Program Name: M.S. in Biological Sciences, Molecular and Cellular Concentration

Faculty Member(s) Responsible for Data:
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Criterion 1: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery

The M.S. in Biological Sciences, Molecular and Cellular Concentration program maintains a dynamic curriculum that is supported primarily by full-time tenured and tenure-track faculty hired into the department with advanced training in the area of cellular and molecular biology and its application to a wide variety of specializations from human disease, human genetics and development, plant developmental biology and evolution, cancer biology, and microbial ecology. The faculty in our department that support students in this program readily embrace change, and the incorporation of technology in the classroom, the field, and the laboratory.

Contemporary Curriculum

The M.S. in Biological Sciences, Molecular and Cellular Concentration program is an inherently rapidly changing discipline; therefore, the faculty that support this program through teaching and research must be responsive to current discoveries and techniques in order to provide masters-level students with the most relevant academic knowledge and research skills. To address changes such as this and others, the Department of Biological Sciences recently restructured its programs and courses, including the addition of two new masters-level programs: the General MA in Biological Sciences, and the MA in Biological Sciences, Stem Cell Concentration. The first cohort of students in these programs matriculated into the university Fall 2009. The Stem Cell M.A. program, based upon the initial foundation of the Molecular and Cellular Concentration in our department, is now providing excellent resources in both curricular material and student interest, which benefit the M.S. Molecular and Cellular degree program. In addition to these new M.A. programs, we have significantly enhanced our two-course (BIO297a/BIO297b) graduate teaching assistantship program that now engages our students in a significant amount of pedagogical research and assessment training along with hands-on training in the classroom. As well, we now offer a new team-taught research methods courses (BIO 221a) which is taken by both our M.A. Stem Cell students and our M.S. Molecular and Cellular biology students in their first year to prepare them for more advanced methods that they may use in their independent research projects. Although we embrace a “peer teaching and learning” philosophy at the laboratory bench, this course establishes a very strong foundation upon which they can build.

Faculty (and staff where appropriate) Qualifications

All seventeen full-time faculty and six part-time faculty members that have taught graduate courses in the department of Biological Sciences since 2006 have a Ph.D. in specializations aligned with their teaching assignment. We currently have nine full-time faculty that engage in teaching and/or research in the M.S. in Biological Sciences, Molecular and Cellular Concentration program. Most of these faculty members also have post-doctoral experience and professional training directly related to their area of specialization within the area of molecular and cellular biology.

Percent of Instruction by Full-time Faculty

Our graduate program is highly integrated. Students in our various graduate concentrations/programs take many of the same courses, especially in their first year. Therefore it is not possible to accurately calculate the proportion of full-time to part-time faculty in each of our separate graduate concentrations/programs. The data for all of our graduate courses for the 2010-2011 academic year is as follows: the total number of full-time and part-time WTUs devoted to non-supervisory graduate courses in Biological Sciences was 36 (18 WTUs each semester). Of those, 30 WTUs were taught by full-time faculty and 6 WTUs by part-time faculty. Therefore, 83% of all of our non-supervisory graduate courses were taught by Full-Time faculty (FactBook, Fall 2011 Appendix A). Note: Of the 6 Part-time WTUs, 3 were in the area of Cellular & Molecular Biology, and 3 were in the area of Ecology. Both courses benefited from having a professional working in the discipline teach the course (e.g. BIO 273: Advanced Fishery Biology and Management was taught by a Senior environmental scientist from the California Department of Fish and Game).
Use of Technology, as appropriate for discipline

Technology is at the very core of the biological sciences and its use is essential to prepare our graduate students to acquire scientific data in today’s high-technology setting, and for successfully training them so that they can excel in the growing Biotechnology workforce.

- We require all of our graduate students to use statistical analysis in their thesis work and research. As such, they use the latest versions of software available including SPSS. Additionally, many of our faculty and students use Mathematica for computer statistics and modeling.
- Educating our graduate students on current research technology specific to their chosen discipline is deemed critical by our faculty and is therefore imbedded in the coursework of their first year of study. In the M.S. in Biological Sciences, Molecular and Cellular Concentration program, students either take BIO221A. Cell and Molecular Methods and Techniques which covers:
  - Advanced molecular technologies including conventional and epifluorescent microscopy, flow cytometry, traditional and real-time PCR, and bioinformatic programs
  - Real-time digital data gathering and sharing systems, including human-based data acquisition
  - Wireless streaming and cyberlearning technologies, such as wiki-based social learning, instant messaging, social networking and social bookmarking.

Student will also be exposed to varying technologies depending on their chosen field of specialty and design of their research project. These techniques will vary among all students in the MS in Biological Sciences, Molecular and Cellular Concentration program. These may include, but are not limited to, the following:

- Advanced methods in cell culturing techniques
- Advanced methods in molecular diagnostics of human diseases
- Advanced methods in microscopy, involving epi fluoresence, confocal, and light microscopy.
Criterion 2: Clearly Developed Learning Outcomes

The MS in Biological Sciences, Molecular and Cellular Concentration program has both maintained currency as well as rigor over the decades of its existence. All of the policies for our program and the requirements for our graduate students are well detailed and organized in our 36 page comprehensive Graduate Program Handbook that is available online: [http://www.csus.edu/bios/Students/2010GradProgHandbook%2010-05-20.pdf](http://www.csus.edu/bios/Students/2010GradProgHandbook%2010-05-20.pdf), with a prominent link to it from our departmental website. Thus, both current as well as prospective students to our program can obtain information on their course of study with expected learning outcomes and assessment of these. Although a formal list of “Learning Outcomes” is not expressly stated in our Graduate Program Handbook, they are inherent in the goals and requirements of our program, and individual learning outcomes are stated in the syllabi of our graduate courses: [http://www.csus.edu/bios/CourseWebPages.html](http://www.csus.edu/bios/CourseWebPages.html). Over the last decade, we have made curricular and program changes to our graduate program approximately every three years. Most of these changes have been based upon a) the outcomes assessment of our students as they progress through a three-tiered assessment process detailed below, b) both formal and informal survey’s of the regional workforce, c) changes in funding/support for our programs, and d) faculty retirements/new hires that have enhanced the expertise of the faculty in our programs.

Clearly Articulated Program Links to Campus Baccalaureate Learning Goals

Not applicable to the MS in Biological Sciences, Molecular and Cellular Concentration program.

Updated Plan that Clearly Identifies Program Learning Goals, Assessment Strategies, and Processes by Which Data Inform Program Curriculum Decisions

Students are required to have a commitment of a faculty advisor prior to acceptance into our MS in Biological Sciences, Molecular and Cellular Concentration program. They are also sent a link to the Graduate Program Handbook in their acceptance letter, and are required to sign a commitment to keep appraised of the policies and requirements of the program that are available and regularly updated on our web site.

All students in our program engage in a three-tiered assessment process.

- **First semester**: BIO 220-Introduction to Scientific Inquiry. Graduate-level introduction to scientific inquiry in the biological sciences. Students learn to apply the scientific method, critically evaluate the scientific literature, initiate their graduate project, and develop written and oral scientific presentation skills.

- **Advancement to Candidacy**. After the first year of study, and within a year of graduation, students are required to Advance to Candidacy. As stated in the Graduate Program Handbook, “The Advancement to Candidacy process serves to ensure that a student is qualified for and making good progress toward successfully completing the Master’s degree. It also provides the student’s Supervisory Committee and the Graduate Committee an opportunity to provide timely feedback to the student regarding the scientific merit, feasibility, and scope of the proposed research or project.” Furthermore, it is a formal assessment of the student’s progress towards the learning outcomes first introduced in the BIO 220 course.

- **Thesis Submission and Thesis Seminar**. The Thesis, as stated in The California Code of Regulations: Title 5 Education, Section 40510, and in our Graduate Program Handbook, is defined as: “the written product of a systematic study of a significant problem. It identifies the problem, states the major assumptions, explains the significance of the undertaking, sets forth the sources for and methods of gathering information, analyzes the data, and offers a conclusion or recommendation. The finished project [product] evidences originality, critical and independent thinking, appropriate organization and format, and thorough documentation.”

This culminating written document and the Thesis Seminar are our final assessment of student progress towards attaining the learning goals that were set forth in BIO 220 their first semester.

During the Thesis Seminar, the student orally presents the general nature of the Thesis to Graduate Advisor, members of the Supervisory Committee (made up of two additional faculty or professionals with expertise...
Section: Clearly Developed Learning Outcomes

within the discipline of the student’s research project) and the Graduate Committee (made up of three faculty in the Department of Biological Sciences, including the Graduate Coordinator). The seminar is also advertised and open to the public; it may be attended by anyone who wishes to attend. The student is then expected to answer questions on the Thesis. Following the question and answer period, the Supervisory and Graduate Committees will then grade the student’s seminar as “acceptable” or “unacceptable.” As stated in our Graduate Program Handbook, this assessment will be made using the following criteria:

a. The successful completion of the thesis/project objectives as stated in the Abstract of the Proposed Thesis/Project
b. Presentation;
c. Organization;
d. Explanation of data/results;
e. Articulation of the broader significance of the work and its relationship to the pertinent literature in the field
f. Ability to effectively respond to questions from the audience.

If a student’s seminar is deemed unacceptable, members of the Graduate and Supervisory Committees inform the student of her/his deficiencies and what the student must do to present an acceptable seminar. If a second seminar is provided but is also not accepted, the student is permanently removed (disqualified) from the Department of Biological Sciences’ graduate program.

It is a rigorous program, and not all of our students make it through even this last phase of assessment. In response to our graduation rate from ten years ago, and a reduction in resource availability, our Graduate Committee made several recommendations to the Department of Biological Sciences to streamline our program and enhance the success rate of our students. The Department approved changes included applying more stringent standards for entrance into our graduate program, and a more connected level of advising from faculty mentors. In making these changes, we have remarkably improved the percentage of our matriculated students that graduate from 20% (100 students enrolled, 20 graduate) to nearly 37% (55 students enrolled, 20 graduate) each year. [http://www.csus.edu/bios/temp/quartile_1290847qwel;rj.html](http://www.csus.edu/bios/temp/quartile_1290847qwel;rj.html)  (graduate student data).

External Assessment and Accreditation Outcomes, where appropriate

Our graduate program does not require external assessment, nor do we have accreditation outcomes to meet.
Criterion 3: Advising Program and Graduation Success

The M.S. in Biological Sciences, Molecular and Cellular Concentration program maintains a dynamic curriculum that is supported primarily by full-time tenured and tenure-track faculty with Cellular biology, Molecular biology, or Microbiology chosen specialization. Additionally, our faculty that teach and engage in research in this area often have other specializations upon which they apply molecular and cellular techniques. These include plant evolution and development, host-pathogen interaction, developmental biology and cancer biology. To better serve its graduate students, the Department of Biological Sciences began a process of revising its graduate programs in fall 2006. Since that time, the Department has made significant changes in its admission requirements, procedures, and courses. In particular, the application procedure was streamlined by requiring submission of a supplementary departmental application, instituting a process to match students with available faculty/resources, and establishing one application period per year. Together, these changes have allowed the department to manage its application process more effectively, maintain a manageable and consistent number of students in a cohort, and provide matriculated students with improved faculty support and advising. Each student is matched with a faculty advisor prior to matriculation into the program, and it is this advisor that formally shepherds the student both in academic advising as well as research advising until the student graduates.

Graduation Rate

Graduate students in the Department of Biological Sciences achieved a high rate of success in graduation. Of students that graduated between Fall 2006 and Fall 2011, 31% completed their degree within 3 years, 19% completed within 4 years, 17% finished within 5 years, and 21% took 6 years to complete their degrees. Of the 100 students who have been enrolled in the M.S. graduate program at any time since fall, 2006, 57% have graduated, 40% are currently enrolled, and 3% left the program without earning a degree. Finally, as of 2010, we had 50 students enrolled in our graduate degree programs, and conferred 20 graduate degrees, maintaining a positive graduation trend that we have continued to observe.

Distribution of Advising Responsibilities Among Faculty Members

Three members of the Department of Biological Sciences serve as the Graduate Committee; one member of the committee is the Graduate Coordinator. The Graduate Coordinator, along with the Graduate Secretary in the Department, serves as a nexus for student contact and information. The responsibility of serving as advisors and mentors to graduate students is voluntary among faculty in the Department of Biological Sciences. Between 2006 and 2012, 83% of our full-time faculty in the Department of Biological Sciences served as Graduate advisors/research mentors for our graduate students. Other faculty members from other departments, including Chemistry, as well as several research collaborators from the region (i.e. UC Davis, VA Hospital research faculty) serve as members of student Supervisory Committees and are an important source of supplementary support for our graduate students.

Proactive Advising Contact with Students to Assure Progress to Degree

The Department of Biological Sciences revised many aspects of its graduate program and a number of these changes were designed to provide proactive advising contact. The current policy is in place is as follows:

- Prior to application, students are required to communicate with departmental faculty and identify a faculty member who agrees to serve as their graduate advisor for the entire duration that the student is matriculated in the program.

- Students are informed upon acceptance of the Department's *Graduate Program Handbook* that is prominently linked to our webpage (http://www.csus.edu/bios/CurrentGradStudents.html) and serves as a roadmap and advising guide.
Section: Advising Program and Graduation Success

- Students are required to maintain continuous contact with their graduate advisor who is available for both academic as well as research advising.

Perhaps the most key proactive advising process the Department utilizes centers around student Advancement to Candidacy (detailed in the Graduate Program Handbook). This is a major milestone for students in our program in that it ensures that they are on the path to success in our program, and that their path to completion is clearly defined. In preparation for their Advancement to Candidacy, students write a research proposal that is reviewed by the student's Supervisory Committee (made up of their graduate advisor and two other faculty members). Members of the student’s Supervisory Committee and members of the Graduate Committee attend the Advancement to Candidacy meeting. Together, these faculty review the students proposed coursework and then listen to the student present their proposed research in a formal seminar setting. Following questions and suggestions for improving the proposed research approach, faculty vote on whether or not to approve advancement. One of the key outcomes of this is approval of the Abstract of Proposed Research which serves as a clear contract defining the student’s project. Since committees change and memories may differ, this serves as a highly effective method of clearly defining the path to graduation success.

Program Roadmap to Curriculum Completion and Graduation Success

Described above.

Use of Technology to Supplement and Strengthen Program Advising Effort

Our primary tool in this area is our online Graduate Program Handbook and supporting advising materials through the Department's website. Additionally, the department is moving from paper tracking, which is a very comprehensive system of file folders and forms, to a database in ACCESS to track our students from entrance to graduation. This will strengthen our advising efforts – especially for students that are nearing the 7-year limit, and will also allow easier access to statistics for prospective students interested in applying to our program.

Post-degree success, Graduate Impact on Community

Students who have earned Master’s degrees in Biological Sciences serve in all levels of public agencies, local, state and Federal as well as private industry. Our graduates serve the state in the Department of Fish and Game, Water Resources Board, Air Resources Board, and California Environmental Protection Agency (Pesticide Management). They are teachers from elementary schools to community colleges. Our M.S. in Biological Sciences, Molecular and Cellular Concentration program are especially competitive in the local biotech industry. Verification for the data on the success of our graduates since 2006 can be found at

http://www.csus.edu/bios/temp/quartile_1290847qwel/r1.html
Section: Strength of Teaching Performance

Criterion 4: Strength of Teaching Performance

The faculty that teach courses and serve as graduate thesis advisors in the M.S. in Biological Sciences, Molecular and Cellular Concentration, as with all of our faculty in the Biological Sciences, are absolutely committed to excellence in teaching. As faculty teaching in all programs in the Department of Biological Sciences are held to the same standards with regard to teaching performance. The responses relating to this criterion apply to all Biology programs, except that part-time faculty do not play a major role in teaching in our graduate program.

Articulated Program Statements regarding Quality of Teaching

The Department of Biological Sciences is committed to ensuring the strength of its faculty's teaching performance. Examples of documents that include articulated statements regarding this commitment and selected excerpts from these documents are provided below.

1. Department RTP Policy: Current Department RTP Policy includes the following statements:

   The Department of Biological Sciences places primary emphasis on Teaching Performance and shall weight performance in this category no less than 55% in the evaluation of candidates for retention, tenure, and promotion. In addition, competent teaching performance shall be the primary and essential criterion for retention, tenure, or promotion. (note: in practice, the normal weight assigned to teaching performance under current policy is 80%, a weight that is proposed to be reduced to 60% in reviews/evaluations beyond the first couple of years in residence, though still maintaining the eminence of the category).

   The Department of Biological Sciences is strongly committed to advancing the teaching mission of the University through classroom instruction and non-classroom activities that foster the intellectual and personal development of students.

3. Department Hiring Policies: When hiring a new full-time tenure-track faculty member, evidence of potential for teaching effectiveness and commitment to teaching is the first consideration brought to bear by the faculty on the Search Committee, and is required by policy set forth in the Department’s Governance model. The job announcement is crafted in such a way as to attract teacher/scholars. A statement such as “teaching experience at the college level is required” is included and applications must include statements of both teaching and research interests. In paper screening selection of candidates for interview, ~40% of the weight is accorded specifically to evidence of potential for teaching effectiveness in assigned courses, including evidence of: breadth of coursework and/or experience in biology, potential for teaching lower division biology for majors and non-majors, potential for teaching effectiveness in area of specialization, and experience with diverse student groups. During the interview, candidates are asked to present a teaching seminar in addition to showcasing their scholarly work. As in the case of paper screening, at least 40% of the weight in making a hiring recommendation from among the candidates interviewed is accorded specifically to potential for teaching effectiveness.

   In part-time hiring, candidates are required to provide a statement of qualifications for the teaching assignment, and prior teaching performance evaluations are given substantial weight in rankings.

Ongoing, Meaningful Assessment of Teaching Performance of Faculty, Post-Tenure

Post-tenure, the importance of teaching performance (which is given significant weight in RTP, see above) is given the same weight in promotion from Associate to full Professor as in the earlier RTP cycle. The Department encourages continued excellence in Teaching Performance through a 5-year review process, governed by its Policy on. “Evaluation of Tenured Faculty not subject to RTP Review.”

Multiple Measures of Teaching Performance of Full-time and Part-time Faculty Members

Multiple measures include:
Section: Strength of Teaching Performance

- Student Evaluations: The Department takes great care to solicit information from students regarding the quality of our teaching. Unless a Full Professor, all faculty members, regardless of experience, are required to have all classes evaluated by students every semester. These evaluations are thoroughly reviewed in RTP and hiring (e.g. Part-time faculty) considerations. Our RTP policy specifies that: “while no minimum instructor performance rating is specified as a condition for retention, tenure or promotions, faculty being evaluated should be advised that an average instructor performance rating below 7.5 (on a 10 point scale) across all courses taught will necessitate explanation and substantial evidence of teaching effectiveness from other sources.” Faculty members being evaluated are also advised that high instructor performance ratings in student evaluations are not in themselves sufficient to demonstrate teaching effectiveness. Faculty members who have completed the promotional cycle (Full Professors) are also required to have their classes evaluated (at least two courses per year, although most continue to have every course evaluated every semester).

- Additional Measures of Teaching Performance: In all RTP Periodic Evaluations and Performance reviews of full-time faculty, candidates must provide a) a reflective statement on teaching (“Overview of Teaching Effectiveness”), and b) Course syllabi and samples of course materials produced by the candidate for courses taught during the semester preceding the evaluation/review. In addition, after the first two years in residence, full-time faculty must provide evidence of additional contribution to the teaching mission of the Institution, which extends beyond their effectiveness in classroom teaching. Examples include: evidence of a positive impact upon the lives and achievements of students, evidence of extra assistance for student learning, revisions of course laboratory exercises, evidence of supervision of students engaged in graduate research or undergraduate research, service learning, internships, volunteer work, and evidence of receiving teaching awards or honors, or other noted contributions to the curriculum.

Part-time faculty do not play a large role in the course-work instruction of our graduate students. In 2010-2011, only 12% of our non-supervisory graduate WTU were accounted for by Part-Time faculty. That equates to two courses, both of which were enriched by the training that the faculty member brought from the workforce. All tenure-track faculty members are required to participate in reviewing and ranking part-time applications, with priority given to applicants with demonstrated teaching effectiveness. Transcripts, a statement of interest and teaching philosophy are required and are rigorously assessed during the hiring process.

Systematic Program Attention to Problematic Individual Teaching Performance

Full-time faculty members are addressed primarily through the RTP process, where a letter is generated in which each candidate’s strengths and possible areas of improvement are articulated. This feedback allows the candidate to see where Teaching Performance needs improvement. In addition, the Department's RTP policy requires that the Professional Development Committee (consisting of the RTP Committee Chair, Department Chair, and another senior faculty member) follow-up with the candidate in a meeting at the completion of each evaluation cycle.

Part-time faculty are invited to meet with the Committee to discuss any aspects of their evaluation, and are referred to the Center for Teaching and Learning if they are interested in working on specific aspects of their teaching.

Perhaps, most importantly, the Department adheres to the view that problematic teaching performance can be avoided altogether by highly selective hiring, and a systematic engagement of faculty in activities and discussions with the specific intention of improving curriculum design and improving teaching performance.
Criterion 5: Program History and Development Status

The M.S. in Biological Sciences, Molecular and Cellular Concentration program has been supported by the department faculty since the program began well over a decade ago. The curriculum and course offerings have been revised regularly to meet with the dynamic nature of Biological Sciences and the addition of new faculty hires in our department. Because of the strength of this M.S. program, in 2009 we were able to consider the addition of a new MA in Stem Cell Biology which has as its foundation, the core courses from the Molecular and Cellular concentration in the M.S. degree program.

Level of program development (e.g. young, growing, mature)

Approximately fifteen years ago, the Department of Biological Sciences revised the core curriculum of the General M.S. Program in Biological Sciences, and added a new “Cellular and Molecular Concentration” to the already established “Conservation” concentration for students interested in a more specialized M.S. graduate degree program. In 2009, two M.A. degree programs were also added, one of which in Stem Cell biology. Now, Spring 2012, 26% (10/38) of the graduate students in our M.S. degree program in Biological Sciences have chosen this concentration for their studies. We believe the popularity of this program is due to the needs of the regional workforce for mid-level management in both Biotechnology as well as in various state agencies and laboratories.

In fall 2006, the Department also made significant changes in its admission requirements and procedures, the programs offered, and the program’s graduate curriculum. Fall 2006 we had 100 students enrolled in our graduate program, and conferred 20 master’s degrees per year (data from SacVault). In 2010, four years after the changes were implemented, our graduate student numbers were purposefully and dramatically reduced to 55 students. Each of these students were one-on-one matched with a graduate research advisor prior to entrance. That year, we were still able to confer 20 graduate degrees. We feel this is a tremendous improvement. The changes we implemented are listed below.

- **Admissions requirements and Application Procedures:** Admission requirements were revised to be less restrictive in specific coursework requirements but more rigorous by adding a GRE Subject Test requirement, an admission preference to applications obtaining faculty sponsorship and letters of recommendation. The application procedure was streamlined by requiring submission of a supplementary departmental application, instituting a process to match students with available faculty/resources, and establishing one application period per year; together these changes have allowed the department to manage its application process more effectively, maintain a more manageable and consistent number of students in a cohort, and provide matriculated students with improved faculty support and department resources.

- **Changes to the curriculum:** To reflect the actual time and effort graduate students in the Department dedicate to their thesis research and writing of their thesis, the Department increased the number of research (Bio 299) and thesis (Bio 500) units required for the degree relative to the number of coursework units. A new team-taught research methods course was created and several courses merged or revised to better reflect the current state of the respective disciplines.

- **Supervisory Committee Composition:** To allow students to benefit from expertise beyond its own faculty, the Department revised its policy on composition of a student’s supervisory committee. A student’s supervisory committee may now include an “outside” member who has earned doctorate in Biological Sciences or a related field and who is not a tenured or tenure-track faculty member in the Department of Biological Sciences at CSU Sacramento.

In making the changes listed above, we have remarkably improved our graduation rate nearly 50%.

Ability of program to adapt to current demands

Our Graduate Program in Biological Sciences has adapted quickly to current demands as follows:

- **Admissions Policy—** A cohort of students is accepted only once per year and students are required connect with a research mentor prior to admission.
Section: Program History and Development Status

- Curriculum changes to include team-taught courses in students’ area of specialization within the concentration.
- Development of two new MA (non-thesis) degree programs (established in 2009):
  - Grant Proposal Track—The Grant Proposal track is a non-thesis degree option designed for students pursuing non-research based careers in biology, including education, science writing, science illustration, science law, science policy, and the health professions.
  - Stem Cell Concentration (Professional Science Master’s Program)—The Stem Cell concentration provides support for 10 graduate students per year through an external grant from the California Institute for Regenerative Medicine. A collaborative effort between CSU Sacramento and UC Davis, the program trains students for careers in stem cell research or biotechnology.
- Revised supervisory committee structure open to Ph.D.-level scientists outside of the department and University; this expands the expertise outside of the department that students can draw experience from. Part-time and Full-time collaboration with agencies outside of the University

Future goals of program

As indicated in this section, many changes have recently been incorporated into our program to address current needs. Therefore, many of our “future goals” are a continuation of recent goals set by the department upon revision of the current graduate program.

- **Continue to improve student time to graduation.** Graduate students in the Department of Biological Sciences achieved a high rate of success in graduation. Of students that graduated between Fall 2006 and Fall 2011, 31% completed their degree within 3 years, 19% completed within 4 years, 17% finished within 5 years, and 21% took 6 years to complete their degree [http://www.csus.edu/bios/temp/quartile_1290847qwel;ri.html](http://www.csus.edu/bios/temp/quartile_1290847qwel;ri.html). Of the 100 students who have been enrolled in the M.S. graduate program at any time since fall, 2006, 57% have graduated, 40% are currently enrolled, and 3% left the program without earning a degree.

- **Continue to maintain student access to current technology and other research resources.** The College of Natural Sciences and Mathematics houses the Center for Interdisciplinary Molecular Biology: Education, Research, and Advancement (CIMERA). Faculty within the Department of Chemistry, as well as in the Department of Biological Sciences, have been awarded $755,000 from American Recovery and Reinvestment Act funds to renovate and modernize the current research facility in the basement of Sequoia Hall to meet the research needs of students and faculty in the department and college. In addition in 2011, a donation from Bayer Pharmaceuticals, valued at one-million dollars, was made in order for students and faculty to have sufficient equipment and supplies to conduct research with in the CIMERA facility. The materials transfer and agreements were spearheaded by faculty in the Department of Biological Sciences, namely Drs. Thomas Peavy and Thomas Landerholm.

- **Continue to move towards a cohorted curriculum.** Currently, all first-year graduate students are advised and encouraged to take BIO 220-Introduction to Scientific Inquiry and BIO 221A-Cell and Molecular Methods and Techniques. The combination of these classes teach students to apply the scientific methods, critically evaluate the scientific literature, and initiate their graduate project.

- **Continue to update/maintain a graduate student database.** The department is moving from paper tracking, which is a very comprehensive system of file folders and forms, to a database in ACCESS to track our students from entrance to graduation. This will strengthen our advising efforts – especially for students that are nearing the 7-year limit, and will also allow easier access to statistics for prospective students interested in applying to our program.
Criterion 6: Impact, Justification and Centrality to University Mission

Centrality to the University’s Mission: Like all programs offered by the Department of Biological Sciences, the M.S. in Biological Sciences, Molecular and Cellular Concentration program advances the University’s mission through its disciplinary focus on preparation of the workforce needed to address scientific issues affecting the region and the state and its pedagogical emphasis on the development of intellectual and practical skill sets (e.g., inquiry and analysis), which are broadly applicable to understanding and addressing societal issues beyond the realm of science.

Unique Program Characteristics/Adding Distinctiveness to our Campus: The closest public university offering M.S. degrees is UC Davis. UC Davis offers a variety of Ph.D. programs within Biology. These programs may span departments within the discipline or represent individual departments. As the main goal of University of California is to train Ph.D.-level scientists, very few departments within various departments in Biological Sciences offer a stand-alone Master of Science program. The Department that is most closely aligned with this graduate program is the Ph.D. program in Biochemistry, Molecular and Cellular Biology, and Developmental Biology. This UCD program prefers that students enter as Ph.D. students, however provisions are made on a ‘case-by-case’ basis to 1) allow students to enter as Master’s level students or 2) for students to leave with a Master’s degree in hand in case they should leave the Ph.D. program prior to completion of the program. This leaves working professionals, including teachers, government policy makers, Bachelor’s level molecular/cellular scientists few options to continue onto Master’s- level work, without committing to a Ph.D. program.

The MS in Biological Sciences, Molecular and Cellular degree program helps to train working professionals in the program for competitive mid-level management positions in private industry, federal, and state agencies. Moreover, it helps to train a growing biotechnology workforce in the Sacramento area. The I-80 corridor to San Francisco is home to many Biotech companies and ranks #2 in Biotech in California. In addition, Sacramento is home to several state and federal agencies, including, but not limited to, the Water Resources Board, and the California Department of Food and Agriculture, to name a few. Finally, our students are also able to gain employment at the Department of Justice nearby in Forensic Science.

Most of the students in the MS in Biological Sciences, Molecular and Cellular degree program work-full time, and because of this employment they bring a breadth of knowledge and numerous resources to our program, including access to materials and expertise. In addition, unlike the graduate program at UC Davis, the majority of our course offerings, are scheduled during evenings and the lunch hour to accommodate these students. Our working students devote their evenings and weekends to work on their thesis research.

Several of our students participate in the Department of Biological Sciences Graduate Teaching Assistant training program, a rigorous course-based training program (BIO 297a BIO297b), and are subsequently employed as Graduate Teaching Assistants and teach in our introductory, undergraduate laboratory and activity-based classes.

Lastly, in recent years, many undergraduate programs in the Biological Sciences at UC Davis have disconnected hands-on laboratory training from their courses, offering most of their classes as Lecture only. Thus, students may not receive the hands-on training they need to go directly into the workforce from their Bachelor’s degree unless they pursued independent research experiences as an undergraduate. Perhaps as an outfall from this trend in the UC system, the Department of Biological Sciences has seen an average of five UC graduates/year enter into our M.S. graduate program (Factbook 2011, Table 3). These students represented on average 35% of the entering class of graduate students in both 2008 and 2010 (Factbook 2011, Table 3).

Additional Information

To facilitate time to graduation and effectiveness of advising, students entering MS in Biological Sciences, Molecular and Cellular Concentration program are required to identify a faculty member who agrees to serve as their graduate advisor. In addition, students are admitted each year as a cohort of students. This cohort is required to take BIO 220-Introduction to Scientific Inquiry and either BIO 221A-Cell and Molecular Methods and Techniques course. All students in the program are required to develop a thesis and present progress and completion of the thesis. In total, the program is accessible, proactive, and rigorous in its content and delivery of a quality graduate education and serves a critical role in the greater Sacramento community.
Criterion 7: External Demand for the Program

How does the program support community engagement with the campus? What is the demand for the program’s resources and expertise? What are the local trends in enrollment? What is the demand from employers, or from graduate schools?

The demand for trained biologists and their roles and impact are clearly described in the 2010-11 Bureau of Labor Statistics Report (http://www.bls.gov/oco/ocos047.htm). In brief, the report concludes that: "Employment of biological scientists is expected to increase much faster than the average for all occupations although there will continue to be competition for some basic research positions." The demand cited in the report spans the breadth of biology (which is a very broad field). Due to our location, virtually all of the high impact areas of growth cited in the report are present in our area--from biotech to health care, and from academia to environmental science. There are a large number of local, state, and federal government positions in our region that require trained students trained across the breadth of biology.

Evidence of this demand is in the successes of our graduates who have earned Master’s degrees in Biological Sciences. Our graduates from the MS in Biological Sciences, Molecular and Cellular Concentration program are competitive applicants in the regional workforce, and serve in many levels of public agencies, local, state and Federal as well as private industry and academia. Federal, State and local employment includes the Water Resources Board, Department of Justice in the criminology laboratory, as well as regional clinical laboratories. Other graduates currently work at biotech companies (Alza and Genentech) along the I-80 corridor, in an academic research laboratory (Stanford, UCLA, UC Davis), or teach in higher education from community colleges to Universities. Verification for the data on the success of our graduates since 2006 can be found at http://www.csus.edu/bios/temp/quartile_1290847qwel;ri.html

### Projections data from the National Employment Matrix

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological scientists</td>
<td>19-1020</td>
<td>91,300</td>
<td>110,500</td>
<td>19,200</td>
</tr>
<tr>
<td>Biochemists and biophysicists</td>
<td>19-1021</td>
<td>23,200</td>
<td>31,900</td>
<td>8,700</td>
</tr>
<tr>
<td>Microbiologists</td>
<td>19-1022</td>
<td>16,900</td>
<td>18,900</td>
<td>2,000</td>
</tr>
<tr>
<td>Zoologists and wildlife biologists</td>
<td>19-1023</td>
<td>19,500</td>
<td>22,000</td>
<td>2,500</td>
</tr>
<tr>
<td>Biological scientists, all other</td>
<td>19-1029</td>
<td>31,700</td>
<td>37,600</td>
<td>5,900</td>
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</tbody>
</table>

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the Handbook introductory chapter on Occupational Information Included in the Handbook.

http://www.bls.gov/oco/ocos047.htm
Criterion 8: Program Size, Scope (please note: the page header for this section is incorrect)

Across its programs, the Department’s graduate curriculum covers a wide range of disciplines within the biological sciences, ranging from molecular and cellular biology to ecology, evolution and conservation. Not only do its course offerings span multiple levels of organization in the discipline, but they also integrate current methods and techniques in the biological sciences. Its courses and research in the Cellular and Molecular field also include representation of different taxonomic groups, including plants, animals, microbes and fungi.

Although the collective expertise of the Department’s 18 Full-time and 3 FERP faculty Faculty span a wide range of disciplines and techniques, it has lost a number of key faculty positions – and thus expertise – over the past several years. These personnel losses have placed significant challenges on its current faculty to meet the academic needs of its students. In addition, while the Department has managed to provide a basic level of resources and support for its curriculum, the graduate program continues to be challenged by the continued erosion of resources available to its faculty and students. Despite all of this, we have managed to continue offering what we believe is a graduate program for our students that clearly values excellence in teaching and in research, albeit on a much smaller scale than what we once had.

Number and types of degrees, concentrations, awarded

As of Fall 2009, the graduate program in Biological Sciences began offering an MA degree.

<table>
<thead>
<tr>
<th>Graduate Degrees Awarded¹</th>
<th>AY 06-07</th>
<th>AY10-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>General</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Ecology, Evolution and Conservation</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Molecular and Cellular Biology</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>MA</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>General - Grant proposal</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Stem Cell Concentration</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

¹ first MA degree conferred Sp ’11; Data for this table is from SacVault

Annual FTES in major, minor, certificate elements of program

<table>
<thead>
<tr>
<th>Matriculated Graduate Students</th>
<th># Students¹</th>
<th>%</th>
<th>AY FTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>General, Biological Sciences (MS)</td>
<td>12</td>
<td>19</td>
<td>10.5</td>
</tr>
<tr>
<td>Ecology, Evolution and Conserv. (MS)</td>
<td>16</td>
<td>25.4</td>
<td>14.0</td>
</tr>
<tr>
<td>Molecular and Cellular Biology (MS)</td>
<td>10</td>
<td>15.9</td>
<td>8.7</td>
</tr>
<tr>
<td>General, Biological Sciences (MA)</td>
<td>2</td>
<td>3.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Stem Cell (MA)</td>
<td>23</td>
<td>36.5</td>
<td>20.1</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>100</td>
<td>55²</td>
</tr>
</tbody>
</table>

¹ Data from SacVault for Spring 2012, ²Data from FactBook AY 10-11
Additional Information for Program Size and Scope (note: page header is incorrect)

Over a decade ago, and as recently as 2006, the graduate program in Biological Sciences used to total approximately 80-100 students (FactBook 2011, Table 4). Many of these students were without a Thesis advisor, wandering and never completing their degree. For some, this was their purpose upon arrival – to take a few graduate courses to prove their academic aptitude, and then to move on to a different professional degree program, others really were wanderers. Beginning in 2006, the Department made significant changes in its admission requirements, procedures, and courses. These changes have allowed the department to maintain a manageable and consistent number of students in a cohort, and provide matriculated students with improved faculty support and advising. One of the changes mandates that each student is matched with a faculty advisor prior to matriculation into the program, and it is this advisor that formally shepherds the student both in academic advising as well as research advising until the student graduates. Although our overall graduate student numbers have decreased dramatically over time (Enrollment numbers in the M.S. Degree programs in Biological Sciences from 2006 to 2010 = 100, 104, 89, 61, and 55 respectively. Factbook 2011, Table 4), the number of awarded degrees has remained consistent. Thus, we have succeeded in enhancing our graduation successes, however, unwittingly, we have also concomitantly lowered the enrollments in our courses, which has now created a new issue that we are making an effort to address.
Section: Internal, Non-major Demand for the Program

Criterion 9: Internal, Non-major Demand for the Program

The courses taken by our graduate students in MS in Biological Sciences, Molecular and Cellular Concentration program cover a multitude of courses taken by students in several of our Graduate Programs (MS General; MA Stem Cell; MA General) in the Department. Additionally, each year, one or two Biochemistry Masters’ degree students from the Chemistry Department enroll in our cellular/molecular-based graduate elective courses. Most recently they have enrolled in BIO 224. Genomics, Proteomics, and Bioinformatics, and BIO245: Host Pathogen Interaction.

Service courses (accompanying A Y FTES)

The MS in Biological Sciences, Molecular and Cellular Concentration program does not provide any graduate level service courses.

GE courses (accompanying A Y FTES)

Not applicable to graduate our programs.

Research resources

The Department of Biological Sciences’ on campus arboretum, greenhouses, and CIMERA cellular/molecular research facility, as well as our autoclaves provide resources to individuals within the College of Natural Sciences and Mathematics, across campus, and in the Community. As well, the Faculty provide guidance for students in other departments (i.e. Chemistry, Anthropology, Criminal Justice, Psychology, Education), especially with regard to research that may involve molecular biology, genetics, or science education. Faculty with research interests in Cellular and Molecular biology utilize all of these resources.
Section: Quality of Program and Resource Utilization

Criterion 10: Quality of Program and Resource Utilization

The Graduate program, as a whole in the Biological Sciences, has been functioning for the last several years with seemingly minimal institutional support. Despite this, we have been very productive.

Faculty productivity in non-teaching areas

Scholarly and Creative Activity: The Department embraces a broad definition of scholarship, similar to that initially described by Ernest Boyer to include the scholarship of discovery, the scholarship of integration; the scholarship of application; and the scholarship of teaching. Each faculty member is expected to pursue a program of scholarship that is reflected by accomplishments that: 1) contribute to the development or creation of new knowledge, OR 2) contribute to the critical analysis and review of knowledge within disciplines or the creative synthesis of insights contained in different disciplines or fields of study, OR 3) apply findings generated through the above to solve real problems in professions, industry, government, the university, and/or the community, OR 4) contribute to the development of critically reflective knowledge about teaching and learning. This enables the Department to contribute to the University’s multi-faceted mission by encouraging faculty to apply their varied talents, interests, and capabilities in ways that ensure that all facets of this mission receive substantial attention.

Grant Applications:

Since 2006, faculty members in the department of Biological Sciences (83% of whom serve the M.S./M.A. in General Biology) obtained $14.67 million in grant funding (source: Research and Contract Administration). In addition, faculty members that serve our graduate program secured over $1 million in donated equipment and supplies (e.g. cell culture hoods, incubators, analysis kits, a mass spectrometer, etc.).

Since 2006, Faculty in the Department of Biological Sciences that supported the MS in Biological Sciences, Molecular and Cellular Concentration program through their research and teaching submitted over 32 grants for research-related projects. Of those, 25 were successfully funded, and secured both internal and external support for research in our program, much of this involving students. (Source: Biological Sciences faculty, [link].)

Scholarly and Creative Activity: Since 2006, faculty members in the department that supported the MS in Biological Sciences, Molecular and Cellular Concentration program through their research and teaching have collectively made over 100 oral and poster presentations to more than 25 different recognized, national professional organizations (i.e. American Society for Microbiology, and American Association for the Advancement of Science). Finally, faculty members in our department that engage in molecular and cellular research and teaching have published 13 articles in refereed journals or books since 2006. (faculty reporting: [link].)

Service to the Community and to the Profession: The Biological Sciences faculty in the cellular and molecular area are also well-represented in professional societies and in the community, serving leadership roles such as: President, CSU Biology Council; Fall Meeting Co-Chair, Northern California American Society for Microbiology; Board member of CSUS/UCDCancer Center partnership, Burnham Institute, Program Leader, 4-H “On the Wild Side” program; CSUPERB grant review committee; collaborator with California Institute for Regenerative Medicine projects.

Service in University Governance: Faculty members from Biological Sciences are well represented on committees at the College and University levels. In the current year, examples include: Graduation Initiative Steering Committee, Faculty Senate Executive Committee, Academic Information Technology, CSUS Student Research Competition, Animal Care and Use, Program Review Oversight Committee, University Grade Appeal

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Section: Quality of Program and Resource Utilization

Committee, as well as every College-level committee. Faculty members from our department have also chaired or served on search committees for numerous administration positions and directorships across campus.

Working with other programs: Our faculty that are involved in graduate student research and teaching are highly collaborative, working with other faculty within the department, college, and across campus. The faculty in our department with research interests in cellular and molecular biology are involved with a number of collaborative programs, the most prominent is CIMERA (Center for Interdisciplinary Molecular biology: Education, Research and Advancement). Our faculty members collaborate extensively with Chemistry Department on research, service, and instructional projects.

Our faculty members have extensive collaborations both locally, nationally, and internationally, including with UC Davis faculty members, VA Hospital research faculty, scientists in Oklahoma, Florida, as well as the far reaches of the South America, Central America, Africa (Tanzania and Kenya), Asia (Vietnam), and Europe including a recent Senior Fulbright fellowship of one of our faculty in Berlin, Germany.

Effective sharing of resources: Faculty share resources for both research and teaching. All of the faculty in our department engaged in Cellular and Molecular biology research and teaching share office space. Additionally, many faculty members share lab space and equipment (e.g. microscopes, models, centrifuges, incubators, safety hoods, field collection equipment and field vehicles). The CIMERA cellular/molecular facility was devised and remains a shared facility available to all faculty across the college and the campus whose investigations or teaching utilize cell and molecular technologies. Addition sharing of resources has come from a California Institute for Regenerative Medicine grant that was recently renewed to support our MA Stem Cell program. A small portion of this grant pays one-half of our dedicated cell and molecular Instructional Staff position, and also heavily supports the BIO 221a methods course that all of our MS in Biological Sciences, Molecular and Cellular Concentration students take.

Finally, the curricula at the graduate level is structured to be efficient such that few courses stands alone. That is, many of our courses may be used in more than one program. For example, the BIO220/BIO221 introductory graduate courses required in the for Molecular and Cellular, Stem Cell, and General Biology concentrations also serves as the introductory course for the Ecology, Evolution and Conservation concentration. In addition, based on past enrollments, a two-year schedule of courses is generated each year, and the Department has a formal class scheduling policy, which prevents scheduling conflicts among required courses in a curriculum.

The Department of Biological Sciences’ on campus arboretum, greenhouses, as well as our autoclaves provide resources to individuals within the College of Natural Sciences and Mathematics, across campus, and in the Community. As well, the Faculty provide guidance for students in other departments (i.e. Chemistry, Anthropology, Criminal Justice, Psychology, Education), especially with regard to research that may involve molecular biology, genetics, or science education.

Facilitating student access to programs.

Through the numerous activities within the community and professional societies, faculty that serve in the graduate program in the Biological Sciences are well informed of programs and opportunities for our students, and are quick to disseminate this information. Much of this occurs through our student clubs and organizations, within each graduate research group, and through individual graduate advising by faculty mentors/graduate advisors that shepherd each of our graduate students on a one-to-one basis.

Information regarding our graduate program is primarily disseminated via our Departmental website http://www.csus.edu/bios/ which has a well-marked link to all things associated with our graduate program {including the Graduate Handbook (http://www.csus.edu/bios/Students/2010GradProgHandbook%2010-05-20.pdf) which details all requirements of the program from admissions to graduation in 30 pages.) as well as individual faculty web pages.
Criterion 11: Revenue and Other Resources Generated by Program

This section has been written for the department as a whole, as budgetary issues are handled on a departmental level.

Enrollment-based budgetary support from University

For our program, we receive budgetary support from the College based on FTEF (for office and facilities expenses) and based on FTES (for instructionally-related expenses). Unfortunately, for the past several years, this allocation has fallen very short of what we need to provide appropriate materials for students in our classes (in 2006-07, our $$/FTES ratio was $69.63/FTES; by 2011-12, the ratio had fallen 29% to $49.70/FTES). To maintain the quality of our program, we have resorted to charging students laboratory and field trip fees for almost every course. While in some ways this may seem like an equitable way to share the cost, we are highly disappointed that students in our program are absorbing the budgetary shortfall.

Research grants, in-kind equipment donations, fundraising

Since 2006, faculty members in our program have obtained $14.67 million in state and federal funding (source: Research and Contract Administration). In addition, faculty members secured over $1 million in donated equipment and supplies (e.g. cell culture hoods, incubators, analysis kits, a mass spectrometer, etc.). This has enabled us to create state-of-the-art laboratory experiences for our students even as the technology rapidly advances and our budget has dwindled. It is clear that without these donations, we would be unable to adequately prepare our students for an increasingly complex scientific job market.

Since 2006, Faculty in the Department of Biological Sciences that supported the MS in Biological Sciences, Molecular and Cellular Concentration program through their research and teaching submitted over 32 grants for research-related projects. Of those, 25 were successfully funded, and secured both internal and external support for research in our program, much of this involving students. (Source: Biological Sciences faculty, http://www.csus.edu/bios/temp/quarterly_1290847qwel-ri.html).

Potential revenue (gifts, alumni support)

Former faculty members have been generous in their support of our facilities and students.

- Dr. Marda West, Professor of Biological Sciences from 1966-2001, generously endowed her entire estate (over $750,000) to the Department of Biological Sciences, to be used primarily for student scholarships. Every year, at least $21,000 in student scholarships are awarded to deserving Biological Sciences majors. Marda also donated her SUV to the department for collection trips and field trips. This past year, when it needed repairs in excess of its worth, Marda’s fund allowed us to replace it (total cost = $22,413).
- Dr. Albert Delisle, Professor of Biological Sciences from 1956-1977, provided an endowment (currently valued at $300,000) whose interest provides yearly student scholarships ($2000 each, with at least two awards/year) and support for student research within the department that is open to all faculty members.
- Dr. David Vanicek, Professor of Biological Sciences from 1967-2000, used excess research funds to found a Biological Conservation scholarship (yearly award of $500)
- Dr. Carl Ludwig, Professor of Biological Sciences from 1949-1980, established an endowment that funds a yearly $700 scholarship to support outstanding teaching assistants
- Dr. Miklos Udvardy, Professor of Biological Sciences from 1966-1984, provides a yearly $500 scholarship to graduate students to support their research projects

Other scholarships available to students have come from alumni and other local donors:

- McDougal-Robinson ($1000) (shared with Nursing, awarded every other year)
- Josephine Van Ess scholarship - $2000/year
- Von Saltza - $2000/yr (this award, shared with English, is awarded every other year)

Value of other services and resources provided: The department also generates at least $5000/AY from students who enroll in our courses through Open University/College of Continuing Education. This money is used to support teaching labs throughout the department.