CHEM 698, or CHEM 699 when the completed thesis is granted final approval.

4. Curriculum *(These requirements conform to the revised 2013 WASC Handbook of Accreditation)*

a. <u>These program proposal elements are required</u>:

- Institutional learning outcomes (ILOs) [7]
- Program learning outcomes (PLOs) [7]
- Student learning outcomes (SLOs) [7]

Describe outcomes (also sometimes known as goals) for the 1) institution, 2) program, and for 3) student learning. Institutional learning outcomes (ILOs) typically highlight the knowledge, skills, and dispositions all students are expected to have upon graduating from an institution of higher learning. Program learning outcomes (PLOs) highlight the knowledge, skills, and dispositions students are expected to know as program graduates. PLOs are more narrowly focused than ILOs.

Student learning outcomes (SLOs) clearly convey the specific and measureable knowledge, skills, and/or behaviors expected and guide the type of assessments to be used to determine if the desired the level of learning has been achieved. [7]

(WASC 2013 CFR: 1.1, 1.2, 2.3)

Institutional Learning Outcomes:
These are currently being developed. Program Student Learning Outcomes (PSLOs) will be aligned with the GLOs upon completion and implementation.

Program Learning Outcomes:

The Master of Science in Chemistry produce graduates who are:

- scholars and professionals in the their chosen field.
- proficient problem solvers who employ critical thinking and sound scientific reasoning.
- able to leverage their expertise and skills to advance the fundamental understanding of their field and to communicate what they have learned to others.

Program Student Learning Outcomes:

Students graduating with a MS in Chemistry will be proficient and knowledgeable scientists in their area of specialization, who are able to:

1. communicate scientific information in a clear and concise manner.
2. critically read and evaluate scientific literature.
3. design and carry out experiments using proper laboratory procedures.
4. explore new areas of research and demonstrate an in-depth understanding in the specialized subject area.

b. <u>These program proposal elements are required</u>:

- Comprehensive assessment plan addressing all assessment elements;
- Matrix showing where student learning outcomes are introduced (I), developed (D), and mastered (M)

Include plans for assessing institutional, program, and student learning outcomes. Key to program planning is creating a comprehensive assessment plan addressing multiple elements, including strategies and tools to assess student learning outcomes, (directly related to overall institutional and program learning outcomes). Constructing an assessment matrix, showing the relationship between all assessment elements, is an efficient and clear method of displaying all assessment plan components. [11]

[11] See "Tips" Section.

Creating a curriculum map matrix, identifying the student learning outcomes, the courses where they are found, and where content is "Introduced," "Developed," and "Mastered" insures that all student learning outcomes are directly related to overall program goals and represented across the curriculum at the appropriate times. Assessment of outcomes is expected to be carried out systematically according to an established schedule.

Assessment Plan

Responsible parties and reporting structure

The department's assessment coordinators for chemistry and biochemistry will use data from student oral and written reports, and presentations to conduct assessment activities. In addition, an Alumni survey will be used to gather data on graduates to track professional pathways and to develop an alumni collective. The respective coordinators will analyze data, summarize their assessment activities, and compile a report that will be provided to the department faculty, and other entities (such as the University Assessment Council) across campus, via the Department Chair.

Assessment schedule and sources of data

The department has created a curriculum map matrix to identify the proposed programs student learning outcomes (PSLOs, Appendix 1). We will use this matrix as a guide to assess PSLOs commencing in the 2nd year of the program. PSLOs will be assessed at least once every two years through annual assessment activities and program review processes currently in place on campus. A comprehensive assessment plan is presented in Appendix 2.

Department faculty will analyze and discuss assessment results at annual fall departmental retreats, beginning in year 3 of the program, using data to guide course and programmatic changes (such as revising course structure and order, the addition or removal of courses when appropriate, and the revision of program and student learning outcomes) to ensure continued student success.

c. Indicate total number of units required for graduation. 30

d. Include a justification for any baccalaureate program that requires more than 120-semester units or 180-quarter units. Programs proposed at more than 120 semester units will have to provide either a Title 5 justification for the higher units or a campus-approved request for an exception to the Title 5 unit limit for this kind of baccalaureate program. N/A

e. If any formal options, concentrations, or special emphases are planned under the proposed major, identify and explain fully and list the required courses. Optional: You may propose a CSU degree program code and CIP code for each concentration that you would like to report separately from the major program.

The Master of Science in Chemistry plans to offer two concentrations:

1. Master of Science in Chemistry: Concentration in Chemistry - This concentration is designed for students primarily interested in organic, inorganic, analytical, or physical

chemistry.

2. Master of Science in Chemistry: Concentration in Biochemistry - This concentration is designed for students primarily interested in biochemistry, biophysical chemistry, enzymology, in vitro biosynthetic chemistry, chemical biology, and/or structural biology.

Within each concentration students may choose from among two culminating experience options. The traditional "thesis-based" option is most appropriate for students interested in ultimately pursuing a Ph.D. and involves the preparation and publication of a master's thesis. In contrast, the "project-based" option is most appropriate for students interested in a career in (or those who are employed in) the biotechnology industry, and who wish to carry out a collaborative academic-industry research project.

In consultation with the graduate advisor students will select a series of elective courses that will give them an in-depth knowledge in the concentration of their choosing. A list of the required courses for the proposed program, and a list of electives that that can be used to choose the a concentration are in part f (below).

f. List all requirements for graduation, including electives, for the proposed degree program, specifying course catalog numbers, course titles, total units required for completion of the degree, major requirements, electives, and prerequisites or co-requisites (ensuring there are no "hidden prerequisites that would drive the total units required to graduate beyond the total reported in 4c above). Include proposed catalog descriptions of all new courses. (WASC 2013 CFR: 2.1, 2.2)

Master of Science in Chemistry

		Units
Required core courses for the degree (10 units)		
Select two from CHEM 501, 502, 504		6
	CHEM 501 - Computational Physical Chemistry - 3 Units Pre-requisite: CHEM 401, CHEM 402 CHEM 502 - Advanced Organic Synthesis - 3 Units Pre-requisite: CHEM 202L CHEM 504 - Advanced Inorganic Chemistry - 3 Units Pre-requisite: CHEM 404	
CHEM 690	Chemistry and Biochemistry Seminar - 1 Unit	2
CHEM 691	Research Colloquium - 1 Unit, Pre-requisite: 2nd year in the graduate program	2

Required courses for the Thesis Option (13 units)
students participating in the Thesis Option will take the following courses:

CHEM 680	Teaching Methods - 1 Unit	1
CHEM 697	Directed Studies - 1-6 Units	6
CHEM 698	Thesis Research - 1-6 Units Pre-requisite: Advancement to candidacy	6

Required courses for the Project Option (12 units)
students participating in the Project Option will take the following courses:

CHEM 696	Project Research - 1-6 Units	12

Electives
(7-8 units)
Students should, in consultation with the graduate advisor, select elective courses, from the list below (except those that are taken as part of the required core courses), to gain an in-depth knowledge in the concentration of their choosing. With consent of the graduate advisor students may use up to five units of course work at the 400 level towards their degree and may also use up to three (3) units of course work from outside the department.

CHEM 402*	Physical Chemistry – Quantum – 3 units Pre-requisite: CHEM 250, MATH 162, and PHYS 202 or PHYS 206	3
CHEM 404*	Inorganic Chemistry – 4 units with Lab Pre-requisite: CHEM 201 and 250	4
CHEM 416*	Instrumental Analysis – 5 units Pre-requisite: CHEM 202, CHEM 202L, CHEM 275, and MATH 160	5
CHEM 450*	Protein Structure and Function – 3 units Pre-requisite: CHEM 351 or CHEM 341	3
CHEM 501	Computational Physical Chemistry - 3 Units Pre-requisite: CHEM 401, CHEM 402	3
CHEM 502	Advanced Organic Synthesis - 3 Units Pre-requisite: CHEM 202L	3
CHEM 504	Advanced Inorganic Chemistry - 3 Units Pre-requisite: CHEM 404	3
CHEM 511	HPLC Methods - 2 Units Pre-requisite: CHEM 416	2
CHEM 514	Electrochemical Methods - 3 Units Pre-requisites: CHEM 404, 416	3
CHEM 521	Organometallics – 2 Units Pre-requisites: CHEM 202L, 404	2
CHEM 531	Biosynthesis of Natural Products - 2 Units Pre-requisite: CHEM 202L, 341 or 351	2
CHEM 532	Medicinal Chemistry - 2 Units Pre-requisite: CHEM 202L, 341 or 351	2
CHEM 533	Polymer Chemistry – 2 Units Pre-requisite: CHEM 202L	2
CHEM 534	Advanced Spectroscopic Methods – 2 Units Pre-requisite: CHEM 416	2
CHEM 550	Protein Structure and Function - 3 Units Pre-requisite: CHEM 341 or 351, CHEM 401	3
CHEM 551	Biophysical Chemistry - 3 Units Pre-requisite: CHEM 341 or 351, CHEM 401	3
CHEM 552	Single Molecule Spectroscopy – 2 Units Pre-requisite: CHEM 341 or 351, CHEM 401	2
CHEM 553	Membrane Protein Biophysics - 2 Units Pre-requisite: CHEM 341 or 352	2

CHEM 555	Enzymology - 3 Units Pre-requisite: CHEM 341 or 351, CHEM 401	2
CHEM 556	Synthetic Biochemistry – 2 Units Pre-requisite: CHEM 341 or 351, CHEM 401	2
CHEM 590	Special Topics in Chemistry – 1-2 Units	1-2

* Students are expected to have completed the needed for these pre-requisites as part of their undergraduate degree.

g. List of any new courses that are: (1) needed to initiate the program and (2) needed during the first two years after implementation. Only include proposed catalog descriptions for new courses. For graduate program proposals, identify whether each course is a graduate-level or undergraduate-level offering.

All of the proposed courses, except for CHEM 402, 404, 416, and 450 are new and are at the graduate level. CHEM 550 and CHEM 555 will be dual listed with existing CHEM 450 and 455.

(1). List of new courses needed to initiate the program

At least two of the following new courses will be needed to initiate the program, and during the first year of the program:

CHEM 501 Computational Physical Chemistry (graduate, 3 units)
Introduces students to computational methods as applied to some of the major theoretical ideas of Physical Chemistry. The concepts to be covered will include examples from: Classical Chemical Thermodynamics, Statistical Thermodynamics, Chemical Kinetics, Quantum Chemistry, and/or Molecular Modeling. The course is designed to build on previous knowledge of Physical Chemistry gained at the undergraduate level.

CHEM 502 Advanced Organic Synthesis (graduate, 3 units)
Builds on the total synthesis concepts introduced in the undergraduate organic sequence. Reactions of organic compounds will be studied from the perspective of conformational analysis, mechanism, reactive intermediates, and synthetic methods.

CHEM 504 Advanced Inorganic Chemistry (graduate, 3 units)
Surveys the elements and compounds of both the main group and transition series, with an emphasis on rationalizing patterns of structure, stability and reactivity across the periodic table. Introduces applications to catalysis, geochemistry and biochemistry.

The following new courses will be needed to initiate the program and during the first year of the program:

CHEM 680 Teaching Methods (graduate, 1 unit)
Introduces graduate students to the procedural information and practical skills needed to be an effective teaching assistant.

CHEM 690 Chemistry & Biochemistry Seminar (graduate, 1 unit)
Provides students with a variety of conceptual tools to help them be successful in integrating the various demands and many activities that comprise their graduate experience, e.g. studying, learning, mentoring and being mentored, choosing a research advisor, starting their research work, critically reading the scientific literature, and presenting scientific research.

CHEM 691 Research Colloquium (graduate 1 unit)
Provides students with opportunities to give a seminar each semester on a selected journal topic or their own research as well as an opportunity to engage with invited speakers in various chemical fields.

CHEM 696 Project Research (graduate, 1-6 units, limit 12 units)
Work on project research for graduate students who are conducting research at, or in collaboration with, a company.

CHEM 697 Directed Studies (graduate, 1-6 units, limit 6 units)
Designed to teach techniques in the research laboratory and developing preliminary data prior to advancement to candidacy.

(2). List of new courses needed during the first two years implementation.

A combination of the following new elective courses will be needed during the first and second years of the program.

CHEM 511 HPLC Methods (graduate, 2 units)
Introduces the theories for different separations and detection modes of High Performance Liquid Chromatography (HPLC). Includes HPLC method development, parameter optimization and the applications of HPLC techniques for the separation of pharmaceuticals and biological samples.

CHEM 514 Electrochemical Methods (graduate, 3 units)
Introduces modern electrochemical methods from a theoretical and practical perspective. Fundamentals of the electrode/solution interface, interfacial electron transfer and mass transport. Provides application to a variety of modern electrochemical techniques is demonstrated.

CHEM 521 Organometallics (graduate, 2 units)
Introduces the chemistry of carbon to transition-metal bonds beginning with rules governing structure and stability; effects of metal and ancillary ligand environment; general mechanistic steps; NMR and IR spectroscopy; fluxional processes. Followed by applications in homogeneous catalysis and stoichiometric organic synthesis.

CHEM 531 Biosynthesis of Natural Products (graduate, 2 units)
Introduces the main building blocks and basic synthetic mechanisms employed in the biosynthesis of natural products. Areas of metabolism fed by the acetate, shikimate, mevalonate and deoxyxylulose phosphate pathways will be studied while investigating modern drug candidates that these pathways have produced.

CHEM 532 Medicinal Chemistry (graduate, 2 units)
Introduces design and development of drug candidates to cure diseases based on the modulation of current drug targets, including proteins, nucleic acids, and other receptor-based functionalities. Focuses on structure-activity relationships, pharmacokinetics, and pharmacodynamics.

CHEM 533 Polymer Chemistry (graduate, 2 units)
Introduces the basics of polymer synthesis. Traditional polymerization techniques, such as free-radical, anionic chain, and step-growth polymerization, as well as newer methods of polymer synthesis will be discussed. Preparation of advanced block, star and brush copolymers, semi-conducting and biodegradable polymers, and the fundamentals of structure and physical properties of polymers, and methods of characterization will also be covered.

CHEM 534 Advanced Spectroscopic Methods (graduate, 2 units)
Introduces advanced spectroscopic techniques used to elucidate the structures of organic molecules of various molecular weights. Emphasizes problem solving, starting with the application of fundamental concepts and techniques, and building toward state-of-the-art methods used by the modern organic and bioorganic chemist.

CHEM 550 Protein Structure & Function (graduate, dual listed with CHEM 450, 3 Units)
Fundamentals of protein structure including structural motifs, domains, and folding, methods of protein structure determination, and structural bioinformatics. In-depth consideration of the structure-function relationship in representative proteins involved in important biological functions such as transport, enzyme catalysis, protein-nucleic acid interactions, signal transduction, immunity, and membrane channels and receptors.

CHEM 551 Biophysical Chemistry (graduate, 3-Units)
Application of the principles of physical chemistry to the study of dynamic biomolecular systems and processes. Review of thermodynamics, chemical kinetics, transport processes, chemical equilibria, and physical equilibria. Use of optical spectroscopy, magnetic resonance spectroscopy, and mass spectrometry. Focuses on biomolecular structure and dynamics; protein folding; protein engineering; membrane protein biophysics; and translation.

CHEM 552 Single Molecule Spectroscopy (graduate, 2 units)
Introduces the development and application of single molecule (SM) detection to problems in biology and biochemistry. Topics covered include early pioneers of the field; the principles of instrument design; methods/approaches for sample preparation and probe attachment; single molecule fluorescence spectroscopy/microscopy; super-resolution imaging techniques; force spectroscopy/microscopy; hardware/software considerations for data acquisition and analysis; and a literature survey of current research applications.

CHEM 553 Membrane Protein Biophysics (graduate, 2 units)
Introduces the principles that govern the structure and function of membrane proteins. Different classes of membrane proteins will be discussed using examples that play important roles in human health and disease.

CHEM 555 Enzymology (graduate, dual listed with CHEM 455, 3 Units)

Focuses on enzyme kinetics, the mechanisms of enzyme catalysis, and enzymatic regulation. Includes a review of basic enzymatic concepts, enzyme kinetics of single substrate reactions, enzyme inhibition and multi-substrate enzyme systems, mechanisms of enzyme catalysis, active site studies, the description of specific well-characterized enzymes, and mechanisms of enzyme regulation.

CHEM 556 Synthetic Biochemistry (graduate, 2 units)
Compares and contrasts cell-based and cell-free approaches to making and engineering commodity small molecules and genetically-encoded biopolymers using naturally-existing or biologically-inspired enzymes. Both templated and non-templated synthetic systems will be explored. Includes biofuels production, drug discovery, protein engineering, and structural biophysics.

CHEM 590 Special Topics in Chemistry (graduate, 1-2 units)
Surveys a topic from the chemical or biochemical literature.

CHEM 698 Thesis Research (graduate, 1-6 units, limit 6 units)
Thesis research to be completed after advancement to candidacy.

CHEM 699 Continuation of Thesis Research (graduate, 1-6 units)
Designed to allow students to remain matriculated, and to use the facilities and resources of the University, while they complete their thesis writing or finish lab work after exhausting all CHEM 698 units. Students should be actively writing the thesis while taking CHEM 699. Registration is limited to students who have received a Satisfactory Progress (SP) in CHEM 698. May be repeated as needed but must be completed no later than 5 years after entry into the program. Units may not be applied to the required units for the Master's degree.

h. Attach a proposed course-offering plan for the first three years of program implementation, indicating, where possible, likely faculty teaching assignments. (WASC 2013 CFR: 2.1, 2.2)

Year 1 (2019)	Course	Units	Instructor
Fall Semester			
CHEM 504	Advanced Inorganic Chemistry	3	Michael Schmidt
CHEM 555*	Enzymology	3	Jose Mendoza
CHEM 511	HPLC Methods	2	Karno Ng
CHEM 680	Teaching Methods	1	Faculty
CHEM 690	Chemistry & Biochemistry Seminar	1	Faculty
CHEM 696/7	Project Research/Directed Studies	1-6	Faculty
Spring Semester			
CHEM 502	Advanced Organic Synthesis	3	Robert Iafe
CHEM 550*	Protein Structure & Function	3	Sajith Jayasinghe
CHEM 531	Biosynthesis of Natural Products	2	Jackie Trischman
CHEM 680	Teaching Methods	1	Faculty
CHEM 690	Chemistry & Biochemistry Seminar	1	Faculty
CHEM 696/7	Project Research/Directed Studies	1-6	Faculty
Year 2 (2019)			
Fall Semester			

CHEM 501	Computational Physical Chemistry	3	Paul Jasien
CHEM 551	Biophysical Chemistry	3	Kambiz Hamadani
CHEM 521	Environmental Chemistry	2	Faculty
CHEM 680	Teaching Methods	1	Faculty
CHEM 690	Chemistry & Biochemistry Seminar	1	Faculty
CHEM 691	Research Colloquium	1	Faculty
CHEM 696/7	Project Research/Directed Studies	1-6	Faculty
CHEM 698	Thesis Research	1-6	Faculty
Spring Semester			
CHEM 514	Electrochemical Methods	3	Michael Schmidt
CHEM 553	Membrane Protein Biophysics	2	Sajith Jayasinghe
CHEM 680	Teaching Methods	1	Faculty
CHEM 690	Chemistry & Biochemistry Seminar	1	Faculty
CHEM 691	Research Colloquium	1	Faculty
CHEM 696/7	Project Research/Directed Studies	1-6	Faculty
CHEM 698	Thesis Research	1-6	Faculty
Year 3 (2020)	Course	Units	Instructor
Fall Semester			
CHEM 504	Advanced Inorganic Chemistry	3	Michael Schmidt
CHEM 555*	Enzymology	3	Jose Mendoza
CHEM 511	HPLC Methods	2	Karno Ng
CHEM 680	Teaching Methods	1	Faculty
CHEM 690	Chemistry & Biochemistry Seminar	1	Faculty
CHEM 691	Research Colloquium	1	Faculty
CHEM 696/7	Project Research/Directed Studies	1-6	Faculty
CHEM 698	Thesis Research	1-6	Faculty
Spring Semester			
CHEM 502	Advanced Organic Synthesis	3	Robert Iafe
CHEM 550*	Protein Structure & Function	3	Sajith Jayasinghe
CHEM 532	Medicinal Chemistry	2	Jackie Trischman
CHEM 680	Teaching Methods	1	Paul Jasien
CHEM 690	Chemistry & Biochemistry Seminar	1	Sajith Jayasinghe
CHEM 691	Research Colloquium	1	Kambiz Hamadani
CHEM 696/7	Project Research/Directed Studies	1-6	All
CHEM 698	Thesis Research	1-6	All
*Indicates courses that are to be dual-listed with current elective courses in Biochemistry.			
CHEM 698 will be offered as needed.			

Elective classes will be taught by faculty whose expertise lies in a specific area of study.

i. For master's degree proposals, include evidence that program requirements conform to the minimum requirements for the culminating experience, as specified in Section 40510 of Title 5 of the California Code of Regulations.[12]

Students will submit a written proposal, and orally present their proposal to the thesis/project committee no later than the beginning of the second year of full-time study, or after twelve (12) units of graduate coursework have been completed. Students will be advanced to candidacy after approval of their proposal by the thesis/project committee. Once advanced to candidacy students must complete a final defense of their thesis or project in order to earn the degree of Master of Science in Chemistry.

j. For graduate degree proposals, cite the corresponding bachelor's program and specify whether it is (a) subject to accreditation and (b) currently accredited. (WASC 2013 CFR: 2.2b)

B.S in Chemistry
B.S. in Biochemistry

Both the B.S in Chemistry (all graduates) and the B.S. in Biochemistry (for graduates who engaged in independent research) are certified by the American Chemical Society Committee on Professional Training.

k. For graduate degree programs, specify admission criteria, including any prerequisite coursework. [13] (WASC 2013 CFR: 2.2b)

Applicants must meet the following qualifications to be considered for program admission:

1. Applicants must meet the general requirements for admission to graduate studies at California State University, San Marcos. These are described in this catalog under Graduate Studies in the section titled "Admission Requirements for Graduates and Post-Baccalaureate Students".

2. The applicant must have earned bachelor's degree with a major in chemistry, biochemistry, biology, biotechnology, physics or related field. Students with majors in other areas may also be accepted contingent upon their satisfactory demonstration of competence in either chemistry or biochemistry depending on which option they intend to pursue (see below).

3. The applicant must have maintained a minimum overall GPA of 2.8 and a minimum major GPA of 3.0. Conditional admission may be granted to applicants who do not meet this requirement.

4. The applicant must have completed the following prerequisite courses (or their equivalent): CHEM 202L, CHEM 250, CHEM 275, CHEM 401. In addition, applicants who wish to pursue the chemistry options should have completed CHEM 402 and

[12] Contact Graduate Studies for assistance in making certain that the program conforms to CSU requirements for a master's program.
[13] This item generally applies to graduate programs and self-support programs. For assistance, contact Graduate Studies for the first situation and Extended Learning for the second. For an undergraduate, state-support program for which admission criteria are desired, contact Academic Programs to discuss this matter.

CHEM 416, and those who wish to pursue the biochemistry option should have completed BIOL 210 and CHEM 351 (or CHEM 341). Applicants who either received their bachelor's degrees two or more years prior to their expected entry into the program, or who received a grade of less than B in any of the prerequisite courses listed above, may be accepted to the program contingent on their demonstration of competence within each sub-field by passing the appropriate ACS placement exams or GRE subject tests either before or during their first semester in the program. Students failing to show competence in this manner will be required to take and pass (with a minimum grade of B) an appropriate undergraduate-level course.

5. All applicants, regardless of citizenship, who do not possess a bachelor's degree from a post-secondary institution where English is the principal language of instruction must satisfy the English language proficiency requirement as described in this catalog under Graduate Studies in the section titled "English Language Admission Requirements for Graduate and Post-Baccalaureate Applicants".

6. All applicants are required to complete the general test of the Graduate Record Examination (GRE). GRE subject tests in either Biochemistry, Cell & Molecular Biology, or Chemistry are recommended but not required.

7. One set of official transcripts from all colleges/universities attended with indication of graduation.

8. Three letters of recommendation acknowledging the applicant's academic capabilities. Two of these letters should come from individuals capable of commenting on the applicant's potential for graduate-level research in chemistry/biochemistry. The last letter can be from an individual outside the applicants chosen field of study.

l. For graduate degree programs, specify criteria for student continuation in the program [14]

Graduate students must maintain an overall GPA of 3.0 and earn at least a C (2.0) in each course. Students who are conditionally classified because of GPA deficiencies may not earn less than a B (3.0) in the courses on their approved program of study. Any student whose overall GPA falls below 3.0 for two semesters, or who receives more than three grades of C (2.0) or lower, will be dropped from the program. A full-time graduate student should be enrolled in at least nine (9) units per semester. Full-time students serving as teaching assistants or graduate assistants should be enrolled in at least six (6) units during the semester of service. In addition, except in unusual circumstances, a completed thesis must be submitted and defended not later than eight semesters following advancement to candidacy, and not later than five years after entry into the program. The student must be registered in CHEM 696, CHEM 698, or CHEM 699 when the completed thesis is granted final approval.

m. For undergraduate programs, specify planned provisions for articulation of the proposed major with community college programs. N/A

[14] This item generally only applies to programs with admission criteria (item 4k). For undergraduate programs, the criteria should be that the student remain on good academic standing (i.e., not be subject to Academic Disqualification). For assistance with this item, contact Graduate Studies, Extended Learning or Academic Programs as in item 4k.

n. Describe advising "roadmaps" that have been developed for the major.[15] N/A

o. Describe how accreditation requirements will be met, if applicable, and anticipated date of accreditation request (including the WASC Substantive Change process). (WASC 2013 CFR: 1.8) N/A

Accreditation Note:

Master's degree program proposals
If subject to accreditation, establishment of a master's degree program should be preceded by national professional accreditation of the corresponding bachelor's degree major program.

Fast-track proposals
Fast-track proposals cannot be subject to specialized accreditation by an agency that is a member of the Association of Specialized and Professional Accreditors unless the proposed program is already offered as an authorized option or concentration that is accredited by an appropriate specialized accrediting agency.

5. Societal and Public Need for the Proposed Degree Major Program

a. List of other California State University campuses currently offering or projecting the proposed degree major program; list of neighboring institutions, public and private, currently offering the proposed degree major program.[16]

List of CSU campuses currently offering a Master of Science In Chemistry and/or Biochemistry.

California State University, East Bay	M.S. in Chemistry and M.S. in Chemistry with Option in Biochemistry
California State University, Fresno	M.S. in Chemistry
California State University, Fullerton	M.A. and M.S. in Chemistry
California State University, Long Beach	M.S. in Chemistry and M.S. in Biochemistry
California State University, Los Angeles	M.S. in Chemistry and M.S. in Chemistry with Option in Biochemistry
California State University, Northridge	M.S. in Chemistry and M.S. in Biochemistry
California State Polytechnic University, Pomona	M.S. in Chemistry
California State University, Sacramento	M.S. in Chemistry and M.S. in Chemistry with Biochemistry Concentration
San Diego State University	M.A in Chemistry and M.S. in Chemistry
San Francisco State University	M.S. in Chemistry and M.S. in Chemistry

[15] Contact the Office of First Year Programs for assistance in developing detailed graduation road maps for the first two years of study.

	with Biochemistry Concentration
San José State University	M.A. in Chemistry and M.S. in Chemistry

List of neighboring public and private institutions currently offering the proposed program.

San Diego State University	M.A in Chemistry and M.S. in Chemistry
University of California San Diego	M.S. in Chemistry

b. Describe Differences between the proposed program and programs listed in Section 5a above.

UCSD's Dept. of Chemistry and Biochemistry currently offers a doctoral program (currently conferring ~32 degrees/year) as well as a master's program (currently conferring ~50 M.S.'s/year). Importantly, the Ph.D. program is almost entirely research-based whereas the *M.S. program is by default a single-year coursework-only program* designed as a brief (24 semester units) extension of the undergraduate degree program primarily used by students who want to establish a better academic record for medical school. M.S. students may petition to switch to a more research-intensive thesis-based option (involving a second year of study), however *this option seems to serve primarily as a stepping-stone for the Ph.D. program.* This M.S. program is also by default a *full-time program without evening classes* and students must again petition to be allowed to take classes on a part-time basis.

The SDSU Dept. of Chemistry and Biochemistry offers a coursework-only M.A. degree in Chemistry (30 units total with a maximum of 3 units of required research training), a thesis-based M.S. degree in Chemistry (30 units total with a minimum of 3 units of required research training), and - in collaboration with the Dept. of Chemistry and Biochemistry at UCSD - a joint Ph.D. program in Chemistry. *SDSU does not have a formal option or emphasis in biochemistry for any of its programs.* Though a few courses are taught in the evening, the majority are taught during the morning and early afternoon. No biochemistry courses are taught in the evening in the SDSU program.
The proposed program is different to those in neighboring institutions since it (1) provides a dedicated Master of Science in Chemistry program with an option in Biochemistry, (2) the program may be completed after 4pm, and (3) the program offers a project based culminating experience that will be attractive to prospective students who are already employed in the chemistry and biotechnology industry.

c. List of other curricula currently offered by the campus that are closely related to the proposed program.

None.

d. Describe community participation, if any, in the planning process. This may include prospective employers of graduates.

None.

e. Provide applicable workforce demand projections and other relevant data.[17]

In the coming decades San Diego County in general and northern San Diego County in particular will experience increased demand for well-trained biochemists and chemists with significant training in research and development. The Employment Development Department of the State of California reports that between 2012 and 2022 **the demand for life scientists within the research and development (R&D) sectors in San Diego County will increase by an average of about 471 jobs/yr** (including both new positions as well as replacement hires). Within this category, **demand for Ph.D.-level biochemists and biophysicists will increase by roughly 100 jobs/yr (demand for M.S.-level biochemists/biophysicists was not separately reported but a similar trend is expected)**. At the same time, demand for physical scientists within the R&D sector is predicted to increase by about 281 jobs/yr. Within this category, **projected increases in demand for research-experienced chemists (80 jobs/yr) and environmental scientists (92 jobs/yr) are the largest**. The San Diego North Economic Development Council (SDNEDC) also reported in their recently-released 2015 State of the Region Report that within Northern San Diego County *alone* from 2010 to 2014, highly-skilled jobs (e.g. managers, professional positions, scientists, computer programmers, engineers, etc.) within the biotechnology and biomedical devices industry cluster (both of which would be expected to employ significant numbers of biochemists) grew at a rate of about 538 jobs/yr and those in the clean technology cluster (which would be expected to employ significant numbers of chemists) grew at a rate of 368 jobs/yr. Importantly, this same report indicated that while the number of STEM degrees conferred within North County's postsecondary institutions (CSUSM, MiraCosta College, and Palomar College) has steadily increased by 110% from 2009 to 2013 (~121 additional degrees awarded/yr), these increases are nowhere near sufficient to meet Northern San Diego County's workforce demand for B.S.-level STEM degrees nor do they even begin to meet the growing regional demand for STEM graduates at higher skill levels (i.e. M.S. or Ph.D. -level). Though these forecasts do not call out Chemists and Biochemists specifically, the categories that contain the jobs these graduates would qualify for are all predicted to grow substantially.

In alignment with these datasets and forecasts, BIOCOM - southern California's largest life science trade association which currently represents over 650 member companies, service providers, and research institutions in the region –has highlighted "talent and professional development for California's life-science workforce" as a major strategic goal as well as a a key determinant for future economic growth not only for San Diego County but for all of southern California. At 5-9 years after earning a B.S. degree, industrial chemists and biochemists with a master's degree have a base salary $14,000 higher than those whose highest degree is a B.S. The proposed program would be the only program in San Diego County to offer professional progression from B.S. to M.S. in Chemistry and Biochemistry through evening-based coursework combined with morning/afternoon research, thus having the potential to promote significant economic growth in the region.

[12] Contact Academic Programs for a list of other CSU campuses offering related programs.

[13]One source of data, in addition to those provided at the end of section 5, is the San Diego Association of Governments website: http://www.sandag.cog.ca.us

The American Chemical Society regularly monitors employment in the chemical industry as an indicator of demand nationally. Full time employment for chemists is at the highest level it has been since 2001 with only 4.6% unemployment for Chemists with M.S. degrees and 2.2% for Chemists with PhD degrees in 2014 as opposed to a general unemployment rate of 6.9% in the same year.

Note: Data Sources for Demonstrating Evidence of Need

APP Resources Web http://www.calstate.edu/app/resources.shtml

US Department of Labor, Bureau of Labor Statistics

California Labor Market Information

Labor Forecast

ACS Salary Report 2014

6. Student Demand

a. Provide compelling evidence of student interest in enrolling in the proposed program. Types of evidence vary and may include national, statewide, and professional employment forecasts and surveys; petitions; lists of related associate degree programs at feeder community colleges; reports from community college transfer centers; and enrollments from feeder baccalaureate programs, for example.[18]

A link to a six-item questionnaire was sent via email to science majors in the college of science and mathematics to access their potential interest in this proposed program. A total of 151 students responded, and the results are summarized below.

Q1: **How interested would you be in pursuing a Master's of Science in Chemistry/Biochemistry at CSUSM?**

	Response Percent	Response Count
Very interested	42	63
Somewhat interested	43	64
Not interested	15	22

Q2: **If you stated that you were "Very Interested" or "Somewhat Interested", which of the following specializations would you be most interested in pursuing:**

	Response Percent	Response Count
Biochemistry	62	36
Chemistry	38	22

[14] Contact Enrollment Management Services to obtain numbers of students with declared majors, options/concentrations/tracks/etc., and minors. Contact Academic Programs to obtain enrollment histories in specific courses. Surveys of potential employers might show the need for the proposed program. Please explain if there are discrepancies between national/statewide/professional manpower surveys and local findings. Contact the Career Center for assistance in completing this section.

Q3: Would you prefer that classes meet during the day, evening, and/or weekend? (Please, mark all that apply)

	Response Percent	Response Count
Daytime	75	45
Evening	67	40
Weekends	50	30

Q4: If you are interested in possibly pursuing the M.S. in Chemistry/Biochemistry at CSUSM, which option would interest you most?

	Response Percent	Response Count
Course work only	19	27
Course work with research-intensive thesis conducted in an academic setting	50	71
Course work with a research-intensive project conducted in an industrial/corporate setting	29	41

Q5: Would the availability of teaching or research assistantships (that would pay you a stipend and defray tuition costs) increase your interest in applying to the Program?

	Response Percent	Response Count
Yes, definitely	79	111
Yes, a little bit	4	6
No, it would not factor into my decision	17	24

Q6: What is your area of undergraduate training?

	Response Percent	Response Count
Biology	25	38
Biochemistry	46	71
Biotechnology	9	14
Chemistry	18	28
Other	1	2

These data indicate that there is a significant interest within our science majors at CSUSM for a masters program in chemistry and biochemistry with the characteristic as detailed in this proposal.

Table 1 provides enrollment data for those CSUSM majors that we expect will produce undergraduates who will choose a masters degree in chemistry and biochemistry after graduation. Undergraduates from these majors who wish to remain in the area may find the proposed program an attractive avenue for advanced study, and those that find employment in the vibrant biotechnology industry may find the proposed program an attractive avenue for career advancement.

Table 1.

Major	Number of Majors	Degrees Awarded

	Fall 2013	Fall 2014	Fall 2015	2012-2013	2013-2014	2014-2015
Biology				42	73	73
Biochemistry	158	181	207	15	16	10
Biotechnology				10	15	21
Chemistry	63	77	87	4	7	5

b. Identify how issues of diversity and access to the university were considered when planning this program. Describe what steps the program will take to insure ALL prospective candidates have equitable access to the program. This description may include recruitment strategies and any other techniques to insure a diverse and qualified candidate pool.

We anticipate that a significant number of applicants will be working professionals who wish to continue their education. Therefore, we plan to offer late-afternoon and/or evening classes that will integrate well with their schedules. The cost of the proposed program will be based on established CSUSM graduate tuition fees and should be comparable to those of other CSU programs in the region. Students enrolled in the proposed program are eligible for federal financial aid, which should make the program accessible to all prospective students who are interested in completing the course of study.

The ACS Salary Report for 2014 notes that female chemists have substantially lower salaries than their male counterparts. The B.S. programs in Chemistry and Biochemistry attract a higher percent of females than males, an unusual statistic in this field. Given this, we expect the M.S. degree to be comparably balanced in terms of gender. Several recent studies by the American Association of University Women (see www.AAUW.org) have shown that the most significant factor in the salary gap for professional women such as chemists is the gap in starting salary. For this reason, we would implement the SmartStart salary negotiation workshops for our students to ensure that they know how to help close the published 17% salary gap in Chemists and Biochemists at the M.S. level.

For master's degree proposals, cite the number of declared undergraduate majors and the degree production over the preceding three years for the corresponding baccalaureate program, if there is one.[19]

See Chemistry and Biochemistry entries in Table 1 (above).

c. Describe professional uses of the proposed degree program.

The response to this question is similar to that given in 5e. San Diego and the surrounding region is home to a vibrant and expanding biotechnology industry. We expect graduates of the proposed program will be employed as chemical and life sciences scientists in the research and development sectors of the biotechnology industry in San Diego county.

d. Specify the expected number of majors in the year of initiation and three years and five years thereafter. Specify the expected number of graduates in the year of initiation, and three years and five years thereafter.[20]

[19] Contact Enrollment Management Services for these data.
[20] Contact Academic Programs for assistance in estimating the number of majors and graduates.

We expect to enroll no more than 6-10 students upon initiation of the program, and do not plan to exceed 10 students. Thus in year 2 of the program there will be 12-20 students, and we anticipate that the program will accommodate a maximum of 10 new students on a continuous basis, with about 30-50% of the students completing their studies and preparing for graduation.

7. Existing Support Resources for the Proposed Degree Major Program

Note: Sections 7 and 8 should be prepared in consultation with the campus administrators responsible for faculty staffing and instructional facilities allocation and planning. A statement from the responsible administrator(s) should be attached to the proposal assuring that such consultation has taken place.

a. List faculty who would teach in the program, indicating rank, appointment status, highest degree earned, date and field of highest degree, professional experience, and affiliations with other campus programs. For master's degrees, include faculty publications or curriculum vitae.

Note: For all proposed graduate degree programs, a minimum of five full-time faculty members with the appropriate terminal degree should be on the program staff.
(Code Memo EP&R 85-20)

Name	**Rank**	**Degree**	**Date**	**Field of Degree**	**Experience**
Wai Man Ng	Associate	Ph.D.		Bio-Analytical	17 yrs
Kambiz Hamadani	Assistant	Ph.D.	2008	Biochemistry	3 yrs
Robert Iafe	Assistant	Ph.D.	2011	Organic	2 yrs
Paul Jasien	Professor	Ph.D.	1984	Physical	26 yrs
Sajith Jayasinghe	Associate	Ph.D.	1999	Chemistry	10 yrs
Jose Mendoza	Professor	Ph.D.	1992	Biochemistry	21 yrs
Michael Schmidt	Professor	Ph.D.	1989	Inorganic	24 yrs
Jacqueline Trischman	Professor	Ph.D.	1993	Bio-organic	20 Yrs

b. Describe facilities that would be used in support of the proposed program.

The Department of Chemistry and Biochemistry maintains research laboratory space in both science hall 1 (~1800 sq feet) and science hall 2 (~1200 sq feet). The department has a wide range of equipment used both in teaching and student research projects that will be used in the proposed program. The proposed program will have access to:

- A Bruker Avance 400 MHz Nuclear Magnetic Resonance spectrometer
- An LC/MS system to be purchased in 2016
- An HP 5890/5972 GC/Mass Spectrometer
- A Jasco Circular Dichroism Spectropolarimeter
- Three spectrofluorometers
- A Varian spectra 220 AA-Scan Atomic Absorption Spectrometer
- Multiple UV/VIS spectrophotometers
- Nicolet iS10 research grade IR spectrophotometer with Diamond ATR
- Multiple gas chromatographsMultiple HPLC systems
- A confocal single molecule fluorescence microscope
- A total internal reflection single molecule fluorescence microscope
- Multiple anaerobic chambers

c. Provide evidence that the institution provides adequate access to both electronic and physical library and learning resources [21]

Many of the electronic and physical library material that would be needed by the proposed program are already part of the existing undergraduate Chemistry and Biochemistry programs. The report from the Library evaluating the resources needed to support the proposed program is included in Appendix 3.

d. Describe existing academic technology, equipment, and other specialized materials[22]

The department of Instructional and Information Technology Services (IITS) provides extensive academic technology support and services. All of the classrooms at CSUSM are equipped with "smart" classroom technology. A report from IITS evaluating the resources needed to support the proposed program is included in the Appendix 4.

8. Additional Support Resources Required

Note: If additional support resources will be needed to implement and maintain the program, a statement by the responsible administrator(s) should be attached to the proposal assuring that such resources will be provided.

a. Describe additional faculty or staff support positions needed to implement the proposed program.[23]

The department currently has a sufficient number of faculty to support initial enrollment in the proposed program, and we do not anticipate the need for any additional staff support positions at the time of launch. We anticipate matching program enrollment to faculty availability and will only increase enrollment as we grow the faculty and staff as detailed in our strategic plan. Program faculty will serve on student thesis committees and will also carry out student advising. When necessary student thesis committees may also include faculty from biological sciences, physics, or computer science (as needed for expertise).

We anticipate that each year several graduate students will seek the opportunity serve as graduate teaching assistants to experience teaching at an undergraduate institution. The chemistry and biochemistry faculty who teach graduate courses will likely need to reduce their lower-division teaching commitments. We expect graduate teaching assistants will fill in the gaps left in the lower-division non-science major labs and general chemistry recitation sections.

b. Describe the amount of additional lecture and/or laboratory space required to initiate and to sustain the program over the next five years. Indicate any additional special facilities that will be required. If the space is under construction, what is the projected occupancy date? If the space is planned, indicate campus-wide priority of the facility, capital outlay program priority, and projected date of occupancy. Major capital outlay construction projects are those projects whose total cost is $610,000 or more (as adjusted pursuant to Cal. Pub. Cont. Code §§ 10705(a); 10105 and 10108).[24]

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[21] Contact the Library for this report.

[22] Contact Instructional and Information Technology Services (IITS) for a report addressing information technology and academic computing resources available to support the program. Programs currently possessing additional equipment and specialized material not addressed in the IITS report should include these here.

[23] Include additional faculty lines needed to support the course offerings indicated in 4.h and 4.m. Indicate whether any external funds are expected to support faculty lines.

[24] Contact Planning, Design and Construction for assistance in answering questions about space that is under construction or being planned. Indicate whether any external funds are expected to support construction of facilities.

The proposed program will not require additional lecture space. Some of the courses will be offered in the late afternoon or evenings and therefore, we expect classroom availability not to be an issue. Faculty in the program maintain active undergraduate research projects. We will manage enrollment in the proposed program to match ongoing faculty research projects, and students in the proposed program will occupy existing laboratory space (see 7b).

c. Include a report written in consultation with the campus librarian, which indicates any necessary library resources not available through the CSU library system. Indicate the commitment of the campus to purchase these additional resources.[25]

   The report written by the library evaluating the resources needed to support the proposed program is included in the Appendix 3.

d. Indicate additional academic technology, equipment, or specialized materials that will be (1) needed to implement the program and (2) needed during the first two years after initiation. Indicate the source of funds and priority to secure these resource needs.[26]

   No additional academic technology equipment or specialized material is needed to implement the proposed program.

9. Self-Support Programs

a. Confirm that the proposed program will not be offered at places or times likely to supplant or limit existing state-support programs.[27]

b. Explain how state-support funding is either unavailable or inappropriate.

c. Explain how the program is different, in one or more of the following ways, from state-supported campus offerings operating on campus:

   i. Primarily designed for career enrichment or retraining
   ii. Program location is significantly removed from state-supported campus facilities
   iii. The program client group receives educational or other services at a cost beyond what could be reasonably provided under state support.

d. For self-support programs, please provide information on the per-unit cost to students and the total cost to complete the program (in addition to the required cost recovery budget elements listed in the CSU degree proposal faculty check list found earlier in this document).

[25] This should follow directly from the Library report in 7.c.
[26] Information technology and academic computing needs should follow directly from the IITS report in 7.d. Additional specialized equipment and materials that will be needed should be addressed here.
[27] Pursuant to Executive order 1099, "Self-supporting special sessions shall not supplant regular course offerings available on a non self-supporting basis during the regular academic year (Education Coder section 89708)."

APPENDIX 1.

PSLO	Courses									
	CHEM 501	CHEM 502	CHEM 504	CHEM 550	CHEM 551	CHEM 555	CHEM 690	CHEM 691	CHEM 696	CHEM 697
1. Communicate scientific information in a clear and concise manner.							I, R	R, A	A	A
2. Critically read and evaluate scientific literature.	R	R	R	R	R	R	I, R	R, A	A	A
3. Design and carry out experiments using proper laboratory procedures.	R	R	R	R	R	R		R, A	R, A	A
4. Explore new areas of research, and demonstrate an in-depth understanding in the specialized subject area.			I, R		I, R			R, A	R, A	A

I = Introduced; R = Reinforced; A = Advanced level application

APPENDIX 2.

Master of Science in Chemistry Comprehensive Assessment Plan

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*
GLOs	*PSLOs*	*Courses (Where SLOs are assessed)*	*Assessment activities (to measure each SLO)*	*Suggested assessment tools*	*Assessment schedule – how often SLOs will be assessed*	*How will data/ Findings be reported?*	*Designated personnel to collect, analyze, and interpret student learning outcome data*	*Program data/ findings dissemination schedule*	*Anticipated closing the loop strategies*
*	1) Communicate scientific information in a clear and concise manner.	CHEM 690	Research Project and Presentation	Common rubric	Year 1 (Biennial schedule)	Rubric scores will be aggregated, reviewed by team; reported to program faculty; annual reports to Academic Programs	Course instructor, program faculty	Semester following assessment activity	Program faculty will determine if change is needed; implement change in following year; re-measure the following year
	2) Critically read and evaluate scientific literature.								
	3) Design and carry out experiments using proper laboratory procedures.	CHEM 691	Research Project and Presentation	Common Rubric	Year 2 (Biennial Schedule)	Rubric scores will be aggregated, reviewed by team; reported to program faculty; annual reports to Academic Programs	Course instructor, program faculty	Semester following assessment activity	Program faculty will determine if change is needed; implement change in following year; re-measure the following year
	4) Explore new areas of research, and demonstrate an in-depth understanding in the specialized subject area.								
**	***Program Goal:*** The Master of Science in Chemistry produce graduates who are •able to leverage their expertise and skills to pursue advanced opportunities.	Alumni	Survey alumni to gather professional information to guide program development	Survey	Begin year 1 (Triennial Cycle)	Data will be reviewed by team; reported to program faculty	Program faculty	Semester following assessment activity	Program faculty will collectively review the data, determine if any changes are needed. Follow-up with alumni-related correspondence.

*University Graduate Learning Outcomes (GLOs) are currently in development; PSLOs will be aligned upon implementation.

**Assessment of program goal in addition to PSLO assessment will be used to track alumni and guide professional advisement