Faculty Member(s) Responsible for Data:

Ruth Ballard
Jennifer Lundmark
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Rose Leigh Vines
Brett Holland
Tom Landerholm
Christine Kirvan
Bill Avery
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Shannon Datwyler
Criterion 1: Quality of Curriculum, Instructional Personnel, Curriculum Delivery

Contemporary Curriculum and Curriculum Rigor

Forensic biology is a rapidly-evolving discipline that applies the approaches, methodologies, and instrumentation of the biological sciences to matters of law. In theory, forensic biology draws from virtually every area of the biological sciences including cell biology, medicine, microbiology, entomology, botany, physical anthropology, wildlife ecology, immunology, biochemistry, and molecular biology. In practice, however, professionals who call themselves "forensic biologists" work as bench scientists in crime labs screening forensic evidence for bodily fluids and DNA, generating reports on their findings, and testifying in court. In addition, most have a strong background in chemistry (DNA is fundamentally a chemical analyte) and devote part of their time to blood alcohol analysis and toxicology.

Modern forensic biology grew out of ABO blood typing, which was discovered in 1901. DNA was first introduced as a forensics tool in the 1985 but early systems required a large amount of fresh biological material and were subject to artifacts that made the interpretation of DNA profiles problematic. However, new tools developed for the Human Genome Project spurred a series of spectacular advances such that, by 2000, DNA profiles could be generated from fewer than 100 cells and all but one in several quintillion persons could be excluded as the source of a sample. This led to "cold case" convictions, dramatic exonerations, and a love affair with the media that continues today. The O.J. Simpson trial was televised in 1995, followed by a highly publicized civil trial in 1996-97. CSI first aired in 2000, Forensic Files in 2002, Cold Case in 2003, The First 48 and Dr. G. Medical Examiner in 2004, Bones in 2005, Vanished in 2006, and many more since. The ID Investigation Discovery channel alone currently lists 23 different forensics shows. In turn, an increasing number of young people were drawn to the profession, including students enrolling in classes at Sacramento State. By 2004, the demand was so obvious that the Department felt compelled to respond.

The Forensic Biology curriculum was developed using a "backward design" model that was later adopted by the Department to redesign its entire curriculum. In the spring of 2005, Dr. Ruth Ballard (Biological Sciences), Bob Jarzen (Director of the Sacramento District Attorney's Laboratory of Forensic Services) and Dr. Will Vizzard (then Chair of Criminal Justice) held a series of meetings to discuss learning outcomes for the program that addressed the hiring practices of crime labs in California as well as trends in the field. The result was an interdisciplinary curriculum that provides broad training in the biological sciences as well as rigorous supplementary training in molecular biology and chemistry. Three criminal justice courses were also hand-picked to provide a context and breadth.

The following fall, Dr. Ballard spent her sabbatical leave interning at the Sacramento District Attorney's Laboratory of Forensic Services. While there, she familiarized herself with forensic biology from a practitioner's point-of-view with the aim of designing a forensic biology course that embodied contemporary approaches, methodologies, and instrumentation. A Pedagogy Enhancement Award in fall 2006 enabled her to write a lab manual for the course and pre-run and troubleshoot all the laboratories. BIO 150 (Forensic Biology) was offered for the first time in the spring of 2007 and filled to capacity. Later (2009), a second course was developed that provides students with a capstone inquiry-based laboratory experience in forensic biology (BIO 151, Advanced Laboratory Techniques in Forensic Biology) and helps meet students' need for research experience prior to graduation (critical in helping them compete for jobs). During this period, the Department also discussed and approved the new Forensic Biology concentration (with a minor in Chemistry). Courses include:

- **Lower Division**
  - 10 units introductory biology (with labs)
  - 10 units physical chemistry (with labs)
  - 4 units organic chemistry (with lab)
  - 4 units quantitative chemistry (lab)

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Program Name: B.S. Biological Sciences, Concentration in Forensic Biology
Section: Quality of Curriculum, Instructional Personnel, and Curriculum Delivery

- 3 units calculus
- 3 units statistics
- 8 units physics (with labs)
- 3 units criminal justice

- **Upper Division**
  - 3 units scientific analysis (strong emphasis on statistics specific to biological sciences)
  - 4 units genetics (with lab)
  - 5 units molecular biology (including 2 units of lab)
  - 6 units biochemistry (3 units with lab)
  - 6 units forensic biology (with labs; includes state-of-the-art instrumentation)
  - 6 units criminal justice
  - 3 units structure/function elective
  - 3 units ecology, evolution, and biodiversity elective

The BS is the terminal degree for entry-level jobs in crime labs. However, many students are opting to obtain additional graduate-level training in one of several professional M.S. programs that have been introduced nationwide in recent years. Unfortunately, most of these (including the near-by program at U.C. Davis) are supported entirely by tuition and are prohibitively expensive for Sacramento State graduates. Therefore, it is critically important that the Forensic Biology program maintains its rigor and continues to respond proactively to the introduction of new technologies and educational priorities adopted by the forensics community.

**Faculty and Staff Qualification**

Faculty who teach in the concentration are primary full-time and part-time faculty members in the College of Natural Sciences and Mathematics. All full-time faculty members have PhD specializations aligned with their teaching assignments and scholarly activities. Most also have post-doctoral experience and professional training directly related to their area of specialization within the biological sciences. The majority of part-time faculty members also have Ph.D. degrees in their areas of specialty; however, an appropriate MS degree is sufficient in some instances. Graduate Teaching Assistants (GTAs) are all pursuing their MA or MS degree in the Biological Sciences and have completed specialized training in scientific pedagogy through our BIO 297A/B courses, which are taught by a faculty member whose research specialty is Science Education. While they do not teach, the majority of our technical staff (57%) also have Masters degrees in their area of expertise; the others all have a minimum of a BS with some level of post-baccalaureate training.

**Percent of Instruction by Full-time Faculty**

It is not possible at this time to provide accurate data on either total faculty WTU’s required to support the concentration or the proportion of full-time to part-time faculty teaching in the concentration. There are no major courses that are exclusive to the concentration (i.e., a course that is required/strongly recommended in one program can be used as a required/recommended course or an elective in at least one other degree program) and several major courses also serve other majors. In addition, the Department does not compile and maintain data for other Departments (e.g. Chemistry, Criminal Justice). A gross estimate of the % of instruction by full-time faculty in the concentration is 59%. Details regarding data: [http://www.csus.edu/bios/temp/quartile_1290847qwel;rj.html](http://www.csus.edu/bios/temp/quartile_1290847qwel;rj.html)

**Use of Discipline-Appropriate Technology**

Technology is at the very core of the forensic biology and its use is essential to prepare students for jobs in today’s high-technology crime labs. In addition to their teaching responsibilities, the biology faculty members who teach in the concentration must collect, maintain and stay current on emerging technologies including:

- Advanced technologies in molecular biology and chemistry: conventional and epifluorescent microscopy, flow cytometry, PCR, real-time PCR, bioinformatic programs, capillary gel electrophoresis, manual and automated DNA extraction techniques, HPLC, and mass spectrometry.
- Data analysis software: Gene Collection, Genemapper-ID, Analysis Desktop, SSIS, TruAllele.
- Presentation technologies (important for court testimony): PowerPoint, graphical imagery software.
Section: Clearly Developed Learning Outcomes

Criterion 2: Clearly Developed Learning Outcomes

Clearly Articulated Program Links to Campus Baccalaureate Learning Goals

The concentration in Forensic Biology is embedded in the curriculum of the Department of Biological Sciences. While specific learning outcomes were identified for the concentration at its inception and continue to be revised (largely in response to evolving accreditation guidelines; see below and next section), all but the 9 units of Criminal Justice are open to students outside the concentration. Therefore, it is important to first define the larger context in which the concentration rests. Recently, the Department of Biological Sciences unveiled a complete set of seven substantially revised undergraduate degree programs. The implementation of these degree tracks represented six years of curricular research, planning, and the intensive crafting of learning outcomes such that students are able to progress through a set of modern foundational courses with the option to specialize in a sub-area of the biological sciences. The undergraduate curricula were designed to meet an agreed upon set of learning outcomes for “key concepts” and “key skills”, which are introduced in the lower division course sequence (BIO 1 and BIO 2), reinforced and expanded in sophomore and junior level courses, and selectively emphasized in a student’s specific degree program. The learning outcomes for all undergraduate programs in the Biological Sciences include the following, and are directly linked to the baccalaureate learning goals as described below:

1) Students will develop a base of factual and conceptual knowledge of basic and applied biological processes.
   Baccalaureate learning goals addressed: Competence in the discipline, Knowledge of human cultures and the physical and natural world, Intellectual and Practical skills

2) Students will be able to generate and communicate scientific knowledge.
   Baccalaureate learning goals: Competence in the discipline, Intellectual and Practical Skills, Personal and social responsibility, Integrative learning

3) Students will develop and appreciate the importance of connections between other academic disciplines and the biological sciences and the social relevance of biology.
   Baccalaureate learning goals: Competence in the discipline, Knowledge of human cultures and the physical and natural world, Integrative learning

4) 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

To clarify these expectations to students, the Department of Biological Sciences posts these learning outcomes on its website home page (http://www.csus.edu/bios/). Furthermore, course learning outcomes include course-specific summaries of these four learning outcomes within syllabi.

The “key concepts” identified by the Department are organized into three concept areas: Cellular and Molecular Biology, Ecology and Biodiversity, and Structure and Physiology of Living Organisms. Within each of these areas, specific learning outcomes have been identified. Although students in all programs are expected to develop a base of knowledge in each of the areas, the concentration in Forensic Biology provides the opportunity for students to gain specialized knowledge and skills specific to the forensics profession including:

- Understanding the roles of law enforcement, the courts, and forensic scientists in solving crimes.
- Critically assessing crime scenes and identifying potential probative evidence.
- Properly documenting, collecting, and preserving biological crime scene evidence.
- Understanding the importance and process of maintaining an intact chain of custody.
- Screening evidence for biological substances, including blood, semen, saliva, and hair.
- Extracting DNA from a variety of cell types and substrates.
- Generating DNA profiles from DNA extracts.
- Applying accurate statistical weights to DNA profiles.
- Understanding problem areas in DNA analysis including complex mixtures and low copy number.
- Appreciating the importance of ethics in forensic science.
- Presenting complex scientific concepts in ways accessible to attorneys, judges, and jurors.
Section: Clearly Developed Learning Outcomes

The “key skills” introduced in BIO 1 and BIO 2 are: Current field methodology, current lab methodology, the scientific method, reading and writing skills, critical thinking, collaborative skills, literature review and application of concepts in biology. All of the curricula require BIO 100 (Introduction to Scientific Analysis), a course that must to be taken by both our native students and transfer students as one of the first upper division courses taken within the major and is meant to serve as a bridge course between the lower and upper division. The scientific skills presented in this course reinforce the basic skills introduced in the lower division while extending them to a level where students feel comfortable with generating hypotheses, interpreting results from other studies, and presenting data. Although programs vary in their emphasis on field or lab methodology (the Forensic Biology emphasizes lab work), all programs require development of proficiency in the other noted skills necessary to generate and communicate scientific knowledge.

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

The Department has collected data on various aspects of its former undergraduate program that can inform our future evaluations of the updated curriculum. They include previous assessment reports, assessment of the NSAC advising center, senior survey results, and an alumni survey. Similar strategies will be employed in assessments of the new and revised programs and are already in place for the Forensic Biology concentration. In addition, for the new curricula, the Department has identified the Experimental Design Ability Test (EDAT), which will address each of the Department-wide outcomes identified above (1-4) by examining student-driven experimental design. The EDAT, which will be administered for the first time in Spring 2012, assesses students’ knowledge of the basic and critical elements of a good experiment, and depending on the prompt used, the EDAT can be adapted to assess specific factual and conceptual knowledge important to different fields within the biological sciences (outcome 1). The EDAT will further evaluate students’ ability to generate and communicate scientific knowledge, as it requires students to design and describe their own experiment in essay format (outcome 2). The prompts for this instrument are generated to address authentic problems that have relevance to students’ lives. Students must understand the process and nature of science, but also have the ability to synthesize information and make connections to other disciplines in order to evaluate real-world scenarios (outcome 3). Lastly, students must employ creativity and other higher order thinking skills, as they analyze the information provided in the prompt, evaluate the claim, and ultimately solve the problem (outcome 4). The EDAT will be administered at several points within the curriculum. An evaluation of EDAT scores at these levels will allow an assessment of student learning throughout the curriculum.

External Assessment and Accreditation Outcomes, where appropriate

The Department is in the process of Program Review. Our external evaluation is planned for April, 2012.

Additional Information

The main accreditation body for forensic science programs in the United States is FEPAC (Forensic Science Education Programs Accreditation Commission) administered by the American Academy of Forensic Sciences.\footnote{FEPAC Accreditation Standards for Undergraduate Programs, \url{http://aafs.org/sites/default/files/pdf/FEPACStandards12082011.pdf}} Our concentration is relatively new but is rapidly moving toward meeting FEPAC accreditation standards. It should be emphasized that most undergraduate and graduate programs in forensic science in the U.S. are not FEPAC accredited and graduation from an accredited program is not a requirement for employment. It should also be noted that the Forensic Biology concentration at Sacramento State currently meets all of the requirements for employment as a forensic biologist in California and our graduates have been very successful finding jobs. Current FEPAC accreditation standards are listed below. The courses and other mechanisms by which the Forensic Biology concentration at Sacramento State meet these standards are in italics. Areas in which our program does not yet meet the criteria are underlined, identifying areas for maturation and growth.

\subsection*{4.3.1 General Curriculum}

The undergraduate program in forensic science shall offer a coherent curriculum that reflects the mission and goals of the program and provides the student with the appropriate skills requisite for the bachelor’s degree.

\footnote{Experimental Design Ability Test (EDAT); Described in: Sirum and Humburg, Bioscene: \textit{Journal of College Biology Teaching} Volume 37(1) May 2011}
Section: Clearly Developed Learning Outcomes

The curriculum shall, at a minimum, ensure that each student:

1. **Obtain a thorough grounding in the natural sciences** *(met by B.S. in Biological Sciences with a concentration in Forensic Biology; students in this concentration also automatically earn a minor in Chemistry)*

2. **Build upon this background by taking a series more advanced science classes** *(met by strong upper division emphasis in biology and chemistry courses, including many courses with laboratories)*

3. **Develop an appreciation of issues specific to forensic science through course work and laboratory-based instruction** *(met by BIO 150 and BIO 151; Forensic Biology and Advanced Laboratory Techniques in Forensic Biology; both have strong laboratory components; BIO 151 is an inquiry-based capstone course)*

The following topics must be covered in the curriculum:

- Courtroom testimony *(met by BIO 150 and CRJ 154)*
- Introduction to law *(met by CRJ 154)*
- Quality assurance *(met by BIO 151)*
- Ethics *(discussed in BIO 150)*
- Professional practice *(met by BIO 150 and BIO 151)*
- Evidence identification, collection, processing *(met by BIO 150)*
- Survey of forensic science *(met by CRJ 121)*

Normally, a topic will involve multiple class meetings and may involve multiple learning modalities, such as lectures, laboratories, and demonstrations. Evaluation of student mastery of each topic may be done through a number of modalities, but the topic material must be specifically addressed in a syllabus and assessed. The program shall have clear procedures for assessing and documenting each student’s progress toward fulfillment of these objectives. *(All Sacramento State classes addressing the accreditation guidelines meet these standards.)*

4.3.1a-d **Specific Curricular Requirements**

The specific curricular requirements that follow are based on the fact that most forensic scientists work in areas such as drug analysis, trace analysis, firearms and toolmarks, and forensic biology. Because certain forensic science disciplines require more rigorous coursework than the minimum described below, in particular, more biology and chemistry, the program shall ensure that its curriculum is adequate to prepare students for specialization in subdisciplines of forensic science such as **forensic biology**, forensic chemistry, toxicology, or pattern evidence examination.

4.3.1a **Natural Science Core Courses**

**Biology:** at least one course, which includes an associated laboratory, in biology for science majors (4 semester hours). *(Met by BIO 1 and BIO 2)*

**Physics:** at least two courses, each of which includes an associated laboratory (8 semester hours). Note: Calculus-based physics is preferred but not required. *(Met by PHYS 5A and 5B)*

**Chemistry:** at least four courses, each of which includes an associated laboratory. Two of the courses shall be in general chemistry for science majors (8 semester hours), and two shall be in organic chemistry for science majors (8 semester hours). *(Met by CHEM 1A and 1B; Currently, our students are required to take 3 semester hours of organic chemistry lecture and 1 semester unit of laboratory. Therefore, we fall 4 units short of this guideline in the area of organic chemistry.)*

**Mathematics:** at least one course in differential and integral calculus (3 semester hours) and at least one course in statistics (3 semester hours). *(Met by MATH 26A and STATS 1)*

4.3.1b **Specialized Science Courses**

A minimum of 12 additional semester hours in more advanced coursework in chemistry or biology. Note: These classes shall be consistent with the degree program and shall meet the needs of students specializing in subdisciplines of forensic science. At least two of the classes shall include laboratory training. Examples of specialized science courses include: Biochemistry *(met by CHEM 161 and CHEM 162)*; Molecular biology *(Met by BIO 180)*; Genetics *(Met by BIO 184)*; Inorganic chemistry *(met by CHEM 1A and 1B)*; Analytical/quantitative chemistry *(Met by CHEM 31)*; Cell biology *(met by BIO 121)*; Microbiology *(available as an elective).*

4.3.1c **Forensic Science Courses**

A minimum of 15 semester hours in forensic science coursework must be covered in the curriculum. Of these 15 hours, 9 semester hours shall involve classes in forensic chemistry, forensic biology, physical methods, or microscopy and contain a laboratory component. *(Currently, we have 5 semester units of forensic biology and 3 semester units of physical evidence. 5 of these units contain a lab component and 3 are lecture-only. Therefore, our program currently falls short 7 semester units in this area.)*

4.3.1d **Additional Courses**

A minimum of 19 additional semester hours of advanced, upper level courses that provide greater depth in the student’s area of specialization beyond an introductory level in the program are required. Students can use these additional courses to begin to specialize along a forensic science discipline track. *(Met by the 36 total upper division unit requirement; 30 of these 4.3.1b, where only 12 units are required.)*
Criterion 3: Advising Program and Graduation Success

Advising Program
The Department of Biological Sciences is a particularly proud of its efforts in advising students, including those in the Forensic Biology concentration. Since 2006, we:

- implemented a new advising center to provide comprehensive attention to incoming students
- developed and implemented sophisticated online advising tools
- structured our gateway courses to be more inclusive of diverse student learning styles
- began efforts to intrusively advise students at risk of failing introductory gateway courses, recently obtaining (in cooperation with other faculty in our College) a $2 million National Science Foundation (NSF) grant (Project PASS) to support student success in introductory science.

Students enrolled in the Forensic Biology concentration receive additional in-depth career and academic counseling from Dr. Ruth Ballard, our resident expert in the field. In addition, Dr. Ballard facilitates participation of Sacramento State students in forensics conferences (e.g. American Academy of Forensic Sciences, California Association of Criminalists) and student organizations to help students begin networking early in their academic careers. The students in the concentration have also formed a student group that actively coordinates guest speaker forums and other events that promote their career development. Many students also assist graduate researchers in the U.C. Davis graduate program in Forensic Science and gain access to crime scene professionals associated with that program, including some of the top forensic biologist practitioners in the country.

Graduation Rate
Determining the graduation rate for students declaring the concentration in Forensic Biology is challenging. Dr. Ballard's experience with advising students is that many have a clear career goal (working as a forensic biologist in a crime lab) and are far enough into their academic careers to have a track record of success in passing their first year of classes and progressing in the degree. Therefore, it may be easier to track graduation rates accurately more accurately for forensic biology students than for other Biological Sciences students. However, the concentration in Forensic Biology is only five years old and there has been insufficient time to collect reliable data on graduation rates. Initial enrollment in the concentration (2007) was 12 and that figure has now grown to nearly 100. During this same period, 34 students have successfully navigated the concentration to graduation. Assuming that (1) the average time between declaring the concentration and the degree is 4 years (an optimistic time-frame given the serious impaction of core classes in the Biological Sciences and Chemistry) and (2) a steady growth of enrollment, 41.4 students should have graduated by Fall 2011 (Table 1). Under this model, the graduation rate is 82%.

The actual situation is somewhat more complex, however. Graphing the data across time indicates that many of the students who initially enrolled in the concentration were nearer the end of their degrees than expected under the model described above. This makes sense as several of the early graduates had been on a forensic biology "advising track" with course requirements similar to those of the current concentration. Therefore, the number of graduates has been more steady across the five year span than the model would predict (Table 2). We expect this
trend to abate as the concentration continues to gather steam and students declare their concentration earlier in their academic program. Collection of data over the next few years should allow us to determine a more accurate graduation rate. However, we expect that it will compare very favorably with the Department graduate rate estimate of 45-50%. (The data used to calculate this figure are available upon request and are included in other IPP documents submitted by the Department for general programs within the major.)

Distribution of Advising Responsibilities Among Faculty Members
Demographic and technological changes have radically changed the way advising is done within the Department of Biological Sciences. In 2006, the Department had approximately 916 majors and 26 full-time faculty (35:1). It has now grown to more than double that figure; we have 1550 majors and 18 full-time faculty (86:1). Therefore, the total number of majors greatly exceeds the number of full-time faculty available to advise. Previous attempts at mandatory advising were ineffective due to the high student/faculty ratio, so we amended it to focus on the most at-risk students (freshmen and first-semester transfers); other students are strongly encouraged to see their advisor. Incoming students are required to see an advisor in our advising center (Natural Sciences Advising Center, NSAC); advisors there refer students to a faculty member in their area of interest. All full-time faculty share advising responsibilities, and NSAC provides all students with career advising information. Students in the Forensic Biology concentration are assigned Dr. Ballard as their advisor when they declare the concentration. This streamlines advising for these students, ensures consistency, and facilitates communication with all enrollees as a group. Other faculty members regularly do advising for students who will eventually declare the Forensic Biology concentration. Thus, most students in the concentration receive advising from more than one faculty member as they progress in their degrees.

Proactive Advising Contact with Students to Assure Progress to Degree
NSAC was piloted in 2009 to provide more comprehensive advising to incoming Biological Sciences students, and has been largely staffed by our invaluable retired faculty who maintain diligent logs about which students visit and why. Using Sign-In software and an Exit Survey designed by Biology faculty, they have compiled information on the 1300+ students that are served by NSAC every semester. Students came for a variety of reasons:

- 86% come seeking advice on course selection
- Many are interested in career advising (75%) or internship opportunities (63%) – NOTE: to address this interest, we now have our Career Center liaison, Shannon Wells, holding office hours in NSAC
- Students come in for help with departmental/university forms (53%), to find a faculty career advisor (51%), or are interested in interpreting transfer credit (44%)
- A growing number are coming for assistance with academic issues, seeking study tips (37%), looking for study groups (29%) or seeking workshops on study skills or time management (40%) NOTE: to address these concerns, an NSF grant has funded a new staff position to assist with student success in gateway science courses. This new staff member began this semester, and will focus her efforts on Early
Intervention with at-risk students in our gateway courses. She is housed in NSAC, and her position is funded by the PASS grant, a joint project led by faculty in Biology, Chemistry, and Physics.

Program Roadmap to Curriculum Completion and Graduation Success
We have long published “ideal” schedules for students within the major, for both 4-year and 5-year plans. We regularly publish offerings schedules for courses that are not regularly offered (e.g. odd springs or fall only). Faculty consult the published multi-year schedule when advising students, and we have advising templates available to all faculty and students within the department. To assist with graduation petitions, a biology-specific template is available on our departmental website. Dr. Ballard provides her Forensic Biology advisees with an advising spreadsheet to help them plan their coursework and meets with them at regular intervals to assess their progress and help them make adjustments, as needed.

Use of Technology to Supplement and Strengthen Program Advising Effort
The Department has created and maintains interconnected websites and online tools that have partially offset the impact of the tremendous change in student:faculty ratios, allowing us to disseminate advising information among faculty as well as direct students to information.

- NSAC – The Natural Sciences Advising Center makes use of online appointments (http://saweb.csu.edu/students/aascheduler/), and maintains a website and Facebook page (http://www.facebook.com/pages/Hot-Stuff-at-NSAC/199202573428705) with current meetings, internships, job opportunities, etc. All websites and appointment and exit survey software were developed or adapted by a Biological Sciences faculty member.
- Department of Biological Sciences website (http://www.csus.edu/bios/): this site contains approximately two dozen web pages, most of which are devoted to advising and otherwise empowering students by providing them with tools to find information and help from faculty and staff. It contains 13 pages of advising sheets, links to online syllabi, advisors by specialty, scholarships, employment, internships, seminars, faculty research, student associations, SEE, MOSS, science educational sites, GE courses, and the BIO sections of the catalog.
- Sacsend to inform all majors of upcoming advising holds, study skills workshops, etc.

Post-degree Success, Graduate Impact on Community, etc.
The Department of Biological Sciences' 2009 Alumni Survey (187 respondents, 75% of whom had graduated in the past 3 years) indicated that the largest subset of our graduates had found work in the health care arena (27%), with others working in clinical or research labs (20%) or for the government in some capacity (16%). 20% were in graduate or professional school; all others were employed, with only 2% working in a field unrelated to biology. Perhaps even more telling, 86% of respondents indicated that their employer considered it important that their degree be in the biological sciences. We realize that our success rates are quite high, something we attribute to intrusive, purposeful, and honest advising. If a student is not likely to meet with success when pursuing a particular career, we gently steer them towards an area where they will reach their professional goals.

Most of our Forensic Biology graduates fall into the category working for the government. The largest single employer is the California Department of Justice, with 11 DNA labs, followed by individual counties (12 total) cities (7 total), and the military. Our students have also entered graduate programs in Forensic Science at U.C. Davis and Towsen University. The data below only includes students who graduated between Spring 2007 (the first semester the concentration was offered) and Spring 2010 as it takes an average of two years for students sit for criminalist exams and pass background checks at state agencies in California. While the program is still very young, of the 22 students included in the data:

- 3 were accepted to graduate programs in Forensic Science
- 12 secured jobs in government crime labs
- 1 joined the U.S. Army (Forensic science unit; currently deployed to Afghanistan)
- 4 secured employment in the biotechnology industry
- 2 (status unknown)
Section: Strength of Teaching Performance

Criterion 4: Strength of Teaching Performance

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 and specific standards are not supplied here for the Forensic Biology concentration.

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.

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 currency in the discipline and 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.”

Part-time faculty members are evaluated on an annual basis by the Department’s Executive Committee, which is summarized in a letter to each individual. They are also 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.
Section: Strength of Teaching Performance

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 in an ongoing fashion. All pre-tenure full-time faculty members and all part-time faculty members (regardless of experience) are required to have all classes evaluated by students every semester. These evaluations are thoroughly reviewed in RTP 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). Part-time faculty members are required to have student evaluations for all courses taught, and these are carefully considered and heavily weighted by the Department’s Executive Committee in its annual evaluation of Part-time Faculty and by area committees in their review of applications for reappointment.

- **Additional Measures of Teaching Performance:** In all RTP Periodic Evaluations and Performance reviews, 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 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 such as preparation of study guides, revisions of laboratory exercises, preparation of audio-visual aids, preparation of tutorial materials, conducting review sessions or open laboratories, providing adjunct courses, and working with study groups, evidence of supervision of students engaged in special activities such as graduate research, undergraduate research, service learning, internships, volunteer work, laboratory preparation, and independent study, and evidence of receiving teaching awards or honors, or other noted contributions to the curriculum. Although multiple measures of effective teaching performance are clearly delineated for full-time faculty, the Department Executive Committee is in the process of considering a request for more detailed information from part-time faculty members as part of their yearly evaluation process. This would include sample exams, class assignments, etc. 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, current CVs, a statement of interest and teaching philosophy are required of all applicants 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. As noted above, 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 its 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

Level of Program Development (e.g. young, growing, mature)

The Biological Sciences program as a whole is mature but is continually evolving as our knowledge of the natural world expands and the demands of the workplace change. As a Department, we have readily responded to these shifts with alterations in our curriculum. Since 2006, we have added several new courses and completely modernized our curricular offerings, largely because advances in the field of molecular biology have infused the other fields in the discipline to such an extent that a substantive response was critical for our program to remain current and relevant. In addition, entirely new professions and areas of study have emerged as a result of the "molecular revolution" and students need to be prepared for the realities of the post-graduation job market.

The concentration in Forensic Biology is a prime example of the Department's ability to adapt to changes in the discipline of biology and to workforce trends as they arise. When Sacramento State was founded, the field of forensic biology did not exist; now it is one of the most important applied sciences in the discipline. The Department responded to this trend proactively, first by developing graduate-level research opportunities for students (starting in 2000) and then by developing undergraduate research opportunities (starting in 2002). As interest grew, and the biology units of crime labs expanded due to increased funding, the Department began the process of developing a curriculum and concentration specific to the area. This step-wise approach was very successful. The introduction of new courses and a new concentration into a Department, particularly one that includes new laboratories, can be extremely stressful for both faculty and laboratory support staff. The Department views the maturation of its forensic biology program as an ideal model for how to navigate this process with minimal disruption for all parties, including students.

Ability of Program to Adapt to Current Demands

In 2006, the Department of Biological Sciences introduced a new first-year biology sequence – BIO 1 (Biodiversity, Evolution and Ecology) and BIO 2 (Cells, Molecules and Genes) - developed to align with recent advances in the life sciences, including those in forensic biology. This was followed by a reexamination of the rest of the curriculum, with the ultimate goal of creating a structure that provides students with three semesters of rigorous introductory "core" classes followed by the opportunity to specialize in specific areas to gain the skills necessary to compete in an increasingly technologically-sophisticated workplace. We introduced a smaller and more agile “mid-level” core consisting of General Genetics (BIO 184; expanded to four units, to include more problem-solving and application of ideas) and a new course, Introduction to Scientific Analysis (BIO 100), which focuses on intermediate skills such as graphic analysis, reading and writing scientific papers, and data interpretation. This change reduced the number of units in the core, leaving room for the development of new courses specific for each area. Of these new offerings several are often taken as electives by students in the Forensics Biology concentration and two are required.

In all instances, advances in scientific discovery, needs of the state and local workforce, and student interest were carefully considered when crafting the course offerings.

Future goals of program

As this restructured program was just introduced in Fall, 2011, our immediate focus will be on assessing its success in preparing students both academically and for the STEM workforce. Although cutting-edge topics and techniques have been introduced into our curriculum, the biological sciences are changing so rapidly that we anticipate further restructuring in the future; however, we feel more than adequately prepared to address these needs, as our faculty are now well-versed in the process of Backwards Design and scaffolded curriculum.

In forensics, a specific future goal is to seek FEPAC accreditation of the program by the American Academy of Forensic Sciences. At this juncture, we are very close to being in compliance (see Criterion 2). However, we would like to introduce more ethics into the program, perhaps through a series of workshops, as well as developing additional coursework in forensics. An advanced course in microscopy would be very helpful for our students, as would a course in human population genetics.
Section: Impact, Justification and Centrality to University Mission

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 concentration in Forensic Biology 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 issues beyond the realm of science.

Alignment with the University’s Baccalaureate Learning Goals:
The BA/BS programs are closely aligned with the Baccalaureate Learning Goals. Specifically:

- Competence in the Discipline is met through a modern curriculum driven by a well-defined set of learning outcomes that are current, focused and flexible enough to accommodate changes in the field.
- Knowledge of Human Cultures and the Physical and Natural World: The biological sciences focus on the study of the living world, and because scientific understanding is pursued on some level by all human cultures, science is a global endeavor. At all levels of study within our department, contributions of various cultures to the study of science are highlighted and given appropriate focus.
- Intellectual and Practical Skills are developed at all levels of our “three-tier” curricular design (introductory, intermediate, advanced). By its very nature, science involves critical thinking, analysis, quantitative and technological literacy, and problem-solving (both individually and in groups). Students work with lab/activity partners in all introductory and intermediate courses, as well as most advanced classes. Expectations of student lab performance, data analysis, and experimental design scale upward as the student progresses through the curriculum.
- Personal and Social Responsibility are highlighted in all applications of science. As science progresses, especially in its applications to human health, ethical, legal, and societal questions multiply.
- Integrative Learning: As a science, biology has its foundations in the disciplines of mathematics, physics, and chemistry; as such, it is really an applied science that integrates these “basic” sciences along with many other fields that affect its application to our society. Forensic Biology is particularly strong in this regard in that it pulls from criminal justice in addition to the fields mentioned above.

Unique Program Characteristics/Adding Distinctiveness to our Campus
Although BA/BS degree programs in Biological Sciences and/or its subfields are offered in most, if not all, four-year universities, it is likely that that there are few that were developed using “Backward Design” and employ our scaffolded learning outcomes design. As should be expected, the closest 4-year university offering baccalaureate degrees in the biological sciences is UC Davis. All of the UCD programs, most of which are housed in their College of Biological Sciences, are designated as BS programs. UCD offers a general BS in Biological Sciences and BS degrees in specific subfields, most of which are represented in the concentrations offered at Sacramento State. In general, Sacramento State’s programs can be distinguished for the UCD programs in two very important ways. First, Sacramento State requires upper-division coursework in each of three designated concept areas. This greater breadth at the undergraduate level provides students a wider range of employment opportunities, as well as the ability to more readily change areas of specialization. Second, the BA/BS programs at Sacramento State have a much stronger laboratory/field component. Unlike the programs at UCD, where most labs are offered as separate and optional courses taught by graduate students, most labs at Sacramento State are offered in combination with the lecture component of the course and are taught by faculty, providing opportunity for one-on-one attention and engagement of active learning and the “doing of science.”

UCD does not currently offer an undergraduate curriculum in forensic biology. Ours is the only option for students in the Sacramento area. UC Davis offers a professional M.S. in Forensic Science; however, its program is funded entirely by student tuition at is prohibitively expensive for many (of not most) of our students, especially those who are currently underrepresented among forensic science practitioners. Therefore, Sacramento State provides a critical pathway for students from underrepresented groups to enter the forensic biology profession and balance the inequity in representation that currently exists in the field.
Criterion 7: External Demand for the Program

Community Engagement
Since 2006:

- Over a dozen students in the Forensic Biology concentration have completed internships at the Sacramento County Coroner's Office, where they assist with autopsies and help link missing persons' dental records with dental records from unidentified remains.
- Several have also assisted the Sacramento Police Department's crime scene unit by volunteering as "ride-alongs" to homicides, where they carry equipment and help with scene documentation.
- Many also participate in the General Genetics (BIO 184) service learning option, which has provided more than 1,000 student volunteers to organizations that serve genetically-disabled adults and children in the Sacramento region (Orange Grove Adult School and Project RIDE).
- Many others have taken part in other community-related activities offered by the Department of Biological Sciences, including teaching internships in local K-12 schools, BioCorps (in which students donate at least 100 hours of service to the community in various projects such as Special Olympics, Bone Marrow Drives, Remote Area Medical care, 4-H’s On the Wild Side, and tutoring of local K-12 students, and programs through SEE (Science Educational Equity) that encourage underrepresented students to matriculate to college.

Demand for the Program's Resources and Expertise
- Faculty who teach in the Forensic Biology concentration 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.
- Many faculty and staff who teach in the forensics curriculum also give several workshops annually in the Expanding Your Horizons program for young women in the community.
- Dr. Ballard, our resident forensic biologist, gives 20-30 presentations for community groups, courses at UC Davis, and courses outside the Department at Sacramento State every year.
- Dr. Ballard also gives expert advice to attorneys across the United States and internationally. Since 2006, she has served as a consultant in the following:
  - California: 14 prosecution; 30 defense; 1 civil
  - Other U.S. States: 5 defense; 1 civil
  - International: 4 defense (Cayman Islands); 2 defense (Guam)
- Paternity Statistics: Sacramento County District Attorney's Laboratory of Forensic Services (14) She has testified, given depositions, or written expert opinions for most of these cases, constituting the bulk of her scholarly activity (scholarship of application under the Department's Boyer model; See Criterion 10). Serving in this way not only benefits the community but also helps inform her teaching and laboratory research. Being able to bring "real world" case studies into the classroom is one of her main motivations for performing this important work. It should be noted that good teachers often make the best expert witnesses because they are able to explain complex scientific topics to attorneys, judges, and jurors, most of whom have insufficient scientific training to understand and interpret forensic serology and DNA without significant assistance.

Local Trends in Enrollment
Since 2006, undergraduate enrollment in the Biological Sciences major has increased 69%, from 916 to 1550. In Forensic Biology, enrollment has increased from 12 (2007; first semester) to approximately 100 (increase of over 800%).

Demand from Employers
The U.S. Bureau of Labor Statistics (BLS) reported in the 2010-2011 edition of the Occupational Outlook Handbook section on the “Biological Scientist” occupational category⁴ that: employment of biological scientists

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⁴ http://www.bls.gov/oco/ocos047.htm

Program Name: B.S. Biological Sciences, Concentration in Forensic Biology
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 BA/BS degree in Biological Sciences (e.g., “science technician”, “conservation scientist”) or require a post-baccalaureate degree, certificate or license for which the BA/BS degree in Biological Sciences provides the required undergraduate preparation (e.g., health professional careers).

The outlook for students graduating with the concentration in Forensic Biology is even better. The U.S. Department of Labor predicts that the job market for forensic scientists will expand by 20% in the 2008-18 decade, which is “much faster than the average” when compared to other fields that hire science technicians with a bachelor’s degree, including other biological technicians. In addition, forensic scientists are among the highest paid; the median salary is 30% higher for forensic biologists than for other biological sciences technicians with the equivalent degree. In addition, the National Academy of Sciences' National Research Council (NRC) recently published a report very critical of forensic science in the United States and calling for improved education and training at the college level. This report has received much discussion in the forensics community and the FEPAC accreditation standards (see Criterion 2) were part of its response. An increase in the educational standards set for entry-level employees is good for the profession while also favoring students with a rigorous degree program like Sacramento State's.

5 http://www.bls.gov/oco/ocos115.htm#outlook
Criterion 8: Program Size, Scope

Breadth of Coverage

Like all BA/BS programs in Biological Sciences, the concentration in Forensic Biology includes a two semester (10 units) introductory sequence, redesigned in 2006, which provides introductory exposure to key concepts, methods, and skills, determined through a “Backwards Design” process by the Department to be the most basic essentials of training in the Biological Sciences. The scope of content of the lower division courses is reflected in their titles: BIO 1: Biodiversity, Evolution and Ecology, and BIO 2: Cells, Molecules and Genes. In addition to including a laboratory component, both of the introductory courses include a one-unit activity section designed to encourage active hand-on learning and the development of intellectual and practical skills (e.g., critical thinking, writing, oral communication). The lower division core includes co-requisite courses in Chemistry, Physics, and Mathematics.

At the sophomore/junior level, the curriculum includes courses that take the key concepts and skills established earlier and delve deeper into the theoretical and factual material at their core. The student learning outcomes at this level enhance skill development and reiterate the major concepts that students are exposed to in the introductory BIO 1/BIO 2 series and provide more detailed analysis of these ideas, introduction of regulatory mechanisms, and newly discovered applications of those learned concepts skills. The common courses at this level include Introduction to Scientific Analysis (BIO 100) and Genetics (BIO 184). Core concepts requiring more in-depth study are embedded in designated courses within each program. These core concepts fall into three areas: 1. Cell and Molecular Biology, 2. Ecology and Biodiversity, and 3. Structure and Function Relationships in Living Organisms. At the senior level, students are provided advanced level instruction that includes experiential learning in the scientific method and in-depth laboratory skills. The student learning outcomes at this level emphasize experimental design and laboratory technologies necessary to operate in an ever-changing STEM workforce. They also provide the opportunity for the development of “mastery” of concepts and methodologies specific to a sub-discipline area of interest. In Forensic Biology, these include BIO 150 (Forensic Biology) and BIO 151 (Advanced Laboratory Techniques in Forensic Biology). Many students also enroll in BIO 199A to complete the research projects they started in BIO 151; therefore, by the time students graduate they have up to a year of independent research experience in an advanced, cutting-edge topic in forensic biology.

Degrees and Certificates Awarded

The program in Forensic Biology is relatively young (5 years). However, in that time 34 students have already received B.S. degrees in Biological Sciences with a concentration in Forensic Biology; most also received a minor in Chemistry. (In the revised curriculum, the Chemistry minor is embedded in the concentration. It was not embedded initially.)

Program Enrollment

Because the concentration is so new, it is difficult to calculate an "average enrollment" figure. The concentration is growing and any number provided at this juncture is likely to change quickly. Twelve students enrolled initially (2007) and this number has grown to approximately 100. Growth has been steady and we expect growth to continue during the next few years. At some point, we anticipate that growth will level off but it is impossible to predict when that will occur and how many students will be enrolled in the concentration at that point. Currently, students in the Forensic Biology concentration constitute about 6.4% of students in Biological Sciences (1550 majors, 100 concentrating in Forensic Biology). FTES for the Department is 1529.60 for 2011-2012. Thus, we can estimate that about 100 are associated with the concentration in Forensic Biology.

Program Resources and Faculty Expertise

In these challenging economic times, creating a curriculum in the biological sciences that prepares students with up-to-date concepts and skills has required tremendous creativity from the Department’s faculty. In part, these challenges have been addressed through faculty grant activity and finding nonconventional or unique partnerships and opportunities (e.g., substantial donations of supplies and equipment from industry). Although additional faculty positions are desperately needed to meet the Department’s enrollment demands, there are 3-5
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Section: Program Size, Scope

tenured/tenure-track faculty members with doctoral level training in each of core concept fields included in all BA/BS curricula and at least 1 faculty member with professional credentials and experience in each of the two career specific programs (Forensic Biology and Clinical Laboratory Science). In Forensic Biology, Dr. Ballard has been extremely successful in building strong relationships with the two major government crime labs in the Sacramento Region: The Sacramento District Attorney's Laboratory of Forensic Services and the Sacramento Department of Justice crime lab. Many of our former students are now working in these and other labs throughout California. Collectively, this provides a superb and ongoing source of "surplused" equipment and expired kits and reagents that the laboratories no longer need or can no longer use, which get funneled into the Forensic Biology program. Thousands of dollars of equipment and reagents have entered the program this way since 2006, though it is difficult to assign an accurate market value to used equipment and expired supplies. However, purchasing these items/supplies new would be prohibitively expensive; DNA typing kits are $3,500 each for 200 samples; qPCR kits are $1500 each and also process about 200 samples. By continuing to broaden and strengthen community ties and graduating students who get successfully hired by crime labs, we have been able to maintain and build a very robust training and research program in Forensic Biology at our institution despite the recent economic downturn and the expense of performing state-of-the-art forensic serology and DNA testing.

It should be noted that we are extremely fortunate to have Robert Jarzen, the Director of the Sacramento County District Attorney's Laboratory of Forensic Services as one of the professors teaching in the concentration. He brings tremendous practical expertise, which he shares with students in his criminal justice class and on a one-on-one basis. He provides students the opportunity to tour his lab, meet with analysts, and learn more about how crime labs are structured and administered. Issues such as quality control and laboratory accreditation are best covered by a person with extensive experience in these areas, and students benefit greatly from Bob's association with our campus.
Section: Internal, Non-major Demand for the Program

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

Non-Major Demand
The Biological Sciences offers courses used to meet the requirement for General Education in Areas B2 and B3, and also provides service courses for other majors and other areas of science (e.g. Chemistry, Environmental Sciences). However, the Forensic Biology program (defined narrowly in this context as including only courses specific for the concentration) primarily serves Biological Sciences and Chemistry majors. Occasionally, a student from outside these two majors enrolls in BIO 150 (Forensic Biology) but this is fairly rare because the course has four prerequisites (BIO 1, BIO 2, CHEM 1A, and BIO 184) and these courses, in combination, comprise 19 units of lab-based science coursework. Dr. Ballard is developing a course for GE ("Murder and Molecules") which would meet requirements for Area B2 and provide students outside the major the opportunity to study forensic biology/chemistry without navigating major's-level courses. Given the popular demand for television shows focusing on forensic science, we believe there is already a demand for this course that is currently unmet. We expect "Murder and Molecules" to be very popular!

Research resources
The Biological Sciences Department houses many resources that serve other programs, including the Greenhouse (which, for example, provides research space for students in Environmental Studies), the autoclave (a large sterilization unit that processes materials for all of NSM), and the human cadaver facility, which serves programs in HHS, including the graduate program in Physical Therapy. Faculty from our department obtained the original funding for (and continue to obtain resources to support) the CIMERA interdisciplinary research facility, which serves as a collaborative research hub for the cellular and molecular sciences, and involves faculty from Chemistry. Faculty and staff from our program also maintain and continue to develop the diverse plantings of the University Arboretum, located on the north side of campus. Finally, the Department houses the CSI-TRU facility (described in detail below), which provides access to DNA typing and sequencing instrumentation to faculty across campus.

CSI-TRU (Crime Scene Investigation Training and Research for Undergraduates) is a modern forensic human identification laboratory that houses state-of-the-art equipment for molecular biology and forensics research. The facility houses a 310 Genetic Analyzer, a Microbial-vac system, computers to run human DNA sequencing and forensic analysis software, thermocyclers, and basic molecular biology laboratory equipment like centrifuges (clinical and micro), several sets of micropipetters, water baths, tube heaters, and vortexers. The facility also has a chemical hood for organic DNA extractions and other work involving volatile reagents. CSI-TRU has been generously funded by the National Science Foundation CCLI Adaptation and Implementation program (to purchase the 310 Genetic Analyzer; grant obtained through CIMERA but analyzer is now housed and run in CSI-TRU), the C.M. Goethe Bequest, CSUPERB, the Instructionally-Related Activities program (IRA), and the Research and Creative Activities (RCA) program. The facility is also supported by donations from local and state crime labs. The facility is used primary by Dr. Ballard and her students but is available to programs across campus and has been accessed by faculty and students in Natural Sciences and Math as well as Social Sciences and Interdisciplinary Studies (Psychology; mouse DNA/behavioral research). CSI-TRU also serves as a hub for research collaborations between Sacramento State and UC Davis, Microbial-Vac (Utah), DNA Genotek, Inc. (Canada), Biotech Forensics (Nairobi, Kenya), and Muhimbili University College of Health Sciences (Tanzania, Africa).
Criterion 10: Quality of Program and Resource Utilization

The Department embraces a broad definition of scholarship, similar to that initially described by Ernest Boyer⁷ 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.

Since 2006, faculty members in the department of Biological Sciences, including those who teach in the Forensic Biology curriculum, obtained $14.67 million in grant funding (source: Research and Contract Administration). In addition, they secured over $1 million in donated equipment and supplies (e.g. cell culture hoods, incubators, analysis kits, a mass spectrometer, etc.). Finally, some members of the CMB group participate in traditional bench/field research, supervising both undergraduate and graduate students in science and science education research.

Scholarly and Creative Activity: Since 2006, faculty members who teach in the Forensic Biology curriculum:

- Have published six refereed articles or other types of professional manuscripts (e.g., text chapters). These include 4 refereed publications in the specific sub-discipline of forensic biology/DNA and over 25 expert reports on forensic DNA for attorneys and the courts.
- Have made 39 poster or oral presentations at professional meetings, including 12 in the specific area of forensic biology/DNA.
- Have secured $3.275 million in grant funding (source: Research and Contract Administration). In addition, these faculty members secured over $1 million in donated equipment and supplies (e.g. cell culture hoods, incubators, analysis kits, a mass spectrometer, etc.).

Service: Faculty members who teach courses within the Forensic Biology curriculum are highly active in the area of service to the institution and community, demonstrating strong dedication to outreach activities that benefit students and programs within the CSU System, the K-12 system and the Sacramento region as a whole. Faulty members in this program serve as faculty advisors to student clubs, organizations and programs within the department (e.g., SEE, Pre-Dental Club and BioCorps) as well as at the university level (e.g., mentor for Guardian Scholar’s Program, which serves CSU students that have been wards of the state). Our faculty members are also dedicated to pre-college student education and teacher training, serving on high school advisory boards (as mentioned in the list above), the Scientific Review Committee for the Sacramento Regional Science and Engineering Fair, and the Sheldon Biotechnology Academy mentoring program, to name a few. Collectively, we review for peer-reviewed Science and Science Education publications (e.g., Journal of College Science Teaching, BioScene: Journal of College Biology) and have edited textbooks and other published curriculum in the areas of Cell and Molecular Biology, Cancer Biology, Biotechnology and Human Anatomy and Physiology. We are further dedicated to teacher professional development and routinely teach workshops for programs such as Expanding Your Horizons, Science in the River City, Sacramento Area Science Project, and Closing the Achievement Gap in Math and Sciences. In addition, the CMB faculty are highly motivated to serve the community at-large in order to advance science and technology in the region and science literacy as a whole. Our CMB faculty members serve on the Sacramento Area Regional Technology Alliance (SARTA) Stem Cell Devices Subcommittee, on the Board of Directors, American River Watershed, and have engaged in activities to

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Section: Revenue and Other Resources Generated by Program

educate our state legislators on topics related to California’s Biotechnology Industry. Our faculty members are also well-represented in regional and national professional organizations, serving such roles as:

- President of the Biology Council for the CSU
- CSU System-wide Coordinator of CSU/CC Lower Division Transfer Pattern in the Biological Sciences;
- Member, Faculty Consensus Group CSUPERB (California State University Program for Education and Research in Biotechnology)
- Member, CSU GE Area B Course Review Committee
- Member, CSUS/UCD Cancer Center Partnership Board and Steering Committee for CSU Fresno/Burnham Institute NIH Grant
- Co-Chair for the Cancer Biology section of the Annual Biomedical Research conference for Minority Students sponsored by the National Institute of General Medical Sciences (NIGMS)
- Member of several national collaboratives to improve undergraduate biology education (NSF Introductory Biology Project and Society for the Advancement of Biology Education Research)

Service in University Governance
Faculty members who teach in the CMB curriculum are well represented on committees at the College and University levels, and have recently served on the following committees: CTL Advisory Board, Animal Care and Use Committee, the NSM and University Curriculum Committees, NSM Student Academic Success, and (2006-07) as Department Chair.

Working with other programs
Our CMB faculty members are highly collaborative, working with others within NSM and across campus. CMB faculty were involved in the design, opening, expansion and leadership (serving as officers) of CIMERA, an NSM College level Center. At least four have served as its Director or Associate Director. Furthermore, CIMERA has been used for SEE’s summer Science Training Program (STP) and for a public Science Open House during River City Days. One faculty member also served as the Faculty Director of the Science, Technology, Engineering and Mathematics (STEM) Initiative. CMB members recently submitted a CSUPERB grant and are writing an NSF-TUES grant in collaboration with Information Research Technology to create a model for faculty and student learning that integrates high-technology laboratory instruments and advanced computer networking and sharing with the development of inquiry-based curriculum that can be applied across a broad range of scientific disciplines. Other projects involve an intra-campus service learning research collaboration with faculty from FACS and Sociology and development of the first Summer Academy for high school students (focus on biotechnology) with the College of Continuing Education. A CMB faculty member also serves as a Co-PI with Teacher Education faculty to provide scholarships for future science teachers (NSF Noyce Grant).

Effective sharing of resources
Faculty share resources for both research and teaching. Most faculty share office space (55% of full-time and 100% of part-time), and most research faculty members share lab space and equipment. The CIMERA facility supports integrated research activities by faculty from both Biological Sciences and Chemistry. Faculty in teaching laboratories share equipment (e.g. microscopes, models, centrifuges, incubators and safety hoods). Students from at least five different courses - Clinical Hematology, Parasitology, Developmental Biology, Histology and Neuroanatomy – use the microscope laboratory (which houses our best scopes). This sharing of results in heavy use of this expensive equipment, which is damaging and potentially problematic, as service contracts are not always affordable. Our Natural Sciences Advising Center includes faculty from Biological Sciences and Chemistry, who provide academic advising to thousands of students in NSM. Finally, the curricula at both the undergraduate and graduate levels are structured to be efficient such that no course “stands alone.” That is, all courses may be used in more than one program. Courses required in a specific concentration are also co-listed as core concept groupings to be used as electives in other programs. The CSI-TRU facility is run by one of our CMB faculty and provides an excellent resource for projects requiring specialized equipment for advanced DNA work such as DNA sequencing.
Criterion 11: Revenue and Other Resources Generated by Program

Enrollment-based Budgetary Support from the University
The Department of Biological Sciences receives 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.

Research grants, In-kind Equipment Donations and Fundraising
Since 2006, Biological Sciences faculty members 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. We would be remiss if we did not mention the fact that without these donations, we would be unable to adequately prepare our students for an increasingly complex scientific job market. We feel extraordinarily fortunate to have acquired this equipment and to be able to continue to offer Sacramento State students with lab-based, hands-on biology learning experiences, including those in forensics.

The Forensic Biology concentration is so heavily embedded in the Department's overall curriculum that teasing out numbers specific to the concentration is impractical and potentially misleading. However, it should be noted that running both BIO 150 (Forensic Biology) and BIO 151 (Advanced Laboratory Techniques in Forensic Biology) would not be possible without substantial external support from the forensics community. The estimated cost of running BIO 150 is $4,000 per semester, which includes the cost of performing serological DNA typing using the same technologies and instrumentation as modern crime labs. It would be possible to run the course without a laboratory component or to modify the labs to include less expensive exercises but this would dramatically lower the course's relevance to students and seriously impact the quality of their education. The cost of running BIO 151 is more difficult to estimate (students do different projects each semester) but the same general situation applies. We are greatly indebted to the forensics community for their generosity and devotion to our program. This includes used equipment, expired kits and reagents, and access to software required to generate, analyze, and interpret DNA profiles.

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