M.A. BIOLOGICAL SCIENCES, STEM CELL CONCENTRATION

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Section: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery

**Criterion 1: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery**

The Biological Sciences’ Master of Arts Stem Cell Concentration program is a unique graduate program leading to a professional science masters degree crafted to take just 20 months. The Program is a joint project of Sacramento State and the University of California, Davis (UCD) and is funded currently by the California Institute for Regenerative Medicine (CIRM). The Program maintains a dynamic curriculum that is supported primarily by full-time tenured and tenure-track faculty at both Sacramento State and UC Davis with both a broad training in Biological Sciences as well as advanced training in their chosen specialization.

**Contemporary Curriculum**

The students enter as a cohort, take nearly all of the coursework together and graduate together in a defined sequence. Like all Sacramento State graduate students, their required coursework over the course of the Master of Arts program is 30 total units, of which 18 must be at the graduate level (course numbers 200 and above). Those 30 units are thus spread across five consecutive semester and summer sessions. Each student who receives a Master of Arts degree from the Department of Biological Sciences must submit a written project based on a research problem in biology under the supervision of a graduate advisor. The program entails two semesters of coursework on the Sacramento State campus (Fall and Spring), both the Summer session and the following Fall semester taking courses and doing research in stem cell laboratories at either the Davis or Sacramento campuses of UCD, and, finally, returning to the Sacramento State campus in the second Spring semester to finish their coursework and write and present their stem cell research project reports. During these sessions the students are also expected to find and be accepted into a UCD research laboratory, read the appropriate literature to participate with their UCD mentor in designing their stem cell research project, prepare a written proposal and advance to candidacy, perform their projects working full time in the laboratory, write their detailed project report, and present their work to a combined Sac State-UCD committee to fulfill their graduation requirements.

The curriculum for stem cell graduate students overlaps extensively with the M.S. Molecular Cell Biology Concentration curriculum since stem cell research relies heavily on a similar skill set but with a different emphasis. The following is a list of the contemporary courses that an incoming stem cell student in the Fall of 2011 would take for graduation in Spring 2013 (5 semesters).

**Fall Semester 2011.** Courses (8 units) include the following:

1) **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. (approved as a Graduate Writing Intensive course) ; 2) **BIO 222**, “Molecular Biology”. Processes and control of DNA replication, transcription, and translation developed from a consideration of the current literature; and 3) **BIO 224**, “Genomics, Proteomics, and Bioinformatics”. Examination of current approaches in structural genomics, functional genomics and proteomics, and the bioinformatics tools utilized to understand genome organization, the regulation of gene expression, gene function and the evolutionary relationships within and between genomes.

**Spring Semester 2012.** Courses (6-7 units) include the following:

1) **BIO 221A**, “Cell and Molecular Methods and Techniques”. Introduction to research methods in molecular and cellular biology. Students learn both cell and molecular techniques in the context of hypothesis-driven research to answer questions relating to a specific gene and cellular system; 2) **BIO 294A**, “Seminar in Molecular and Cellular Biology”. Review and discussion of scientific literature in cell and molecular biology. Seminar topics will vary by semester; and 3) **one elective course**, such as, BIO 245 Host Pathogen Interactions or BIO 247 Contemporary Topics in Immunology.
Section: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery

Summer semester 2012. Courses (6 units) include the following:

1) BIO 225, “Stem Cell Biology and Manufacturing Practices”. Graduate level introductory course in human stem cell biology with specific emphasis on adult, embryonic, and induced pluripotent stem cells. Topics will include how stem cells are isolated or generated, how they are cultured, and how they are used for regenerative therapies. In addition, students will learn about Good Manufacturing Practice (GMP) and how to manufacture human stem cells; 2) BIO 294G, “Buck Institute Seminar in Embryonic Stem Cell Biology”; A five day training course in the theory and handling of stem cells with an emphasis on the culturing and differentiation of embryonic stem cells; and 3) BIO 299, "Problems in Biological Sciences”. Library research, original research, or technique development.

Fall semester 2012. Courses (6 units) include the following:

1) BIO 293, “Research Conference”. Presentation and discussion of graduate student and faculty research and current literature with emphasis on critical evaluation of research design, data analysis and presentation techniques and 2) BIO 299, “Problems in Biological Sciences” (same as above).

Spring semester 2013. Courses (4-5 units) include the following:

1) BIO 223, “Human Molecular Genetics”, An in-depth study of the molecular basis of human disease, emphasizing current experimental approaches and technologies; and 2) BIO 502, “Master's Project”. Completion of a written project based on a research problem in biology approved for the Master of Arts Degree taken in final semester prior to the completion of all requirements for the degree and one elective course.

Faculty (and staff where appropriate) Qualifications

All full-time faculty and part-time faculty members teaching in the Program have a Ph.D. or M.D.in specializations aligned with their teaching assignment. Most also have post-doctoral experience and professional training directly related to their area of specialization within the biological sciences.

Percent of Instruction by Full-time Faculty

Since the beginning of the Program in Fall 2009 only three semester courses have been taught by non-tenure track employees. All of them on the Sacramento State campus. In Fall 2010, BIO 220 and BIO 222 and in Fall 2012 BIO 220 were taught by part-time faculty with Ph.D..in their area of expertise.

Use of Technology, as appropriate for discipline

Technology is at the very core of the biological sciences and its use is essential to prepare students to acquire scientific data in today’s high-technology setting, and to successfully enter the growing stem cell research workforce. Having said that, the skills and concepts learned in the Stem Cell Concentration are applicable to ALL fields of biology and does not limit the student to this discipline. The participating faculty members (Sac State, UCD, and Buck Institute) supply essential technical expertise to our students and teach them the most cutting edge techniques using modern instrumentation and the software tools to interpret the data. In addition, our faculty have worked very hard to obtain modern equipment for our students to be trained on (grants and gift acquisitions). Some of the advanced technological expertise includes:

- DNA, RNA and protein technologies, flow cytometry, PCR, real-time PCR, and bioinformatic programs
- Microscopy technologies (inverted, fluorescence and confocal) and digital capture and image analysis programs with real-time instructor/student data gathering and sharing capabilities
- Laminar flow hoods, sterile and non-sterile culture incubators, temperature and CO2 controlled incubators
- Wireless streaming and cyberlearning technologies, such as wiki-based social learning, instant messaging, social networking and social bookmarking
Section: Advising Program and Graduation Success

Criterion 2: Clearly Developed Learning Outcomes

The stem cell sciences have inherent rigor in both the subject matter and the skills needed to learn and integrate ideas from this rapidly changing field. Understanding the biological complexity of stem cells and their applications to health requires:

- Detailed learning and integration of ideas from multiple courses (including application of principles from the fields of chemistry, physics, and mathematics)
- The capacity to understand, generate and communicate information using complex technology
- The ability to conduct both laboratory and library-based (primary literature) research, analyze data, and draw evidence-based conclusions
- Critical thinking, writing, and oral communication skills that break down complicated theories and data
- Accurate use of high-technology instruments (more fully described below)
- Problem-solving, scientific reasoning and critical thinking skills
- Time management to complete various projects/assessments

Critical thinking and analysis is foundational to our program. Faculty employ teaching and assessment techniques that require students to be facile with their acquired skills and to demonstrate knowledge in a variety of ways.

- Inquiry-based laboratory protocols and research experiences within research laboratories and classes
- Teaching and learning with current technology and instrumentation (particularly in laboratories)
- Writing, library research, and the use of primary literature
- Essay exams with questions that require data analysis
- Assessment of student skill with regard to experimental design and data portrayal (graphs, figures)
- Rigorous pre-requisite courses and minimum math/chemistry standards for most courses

Clearly Articulated Program Links to Campus Baccalaureate Learning Goals

The stem cell and molecular sciences are extreme in their technical rigor as well as in the ethical rigor required in their use. The broad learning outcomes established for all undergraduate programs are arguably more important at the graduate level and are directly linked to the baccalaureate learning goals as described below:

- Students will develop a base of factual and conceptual knowledge of basic and applied stem cell and molecular biological processes.
  - Baccalaureate learning goals addressed: Competence in the discipline, Knowledge of human cultures and the physical and natural world, Intellectual and practical skills
- Students will be able to generate and communicate scientific knowledge in both written and oral form.
  - Our objective for each student includes peer reviewed publication although it is not always feasible in the short time of the program.
  - Baccalaureate learning goals: Competence in the discipline, Intellectual and Practical Skills, Personal and social responsibility, Integrative learning
- Students will develop and appreciate the importance of connections between other academic disciplines and the biological sciences and the social relevance of stem cell and molecular biology.
  - Baccalaureate learning goals: Competence in the discipline, Knowledge of human cultures and the physical and natural world, Integrative learning
- Students will be able to implement the skills needed to be life-long learners in any field of study.
  - Baccalaureate learning goals: Competence in the discipline, Knowledge of human cultures and the physical and natural world, Intellectual and Practical Skills, Personal and social responsibility, Integrative learning
Updated Plan that Clearly Identifies Program Learning Goals, Assessment Strategies, and Processes by Which Data Inform Program Curriculum Decisions.

Due to its requirements for advanced training and inter-institutional instruction, the MA Stem Cell Program has an unusually rigorous schedule of formal advising and assessment of student success. Close contact with multiple faculty members is required prior to the students beginning the program and continues throughout the ensuing twenty months of training. All incoming students are assigned to the Sacramento State Stem Cell Academic Coordinator (full-time faculty member) prior to acceptance and are required to attend an Orientation prior to each Fall semester. Importantly, the students enter the Program as a cohort and perform nearly all of their non-Internship activities with their peers throughout the Program. An important point of advising and assessment for the students as they transition to graduate studies occurs in the first semester course, BIO 220 (Introduction to Scientific Inquiry). Students are exposed to graduate level scientific inquiry in the biological sciences and learn to apply the scientific method, critically evaluate the scientific literature, initiate their graduate project, and develop written and oral scientific presentation skills under the guidance of Sacramento State faculty. In the Spring of the first year the students Advance to Candidacy in a process that serves to ensure that a student is qualified for and making good progress toward successfully completing the Master’s degree. The students have mandatory writing deadlines and meetings with Sacramento State faculty mentors every two weeks through this process. 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 project. Furthermore, it is a formal assessment of the student’s progress towards the learning outcomes first introduced in the BIO 220 course.

In the Summer and second Fall semesters, the students work on Internship projects in stem cell laboratories on the Sacramento and Davis campuses of UC Davis under the supervision of UCD faculty and the Externship Program of the UCD Human Resources Program for Training and Development. The students remain in close contact with the Sacramento State faculty mentor and peers through regular meetings throughout the seven month Internship. The students also attend a UC Davis Stem Cell Journal Club during the fall semester that includes other graduate and post-graduate researchers in which students present a review of a current journal article in the field. The students return to the Sacramento State campus for the second Spring semester to finish their coursework and begin to write their Project Report. This culminating written document and the Project Exit Seminar are our final assessment of student progress towards attaining the learning goals that were set forth in BIO 220 their first semester. The students again have mandatory writing deadlines and meetings with Sacramento State faculty mentors every two weeks through this process. The Exit Seminar must be attended by the Graduate Advisor, members of the Supervisory Committee (made up of two additional faculty or professionals with expertise 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 advertised and open to the public; it may be attended by anyone who wishes to attend. During the seminar, the student orally presents the general nature of the Project. The student is then expected to answer questions about their research project. 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 Handbook, this assessment will be made using the following criteria: 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. Finally, the students and their UCD faculty mentors both submit an Exit Survey that assesses the quality of the their experiences and allows us to make adjustment for incoming cohorts.

External Assessment and Accreditation Outcomes, where appropriate

The MA Stem Cell Program submits yearly reports to CIRM as external assessment but we do not have accreditation outcomes to meet.
Criterion 3: Advising Program and Graduation Success

The M.A. Stem Cell Concentration program has a unique advising program which combines expertise from both Sac State and UC Davis faculty and also Sac State administrators. The Stem Cell Program has an advisory committee consisting of two faculty members each from both Sac State and UC Davis and also Sac State’s NSM College Associate Dean who serves a director for the program. All of these advisory members are involved in advising for the direction of the program and directly with the students. As for involvement directly with the students, advising includes coursework planning, discussing expectations and procedures for the program, facilitating the matching of students with UC Davis faculty research mentors, and career planning. In addition, students are advised by their UC Davis faculty research mentors after entering their laboratory in the third semester. Thus, the design of this program integrates advising and mentoring from a multitude of individuals to support student success.

Graduation Rate

The program has only had one graduating class since its inception in Fall of 2009. Of the 10 students admitted in 2009, 8 graduated on time in the Spring of 2011 (80% success rate). One student dropped out of the program by choice, and the other is continuing their progress to degree and is expected to graduate this Spring 2012 (would increase rate to 90%).

Distribution of Advising Responsibilities Among Faculty Members

The Sac State Academic Coordinator takes a primary role for coursework advising and guidance through much of the process (when to file paperwork, conference registration, etc.). The Coordinator and the director of the UC Davis Stem Cell Program advise students as to which UC Davis laboratories might best fit their internship requirement and career development. The Coordinator and other involved faculty participate in advising students during their progression from Advancement to Candidacy to finishing their final Project Report and Exit Seminar which entails both writing and oral presentation advising. All involved faculty from Sac State and UC Davis advise students professionally for career development and placement. In this respect, students benefit from the strong relationships that faculty have to regional employers (academic, biotechnology, pharmaceutical, and government agencies).

Proactive Advising Contact with Students to Assure Progress to Degree

After acceptance into the program and prior to their first semester, the Academic Coordinator contacts the students and discusses the basic roadmap of the program with the students and advises them on their coursework plan. Near the beginning of the semester, a Welcome Party is held so students can meet the faculty and administrators associated with the program and then a more formal Orientation meeting is held. The Orientation meeting highlights the expectations for the program, provides a more detailed timeline for the degree completion, and outlines the paperwork that students must submit (including UC Davis forms that are required). Follow-up meetings are held periodically throughout the year with the cohort groups to re-focus the group on upcoming events and requirements. In addition, students are required to meet with their faculty advisors regularly when they are preparing their Advancement to Candidacy and final Project Report materials (written report and oral PowerPt presentations).

Program Roadmap to Curriculum Completion and Graduation Success

The program curriculum design does not have much room for deviation (only one elective course can be selected from an approved list) and therefore students have a very clear roadmap from the beginning. Courses need to be taken in a particular sequence and are advised thoroughly as mentioned above. Since the program is grant-funded, students receive a stipend during their internship research period (2 semesters) which thereby enables them to be full time students and progress towards their degree. Students are closely monitored during the entire process and advised when needed to keep forward progress to degree completion.
Section: Advising Program and Graduation Success

Use of Technology to Supplement and Strengthen Program Advising Effort

Students are contacted through an email listserv (only Stem Cell students) and reminded of all deadlines and upcoming events. This is normally performed by the Academic Coordinator, but the Graduate Secretary often sends out more general notices through an email listserv for all graduate students. The Director of the program also uses the listserv for important announcements such as gathering information for progress reports.

Post-Degree Success, Graduate Impact on Community

Of the eight students who have graduated, seven of them are currently employed in academic laboratories at UC Davis and the Buck Institute. These former students have had a significant impact on the stem cell research workforce and are directly contributing towards the development of new cures or treatments for debilitating diseases such as Huntington’s disease, Fragile X syndrome, and HIV. UC Davis colleagues have reported the need is great for highly trained stem cell biologists in the academic and industry setting.
Section: Strength of Teaching Performance

Criterion 4: Strength of Teaching Performance

The Sacramento State faculty members who teach courses and serve as graduate advisors in the Stem Cell Program, as with all of our faculty in the Biological Sciences, are absolutely committed to excellence in teaching. The additional UC Davis and Buck Institute faculty that teach courses in the program are renowned scientists that deliver cutting edge curriculum and allow our students to see into the scientific process very deeply. We are proud of the teaching collaboration in the 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. Note: Faculty teaching in all programs in the Department of Biological Sciences are held to the same standards with regard to teaching performance. Therefore, responses relating to this criterion apply to all Biology programs.

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.

2. 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:

- **Student Evaluations:** The Department takes great care to solicit information from students regarding the quality of our teaching. Unless a 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 members 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 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.
Section: Program History and Development Status

Criterion 5: Program History and Development Status

The M.A. Stem Cell Concentration is a young blossoming program having only been initiated in the department in 2009 subsequent to the official establishment of the M.A. general degree offering in the same year. The impetus for a program concentration in stem cells derived from a Request for Applications to the California Institute for Regenerative Medicine (CIRM) for the Bridges to Stem Cell Research Awards in the Fall of 2008. A collaboration was forged between Sacramento State and the UC Davis Stem Cell Program during the formulation of the grant proposal through meetings with Sac State faculty and administrators and the directors of the UCD Stem Cell Program and Good Manufacturing Lab facility, Drs. Jan Nolta and Gerhard Bauer, respectively. The proposal was submitted and awarded $1.1 million over a three year grant period to educate and train ten master degree students per year (total of 30). The first cohort of ten students were admitted the spring of 2009, begin their studies in the fall of 2009, and graduated after five semesters (20 months) in the spring of 2011. In addition, the program has been approved the designation as a Professional Science Master’s degree which requires that the curriculum has a professional component to train students for the current job market.

Level of Program Development

Even though the program is relatively new, only a few courses needed to be added to the curriculum since the existing graduate courses for the M.S. Molecular Cell Biology Concentration program were an excellent fit for the learning objectives of this program. In particular, a new course entitled “Stem Cell Biology and Manufacturing Practices” (BIO 225) was designed, approved, and implemented by the department and Dr. Bauer who taught the course for the first time in the summer of 2010. In addition, a new seminar series workshop course entitled “Stem Cell Techniques Seminar” taught by Dr. Xianmin Zeng, a renowned stem cell scientist, at the Buck Institute for the Ageing (Novato, CA) was instituted to accommodate the specialized stem cell training needs for the program under the BIO 294 heading. The addition of these two new courses solely for the Stem Cell Concentration rounded out the curriculum and provided the needed practical aspects to student training for research in stem cells. The program also has incorporated BIO 502 “Master’s Project” units (BIO 502) that is used for both the M.A. General and the Stem Cell Concentration for completion of the project (written report and exit seminar). No new classes are being planned for incorporation into the program at this time. CIRM has re-funded the program for another three years and has not recommended any curricular changes. As for admission into the program, admission requirements remained consistent with the other graduate programs, and the only procedural difference is that the selection of candidates is through the stem cell faculty advisory committee.

Ability of Program to Adapt to Current Demands

The program has adapted to current demands for the professional preparation of the students when it was established in 2009 by consulting with UC Davis collaborators throughout the process. This can be evidenced by the fact that all graduating students were offered and accepted jobs after graduating.

Future Goals of the Program

The goal of the program is to sustain funding levels so as to maintain its internship research funding and stem cell seminar workshop course (Buck Institute) since these are unique to this program.
Criterion 6: Impact, Justification and Centrality to University Mission

The Stem Cell Concentration is a unique and distinctive collaboration between four great institutions, California State University Sacramento, the University of California Davis, the Buck Institute for Research on Aging, and the California Institute for Regenerative Medicine. This collaboration is dedicated to the life-altering potential of learning that balances civic responsibility with depth of knowledge in a discipline. We are committed to providing an excellent education to qualified applicants who aspire to expand their knowledge and prepare themselves for meaningful lives, careers, and service to their community. Sacramento State is also committed to teaching and learning as its primary responsibility and success is measured in terms of student learning. In addition, the University recognizes the vital connections between pedagogy and learning, research activities and classroom instruction, and co-curricular involvement and civic responsibility. All students, regardless of their entering levels of preparation, are expected to complete their degree programs with the analytical skills necessary to understand not just the science but the social, economic, political, cultural, and ecological complexities of an increasingly interconnected world. The Stem Cell Concentration is a comprehensive curricular program that will produce about 10 Masters of Arts degree graduates each cohort with the scientific foundation, research experience, practical laboratory skills and ethical training to pursue careers in stem cell research. Graduates of the Concentration will develop knowledge and skills suitable for basic research as well as its translation into clinical applications for patients. Graduates will help fill the future demand for laboratory managers and other research-support professionals in a growing number of laboratories devoted to stem cell research. Rather than a traditional, independent master’s thesis project, students engage in activities specifically intended to improve the professional preparation of graduates desiring industry or laboratory careers in applied biosciences.

Reflecting the metropolitan character of the area, California State University, Sacramento is a richly diverse community. As such, the University is committed to fostering in all its members a sense of inclusiveness, respect for human differences, and concern for others. In doing so, we strive to create a pluralistic community in which members participate collaboratively in all aspects of university life. A diverse pool of applicants is actively recruited from juniors and seniors with declared majors in Biological Sciences at Sacramento State, of which typically 54% are minority students. In addition, invitations to apply are extended to students from 22 campuses of the California State Universities and community colleges that participate in programs designed to increase the number of underrepresented students in science. Located in the capital of the nation's most populous and diverse state, California State University, Sacramento is dedicated to advancing the many social, economic, political, and scientific issues affecting the region and the state. Our research centers and much of our individual scholarly efforts also remain directed at the enhancement of the quality of life within the region and the state.

The Concentration builds upon curricular strengths in cellular and molecular biology at Sacramento State and the outstanding research facilities of the UC Davis Stem Cell Program. The twenty-month program of study consists of graduate courses taken at Sacramento State and an internship at the UC Davis Stem Cell Center and at the UC Davis hESC Shared Research Facility. During the seven-month internship at UC Davis, student interns work with mentors as part of disease teams that bring students and research scientists together with clinicians to work toward cellular therapy trials, including neurodegenerative disorders, spinal cord injury, epilepsy, traumatic brain injury, stroke, HIV infection and AIDS, non-healing ulcers, osteoporosis, cartilage degeneration, blood disorders, bladder reconstruction or burns. Proximity of the Home and Internship Host Institutions, which are only 6 miles apart facilitates program coordination, and ensures that students have ready access to mentors from both institutions. At California State University, Sacramento, we are constantly striving to create a sense of unity among faculty, staff, administrators, students, alumni, and community members. In pursuing the combined elements of our mission, we seek to foster a sense of pride in all who view this campus as their own – pride in Sacramento State as the institution of choice among our current students; pride among our alumni in the ongoing impact of the Sacramento State education upon their lives; pride among faculty, staff, and administration in their university's achievement of excellence in teaching, learning, and scholarship; and pride in Sacramento State as an asset to the community among residents of the Greater Sacramento region. The Stem Cell Concentration achieves a level of cooperation and vision that should make us all very proud.
Criterion 7: External Demand for the Program

Community Engagement

World-renowned speakers from across the US, particularly showcasing those engaged in our program from UC Davis, speak in a seminar series on the Sacramento State campus put on by the program four evenings per year. Invitations sent to local schools and colleges, related private and government participants, and radio advertisements to the general public produce a consistent attendance of 250-300 people for these accessible talks.

Demand for the Program’s Resources and Expertise

CMB faculty members:

- Provide workshops and field experiences in support of academic programs for area high school and middle school students, such as the Science Olympiad and the Academic Talent Search.
- Design and teach workshops annually in the Expanding Your Horizons program for young women in the community, as well as intensive summer laboratory-based workshops for high school students.
- Conduct professional development workshops such as Science in the River City, Sacramento Area Science Project and Closing the Achievement Gap in Math and Sciences.
- Serve on external academic advisory boards for regional high schools and community colleges and participate in local collaborative efforts, such as Biotech SYSTEM (UC Davis).
- Serve as science consultants or experts to local public and private organizations.

Local Trends in Enrollment

The first six cohorts of the MA Stem Cell Program will be capped at ten students per year. Each of the first three years has seen the number and quality of applicants increase, from sixteen in 2009 to more than thirty in 2011. Five of the ten accepted applicants in 2011 had taken courses at Sacramento State prior to matriculation. This parallels an increase in both the undergraduate and Masters of Science Cell and Molecular Biology programs. In November 2011, data obtained from Sacvault indicated that there were 93 majors in Molecular Biology concentration (which is a closely related program), and that by February 2012, data from the same source indicate that there are now 102 declared majors in the Cell and Molecular Biology concentration.

Demand from Employers


- employment of biological scientists is projected to grow 21 percent over the 2008-18 decade, much faster than the average for all occupations; people with bachelor's and master's degrees are expected to have more opportunities in nonscientist jobs related to biology, in fields like sales, marketing, publishing, and research management; and biological scientists are less likely to lose their jobs during recessions than those in other occupations, because many are employed on long-term research projects. The “biological scientist” category is only one of many occupational categories that require a minimum of a BA/BS degree in Biological Sciences or require a post-baccalaureate degree, certificate or license for which the BA/BS degree in Biological Sciences is required.

100% of our graduates to date have found immediate employment or gone on to pursue an advanced degree.

Projections data from the National Employment Matrix

Criterion 8: Program Size, Scope

The curriculum for the M.A. Stem Cell Concentration ranges from the theory of biological concepts to the practical aspects of research applications. Students are provided a broad knowledge base of biological concepts with a focus on cellular and molecular biology as the central unifying theme since stem cell biology is a subdiscipline within this broader context. Course instruction is designed to expand on the required knowledge base that a student is supposed to have obtained during their undergraduate degree courses and therefore deepen the student's understanding and relatedness of different topics. For example, the course BIO 222 entitled "Molecular Biology" is designed to go into the current scientific literature and discern the latest experimental evidence for various molecular mechanisms that underlie biological phenomena. In addition, the more practical aspects of how to apply scientific inquiry to research questions are also taught within the curriculum beginning with the BIO 220 course entitled "Introduction to Scientific Inquiry". Students are taught how to formulate and frame scientific questions into testable hypotheses and then how to rigorously test them. In the BIO 221A course entitled "Cell and Molecular Methods and Techniques", the students delve even deeper into how to experimentally test hypotheses and the modern tools and instrumentation to do so through a rigorous laboratory experience. Students learn more about the specific handling of stem cells, research techniques, and their biological attributes in more applied course such as BIO 225 (“Stem Cell Biology and Manufacturing Practices”) and BIO 294G (“Buck Institute Seminar in Embryonic Stem Cell Biology”). Students then learn to apply these practical research skills by performing authentic original stem cell research during their internship period in which they are enrolled in BIO 299 units (“Problems in Biological Science”). Also, students learn communication skills throughout the program in nearly all courses taken. All courses have written assignments and oral communication components to them (e.g. PowerPoint presentations) and emphasize professional dissemination of scientific information. In addition, students need to present their research proposals (written and oral) in order to advance to candidacy and also for their final research projects (written and oral) which is the culminating Master's project referred to in the course description of BIO 502.

Number and types of degrees, concentrations, and certificates awarded (relative to campus standards, or national standards, as appropriate)

There is only a Master of Arts Stem Cell Concentration degree conferred for this program.

Annual FTES in major, minor, certificate elements of program

The program has twenty full time graduate students (20 FTES) enrolled in any given year (overlapping cohorts of ten each) and each student completes thirty semester Units over the two year academic period (five semesters which includes the summer).
Criterion 9: Internal, Non-major Demand for the Program

The Concentration is designed to have consistent enrollment, ten students in the first year cohort and ten students in the second year cohort, combined with a set schedule of courses. A critically important aspect of this design is that it guarantee that all of the required courses have adequate enrollment and are, thus, available to graduate students from other disciplines in Biological Sciences, as well as those studying Biochemistry or Bioengineering. It is not uncommon for low enrolled courses to be postponed a semester or even a year until demand warrants the expenditure of their resources. The high enrollment guaranteed by the Concentration lowers the time to graduation of all of the Department’s graduate students, particularly those in the cell and molecular sciences, and many others by assuring them access to required courses.

The advanced biology and cutting-edge basic and clinical research being performed by our students in the Concentration reaches many more students and faculty members in the Department than just those directly involved. Stem Cell topics and discoveries are embedded in many of our courses and reach most of our students by this indirect route. Faculty teaching in required courses in the Concentration are also scheduled to teach BIO 002, BIO 100 – Introduction to Scientific Analysis, BIO 121 – Molecular Cell Biology, BIO 127 – Developmental Biology, BIO 143 – General Virology, BIO 149A – Immunology, BIO 180, BIO 183 – Cancer Biology, BIO184 - Genetics, BIO 186A – Seminar in Cell and Molecular Biology, BIO 187, BIO 220 – Introduction to Scientific Inquiry, BIO 222 – Molecular Biology, BIO 224 – Genomics, Proteomics and Bioinformatics. Current Stem Cell Concentration graduate students also serve as Teaching Assistants for BIO 002, BIO 187 and even the 221A course for their peers in the cohort behind them. Similarly, a very important aspect of the recent Department of Biological Sciences curriculum redesign is the alignment of significant portions of the laboratory curriculum between BIO 221A - Cell and Molecular Methods and Techniques course, our new undergraduate BIO 180 - Advanced Molecular Biology and BIO 187 - Advanced Cell Biology courses, and even our BIO 002 – Introduction to Cells, Molecules and Genes course. This allows us to share resources, from consumable reagents, small equipment and large equipment to expertise, protocols and instruction.

The Stem Cell Concentration also provides public service through its Stem Cell Lecture Series. This publically advertised and open-door series brings world-renowned stem cell speakers to campus four times per year. This Series has grown consistently over the first three years of the program until the average attendance approximates three hundred people. Our Stem Cell partners from UC Davis and Biomedical Engineering at Sacramento State have also speak regularly in our undergraduate courses, including BIO 121, BIO 184 and BIO 186A.

Research resources

The Stem Cell Concentration and its teaching faculty have contributed to a dramatic expansion of our research capacity in Cell and Molecular Biology. This has primarily been through external grants and in-kind donations that have modernized our infrastructure at every level. The California Institute for Regenerative Medicine grant provides significant funding for the Stem Cell Concentration, including small equipment purchased for the BIO 221A course that is then available for Department researchers and others to borrow. This course was originally built with the assistance of two approximately $15K California State University Program in Education and Research in Biotechnology (CSUPERB) grants. The Stem Cell faculty members were principally responsible for obtaining nearly $1 million in in-kind donations of equipment, both large and small, and consumable resources that have elevated our capacity for cell and molecular research and teaching tremendously. These materials are being used currently in various research laboratories, our cell and molecular teaching laboratories and the College Center for Interdisciplinary Molecular Biology: Education, Research and Advancement (CIMERA). In addition, Concentration faculty have also been instrumental in obtaining $350K to build an Advanced Cell Analysis Laboratory that allows our researchers and classroom students the ability to collect data and train at the cutting-edge of cell biology. Finally, Concentration faculty members were also principally responsible for obtaining a $755K National Science Foundation grant to remodel the CIMERA Facility into a modern and highly effective cell and molecular research facility.

Service courses and GE courses (accompanying AY FTES)

Not applicable to Concentrations in our graduate program.

Program Name: M.A. Biological Sciences, Stem Cell Concentration
Criterion 10: Quality of Program and Resource Utilization

Faculty productivity in non-teaching areas

The scholarly and creative activity of the faculty members associated with the Stem Cell Concentration is varied and the effect of the Concentration has been to increase its relationship to stem cells.

- Our faculty members have utilized sabbatical leaves to study in stem cell laboratories at UC Davis, which has increased the knowledge base in our laboratories and courses, as well as strengthened the ties of the CIRM collaborative. Other faculty members share resources to research topics that provide important related information to our students, including cancer biology, reproductive developmental biology, cardiovascular developmental biology and immunological pathology.
- Our faculty members helped to secure Adjunct Faculty status for a local businessman and researcher in stem cell biotechnology who has brought external resources to our campus laboratories. This is providing exciting intellectual development for our faculty and employing multiple students.
- Our faculty members are currently adapting both graduate (BIO 221A) and undergraduate (BIO 187) courses to the uniform conceptual framework encompassed by the cellular and molecular mechanisms of wound healing. This is consistent with current sabbatical investigations and maximizes use of resources.

The service efforts of the faculty members associated with the Stem Cell Concentration is varied provides access to multiple stem cell resources for our students and faculty, as well as for our regional partners and the public.

- Our faculty members sit on the Sacramento Area Regional Technology Alliance (SARTA) Stem Cell Device Subcommittee
- Our faculty members coordinate the speaking engagements of noted stem cell scientists in the public Stem Cell Lecture Series.
- Our faculty members coordinate speaking engagements from our Stem Cell partners at UC Davis and Biomedical Engineering in our undergraduate courses

Access to and utilization of resources

Collaborations across program lines that improves the quality of both ours and other programs.

- Our faculty members collaborate extensively with Chemistry Department faculty members on research, service and instructional projects both in the stem cell arena and without
- Our faculty members collaborate with Electrical and Electronic Engineering faculty members to promote development of complex biomedical devices that can aid in surgical and non-surgical environments
- Our faculty members collaborate with UC Davis faculty members on research, service and instructional projects both in the stem cell arena and without

Effective sharing of resources across program lines that improves the quality of both ours and other programs.

- The CIRM grant pays one-half of our dedicated cell and molecular Instructional Staff position
- The CIMERA facility was devised and remains a shared facility available to all whose investigations or teaching utilize cell and molecular technologies
- The in-kind donations of Bayer Health Care have been shared in teaching and research laboratories in Biological Sciences and Chemistry and many will be available to all who utilize the CIMERA facility

Facilitating student access to Programs

- Many of our undergraduates, current graduate students and former graduate students have gained experience in UC Davis stem cell laboratories due to this program and its established collaborations
- Many of our undergraduates, current graduate students and former graduate students have also accessed the UC Davis Externship and Volunteer Programs due to this program and its established collaborations.
- Adjunct Professor stem cell laboratory on campus Electrical and Electronic Engineering-Business-Biological Sciences collaborative for an innovation and entrepreneurship competition at CSUPERB.
Criterion 11: Revenue and Other Resources Generated by Program

The M.A. Stem Cell Concentration has from the start acquired external funds to support the program. The program was initiated after being awarded a Bridges to Stem Cell Research grant from the California Institute for Regenerative Medicine (CIRM) in 2009 (grant #TB-01184) for $1.1 million over a three year period. These funds were secured to support the training of ten students per year with a total of thirty students trained in the initial grant period. The program has since been awarded an extension of the grant for an additional three years (at up to $1,429,523 for three years). These funds support course expenses, new equipment for courses, graduate assistants to support teaching activities, 50% salary for an Instructional Staff personnel to support courses, faculty assigned time to support the program, stipends and registration funds for students during seven month internship period (two semesters), travel to meetings, and enrollment in the "Buck Institute Seminar in Embryonic Stem Cell Biology" five day workshop.

Enrollment-based budgetary support from University

The program receives normal operating expenses for the graduate level courses that are taught in the curriculum. The curriculum overlaps extensively with other graduate programs such as the M.S. Cell and Molecular Concentration thus these expenses are shared.

Research grants, in-kind equipment donations, fundraising

As stated above, the CIRM grant provides the extra support for the additional educational and training activities for the program. In addition, the BIO 221A course (“Cell and Molecular Methods and Techniques”) was initially funded by two ~$15K California State University Program in Education and Research in Biotechnology (CSUPERB) grants. In addition, the faculty members involved in the stem cell program were principally responsible for obtaining nearly $1 million in in-kind donations of equipment, both large and small, and consumable resources that have elevated our capacity for cell and molecular research and teaching tremendously (primarily from Bayer Pharmaceutical company). These materials are currently being used in the courses and will also become more accessible after completion of the renovation of shared teaching and research facility (CIMERA: Center for Interdisciplinary Molecular Biology: Education, Research and Advancement). It should be noted that the renovation is funded by an American Recovery and Reinvestment Act grant ($755K) that was secured by highlighting programs such as the Stem Cell Concentration and the other cell and molecular activities in our department. In addition, Stem Cell Concentration faculty have also been instrumental in obtaining $350K to build an Advanced Cell Analysis Laboratory that allows our researchers and classroom students the ability to collect data and train at the cutting-edge of cell biology. These funds were acquired through a congressionally-directed grant and the support of Congresswoman Doris Matsui.

Potential revenue (gifts, alumni support)

None to report.

Value of other services and resources provided

None to report