PROGRAM PERFORMANCE REVIEW

Department of Biological Science
Cal State Fullerton
AY 2000/01 – 2007/08

Submitted by,

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I. *Department/Program Mission, Goals and Environment*

The unit might use the SWOT Analysis (see appendix) of **strengths**, **weaknesses**, **opportunities** and **threats** to inform the response to the following:

A. Briefly describe the mission and goals of the unit and identify any changes since the last program review. Review the goals in relation to the university mission, goals and strategies.

I.A. Mission, Goals & Strategies

The Mission, Goals & Strategies for the Department of Biological Science were developed by the Long Range Planning Committee in accordance with the University M&G and received final approval by the faculty in May, 1996. They continue to guide us in making strategic decisions and remain consistent with the University M&G. All plans presented in this report are consistent with these goals and objectives.

I.A.1. Mission Statement

As an integral component of a large, comprehensive, public university, the Department of Biological Science benefits from and contributes to the rich and changing character of California State University, Fullerton. Our students, majors and non-majors, undergraduate and graduate, are a cross-section of a diverse population with respect to age, ethnicity, culture, academic experience, and economic circumstances.

As a department concerned with creating new knowledge through innovative research and with disseminating current knowledge across the broad discipline of biology, we serve as a regional center for the scientific study of the processes of life.

The Department embraces the University's mission and goals, and acknowledges its substance as the underpinning of our mission as a department. Our students are challenged to develop intellectually and scientifically, while being prepared for challenging professions and to work for the betterment of society.

Our faculty and staff: (1) strive for excellence in both teaching and research, (2) actively involve students in scholarly, creative and collaborative activities in the classroom, laboratory and field, and (3) affirm that collaborative faculty-student research is an integral and requisite part of learning in the biological sciences.

The Department strives to implement these goals and strategies independent of gender, ethnic, and cultural bias. We assiduously assess our strengths and weaknesses, determine our success in achieving goals, and use these data to update our strategies. We endeavor to maintain an exciting, dynamic, comprehensive and contemporary educational program in biological science.

I.A.2. Goals and Strategies:

I. To ensure the preeminence of learning and to be a high-quality program that meets the evolving needs of our students, we will:

A. provide a learning environment that promotes collaborative faculty-student research, written and oral communication, the use of critical thinking in the scientific process, and an understanding and appreciation of the full breadth of biological science.

B. promote high-quality research as a fundamental component of the educational process in biological science by continuing our commitment to the total education of our students in both theoretical and applied scientific principles through classroom, laboratory and field research experiences.
C. provide a teaching environment that promotes excellence and innovation in teaching; that promotes constructive evaluation of teaching; and that supports improvement in teaching styles and methods.
D. develop, maintain, and support the use of modern facilities and instrumentation required for the pursuit of scientific knowledge.
E. recruit and retain a highly qualified, productive, and diverse staff and faculty.
F. incorporate advances in information technology and scientific methodologies into teaching and research.
G. prepare our students (both non-biology and biology majors) for the challenges and demands of leadership in their chosen field and offer opportunities that promote the acquisition of knowledge necessary to make meaningful contributions to society.
H. seek extramural funding that promotes the development and maintenance of high-quality teaching and research.

II. To enhance student and faculty learning through research, we will:

A. support grant and research activity that leads to the generation and dissemination of knowledge.
B. promote opportunities for collaborative faculty-student research and seek extramural funding to create or continue special programs that emphasize student participation in research.
C. enhance learning through research and research productivity by maintaining an environment that makes it possible for faculty, students and staff to balance high-quality teaching and research programs.
D. develop, maintain, and support modern facilities required for biological research.
E. support collaborative research efforts within the Department, School, University and community.

III. To create an environment where students of varying age, ethnicity, culture, academic experience, and economic circumstances have the opportunity to succeed, we will:

A. support programs designed to recruit high-quality students.
B. encourage student participation in collaborative faculty-student research and in other departmental activities.
C. offer the curriculum in such a way that students have access to courses needed for a timely graduation.
D. provide advising to all majors in support of their timely progress through the curriculum and their consideration of potential career paths.
E. support programs designed to retain at-risk students.

IV. To expand collaborations, connections and partnerships, we will:

A. promote cooperative interactions with other departments on campus and at nearby campuses, and with other groups or institutions interested in pursuing the scientific understanding of life processes.
B. support development of partnerships (e.g., consulting activities, collaborative research, and internship programs) with institutions involved in biologically-related endeavors.

C. promote relationships between the department and local schools by providing speakers, sponsoring departmental visits, supporting student research activities, collaborating on educational projects, and supporting other productive interactions.
D. establish strong ties with alumni and foster their interest in the development and future success of the Department.

V. To strengthen departmental effectiveness and our sense of community, we will:

A. encourage ongoing assessment of administrative and educational processes to ensure that they are effectively contributing to our goals.
B. foster a sense of community to assure that faculty, students, and staff have as a common purpose the achievement of the goals of the Department.
C. provide an environment that enhances the productivity of faculty and staff and encourages cooperation and interaction in meeting the Department's mission, goals and strategies.
D. encourage faculty involvement in departmental governance, while making effective use of faculty time and streamlining decision making processes.
E. provide an appropriate system to recognize and reward the efforts of faculty, staff, and students who make contributions towards meeting the Department's mission, goals and strategies.
F. enhance communication between faculty, staff, and students through the use of information technologies.

B. Briefly describe changes and trends in the discipline and the response of the unit to such changes. Identify if there have been external factors that impact the program. (community/regional needs, placement, and graduate/professional school).

I.B. Department SWOT Analysis

During our department retreats in 2007, both faculty and staff performed a SWOT analysis of the department with the following outcomes. Where a characteristic was noted by only one of the two groups, that group is identified; otherwise, the characteristics were noted in both forums. The explanation of each criterion has been kept short and may be amplified in other sections of this report. Further clarification on issues not covered may be sought in the on-site review process.

I.B.1. Department Strengths

I.B.1.a. Faculty. (i) We have an excellent group of collegial part-time and tenure-track faculty members who are dedicated to students and research, and value active learning and inquiry-based instruction. (ii) This group is aware of new trends in pedagogy and, by working together as a department to develop a curriculum based on them, has developed as a model for other comprehensive universities. (iii) The faculty is dedicated to academic success of our students and support student success in the curriculum, academic advising and research efforts. (iv) The faculty is collegial and cohesive.

I.B.1.b. Staff. Skilled and hard-working staff members provide support for administrative, teaching and research activities. The staff, as a group and individually, respond rapidly to the ongoing and urgent needs of the department. That the University provides competent radiation/chemical safety officers is an asset.

I.B.1.c. Administrative Leadership. The Department Chair and Vice Chair, as well as the College Dean, are supportive of the faculty and the department. Channels of communication are open and work effectively to keep faculty and staff apprised of on-going developments in the College and Department. We have seen growth in department FTES that has led to growth in budget and allows for increased support of teaching and research. Additionally, there has been important, positive change in the utilization and renovation of space that has made space more efficient and productive.

I.B.1.d. Students. We have a diverse population of students who reflect our local population. A large number of our students are serious, hard working, and collegial; student-faculty interactions and relationships are strong and productive. Students in special programs like MARC, SCERP, SACNAS, Undergraduate Biology Club, and Graduate Student Club make significant contributions to the success of the department and are active in the Associated Student Inc. Inter-Club Council, which brings travel and research funding to students in the department.

I.B.1.e. Research. Undergraduate and graduate students participate in research led by dedicated faculty. In addition to internally and externally funded research by individual principal investigators, there are excellent externally funded undergraduate research programs that cater to our underrepresented students. At any given time, there are approximately 100 undergraduate students and 60-75 graduate students actively engaged in research in department faculty research laboratories.

I.B.1.f. Graduate Program. We have a rigorous Graduate Program that engages a diverse group of students in self-initiated, thesis-based research. Students become experts in research in their selected area of study based on coursework, seminars, and hands-on bench work, and they have the opportunity to excel in teaching based on our professional aspects of university teaching course as well as the oversight from faculty laboratory coordinators who provide feedback.

I.B.1.g. Undergraduate Program. Implemented in Fall 2004, our undergraduate curriculum includes a new core curriculum and four concentrations and incorporates laboratory skills early in the student's career. Faculty members are developing strong assessment tools.

I.B.1.h. Infrastructure. The department provides support for faculty research through reduced teaching loads. Several service centers support instruction as well as research activities in microscopy, molecular biology, microbiology, ecology, organismal biology, and greenhouses, and shared equipment facilities with sophisticated instrumentation, and vehicles/boats support modern, high-quality laboratory and field research activities. University support of IT needs is strong.

I.B.1.i. Space. Some space is an asset and some space is not. The research space used for faculty-student research is generally considered of high quality by faculty. Dan Black Hall is nearly fifteen years old, but offers functionality. Research labs in McCarthy Hall have been renovated within the last five years (except for one lab that will be remodeled in AY 09-10 if funding permits). Teaching labs are basically adequate overall, but MH labs are showing signs of age and need to be upgraded. MH instructional service centers are in particular need of upgrading.

I.B.1.j. Working Conditions. New faculty salaries, start-up packages and benefits, which include FERP and pension packages, are very competitive. Although full equity has not been reached among all faculty members, the campus leadership has succeeded in relieving the salary inversion among the untenured faculty and has adjusted a few of the Associate Professor salaries. The Retention-Tenure-Promotion (RTP) expectations and the processes for assessing them are

clearly outlined in the Department and the University guidelines, and the campus has been recognized in a survey of junior faculty by the Harvard-based Collaborative on Academic Careers in Higher Education (COACHE) for overall transparency in the tenure process (http://insidehighered.com/news/2007/12/05/coache). In addition to the compensation mentioned above, the University and Department provide support for new untenured faculty research through lowered teaching loads (one course per semester for four semesters). Although staff compensation is not fully equitable, staff excellence is recognized as an asset to the Department and is rewarded by nominations for College and University recognition.

I.B.1.j. Communication. Staff members have strong communication ties with their counterparts in other departments in the College of Natural Sciences and Mathematics. This helps them collaborate in the support of the technical needs of the College.

I.B.2. Department Weaknesses

I.B.2.a. Space. (i) Although the *quality* of most departmental research laboratory space is considered to be high, the *size* of this space is generally considered to be too low. For most faculty, research labs are approximately 600 ft^2, but very active, funded labs need to have twice that space (as faculty in Chemistry/Biochemistry do have) to handle the >8 students working in any given semester. Full-time faculty offices, although single and generally larger than the 110 ft^2 designated by CSU, are in locations often inconvenient to research labs and are adapted from spaces originally designed for instructional support. Staff offices are generally shared. (ii) Teaching labs that are not of high functionality include MH-237 complex (the human anatomy laboratory), MH-354-366 complex (microbiology and cell biology and the service center space that supports them; counter tops are especially in need of repair). These areas are on a long-term renovation plan that has not been funded. (iii) Renovation of MH-301 to construct a microbiology lab that will house nursing microbiology, some sections of general microbiology and immunology is in progress. We do not have a permanent home for the cell culture and stem cell biology laboratory. (iv) At the time of the SWOT, staff members were especially displeased with the absence of instant hot water in their support labs—we think this has now been remedied. (v) The Greenhouse Complex requires complete renovation; this is included in our Long-term Plans (Section VI.B.2 and Appendix VIII. *White Paper on the Renovation/Relocation of the Greenhouse Complex*), but no funds are immediately available.

I.B.2.b. Time. The demand on faculty time to maintain a high-quality biology department is very high. (i) All of our faculty members have functional research labs where they spend a large portion of their time engaged in working with undergraduate and graduate students in research—a critical aspect of our educational process. (ii) High quality instruction is a goal shared by all of our faculty members, but incorporating the non-traditional approaches that we advocate often takes more time than standard lecture formats. (iii) All full-time faculty members advise students (40-50 each) every semester. (iv) The department has nine standing committees, usually five or six ad hoc committees, three student clubs, two undergraduate research training programs, six faculty participate in College committees, fourteen faculty participate in University committees, six faculty members participate in CSU-wide programs (see Appendix IX: *AY07-08 Committee Structure*).

I.B.2.c. Student limitations. (i) Students arrive to participate in our undergraduate BS program with limited skills in communication and weak backgrounds in basic biology, study skills and quantitative skills. The commitment of nearly 50% of them is questionable. Many of these students require remediation in math and English prior to entering the biology curriculum.

It is frustrating not to be able to control the quality of students overall. (ii) The fact that students are largely commuters limits the expectations that we can place on the students for extended activities that go beyond the scheduled times as is often required of advanced laboratories. (iii) There is a difference in the preparation and background of our native vs. transfer students especially with respect to the core course experience. This difference, which does not imply a qualitative difference necessarily, requires that gateway courses accommodate the varied backgrounds and limits their efficiency. (iv) Students distribute themselves unevenly among our four concentrations making it difficult for faculty members in the Marine Biology and Biodiversity, Ecology and Conservation Biology Concentrations to offer the variation in courses desired to meet currency requirements in these disciplines.

I.B.2.d. Faculty. (i) The faculty age demographic is such that we have a gap in advanced Associate Professors and Professors who are ready to take over leadership of time consuming department or program administration activities. (ii) The percentage of full-time to part-time faculty, including the four new hires for fall 2008, is approximately 60%. Our long-term plan has been to get this up to approximately 75% so that we can spread the work of running the department among a larger number of people. (iii) For budgeting purposes, our department's student-faculty ratio is19.8—it has held between 19.6 an d 19.8 for many years, but has not decreased in years of sound economy.

I.B.2.e. Administration. (i) Biology faculty and staff find that administration above the College level is not closely connected to them and appear to be aloof. (ii) Support from Grants and Contracts is not dependable and as extensive as appropriate. (iii) The Auxiliary Service Corporation could provide stronger support of percent-effort reporting and budget handling. (iv) IT support at the University level is often of spotty quality.

I.B.2.f. Reputation. The Department is not noted locally for the areas in which it actually excels.

I.B.2.g. Communication. Interdepartmental communications are in need of improvement as seen from the faculty, but not the staff, perspective.

I.B.2.h. Undergraduate Program. (i) The assessment plan for our programs is not complete. We need to complete the development of the assessment process for the core to include: laboratory, communications skills, team-based functioning and critical thinking skills. (ii) We need to increase the offering of upper-division labs in the Cell & Developmental Biology and Molecular Biology & Biotechnology Concentrations. (iii) Many faculty members feel that the course repetition policy is not restrictive enough and not consistently applied. (iv) The quality of instruction offered by our TAs in the core course laboratories is not always as strong as we would like. TAs require greater supervision during their first year of teaching, especially during open discovery modules. (v) At the time of the SWOT analysis, we did not have any minors in Biology—we now have two in the approval pipeline. (vi) We do not have a careers-oriented course or mechanisms to help students be placed in jobs.

I.B.2.i. Equipment. (i) Equipment purchasing that was recently baselined, is slated for elimination due to baseline budget reductions; our list of desired equipment is about $300,000 excluding major research instrumentation that should be acquired via external funding. (ii) Better ongoing monitoring of research equipment functionality is desirable.

I.B.3. Department Opportunities

I.B.3.a. External Collaborations. There are many opportunities to enhance our teaching and research activities with other nearby institutions. We should develop associations with regional campuses to enhance our programs.

I.B.3.b. Connectivity. There are opportunities to more effectively and efficiently deliver course content and improve research collaborations. We can use our website to recruit good students more effectively.

I.B.3.c. Student recruitment. We do not actively recruit at present. We could improve our outreach to a variety of student populations by: (i) increasing our association with Troy High School's Troy Tech program and offering incentives to enroll could have positive effect; (ii) sponsoring more department tours by high school biology courses could increase awareness among students; (iii) increasing awareness of the local community to the level of student-faculty research opportunities; (iv) increasing internship opportunities to increase student awareness of connections to the job market.

I.B.3.d. Stem cell biology and biotechnology. We could use interest in new technologies, the stem cell initiative and stem cell interests to increase student interest in becoming biology majors and to increase funding opportunities.

I.B.3.e. Environmental biology. We need to capitalize on the increasing interest on campus and in the local community on issues of sustainability by increasing the visibility and focus of our department in courses and programs connected to this area.

I.B.3.f. Interdisciplinary activities. Although individual biology faculty have interactions with faculty members in biochemistry, geology, and applied mathematics, there are opportunities for increasing these to develop research and instructional collaborations that will increase funding opportunities as well as collaborative research and teaching activities, the latter of which could lead to new program development.

I.B.3.g. Pedagogical activities. We are well poised as a department to increase external funding and to play a national leadership role.

I.B.3.h. Funding. (i) We are not fully exploiting funding opportunities that are available to us—notable examples include those available to Hispanic-serving institutions, pedagogy and stem cell biology. (ii) Donation of equipment and funds from corporate sponsors could be increased. (iii) We could alert local corporations to opportunities for use of department equipment and expertise.

I.B.3.i. Concentration-specific advising. We have not developed a process for tracking students so that we can offer stable advising provided by faculty members expert in a student's chosen Concentration.

I.B.4. Department Threats

I.B.4.a. Financial. (i) The expense of living in southern California negatively impacts faculty, staff and students. Notably, it reduces ease of recruiting faculty. (ii) The state budget fluctuates unpredictably; funds available for department activities in all areas are threatened. (iii) Increase in student fees negatively impacts students even though it increases reliable funding for CSU; the requirement for students to work outside the university will increase, thereby decreasing time available for studying. (iv) Support for graduate students is too low. (v) Official distribution of operating expenses, equipment and other baseline funding in the department budget is not sufficient to meet the increasing needs of the Department. (vi) Staff salary equity issues threaten to drive high-quality staff to other career opportunities.

I.B.3.b. Non-fiscal resources. (i) Increased dependence on part-time faculty decreases the number of full-time faculty who can cover non-instructional operational needs of the Department. (ii) Much of our space is inappropriately configured, not available or too small for selected activities, or needs renovation.

I.B.4.c. Physical. (i) Natural disasters and terrorist attacks impose concern on individuals and requirements for departmental readiness. (ii) Urban sprawl is increasing and our best area for increasing student enrollment is San Bernardino and Riverside counties where commuting problems are high. (iii) Many university teaching facilities are aging and in need of improved instructional support.

I.B.4.d. Educational. (i) The shift of students interested in organismal biology to those interested in cell and molecular biology threatens the integrity of the integrated biology program. (ii) Fulfilling the BIO 2010 vision requires more multidisciplinary faculty, especially those with expertise in quantitative biology. (iii) We have only one online course, but move to increase online offerings is seen as taking faculty time away from on-campus students.

I.B.4.e. Societal. (i) Perception among some in external society that science undermines family values and societal morals; this is particular visible with respect to perceptions of the role of evolution in biology. (ii) Students not prepared to commit to the work required of biology majors are increasing in numbers. (iii) External perception of CSUF as a teaching institution despite high-level research productivity quality in the sciences decreases student interest. (iv) Declining student ethics and work habits.

I.B.5.f. Operational. (i) There is too much work in running a high-quality department for the present full-time faculty and staff to accomplish in the regular work week. (ii) Some staff positions may not be aligned with instructional needs of the department. (iii) Instructional techs need more flexibility in time-management options.

C. Identify the unit's priorities for the future.

I.C. Strategic Plan for 2007/08-2014/15

I.C.1. Priorities for Staff:

To maintain support for administrative, instructional, research and maintenance needs of the Department, the Department's priorities are to:

i. Maintain a minimum of three administrative positions in the front office.
ii. Maintain a minimum of one accounts administrator to handle stockroom orders and accounting processes.
iii. Maintain a minimum of one equipment maintenance and fabrications technician.
iv. Maintain a minimum of one animal care manager.
v. Maintain a minimum of one plant care manager.
vi. Maintain a minimum of one microscopy technologist.
vii. Maintain a minimum of 0.5 laboratory manager for non-majors course support.
viii. Maintain a sufficient number of laboratory managers for lower- and upper-division multi-sectioned laboratory courses to provide each section of each course the basic chemical, materials, equipment support necessary to deliver quality instruction and to free instructors/TAs so they can focus on instructional activities.
ix. Avoid supporting staff activities with non-staff positions.

x. Evaluate staff effectively to maintain quality performance.
xi. Promote professional development of staff members by encouraging them to attend one professional function per year.
xii. Evaluate staff salaries to maintain equity.
xiii. Recognize the accomplishments of staff members by nominating them for awards as appropriate.
xiv. Evaluate time-management constraints for various staff and determine maximum flexibility.

I.C.2. Priorities for Faculty:

In its hiring of tenure-track faculty, the Department's priorities are to:

i. Maintain a minimum of five members in each Concentration to offer the upper-division courses as required to cover the needs of that Concentration.
ii. Protect the departmental SFR and hold it at or below the historical 19.8.
iii. Keep tenure-track faculty teaching loads at levels (approximately 2 courses per semester) that will allow faculty to support an active/productive undergraduate and graduate research program.
iv. Promote professional development of all faculty members.
v. Leave sufficient positions unfilled to support our graduate program and provide teaching associates for any course with multiple laboratory sections.
vi. Leave sufficient positions unfilled to hire part-time instructors to cover the departmental needs.
vii. Assign only tenure-track faculty to teach in the lower-division core courses.
viii. Hire faculty within concentrations to build centers of excellence ("core concentration faculty").
ix. Hire faculty to build bridges between concentrations ("integrative concentration faculty") or to contribute to identified interdisciplinary research groups.

I.C.3. Priorities for Faculty Participation in Governance

In governing itself and contributing to the governance of the University, the Department's priorities are to:

i. Maintain balanced representation of each concentration or research group on the standing committees.
ii. Maintain and revise the number of standing committees and number of members on each committee needed to make ongoing decisions in the department with the goal of minimizing faculty person-hours committed to committee work.
iii. Establish goals and expected outcomes for each committee for each academic year.
iv. Maintain and revise operating practices and a timetable for action as relevant for each committee.
v. Include students and staff on relevant committees as deemed necessary and appropriate.
vi. Follow UPS procedures in determining committee membership as necessary and appropriate.
vii. Encourage participation in University committees, especially where we have a stake in the outcome, e.g., General Education, Curriculum, Sabbatical and Leaves, University Personnel, Research, and Planning-Resource-Budget.

I.C.4. Priorities for Promoting Research and Scholarly Activities.

To promote the advancement of faculty and student research, the Department's priorities are to:

i. Encourage all faculty members to submit proposals for external and internal support of their research.
ii. Promote seeking of external grant support by participating in the College's practice of adjusting the teaching loads of faculty who are awarded extramural grants.
iii. Support professional development of faculty that will enhance research and funding strategies.
iv. Promote collaborations and interdisciplinary activities on and off campus.
v. Encourage faculty in the pedagogy research group to strive for national leadership roles among comprehensive universities.
vi. Promote joint ventures by facilitating interactions with local industry.

I.C.5. Priorities for Undergraduate Program. (Also see Section II.B. and II.C. below.)

In developing our undergraduate curriculum, the Department's priorities are to:

i. Enhance undergraduate student recruitment.
ii. Establish long-term relationship with local HS biology teachers and their students.
iii. Renew contacts with local community colleges to increase level of articulation with our core program.
iv. Support enhancement of orientation of freshman and transfer students.
v. Analyze the loss of majors to other programs and develop plan to recapture some ot those lost.
vi. Develop processes to improve academic advising.
vii. Develop a biology-related careers course and synchronize its activities with Career Day activities.
viii. Enhance the internship course and synchronize its activities with Career Day activities.
ix. Complete our UG Program Assessment Plan so that it "closes the loop" and fosters improvement of our curriculum by triggering development of new courses or refinement of existing courses.
x. Promote development of online courses in small, upper-division courses for non-majors and majors.
xi. Develop new degree programs that prepare students for the varying demands of the work place.

I.C.6. Priorities for Graduate Program. (Also see Section II below.)

In developing our graduate program, the Department's priorities are to:

i. Increase our graduate student population to 100 within five years.
ii. Develop a graduate student recruitment program.
iii. Use the instruction of stem cell biology courses as an attractor.
iv. Initiate proposals and activities to increase resources graduate students support.
v. Increase the number of 500-level courses available for our graduate students to take as part of their study plan with the goal of having each study plan made up of 75% or greater 500-level courses.

vi. Continue to the collaborative development and implementation of the Master of Applied Biotechnology Studies professional science masters degree.
vii. Take a leadership role in the collaborative development of an environmental/sustainability science program.
viii. Seek ways to better prepare our graduate students for the various professional objectives that develop in the workplace.

I.C.7. Priorities for Fiscal Resource Management.

Fiscal support comes to the Department in three basic forms, the State General Fund, the State Lottery Fund and external sources, and only the latter source has the potential to increase significantly. In managing the its budget, the Department's priorities are to:

i. Hire excellent tenure-track faculty at competitive salaries and follow collective bargaining protocols to maintain salary equity.
ii. Offer competitive start-up packages to new faculty.
iii. Hire excellent staff at competitive salaries and follow collective bargaining protocols to maintain salary equity.
iv. Hire excellent temporary faculty at competitive salaries and follow collective bargaining protocols to maintain salary equity.
v. Hire excellent teaching associates, graduate assistants and instructional student assistants at competitive salaries and follow collective bargaining protocols to maintain salary equity.
vi. Assign instructors to courses and labs to maximize quality of instruction and fiscal efficiency.
vii. Exploit external funding opportunities.
viii. Seek corporate and other external support of student research activities.
ix. Purchase equipment for instruction and research to meet priorities below.
x. Contribute to renovations for instruction and research to meet priorities below.

I.C.8. Priorities for Physical Resource Management

Space and equipment are used to support both instructional and research activities. In managing these resources, the Department's priorities are to:

i. Insure that quality and quantity of space meets department needs for supporting instructional and research activities.
ii. Insure that quality and quantity of equipment meets department needs for supporting instructional and research activities.
iii. Seek sponsors for research laboratories.
iv. Seek more equipment donations.

I.C.9. Priorities for Continuity of Business Plan

To facilitate ongoing functions in the case of disasters, the Department's priorities are to:

i. Develop detailed phone tree and update it each semester.
ii. Set up an alternative campus for reporting personnel status following disasters.
iii. Encourage faculty to understand "sheltering in location" program.
iv. Designate roving building marshals for biology space in MH and DBH.
v. Set responsibility for long-term maintenance of disaster preparedness protocols.

I.C.10. Priorities for Responding to External Societal "Threats".

To reduce the negative impact of societal threats, the Department's priorities are to:

i. Improve visibility in the local community.
ii. Designate speakers/participants available to attend community forums on evolution, sustainability, global warming, etc.
iii. Update and maintain our participation in the Public Affairs list of experts.
iv. Increase the level of response to Public Affairs for information and participation in community activities.
v. Continue support for College newsletter.

D. If there are programs offered in a Special Session self-support mode, describe how these programs are included in the mission, goals and priorities of the department/program (e.g. new student groups regionally, nationally, internationally, new delivery modes, etc).

I.D. Special Session Programs

There are no such programs at present. We evaluate the biology-related curriculum for all programs developed by Extended Education—at present these include courses for the Forensic Science Certificate and courses in the Bioinformatics Certificate.

II. *Department/Program Description and Analysis*

A. Identify substantial curricular changes in existing programs, new programs (degrees, majors, minors) developed since the last program review. Have any programs been discontinued?

II.A.1. Fully Revised Bachelor of Biological Science Degree Program Curriculum

The Biology curriculum has been completely redesigned since the last PPR. The process was underway during the last PPR and was one of the primary strategic initiatives therein. It was completed and implemented as summarized below and is more completely defined in our *Undergraduate Advising Handbook* (Appendix X). All of our courses can be found in Appendix XI. *Biology Catalog Listings*. The revised program was fully implemented in Fall, 2004.

II.A.1.a How is the study of biology approached at Cal State Fullerton?

The Department of Biological Science is dedicated to educating the individual student using active-learning, inquiry-based educational approaches throughout its curriculum. The curriculum for biology majors provides a broad exposure to key biological principles through the core and depth of knowledge within the student's chosen emphasis. Many opportunities for faculty-mentored student research exist. Our focus is on guiding students to acquire the skills, develop the attitudes, and master the information necessary to continue their education, obtain desirable employment in biology-related areas, and be productive citizens.

II.A.1.b. What can students expect to gain from their experience in the biology major? (Also see II.A.4 below for student learning goals.)

- Skills in experimental design, hypothesis testing, critical thinking, problem solving, observation, data collection and record keeping, data analysis and interpretation, use of laboratory and field instrumentation and techniques, information retrieval and evaluation, written and oral communication, and working as part of a team. In this context, students will learn to question and evaluate biological ideas.
- A positive attitude toward biology, an appreciation for the value of living systems and bioethics, a desire for life-long learning, and a realization that scientific investigations involve creativity, ingenuity, and imagination.
- Mastery of biological principles and concepts and their interrelationships, and an understanding of the unifying role in biology of evolution and biodiversity, and the dynamics of biological systems.

II.A.1.c. New Curriculum

The new curriculum uses themes and perspectives to connect and integrate major concepts, principles and basic facts. Three ***Themes*** run throughout the curriculum: **Evolution** (inherited changes in organisms accumulate over time), **Unity and Diversity** (organisms possess common characteristics while exhibiting a wide range of variability), and **Dynamics of Biological Systems** (living systems continually respond to their external and internal environments by making changes necessary to sustain life).

Each theme is presented from two ***Perspectives***: **Human Impact** (the interactions between humans and the biological world) and **Scientific Process** (the testing of new ideas, questions or hypotheses through observation and experimentation).

II.A.1.c.1. Lower-division Core (began Fall 2002). The two-year Core provides a solid basis for understanding the principles that underlie the many distinct disciplines of biology, and focuses instructional attention on individuals working as part of small teams. These teams work together in the laboratory and field to discover information about the biological world.

The Core is composed of four sequential courses (20 units):

- BIOL 171: Evolution & Biodiversity: Introduction to scientific processes and methods of biology. Explorations of underlying and unifying principles of evolution, processes leading to biodiversity, and principles of conservation biology. (3 hours lecture; 6 hours laboratory/fieldwork, 5 units).
- BIOL 172: Cellular Basis of Life: Biology 171 or consent of instructor. Exploration of the structure and function of prokaryotic and eukaryotic plant and animal cells, including: evolutionary relationships; cell membranes; compartmentation; signaling and metabolic pathways; cell adhesion and motility; cellular reproduction; cell differentiation; multicellularity and development. (3 hours lecture; 6 hours laboratory, 5 units).
- BIOL 273: Genetics & Molecular Biology: Prerequisite: Biology 172 or consent of instructor. Corequisite: Completion or enrollment in CHEM 120A. Explorations of the underlying principles of inheritance, structure and functions of nucleic acids, regulation of gene expression, the mechanisms by which populations evolve, and the impact of biotechnology on society. (3 hours lecture; 6 hours laboratory, 5 units).
- BIOL 274: Principles of Physiology & Ecology: Prerequisites: BIOL 273 and CHEM 120A or consent of instructor; MATH 130, 150A, or 337 suggested. Principles of

organisms' interactions with their environments; physiological and evolutionary mechanisms of change in response to environmental factors; population and community ecology; energy and material flow through ecosystems. (3 hours lecture; 6 hours laboratory/fieldwork, 5 units).

II.A.1.c.2. Upper-division Concentrations. Begun in fall 2004, students take upper-division courses in one of four Concentrations. A concentration focuses students on a specific field of study within biology. Each concentration includes 23 units of classroom study and laboratory- or field-based activities at the 300- and 400-level. Two 400-level biology elective courses must be taken. The University's upper-division writing requirement may be fulfilled by two specified 400-level courses, English 301 or Chemistry 340. A capstone course culminates each concentration. Biology majors will graduate with a Bachelor of Science in Biological Science with an Concentration in…

Biodiversity, Ecology, and Conservation: The study of all biological organisms (ranging from the level of the individual to the ecosystem), their responses to the environment on evolutionary and ecological time scales, and their conservation.

Cell & Developmental Biology: The study of the structural and functional dynamics of cells, including topics such as compartmentation and secretion, cell motility, and cell-cell interactions as they apply to the specialized fields of immunology, microbiology, neurobiology, physiology and developmental biology.

Marine Biology: The study of marine organisms and their coastal and oceanic habitats, including: (1) classification, structure/function, ecology and physiology of these organisms, and (2) conservation, environmental and evolutionary issues related to these organisms and their habitats.

Molecular Biology & Biotechnology: The study of genetics, molecular biology, and biotechnology and their applications to medicine, agriculture and the environment (e.g., cancer, infectious diseases, gene therapy, crop improvement, and bioremediation).

Students interested in health professions or a teaching credential may take any concentration.

II.A.1.c.3. Supporting Courses (29-30 units). **Math**: one semester of calculus or a designated upper-division statistics course. **Chemistry**: one year of general chemistry with lab and one year of organic chemistry with lab. **Physics**: one year of elementary physics with lab.

II.A.1.d. Student Learning Goals for BS in Biological Science.

Knowledge. Students must be able to: (a) *Explain*[1] (i.e., *expound, explicate, elucidate, and interpret*) fundamental concepts and principles in the following areas of biological knowledge: biodiversity, cell biology, developmental biology, ecology, evolution, genetics, molecular biology, organismal biology, and physiology. (b) *Interpret* the following unifying

[1] ***Webster's New World Dictionary of the American Language**, (D.B. Guralinik, ed), second college edition, Simon and Schuster, NY.
Explain implies making a clear or intelligible of something that is not known or understood [by the listener].
Expound implies a systematic and thorough explanation.
Explicate implies a scholarly analysis or exposition that is developed in detail.
Elucidate implies a shedding light upon by clear and specific explanation.
To **interpret** is to bring our meanings not immediately apparent [to the listener].

theme in the context of the above areas of biological knowledge: complexity of biological systems, cycles, feedback loops, energy flow, homeostasis, information flow, networks, and structure-function relationships. (c) Demonstrate specialization and thus be able to *explain* (i.e., expound, explicate, elucidate, and interpret) advanced concepts in one of the areas of biological knowledge noted above. (d) *Interpret* connections between: science and technology, past scientific discoveries and current scientific progress, academic requirements and careers or professional advancement, scientific method including its limitations and the discovery of new knowledge, and bioethics/scientific integrity and the advancement of science.

Skills. (a) *Communication*. Students will be able to: communicate effectively orally; communicate effectively in writing; and write in scientific format acceptable by scientific journals. (b) *Teamwork*. Students will be able to: work cooperatively in a group of diverse composition; and, solve problems in a group of diverse composition. (c*) Finding biological information*. Students will be able to: find, evaluate, use, and integrate published information; and, use databases and information technology. (d) *Critical thinking and problem-solving*. Students will be able to: make an argument and support it; recognize and use deductive and inductive reasoning; integrate concepts within and among disciplines; recognize patterns; identify unifying principles; solve problems; distinguish between data and inferences based on data; and, distinguish information from scientific versus pseudo- and non-scientific sources and methods. (e) *Use of the scientific method.* Students will be able to: use deductive methods of inquiry; and, apply the scientific methods to problems by generating hypotheses and designing experiments to test these hypotheses. (f) *Analytical and quantitative skills.* Students will be able to: create data sets from observations; objectively analyze data; interpret data; and, use quantitative methods for the analysis of data. (g) Lab and field work. Students will be able to: use appropriate technology; use equipment properly; follow safety procedures; and, apply government regulations that govern their work.

Attitudes. (a) Students will *embrace lifelong learning* by: being capable of self-directed learning; having a continual interest in biology; and, having confidence in their knowledge, skills, and abilities. (b) Students will *value learning* by: being open-minded; appreciating the value of knowledge; appreciating and respecting alternative possibilities and explanations; experiencing the joy of discovery. (c) Students will *demonstrate knowledge of careers* by: defining potential career paths; and, being aware of the requirements for career or professional advancement. (d) Students will be aware of impacts of biological issues on society by: valuing the support of science by society; appreciating the relevance of biology to society; and, recognizing the connectedness of science, society, and history. (e) Students will *demonstrate an awareness of bioethics* by: identifying and evaluating ethical issues in biology; appreciating the value of integrity; and, valuing ethical behavior. (f) Students *will demonstrate appropriate stewardship and advocacy* by: respecting biodiversity; contributing to the understanding of true science; helping the public make informed decisions; and, being responsible stewards of biological resources. (g) Students will *demonstrate biological literacy* by: distinguishing science from pseudoscience; recognizing that science is a way of viewing the world and is not just a collection of facts; understanding the limitations of science; applying scientific thinking to everyday problems; and, recognizing the impermanence of "truths".

II.A.1.e. Introduction of New Courses Upper-Division Elective Courses for the BS in Biological Science

Several new upper-division courses have been introduced that play important roles as Foundation or Elective courses in the one or more concentrations.

II.A.1.e.(1). BIOL 325, Principles of Evolution. This course is a Foundation course in the Biodiversity, Ecology & Conservation in Biology concentration and is currently in the University Curriculum Committee awaiting approval. It illustrates the relevance of evolution to all of modern biology and to practical real-world problems. Evolutionary questions that may be considered include: (1) Where did HIV come from? (2) Why are flowering plants so evolutionarily successful? (3) How does antibiotic resistance evolve? (4) Why do vampire bats share food? This course will explore mechanisms of evolutionary change, including mutation, selection, migration, and drift. Students will be introduced to methods for studying adaptations. Students who successfully master the material in this course will be able to:

- Describe classical and modern evidence for evolution and natural selection.
- Use a combination of mathematical and experimental models to describe how selection, mutation, migration, and drift act on variation to produce evolutionary change.
- Design experiments to test the hypothesis that a particular trait is adaptive.
- Explain the evolutionary basis of sexual selection, altruism, and kin selection.
- For selected examples, discriminate among the processes and patterns involved in speciation, including geographic isolation, selection for reproductive isolation, and ecological specialization.
- Integrate skills and conceptual understanding of phylogenetic inference throughout the course, including evaluation of the evidence supporting particular groupings.
- Analyze how biological questions such as coevolution, ecological specialization, and adaptation can be tested from a phylogenetic perspective.
- Illustrate how organisms have diversified, the impact of mass extinctions, and how molecular genetics and bioinformatics can be applied to explain key innovations in organisms.
- Investigate comparative phylogenomic patterns made possible by the availability of multiple complete genome sequences.
- Illustrate the integration of evolution and development in the investigation of patterns of gene regulation and expression in animals and plants.

II.A.1.e.(2). BIOL 407, Genes and Genomes: Topics in Molecular Evolution. This course covers methods for analyzing the genetic change within populations, gene and genomic sequence data, comparative genomics, evolution of gene families, and evolution of genome structure and organization. The objective is to gain an overview of the processes and patterns of the evolution of genetic material, from specific genes to entire genomes. An evolutionary perspective and a comparative approach can provide tools that will enhance the investigation of problems in molecular biology and biotechnology. This course also provides a foundation for understanding evolutionary approaches that are increasingly widespread in both theoretical and empirical applications of molecular biology, including fields related to health professions and biotechnology. The topics vary; examples of potential topics include:

- Databases and sequence matching: database searching: protein sequence versus protein structure; homology; mathematical, statistical, and theoretical aspects of sequence database searches
- Comparative genomics: genome content; genome structure; genome evolution

- Transposable elements: types; history; evolutionary dynamics; as a major component of genomes; the origin and persistence of selfish gene elements
- Coevolution between genes of the nuclear, mitochondrial, or chloroplast genomes that are functionally integrated
- Phylogenetic analysis: sampling properties of sequence data; approaches for multiple sequence alignment; parsimony, distance, likelihood, and Bayesian analysis; hypothesis testing
- The relationship between phylogenetics and population genetics: coalescent theory; maximum likelihood estimation of population genetic parameters
- Molecular evolution and development: gene duplication and divergence; gene family organization; evolutionary variation in coordinated gene expression; examples of gene regulation pathways co-opted for novel functions
- Molecular evolution integrated at lower levels: biochemistry; cell biology; physiology; relationship of genotype to phenotype
- Molecular evolution integrated at organism and higher levels: population biology; biogeography; ecology; systematics and conservation

II.A.1.e.(3). BIOL 427, Stem Cell Biology. Excitement and controversy come hand in hand in current stem cell research. The overall goal here is to guide students through this chaotic but exciting new research to obtain a basis with which students can think critically about stem cells. This basis consists of: (1) historical context, (2) principle and methodology, (3) clinical impact on society and the individual, (4) recent relevant scientific facts and progress, and (5) controversy and perspective. Class meetings will include frequent student-led discussions of current research reports. As a capstone project each student generates an original and comprehensive proposal for grant or business on the topic of her/his choice in stem cell biology. Upon the completion of this course, students should be able to:

- Critically evaluate, orally and in writing, the primary literature in stem cell research.
- Create, present (orally and in writing), and defend a mock grant proposal exploring a research or clinical application of stem cell biology.
- Explain the techniques used in studying stem cell biology and their application to regenerative medicine and tissue engineering.
- Utilize knowledge of germ cell specification, nuclear reprogramming, and cell plasticity to issues in regenerative medicine and tissue engineering.
- Distinguish applications of stem cell biology to regenerative medicine or tissue engineering that are feasible and productive from those that are not.
- Incorporate the knowledge of ethical, political and patent issues to applications of stem cell biology.

II.A.1.e.(4). BIOL 429, Cell Culture Techniques and Stem Cell Biology Laboratory. Stem cell research holds a lot of promise for human health. The purpose of this course is to introduce the concepts underlying tissue culture techniques and stem cell research to advanced-level biology students. Stem cell research is rooted heavily into tissue culture techniques. Thus, the primary objective of this course is to teach all the routine and some advanced tissue culture techniques. This course aspires to provide students the experience that will increase their chances of securing a job in areas of cell biology, stem cell research, and biotechnology.

By the end of the course, students should be to:

- Maintain, grow, harvest, and cryopreserve various cell lines.
- Use of three different cell-lines and understand their different requirements.

- Generate embryoid bodies, which represent all 3 germ-cell types.
- Differentiate germ-cell cultures into various cellular lineages.
- Cryo-preserve cell lines for future classes.

The students should have an intermediate/advanced level skill in the following cell biology techniques:

- Pulse-chase experiments,
- Labeling of surface-proteins,
- Labeling endocytosis of compounds from the extracellular space,
- Immuno-cytochemistry.

II. A.2. New Minor in Cell and Molecular Biology.

This minor is currently in the approval process. At the time of this writing, the College of NSM Curriculum Committee is reviewing the proposal.

II.A.2.a. Purpose of the Minor.

The new minor represents a grouping of lower-division core biology units and upper-division biology electives that will provide students the opportunity to integrate biological sciences into their current degree program. The minor program will ensure that students acquire a depth of knowledge in cell and molecular biology, serving to complement their major discipline. The Cell and Molecular Biology minor will better prepare students for career opportunities by enhancing and diversifying their academic experiences.

II.A.2.b. How the Minor meets CSUF's Mission, Goals and Strategies.

The proposed program will meet the following CSUF mission, goals and strategies:

M&G II. To provide high-quality programs that meet the evolving needs of our students, community, and region, we will…support undergraduate and graduate programs in professional and pre-professional studies and in the arts and sciences.

This minor is intended for students interested in combining their major with a solid understanding of cell and molecular biology. This preparation could serve those students who are not already biology majors but are interested in various health professions graduate programs or in entering the biomedical, biodevice, pharmaceutical and other health related industries.

M&G III. To enhance scholarly and creative activities, we will…encourage departments to reconsider the nature and kinds of scholarship within the discipline and to create a culture conducive to scholarly and creative activity.

The BIOL 172, 273, 302 and 362 courses include two units (or one unit in the case of 362) of laboratory instruction where the students learn to work in teams to perform research. They learn to develop original approaches to solving problems or testing hypotheses of their own device based on data they collect from experiments they have created using equipment and techniques they have mastered in the course. They also learn to think critically, to analyze data, and to draw conclusions based on their data.

Mastering the material in the minor would also make the student eligible to participate in student-faculty collaborative research in the Biology Department.

M&G IV. To make collaboration integral to our activities…encourage, recognize, and reward interdisciplinary and cross-unit collaboration.

By its very nature, a minor taken by a student majoring in another subject constitutes collaboration between the disciplines from the student's perspective.

Again, mastering the material in the minor would also make the student eligible to participate in student-faculty collaborative research in the Biology Department.

M&G VI. To increase external support for university programs and priorities, we will…convey a clear message to the public that we are essential to the cultural, intellectual, and economic development of the region.

The availability of the minor will help communities outside of the University to see that we offer opportunities to students beyond the biology major.

M&G VIII. To strengthen institutional effectiveness, collegial governance and our sense of community, we will…assess university activities and programs to ensure that they fulfill our mission and to identify areas of needed improvement, change, or elimination, [and]…integrate advances in information and communication technologies into work environments.

We are developing plans for assessing our programs. Because the minor is composed of courses that are integral to two of our Concentrations offered to biology majors, they will be aggressively assessed and rigorously modified in accordance with our on-going program assessment plans.

II.A.2.c. Need for the Minor

Science has become increasingly interdisciplinary with biophysics, biochemistry, bioengineering, psychology and kinesiology as examples of disciplines that rely heavily on knowledge of biological science in the area of cell and molecular biology. Students majoring in these disciplines will be more competent and more competitive for graduate programs or employment with evidence of a minor that requires extensive education in cell and molecular biology. The minor will provide students planning for careers in secondary education science teaching with an expanded knowledge base that may qualify them for additional teaching assignments.

II.A.2.d. Student Learning Goals and Proposed Assessments for the Minor

II.A.2.d.1. Cell Biology.

- Discuss the structure and function of prokaryotic and eukaryotic cells
  - Relate cellular and organelle structures including membranes to the functions of those structures
  - Compare homologous structures across a variety of organisms
  - Describe how signal transduction occurs and explain how cell signals can affect gene expression
  - Describe and explain cellular reproduction, fertilization and early development
- Discuss energy flow within cells and between cells
  - Compare metabolic pathways across a variety of organisms
  - Relate metabolic processes to homeostasis of the cell
  - Compare the processes of glycolysis, respiration, fermentation and photosynthesis
  - Assess the role of photosynthesis in life on earth

II.A.2.d.2. Molecular Biology.

- Discuss the structure, function and biochemistry of nucleic acids

- Arrange the components of nucleotides to construct a single polynucleotide chain
- Construct a double stranded polynucleotide utilizing complementarity
- Describe the antiparallel nature of the double-stranded DNA
- Compare the structures of DNA and RNA
- Model the replication of DNA
- Describe, model, analyze and depict the structure of chromosomes
- Model the chromosomal events in mitosis

- Discuss the flow of information within cells and between cells
  - Describe, model and analyze the mechanisms of transcription and translation
  - Compare these events in prokaryotes and eukaryotes
  - Understand how the function of a protein is related to its structure
  - Describe the types of mutations that can occur
  - Discuss the potential consequences of mutations within coding sequences and within regulatory regions
  - Compare regulatory mechanisms that function at the levels of transcription, mRNA stability, translation, and post-translational modifications

II.A.2.d.3. Research Skills.

Utilize the tools of cell biology, molecular biology, biotechnology, genetics, and genomics to:

- Make quality observations and utilize inductive logic to formulate hypotheses
- Create appropriate study designs that include awareness of issues of controls and treatments, sample size, replication, independence of observations, etc.
- Use library and database resources to locate and collect current and older primary literature articles on a research topic
- Work successfully in groups to collect, analyze and present scientific data
- Use word-processing software to produce reports and papers in essay format as well as in the format of scientific articles
- Use a spreadsheet to perform basic calculations, statistical analyses, and create graphic representations of data
- Calculate and interpret appropriate descriptive statistics
- Create and interpret graphical displays of data

II.A.2.d.4. Assessment.

Student learning within the courses will be evaluated through examinations, project presentations, quizzes, homework, laboratory reports, writing activities, and in-class activities as currently conducted within these classes, which are part of the biology major. Other assessments will be collected through surveys such as SALGains and through student opinion questionnaires.

II.A.2.e. Courses required in the Minor in Cell and Molecular Biology

A minimum of 26 units is required for the minor. Ten lower-division units are required (BIOL 172 & 273). Students must take Intermediate Cell Biology (BIOL 303) and Intermediate Molecular Biology (BIOL 309) and complete either General Microbiology BIOL 302) or Mammalian Physiology (BIOL 362). At least 6 units of 400 level cell and molecular courses must be selected from the list below. Students enrolling in this Minor should complete Chem 120A, which will also satisfy the General Education requirements of Category III. A. 2 - Physical Science.

A. Lower Division Core (10 Units)
Biology 172 Cellular Basis of Life (5, 2 of which are laboratory)
Biology 273 Genetics and Molecular Biology (5, 2 of which are laboratory)
B. Gateway (6 Units)
Biology 303 Intermediate Cell Biology (3)
Biology 309 Intermediate Molecular Biology (3)
C. Upper-Division Cell and Molecular Courses (10 units)
Biology 302 General Microbiology (4) OR
Biology 362 Mammalian Physiology (4)
Six (6) units from the following
Biology 402 Computer Lab in Molecular Systematics (3)
Biology 405 Developmental Biology (3)
Biology 411 Medical Genetics and Systems Biology (3)
Biology 412 Principles of Gene Manipulation (3)
Biology 413 Advances in Molecular Genetics (3)
Biology 414 Microbial Genetics (3)
Biology 417 Advances in Cell Biology (3)
Biology 418L Advances in Cell Biology Laboratory (2)
Biology 424 Immunology (4)
Biology 426 Virology (3)
Biology 428 Biology of Cancer (3)
Biology 445 Plant Cell Physiology (3)
Biology 448 Plant Molecular Biology (3)
Biology 470 Cellular Neurobiology (3)
Chemistry 421 Biological Chemistry (3)

II. A.3. New Minor in Environmental Biology.

This minor is currently in the approval process. At the time of this writing, the College of NSM Curriculum Committee is reviewing the proposal.

II.A.3.a. Purpose of the Minor.

The new minor represents a grouping of lower division core biology units and upper division biology electives that will provide students the opportunity to integrate biological sciences into their current degree program. The minor program will ensure that students acquire a depth of knowledge in environmental biology, including hands-on application of knowledge, which will serve to complement their major discipline. The Environmental Biology minor will better prepare students for career opportunities by enhancing and diversifying their academic experiences.

II.A.3.b. How the Minor meets CSUF's Mission, Goals and Strategies.

The proposed program will meet the following CSUF mission, goals and strategies:

M&G II. To provide high-quality programs that meet the evolving needs of our students, community, and region, we will…Support undergraduate and graduate programs in professional and pre-professional studies and in the arts and sciences.

This minor is intended for students interested in combining their major with a solid understanding of environmental biology. This preparation could serve those students who are

not already biology majors but are interested in various environment-oriented graduate programs or in entering the workforce in environmental consulting and related industries.

M&G III. To enhance scholarly and creative activities, we will…Encourage departments to reconsider the nature and kinds of scholarship within the discipline and to create a culture conducive to scholarly and creative activity.

The BIOL 171 and 274 courses include two units of laboratory instruction where the students learn to work in teams to perform research. They learn to develop original approaches to solving problems or testing hypotheses of their own device based on data they collect from experiments they have created using equipment and techniques they have mastered in the course. They also learn to think critically, to analyze data, and to draw conclusions based on their data.

Mastering the material in the minor would also make the student eligible to participate in student-faculty collaborative research in the Biology Department.

M&G IV. To make collaboration integral to our activities…Encourage, recognize, and reward interdisciplinary and cross-unit collaboration.

By its very nature, a minor taken by a student majoring in another subject constitutes collaboration between the disciplines from the student's perspective.

Again, mastering the material in the minor would also make the student eligible to participate in student-faculty collaborative research in the Biology Department.

M&G VI. To increase external support for university programs and priorities, we will…Convey a clear message to the public that we are essential to the cultural, intellectual, and economic development of the region.

The availability of the minor will help communities outside of the University to see that we offer opportunities to students beyond the biology major.

M&G VIII. To strengthen institutional effectiveness, collegial governance and our sense of community, we will…Assess university activities and programs to ensure that they fulfill our mission and to identify areas of needed improvement, change, or elimination, [and] …Integrate advances in information and communication technologies into work environments.

We are developing plans for assessing our programs. Because the minor is composed of courses that are integral to two of our Concentrations offered to biology majors, they will be aggressively assessed and rigorously modified in accordance with our on-going program assessment plans.

II.A.3.c. Need for the Minor

Understanding and controlling our environment has become an important career path in the 21st century. Environmental studies programs have developed that encompass an increasingly diverse, interdisciplinary field with students majoring in fields such as biological or physical sciences, economics, engineering and political science. Understanding the biological science relevant to environmental studies is needed for those students majoring in other disciplines to be more competent and more competitive for entry into graduate programs or into the work force. The minor will provide students planning for careers in secondary education science teaching with an expanded knowledge base that may qualify them for additional teaching assignments.

II.A.3.d. Student Learning Goals and Proposed Assessments for the Minor

II.A.3.d.1. Biodiversity.

- Demonstrate an understanding of the principles and mechanisms of evolution including the role of natural selection
- Use the Comparative Method to describe how related organisms have modified ancestral characters to adapt to different situations and solve different problems, and how organisms from different taxa that are subjected to similar environmental conditions have evolved similar mechanisms or novel adaptations to deal with those problems
- Discuss how physiological and morphological limitations determine the distribution and abundance of organisms in nature

II.A.3.d.2. Ecology.

- Describe major terrestrial, aquatic and marine ecosystems and the climatic, physical and biological factors that determine global and local patterns of diversity and distribution
- Describe major pathways of energy flow in ecosystems, including primary and secondary production, consumption and decomposition
- Construct simple food chains and estimate rates of energy transfer between trophic levels
- Describe population structure (e.g., dispersion & density) and explain how biotic and abiotic factors can influence population structure
- Describe and give examples from natural populations of the different types of the major types of species interactions (competition, mutualism, consumer-resource interactions)
- Explain major approaches used to study process and pattern in species interactions in natural communities
- Describe hypotheses to explain the relationship between community diversity and stability and their relevance in conservation
- Contrast marine and terrestrial food webs
- Define disturbance and explain different responses of communities to small and large-scale disturbance events
- Describe the process of succession and the main hypotheses used to explain patterns of temporal change in communities
- Describe spatial patterns of species diversity, e.g. with latitude, on islands, on Earth and provide possible hypotheses about how abiotic vs. biotic factors influence these patterns
- Understand issues of environmental changes at different scales and how they affect patterns of distribution and abundance of flora and fauna

II.A.3.d.3. Conservation.

- Identify global biodiversity hotspots and describe the major threats to biological diversity and approaches to conservation
- Describe major terrestrial, aquatic and marine ecosystems of southern California and appreciate the great diversity of biological resources regionally and in the state
- Describe the major conservation threats and natural resources management options for one of ecological systems (desert, coastal, marine, Mediterranean scrub) in southern California
- Define ecosystem management and contrast it with single-species approaches to conservation
- Identify and explain different types of values assigned to nature and living things and how they affect conservation and management

- Explain the applications of genetics in conservation
- Define invasive species and describe a specific example and its ecological effects
- Describe the rewards, consequences, and management policies for the exploitation of natural resources for human use (e.g., logging, fisheries)
- Define and explain the basic tenets of landscape ecology and its importance in conservation

II.A.3.d.4. Research Skills.

- Make quality observations and utilize inductive logic to formulate hypotheses
- Create appropriate study designs that include awareness of issues of controls and treatments, sample size, replication, independence of observations, etc.
- Use library and database resources to locate and collect current and older primary literature articles on a research topic
- Work successfully in groups to collect, analyze and present scientific data
- Use word-processing software to produce reports and papers in essay format as well as in the format of scientific articles
- Use a spreadsheet to perform basic calculations, statistical analyses, and create graphic representations of data
- Calculate and interpret appropriate descriptive statistics
- Create and interpret graphical displays of data

II.A.3.d.5. Assessment.

Student learning within the courses will be evaluated through examinations, project presentations, quizzes, homework, laboratory reports, writing activities, and in-class activities as currently conducted within these classes, which are part of the biology major. Other assessments will be collected through surveys such as SALGains and through student opinion questionnaires.

II.A.3.e. Courses required in the Minor in Environmental Biology

A minimum of 22 units is required for the minor of which 19 units must be from Biological Science. Ten lower-division units are required (BIOL 171 & 274) and the remaining units must be upper-division and include Population and Community Ecology (BIOL 314). At least one 400-level ecology course is required (see below) and to complete the minor students must take at least one upper-division biology course with a field/laboratory component from the courses listed below.

A. Lower Division Core (10 Units)
   BIOL 171 Evolution and Biodiversity (5) &
   BIOL 274 Physiology and Ecology (5)

B. Gateway (3 Units)
   BIOL 314 (3) Population & Community Ecology

C. Upper Division Ecology Courses (at least 3 units)
   BIOL 419 & 419 L Marine Ecology & Laboratory (3/1)*
   BIOL 422 Coastal Ecology (4/2)
   BIOL 443 Plant Ecology (4/2)
   BIOL 449 Desert Ecology (4/2)
   BIOL 444 Plant Physiological Ecology (4/2)
   BIOL 466 Behavioral Ecology (3)
   * (total units/lab units)

D. Upper Division Electives (at least 3 units)

BIOL 317 Field Marine Biology (4/2)*
BIOL 325 Intermediate Evolution (3)
BIOL 340 Field Botany (3/2)
BIOL 401 Biogeography (3)
BIOL 441 Plant Taxonomy (4/2)
BIOL 446 Marine Phycology (4/2)
BIOL 447 Ethnobotany (3/1)
BIOL 450 Conservation Biology (3)
BIOL 461 Invertebrate Zoology (4/2)
BIOL 467 Entomology (4/2)
BIOL 475 Ichthyology (4/2)
BIOL 476 Herpetology (4/2)
BIOL 478 Mammalogy (4/2)
BIOL 479 Ornithology (4/2)

* (total units/lab units)

E. Courses Outside of Biology That Count Towards the Minor (no more than 3 units)

CHEM 313A Environmental Pollution and Its Solutions: Air Pollution (1)
CHEM 313B Environmental Pollution and Its Solutions: Water Pollution (1)
CHEM 313C Environmental Pollution and Its Solutions: Land Pollution (1)
CHEM 435 Chemistry of Hazardous Materials (3)
CHEM 436 Atmospheric Chemistry (3)
CHEM 448 Environmental Biochemistry (3)
ECON 362 Environmental Economics (3)
GEOG 323 Weather and Climate (3)
GEOG 450 Human Response to Environmental Hazards (3)
GEOG 481 Geographic Information Systems (3)
GEOL 333 Oceanography (3/1)*
GEOL 335 Hydrology Surface Processes (3)
GEOL 380 Geologic Field Techniques (3)
HESC 415 Environmental Health (3)
PHIL 313 Environmental Ethics (3)

* (total units/lab units)

II.A.4. Masters of Science in Biology Degree Program

The Graduate Program, which can best be defined by the Graduate Handbook found in Appendix XII, has not change significantly over the review period. This is not because we have not examined it, but because we think it is performing appropriately. The analysis follows.

II.A.4.a. Analysis of the Graduate Program with respect to UPS documents.

II.A.4.a.1. Review/adoption of department structures for graduate committees and departmental graduate advisors (UPS 270.102). We found our program to be in compliance. Our graduate program committee (the Graduate Advancement Committee) has five qualified members including the Graduate Adviser. Our supervisory committees are called the Thesis

Committee and it assures compliance with our practices and rules, which are in compliance with the UPS and are set out in the Graduate Handbook (see Appendix XII).

II.A.4.a.2. Review/adoption of standards for faculty qualifications to teach 500-level courses (UPS 270.103). Our program meets the requirements of UPS 270.103 regarding staffing of 500-level graduate courses—all 500-level courses are taught by tenured or tenure-track faculty with PhD or equivalent degrees.

II.A.4.a.3. Review requirements for the "culminating experience" (UPS 330.163). The culminating experience for our graduate students is their thesis defense and public presentation. This experience is further defined in the Graduate Handbook. Essentially, this is the opportunity for the graduate student to present her/his data and place them in the context of the existing literature demonstrating in the process mastery of the larger body of knowledge associated with the thesis topic. The public presentation demonstrates the graduate student's ability to communicate orally and coherently answer questions posed by those inside and outside of her/his area of expertise.

II.A.4.a.4. Consider the percentage of graduate study plan units taken at the 500-level (UPS 410.106). Currently, we require 50%, but this is below the CSU norm of 70%. To increase our percentage of 500-level course in the study plan, we are developing 500-level versions of our 400-level courses that have been taken by most of our graduate students. At present, enhanced expectations for graduate students are listed in the syllabi for all 400-level courses taken as part of a graduate study plan.

II.A.4.b. MS in Biology Student Learning Goals.

All students who successfully complete the MS in Biology are expected to be able to:

- Conduct original research.
- Write a scientific paper suitable for publication in a peer-reviewed journal.
- Prepare and give a high quality, professional presentation (poster or talk) at a scientific meeting.
- Use library and electronic sources to obtain virtually all of the primary and secondary sources published on a specific topic in biology.
- Place the thesis research in the context of the current state of knowledge of the field (understand the significance and contribution made by the thesis research).
- Master a body of knowledge appropriate to the specific subdiscipline and thesis topic.
- Master laboratory and/or research techniques appropriate to the specific subdiscipline (understand the principles of the techniques and be able to carry them out unsupervised, apply them to new problems and teach them to a peer).
- Analyze data appropriately (appropriate visual/graphical analysis, apply the appropriate statistical analyses, knowing the assumptions of the statistical tests and be able to interpret the results in a biologically meaningful way).
- Be prepared for careers in teaching, the health professions, government agencies, environmental consulting firms, and private industries, to enter PhD programs or professional programs in the health sciences.
- Critically review primary research articles.

II.A.5. New Biology Masters in Applied Biotechnology Studies (a professional science masters degree).

The Masters in Applied Biotechnology Studies degree, being developed as a professional science masters degree with the support of funding from the CSUPERB and Sloan Foundation, will enroll it first cohort of students in Fall, 2009.

II.A.5.a. Summary of the Program.

The Program for Applied Biotechnology Studies will offer the professional science masters (PSM) degree, called the Masters in Applied Biotechnology Studies, in association with the colleges that house science, mathematics, engineering, computer science, and business on each of the four member campuses (Cal State Fullerton, Cal State LA, CSU Dominguez Hills, and Cal Poly Pomona) using the faculty of the appropriate departments. PABS will be governed by an intercampus interdisciplinary PABS Program Council that will consist of one dean per campus selected from participating colleges, two chairs of participating departments per campus, one selected active faculty member taken from a PABS-associated department on each campus, the PABS coordinator, the Cal State Fullerton Center for Applied Biotechnology Studies (CABS) director and associate director for education. Cal State Fullerton College of Natural Science and Mathematics will have the primary responsibility for PABS maintenance.

The PSM in Applied Biotechnology curriculum will focus on preparing graduates for the workforce in biocomputing-, biodevice-, and biopharmaceutical-oriented industries. Students with bachelor's degrees in molecular biology, biochemistry, applied mathematics, engineering, computer science or business and an interest in working in companies involved in these areas are candidates for acceptance into the program. The PABS begins with a survey of applied biotechnology that will bring all students up to a minimum level of understanding so that they can be communicative members of teams made up of each of the six areas from which students may be drawn. Students will also take an applications training course in which real projects will be solved by teams of students from various disciplines and courses in regulatory affairs, finance and business management in which the business of biotechnology will be mastered. One of these required courses will be taught at each of the member campuses where the appropriate expertise is housed. To gain depth, each student will declare a primary area of expertise from which she or he will take additional graduate level courses, and will engage in a summer internship with a biotechnology company.

The initial PABS concept, guidelines, and basic curriculum were developed at Cal State Fullerton, by the CABS faculty under the leadership of Professor Robert A. Koch, Chair of the Department of Biological Science and Director of Cal State Fullerton CABS, CABS Associate Director for Research, Dr. Marcelo Tolmasky (Associate Professor, Biology), CABS Associate Director for Education, Dr. Katherine Kantardjieff (Professor, Chemistry & Biochemistry and Director of the Center for Molecular Structure), and CABS Industry Liaison, Dr. Chandra Srinivasan (Assistant Professor, Chemistry & Biochemistry) and other members of the CABS Planning Team, Dr. Tae Wan Ryu (Assistant Professor, Computer Science), Dr. Jeff Kuo (Associate Professor, Civil Engineering), and Elaine McClanahan (Consulting Project Manager).

With the addition of three new LA Basin campuses, PABS curriculum was further developed under the leadership of the **PABS Intercampus Coordination Team** with the participation of faculty from all campuses; the **PABS Deans Group** met to develop the operating principles and secure agreements that would allow cooperation among the four campuses.

The **PABS Intercampus Coordination Team** members are: Professor Robert A. Koch (Chair, Fullerton), Professor Jill Adler Moore (Pomona), Professor Sandra Sharp (Los Angeles), Professor Katherine Kandtardjieff (Fullerton), Assistant Professor Howard Xu (Los Angeles), and Professor Getachew Kidane (Dominguez Hills).

The **PABS Deans Group** members are: Dean Steven N. Murray (CNSM, Fullerton), Associate Dean David Fromson (CNSM, Fullerton), Dean Jose Galvan (Grad Studies & Res, Los Angeles), Associate Dean Alan Muchlinski (Grad Studies & Res, Los Angeles), Dean Donald Straney (CScience, Pomona), and Dean Charles Hohm (CN&BS, Dominguez Hills).

II.A.5.b. Student Learning Goals

II.A.5.b.1. Communications Skills. A PABS student should be able to:

- Work effectively as a member of an interdisciplinary team.
- Converse with colleagues in all disciplines related to the mission of PABS.
- Write and present project proposals and technical reports that communicate effectively with all levels of an organization.
- Communicate effectively with individuals at governmental and public entities.

II.A.5.b.2. Content Knowledge. A PABS student should be able to:

- Demonstrate knowledge in a primary area of expertise.
- Identify and critically evaluate the literature in the primary area.
- Understand the basic processes of product life cycles.

II.A.5.b.3. Applications. A PABS student should be able to:

- Demonstrate mastery of basic application skills in PABS disciplines.
- Develop experimental or practical designs for solving problems in product or process development.
- Analyze the driving forces for product development.
- Use knowledge effectively in new situations and diverse contexts.

IIA.5.c. Criteria for new PABS Courses

All PABS courses should:

- Have a primary focus on developing expertise appropriate for the workforce and/or applied research.
- Include practical applications of the discipline, which are oriented toward effectiveness in the workplace.
- Reinforce communication and critical thinking skills.
- Require only mastery of *Survey of Biotechnology* courses as prerequisite for required courses in the PABS curriculum.
- Fill a content or skill area critical to the PABS curriculum.

II.A.5.d. PABS Master's in Applied Biotechnology (39 units)

Year 1	First Semester (12 units) *Survey of Biotechnology:* *Part A.* Commercialization (3) {summer prior to fall start} *Part B.* Molecular Biology and Pharmacology/Toxicology (3) *Part C.* Mathematical Modeling and Bioinformatics (3) *Part D.* Pharmaceuticals and Biomedical Device Technology (3) (TWR evening, 3 hr per meeting) {Homed at Cal State Fullerton}	Second Semester (9 units) *Biotech Skills I* (3): Applications Training Modules (MWR afternoon to evening) {Homed at CSULA in winter quarter} *Biotech Skills II* (1): Applications Training Module on Medical Devices {Homed at Cal Poly Pomona in spring quarter} *Clinical Trials/Regulatory Affairs* (2) {Homed at Cal Poly Pomona in spring quarter} (F afternoon) Course in *Concentration* (3)* (Selection of thesis project topic and committee) {Home campus}
Summer	Internship (1)	
Year 2	Third Semester (8 units) *Biotech Skills III* (3): Applications Training Modules {Homed at CSUDH} (F/S 4.5 hr per meeting) *Applied Masters' Research Project* (3)# {Home campus} Course in *Concentration* (3)* {Home campus}	Fourth Semester (9 units) *Applied Masters' Research Project* (2)# {Home campus} *Writing & Presentation of MS Project* (1)# *Business/Management course* (3) {ideally project management taken from the list of selected courses on each campus} Courses in *Concentration* (3)* {Home campus}

A total of 6 units will count toward degree.
* A total of 9 units.

*List of Courses will be added from Each Campus for the Following Concentrations:

- Applications of Molecular Biology/Biochemistry to Biotechnology
- Applications of Analytical Chemistry to Biotechnology
- Applications of Regulatory Affairs/Clinical Trials to Biotechnology
- Applications of Engineering to Biotechnology
- Applications of Business/Law to Biotechnology
- Applications of Informatics/Biomathematics to Biotechnology

II.A.6. Consideration of a Master of Arts in Biology Degree.

The Graduate Advancement Committee (GAC) studied the concept of offering a Master of Arts in Biology degree to graduate students who are not interested in completing a Master of Science in Biology degree due to the research thesis the latter program requires. The GAC determined that graduate students likely to enroll in such a program would include those: (a) preparing to enter a health professions program, (b) already teaching and interested in an advanced degree, (c) entering a profession in environmental biology, and (d) interested in employment in biomedical industries. These groups are already being served by, respectively, (i) our Health Professions Post-baccalaureate program, (ii) our successful Master of Arts in Teaching Science program, (iii) the Master of Arts in Environmental Science program, and (iv) the new Master of Applied Biotechnology Studies offered by the Program in Applied Biotechnology Studies. Thus, the GAC decision was not to develop the MA.

II.A.7. Biology General Education Program Changes.

The CSUF General Education Biology Program serves almost 5,000 non-biology undergraduates each year. The majority of the students served (approximately 3,000) are enrolled in BIOL 101, Elements of Biology, with another 1,200 enrolled in BIOL 101L, Elements of Biology Laboratory. The remaining students are enrolled in various upper-division non-majors courses, such as BIOL 300 Environmental Biology, BIOL 305 Human Heredity and Development, BIOL 319 Marine Biology, and BIOL 360 Biology of Human Sexuality.

In the last five years, the Biology Department has invested a significant amount of time and resources into redesigning the General Education Biology Program, with the goal of developing a coherent non-majors curriculum emphasizing higher order thinking skills and science as process. Additional goals included establishing consistency among the seventeen sections of BIOL 101 in content coverage and intellectual rigor, and more integration between BIOL 101 lecture and 101L laboratory experiences (even though they are stand-alone courses). A critical element of this redesign has been integrated assessment instruments, so that we can determine whether or not we are meeting our goals. We have also developed assessment training for faculty and graduate students (teaching associates and graders) working with our non-majors. (More about these in Section III.C).

II.A.7.a. BIOL 101, Elements of Biology

II.A.7.a.1.Development of Student Learning Outcomes. To develop appropriate assessments, we first needed agreement on what students should be learning in our non-majors courses. Because non-majors have quite different motivations and needs than our majors, we ran a series of workshops (funded by intramural grants) to update 101 faculty and 101L TAs on recent findings about how students learn best and the successes of recent science education reform. We then developed student learning outcomes (below) as a group by first asking what a non-major should know about biology after taking what would probably be her or his last science class ever. This was an eye-opening experience for participants, as the SLOs they proposed were somewhat different from what they were currently teaching. These SLOs were then used to develop new curricula and assessments for both 101 and 101L.

The goals for BIOL 101 are for student learning of the following major scientific ideas:

Living things are made of smaller structures whose functions enable the organism to survive.

Students should be able to:

- Define the characteristics of life

- Differentiate between the main classes of biologically important molecules.
- Summarize cell theory
- Explain the processes associated with cell growth & division
- Compare & contrast characteristics of prokaryotic & eukaryotic cells
- Relate cell structure to cell function
- Explain how an organism maintains homeostasis
- Organize functions within levels and explain relationships between levels of biological organization (cell, tissue, organ, organ system, organism)

Living things depend on each other and the physical environment as they interact to obtain, change, and exchange matter and energy.

Students should be able to:

- Describe how energy from the sun drives most activities on the earth's surface
- Sketch the flow of energy & matter through higher levels of biological organization
- Explain the ways in which organisms may interact
- Identify factors that affect population growth and decline
- Identify factors that affect ecological organization at the community & ecosystem level
- Assess the role of humans in natural systems
- Describe & give examples of the value of biodiversity & the natural world

The great diversity of living things is the result of billions of years of evolution of organisms through the mechanisms of heredity, random change, and natural selection.

Students should be able to:

- Illustrate the Central Dogma
- Explain & apply the basic principles of inheritance
- Summarize the evidence for evolution
- Describe how different processes (e.g. mutation, gene drift, selection) can lead to
- genetic differentiation and speciation
- Define and explain natural selection
- Interpret evolutionary relationships among organisms
- Explain how evol principles & ideas influence daily lives (eg GMOs, AIDS, antibiotic resistance)

Our BIOL 101 students will also possess the following skills:

Students should be able to:

- Retrieve information from a variety of sources (eg pop press, scient papers)
- Apply the scientific method
- Critically evaluate data accurately (graphs, tables, text)
- Critically evaluate claims rather than accept authoritative statements
- Recognize the historical context of science
- Differentiate between science and non-science
- Analyze societal issues based on biologically sound principles
- Justify opinions on social issues related to biology (stem cells, GMO)

II.7.a.2. Writing Assignments. In all sections of BIOL 101, we now have shared writing assignments that meet the CSUF General Education writing requirement. The primary goal when developing these assignments was to maximize the educational value to our students,

increasing their content knowledge and critical thinking skills by making the assignments relevant and meaningful to them, and giving them the guidance and feedback necessary for their writing to improve. A secondary goal was to minimize the logistical difficulties to our faculty, by helping them to adapt to a substantial increase in grading responsibilities and by ensuring that grading was consistent between sections. Each 101 student writes two papers, the first on a topic in cell biology or genetics (covered early in the term) and the second on a topic in either ecology or physiology. The papers require students to apply their knowledge of biology to a current issue or controversy, in an authentic, "real life" context, for example as a letter to a family member who is facing medical treatment or to a senator who is making a decision about whether to support an environmental bill.

II.A.7.b Revisions to BIOL 101L, Elements of Biology Laboratory

We held a BIOL 101L Curriculum Development retreat in December 2005, with 101 faculty and 101L TAs, as the first step in developing a new 101L laboratory curriculum based on multi-week research modules that engage non-majors and emphasize science as process (funded by an intramural grant). The following year, we began offering a pre-semester workshop for 101L TAs, to develop weekly homework and quizzes that emphasize higher order thinking skills and help students learn course content. This has the added benefit of training our graduate students to teach for critical thinking skills as well as content knowledge. In Fall 2006, we field-tested the new 101L ecology research module in two sections of 101L, and in Spring 2007 all 26 sections of 101L offered the new module, which included a course-wide poster session. In Fall 2007, the new curriculum went fully on-line, including pre- and post-assessments (see Section III for CTLEA and NYSED Assessments), a Laboratory Notebook Assessment and an Assessment Training Program for the TAs (development supported by an intramural grant). Student and TA response has been extremely positive to date, and we look forward to evaluating student learning gains under the new curriculum. We held a weekend retreat in December 2007 to review and revise the new curriculum and assessments with the 101L TAs and Laboratory Manager, while it was still fresh in everyone's mind and before the start of the next semester. This resulted in a re-ordering of research modules, modifications to the lab notebook assignments, and a revised grading scheme.

II.A.8 Responses to New Nursing Program Degrees.

In response to requests to the Nursing Department, we developed two service courses; a two-semester integrated human anatomy and physiology course in collaboration with Kinesiology Department (BIOL/KNES 191A/B, Integrated Human Anatomy and Physiology) and BIOL 202, Microbiology for Nursing and Allied Health Professions.

II.A.8.a. KNES/BIOL 191A, Integrated Human Anatomy and Physiology, semester one, SLOs. This course (submitted by Department of Kinesiology) is designed to introduce the student to the concepts and interactions of human anatomy and physiology as they relate to homeostasis and human movement.

By the end of the course, students should be able to:

- Understand the structure and function of the musculoskeletal system as it relates to homeostasis and human movement;
- Understand the structure and function of the cardiorespiratory system as it relates to homeostasis and human movement;

- Understand the structure and function of the nervous system as related to control of the previous systems; and
- Application and synthesis of structure and function of these systems to health and/or physical activity issues.

II.A.8.b. BIOL/KNES 191B, Integrated Human Anatomy and Physiology, semester two, SLOs. This is the second semester (submitted by Department of Biological Science) of a two-semester integrated introduction to concepts in human anatomy and physiology, designed primarily for students preparing for nursing and other allied health professions. Emphasis is on nutrition, ion and water balance, and homeostasis, and structure-function of the digestive, renal, cardio-respiratory, endocrine, and nervous systems.

By the end of the course, students should be able to:

- Know the components (solutes, solvent, and nutrients) of the body fluids, how they may change, and how they are regulated
- Recognize causes of osmotic pressure in a body compartment, how osmotic pressure may change, and how it is regulated
- Understand how body fluid pH and volume are regulated, and how different organ systems and chemical messengers are involved in the regulatory processes
- Explain how changes in volume and composition of urine are related to the maintenance of water and electrolyte balance in response to changing body conditions
- Explain how the nutrients in food are released, moved into the blood stream, distributed throughout the body, and used or stored by different cells, how stored nutrients are mobilized as needed, and how the processes are regulated
- Understand how the above processes and systems are controlled to allow for individual variation and for changes when body conditions are altered (homeostasis)
- Understand the relationship between cellular structure and function, and the structure and function of organ systems of which the cells are a part
- Understand how different organ systems communicate and coordinate to maintain homeostasis
- Perform a defined role (e.g., Principal Investigator) as a team member to conduct an experiment and record meaningful results
- Follow a defined protocol to investigate a research question and to obtain evidence used to arrive at a valid conclusion; be able to articulate, explain, and justify reasoning for the conclusion based on evidence
- Design and perform feasible and sound physiology experiments with appropriate controls, and recognize significant cause and effect relationships among variables.
- Use appropriate techniques and equipment (microscopy, spectroscopy, computer-interfaced physiological instruments, etc.) to make accurate observations or measurements
- Use appropriate units of measure for all data, and recognize limitations to the precision and accuracy of measurements.
- Use computers to collect physiological data, generate graphs and perform simple statistical analyses
- Use anatomical and physiological models or explanations to relate experimental results to concepts being investigated

- Listen to and share ideas with others in order to present, analyze, and interpret data effectively and to draw reasoned conclusions from experimental results
- Use a scientific laboratory notebook to keep notes and record results in suitable ways
- Integrate, synthesize and apply course subject matter to understand and solve problems

II.A.8.c. BIOL 202, Microbiology for Nursing and Applied Health SLOs.

Upon completion of the course, students should be able to:

- Describe the morphology, physiology, and classification of bacteria, protozoa, and fungi
- Explain the structure and modes of multiplication of viruses
- Describe the epidemiological and biological bases for selected human diseases caused by bacteria, protozoa, fungi, and viruses
- Compare the physical and chemical methods used to control microorganisms and reduce disease
- Explain the molecular and cellular basis for the human immune response, hypersensitivity, immunization, and serology
- Compare current methods for diagnosis, prevention and treatment of microbial diseases.
- Demonstrate microbiological skills and manipulations such as lab safety, microscopy, aseptic technique, identification methods (staining, culturing) and quantitative techniques (pipetting, population counts)
- Apply these manipulative and analytical skills to a variety of clinical problems

B. Using data provided by the office of Analytic Studies/Institutional Research discuss student demand for the unit's offerings; discuss topics such as over enrollment, under enrollment, (applications, admissions and enrollments) retention, (native and transfer) graduation rates for majors, time to degree. (See instructions, Appendix I)

II.B. Issues Pertaining to Student Demand

II.B.1. Undergraduate Student Demand, Retention and Time to Degree.

II.B.1.a. Capture of First-time Freshmen Applications (Appendix I, Table 1-A).

The percentage of applicants admitted was >70% for the period from 2002-03 to 2006-07. This ratio reflects the exercise of University admission standards and rules by Admission & Records; these rules are out of the control of the Department.

The percentage of admitted first-time freshmen who enroll is low at <25% and dropped between 2002-03 and 2006-07 from 24% to 18%. This statistic indicates that the Department has an opportunity to increase its capture rate. One process that could help us to increase the percentage of admitted freshmen who enroll, is to increase our visibility within the local community. Students need to be more aware of the quality of our biology program and the various career options they will have when graduating with a major in Biology. This focus is reflected in our priorities for the undergraduate program (Priorities I.C.4.i. and I.C.4.ii.) and in our long-term plans for the Department (Section VII.F).

II.B.1.b Capture of Upper-division Transfer Applications (Appendix I, Table 1-B).

The percentage of applicants to admitted was 50-60% for the period from 2002-03 to 2006-07. Again, this ratio reflects the exercise of University admission standards and rules by Admission & Records, and these rules are out of the control of the Department..

The percentage of admitted transfer students who enroll is relatively high at 44-65% but has dropped steadily between 2003-04 and 2006-07 from 65% to 44%. This drop has coincided with the introduction of our new curriculum and may reflect the poorer articulation with some of the many community colleges in our area. Our effort to achieve articulation with all of our core courses has not succeeded in some of the cases, although our primary feeder campuses have full articulation. Again, this statistic indicates that the Department has an opportunity to increase its capture rate. However, any effort to take advantage of this opportunity is complicated by the fact that we must depend on responses by the community colleges—our past outreach efforts have not resulted in improved articulation in several cases. Because we have been so heavily occupied by our own curricular reform efforts, we have not pursued the campuses that are least responsive to our changed curriculum. But with this type of steady decline, it is time for us to renew our efforts. In this regard, the campuses that are not interested in articulating with all four of our core courses can be encouraged to promote the LDTP curriculum, which requires students to take only the first year of biology. This focus is reflected in our priorities for the undergraduate program (Priority I.C.4.iii.).

II.B.1.c. FTES and Headcount in the Major (Appendix I, Table 2-A and 2-B).

Despite the declining percentage of capture in both first-time freshmen and upper-division transfers, our FTES has risen over the review period. This rise reflects the increased overall student enrollment and indicates that if we increased our percentage of capture, we could have even higher numbers.

These data also show that we are not capturing many students in the credential seeking process. These numbers, supplied by Institutional Research, are lower than our estimates of students involved in taking credentialing courses, but compared to the numbers from other biology departments across the CSU we are underperforming. At present, with the loss of its director, the Science Education Program is floundering. We have lost the TTF member who was our participant in the program and the new FTL who has replaced her is just getting up to speed on the expectations and options available. As thing progress, we will know more about the destiny of the Science Education Program and can plan our response more coherently. Nevertheless, we plan to hire a TTF with expertise in biology pedagogy and interesting secondary education during AY 09-10 (Supported by priority I.C.2.ix. and long-term plan VII.B.3.iii).

II.B.1.d. Graduation Rates for those who enter the Major as Freshmen (Appendix I, Table 3-A).

Prior to graduation, we lose a significant percentage of majors who entered the biology major as freshmen. During the review period, by six years following entry into the program, only 13-20% of those who entered as first-time freshmen had graduated with a BS in Biological Science, but another 14-25% remain enrolled in the seventh fall semester, retaining the potential to graduate in seven or eight years (not unusual for our students). During the same time period, 24-28% of students who entered as biology majors had graduated with another major and 28-38% remain enrolled in the seventh fall semester in another major. These data illustrate that >50% of those who enter the biology major as first-time freshmen graduate (or will graduate) with a

different major, whereas <45% graduate or have the potential to graduate with a BS in Biological Science.

Our analysis of the first-time freshmen in our introductory core class (BIOL 171) indicates that 30-50% are lost after taking that class once or twice, so the exodus occurs early in the program. We have analyzed the effect of holding special cohort-based workshops (Fall 06) and special tutoring sessions (Fall 07) and neither had a significant effect on the BIOL 171 success rate. Our present conclusion is that 30-40% of the students who enter the biology major are not suited for the discipline. We remain interested in recapturing a portion of those lost (about 10%, we think) —the ones who can succeed in Biology but who might continue if they had additional background preparation, personal encouragement or a better idea of career options (Priorities I.C.4.v, I.C.4.vi, I.C.4.vii).

There is another cause of exodus of student from the major associated with the way our lower-division core is constructed. An informal analysis indicates that an increasing number of students interested in health professions especially pharmacy, but also medicine and dentistry, are changing their major to Health Science and Biochemistry in order to avoid our BIOL 171 (Evolution and Biodiversity) and 274 (Principles of Physiology and Ecology) courses—courses they perceive to be irrelevant to their career interests because they are not required by the professional schools. We have developed the Minor in Cell & Molecular Biology as an enticement to take two additional upper-division biology electives, but we will not recapture the full FTES value of a major unless we can convince them to remain biology majors.

II.B.1.e. Graduation Rates for those who enter the Major as Transfers (Appendix I, Table 3-B).

Transfer students enter our program with extremely variable levels of completion of the biology core and supporting courses, so there is no way to treat them uniformly. Each transfer student receives individual analysis of articulation of courses and advising as to how to proceed in our major. Anecdotally, it appears that students whose coursework resembles the LDTP the most closely are most likely to remain in the major. Those who have taken a myriad of courses that were intended for health professions, but that are taught at the upper-division level in our department are most likely to switch to a non-biology major since many think they have already met the perquisites for their intended health profession program.

The data show that the percentage of transfer students who complete the BS in Biological Science within five years of entering our biology program ranges from 31 to 44% showing a steady increase until the last cohort, the 2001 entrants, showed a large decrease from the high of 44% to the low of 31%. Anecdotally, these are the students who have been exposed to aggressive recruiting by Health Sciences. The ratio of retained to lost transfer students in this group was 3.43 for those who entered in 2000 and 1.15 for those who entered in 2001. We are exploring reasons for this shift, but, again, based on anecdotal information from the Health Professions Office, students are trying to avoid our BIOL 171 and 274 courses.

II.B.1.f. Degrees Awarded (Appendix I, Table 4).

The number of degrees we have awarded has vacillated over the review period. Looking at the absolute numbers of graduates, there was a 7% drop in 2004, followed by a 35% increase in 2005. Despite the drop in 7% drop in first-time freshman and 13% drop in transfer students graduating in 2007, there was a 4.6% increase in degree awarded—probably indicating that some of the 7-year-or-greater students graduated that year. The statistic in the last column of Table 4 indicates that if number of degrees awarded is compared to upper-division FTES, the numbers show a peak in 2005 at 54% declining to 40% in 2007. Clearly, the Department has an

opportunity to increase its retention of students and to increase its degrees awarded. In response to this, we will develop a survey to give to those who switch majors so that we can determine why they change and develop a strategy based on those data.

II.B.1.g. Time to Graduation.

It is clear that a considerable percentage of our students graduate six or more years after they enter the major. The cause of this delay cannot be accurately attributed to specific causes, but we had a bottleneck in moving our Cell & Development and Molecular Biology & Biotechnology concentration students through BIOL 302, General Microbiology during AY 2004-05 and all students through PHYS 211L and 212L, Elementary Physics Laboratory (first and second semester) in 2004-2006. We increased from three to four sections of BIOL 302 in fall 2005 and to five sections in spring 2007. In order to increase our offering to six sections (the number we think we need to meet demand), we are renovating a lab that will be ready by Spring 2009. Finally, after considerable discussion, during Fall 2007 and Spring 2008, we (and Chemistry/Biochemistry) persuaded Physics to increase lab sections offered (F07-PHYS 211L from 6 to 9, PHYS 212L from 3 to 4; Sp08- PHYS 211L from 4 to 5, PHYS 212L from 5 to 7). These changes should have significant effects on removing the bottlenecks in our gateway and supporting course curriculum.

II.B.2. Graduate Student Demand, Retention, and Time to Degree.

II.B.2.a. Capture of Graduate Applications and Headcount in Graduate Program (Appendix II, Table 5 & 6).

Over the review period, the number of applications increased from 49 in 2002-03 to 70 in 2006-07 (with 74 applications in 2005-06). We admitted a decreasing percentage of those applications (53% to 36%) in the same time span, nevetheless the number of admitted graduate students remained fairly constant. The limiting factor has been the number of labs available to accept graduate students. During this period, the number of TTF remained relatively constant (22-23) as we were able to just offset retirements and resignations with new hires. Without an increase in the number of functioning lab with TTF as PI, there was limited space and faculty time to allow additional graduate students into the program. (Note that the total graduate student headcount remained steady at 54-59. Our capture rate of admitted to enrolled graduate students fluctuated between 71 and 85%. This range is relatively high and is acceptable to us. As we approach our target of have 65-70% of our FTEF positions filled with TTF (as proposed in Section VII.B), then our number of graduate students enrolled will increase accordingly. In fall 2008, we add four TTF and that will have a major effect on the graduate student capture rate.

II.B.2.b. Time to Degree for Graduate Students (Appendix II, Table 7 & 8).

Over the review period, 20-30% of our graduate students have completed their degree within three years. Another 10-20% of them require 4 years to complete the program and by 5 years following entry, 50-75% have completed their degrees. The length of time a graduate student takes to complete the MS in Biology is dependent on the time that the student has to put into the research activities—the success of the research project is less of an impediment, but in a few cases, problems with the project may slow the progress of a student. Many students just work too much outside and do not make rapid progress on their projects due to lack of time spent in the lab—this is a very difficult issue for the faculty mentor to address and many are reluctant to demand completion in a specific time period.

Many students (around 20%) do not finish their degrees even after six years although they remain enrolled during a seventh year. These students are largely enrolled in our GS-700 and

have moved into a MD, DDS or PhD program without completing the MS. Most of them remain enrolled in GS-700 for a year or two with the plan to write their theses during the early year of their new program; the percentage who actually complete their thesis after leaving is small and most of these students never earn the degree despite having completed most or all of their research projects.

Our graduate program has been in a near steady state during the review period with around 20 students enrolled each year and 10-20 students graduated each year.

C. Discuss the unit's enrollment trends since the last program review, based on enrollment targets (FTES), faculty allocation, and student faculty ratios. For graduate programs, comment on whether there is sufficient enrollment to constitute a community of scholars to conduct the program. (See instructions, Appendix II)

II.C. Issues Pertaining to Enrollment Trends (Appendix IV, Table 9 and Appendix II, Table 5)

II.C.1. FTES Target and FTEF allocations.

Enrollment targets (FTES) achieved and the actual FTES generated have increased from 675 in 2002-03 to 891 in 2006-07 and 745.4 and 891, respectively. The SFR used in budgeting rose from 19.6 in 2002-03 to 19.8 in 2004-05 and has been stable ever since. Prior to 2002, the SFR was stable at 19.6 for five or more years; the modification to 19.8 reflects College internal agreements necessary to cover the FTEF needs of the College. The availability of faculty positions has been sufficient to allow the Department to meet the needs of the class schedule.

II.C.2. Graduate Program Enrollment

The graduate program is sufficiently enrolled that we have a vibrant research community, especially with the addition of our undergraduate researchers. We would like to increase population of graduate students to 75 within three years and 100 within five years, and feel that the addition of four new faculty members who will have active labs and the retirement/resignation of three faculty members who did not have active labs will have a major impact on our ability to achieve this number. Our plan to hire additional new faculty over the next five years to reach the 65-70% TTF/FTEF occupancy should allow us to reach this goal.

D. Describe any plans for curricular changes in the short (three-year) and long (seven-year) term, such as expansions, contractions or discontinuances. Relate these plans to the priorities described above in section I. C.

II.D. Plans for Curricular Modifications

II.D.1. Short term (within 3 years)

II.D.1.a. Undergraduate Curriculum.

In accordance with Priority I.C.5.ix, the faculty will modify the Core and Concentrations as dictated by our Assessment Plan. We will also add new upper-division electives, writing courses, and capstone courses. These are the areas where our offerings are more limited than they could or should be. The newly hired faculty will each develop a new upper-division or graduate level course in their specialty.

In accordance with Priority I.C.5.vii and viii, we will develop career-oriented courses that help the students to focus their long-term interests and to select concentrations or courses that will prepare them for their chosen careers.

In accordance with Priority I.C.5.x, some faculty will develop online courses that meet the needs of our concentrations or service obligations and do not compromise our quality standards.

In accordance with Priority I.C.5.xi, complete the development of a Business of Biology Concentration that will be offered jointly with the College of Business and Economics. This program will allow students to gain a solid background in both biology and business and prepare them to enter the workforce in biomedical or environmental industries.

II.D.1.b. Graduate Curriculum.

In accordance with Priority I.C.6.v, we will increase the number of 500-level courses that are available. In the past, we have developed new courses at the 400-level and added elevated criteria that any graduate student taking the course would have to meet. Over the next three years, we will develop a 500-level equivalent for each of these 400-level courses until we can assure that all graduate students can have 75% of the courses in their study plan made up of 500-level courses.

In accordance with Priority I.C.6.vi and in collaboration with our partners in the biotechnology, medical diagnostics, and biomedical device industries as well as our partners at Cal Poly Pomona, CSU Dominguez Hills, and Cal State LA, we will continue to develop and implement the Program for Applied Biotechnology Studies professional science masters degree (Master in Applied Biotechnology Studies) program. This will require development of additional courses at the graduate level that will also serve our MS in Biology students.

II.D.2. Long Term (within 7 years)

II.D.2.a. Undergraduate Program.

In the long term, the undergraduate program will change most in two general ways: (i) We will respond to our Assessment Plan (Priority I.C.5.ix). (ii) We will adapt to the offering of online courses that meet the needs of our students and faculty (Priority I.C.5.x). Changes in these two areas cannot be specified, but will be consistent with the overall Student Learning Goals of the BS in Biological Science.

II.D.2.b. Graduate Program.

Over the long term, we will work with partners in the Departments of Geology, and Chemistry/Biochemistry (and possibly with the Environmental Studies Program) to develop a professional science masters degree in Environmental Sciences. The basic discussions on this endeavor have taken place, but no clear leadership has emerged. The Department will support faculty to engage in dialogue that will lead to this new workforce development activity (Priority I.C.6.viii).

E. Include information on any Special Sessions self-support programs offered by the department/program.

Not applicable**.**

III. *Documentation of Student Academic Achievement and Assessment of Student Learning Outcomes*

(Find attached *Plan for Documentation of Academic Achievement* (Assessment of *Student Learning*). Please complete. This document/template will guide the

department/program's response in documenting academic achievement. [See Appendix III])

Because student learning is central to our mission and activities, it is vital that each department or program includes in its self study a report on how it uses assessment to monitor the quality of student learning in its degree program(s) and/or what plans it has to build systematic assessment into its program(s*). Assessment*, in this context, refers to whatever combination of means the department or program employs to provide evidence to answer the following questions:

A. How well are our students learning what the program is designed to teach them?
B. What direct strategies or systematic methods are utilized to measure student learning?
C. Are the assessment strategies/measures of the program changing over time?
D. What modifications should we make to the program to enhance student learning? (And after having made changes, how have these changes affected student learning and the quality of the department or program as a learning community?)
E. Many department/programs are offering courses and programs via technology (on-line, video conferencing etc.) and at off campus sites and in compressed schedules. How is student learning assessed in these formats/modalities?

III. Assessment Plan for the Department.

Rather than providing separate responses to the questions in A-E above, the following narrative will be addressed them cumulatively.

III. A. Biology Undergraduate Major Program Assessment Plan.

The Department's Program Assessment Plan has five levels of application: University-wide Assessments (III.A.1), Programmatic Assessments (III.A.2), Course Assessments (III.A.3), Assessments of Students Effectiveness (III.A.4), and Assessments of Faculty Effectiveness (III.A.5). The actions taken in at each level is delineated below and each area will be explained in additional detail.

III.A.1. University-wide Assessment.

The University offers assessment of via the (i) English Writing Proficiency (EWP) exam and (ii) Entry Level Math (ELM) exam. There are or have been discussion of establishing student effectiveness via establishing Information Competency and Computer Literacy. The latter will be an outgrowth of activities in which the Department will engage the students as we complete our Program Assessment Plan. In addition, it is clear that the current (iii) WASC initiative will have an impact of University-wide Assessment activities by creating a process for setting Program SLOs across the campus establishing a campus wide database to be used for PPR like this one.

III.A.2. Programmatic Assessment.

(i) We are developing a Biology-specific Critical Thinking Longitudinal Embedded Assessment (CTLEA) process by which we will determine the development of critical thinking/problem solving (CT/PS) skills throughout our LD Core and UD Concentrations (see III.A.2.a). (ii) This Program Performance Review is a form of program assessment. (iii) We have our students complete the Education Testing Service Major Field Test (ETS/MFT) (see III.A.2.b.). (iv) We propose to add a Student Assessment of Learning Gains (SALGains) to our

exit ETS exam expectation. (v) We will add an Alumni Survey to assess the students' determination of the value of our degree program on their career success.

III.A.2.a. Critical Thinking Longitudinal Embedded Assessment (CTLEA).

The CTLEA is an assessment tool designed to provide an objective measure of the critical thinking/problem solving (CT/PS) skills of students in the biology major. It has been administered to students in our non-majors (BIOL 101; see III.B for more details on progress in CTLEA development), lower-division majors (BIOL 171 & 172) and upper-division majors (BIOL 302 & 303). Validation of this assessment tool has been initiated through a comparison of student performance on it and on a known assessment of critical thinking, the California Critical Thinking Skills Test (CCTST). Time was dedicated to the production of new CTLEA questions during the Spring 2007 departmental retreat with the goal of implementing critical thinking-based assessments throughout the lower division core and gateway courses. The long-term goal of this project will be to collect data from CTLEA questions embedded throughout the curriculum, providing both a longitudinal assessment of individual student performance and a programmatic evaluation of critical thinking skill development within the major.

The goal for AY 07-08 is for each Teaching Collaborative to create and administer a set of questions for each core course in Spring 2008. Success, in the short term, will be determined by the development and administration of the sets of questions and, in the long term, by the relative success of our students on these CT/PS questions.

III.A.2.b. Education Testing Service Major Field Test (ETS/MFT). When the Department went to the new, active-learning, inquiry-based curriculum outlined above, it sacrificed coverage of facts to provide the time required for non-traditional group work driven by problems and case studies. To determine whether the curriculum would have a negative impact on fact mastery, we began giving the ETS/MFT as a way to assess the mastery of facts in the new curriculum compared to the old, facts-based curriculum. Here is a summary of the results from 2002-2007 (For details see Appendix XII. *ETS/MFT Data*):

- Except in the organismal and population biology, evolution, and ecology subscores, there has been significant trends toward decreased performance and significant decreases comparing pre-core versus post-core.
- Student interested in molecular biology score highest overall on the ETS exam even after correcting for differences in GPA. Cell and BEC/MB students perform at approximately the same level.
- Although student interest/concentration impacted subcategory scores there was no evidence (e.g. a significant interaction between Year and Student Interest/Concentration) that students were gaining more concentration specific knowledge after our implementation of the core.
- The overall summary of the analyses are: (1) ETS scores are decreasing and (2) concentration/interest predicts subcategory scores and (3) there was no significant interaction between year & concentration/interests of students indicating that scores are decreasing across the board regardless of what concentration/interest the students have.

Although these points indicate that the new curriculum is not offering the overall level of fact mastery the old curriculum did, and, in fact, indicates that the overall performance of our students is declining, there are two facts that should be borne in mind: (a) the offsetting of these facts with critical thinking skills may be an effective trade off, but has yet to be established by our CTLEA analysis (a CT/PS section will be developed by each Concentration and added to the ETS/MFT as an assessment of those skills), and (b) the overall decline is 3-4 percentiles, with

2007 showing an increasing trend over 2006—if this is real, then we may see the results stabilize at 1-2 percentile below the pre-test data.

III.A.3. Course Assessments.

III.A.3.a. Core Courses. (i) Student Assessment of Learning Gains (SALGains) is a survey that addresses students' perception of the educational experience in core courses is administered in our lower-division core courses. The short- and long-term goal is to collect yearly data for analysis at various intervals. If the core course has been successful in the eyes of the students, these surveys will have an overall positive mean score. Individual comments will also contribute to an understanding of student assessment of the courses. The survey is composed of a number of items that address student experiences in lecture and lab as well as student perceptions related to knowledge and skill acquisition. Survey items are customized to align with the student learning outcomes of each course and to reflect the individual pedagogy of each instructor. Survey data is available to individual instructors for the purposes of self-improvement. Data can also be analyzed for consideration of longitudinal trends and programmatic evaluation.

(ii) The Core Instructor Group meets regularly to assess the effectiveness of core courses in selected areas and develops responses to areas where deficiencies have been identified. Here are two examples of recent faculty surveys associated with this group's concerns:

- Post-core Faculty Survey: An online survey was created to survey faculty teaching the gateway courses to determine how well students performed in critical thinking tasks in post-core courses. All eight faculty members who teach post-core courses responded. The survey requested yes/no answers to 10 criteria defined by the department as definitions of critical thinking and problem solving in biology. A majority of faculty felt that: 1) students are able to represent biological data in an accurate, visual format, and 2) students are able to devise tests for a hypothesis. Students completing the core were lacking in the eight other criteria for critical thinking and problem solving in biology. A focus group involving these faculty members, based on the responses in this survey, will be implemented to gain additional feedback on whether expectations in gateway courses need to be revised or how the core courses could be improved to better prepare students for upper division courses. This information will be provided to faculty teaching the core courses and a discussion between these faculty and those teaching the post-core courses is planned.
- Faculty Survey - Assessing the Teaching and Learning Environment: This survey was designed to examine faculty perceptions of the degree that practices reflecting a learning community have been institutionalized. The responses of 35 participating faculty members (tenure-track and adjuncts) supported the idea that teaching and instructional improvement are important components of the hiring and personnel process and that faculty discuss teaching with and learn from their colleagues and use other strategies to keep current in the field of teaching and learning. Their courses provide students with a variety of learning experiences that reflect inquiry-based and active learning and assessments of their learning.

(iii) A Core Course-based assessment of inquiry-based labs and skills building needs to be developed over the next three-year period.

III.A.3.b. Concentration Courses. (i) Concentration Collaborative Groups meet to assess concentration specific issues. Each concentration works on different issues as deemed appropriate. The Cell and Developmental Biology Concentration Group is engaged in a collaboration with the Brigham Young University, Department of Biology. This activity focuses

on enhancing active learning in our cell biology core and gateway courses involved participation by Dr. Merri Lynn Casem, Dr. Ben Murray, and Dr. Nilay Patel. Dr. Casem has continued her collection of data on active learning processes in BIOL 172. An outgrowth of this work was the funding of an NSF CCLI grant to study how students respond to images in learning about cell structure. Dr. Murray continued to experiment with graded vs. non-graded in-class, group-work assessments while maintaining successful activities like poster sessions. Dr. Patel visited BYU and observed our collaborators in action. He incorporated several active learning strategies into his 303 section and is convinced that it will increase collaborative work between students and engage the students to explore inter-connections between fundamental concepts in cell and molecular biology. Our Brigham Young collaborators are analyzing data from the submission of mutually agreed upon final examination questions and end-of-semester affective surveys. They are analyzing changes in student learning to assess whether the changes in instructional methods are reflected in changes in student learning. Drs. Math Cuajungco (C&D, 2007), Alison Miyamoto (C&D, 2008), Hope Johnson (MB&B, 2008), Melanie Sacco (2008, MB&B), and NIkolas Nikolidis (2008, MB&B) will attend training sessions at BYU this summer to bring back various skills in non-traditional instruction to the LD Core and UD Gateway courses they will teach. (ii) SALGain Surveys are in place or being developed for several concentration courses. (iii) Because the ETS/MFT is given in the last semester prior to graduation, it also measures mastery of facts from the concentrations.

III.A.4. Assessments of Student Effectiveness.

This assessment uses a variety of in-class/in-lab methods of assessments: exams, quizzes, homework, class/lab project presentations, class/lab activities, written class/lab reports, and lab practica skills tests.

III.A.3. Assessments of Faculty Effectiveness.

These assessments are made by students via the Student Opinion Questionnaires, by peers via classroom observations and peer review by the Departmental Personnel Committee members, by the individual faculty member in their portfolio teaching narrative, and by the review of the entire portfolio during the Retention, Tenure and Promotion process.

III. B. Biology Graduate Program Assessment Plan.

All graduate students are assessed for these student learning goals; all students who successfully complete the MS in Biology are expected to be able to:

- Work independently to conduct original research.
- Write a scientific paper suitable for publication in a peer-reviewed journal.
- Prepare and give a high quality, professional presentation (poster or talk) at a scientific meeting.
- Use library and electronic sources to obtain virtually all of the primary and secondary sources published on a specific topic in biology.
- Critically review and evaluate primary research articles.
- Place the thesis research in the context of the current state of knowledge of the field (understand the significance and contribution made by the thesis research).
- Master a body of knowledge appropriate to the specific subdiscipline and thesis topic (as demonstrated in the thesis defense of an area of concentration, in the thesis presentation, and in the written thesis).

- Master laboratory and/or research techniques appropriate to the specific subdiscipline (understand the principles of the techniques and be able to carry them out unsupervised, apply them to new problems and teach them to a peer).
- Analyze data appropriately (apply the appropriate visual/graphical analyses, apply the appropriate statistical analyses, knowing the assumptions of the statistical tests, and be able to interpret the results in a biologically meaningful way).
- Be prepared for careers in teaching, the health professions, government agencies, environmental consulting firms, and private industries, to enter PhD programs or professional programs in the health sciences.
- Organize, prepare, manage and assess an instructional session (lecture or lab) that addresses the diversity of student learning styles (for Teaching Associates).

During the process of completing their study plan courses and defending their theses, graduate students are all individually evaluated for successfully achieving these learning goals—by their instructors in the courses, by their thesis adviser and committee in the thesis defense, and by the public in their public presentation of the thesis. However, at present, there is no formal graduate program assessment plan. The development of such a plan is discussed in VII.E.2.

III. C. Biology General Education Program Assessment Plan.

Changes in the Biology GE Program curricula were addressed previously in II.A.7. These curricular changes have been accompanied by new assessment strategies that are discussed here.

III.C.1. Assessment for Critical Thinking.

To assess whether students in BIOL 101 and 101L were developing higher order thinking skills, one of our main goals, all students were given a pre- and post-test focused on critical thinking and problem solving: the CTLEA (Critical Thinking and Learning Embedded Assessment). This test is based on the department's CT/PS rubric (Appendix XIV), a taxonomy of critical thinking/problem solving similar to Bloom's Taxonomy of Learning (Bloom, B, Mesia, B., and Krathwohl, D. 1964. *Taxonomy of Educational Objectives*. New York: David McKay). but covering a narrower and higher range of thinking skills. The CT/PS rubric has ten elements, and each year we choose three of these elements to test with the CTLEA. For example, this year's pre-test (given in all 101L classes) asked students to: (a) interpret a graph about human birth weights (CT/PS Element 1, *Interpret data accurately*), (b) predict how human birth weights will change over time, from information presented in two graphs (CT/PS Element 5, *Make appropriate inferences and deductions from biological information*), and (c) develop a testable hypothesis about the cause of the relationship between human birth weight and mortality illustrated in the two graphs (CT/PS Element 7, *Formulate a testable hypothesis with a coherent biological rationale*). The post-test is an embedded assessment based on content covered in the class and tests the same CT/PS Elements as the pre-test did. In Fall 2007, the post-test for Biology 101L was based on the final, ecology laboratory module. (See Appendix XV. *AY 07-08 CTLEA Pre- and Post-Tests*.) We collected CTLEA pre- and post-tests for all students in Biology 101 in Fall 2004, Spring 2005 and Fall 2005, and for all students in BIOL 101L for Fall 2007 and Spring 2008.

We are in the process of analyzing the results of the CTLEAs, and we have confirmed that our scoring rubric is reliable both within and between scorers. We are currently testing the validity of the CTLEA by correlating student scores with their grades on writing assignments and

exams. We are also comparing BIOL 101L student scores on the CTLEA with those on a test developed by the New York State Education Department (NYSED) that assesses student understanding of the scientific method (http://pals.sri.com/tasks/9-12/Testdrug/). Our preliminary analyses suggest that students are developing their critical thinking skills and their understanding of science as a process, but more strongly in some areas than others.

Frequent assessment helps students learn better and remember course content longer (Casem, ML, *CBE Life Sci Educ*. 2006 Spring; 5:65-75.). Furthermore, students need practice using higher order thinking skills if they are to use these skills in a meaningful way. We have instituted more frequent assessment in some sections of BIOL 101 by requiring students to use Personal Response Systems (PRS; in which students respond to multiple-choice queries with wireless transmitters and receive rapid feedback on the choices the class made; also known as clickers) and incorporating daily or weekly clicker quizzes and exams into the syllabus. We will be comparing these students' performance on the CTLEA with students in classrooms that have a more traditional exam schedule. In BIOL 101L, students have weekly homework, quizzes and laboratory notebook entries, which will be discussed below.

In all sections of BIOL 101, we now have shared writing assignments that meet the CSUF General Education writing requirement. To ensure that all graders (biology graduate students) use the same grading standards, we use rubrics specific to each assignment (example in Appendix XVI). The language in the rubrics is closely related to that in the assignments, so that students know exactly what is expected of an excellent paper. The BIOL 101 students are given a copy of the rubric with the assignment.

Graders are trained in grade-norming sessions based on those used in standardized exams such as the SAT and MCAT. Besides marking the rubric, graders give feedback to students in two ways. First, they choose one paragraph on which they give detailed feedback, identifying typos, grammatical errors and word usage errors as well as any problems with content or logic. Second, at the end of the paper they write a brief note to the student. The student is addressed by name, and the first sentence identifies something positive about the paper (e.g., that they identified the controversy well). The following sentence or sentences give a recommendation for improvement that is general rather than specific. For example, the grader may suggest that the student explain more clearly the therapy being discussed, or to define global warming in more depth.

We have found that student writing does improve from the first to the second assignment. We had hoped that the writing assignments would increase students' content knowledge, but we did not find a correlation between performance on the writing assignments and several measures of content knowledge (test scores, final grades, early introduction to assignment topics; Houtman in prep.). We did find that students who were required to write the assignments in separate, smaller assignments over several weeks produced significantly better final papers. This is probably due both to students not being as rushed to complete the assignments, and the practice of writing multiple times (Houtman, unpublished observations).

As a corollary to these shared writing assignments, we instituted a plagiarism prevention program, requiring all papers to be submitted to Turnitin.com. Any paper with over 20% shared content received a zero, and the student was referred to the CSUF Dean of Students. In six semesters, plagiarism rates dropped from 30% to 6% of all submitted papers (Houtman and Walker, in press). We are trying to proactively decrease student plagiarism rates by offering plagiarism prevention workshops to part-time faculty, BIOL 101 faculty and 101L TAs.

IV. *Faculty*

A. Describe changes since the last program review in the full-time equivalent faculty (FTEF) allocated to the department or program. Include information on tenured and tenure track faculty lines (e.g. new hires, retirements, FERP's, resignations, and how these changes may have affected the program/department's academic offerings. Describe tenure density in the program/department and the distribution among academic rank (assistant, associate, professor) (See instructions, Appendix IV)

IV.A.1. Current Situation for Faculty Positions.

(i) At present, Biology is assigned 41.8 full-time equivalent faculty (FTEF). Including the four new hires (molecular microbiologist, plant molecular biologist, molecular bioinformaticist, cellular developmental biologist) who will begin in fall 2008, in AY 08-09 we will have 24.0 FTEF positions occupied (counting one position for our two FERPers, not counting Presch who is on administrative leave and counting one position for the Chair) with tenured or tenure-track faculty (TTF) for a TTF occupancy of 57.4%. By the end of AY08-09, both FERPers will fully retire, so in fall 2009 we will be back to TTF occupancy of 52.6% if we do not hire in AY 08-09.

(ii) Our distribution of faculty is as even as possible. AY07-08 finds 8 Assistant Professors, 8 Associate Professors, 7 Professors and 2 FERPers. AY08-09 will see no net change in Assistant Professor (addition of 4 new hires, loss of one via unsuccessful tenure decision, and loss of three via successful tenure decision), addition of 2 Associate Professor (3 successful tenure decisions, loss of one via retirement), and no net change in Professors equaling 8 Assistant Professors, 10 Associate Professors, and 7 Professors.

(iii) There are 7.5 FTEF TTF in BEC Concentration Teaching Collaborative, 4.0 FTEF TTF in MB Concentration Teaching Collaborative, 5.5 FTEF TTF (1 of whom is the Chair) in C&D Concentration Teaching Collaborative, 6.0 FTEF TTF in MB&B Concentration Teaching Collaborative.

(iv) Faculty members also distribute themselves into research interest groups generally along the lines of the concentrations with the following results (as of AY 08-09): Biodiversity, Ecology & Conservation (BEC) Biology (faculty of 10), Sandra Banack, Douglas Eernisse, William Hoese, Michael Horn, Anne Houtman, William Presch, Darren Sandquist, Jochen Schenk, Paul Stapp, and Sean Walker; Marine Biology (MB, faculty of 4), Kathryn Dickson, Douglas Eernisse, Michael Horn, and Danielle Zacherl; Cell & Developmental (C&D) Biology (faculty of 6), Merri Lynn Casem, Math Cuajungco, David Drath, Robert Koch, Alison Miyamoto (08-09 hire) and Nilay Patel; Molecular Biology & Biotechnology (MB&B, faculty of 6), Esther Chen, Math Cuajungco, Amybeth Cohen, Hope Johnson (08-09 hire), Nikolas Nikoloidis (08-09 hire), Nilay Patel, Melanie Sacco (08-09 hire), and Marcelo Tolmasky; Biology Pedagogy Research (faculty of 3), Merri Lynn Casem, William Hoese, and Anne Houtman. (see Appendix XVII. *Graduate Program View Sheet.*

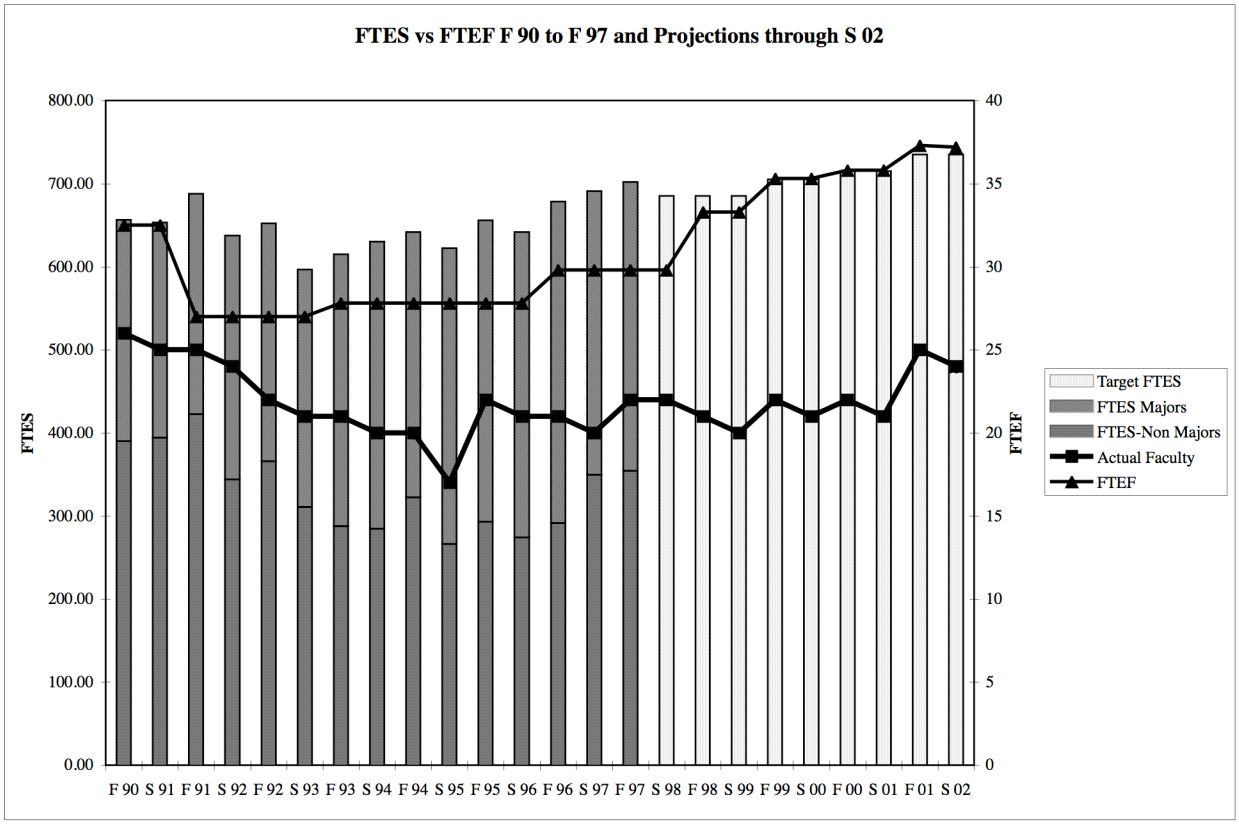
(v) We have 2.0 full-time lecturers (FTL), one (Megan Tommerup) teaching courses in the credentialing program (BIOL 102 and 453) and one (Jayson Smith) in marine biology who is 50% released to do research with Dean Murray.

(vi) The Department employs 25-30 part-time temporary faculty (PTF) members, predominantly to teach non-majors courses and some lab sections.

IV.A.2. Change in Faculty Positions since Last Program Review.

The graph below illustrates the relative flatness of actual faculty during the decade prior to the onset of the review period (2002-2007). Note that as the FTES targets went up and allocated FTEF followed, the headcount remained relatively constant. Over this time, we were unable to make gains in % FTEF Occupancy and this trend has continued during the review period (see above and Appendix IV, Table 9). The rate of loss has exceeded or equaled the rate of hires for all the years of the review through expected retirements, unexpected resignations, untenured faculty failing to earn tenure, and failed or terminated searches.

The inability to increase the % FTEF Occupancy over such a long period of time has strained the TTF and required that the Department increase its cadre of PTF. This has allowed efficient use of budget allocations, but has required that TTF carry a heavier and heavier load of activities outside of instruction, notably, committee work, peer evaluations and advising. The situation has become so difficult that for a couple of years we had to suspend our repetition-of-service or ratio of professors-to-associate professors rules for the Departmental Personnel Committee in order to elect a full committee. In addition, our multiple and repetitive failed searches (blamed primarily on cost-of-living issues) required serial searches sometimes for the same position requiring the time of the same faculty for several searches.



B. Describe priorities for additional faculty hires. Explain how these priorities and future hiring plans relate to relevant changes in the discipline, the career objectives of students, the planning of the university, and regional, national or global developments.

See Sections IV.A.1 Current Situation for Faculty Positions, IV.A.2. Change in Faculty Positions since Last Program Review, and VII.B. Faculty Long-term Plans.

C. Describe the role of full-time or part time faculty and student assistants in the program/department's curriculum and academic offerings. Indicate the number and percentage of courses taught by part-time faculty and student teaching assistants. Identify any parts of the curriculum that are the responsibility of part-time faculty or teaching assistants.

IV.C.1 Role of Faculty in Teaching Core Courses to Majors.

Full-time, tenured or tenure-track faculty (TTF) teach all of our core courses with one exception. Dr. Ben Murray, a part-time temporary faculty (PTF) member has taught one section of our BIOL 172, Cellular Basis of Life each semester for the last year. Dr. Murray is a retired senior research scientist from Caltech who also taught in an early part of his career at UC Irvine. He has participated aggressively in our curriculum reform and works actively with our cell biology collaboration with Brigham Young University. One of our priorities is to have only TTF teach in the core, but Dr. Murray is heavily invested in our curricular reform and has functioned as well as any TTF would have—we are not sacrificing quality or dedication in this case. However, students who may be interested in participating in research or looking for an advisor will not be making that type of contact in his sections.

IV.C.2. Role of Faculty in Teaching Gateways/Foundation Courses to Majors.

TTF teach majors in the gateway/foundation courses with two exceptions over the last few years. Dr. Murray has taught one section of BIOL 303, Intermediate Cell Biology each semester for the last four years. In fact, he invented the course for the Department. A post-doctoral fellow from UC Irvine or Beckman Research Institute of the City of Hope has taught BIOL 309, Intermediate Molecular Biology for the last two years while Dr. Rodrigo Lois has been on medical leave. Because we expected Dr. Lois to return to the faculty (he has decided to retire at the end of the academic year), we did not seek to hire a new molecular biologist to replace him until this year; Dr. Melanie Sacco replaces his expertise and will take over this course.

IV.C.3. Role of Faculty in Teaching Upper-division Elective Courses to Majors.

TTF, full-time lecturers (FTL) and PTF have taught upper-division courses to majors. The FTL and PTF have been specially selected for the relationship of their expertise to the elective course that is being taught. In all cases, they offer expertise that is unavailable at the time within the ranks of our TTF. Most of the courses in questions are taught from the primary literature in the style of a journal club—a format with which these post-docs are very familiar. In addition, we offer them rubrics and templates for grading and planning their writing and presentation assignments.

IV.C.4. Role of Teaching Associates and Instructional Student Assistants in Teaching Laboratory Sections.

Teaching Associates (TA) and instructional student assistants (ISA) teach majors and non-majors in our lower- and upper-division courses with multiple sections of laboratories. All TAs who teach in the Biology General Education Program and in the lower-division core courses

must take and nearly all TAs who teach upper-division elective labs take BIOL 500C, Professional Aspects of Teaching. In this course, they learn a variety of teaching techniques and are given specific assignments to employ them in their courses. TTF function as laboratory coordinators and, along with permanent staff, work closely with the TAs in the planning of each lab session and oversee assessment of student products.

IV.C.3. Role of Faculty in Teaching Courses to Non-Majors.

TTF, FTL and PTF teach lower- and upper-division courses to non-majors. The Biology General Education Coordinator, Dr. Anne Houtman, works closely with Teaching Collaboratives made up of subsets of these faculty members organized around the courses that they teach. Dr. Megan Tommerup, a FTL, specifically coordinates the BIOL 453, Concepts in Life Science that is taken by the multiple subject credentialing students. In both cases, these individuals lead the Teaching Collaborative through the process of developing and refining template syllabi and examining and updating student learning objectives for each class. Dr. Houtman is also an expert on writing assignments and helps each group tailor their assignments to meet the student learning goals of the General Education as well as the expected student learning outcomes of the course.

D. Include information on instructor participation in Special Sessions self-support programs offered by the department/program.

Not applicable.

V. *Student Support and Advising*

A. Briefly describe how the department advises its majors, minors, and graduate students

V.A. The Advising Process in the Department

Every major is advised each semester prior to registration for the following semester. One hundred percent of the majors obtain advice because holds are placed on their registration until they complete the advising process. Students in minors can be advised upon request, but must actively seek it. With the addition of two more minors that we anticipate will be popular, we may need to offer more organized advising to students taking them. Graduate students work with their thesis committee to create a study plan and meet with their thesis adviser to decide when specific courses should be taken—they do not have a hold placed on their registration and could, if they wished, register without the consent of their thesis adviser.

B. Describe opportunities for students to participate in departmental honors programs, undergraduate or graduate research, collaborative research with faculty, service learning, internships, etc. How are these opportunities supported? List the faculty and students participating in each type of activity and indicate plans for the future.

V.B. Opportunities for Student Participation in Research.

All undergraduates have the opportunity to participate in research, if they can find a faculty member who will accept them into their lab. Two externally funded, undergraduate training programs are in place; namely, the NIH-funded Minority Access to Research Careers (MARC) Scholars Program and the NSF-funded Southern California Ecosystems Research Program (SCERP). And, the recently funded, HHMI-sponsored Howard Hughes Medical Institute Scholars Program is preparing to interview applicants to begin the program in Fall 2008. In addition, a proposal is pending to support a Research Preparatory Programs designed to feed prepare freshman and sophomores to enter the MARC, SCERP and HHMI Scholar Programs when they are two years from graduation.

V.B.1. MARC Scholars Program.

The mission of the Cal State Fullerton MARC U*STAR Program will be to recruit and prepare promising minority life science students for graduate schools and research careers in biomedical science. The success of the Program will be measured in the short term by the number of Scholars entering doctoral programs and in the long term by their progress toward, and eventual entry into, research-oriented careers. Over the course of the funding period, we propose to have two-thirds of all Scholars enter high-quality, doctoral programs where they will earn research- oriented doctoral degrees and from which they will enter research careers. The short-term goals will be: (1) recruit, select and retain well-qualified students in the Cal State Fullerton MARC U*STAR Program; (2) develop MARC Scholars' skills for doing scientific research (3) develop MARC Scholars' written and oral communication skills for disseminating scientific discoveries; (4) prepare MARC Scholars academically for a Ph.D. or M.D./Ph.D. program in biomedical science; (5) develop in MARC Scholars an understanding and appreciation of professional integrity issues encountered in a research career; (6) provide MARC Scholars with personalized career and academic advisement; and, (7) prepare MARC Scholars for the demands of a research career as minority scientists. To measure the short- term progress, the Program will use specially developed assessment tools, forms, and e-journal entries. The Mentors and Program Director will complete the rubrics and forms, and the Scholars will create the e- journals entries. On a yearly basis, all MARC Scholars will be expected to improve to, or achieve at, Level 4-5 (scale 1-5) in laboratory performance, scientific skills, and oral and written communication skills, so that by the end of their two-year participation in the Program they have shown improvement or high achievement in at least 75% of the measurable objectives. To measure long-term success, the Program will do a three- year follow up of all graduated Scholars using a specially designed questionnaire. The Cal State Fullerton MARC U*STAR Program will contribute to the success in the research careers of the participating MARC Scholars, and will have a broader impact on the participating departments and colleges via the enhancement of their curricula, and an increased richness in the student research environment.

The faculty mentors, their department, and the undergraduate Scholars working in their labs are: Nancy Segal (Psychology), Vanessa Harris; Jennifer Trevitt (Psychology), Lilia Rodriguez; Peter De Lijser (Chemistry), Anna Trinidad; Christopher Hyland (Chemistry), Gary Gallego; Christopher Meyer (Biochemistry), Jacob Gonzalez; Robert Koch (Biology), Jose Corleto.

V.B.2. SCERP Scholars Program.

The central theme of the program is to enhance understanding of the ecology and environmental biology of changing southern California ecosystems. Sub-themes within the

research and educational aspects of the program will revolve around this main objective. The research focus emphasizes the changing nature of southern California's natural environment in the face of ever increasing urban populations and economic pressures. The education focus is on developing knowledge about these natural systems and academic skills that will make the SCERP Scholars competitive for graduate degrees and careers in environmental biology.

The specific objectives of the program are to: 1) foster greater participation and recruitment of minority and urban-raised students into environmental biology; 2) increase opportunities for these students to experience field-oriented research; 3) guide the development of independent field and laboratory research skills; 4) engage students in the breadth of disciplines within environmental biology; 5) expose students to the diversity of viable careers available in environmental biology and related fields; 6) introduce students to policy issues and the mechanisms used to effect policy change; and 7) provide mentoring opportunities for faculty and students to help develop mentoring skills.

The faculty mentors (all in Biology) and the undergraduate SCERP Scholars are: Houtman—Cory Castro, Sarah English; Banack—Carmen Cortez; Murray—Stephanie Diaz; Zacherl—Serra Kelly, Meredith Raith, Lily Sam; Stapp—Kimberly Nelson; Schenk—Daisha Ortega, Jeremy Smith, Lauren Velasco; Walker—Eric Peralta; Cohen—Yareli Sanchez.

V.B.3. Future Scholars Program.

V.B.3.a. HHMI Scholars Program.

Our Howard Hughes Medical Institute proposal, submitted jointly with faculty from Chemistry/Biochemistry and Mathematics with Dr. Maria Linder as the primary author and PD, has been funded and will offer positions to eight Scholars per year when it is fully operational. The three-tiered program will not only expand CSUF's community of undergraduate scholars interested in biomedical careers but extend the community down the "pipeline" to its feeder community colleges and high schools, creating mechanisms to engage younger students in scientific research and biomedical studies.

With goals that are closely aligned with the HHMI's Undergraduate Education Program objectives, the CSUF HHMI Scholars Program will leverage existing CSUF and CNSM programs and resources, drawing on institutional strengths to: (1) expand CNSM's capacity to serve interested and capable students (including but not restricted to underrepresented minorities and women) with laboratory research experiences; (2) acquaint them with and prepare them for careers and graduate and professional studies in biomedical science, medicine and science education; (3) attract promising new students by reaching out to CSUF's feeder high schools and community colleges with research experiences that will engage students in biology, chemistry, biochemistry and mathematics; (4) enlist high school and community college faculty to provide their students with inquiry-based science experiences and advise them about biomedical careers; and (5) help ensure CSUF's ability to continue offering these activities on an ongoing basis.

The three parts comprising the program include:

- the **HHMI Undergraduate Research Scholars**, an intensive 2-year program of research, supportive studies and workshops for yearly cohorts of 4 undergraduates who have exceptional potential for and a serious commitment to pursuing graduate and professional studies in the biomedical sciences, and who are willing to undergo rigorous preparation for that goal;
- the **HHMI Summer Research Scholars**, a research experience for 24 undergraduates from CSUF and the community colleges, as well as 32 high school

students working in pairs with one of their high school teachers (16 total), for 10 and 5 weeks, respectively. Each undergraduate participant or high school cohort will work with a faculty member at CSUF to carry out meaningful research that adds to knowledge in chemistry, biochemistry, biology or mathematics; and

- the **HHMI Weekend Research Scholars**, which will expose community college freshmen and sophomores, as well as small groups of high school students working in tandem with their teachers, to an intensive, 2-weekend research experience. Working in smaller groups under CSUF and community college chemistry and biology faculty, a total of 64 community college students, 16 teachers and 64 high school students will help answer real-life research questions.

V.B.3.b. Research Preparatory Program.

This program is designed to develop a pipeline of students interested in entering the MARC, SCERP or HHMI Scholars Program. We propose to develop a research preparatory program (RPP) in the Department of Biological Science for freshman, sophomore and transfer students in order to stimulate interest in biology research careers. The main goal of the program is to provide participants with the tools they need to be successful in their major, and as future research scientists. The students will receive extensive mentoring and academic support, as well as exposure to the culture that exists within a research laboratory through a special seminar-based course and interactive lab activities. The goals of the RPP are to (i) raise student awareness of research opportunities at CSUF, (ii) provide students with the skill sets they need to be successful scientists at CSUF, and (iii) move more students into research-based graduate programs or jobs within Orange County.

The RPP will allow students the opportunity to explore the possibility of a research career through a specially designed seminar course. We will work to place them in faculty labs, and direct them to specific externally-funded research programs within the Department. Two such programs include the MARC (Minority Access to Research Careers) Program, which prepares promising minority life science students for graduate schools and research careers in biomedical science, and the SCERP (Southern California Ecosystems Research Program), which prepares undergraduates for careers in ecology and environmental biology. An important component of our preparatory course will be the exposure of students to the lab culture in their formative years.

The preparatory course will be run by a faculty member who will oversee the student activities in the class meetings and coordinate events inside and out of the classroom. We will rely on a network of faculty to aid in making the seminar course a success. We will invite faculty to lead sessions on topics such as: (1) scientific writing, (2) the nuts and bolts of oral presentations, (3) research ethics, (4) basic lab etiquette, (5) lab safety, (6) research design, (7) managing competing demands of academic life, (8) the importance of good math skills in science, and (9) career options (including academia vs. industry).

VI. *Resources and Facilities*

A. Itemize the state support and non-state resources received by the program/department during the last five years. (See instructions, Appendix V.)

VI.A.1. State Support during Last Four Years.

Appendix XVII. *Department Budget 2004-05 through 2012-13* shows the state support that was available to support all operations of the Department. Excluding salaries for full-time faculty and staff members, the total revenues available to the Department range from approximately $1.7 to $2.5 million each year and expenses range from approximately $1.3 to $1.9 million each year depending on conditions. Carryforward varies from approximately $65,000 to $650,000 depending on conditions. The projections into the future adjust for budget reductions and new hiring costs according to plans stated in VII.B.2.

VI.A.2. Non-State Support during Last Four Years

External sources of support for research, research training, curricular development, and enhancement of instruction that have been available to the Department between 2003-04 and 2006-07 are listed in Appendix VI, Tables 10-A through 10-D. The total support was $6,016,331.

B. Identify any special facilities/equipment used by the program/department such as laboratories, computers, large classrooms, or performance spaces. Identify changes over last five years and prioritize needs for the future.

VI.B.Special Facilities and Equipment

VI.B.1. Special Equipment Rooms

Digital Fluorescence Microscopy Lab (DBH-116N)

- Olympus BX61 Epi-fluorescence Microscope
- Hammatsu Orca Cooled-CCD camera
- C-Imaging software for image collection and analysis

Microscopy Facility (MH-13)

- Hitachi H-7000 TEM
- Hitachi S-700 SEM
- Leica TSP AOBS Scanning Confocal Microscope (acq. 2004)
- Life Cell quick freeze device
- Ultramicrotomes

Chemiluminescence Analysis Dark Room (DBH-113S)

- Kodak Western Imaging System w/ dedicated computer (acq. 2007)
- Wet bench for chemiluminescence exposure of X-ray film
- Gel Dryer

Shared Molecular Biology Equipment Room (DBH-115)

- Phosphoimager
- Kodak Gel Imager (acq. 2005)
- Two -70^{o}C Freezers (one acq. 2007)
- Beckman Ultracentrifuge
- Beckman High Speed Centrifuge

Small Cold Room (DBH-116S)

Large Cold Room (DBH-176)

Tissue Culture Room (DBH-174)

Autoclave Room (DBH-172 MH-387)

Constant Temperature Chambers (MH-387, MH-338)

Museum Storage Facilities (MH-217A, 207F-J)
- Wet samples (MH-217A)
- Dry specimens (MH-211)
- Entomology specimens (MH-207A)
- Skeleton specimens (MH-207J)

Human Anatomy Complex (MH-237)

Plant Growth Chamber Rooms (MH-301, DBH-269; five chambers acq. 2004)

Greenhouse Complex
- Four greenhouses
- Head house
- Lath house
- External grounds with tables for projects
- Chuckwalla enclosure

Animal Care Facilities
- Mammals (DBH-185)
- Amphibians & Reptiles (MH-217B, MH-231)
- Marine Invertebrates (MH-278; tanks)
- Marine Invertebrates and Vertebrates (DBH-246; flow through SW)

Cell, Molecular, Microbiology Service Center (MH-354ABC/366AB complex)
- Preparation of materials in support of BIOL 172, 273, 202, 302, 424

VI.B.2. Newly Renovated (or under Construction) Laboratories/Facilities

Instructional Computing Facility (DBH-289; constructed in 2006)
- 20 stations with drop down storage of LCD panels
- 1 master station

Cell Culture and Stem Cell Biology Laboratory (DBH-286; constructed in 2006)
- Inverted microscopes
- Tissue culture hoods, bench-top
- (This will become a marine biology lab when we move the Stem Cell Lab to DBH-102 & 103 in 2009)

New Faculty Research Labs (MH-317; MH-319)

- Under construction, estimated completion, May, 2008
- These are molecular biology labs for Sacco and Nikolaidis

New Microbiology/Immunology Instructional Laboratory (MH-301,)

- This will house BIOL 202, Microbiology for Nursing and Allied Health (4-6 sections), BIOL 302, General Microbiology (2 sections), and BIOL 424, Immunology (2 sections)
- Renovation to begin in June, 2008 for occupancy in Spring, 2009.

New MH Plant Growth Chamber (MH-327)

- MH-301 facility will move to MH-327 to make room for Micro/Immuno Lab (Aug 2008)

VI.B.2. Planned Renovated Laboratories/Facilities

Greenhouse Complex

- Remodel each greenhouse one at a time over five-year period beginning 2010

New Stem Cell/Tissue Culture Room

- DBH-103 to house tissue culture hoods

New Tissue Sectioning Room

- Enlarge DBH-116N to accommodate tissue handling equipment from DBH-103

VII. *Long-term Plans*

A. Summarize the unit's long-term plan, including refining the definitions of the goals and strategies in terms of indicators of quality and measures of productivity. (See instructions, Appendix VI)

B. Explain how the long-term plans implement the University's mission, goals and strategies and the unit's goals.

VII. Long-term Plans.

The discussion below will combine elements of answers to A and B above. The agreement between these plans and the University and Department M&G are clear from the reference to the Priorities and their alignment to the M&G.

VII.A. Staff Long-term Plans.

VII.A.1. Current Situation.

At present, we have 13 staff positions filled (one position is paid out of non-staff baseline funds and is not technically a "staff" position). The table in Appendix XIX: *Biology Staff Members and Duties* shows our staff positions and how the staff members focus their efforts.

VII.A.2. Long-term Actions.

In accordance with the Priorities (I.C.1), the Department shall:

(i) analyze staff support for instructional and research needs in the Department,

(ii) modify assignments of staff members as appropriate based on this analysis,
(iii) maintain rigorous evaluation of performance and expectation of high-quality work,
(iv) maintain equity in salary structures,
(v) nominate staff members for performance-related awards as appropriate,
(vi) fill animal care manager position following expected retirement in 2013-14.

VII.A.3. Short-term Actions.

(i) Submit (again) official request for a full-time staff position to support BIOL 171 and 274. (Funding this position as a PTF creates expectations of evaluations and assignment entitlement consistent with Unit 3 CBA; however, standard staff evaluation protocols are being followed consistent with the expectations of the position.),
(ii) evaluate staff performance and set yearly goals for performance,
(iii) recommend staff attend at least one professional development course/conference per year,
(iv) evaluate salary equity and request in-range elevation for at least one staff member in each of the next three years.

VII.B. Faculty Long-term Plans.

VII.B.1. Long-term Actions.

In accordance with the Priorities (I.C.2), the Department shall:
(i) increase our TTF occupancy to 65-70%,
(ii) search for faculty to maintain minimum of five TTF per concentration group and develop centers of excellence among the core concentration faculty,
(iii) hire integrative concentration bridge faculty, most recently identified as microbiologists whose expertise span one or more concentrations as well as support growing needs in molecular microbiology thus offering expertise of interest to colleagues and students in multiple concentrations,
(iv) insure that sufficient FTEF positions remain unfilled so that we can hire PTF to teach our non-majors courses and TAs to teach our multi-sectioned labs,
(v) respond promptly to retirements and resignations—2 FERPs end in 08-09, 1 cell biologist retires in 11/12, 1 cell biologist retires in 12/13 and 1 marine biologist will retire by 14/15.

VII.B.2. Short-term Actions.

These plans largely deal with hiring, but also recognizes the need to support professional development of our faculty.
(i) Convince the dean to offer the marine biology position to those on our current list for a fall 2009 start date;
(ii) if (i) fails, in AY 08-09, search for a marine biologist—we need to add an additional marine biologist to meet the minimum of five per concentration group,
(iii) in AY 09-10, search for a biology educator to participate in the single-subject science education program and strengthen our Pedagogy Research Group,
(iv) in AY 10-11, search for a cellular microbiologist who can function as an integrative concentration faculty,
(v) in AY 10-11 respond to projected retirement and search for cell biologist/immunologist.
(vi) support travel of faculty to attend professional meetings where they are presenting.

(vii) support the development of new grant proposals by providing resources required to response to emerging areas of funding.

VII.C. Faculty Participation in Goverance.

VII.C.1. Current Situation.

The department has nine standing committees, usually five or six ad hoc committees, three student clubs, two undergraduate research training programs, six faculty participate in College committees, fourteen faculty participate in University committees, six faculty members participate in CSU-wide programs (see Appendix IX: *AY07-08 Committee Structure*).

VII.C.2. Long-term Actions.

(i) Adhere to the Priorities (I.C.3) and "ongoing" short-term actions VII.C.3.iii-x.

(ii) Set annual priorities for standing and *ad hoc* committees.

VII.C.3. Short-term Actions.

(i) AY 08/09, Charge all standing committees will developing operating practices and a standard timetable for activities,

(ii) AY 08/09-11/12, Assessment Team finalize program assessment practices as outlined in Section III below,

(iii) ongoing, Departmental Personnel Committee oversee evaluation of tenured, tenure-track, and temporary faculty,

(iv) ongoing, Curriculum Committee oversee quality of proposed new courses and re-evaluate the syllabi of existing courses to insure compliance with University protocols,

(v) ongoing, Graduate Advancement Committee, in association with Graduate Adviser and Administrative Support Coordinator II and Administrative Support Assistant I, oversee the refinement of the Graduate Student Handbook, admit new graduate students, and maintain graduate program,

(vi) ongoing, Undergraduate Advancement Committee, in association with the Administrative Support Assistant II, oversee the refinement of the Undergraduate Advising Handbook, perform graduation checks, and organize advising activities,

(vii) ongoing, Core Instructors Group oversees coordination among core courses with respect to knowledge and skills,

(viii) ongoing, IT Committee oversee and set rules for website, oversee and set rules for server use, oversee compliance with CSU and University policies,

(ix) ongoing, Vehicle/Boat Committee oversee and set rules of use of trucks and boats in support of instruction and research activities, set plans to replace vehicles/boats, oversee compliance with Department and University Field Trip Protocols,

(x) ongoing, Management Team oversee operation of Department and strategic plan

VII.D. Curricular Plans.

A discussion of short-term and long-term plans to modify our curriculum can be found in II.D. Plans for Curricular Modifications.

VII.E. Assessment Plans.

VII.E.1. Undergraduate Program Assessment Plan.

VII.E.1.a. Refinement of Processes already in Development

The assessment of the Core requires that assessment agree with student learning outcomes of the core and its composite courses as found in Appendix XX. *Student Learning Outcomes of the Core.*

(i) The Biology-specific Critical Thinking Longitudinal Embedded Assessment (CTLEA) process by which we will determine the development of critical thinking/problem solving (CT/PS) skills throughout our LD Core and UD Concentrations (see III.A.2.a) is under development and needs to be refined and validated. We will borrow from lessons learned in BIOL 101. The Assessment Committee will accomplish this task.

(ii) The Education Testing Service Major Field Test (ETS/MFT) (see III.A.2.b.) will be modified to include some CT/PS assessments for each section. The Concentration Teaching Collaboratives will accomplish this task.

VII.E.1.b. Development of New Assessment Tools.

(i) An Alumni Survey to assess the students' determination of the value of our degree program on their career success. The Assessment Committee will develop this instrument.

(ii) Three critical areas of assessment are missing from our core assessment process.

- A Communication Skills Assessment,
- Laboratory Technical Skills Assessment and
- Team-work Skills Assessment

These will be developed to determine how well students acquire skills in each of these areas that have been included in our core laboratories, but whose assessment has not been addressed. The Core Instructors Group will accomplish this task.

(iii) A Student Assessment of Learning Gains (SALGains) will be added to our exit process for graduating seniors. The Assessment Committee will develop this instrument.

VII.E.2. Graduate Program Assessment Plan

Learning goals for the graduate program are discussed in III.B. A detailed assessment plan has not been developed for our graduate program. The Graduate Advancement Committee is charged with the development of a program assessment plan and will begin developing the plan as its AY 2008-09 charge. Clearly, assessing the ability of the Graduate Program to provide the milieu in which each student can achieve the program learning goals will be the foundation of this effort.

VII.E.3. Biology General Education Program Plan

Our future assessment goals for the General Education Biology program are to: (i) continue to assess student learning (especially higher order thinking and an understanding of science as process) across all sections of 101 and 101L, (ii) develop shared homework for Biology 101 (like that in 101L), (iii) increase the use of clicker technology by instructors in Biology 101, (iv) consider the possibility of a shared final exam in Biology 101, (v) continue to review and revise the new 101L curriculum and associated assessments (especially the lab notebook) in its first two years, and (vi) begin development of assessment instruments for upper-level non-majors biology courses.

VII.F. Improving the Undergraduate and Graduate Programs Support and Recruitment.

In accordance with Priority I.C.5.i-ii, we will improve our outreach to local groups. For example, we will improve our relationship with the Troy Tech program, offer on-campus experiences to local high school biology groups (a goal of our new HHMI Program), promote awareness of special opportunities that our department offers like student-faculty collaborative research, consult with local high school biology teacher to see what resources we can to help improve their success, and participate in the K-12 teaching fellow grant proposal being submitted to Department of Education.

In accordance with Priority I.C.5.vi, we will develop a plan to allow students to remain with a single adviser over the course of their studies and to maximize the quality of the advice they receive with respect to their selected concentration. Because approximately 60% of our students are in the Cell & Developmental Biology Concentration, we cannot expect each student to be advised by an instructor in their concentration, but that will be the overall goal as the distribution of faculty become more reflective of the distribution of students.

In accordance with Priority I.C.6.iv, we will increase support for our graduate students by developing research training grants like Bridges to the PhD and identifying corporate sponsors for our graduate student research. This latter process will be a particular effort in the new Master in Applied Biotechnology Studies degree.

VII.G. Improving our Continuity of Business Plan.

We will develop a detailed plan that supports all of the priorities set forth in section I.C.9.

VII.H. Responding to External Societal "Threats".

We will develop a detailed plan that supports all of the priorities set forth in section I.C.10.

C. Explain what kinds of evidence will be used to measure the unit's results in pursuit of its goals, and how it will collect and analyze such evidence.

See Sections II for SLOs and III for Assessment Plans.

D. Develop a long-term budget plan in association with the goals and strategies and their effectiveness indicators. What internal reallocations may be appropriate? What new funding may be requested over the next seven years?

See Section VI.A for this discussion.

Appendix VIII. *White Paper on the Renovation/Relocation of the Greenhouse Complex*

Appendix IX. *AY07-08 Committee Structure*

Appendix X. *Undergraduate Advising Handbook*

Appendix XI. *Biology Catalog Listings*

Appendix XII. *Graduate Handbook*

Appendix XIII. *ETS/MFT Data*

Appendix XIV. *Critical Thinking/Problem Solving Elements*

Appendix XV. *AY 07-08 CTLEA Pre- and Post-Tests*

Appendix XVI. *BIOL 101 Grading Rubric*

Appendix XVII. *Graduate Program View Sheet.*

Appendix XVIII. *Department Budget 2004-05 through 2012-13*

Appendix XIX. *Biology Staff Members and Duties*

Appendix XX. *Student Learning Outcomes of the Core*

Position Paper on the Relocation of the Greenhouse Complex

10 April 2005

submitted by

Darren Sandquist, Jochen Schenk, Kathryn Dickson, Paul Stapp, Edward Read, and Robert A. Koch

Department of Biological Science.

(revised following original discussions by D. Sandquist, D. Fromson, C. Barnhill, R. Young, J. Bond, and R. Koch on 24 March 2005)

A. The Need for Biology Greenhouse Complex

The Biology Greenhouse Complex (herein referred to as the Complex) supports the mission and goals of the Department of Biological Science (see attached document). Central to that document is the following statement: *As a department concerned with creating new knowledge through innovative research and with disseminating current knowledge across the broad discipline of biology, we serve as a regional center for the scientific study of the processes of life*. The Complex is critical to our ability to accomplish our mission and to achieve many of the strategies we have outlined.

The Complex, as it presently stands, supports both research and instructional needs. With respect to botanical needs, the instructional and research can be separated and supported by distinct physical operations, and, whereas the marine, field biology, animal care and general biology needs, as well as animal observation areas and potential specimen collection storage, need not be near either greenhouse complex but do require a location near MH and SLC. *This position paper is built on the assumption that separation of will be the outcome of relocating the various components of the Complex for research and instructional needs in botanical work, and that instructional greenhouse and others uses must be near to current instructional activities (i.e., MH and SLC).*

The Complex directly supports the **research** of **plant biologists** (Drs. Sandra Banack, Amybeth Cohen, Gene Jones, Rodrigo Lois, Darren Sandquist, and Jochen Schenk), **marine biologists** (Drs. Kathryn Dickson, Doug Eernisse, Michael Horn, Steven Murray, and Danielle Zacherl), and **field biologists** (Drs. Sandra Banack, Bill Hoese, Anne Houtman, Paul Stapp, Barry Thomas, and Sean Walker) and all of their undergraduate and graduate research students.

Our **instructional** needs are in the following courses; impact on the number of students per year is shown in parentheses and on the number of student-days per year is shown in brackets. The primary effect is on courses that will use greenhouse complex facilities (including marine and field biology areas) for experiments in instructional laboratories. The secondary effect is on courses where plants will be used for demonstration or students will tour the greenhouse.

General Education (non-majors) Courses

Primary effect

BIOL 101L: Elements of Biology Laboratory (1200/yr) {?}

Secondary effect

BIOL 101: Elements of Biology (3000/yr)
BIOL 352: Plants and Life (190/yr)

Lower-division Core Courses
Primary effect
BIOL 171: Evolution and Biodiversity (360/yr) {7,560 student-hr/yr}
BIOL 274: Principles of Physiology and Ecology (150/yr) {600 student-hr/yr}

Secondary effect
BIOL 172: Cellular Basis of Life (380/yr) {1,520 student-hr/yr}
BIOL 273: Genetics and Molecular Biology (300/yr) {1,200 student-hr/yr}

Upper-division Elective Courses
Primary effect
Plant courses
BIOL 344: Survey of Land Plants (20/yr) {160 student-hr/yr}
BIOL 353: Ethnobotany (a new course; 20/yr) {200 student-hr/yr}
BIOL 441: Plant Taxonomy (20/yr) {320 student-hr/yr}
BIOL 442: Pollination Biology (20/yr) {160 student-hr/yr}
BIOL 443: Plant Ecology (20/2 yrs) {80 student-hr/yr}
BIOL 444: Plant Physiological Ecology (20/2 yr) {320 student-hr/yr}
BIOL 445: Plant Cell Physiology (20/2 yr) {80 student-hr/2yr}
BIOL 448: Plant Molecular Biology (new course, not offered yet)
BIOL 449: Desert Ecology (10/2 yr) {40 student-hr/2 yr}

Marine courses
BIOL 317: Field Marine Biology (20/yr) {120 student-hr/yr}
BIOL 419/419L: Marine Ecology/Laboratory (20/yr) {120 student-hr/yr}
BIOL 446: Marine Phycology (20/yr) {120 student-hr/yr}
BIOL 461: Marine Invertebrate Biology (20/yr) {120 student-hr/yr}
BIOL 462:Comparative Animal Physiology (20/2 yrs) 120 student-hr/yr}
BIOL 475: Ichthyology (20/yr) {120 student-hr/yr}

Field courses
BIOL 301: Problems in Environmental Biology (6/yr) {120 student-hr/yr}
BIOL 466: Behavioral Ecology(20/yr) {120 student-hr/yr}
BIOL 467: Entomology (20/yr) {120 student-hr/yr}
BIOL 474: Natural History of Vertebrates (20/yr) {120 student-hr/yr}
BIOL 476: Herpetology (20/yr) {120 student-hr/yr}
BIOL 478: Mammalogy (20/yr) {120 student-hr/yr}
BIOL 479: Ornithology (20/yr) {120 student-hr/yr}

Graduate Courses
Primary effect
BIOL 598: Thesis (20/yr) {highly variable}
BIOL 599: Independent Graduate Research (20/yr) {highly variable}

B. The Present Situation

Current Facilities		**Footprint**
5- 18' x 40' aluminum/glass structures		- 3600 ft^2
1- 40' x 50' aluminum lath structure		- 2000 ft^2
Office / lab	18'x 10'	- 180 ft^2
Boiler House	9'x 9'x 9'H	- 81ft^2
Pesticide Locker	8'x 8'x 9'H	- 64 ft^2
Marine House	16' x 16' x 10'H	- 256 ft^2
Parking for Marine Whaler	16 x 20	- 320 ft^2
Storage Containers:		
1. Field Ecology/Bio- 8' x 27'		- 216 ft^2
2. Zoology/Animals- 8' x 40'		- 320 ft^2
3. Greenhouse - 8' x 20'		- 160 ft^2
Soil bins*	3- 6'x 6'x 6'H	- 108 ft^2
5 - triangular raised bed planters*		- 250 ft^2
5 - raised bed planters* 4'x 8'		- 160 ft^2
1 – Reptile observation pen:* 14.5' x 28'		- 406 ft^2
* Cement block		
36 - 4' x 8' benches		- 1,152 ft^2
1 - 4' x 20' bench		- 80 ft^2
1 - 4' x 19' bench		- 76 ft^2
	subtotal structures	9,429 ft^2
	grounds	11,471 ft^2
Total estimated area:		***20,900ft^2***

Lath House

- Aluminex aluminum lath 40' x 50', 8' and 12' ceilings – can be moved to new site
- 4 Center benches: 429 ft^2
- Perimeter benches: 420 ft^2
- Planter: 96 ft^2
- Pond: 96 ft^2
- Cement walkways, open under benches
- Lighting: perimeter and inner lighting
- Electric: outlets along perimeter and two per center bench
- Plumbing: industrial and DI lines around perimeter

Head House 2 Part

1. Aluminex aluminum, transite and glass head house. 18' x 40' (720 ft^2)

- Dual doors on each end and two single side doors.
- Cement floor with floor drains
- Ridge window vents
- Side window vents

- Sink and counter (stainless, three basin) 39 ft^2
- Bench space (soil works, potting, growing) 129 ft^2
- Electric: 120AC outlets along inner and outer perimeter.
- Plumbing: hot and cold water, DI
- Lighting: 8 ceiling lamps
- Environment: control panel with heating and cooling controls. Two ceiling heater fans (hot water), and one forced air evaporative cooler.

2. Office/Lab: 10' x 18' Aluminex aluminum, transite and glass.

- Ridge and side window vents
- Double doors
- Cement floor
- Sink and counter 40 ft^2
- Ceiling lamps
- Electric: 120 AC outlets on two sides
- Plumbing: hot/cold, DI water, and natural gas.
- Communication: voice and data

Greenhouses

The following is for all greenhouses:

- Aluminex aluminum frame, transite and glass glazed. 18' x 40' – 720 ft^2
- Ridge and side window vents.
- Environment: automated heating, cooling and humidity controls for each house.
- Finned tube hot water heating under benches.
- Forced air evaporative coolers
- Under bench misting (corroded and subsequently removed, controls still intact)
- Cement floors throughout except under perimeter benches. Isolation chamber floors are cement with a floor drain.
- Pipe/wire mounted on roofs and sides for mounting external shade cloth.
- Redwood benches
- Plumbing: industrial and DI water on both ends of house on inside and outside. Reverse Osmosis unit and two stainless water storage tanks.
- Electric: multiple AC outlets along perimeter benches. Two additional separate circuits with outlets along perimeter that are controlled by thermostats.
- Lighting: 8 ceiling lamps

Greenhouse 1

- Bottom heated bench space: 216 ft^2
- Center bench space: 36 ft^2
- Center raised planter: 20'x4'x2' 80 ft^2

Greenhouse 2

- Bottom heated bench space: 159 ft^2
- Four isolation chambers:
    - 10'x 6' each with individual automated heating, cooling and supplemental lighting controls.

- Supplemental lighting and misting systems.
- Window vents.
- Bottom heated benches – 40 ft2
- AC outlets, Industrial and DI water taps.
- Individual forced air evaporative cooler for each chamber.

Greenhouse 3

- Bottom heated bench space: 240 ft^2
- Center bench space: 144 ft^2

Greenhouse 4

- Bottom heated bench space: 228 ft^2

C. The Basic Requirements of a New Facility

Marine Storage Area *(Must be adjacent to MH and SLC, but need not be near greenhouses, but if it were shower, etc. could be shared.)*

- general marine storage (min. 320 ft^2)
  - lockable
  - dust-free
  - space to dry nets/seines
  - open shelves
  - closed cabinets
  - floor space for large objects
  - racks for boots, etc.
- special dive equipment area (min. 320 ft^2)
  - running water
  - shower/drain
  - sink/tub for rinsing gear
  - small drying area
  - storage for dive equipment
  - ventilation
- parking for boat (min. 320 ft^2)
  - running water
  - drain
  - cover

Field Biology Storage Area *(Must be adjacent to MH and SLC, but need not be near greenhouses, but if it were shower, etc. could be shared.)*

- general field storage (min 320 ft^2)
  - lockable
  - individual lockers for five course
  - cabinets for large items (eg., traps, camping gear, etc)

  - bench space for cleaning, examining and packing equipment and specimens fresh from the field (smell is often a factor in bringing these items into the labs)
  - sink for washing equipment
  - outdoor bench area for inspecting and cleaning equipment
  - drying oven

Animal Care and General Biology Storage Areas *(must be adjacent to MH and SLC, but need not be near greenhouses)*

- same as present
- must be a location for greenhouse pesticide storage

Animal Specimen Collections Storage and Use Area *(This is a new consideration. This collection takes up valuable space in MH that needs to be used for new research laboratories, and we think that to total cost of housing would be improved by construction of a separate room in the greenhouse complex. Such a facility will need to be near SLC.)*

- space for 30 4'x8' cabinets
- three work tables
- wet bench with sink and drain
- wall space for mounting vertebrate specimen heads
- a small lecture arena would be extremely useful

Animal Behavior Observation *(must be adjacent to MH and SLC, but need not be near greenhouses)*

- current chuckwalla observation area must be duplicated (406 ft^2)
- three additional spaces that could double as planters are required (each min. 60 ft^2)

Instructional Greenhouse *(must be adjacent to MH and SLC)*

- 2 Glass houses (min. ca. 1200 ft^2)
  - partitioned for special needs
  - temp, light, humidity computer controlled
- 1 Head house (min. ca. 1200 ft^2)
  - technician office with control panels for green houses
  - bath room with shower
  - sterile room for tissue culture
  - wet bench and sink
  - hood (stand alone is okay)
- 1 Lath house (min. ca. 1000 ft^2)
- outdoor (min. ca. 4800 ft^2)
  - benches (20 each @ 32 ft^2)
  - soil bins
  - planters (10 each @ 16 ft^2)

Research Greenhouse

It is important to note that over the past five yrs the lack of sufficient research greenhouse facilities has forced many of the current faculty and student research to take place elsewhere or to adapt experiments to be conducted under natural, outdoor conditions. Some experiments have suffered greatly owing to the lack of climate control and fully functional greenhouses. The result is research products that don't reflect the potential of the Department's faculty and students.

Many aspects of the research greenhouse use are not easily segregated from the instructional mission of the Department. For example, some plant collections that are used for upper-division courses taught on a 2-yr rotation require a high diversity of species, but due to space constraints these specimens would not be allowed to be permanently housed in the instructional greenhouse on lower campus. As such, these plants must reside in the research-area of the greenhouse facility. Additionally, many plants being used for faculty or graduate-student research are often recruited for use in upper-division courses, such as desert and coastal Brittlebush ecotypes that are used for thermo-tolerance studies in BIOL 444. Lastly, many upper-division courses require semester-long research projects that often demand precision climate control or large areas for plant growth. Such provisions can only be met in the research greenhouses.

Below is a tentative outline of research greenhouse facilities previously discussed during the informal greenhouse meetings of spring 2004. Included with each space description is a list of probable uses for research and, as described above, the likely crossover applications to instructional needs.

- 2 Glass houses (ca. 1400 ft^2)
    - 2-3 partitions as needed, and mist-bench germination area
    - Temp, light, humidity computer controlled
    - Uses – Broad climate conditions are needed for many experiments or for simply raising plants to the stage at which they can be used for experimentation. The following projects (all funded by external research grants) have high demand for such controlled conditions. Desert vegetation recovery (Sandquist - USGS Mojave Project), Desert plant root architecture (Schenk – Mellon Foundation), Tropical plant toxins (Banack - NSF), Hawaii forest productivity (Sandquist – NSF), Hawaii forest seedling responses (Sandquist – USDA), Endangered species studies: Lilies (Jones – LSA Inc), Lilies (Sandquist – LSA Inc), Spineflower (Jones, Sandquist & Walker – Newhall Ranch), Woolystar (Jones, Sandquist, & Schenk – Sapphos Inc.). Each of the above projects has at least one additional graduate student associated with the project and some have up to 5 additional undergraduates. Plants from most have also been used for instructional purposes in courses like Plants & Life (BIOL 352), Plant Ecology (BIOL 443) and many others.
- 1 Glass house w/4 isolation chambers (ca. 1700 ft^2)
    - For high resolution environmentally-controlled experimentation
    - Temp, light, humidity computer controlled

  - Uses – When experimentation requires high-resolution climate conditions, but enough space to raise many plants or apply additional conditions, isolation chambers are the only means to meet the experimental needs. The following projects, which are all currently funded, have need for such highly controlled conditions. Desert plant thermo-tolerance studies (Sandquist – CSUF Internal Grants), *Sueada* hybridization (Schenk & graduate students), Tropical plant toxins (Banack - NSF), Hawaii forest responses to pulsed resources (Sandquist – NSF & USDA), Endangered species studies: Lillies (Jones – LSA Inc), Lillies (Sandquist – LSA Inc), Spineflower (Jones, Sandquist & Walker – Newhall Ranch), Woolystar (Jones, Sandquist, & Schenk – Sapphos Inc.). Each of the above projects has at least one additional graduate student associated with the project and some have up to 5 additional undergraduates. Studies using isolation chambers is of primary importance to semester projects in Desert Ecology (Biol_449) and Plant Physiological Ecology (Biol_444) among others.
- 1 Head house (ca. 1400 ft^2)
  - Technician office with computer control for green houses
  - Bath room with shower
  - Soil sterilization facilities
  - Wet benches and sinks
  - Hood (standalone is okay)
  - Drying oven
  - Refrigerator/freezer
  - seed & soil storage facilities
  - Other short-term storage (e.g., potting materials)
  - Uses – facilities in the head house will support *all* research activities. Specific examples include: Soil sterilization for mitigation studies of endangered lilies (Jones & Sandquist), refrigerators and freezers for seed storage experiments (Jones, Schenk), and student projects for graduate theses and upper division courses
  - Root washing facility??
- 1 Small Lath house (ca. 1000 ft^2)
  - Uses – see Outdoor planting areas (below)
- Outdoor planting and experimentation areas (ca. 4800 ft^2)
  - benches (20 each @ 32 ft^2)
  - raised bed planters (10 each @ 32 ft^2)
  - Uses – Large-scale experiments often cannot be accommodated within the greenhouse area. In the recent past, these experiments have taken place on Arboretum property and in the large outdoor space of the current greenhouse facility. In addition, owing to the lack of fully functional greenhouses, much of the indoor research proposed in our grants has been delayed or adapted for outdoor settings, with mixed results. The following project have or will need outdoor areas for research: Desert vegetation recovery (Sandquist - USGS Mojave Project), Desert plant root architecture (Schenk – Mellon Foundation), Hawaii forest productivity (Sandquist – NSF), Hawaii forest seedling responses (Sandquist – USDA),

Endangered species studies: Lilies (Jones – LSA Inc), Lilies (Sandquist – LSA Inc), Spineflower (Jones, Sandquist & Walker – Newhall Ranch), Woolystar (Jones, Sandquist, & Schenk – Sapphos Inc.). Each of the above projects has at least one additional graduate student associated with the project and some have up to 5 additional undergraduates. Plants from most have also been used for instructional purposes in courses like Plants & Life (BIOL 352), Plant Ecology (BIOL 443) and many others.

- Outdoor storage facilities
  - Soil bins (ca. 250 ft^2)
  - Greenhouse truck/cart parking (ca. 200 ft^2)
  - Storage containers (3@ 8x25 = 600 ft^2)
  - Uses – storage facilities will support *all* research activities.

Herbarium Space

Combining the Department's and the Arboretum's herbaria with the living collection of the Arboretum is a logical move that could enhance the scholarly prestige of the Arboretum and become a major selling point for it. Both herbarium staff and Arboretum visitors could use the combined facility.

- Room (ca. 800 ft2)
- Dry air-conditioned
- Tables and cabinets

Committees AY 07-08

Departmental Personnel Committee • {Banack (1st of 2 yr) *Prof Leave*} • Eernissee (1st of 2 yr) • Dickson, (2nd of 2 yr) *(Chair)* • Horn (1st of 2 yr) • Sandquist (1-yr replacement) • Stapp (alternate)	**Core Instructors Group** *(core course instructors for AY)* • Cuajungco, Cohen, Dickson, B. Murray, Sandquist, Schenk, Stapp, Walker, Whipple, Zacherl • Sandquist, *Chair*
Concentration Groups Chairs • Walker (BEC) • Dickson (MB) • Cohen (MB&B) • Drath (C&D)	**Curriculum Committee** • Jones (BEC-Fall) *Chair and College rep* • Kandel (C&D-Spring) *Chair and College rep* • Smith, J. (MB) • Tommerup (Pedagogy) • Whipple (MB&B-Fall)
Graduate Advancement • Cohen (MB&B) • Horn (MB) • Patel (C&D) • Stapp (BEC) • Schenk, *Chair* (BEC)	**Undergraduate Advancement** • Chen (MB&B) • Cuajungco (C&D) • Jones/Kandel (Fall-BEC/Spring-C&D) *Chair* • Zacherl (MB)
Cell Biology Search • Drath • Patel • Sandquist (Chair) • Cuajungco • Dickson	**Molecular Search** • Cohen, *co-Chair* • Chen • Tolmasky, *co-Chair* • Walker • Srinivasan (Chem/Biochem)
Marine Biology Search • Eernisee • Houtman • Horn, *Chair* • Stapp • Zacherl	**Assessment Team** • Houtman (BEC/Pedagogy), *Chair* • Walker (BEC) • Dickson (PPR rep)

Information Technology Committee • Walker, *Chair* • Tolmasky • Nguyen • Stapp	**Vehicle/Boat Committee** • Zacherl • Sandquist • Walker • Dickson • Stapp, *Chair*
Management Team • Koch, *Chair* • Dickson, *Vice Chair* • Chair, DPC • Chair, Curriculum • Chair, Graduate Advancement • Chair, Undergraduate Advancement	**PPR Preparation and Retreat Planning Committee** • Koch • Dickson • Assessment Chair • Graduate Adv Chair
Graduate Student Club • Biology Grad Adviser (Stapp)	**Undergraduate Student Club** • Biology UG Club Adviser (Sandquist)
Biology GE Program: • Houtman, *Coordinator*	**Research Training Programs** • **UMEB:** Sandquist • **MARC:** Cohen
College Committees • **Career Group** (Casem) • **Credentialing** (Tommerup) • **Curriculum** (*selected from dept committee*) • **MARC Steering** (Cohen, Koch) • **Safety Committee** (Cohen) • **Research** (Stapp)	**University Committees** • **Accessible Technology Initiative E & IT Procurement Subcommittee** (Hoese??) • **Campus Landscape** (Sandquist) • **Conflict of Interest Committee** (Cohen) • **Faculty Leaves** (Drath) • **Health Professions** (Drath, Cohen) • **Honors Program** (Tolmasky) • **IACUC** (Dickson, Presch) • **Library** (Chen) • **PBRC** (Koch) • **President's Scholars** (Tolmasky) • **Radiation Safety** (Cohen, Tolmasky) • **Select Agents Liaison** (Tolmasky) • **Sustainability Committee** (Schenk) • **University Information Technology** (Walker)
***Ad hoc* Committee to Review Use of Lottery Funds** • Dickson, Chair (faculty) • Tolmasky (faculty) • Craddock (staff) • Garden (staff) • (grad student) • (grad student)	**CSU Activities** • **CSUPERB SPC/FCG, Chair** (Koch) • **CSUPERB FCG** (Tolmasky) • **Desert Studies Director** (Presch) • **Desert Studies Board** (Sandquist) • **Tucker Science Advisory Board** (Sandquist) • **OSI Board** (Dickson/Zacherl)

	• **OSI Dive Control** (Zacherl)

revised 31 Aug 07

Undergraduate Advising Handbook

Department of

Biological Science

California State University
Fullerton

Fall 2007

CAL STATE FULLERTON
Department of Biological Science
(714) 278-3614 / Fax (714) 278-3426

Dear Biology Major:

Welcome to the Department of Biological Science at Cal State Fullerton!

This handbook is intended to help you navigate through the requirements for your degree in biology. Please review its contents and make it a part of your permanent University record.

As part of our mandatory advising program, which is designed to help you use your time here efficiently, you have been assigned to a Biology faculty adviser. You will meet each semester to evaluate progress toward your degree objectives and to remove you advising hold. Please bring a copy of your Titan Online Degree Audit when attending academic advising sessions.

In addition, I recommend that you establish a strong relationship with your advisor so that you have someone who knows you well and can write letters of recommendation when needed.

If you need additional assistance at any time, please stop by the Department office to ask for help. We look forward to meeting you and working with you.

Sincerely,

Robert A. Koch, PhD
Professor of Cell Biology
Chair, Department of Biological Science

TABLE OF CONTENTS

BACHELOR OF SCIENCE DEGREE IN BIOLOGICAL SCIENCE

A. BIOLOGY MAJOR REQUIREMENTS

		Units
I.	Core Biology Courses	20
II.	Upper Division Electives	23
III.	Supporting Science & Math Courses For The Major	29-30

B. UNIVERSITY REQUIREMENTS

IV.	General Education Courses (see appendix, or University Catalog) 51 units required; some courses above in core and supporting courses count for all 12 units in GE category IIIA. Total remaining GE units (51-12=39)	39
V.	Upper Division Writing Requirement	0-3
VI.	Free Electives (any courses)	5-8
	TOTAL UNITS	**120**

BACHELOR'S DEGREE REQUIREMENTS

To track your progress in fulfilling the following requirements access your Titan Degree Audit *(www.fullerton.edu→Portal login→Student Academics→TITAN degree audit)*.

A. Major requirements:

- ☐ 20 units of core biology courses (minimum grade of C in each course)
- ☐ 30 units of supporting courses (at least a C average = 2.0)
- ☐ 23 units of upper division biology electives required by one of the concentrations (minimum grade of C in each course)
- ☐ 5 of the 23 upper division units must be laboratory/fieldwork
- ☐ Take the biology exit examination (Major Field Test) during the spring of the senior year prior to graduation.

B. University requirements:

- ☐ General education requirements (at least 51 GE units) including:
  - ☐ at least **9** units of upper division GE (300-400 level courses)
  - ☐ at least **9** units of GE taken at CSUF
  - ☐ at least **3** units of Cultural Diversity coursework (GE category V)
  - ☐ no more than **6** units from any one category or any one department
  - ☐ no units from the department of your major (except Biol 171 for Life Science requirement)
  - ☐ Complete at least 40 units of upper division coursework (300 and 400 level), (Note: Completion of the major usually fulfills this requirement).
- ☐ Complete at least 30 units at CSUF
  - ☐ at least 9 units must be GE courses
  - ☐ at least 24 of the 30 units must be upper division
    - ☐ at least 12 of the 24 upper division units must be in your major
- ☐ No more than 36 "credit/no credit" units
- ☐ No more than 24 units taken through Extended Education
- ☐ No more than 9 units of internship (495 courses in any department)
- ☐ No more than 4 units of reading skills courses
- ☐ Satisfy the upper division writing requirement (Engl 301 or Chem 340 or 6 units of Biol courses that meet this requirement)
- ☐ Pass the Examination in Writing Proficiency (EWP)
- ☐ Apply for a **graduation check** approximately one year (two semesters) before graduation (less than 48 units to complete). Submit graduation check application form to the Graduation Unit. Forms are available at both the Graduation Unit (LH-108) and the Admissions & Records Information Counter (LH-109). Upon notification from the Department, pick up completed form from the Biology Office (MH-282) and return it to the Graduation Unit by the last day of classes of the semester preceding the semester in which you anticipate graduating.
- ☐ Finish with at least a 2.0 (C) grade point average in all courses at CSU Fullerton and elsewhere. (Note: A "C-" counts as 1.7 grade point units.)
- ☐ Complete at least 120 total units for your degree

THE BIOLOGY MAJOR

I. Core Biology Courses

The two-year Core provides a solid basis for understanding the principles that underlie the many distinct disciplines of biology, and focuses instructional attention on individuals working as part of small teams. These teams work together in the laboratory and field to discover information about the biological world. The Core is composed of four sequential courses (20 units):

BIOL 171: Evolution & Biodiversity (5 units)
BIOL 172: Cellular Basis of Life (5 units)
BIOL 273: Genetics & Molecular Biology (5 units**)**
BIOL 274: Principles of Physiology & Ecology (5 units)

TOTAL (20 units)

II. Upper Division Courses (see concentration worksheets, pp. 5-8)

Upon completion of the core biology courses each student selects one of four concentrations. Biology majors will graduate with a Bachelor of Science degree in Biology with a Concentration in Biodiversity, Ecology & Conservation Biology, Cell & Developmental Biology, Marine Biology, or Molecular Biology and Biotechnology. Each concentration focuses on a specific field of study within biology. Concentrations require 23 units of classroom study, including at least 5 units of laboratory or field-based activities at the 300- and 400-level, and at least 6 units of 400-level biology courses. Two 400-level elective courses (see those marked by a #) may be taken to fulfill the University's upper-division writing requirement. A capstone course (2 units minimum) culminates each concentration.

TOTAL (23 units)

III. Supporting Courses

Supporting courses in Chemistry, Mathematics, and Physics provide the broad-based knowledge that is essential to any scientist. The concepts introduced build the foundation necessary to advance to upper division coursework in Biology.

MATH: Calculus or statistics (3-4 units)
CHEM: General and organic chemistry (18 units)
PHYS: Elementary physics (8 units)

TOTAL (29-30 units)

BIOLOGY CORE AND SUPPORTING COURSES WORKSHEET

Required Core Biology Courses must be taken in sequence and passed with a C or better (20 units):

Met	Course	Title (units)	When passed	Equiv. Course # / campus	Grade
	BIOL 171	Evolution & Biodiversity (5)			
	BIOL 172	Cellular Basis of Life (5)			
	BIOL 273	Genetics & Molecular Biology (5)			
	BIOL 274	Principles of Physiology & Ecology (5)			

Required Supporting Courses for Biological Science Majors (C average required) (30-33 units)

Met	Course	Title (units)	When passed	Grade
	MATH 130[1]	Short Course in Calculus (4) OR		
	MATH 150A[1]	Calculus (4) OR		
	MATH 337	Intro. to Expl Design & Stats in Lab Sciences (3)		
	CHEM 120A	General Chemistry (5)		
	CHEM 120B	General Chemistry (5)		
	CHEM 301A	Organic Chemistry (3)		
	CHEM 301B	Organic Chemistry (3)		
	CHEM 302	Organic Chemistry Lab (2)		
	PHYS 211	Elementary Physics (3)		
	PHYS 211L	Elementary Physics Lab (1)		
	PHYS 212	Elementary Physics (3)		
	PHYS 212L	Elementary Physics Lab (1)		
	ENGL 301	Advanced College Writing (3) **OR**		
	CHEM 340	Writing for the Chemical Sciences (3) **OR**		
	6 units of any Bio course meeting the upper div. writing requirement[†]			

Prerequesites required for core biology and supporting courses:

Course	Prerequisites/(Corequisites)
BIOL 171	None
BIOL 172	BIOL 171
BIOL 273	BIOL 172, CHEM 120A (Pre- or Coreq)
BIOL 274	BIOL 273, CHEM 120A. MATH 130, 150A, or 337 suggested.
MATH 130/150A	Passing score on MQE
MATH 337[1]	Passing score on the ELM (or exemption) + completion of one: BIOL 171, 172, CHEM 120, PHYS 211, or 225 (MATH 337 does not satisfy GE IIIA1)
CHEM 120A	Passing score on ELM (or exemption) **OR** CHEM 115
CHEM 120B	CHEM 120A
CHEM 301A	CHEM 120B
CHEM 301B	CHEM 301A
CHEM 302	CHEM 301A; CHEM 301B (coreq)
PHYS 211	MATH 130, 150A, OR 337; PHYS 211L (coreq)
PHYS 211L	PHYS 211 (coreq)
PHYS 212	PHYS 211; PHYS 212L (coreq)
PHYS 212L	PHYS 212 (coreq)

[1]Students interested in health professions careers should take Math 130 or Math 150A or equivalent.

[†] Courses meeting the writing requirement: BIOL 411, 414, 417, 422, 426, 445, 446, 449, 468, 470, 495. Students interested in health professions careers should take Engl 301.

MARINE BIOLOGY CONCENTRATION (MB) WORKSHEET *(rev 3/26/07)*

The study of marine organisms and their coastal and oceanic habitats, including classification, structure/ function, ecology and physiology of these organisms, and conservation, environmental and evolutionary issues related to these organisms and their habitats.

Course categories	√	Courses*
Core courses (Required) 20 units		BIOL 171 Evolution & Biodiversity (5) BIOL 172 Cellular Basis of Life (5) BIOL 273 Principles of Genetics and Molecular Biology (5) BIOL 274 Principles of Physiology and Ecology (5)
The concentration consists of 23 units of upper-division **biology** electives, of which at least 5 units must be laboratory- or field-based, at least 6 units must be 400-level, and at least 2 capstone units. The 23 units of upper-division biology electives must also meet the following requirements:		
Foundation courses (3 units)		BIOL 314 Population and Community Ecology (3) **OR** BIOL 325 Intermediate Evolution (3)
Upper-Division Biology electives 11 units minimum † courses that meet the upper division writing requirements (6 units required)		Ecology Courses –take at least one of the following: (4 units minimum) BIOL 419 Marine Ecology (3) and BIOL 419L Marine Ecology Laboratory (1/1) **OR** BIOL 422 Coastal Ecology (4/2)† OSI (Catalina Semester) courses: 353, 420, 455, 458 Organismal/Systematics courses - take at least one of the following: (4 units minimum) BIOL 446 Marine Phycology (4/2)† BIOL 461 Marine Invertebrate Zoology (4/2) BIOL 475 Ichthyology (4/2) OSI (Catalina Semester) courses: 313, 417, 419, 420, 425 Other Marine Biology courses – take at least one of the following: (3 units minimum) BIOL 301 Problems in Environmental Biology (3/2) BIOL 302 Microbiology (4/2) BIOL 317 Field Marine Biology (4/2) BIOL 402 Computer Lab in Molecular Systematics (3/1) BIOL 404 Evolution (3) or BIOL 409 Evolution for Teachers (3) BIOL 405 Developmental Biology (3) BIOL 436 Advanced Applied Statistics (3/1) BIOL 468 Comparative Animal Physiology (4/1)† [was 4/2 prior to F06] OSI (Catalina Semester) courses: 345, 460 any Foundation, Ecology, or Organismal/Systematics course listed above and not used to meet the above requirements
Free upper-division electives		Additional upper-division Biology electives to reach at least 23 units. Although it is recommended that Marine Biology majors select these additional elective units from the courses listed above, any upper-division Biology majors course may be utilized to fulfill these additional units.
Capstone Courses 2 units minimum		BIOL 400 Seminar in Biology Education (Issues in Teaching Evolution & Biodiversity OR Issues in Teaching Physiology & Ecology) (2) BIOL 401 Biogeography (3) BIOL 422 Coastal Ecology (4/2)† BIOL 450 Conservation Biology (3) BIOL 482 Capstone Studies in Biology (2) BIOL 495 Biological Internship (3/2)† BIOL 498 Senior Thesis (1-2) BIOL 499L Independent Laboratory Study (1-3) OSI (Catalina Semester) course: 496
Total upper-division units	**23**	

† courses above that meet the upper division writing requirements (6 units required)
* Courses shown as total units / lab-field units e.g. 4/2

Other concentration requirements:	Courses	units
5 units of lab- or field- courses		
6 units of 400-level biology courses		
Upper-division writing requirement		
No more than a combined total of 6 units of BIOL 480 (3 max), 482 (2 max), 495 (3 max), 498 (3 max), and BIOL 499L (6 max) shall be counted toward the 23 upper-division Biology units required for the major		

BIODIVERSITY, ECOLOGY, & CONSERVATION BIOLOGY CONCENTRATION (BEC) WORKSHEET (rev. 3/1/07)

The study of all biological organisms (ranging from the level of the individual to the ecosystem), their responses to the environment on evolutionary and ecological time scales, and their conservation.

Course categories	√	Courses*
Biology Core		BIOL 171, 172, 273 and 274 completed prior to starting concentration
The concentration consists of 23 units of upper-division **biology** electives, of which at least 5 units must be laboratory- or field-based, at least 6 units must be 400-level, and at least 2 capstone units. The 23 units of upper-division biology electives must also meet the following requirements:		
Foundation courses (6 units)		BIOL 314 Population and Community Ecology (3) AND BIOL 325 Intermediate Evolution (3)
Upper-Division BEC electives in Organismal Biology and Physiology (6 units minimum)		**Organismal Biology courses - students must take at least one of the following: (3 units minimum)** Animal Biology: BIOL 467 Entomology (4/2) BIOL 474 Natural History of Vertebrates (4/2) BIOL 476 Herpetology (4/2) BIOL 478 Mammalogy (4/2) BIOL 479 Ornithology (4/2) Plant Biology: BIOL 340 Field Botany (3/2) BIOL 344 Survey of Land Plants (4/2) BIOL 441 Plant Taxonomy (4/2) Microbiology: BIOL 302 General Microbiology (4/2) **Physiology Courses – students must take at least one of the following: (3 units minimum)** BIOL 362 Mammalian Physiology (4/1) [was 4/2 from F99 – F04] BIOL 444 Plant Physiological Ecology (4/2) BIOL 445 Plant Cell Physiology (3)† BIOL 468 Comparative Animal Physiology (4/1)† [was 4/2 prior to F06]
Additional Upper-Division BEC electives (5 units minimum) [1]a maximum of 4 units of these marine biology classes may be applied toward the 23 upper-division electives required for the BEC concentration		**Any additional upper-division Biology courses(s) from the Organismal Biology or Capstone list (additional units from Organismal Biology or Capstone courses not used to fulfill those requirements count here) or courses from among the following: (5 units minimum)** BIOL 301 Problems in Environmental Biology (3/2) BIOL 317 Field Marine Biology (4/2)[1] BIOL 402 Computer Lab in Molecular Systematics (3/1) BIOL 404 Evolution (3) or BIOL 409 Evolution for Teachers (3) BIOL 419 Marine Ecology (3)[1] BIOL 419L Marine Ecology Laboratory (1)[1] BIOL 422 Coastal Ecology (4/2)[1]† BIOL 436 Advanced Applied Statistics (3/1) BIOL 442 Pollination Biology (3/1) BIOL 443 Plant Ecology (4/2) BIOL 444 Plant Physiological Ecology (4/2) BIOL 446 Marine Phycology (4/2)[1]† BIOL 449 Desert Ecology (4/2)† BIOL 461 Marine Invertebrate Zoology (4/2)[1] BIOL 466 Behavioral Ecology (3) BIOL 468 Comparative Animal Physiology (4/1)† [was 4/2 prior to F06] BIOL 475 Ichthyology (4/2)[1]
Free upper-division electives		Additional upper-division Biology electives to reach at least 23 units. Although it is recommended that BEC majors select these additional elective units from the courses listed above, any upper-division Biology majors course may be utilized to fulfill these additional units.
Capstone Courses 2 units minimum		BIOL 400 Seminar in Biology Education (Issues in Teaching Evolution & Biodiversity OR Issues in Teaching Physiology & Ecology) (2) BIOL 401 Biogeography (3) BIOL 447 Ethnobotany (3/1) BIOL 450 Conservation Biology (3) BIOL 481 Advances in Evolution and Ecology (3) BIOL 482 Capstone Studies in Biology (2) BIOL 495 Biological Internship (3/2)† BIOL 498 Senior Thesis (1-2) BIOL 499L Independent Laboratory Study (1-3)
Total upper-division units	**23**	

† courses above that meet the upper division writing requirements (6 units required)
* Courses shown as total units / lab-field units e.g. 4/2

Other concentration requirements:	Courses	units
5 units of lab- or field- courses		
6 units of 400-level biology courses		
Upper-division writing requirement		
No more than a combined total of 6 units of BIOL 480 (3 max), 482 (2 max), 495 (3 max), 498 (3 max), and BIOL 499L (6 max) shall be counted toward the 23 upper-division Biology units required for the major		

CELL AND DEVELOPMENTAL BIOLOGY CONCENTRATION (C&D) WORKSHEET

The study of the structural and functional dynamics of cells, including topics such as compartmentation and secretion, cell motility, and cell-cell interactions as they apply to the specialized fields of immunology, microbiology, neurobiology, physiology, and developmental biology.

Course categories	√	Courses (total # units/# lab-field units)
Biology Core		Biol 171, 172, 273 and 274 completed prior to starting concentration
The concentration consists of 23 units of upper-division **biology** electives, of which at least 5 units must be laboratory- or field-based, at least 6 units must be 400-level, and at least 2 capstone units. The 23 units of upper-division biology electives must also meet the following requirements:		
Gateway courses (7 units)		Complete both of these before entering the other upper division electives: BIOL 302 General Microbiology (4/2) BIOL 303 Intermediate Cell Biology (3)
Upper-Division Biology electives 10 units minimum ‡courses count as electives or capstone, but not both		<u>Cell Biology Courses – students must take a minimum of 7 units of the following</u>: BIOL 362 Mammalian Physiology (4/1)[Was 4/2 from F99 – F04] BIOL 405 Developmental Biology (3) BIOL 417 Advances in Cell Biology (3)† BIOL 418L Advances in Cell Biology Lab (2/2) BIOL 424 Immunology (4/2) BIOL 426 Virology (3)† ‡ BIOL 428 Biology of Cancer (3) ‡ BIOL 470 Cellular Neurobiology (3)† ‡ Molecular Biology Courses – students may use the following courses to complete the 10-unit minimum: BIOL 309 Intermediate Molecular Biology (3) BIOL 402 Computer Lab in Molecular Systematics (2,1) BIOL 411 Medical Genetics and Systems Biology (3)† BIOL 412 Principles of Gene Manipulation (3) BIOL 413 Advances in Molecular Genetics (3) BIOL 414 Microbial Genetics (3)† BIOL 445 Plant Cell Physiology (3)† BIOL 448 Plant Molecular Biology (3) CHEM 421 Biological Chemistry (3)
Free upper-division electives		Any additional upper-division Biology elective. Many students choose additional courses from above or select from the following: BIOL 304 Supervised Biology Lab Instruction (2) BIOL 361 Human Anatomy (4/2) BIOL 480 Advanced Topics in Undergraduate Biology (1-3)
Capstone Courses 2 units minimum		BIOL 400 Seminar in Biology Education (Issues in Teaching Cell Biology) (2) BIOL 426 Virology (3)† ‡ BIOL 428 Biology of Cancer (3) ‡ BIOL 470 Cellular Neurobiology (3)† ‡ BIOL 482 Capstone Studies in Biology (2) BIOL 495 Biological Internship (3/2)† BIOL 498 Senior Thesis (1-2) BIOL 499L Independent Laboratory Study (1-3)
Total upper-division units	**23**	

† courses above that meet the upper division writing requirements (6 units required)
* Courses shown as total units / lab-field units e.g. 4/2

Other concentration requirements:	Courses	units
5 units of lab- or field- courses		
6 units of 400-level biology courses		
Upper-division writing requirement		
No more than a combined total of 6 units of Biol 480 (3 max), 482 (2 max), 495 (3 max), 498 (3 max), and Biol 499L (6 max) shall be counted toward the 23 upper-division Biology units required for the major		

MOLECULAR BIOLOGY AND BIOTECHNOLOGY CONCENTRATION (MB&B) WORKSHEET

The study of genetics, molecular biology, and biotechnology and their applications to medicine, agriculture and the environment (e.g., cancer, infectious diseases, gene therapy, crop improvement, and bioremediation).

Course categories	√	Courses (total # units/# lab-field units)
Biology Core		Biol 171, 172, 273 and 274 completed prior to starting concentration
The concentration consists of 23 units of upper-division **biology** electives, of which at least 5 units must be laboratory- or field-based, at least 6 units must be 400-level, and at least 2 capstone units. The 23 units of upper-division biology electives must also meet the following requirements:		
Gateway courses (6-7 units)		Complete these before entering the other upper division electives: BIOL 309 Intermediate Molecular Biology (3) **and one or more of the following:** BIOL 302 General Microbiology (2,2) CHEM 421 Biological Chemistry (3) **or** CHEM 423A General Biochemistry (3)
Upper-Division Biology electives 13 units minimum ‡courses count as electives or capstone, but not both		Molecular Biology Courses – students must take a minimum of 8 units of the following: BIOL 402 Computer Lab in Molecular Systematics (2,1) BIOL 405 Developmental Biology (3) BIOL 411 Medical Genetics and Systems Biology (3)† BIOL 412 Principles of Gene Manipulation (3) BIOL 413 Advances in Molecular Genetics (3) BIOL 414 Microbial Genetics (3)† BIOL 445 Plant Cell Physiology (3)† BIOL 448 Plant Molecular Biology (3) BIOL 472A Advances in Biotechnology Lab (3/2) ‡ BIOL 472B Advances in Biotechnology Lab (3/2) ‡ BIOL 473 Bioinformatics (2,1) Cell Biology Courses – students may use the following courses to complete the 13-unit minimum: BIOL 362 Mammalian Physiology (4/1)[Was 4/2 from F99 – F04] BIOL 417 Advances in Cell Biology (3) BIOL 418L Advances in Cell Biology Lab (0,2) BIOL 424 Immunology (2,2) BIOL 426 Virology (3)† BIOL 428 Biology of Cancer (3) BIOL 444 Plant Physiological Ecology (2,2) BIOL 470 Cellular Neurobiology (3)† BIOL 477 Advances in Biotechnology (3) BIOL 499L Independent Laboratory Study (must be in the concentration) (1-3)
Free upper-division electives		Any additional upper-division Biology electives to reach a total of at least 23 units. Many students choose additional courses from above or select from the following: BIOL 304 Supervised Biology Lab Instruction (2) BIOL 480 Advanced Topics in Undergraduate Biology (1-3)
Capstone Courses 2 units minimum		BIOL 400 Seminar in Biology Education (Issues in Teaching Genetics and Molecular Biology) (2) BIOL 472A Advances in Biotechnology Lab (3/2) ‡ BIOL 472B Advances in Biotechnology Lab (3/2) ‡ BIOL 482 Capstone Studies in Biology (2) BIOL 495 Biological Internship (must be in the concentration) (3/2)† BIOL 498 Senior Thesis (must be in the concentration) (1-2) BIOL 499L Independent Laboratory Study (must be in the concentration) (1-3)
Total upper-division units	**23**	

† courses above that meet the upper division writing requirements (6 units required)
* Courses shown as total units / lab-field units e.g. 4/2

Other concentration requirements:	Courses	units
5 units of lab- or field- courses		
6 units of 400-level biology courses		
Upper-division writing requirement		
No more than a combined total of 6 units of Biol 480 (3 max), 482 (2 max), 495 (3 max), 498 (3 max), and Biol 499L (6 max) shall be counted toward the 23 upper-division Biology units required for the major		

ALL BIOLOGY ELECTIVES

The following is a list of all of the elective courses offered by the Department.
Not every course is taught each semester.

FOR PREREQUISITES SEE COURSE CATALOG

300-Level Courses that **DO** count toward "Biology Electives" - list shows the total number of units followed by the number out of the total that may be applied toward the 5-unit "laboratory/fieldwork" requirement:

301	Problems in Environmental Biology	3/2
302	General Microbiology	4/2
303	Intermediate Cell Biology	3
304	Supervised Biology Lab Instruction	2
309	Intermediate Molecular Biology	3
314	Population and Community Ecology	3
317	Field Marine Biology	4/2
325	Intermediate Evolution	3
340	Field Botany	3/2
344	Survey of Land Plants	4/2
352	Plants and Life (accepted prior to F05)	3
361	Human Anatomy	4/2
362	Mammalian Physiology	4/1 (4/2 from F99 –F04)

400-Level Courses that **DO** count toward "Biology Electives" - list shows the total number of units and the number out of the total (in parentheses) which may be applied toward the 5-unit "laboratory/fieldwork" requirement:

401	Biogeography	3 units
402	Computer Lab in Molecular Systematics	3/1
404★	Evolution	3
405	Developmental Biology	3
409★	Evolution for Teachers (WEB)	3
411†	Medical Genetics	3
412	Principles of Gene Manipulation	3
413	Advances in Molecular Genetics	3
414†	Microbial Genetics	3
417†	Advances in Cell Biology	3
418L	Advances in Cell Biology Laboratory	2/2
419	Marine Ecology	3
419L	Marine Ecology Lab	1/1
422†	Coastal Ecology	4/2
424	Immunology	4/2
426†	Virology	3
428	Biology of Cancer	3
433	Microbial Problems in Foods	2/1
436	Advanced Applied Statistics	4/1
438	Public Health Microbiology	4/2
441	Plant Taxonomy	4/2
442	Pollination Biology	3/1
443	Plant Ecology	4/2
444	Plant Physiological Ecology	4/2
445†	Plant Cell Physiology	3
446†	Marine Phycology	4/2
447	Ethnobotany	3/1
448	Plant Molecular Biology	3
449†	Desert Ecology	4/2
450	Conservation Biology	3
451	Advanced Human Evolution	3
461	Invertebrate Zoology	4/2
462	Parasitology	4/1
466	Animal Behavior	3
467	Entomology	4/2
468†	Comparative Animal Physiology	4/1 (4/2 prior to F06)
470†	Cellular Neurobiology	3 (Cont. next page ➔)
472A	Advances in Biotechnology Laboratory	3/2
472B	Advances in Biotechnology Laboratory	3/2
473	Bioinformatics	3/1
474	Natural History of the Vertebrates	4/2
475	Ichthyology	4/2
476	Herpetology	4/2
477	Advances in Biotechnology	3
478	Mammalogy	4/2
479	Ornithology	4/2
* 480	Advanced Topics in Undergrad Biology	1-3

* 480E	Environmental Biology Proseminar	1
* 480M	MARC Proseminar (for MARC Scholars only)	1
481T	Sexual Selection, Behavior & Mate Choice (F05)	3
* 482	Capstone Studies in Biology	2/2
* 495†	Biological Internship	3/2
* 498	Senior Thesis	2
* 499L	Independent Laboratory Study	(1 to 3)

*A combined total of 6 units from all of these classes may be applied to elective requirement.

**CHEM 421	3
**CHEM 423A, B	3

** Maximum of 3 units (total) may be applied to elective requirements for students entering Fall 1992 or later. Students entering prior to Fall of 1992 may use 6 of these units toward elective requirements.

300-level Courses that **DO NOT** count toward "Biology Electives"—
If you are a Biology Major do not take these courses:

300	Environmental Biology	3
305	Human Heredity and Development	3
306	Biology of Aging	3
310	Human Physiology	3
310L	Human Physiology Lab	1
311	Nutrition and Disease	3
318	Wildlife Conservation	3
319	Marine Biology	3
330	Ecology of American Indians	3
352	Plants and Life (accepted to majors prior to F05)	3
360	Biology of Human Sexuality	3
453	Life Science Concepts	3

400-level Courses that **DO NOT** count toward "Biology Electives" but may count toward graduation as "Free Electives:"

496	Biological Science Tutorials

Only upper division courses can be transferred (if equivalent) for elective units.
No courses taken at community colleges are upper division.

★ **Students may not count both 404 and 409 toward upper division electives.**

† courses above that meet the upper division writing requirements (6 units required)

PLANNING YOUR COURSEWORK

Many CSUF students work. This impacts the amount of time students have outside of class to study.

If You Are Employed:	Then Your School Work Should Be:

(Hours Per Week)	(Maximum Units Per Semester)
0	16
1-9	14-15
10-19	13-14
20-29	9-12
30-39	6-9
40+	3-9

This plan is based on a 60-hour work-week (employment plus school work, and not including other time commitments, such as commuting) and the need to study for: 2 hours for each 3 hours lab
3 hours for each 1 hour lecture

If You Complete:	**You Will Graduate In:**
30 units per year	4 years
24 units per year	5 years
20 units per year	6 years

Use one of the matrices on the following 2 pages to plan your college coursework.

SAMPLE COURSE MATRIX FOR STUDENTS PLANNING TO GRADUATE IN 4 YEARS (no summer school)

Year 1		Year 2		Year 3		Year 4	
Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Biol 171 (5)	Biol 172 (5)	Biol 273 (5)	Biol 274 (5)	Upper division elective (3-4)	2 Upper division electives (3) (3)	2 Upper division electives 2 X (3-4)	4 Upper division electives 4 X (3-4)
Math 130/150A (4)	Chem 120A (5)	Chem 120B (5)	Chem 301A (3)	Chem 301B (3) Chem 302 (2)	Phys 211 (3) Phys 211L (1)	Phys 212 (3) Phys 211L (1)	Free electives (to make 120 total units)
GE IA Eng 101 (3)	GE I B or C (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3)	
GE (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3)		
Total: 15 units	Total: 16 units	Total: 16 units	Total: 14 units	Total: 14-15 units	Total: 16 units	Total: 13-15 units	Total: 15-17 units

Blank Matrix for Planning Purposes

Year 1		Year 2		Year 3		Year 4	
Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Intersession	Summer						
Total: 15 units	Total: 16 units	Total: 16 units	Total: 14 units	Total: 14-15 units	Total: 16 units	Total: 13-15 units	Total: 15-17 units

*These matricies assume no remedial courses needed.

SAMPLE COURSE MATRIX FOR STUDENTS PLANNING TO GRADUATE IN 5 YEARS (no summer school)

Year 1	Year 2	Year 3	Year 4	Year 5

Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Biol 171 (5)	Biol 172 (5)	Biol 273 (5)	Biol 274 (5)	Upper division elective (4)	Upper division elective (3)	Upper division elective (3-4)	Upper division elective (3-4)	Upper division elective (3-4)	2 Upper division electives 2 X (3-4)
Math 130/150A (4)	Chem 120A (5)	Chem 120B (5)	Chem 301A (3)	Chem 301B (3) Chem 302 (2)	Phys 211 (3) Phys 211L (1)	Phys 212 (3) Phys 211L (1)	Upper division elective (3-4)	Upper division elective (3-4)	Upper division elective (3-4)
GE IA Eng 101 (3)	GE I B or C (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3)	GE (3) *if not taken earlier*
			Free elective (1)		GE (3)	Free electives (1-2)	GE (3) OR Free Elective (1)	GE (3) OR Free elective (1-2)	GE (3) *if not taken earlier*
Total: 12 units	Total: 13 units	Total: 13 units	Total: 12 units	Total: 12 units	Total: 13 units	Total: 12 units	Total: 12 units	Total: 12 units	Total: 12-

Blank Matrix for Planning Purposes

Year 1		Year 2		Year 3		Year 4		Year 5	
Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
Intersession	Summer								
Total: 12 units	Total: 13 units	Total: 13 units	Total: 12 units	Total: 12 units	Total: 13 units	Total: 12 units	Total: 12 units	Total: 12 units	Total: 12-

*These matricies assume no remedial courses needed.

MINORS ASSOCIATED WITH BIOLOGY

Minor in Biotechnology

The biotechnology minor requires a minimum of 31 acceptable units of chemistry and biology as shown below. These courses must be completed with an overall GPA of 2.0 and must include 12 units unique to the minor and not used to meet requirements for the biological science or biochemistry major.

Required Biotechnology Minor Core Courses			Units
BIOL 273	Genetics & Molecular Biology		5
BIOL 309	Intermediate Molecular Biology	***Or***	3
CHEM 421	Biological Chemistry		3
CHEM 301A,B	Organic Chemistry (3,3)		6
CHEM 302	Organic Chemistry Lab		2
BIOL 412	Principles of Gene Manipulation		3
BIOL/CHEM 472A,B	Advances in Biotechnology Lab (3,3)		6
CHEM/BIOL 477	Advances in Biotechnology		3
		Total Core	**28**

Supporting Courses

Students must complete **one** of the following courses:

CHEM 421	Biological Chemistry	3
BIOL 309	Intermediate Molecular Biology	3
BIOL 413	Advances in Molecular Genetics	3
BIOL 424	Immunology	4
CHEM 423A	General Biochemistry (1st semester)	3
CHEM 423B	General Biochemistry (2nd semester)	3
	Total Supporting	**3-4**

Minor in Business Administration

In a concerted effort to meet a current need for many of our students, we suggest that students interested in both biology and business sign up for a minor in Business Administration. To do that go to the Business Advising Center in LH-731 (phone: 278-2212) and get the details on the minor.

A student who completes this minor and meets all other entrance requirements, will be poised to apply to the Master of Business Administration (MBA) degree program, and will then only need to take the second year (33 units) of coursework to complete the MBA.

Services Available Through the CSUF Health Professions Program

Students wishing to pursue careers in the following health professions: medicine, dentistry, pharmacy, optometry, physician assistant programs, veterinarian medicine, and physical therapy, should schedule an appointment with an advisor in the Health Professions Office in UH-223 by calling 714 278-3980.

Professional schools have specific course requirements that students should be aware of. Even though the Biology major is an excellent venue for preparation for the health professions there are particular math requirements and upper division biology elective courses within the major that are more relevant for specific health professions. In addition, there are certain activities that professional schools favor, such as basic science research, clinical work, and extra-curricular and community service that students should be familiar with. A health professions advisor will be able to point out appropriate courses and activities and in many cases recommend specific programs that students should participate in. Students may use the facilities of the Health Professions Office as needed, but should seek advising at least once a semester prior to registration. Many more meetings will be scheduled when a student enters the application process. **Meeting with a health professions advisor does not take the place of mandatory advising through the Biological Science Department.**

Other services that the Health Professions Program provides include helping student's select appropriate clinical career and the professional schools. An advisor will make suggestions on how students might improve their applications and personal statements and provide advice related to letters of recommendation and the interview process. When requested, mock interviews can be arranged through the Career Development Center. The Health Professions Program also supervises the on-campus club, the Students Health Professions Association, and students are encouraged to join this group. In addition, the Program evaluates files prepared by students who submit applications and, where appropriate, will prepare committee letters of support for qualified students.

Interested In Teaching Science?

For information concerning grade 7-12 teaching credentials in science with a concentration in biology, see Doug Stone in MH 629C. Successful completion of the teaching program allows you to teach: (a) every science in the middle school, junior high school, and at the 9th grade level in high school; (b) all sciences in an integrated science program at the high school level; and (c) the subjects in your concentration at the high school level. Contact Doug Stone to be advised about how to prepare for a teaching credential. **Call for an appointment: 714.278.5637.**

Before applying to the credential program, attend a Teacher Education overview session. For information, visit Teacher Education in the Education Classroom building (EC182), or go to http://ed.fullerton.edu/adtep and follow the Single Subject links. Prior to attending an overview, check the schedule at the overview phone tree: 714-278-3412.

For students interested in becoming teachers, you are encouraged to view the values, vision, and mission of the College of Education.
http://ed.fullerton.edu/documents/Core%20Values.doc

Steps for Admission to the Teaching Credential Program

1. Visit the **Office of Admission to Teacher Education in EC182**, to obtain a schedule of overview sessions or call Christine Wyder at 714.278.4028. You must attend an overview session to receive the *Admission to Teacher Education* packet with application materials.
2. Have a **GPA of at least 2.75** in last 60 semester units attempted.
3. Demonstrate that you have **Core General Science and A Breadth of Advanced Biology Subject Matter Competence** by successfully completing a CSUF Subject Matter Preparation Program in Science (SMP-S) or through a passing score on appropriate subject matter examination (CSET [all subtests]). In general, to get a teaching credential, students must verify subject-matter competence through core and upper division course work in ecology, evolution, physiology, cell, genetics, and organism biology in addition to the core breadth requirements in Earth and Space Science, Physics, and Chemistry.
4. Complete Department of **Secondary Education (EDSC) prerequisites**.

RESEARCH AND OTHER OPPORTUNITIES FOR UNDERGRADUATE BIOLOGY MAJORS

Research Courses. The Department offers undergraduate research courses that provide opportunities for undergraduates to progress from closely-directed research (BIOL 299L, usually performed at the freshman or sophomore level) to more independent work (BIOL 499L, usually performed at the junior or senior level). Student-faculty collaborations are created by mutual interest. The list on the following pages briefly summarizes faculty research interests. Limited funding is available from the Department to support this student research.

Intramural Research Funding. In addition to funding by the Department, two avenues for university-wide support are in place: the ASI Research Grants, a student-operated committee that funds student research, and the Undergraduate Research Initiative that fosters faculty-student collaborative research with awards of up to $1,000 per student. Both require students to submit formal, competitive research proposals.

MARC Scholars Program. This Minority Access to Research Careers (MARC) applications is available from March to April. Students who are eligible must be from an ethnic background underrepresented in the fields of scientific research and medicine and pursue a Ph.D, M.D./Ph.D., or other combine degree. Applicant must have junior standing or be at least two years away from graduation with a minimum GPA of 3.2 or above while majoring in biology, chemistry, biochemistry, mathematics, computer science, engineering or psychology. As honors undergraduate training program, the NIH develops six exceptional Scholars per year and prepares them for success in Ph.D. programs. Scholars receive stipends, tuition, research materials, and travel support. They also participate in a MARC Proseminar where they study the work of and interact with visiting scientists. Scholars may work with faculty members in the Department's of Biological Science, Chemistry, Biochemistry, Engineering, Mathematics and Psychology. Graduates are in research MD and MD/Ph.D. programs. Fact sheets are available online, from the program director, Dr. Amybeth Cohen (278-2178), and in the MARC Program Office (278-4251) in the Opportunity Center, MH-488. http://marc.fullerton.edu

MHIRT Program. The **Minority Health & Health Disparities International Research Training program** (MHIRT) is an additional NIH-sponsored program that provides minority students with the opportunity to carry out research during the summer (ten weeks) at laboratories in Thailand (Chiang Mai University) or Mexico (Instituto de Biotecnologia) availability alternates each year); or England (King's College, Cambridge University, Oxford University, St. George's Hospital Medical School, Royal Holloway, York University), under the direction of world-renown biochemists and molecular biologists. Fact sheets are available from the director, Dr. Marcelo Tolmasky (278-5263), or Eileen Simkin, Department of Chemistry/Biochemistry (278-3621). http://chemsrvr2.fullerton.edu/DeptWebsite/Resear

SCERP. The **Southern California Ecosystems Research Program** (SCERP) at CSUF, sponsored by the National Science Foundation UMEB program, is a series of educational experiences for undergraduates focused on learning through discovery in environmental biology. This program strives to attract primarily underrepresented students to environmental biology early in their academic careers, typically at the end of the freshman year. A diversity of approaches to investigating environmental issues in Southern California is undertaken by as many as 18 students over a 4-year period. Scholars receive stipends, research materials, and travel money in support of an independent research project developed in collaboration with a faculty member who also serves as their mentor. Information is available from Dr. Bill Hoese (278-2476) or the Biology Dept. Office, MH-282 (278-2476). http://biology.fullerton.edu/scerp

Ronald McNair Scholars Program. Year-round program open to full-time students majoring in natural sciences, mathematics and engineering. The program is designed to prepare students to

purse doctoral studies. Applicants must be members of a group underrepresented in graduate education and/or a first generation college student. Applicants must have completed at least 59 semester units and have a minimum G PA of 3.0. Applications are available at the beginning of the spring semester at McNair Scholars Office, UH-179 (278-7315). http://www.fullerton.edu/mcnair/

REU Program. The Department of Chemistry/Biochemistry has had a NSF-supported **Research Experience for Undergraduates** (REU) program for the past six years, and has received an additional three years of support. The REU programs provide intensive research opportunities during the summer months to interested students who might not otherwise have the opportunity because of economic constraints. The students interact regularly with each other and attend workshops on ethical conduct of research and opportunities for careers in research. Information is available from Dr. Scott Hewitt (278-3698) or the Department of Chemistry/Biochemistry (278-3621). http://chemstryr2.fullerto.edu

Marine Biology Semester at Catalina. This semester-long program, offered through the California State University Ocean Studies Institute (OSI) and the Southern California Marine Institute (SCMI), provides an intensive undergraduate exposure to marine biology, and is designed for students with a serious commitment to environmental and marine science. The program is based at the University of Southern California (USC) Wrigley Marine Science Center (WMSC), situated on Santa Catalina Island 26 miles from Los Angeles, CA. http://osi.scmi.us/osicsucatalina.html

Overseas Programs:

Spring 2008 semester in Brazil in environmental biology:
http://hdcs.fullerton.edu/faculty/orozco

Studies in Denmark in Marine & Environmental Biology:
http://www.gateway.calstate.edu/csuienet/county

ADMINISTRATIVE OFFICES

California State University, Fullerton, General Information	278-2011	
Biology Department Office	278-3614	MH 282
Chair - Dr. Robert A. Koch	278-3614	MH 282-B
Administrative Support Coordinator - Janie Kirk	278-2440	MH 236-B
Biology Club – Dr. Bill Hoese (biologyclub@student.fullerton.edu)	278-2476	MH 308
Biotech Minor Advisor - Dr. Robert Koch	278-3637	SLC 112-A
Internship Coordinator - Check with Biology Office	278-3614	MH 282
Teaching Credential Advisor – Douglas Stone Advises Biology majors seeking admission to the Single-Subject Program.	278-2307	MH 629-C
Undergraduate Academic Advisor - Dr. Bill Hoese Provides general information graduation checks.	278-2476	MH 308
College of Natural Science and Mathematics Dean's Office	278-2638	MH 166
Health Professions Office Coordinator - Dr. David B. Drath NOTE: Advisement through the Health Professions Office does not replace mandatory advisement through the Department.	278-3980	UH 223
Academic Advisement Center Provides guidance in the selection of elective and general education courses, advises, and is the center for undeclared majors. No appointment is necessary.	278-3606	UH 179
Academic Appeals Students are encouraged to resolve grade disputes informally through the instructor, Department Chair, and Dean of the College. If informal resolution is not possible, the Coordinator of Academic Appeals will provide information and clarification about University policies and will work to resolve the dispute.	278-3836	LH 805
Admissions and Records Maintains students' matriculation and grade records and processes graduation checks to verify degree completion. Students are required to submit official transcripts of all work to this office.	278-2300	LH 111
Adult Re-entry & Women's Center Provides programs, counseling and education on issues of communication, health, academics, and political issues specific to women and students returning to school.	278-392	UH 205
Career Planning and Placement Center Offers personal and career counseling. CDC offers a career resources library, alumni part-time job listings, career bank, and programs on a variety of career-oriented subjects.	278-3121	LH 208
Center for Careers in Teaching Resource center for those interested in teaching middle or high school.	278-7130	FTS 710
Disabled Student Services Provides assistance and services to physically and learning disabled students.	278-3117	UH 101
Financial Aid	278-3125	UH 146
Library Houses over 700,000 books and periodicals and one and a half million other resource items. May access collections of the 19 CSU libraries, UCI, UCR, and Fullerton College. Tours are available.	278-2714	Library
Student Health Center Provides medical care for illness and injury, family planning, health education, and immunization programs.	278-2800	HC
Student Study Center Offers academic support and tools to assist students in mastering test taking and exam preparation skills. Lab and strategies classes are available.	278-2738	UH 123
Testing Center University testing services, including EWP, ELM, GRE, EPT,TOEFL, and CBEST.	278-3838	UH 229
Tutoring Opportunity Center (OCSAMS) provides tutoring, computers, and photocopy machine.	278-7082	MH 488

DEPARTMENT OF BIOLOGICAL SCIENCE FACULTY ROSTER

BANACK, Sandra A. * (1997) Associate Professor; Ph.D., UC Berkeley

Teaches: Evolution and Biodiversity, Plants and Life, Pollination Biology, Natural History of Vertebrates, Mammalogy

Research Interests: Integrative biology, plant animal interactions, pollination biology, ethnobotany

Office: MH 301 B Phone: 278-4573 sbanack@fullerton.edu

CASEM, Merri Lynn (2000) Assistant Professor; Ph.D., UC Riverside

Teaches: Elements of Biology, Cellular Basis of Life

Research Interests: Biology education; spider silk

Office: MH 359 Phone: 278-2491 mcasem@fullerton.edu

CHEN, Esther J. (2006) Assistant Professor; Ph.D., Massachusetts Institute of Technology

Teaches: Microbiology

Research Interests: Molecular biology of microbe-host interactions; genes and signals in the symbiosis between *Sinorhizobium meliloti* and its host, *Medicago sativa*

Office: MH 207C Phone: 278-2543 echen@fullerton.edu

COHEN, Amybeth (1997) Associate Professor; Ph.D., UC Riverside

Director, MARC Scholars Program

Teaches: Genetics and Molecular Biology, Principles of Gene Manipulation, Plant Cell Physiology

Research Interests: Regulation of photosynthetic gene expression in plant cells, nuclear-chloroplast interactions, expression of foreign therapeutic proteins in the unicellular green alga, *Chlamydomonas reinhardtii*

Office: MH 301A Phone: 278-2178 acohen@fullerton.edu

CUAJUNGCO, Math P. (2007) Assistant Professor; Ph.D.,University of Auckland, New Zealand

Teaches: Cellular Basis of Life

Research Interests: Molecular structural and cellular biology of transient receptor potential (TRP) ion channels, zinc neurobiology, metallobiology of Alzheimer's disease

Office: MH 207G Phone: 278- mcuajungco@fullerton.edu

DICKSON, Kathryn A. (1988) Professor; Ph.D., Scripps Institution of Oceanography, UC San Diego

Vice Chair

Teaches: Principles of Physiology and Ecology, Human Physiology, Mammalian Physiology, Comparative Animal Physiology, Marine Biology

Research Interests: Locomotion and endothermy in fishes; comparative physiology and biochemistry

Office: SLC 117A Phone 278-5266 kdickson@fullerton.edu

DRATH, David B. (1990) Professor; Ph.D., New York University

Teaches: Immunology, Biology of Cancer

Research Interests: Immune response to infection; immunotherapy; tumor metastasis; neuroimmune communication; stress and immune dysfunction

Office: MH 307 Phone 278-7294 ddrath@fullerton.edu

EERNISSE, Douglas J. (1994) Associate Professor; Ph.D., UC Santa Cruz

Teaches: Evolution, Field Marine Biology, Molecular Systematics, Invertebrate Zoology

Research Interests: Animal phylogeny; evolution of Mollusca; marine zoology; systematics; population genetics; bioinformatics

Office: MH 217C Phone 278-3749 deernisse@fullerton.edu

HOESE, William J. (2000) Assistant Professor; Ph.D., Duke University

Director, Southern California Ecosystems Research Program (SCERP)

Teaches: Elements of Biology, Evolution and Biodiversity, Professional Aspects of Biology: Teaching, Problems in Environmental Biology,Intermediate Evolution

Research Interests: Biology education; student learning; animal communication; functional morphology

Office: MH 308 Phone: 278-2476 bhoese@fullerton.edu

HORN, Michael H. (1970) Professor; Ph.D., Harvard University

Teaches: Biogeography, Ichthyology, Conservation Biology, Professional Aspects of Biology

Research Interests: Ecology and physiology of fish-plant interactions in coastal seas and tropical rain forests; fish herbivory; seabird feeding ecology; landscape-scale conservation biology

Office: SLC 249 Phone: 278-3707 mhorn@fullerton.edu

HOUTMAN, Anne M. (2003) Associate Professor; D.Phil., University of Oxford, England

Teaches: Elements of Biology, Animal Behavior, Ornithology

Research Interests: Behavioral ecology, sexual selection and reproductive behavior in birds, biology education.

Office: MH MH 361 Phone: 278-5491 ahoutman@fullerton.edu

JONES, C. Eugene (1969) Professor; Ph.D., Indiana University

(*not accepting graduate students)* ***Partially retired, on campus during spring semester***

Teaches: Plant Taxonomy, Plants and Life, Survey of the Land Plants, Pollination Biology

Research Interests: Pollination ecology; ethnobotany

Office: MH 201B Phone: 278-3548 cejones@fullerton.edu

KANDEL, Judith S. (1972) Professor; Ph.D., M.P.H., UC Los Angeles

(*not accepting graduate students)* ***Partially retired, on campus during spring semester***

Teaches: General Microbiology, Virology

Research Interests: Microbiology education

Office: MH 364 Phone: 278-2546 jkandel@fullerton.edu

KOCH, Robert A. (1976) Professor; Ph.D., Florida State University

DEPARTMENT CHAIR, Director, Center for Applied Biotechnology Studies (CABS)

Teaches: Cellular Basis of Life, MARC Scholars Program, Cell and Developmental Biology, Biology of Aging, Introductory Electron Microscopy, Advanced Topics in Scanning and Transmission Electron Microscopy, Advances in Cell Biology

Research Interests: Cell biology and ultrastructure of ascidian gametes during fertilization

Office: MH 282B Phone : 278-3614 rkoch@fullerton.edu

LOIS, Rodrigo I. (1991) Associate Professor; Ph.D., UC Los Angeles

Director, Institute for Molecular Biology & Nutrition

Teaches: Genetics and Molecular Biology, Advances in Molecular Genetics, Principles of Gene Manipulation, Plant Molecular Biology Seminar

Research Interests: Molecular biology and genetics of plant defenses; environmental stress in plants; plant biotechnology

Office: SLC 114A Phone: 278-2540 rlois@fullerton.edu

PATEL, Nilay V. (2006) Assistant Professor; Ph.D., State University of New York at Stony Brook

Teaches: Genetics and Molecular Biology, Intermediate Cell Biology

Research Interests: Role of apolipoprotein-E in Alzheimer Disease; apolipoprotein-E gene regulation

Office: SLC 111A Phone: 278-2483 nilaypatel@fullerton.edu

PELAEZ, Nancy J. (1999) Associate Professor; Ph.D., Indiana University School of Medicine

Teaches: Human Physiology, Biology for Future K-6 Teachers, Teaching Evolution: Online Course for Teachers, Into the Streets with Science Education, Theoretical Designs in Science Education, Issues in Science Education, Advances in information Technology for Science Learning Environments, Life Science Concepts for K-8 Teachers

Research Interests: Vascular physiology; zebrafish (*Danio rerio)* as a model to teach physiology; misconceptions about human blood circulation

Office: MH 243 Phone: 278-7260 npelaez@fullerton.edu

SANDQUIST, Darren R. (1999) Associate Professor; Ph.D., University of Utah

Teaches: Principles of Physiology and Ecology, Plant Physiological Ecology, Field Botany, Plant Ecology, Desert Ecology

Research Interests: Desert plant ecology; evolution and ecology of plant physiology; biogeochemistry; applications of stable isotopes in ecological research; invasive species

Office: MH 313 Phone: 278-2606 dsandquist@fullerton.e

SCHENK, H. Jochen (2002) Assistant Professor; Ph.D., UC Santa Barbara

Teaches Field Botany, Evolutionary Ecology, Ecosystem Ecology

Research Interests: Plant ecology, especially ecology of plant roots; spatial ecology of plant populations, communities, and ecosystems; desert ecology; plant taxonomy.

Office: MH 229A Phone: 278-3678 jschenk@fullerton.edu

STAPP, **Paul** (2002) Assistant Professor; Ph.D., Colorado State University

Teaches Evolution and Biodiversity

Research Interests: Vertebrate population and community ecology; food webs; wildlife-habitat relationships; invasive species; ecology of insular, desert and grassland ecosystems; conservation biology

Office: MH 207E Phone: 278-2849 pstapp@fullerton.edu

TOLMASKY, Marcelo E. (1995) Professor; Ph.D., University of Buenos Aires

Associate Director for Research, Center for Applied Biotechnology Studies (CABS)

Director, Minority Health & Health Disparities International Research Training Program (MHIRT)

Teaches: General Microbiology, Advances in Biotechnology Laboratory

Research Interests: Molecular genetics of mechanisms that contribute to the virulence of pathogenic bacteria

Office: MH 382 Phone: 278-5263 mtolmasky@fullerton.edu

WALKER, Sean E. (2003) Assistant Professor; Ph.D., Miami University

Teaches: Evolution and Biodiversity, Principles of Physiology and Ecology, Entomology

Research Interests: Evolutionary and behavioral ecology; Evolution of sexual dimorphism; Life history evolution; Sexual selection

Office: MH 389 Phone: 278-3610 swalker@fullerton.edu

WHIPPLE, Frederick W. (2001) Assistant Professor; Ph.D., Tufts Medical School, Boston

Teaches: Genetics and Molecular Biology, Medical Genetics

Research Interests: Molecular mechanisms of genetic recombination and DNA repair in bacteria and higher cells; bacterial transcription and gene expression.

Office: MH 207F Phone 278-5608 fwhipple@fullerton.edu

ZACHERL, Danielle C. (2003) Assistant Professor; Ph.D., UC Santa Barbara

Teaches: Marine Biology, Invertebrate Zoology, Marine Ecology, Evolution and Biodiversity, Problems in Environmental Biology

Research Interests: Effects of larval dispersal and recruitment on the population ecology and biogeography of marine invertebrates

Office: MH 278A Phone: 278-7510 dzacherl@fullerton.edu

DEPARTMENT CHAIR
Robert Koch

DIRECTOR, GRADUATE PROGRAM
Michael Horn, Jochen Schenk

DEPARTMENT OFFICE
McCarthy Hall 282

DEPARTMENT WEBSITE
http://biology.fullerton.edu

PROGRAMS OFFERED
Bachelor of Science in Biological Science with Concentrations in:
- Biodiversity, Ecology and Conservation Biology
- Cell and Developmental Biology
- Marine Biology
- Molecular Biology and Biotechnology

Minor in Biotechnology
Master of Science in Biology
Subject Matter Preparation Program for Single Subject Teaching Credential

FACULTY
Sandra Banack, Merri Lynn Casem, Esther Chen, Amybeth Cohen, Kathryn Dickson, David Drath, Doug Eernisse, David Fromson, William Hoese, Michael Horn, Anne Houtman, C. Eugene Jones, Judy Kandel, Robert Koch, Rodrigo Lois, Steven Murray, Nilay Patel, Nancy Pelaez, William Presch, Darren Sandquist, Jochen Schenk, Paul Stapp, Marcelo Tolmasky, Sean Walker, Fred Whipple, Danielle Zacherl

INTRODUCTION
Biology is the branch of science concerned with the study of life. The discipline is dynamic, diverse, and expanding with the integration of new molecular approaches, information technology and concerns for the environment. Through the study of biology students will: learn principles that govern the function of their own body and those of other organisms; explore how complex organisms develop from a single cell and how genes and the environment govern these events; and learn how plants capture the energy from the sun and, ultimately, sustain almost all life on Earth through intricate relationships with other organisms, including humans. In addition, in Southern California, proximity to a variety of employers ranging from

biotechnology and biomedical companies to environmental consulting firms provides biology majors with diverse employment opportunities.

The department has designed a curriculum that builds on a core of biology and supporting courses for students who: (1) seek careers in industry and state or federal agencies, (2) wish to prepare for secondary school teaching, or (3) desire to enter graduate and professional schools. The curriculum beyond the basic core experience will be developed through individual advising. Students will be assigned a faculty adviser when they enter the University or they may choose a faculty member to serve as their adviser. Each semester, students are required to meet with their designated adviser in order to develop an appropriate program of study. After discussion with their adviser, students will elect upper-division courses in one of four concentrations that will satisfy their individual interests and professional goals.

Special Programs

In addition to the usual course offerings, the Department of Biological Science participates in the Center for Applied Biotechnology Studies, the Institute for Molecular Biology and Nutrition, and three consortial programs with other California State University campuses. These are CSUPERB (California State University Program for Education and Research in Biotechnology), the Ocean Studies Institute (through the Southern California Marine Institute) and the California Desert Studies Consortium at Soda Springs. Each of these centers is described in this catalog under "Research Centers."

Pre-professional Information

The Health Professions Advising Office provides advising services to students wishing to enter the health professions. The services include counseling students to plan their academic programs, providing students with information about volunteer opportunities in the area of their interest, and providing assistance in the preparation of applications, including interviewing techniques.

Teaching Credential Information

The bachelor's degree in biology may be effectively combined with requirements for the Subject Matter Preparation Program for the Single Subject Teaching Credential. Undergraduate students are encouraged to work with the Science Education Program in MH 527 and/or the Center for Careers in Teaching as early as possible in their academic careers to plan efficient course selections for general education, the major, and electives. Before applying to the Credential Program, undergraduate and postgraduate students should contact the Admission to Teacher Education office in the College of Education to obtain information on attending a required overview presentation and orientation.

Recommendations for Transfer Students

Students planning to transfer from another college or university should take biology, chemistry, mathematics, and/or physics courses that are equivalent to those required for the B.S. in Biological Science (refer to **www.assist.org**). Prospective transfer students should contact the Biology Department as soon as possible prior to transfer to select appropriate courses

Recommended Program in General Education

Because of high unit requirements for the B.S. in Biological Science, students are urged to consult with their adviser to design their general education program.

UPPER-DIVISION BACCALAUREATE WRITING REQUIREMENT

To meet the upper-division baccalaureate writing requirement, students must (1) pass the English Writing Proficiency exam and (2) pass with a "C" (2.0) or better English 301 or Chemistry 340 or 6 units from Biology 411, 414, 417, 422, 426, 445, 446, 449, 468, 470 and 495.

Internships

Biology 495 Biological Internship provides students with the opportunity to participate in a practical work experience that integrates their interests with classroom studies.

SCHOLARSHIPS IN BIOLOGICAL SCIENCE

For additional information, please see the CSUF Financial Aid website: **http://www.fullerton.edu/financialaid**

Dr. and Mrs. Donald B. Bright Environmental Scholarship

To preserve the memory of Dr. Donald B. Bright, one or more scholarships per year are awarded to deserving undergraduate and graduate students of biology.

Judith A. Presch Desert Studies Scholarship

To preserve the memory of Judith A. Presch, two scholarships per year are awarded (one undergraduate and one graduate student) by the Desert Studies Consortium for work in the Mojave Desert.

Jerome Wilson Scholarship

To preserve the memory of Dr. Jerome Wilson, scholarships are awarded to deserving undergraduate or graduate students of biology.

Coppel Graduate Science Award
Established by Lynn and Claude Coppel for biology graduate students for their unrestricted use.

Rachel Carson Scholarship in Conservation Biology
To preserve the memory of Rachel Carson, a scholarship was created to encourage biology majors to pursue a career in Conservation Biology.

BACHELOR OF SCIENCE IN BIOLOGICAL SCIENCE
A total of 120 units, including general education, 43 units in biology courses (20 units in the core and 23 units of upper-division electives constituting one of the concentrations described below), and 30 units of supporting courses in physical sciences and mathematics is required for completion of the B.S. in Biological Science. In addition, as a graduation requirement, students pursing the B.S. in Biological Science must complete an exit exam on biology in the spring semester of their senior year.

The supporting courses must include one year of general college chemistry including qualitative analysis with laboratory; one year of organic chemistry with laboratory; one semester of college calculus or introduction to experimental design and statistics for biologists; and one year of college physics with laboratory. Those students seeking careers in the health professions should speak to a health professions adviser about specific course recommendations. Students who wish to earn a doctoral degree should consider, in addition, a modern foreign language or advanced courses in computational sciences.

To qualify for a baccalaureate degree in Biological Science, students must have a 2.0 overall average in all biology courses and in all required supporting courses. No credit toward the major will be allowed for biology courses in which a grade of C-, D or F is obtained. Courses taken under the Credit/No Credit grade option may not be applied towards the major.

All full-time upper-division students are expected to attend the departmental seminars.

Core Requirements for the Major (20 units):
The core program in Biology provides an introduction to basic principles of biology and to the investigative nature of science. The curriculum uses Themes and Perspectives to connect and integrate major concepts, principles and basic facts. Three Themes run throughout the core curriculum:

Evolution: Inherited changes in organisms accumulate over time.

Unity and Diversity: Organisms possess common characteristics while exhibiting a wide range of variability.

Dynamics of Biological Systems: Living systems continually respond to their external and internal environments by making changes necessary to sustain life.

Each theme will be presented from two perspectives:

Human Impact: The interactions between the human and the biological world, and

Scientific Process: The testing of new ideas, questions or hypotheses through observation and experimentation.

Students should complete the following four core courses with a passing grade ("C" (2.0) or better) before they take most upper-division biology courses.

Biology 171 Evolution and Biodiversity (5)
Biology 172 Cellular Basis of Life (5)
Biology 273 Genetics and Molecular Biology (5)
Biology 274 Principles of Physiology and Ecology (5)

Upper-division courses (23 units):

The upper-division program is designed to provide students with depth in a chosen concentration. With approval from his or her departmental adviser, each student selects a program leading to a concentration in one of four areas (see below). The upper-division program requires 23 units of upper-division coursework, including at least 5 units of laboratory- or field-based activities, at least 6 units of 400-level biology courses, and at least 2 units of a specified capstone course.

Students with junior or senior standing will be permitted to enroll in Biology 480 Advanced Topics in Undergraduate Biology, Biology 495 Biological Internship, and Biology 499L Independent Laboratory Study; however, only a combined total 6 units of Biology 499L or 3 units from Biology 480 or 495 may be applied to the biology upper-division elective requirement.

No more than a combined total of 6 units of Biology 480 Advanced Topics in Undergraduate Biology (2 max), Biology 482 Capstone Studies in Biology (2 max), Biology 495 Biological Internship (3 max), Biology 498 Senior Thesis (2 max) and Biology 499L Independent Laboratory Study (6 max) shall be counted toward the 23 upper-division biology units required for the major, and no more than 3 of these units may count toward the requirement to complete at least 5 units of upper-division biology laboratory/field electives.

Concentration in Biodiversity, Ecology, and Conservation Biology

The concentration consists of 23 units of upper-division biology electives, of which at least 5 units must be laboratory- or field-based activities, at least 6 units must be 400-level biology courses, and at least 2 units must be a capstone course. The 23 units of upper-division biology electives must also meet the following requirements:

Ecology Courses (6 units minimum)

Biology 314 Evolutionary Ecology (3)
AND at least one of the following:
Biology 419 Marine Ecology (3)
Biology 422 Coastal Ecology (4)
Biology 443 Plant Ecology (4)
Biology 449 Desert Ecology (4)
Biology 466 Behavioral Ecology (3)

Organismal/Systematics Courses (3 units minimum)
Biology 301 Problems in Environmental Biology (3)
Biology 340 Field Botany (3)
Biology 344 Survey of the Land Plants (3)
Biology 402 Computer Lab in Molecular Systematics (3)
Biology 441 Plant Taxonomy (4)
Biology 446 Marine Phycology (4)
Biology 461 Marine Invertebrate Biology (4)
Biology 467 Entomology (4)
Biology 474 Natural History of the Vertebrates (4)
Biology 475 Ichthyology (4)
Biology 476 Herpetology (4)
Biology 478 Mammalogy (4)
Biology 479 Ornithology (4)

Physiology/Development Courses (3 units minimum)
Biology 362 Mammalian Physiology (4)
Biology 405 Developmental Biology (3)
Biology 417 Advances in Cell Biology (3)
Biology 444 Plant Physiological Ecology (4)
Biology 445 Plant Cell Physiology (3)
Biology 468 Comparative Animal Physiology (4)

Free Upper-Division Biology Electives (0 – 9 units; number required to reach a total of 23 upper-division biology electives. Choose additional courses from above or select from the following:
Biology 304 Supervised Biology Lab Instruction (2)
Biology 317 Field Marine Biology (4)

Biology 404 Evolution (3)
Biology 436 Advanced Applied Statistics (4)
Biology 480 Advanced Topics in Undergraduate Biology (1 – 3)
Any upper-division biology elective from this or another concentration

Capstone courses (2 units minimum)
Biology 400 Seminar in Biology Education (2)
Biology 401 Biogeography (3)
Biology 450 Conservation Biology (3)
Biology 482 Capstone Studies in Biology (2)
Biology 495 Biological Internship (3)
Biology 498 Senior Thesis (2)
Biology 499L Independent Laboratory Study (1 – 3)

Concentration in Cell and Developmental Biology

The concentration consists of 23 units of upper-division biology electives, of which at least 5 units must be laboratory- or field-based activities, at least 6 units must be 400-level biology courses, and at least 2 units must be a capstone course. The 23 units of upper-division biology electives must also meet the following requirements:

Required Gateway Courses (7 units)
Biology 302 General Microbiology (4)
Biology 303 Intermediate Cell Biology (3)

Cell Biology Courses (10 units minimum)
Biology 362 Mammalian Physiology (3)
Biology 405 Developmental Biology (3)
Biology 417 Advances in Cell Biology (3)
Biology 418L Advances in Cell Biology Lab (2)
Biology 424 Immunology (4)
Biology 426 Virology (3)
Biology 428 Biology of Cancer (3)
Biology 470 Cellular Neurobiology (3)
No more than one of the following:
- Biology 309 Intermediate Molecular Biology (3)
- Biology 402 Computer Lab in Molecular Systematics (3)
- Biology 411 Medical Genetics and Systems Biology (3)
- Biology 412 Principles of Gene Manipulation (3)
- Biology 413 Advances in Molecular Genetics (3)
- Biology 414 Microbial Genetics (3)
- Biology 445 Plant Cell Physiology (3)
- Biology 448 Plant Molecular Biology (3)
- Chemistry 421 Biological Chemistry (3)

Free Upper Division Biology Electives (0 - 4 units; number required to reach a total of 23 upper-division biology electives). Choose additional courses from above or select from the following:
Biology 304 Supervised Biology Lab Instruction (2)
Biology 361 Human Anatomy (4)
Biology 480 Advanced Topics in Undergraduate Biology (1 – 3)
Any upper-division biology elective from this or another concentration

Capstone courses (2 units minimum)
Biology 400 Seminar in Biology Education (2)
Biology 426 Virology (3)
Biology 428 Biology of Cancer (3)
Biology 470 Cellular Neurobiology (3)
Biology 482 Capstone Studies in Biology (2)
Biology 495 Biological Internship (3)
Biology 498 Senior Thesis (2)
Biology 499L Independent Laboratory Study (1 – 3)

Concentration in Marine Biology

The concentration consists of 23 units of upper-division biology electives, of which at least 5 units must be laboratory- or field-based activities, at least 6 units must be 400-level biology courses, and at least 2 units must be a capstone course. The 23 units of upper-division biology electives must also meet the following requirements:

Ecology Courses (6 units)
Biology 314 Evolutionary Ecology (3)
AND at least one of the following:
Biology 419 Marine Ecology (3)
Biology 422 Coast Ecology (4)

Organismal/Systematics Courses (4 units minimum)
Biology 446 Marine Phycology (4)
Biology 461 Marine Invertebrate Biology (4)
Biology 475 Ichthyology (4)

Physiology/Development Courses (3 units minimum)
Biology 362 Mammalian Physiology (4)
Biology 405 Developmental Biology (3)
Biology 417 Advances in Cell Biology (3)
Biology 444 Plant Physiological Ecology (4)
Biology 445 Plant Cell Physiology (3)
Biology 468 Comparative Animal Physiology (4)

Free Upper-Division Biology Electives (0 - 8 units; number required to reach a total of 23 upper-division biology electives). Choose additional courses from above or from the following:

Biology 304 Supervised Biology Lab Instruction (2)
Biology 317 Field Marine Biology (4)
Biology 404 Evolution (3)
Biology 419L Marine Ecology Laboratory (1)
Biology 436 Advanced Applied Statistics (4)
Biology 480 Advanced Topics in Undergraduate Biology (1 – 3)
Any upper-division biology elective from this or another concentration

Capstone Courses (2 units minimum)
Biology 400 Seminar in Biology Education (2)
Biology 401 Biogeography (3)
Biology 450 Conservation Biology (3)
Biology 482 Capstone Studies in Biology (2)
Biology 495 Biological Internship (3)
Biology 498 Senior Thesis (2)
Biology 499L Independent Laboratory Study (1 – 3)

Concentration in Molecular Biology and Biotechnology

The concentration consists of 23 units of upper-division biology electives, of which at least 5 units must be laboratory- or field-based activities, at least 6 units must be 400-level biology courses, and at least 2 units must be a capstone course. The 23 units of upper-division biology electives must also meet the following requirements:

Required Gateway Courses (6 or 7 units)
Biology 309 Intermediate Molecular Biology (3)
AND one or more of the following:
Biology 302 General Microbiology (4)
Chemistry 421 Biological Chemistry (3)
OR Chemistry 423A General Biochemistry (3)

Molecular Biology Courses (13 units minimum)
Biology 402 Computer Lab in Molecular Systematics (3)
Biology 405 Developmental Biology (3)
Biology 411 Medical Genetics and Systems Biology (3)
Biology 412 Principles of Gene Manipulation (3)
Biology 413 Advances in Molecular Genetics (3)
Biology 414 Microbial Genetics (3)
Biology 445 Plant Cell Physiology (3)
Biology 448 Plant Molecular Biology (3)
Biology 472A Advances in Biotechnology Lab (3)
Biology 472B Advances in Biotechnology Lab (3)
Biology 473 Bioinformatics (3)
No more than 5 units of the following:
Biology 362 Mammalian Physiology (4)
Biology 417 Advances in Cell Biology (3)

Biology 418L Advances in Cell Biology Lab (1)
Biology 424 Immunology (4)
Biology 426 Virology (3)
Biology 428 Biology of Cancer (3)
Biology 444 Plant Physiological Ecology (4)
Biology 470 Cellular Neurobiology (3)
Biology 477 Advances in Biotechnology (3)
Biology 499L Independent Lab Study (1-3)

Free Upper-Division Biology Electives (0-2 units; number required to reach a total of 23 upper-division biology electives. Choose additional courses from above or from the following:
Biology 304 Supervised Biology Lab Instruction (2)
Biology 480 Advanced Topics in Undergraduate Biology (1-3)
Any upper-division biology elective from this or another concentration

Capstone courses (2 units minimum)
Biology 400 Seminar in Biology Education (2)
Biology 472A Advances in Biotechnology Lab (3)
Biology 472B Advances in Biotechnology Lab (3)
Biology 482 Capstone Studies in Biology (2)
Biology 495 Biological Internship (3)
Biology 498 Senior Thesis (2)
Biology 499L Independent Laboratory Study (1-3)

Supporting Course Requirements for the Major (29-30 units)

Chem 120A,B General Chemistry (10)
Chem 301A,B Organic Chemistry (6)
Chem 302 or Chem 302A,B Organic Chemistry Laboratory (2)
Physics 211, 211L Elementary Physics and Laboratory (4)
Physics 212, 212L Elementary Physics and Laboratory (4)
Math 130A Short Course in Calculus (4),
OR Math 150A Calculus (4),
OR Math 337 Intro to Experimental Design and Statistics in the Laboratory Sciences (3)

MINOR IN BIOTECHNOLOGY

The biotechnology minor is appropriate for students majoring in biological science or biochemistry and interested in gaining employment in nearly any area of the growing medical and agricultural biotechnology industries, working in academic research laboratories, or pursuing postgraduate degrees in basic molecular biology or biochemistry.

The biotechnology minor requires a minimum of 31 acceptable units of chemistry and biology. These courses must be completed with a minimal overall grade-point average of 2.0 and include 12 units unique to the minor

that are not used to meet requirements for the biological science or biochemistry major.

Required Core Courses (28 units)

Biology 273 Genetics and Molecular Biology (5)
Biology 309 Intermediate Molecular Biology (3)
OR Chem 421 Biological Chemistry (3)
Chem 301A,B Organic Chemistry (6)
Chem 302 or Chem 302A,B Organic Chemistry Laboratory (2)
Biology 412 Principles of Gene Manipulation (3)
Biol/Chem 472A,B Advances in Biotechnology Laboratory (6)
Chem/Biol 477 Advances in Biotechnology (3)

Supporting Courses (3-4 units)

Students must complete one of the following courses:
Biology 309 Intermediate Molecular Biology (3)
Biology 413 Advances in Molecular Genetics (3)
Biology 424 Immunology (4)
Chem 421 Biological Chemistry (3)
Chem 423A General Biochemistry (3)
Chem 423B General Biochemistry (3)

MASTER OF SCIENCE IN BIOLOGY

The M.S. in Biology is a thesis-based degree for which the student completes original, independent research in one of the following areas: Biodiversity, Ecology & Conservation Biology, Cell & Developmental Biology, Marine Biology, Molecular Biology & Biotechnology, or Biology Pedagogy Research. The program offers specialized educational opportunities and training in preparation for (a) advanced graduate work toward a doctoral degree in the biological sciences or science education, (b) teaching at the secondary and community college levels, (c) participation in research programs and employment as a research technician, (d) participation in various field service and conservation positions within local, state and national governments, (e) entering the field of public-health service, or (f) technological work in the health sciences.

Admission Requirements

An applicant must meet the university requirements for admission, which include a baccalaureate from an accredited institution and a grade-point average of at least 2.5 in the last 60 semester units attempted (see section of this catalog on Graduate Admissions for complete statement and procedures). Students must make two applications, one to the university and another to the department. In addition to the university requirements for admission, acceptance into this program is contingent upon the following: (1) a B.A. or B.S. in Biological Science or related area at an accredited institution with a grade-point average of 3.0 in biology courses and a GPA of 2.5 in the

related courses in mathematics, chemistry and physics; (2) submission of scores on one of the following: (a) Graduate Record Examination General Test, (b) Medical College Admission Test, or (c) Dental Admission Test; (3) completion of the departmental application; (4) submission of two letters of recommendation; and (5) acceptance by a thesis adviser.

Students with deficiencies may be considered for conditional acceptance into the program. For conditionally accepted students, the specific conditions and a deadline for their completion are determined at the time of admission; continuation in the M.S. program is dependent upon completion of the admission conditions by the specified deadline.

Application Deadlines

The deadlines for completing online applications are March 1st for the fall semester and October 1st for the spring semester (see **http://www.csumentor.edu**). Mailed applications need to be postmarked by the same deadlines. However, deadlines may be changed based upon enrollment projections. Check the university graduate studies website for current information **http://www.fullerton.edu/graduate**

Classified Standing

Students should achieve classified graduate standing as soon as they are eligible, since no more than nine units of graduate work taken before classification can be included on the study plan (see below) for the degree. A student who meets the admission requirements may apply for classified standing, which requires the development of a study plan approved by the thesis adviser, thesis committee, director of the departmental graduate program and dean of graduate studies. Students admitted with conditional acceptance must meet conditions (see above) before being considered for classified standing.

Advancement to Candidacy

Advancement to candidacy is attained by requesting a graduation check and receiving subsequent approval of the departmental graduate program director on the Grad Check Review Form, mailed by the Graduate Studies Office.

Study Plan

Students must meet the Graduate Level Writing Requirement, which is described in this catalog under "Graduate Regulations." Biology M.S. candidates will meet this requirement by taking Biology 500A,B Professional Aspects of Biology.

A study plan includes 30 units of adviser-approved graduate work; at least one-half of the total units must be at the 500-level. All study plans must include Biology 599 Independent Graduate Research, Biology 500A,B

Professional Aspects of Biology, Biology 598 Thesis, and at least two graduate seminars.

A thesis acceptable to the adviser and committee, covering a research problem, as well as a final oral examination and a public presentation on the thesis research, are required to complete the degree program.

Supervising the work of graduate students requires the personal attention of advisers. To insure that advisers are available for new graduate students, a graduate student is expected to complete the requirements for graduation within three years after classification.

For more detailed information or advisement, students should contact the Biological Science Department, or the Graduate Program Director of the Biological Science Department (**biogradadv@fullerton.edu**).

BIOLOGICAL SCIENCE COURSES

Courses are designated as BIOL in the class schedule. Unless otherwise designated, prerequisites may be waived by the instructor of the course if the instructor is satisfied that the student is qualified for the course.

101 Elements of Biology (3)
Underlying principles governing life forms, processes and interactions. Elements of biology and reasoning skills for understanding scientific issues on personal, societal, and global levels. For the non-science major. No credit toward biological science major.

101H Elements of Biology (Honors) (3)
Corequisite: Biology 101LH (Honors). Students must meet honors qualifications. Living organisms and characteristics of the natural environment. Emphasis on the scientific reasoning leading to our current understanding of living systems. For the non-science major.

101L Elements of Biology Laboratory (1)
Prerequisite or corequisite: Biology 101. Laboratory experiments demonstrating the principles presented in the lecture course. Scientific inquiry, cell structure and function, physiology, genetics, biodiversity, evolution and ecology. For the non-science major. (3 hours laboratory or fieldwork; weekend field trips may be required).

101LH Elements of Biology Laboratory (Honors) (1)
Corequisite: Biology 101H (Honors). Students must meet honors qualifications. Laboratory experiments and demonstrations which provide insight into scientific reasoning and the basis of our current understanding of living systems. For the non-science major. (3 hours laboratory or fieldwork; field trips may be required)

102 Biology for Future Teachers (3)
Designed especially for the prospective teacher, this activity-based course will examine biological concepts in real-world contexts such as the medical examination, genes and evolution, and the environment. Lecture and laboratory form a single unified learning experience. No credit toward biological science major. (6 hours activity)

105 Survey of the Molecules of Life (3)
An introduction to the biochemical processes of life, including metabolism, development, and disease. Recent scientific advances are discussed with emphasis placed on AIDS, cancer, diabetes, and cloning. Scientific methods and ethical issues in scientific research are also examined. For the non-science major. (Same as Chemistry 105)

171 Evolution and Biodiversity (5)
Introduction to scientific processes and methods of biology. Explorations of unifying principles of evolution processes leading to biodiversity, and principles of conservation biology. (Primarily for majors in the Colleges of Natural Science/Mathematics and Engineering/Computer Science; 3 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

172 Cellular Basis of Life (5)
Prerequisite: Biology 171. Exploration of the structure and function of prokaryotic and eukaryotic cells including: evolutionary relationships; cell membranes; compartmentation; signaling and metabolic pathways; cellular reproduction; cell differentiation, multicellularity and development. (For majors in Colleges of Natural Science/Mathematics and Engineering/Computer Science; 3 hours lecture, 6 hours laboratory)

202 Microbiology for Nursing and Allied Health Professionals (4)
Prerequisite: Biology 101; co-requisite: Chemistry 200. An introduction to bacteria, fungi, protozoa and viruses with emphasis on pathogenic agents and how they are controlled by host defenses and human intervention. Laboratory will provide practice with basic microbiological skills. No credit toward biological science major. (3 hours lecture, 3 hours laboratory)

210 Human Anatomy and Physiology (3)
Introductory anatomy and physiological concepts for Kinesiology and Health Science majors. Gross and micro-level human anatomy as well as the structure and function of selected systems. Preparation for Kinesiology 260, 300, 348, 371, and the major in Health Science. No credit toward biological science major. (Same as Kinesiology 210)

220A Integrated Human Anatomy and Physiology (4)
(Same as Kinesiology 220A)

220B Integrated Human Anatomy and Physiology (4)
Prerequisite: Biology 101, Kinesiology/Biology 220A; co-requisite: Chemistry 200. Second semester of integrated concepts in human anatomy and physiology for nursing, allied health, and kinesiology majors.

273 Genetics and Molecular Biology (5)
Prerequisite: Biology 172. Corequisite: Completion or enrollment in Chemistry 120A. Explorations of the underlying principles of inheritance, structure and functions of nucleic acids, regulation of gene expression, the mechanisms by which populations evolve, and the impact of biotechnology on society. (3 hours lecture, 6 hours laboratory)

274 Principles of Physiology and Ecology (5)
Prerequisites: Biology 273 and Chemistry 120A; Mathematics 130, 150A, or 337 suggested. Principles of organisms' interactions with their environments; physiological and evolutionary mechanisms of change in response to environmental factors; population and community ecology; energy and material flow through ecosystems. (3 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

299L Directed Laboratory Study (1-3)
Prerequisites: Biology 171 and 172 and consent of instructor. Research in biology under the supervision of a biology faculty member. Intended for students (especially lower-division) who may not have completed sufficient course work to allow them to work independently, but who are eager for laboratory research experience. May be repeated for university credit, but units do not count toward major. (3 hours laboratory per unit)

300 Environmental Biology (3)
Prerequisite: Biology 101 or equivalent. Biological consequences of human intervention in ecosystems: Endangered and threatened species, pollution impact on organisms, pest control, population dynamics, genetic engineering of agricultural species, management of natural areas and urban ecosystem dynamics. No credit toward biological science major.

301 Problems in Environmental Biology (3)
Prerequisite: admission into the Southern California Ecosystems Research Program in environmental biology. Showcases environmental problems in Southern California ecosystems. Students investigate effects of human activities on desert, foothill, and wetland ecosystems. Course offered as an intensive four-week summer field experience. (Equivalent to 1 hour lecture, 6 hours laboratory/fieldwork during a normal semester)

302 General Microbiology (4)
Prerequisites: completion of biology lower-division core and Chemistry 120B. Introduction to structure and function of bacteria and viruses including beneficial and detrimental activities and interactions with other organisms. Laboratory provides investigations with microscopy, culture, physiology and genetics of microbes. (2 hours lecture, 6 hours laboratory)

303 Intermediate Cell Biology (3)
Prerequisites: completion of biology lower-division core. Corequisite: Chemistry 301A. Evidence-based examination of cells in action, roles of information, matter and energy flow as driving forces for compartmentation, protein sorting, metabolic and signaling pathways, motility and adhesion; examples taken from developmental, neural and cancer processes.

304 Supervised Biology Laboratory Instruction (2)
Prerequisites: Biology 172, 273 or 274 and permission of instructor For students interested in assisting in lower division biology lab that they have completed. Students will gain practical experience in laboratory teaching and will be introduced to major topics in biology education.

305 Human Heredity and Development (3)
Prerequisite: Biology 101 or equivalent. Principles of human heredity and embryology relating to human development. Mendelian genetics, single gene effects, genetics, prenatal diagnosis, and human embryology. No credit toward biological science major.

306 Biology of Aging (3)
Prerequisite: Biology 101 or equivalent. Biological changes in cells, tissues, organs and the whole body associated with aging. Theories of aging will be discussed with primary emphasis on mammals. No credit toward biological science major.

309 Intermediate Molecular Biology (3)
Prerequisites: completion of biology lower-division core. Corequisite: Chemistry 301A. Molecular and genetic basis of cellular functions. The role of gene expression and protein function in metabolism, physiology, growth, development. Introduction to recombinant DNA and its uses, and to critical analysis of primary literature.

310 Human Physiology (3)
Prerequisite: Biology 101 or equivalent. Human physiological systems and their relationship to human function for non-biology majors and students in Kinesiology and Health Sciences. No credit for biological science major.

310L Human Physiology Laboratory (3)
Prerequisite: completion of General Education Category III.A; Biology 310 is a co- or pre-requisite. Investigation of human physiology; the cellular to organ system level of muscular, cardiovascular, respiratory and renal systems; the neural and endocrine control of these systems.

311 Nutrition and Disease (3)
(Same as Chemistry 311)

314 Evolutionary Ecology (3)
Prerequisites: completion of biology lower-division core. The integration of evolutionary and ecological principles. Includes the nature and causes of

variation, population genetics, life histories, adaptation, evolution of behavior, ecology of interspecific interactions, paleoecology and life through time, and the interplay between ecology and phylogeny. (3 hours lecture)

317 Field Marine Biology (4)
Prerequisites: completion of biology lower-division core. Field biology and natural history of local marine plants and animals. Identification of common species and factors determining their distributions and abundance in marine habitats. Effects of human activities on marine organisms. (2 hours lecture, 6 hours lab or fieldwork; weekend field trips may be required)

318 Wildlife Conservation (3)
Prerequisite: completion of General Education Category III.A.2.c. Causes and consequences of loss of biological diversity, with an emphasis on wildlife populations and science-based conservation. Threatened and endangered species/ecosystems, ecosystem management, habitat restoration, captive species reintroductions and conservation legislation.

319 Marine Biology (3)
Prerequisite: Biology 101 or equivalent. Survey of marine plants and animals in their habitats. No credit toward biological science major.

322 Human Behavioral Ecology (3)
(Same as Anthropology 322)

330 Ecology of American Indians (3)
Prerequisite: Biology 101 or equivalent. Interrelationships of native peoples of the Americas with the local flora and fauna and the natural environment. Roles of American Indians in predator-prey interactions, ecological hierarchy, nutrient cycling, successional change and resource management. No credit toward biological science major.

340 Field Botany (3)
Prerequisites: completion of biology lower-division core. The native flora of southern California. Identification, natural history and factors that determine the distribution of species. (1 hour lecture, 6 hours laboratory or fieldwork; weekend field trips are required)

344 Survey of the Land Plants (4)
Prerequisites: completion of biology lower-division core. A survey of the anatomical and morphological characteristics of the land plants as they relate to the evolutionary development and ecological strategies of these plants. (2 hours lecture, 6 hours laboratory)

352 Plants and Life (3)
Prerequisite: one semester of college biology. The importance of plants in our lives, including such things as plant domestication and the origin of agriculture. Why plants are fascinating organisms. No credit toward biological science major.

360 Biology of Human Sexuality (3)
Prerequisite: Biology 101 or equivalent. The biology of the human reproductive system, sexual differentiation, anatomy and physiology, sexual behaviors, procreation, contraception and sexually transmitted disease. No credit toward biological science major.

361 Human Anatomy (4)
Prerequisites: completion of biology lower-division core. A systems approach to the structure and function of the human body. For biology majors and related health sciences. (2 hours lecture, 6 hours laboratory)

362 Mammalian Physiology (4)
Prerequisites: completion of biology lower-division core and Chemistry 120B. The fundamental mechanisms of mammalian and human physiology. Integration of cellular and organ system functions with emphasis on regulatory processes. For biology majors and related health sciences. (3 hours lecture, 3 hours laboratory).

400 Seminar in Biology Education (2)
Prerequisites: one of the following: Biology 302, 303, 309, 314 and permission of instructor. For students interested in biology education/science education. Students discuss major topics in biology education and conduct research. (2 hours lecture/discussion)

401 Biogeography (3)
Prerequisites: completion of biology lower-division core. Evolutionary patterns and mechanisms of the distribution of plants and animals in the major habitats of the world. Current concepts and theories.

402 Computer Lab in Molecular Systematics (3)
Prerequisites: completion of biology lower-division core. To gain practical and theoretical experience with software-based methods in molecular systematics, with emphasis on Internet resources for molecular biologists, acquisition of gene protein sequences, multiple sequence alignment, PCR primer design, phylogenetic analysis, and controversies in the field. (2 hours lecture, 3 hours laboratory)

404 Evolution (3)
Prerequisites: completion of biology lower-division core. The history of evolutionary thought; origin of universe, earth and life; geological and paleontological history of the earth; evidence derived from comparative anatomy, embryology, genetics, zoogeography; mechanisms of evolution.

405 Developmental Biology (3)
Prerequisite: Biology 303 or 309. Molecular and cellular processes in embryonic development encompassing mechanisms of fertilization, cell and tissue interactions, morphogenesis, organogenesis, and the regulation of gene expression.

409 Teaching Evolution: Online Course for Teachers (3)
Prerequisites: completion of biology core, General Education Category III.A. and instructor permission. Introduces concepts of evolution, methods of teaching evolution, information competence and ethics. Technology employed for communication, collaboration, investigation and organization. If both Biology 404 and 409 are taken, only Biology 404 counts for biological science major.

411 Medical Genetics and Systems Biology (3)
Prerequisites: completion of biology lower-division core and one of the following: Biology 302, 309, Chemistry 421 or 423A. Advances in genetics, genomics, proteomics, and systems biology. Implications for the pharmaceutical industry, the clinic, and for genetic counseling. Uses of biological arrays in diagnosing and treating diseases.

412 Principles of Gene Manipulation (3)
Prerequisites: Biology 309 and Chemistry 301B. Current approaches to and applications of recombinant DNA technology. Principles behind construction of recombinant molecules including vectors and enzymes, introduction into organisms, selection, expression of cloned genes, and impact of research on society.

413 Advances in Molecular Genetics (3)
Prerequisites: Biology 309 and Chemistry 301A,B. The function of genetic material and informational macromolecules. Extensive analysis of recent scientific articles in molecular genetics illustrating mutagenesis, protein synthesis, protein structure and function, biogenesis of RNA molecules, regulation of gene expression and their relationship to important biological processes.

414 Microbial Genetics (3)
Prerequisite: one of the following: Biology 302, 309, Chemistry 421, or 423A. A perspective of genetics of microbial systems including background information, experimental methods, data interpretation, genetic analysis and applications to biotechnology.

417 Advances in Cell Biology (3)
Prerequisite: Biology 303. Current topics in the cell biology of cell motility, cell multiplication and regulation, membranes and permeability, cell signaling, cell-to-cell contact and extracellular matrix, and cell differentiation using current journal articles.

418L Advances in Cell Biology Lab (2)
Prerequisite: Biology 303. Use of current techniques like fluorescence microscopy, immunolabeling, ion-sensitive dye ratiometry, image processing, and 2-D and 3-D reconstruction to study problems in cell biology, cellular developmental biology, and cellular neurobiology. (6 hours laboratory)

419 Marine Ecology (3)
Prerequisite: Biology 314. Ecology of planktonic, nektonic and benthic organisms; their communities and environments.

419L Marine Ecology Laboratory (1)
Corequisite: Biology 419. Field and laboratory studies of planktonic, nektonic and benthic communities. (3 hours laboratory or field work; weekend field trips may be required)

422 Coastal Ecology (4)
Prerequisites: Biology 274 and 314. Ecology or coastal populations and communities with emphasis on rocky intertidal or other marine or ocean-influenced habitats. Field and laboratory experiments and studies or ecological processes affecting species distributions and abundances. (2 hours lecture, 6 hours laboratory/field work; weekend field trips may be required)

424 Immunology (4)
Prerequisites: Biology 302, and 303 or 309. The molecular, cellular and organismic nature of the immune process. Inflammation, phagocytosis, antigens, immunoglobulins and cell-mediated immune phenomena. Modern immunology techniques. (2 hours lecture, 6 hours laboratory)

426 Virology (3)
Prerequisite: Biology 303 or 309. Viral structure and replication and host-virus interactions in the viral replication process, with emphasis on animal and bacterial virus systems.

428 Biology of Cancer (3)
Prerequisite: Biology 303 or 309 or 314. Biology 424 is recommended. The cancer problem as a dilemma of biology. Clinical and epidemiological aspects. Current research.

433 Microbial Problems in Foods (2)
Prerequisite: Biology 302 or equivalent. Food spoilage, food intoxication and food-borne diseases caused by microbes in food processing. The microbes involved, sources of contamination, and methods used in detection and prevention of problems. (1 hour lecture, 3 hours laboratory or fieldwork; weekend field trips may be required)

436 Advanced Applied Statistics (4)
Prerequisites: Math 337 or 338; junior or senior standing. Linear models, including mixed models, applied to experimental and field data from current research projects. Poisson and logistic regression. Emphasis on model fitting and checking; use of permutation tests as needed. Presentation of results suitable for publication. (3 hours lecture, 3 hours laboratory) (Same as Math 436)

438 Public Health Microbiology (4)
Prerequisite: Biology 302. The control and epidemiology of infectious diseases of public health importance, water and sewage microbiology. Control of current problems. (2 hours lecture, 6 hours laboratory)

441 Plant Taxonomy (4)
Prerequisites: completion of biology lower-division core. Classification and evolution of vascular plants; emphasis on the flowering plants. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

442 Pollination Biology (3)
Prerequisites: completion of biology lower-division core. Pollination in the plant kingdom. Floral cues, pollination syndromes, pollinator behavior, chemical and physical characteristics of pollination, energetics, gene flow, phenology, and ecological aspects of pollination. (2 hours lecture, 3 hours laboratory or fieldwork)

443 Plant Ecology (4)
Prerequisite: Biology 314. Community and population ecology of terrestrial plants. Environmental factors and plant distribution with emphasis on California vegetation. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

444 Plant Physiological Ecology (4)
Prerequisites: completion of biology lower-division core. Biology 445 is recommended. Fundamental mechanisms of plant physiological responses to the environment with primary emphasis on whole plants and ecosystems. (2 hours lecture, 6 hours laboratory; weekend field trips may be required)

445 Plant Cell Physiology (3)
Prerequisites: completion of biology lower-division core plus one of the following: Biology 302, 309, 314, Chemistry 421, or 423A. Cellular and molecular mechanisms of behavior, growth, transport processes, and environmental responses in vascular plants. Plant cell development, nutrition, respiration, photosynthesis, hormones, photoperiodism, and stress biology.

446 Marine Phycology (4)
Prerequisites: completion of biology lower-division core. Biological aspects of marine algae; comparative development, morphology, taxonomy, physiology, and ecology. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

447 Ethnobotany (4)
Prerequisites: completion of Biology 171, 172, 273, 274 and 314. The study of how people interact with plants and the environment, including such things as western medicinal plant use, traditional medicine and dentistry, exotic foods and conservation. (2 hours lecture, 3 hours laboratory; weekend field trips may be required)

448 Plant Molecular Biology (3)
Prerequisite: Biology 302 or 303 or 309 or Chemistry 421 or 423A. Genetic mechanisms in vascular plants controlling metabolism, growth, development, and responses to biotic/abiotic environmental stresses. Emphasis on molecular regulation of gene expression and transduction of internal and external signals.

449 Desert Ecology (4)
Prerequisites: completion of biology lower-division core; Biology 314. Investigation of adaptations, distributions and interactions of desert plants, animals and microbes, including the influences of environmental factors. (2 hours lecture, 6 hours laboratory of fieldwork; weekend field trips may be required)

450 Conservation Biology (3)
Prerequisite: Biology 314 or consent of instructor. Current topics involving theory, concepts and techniques in the conservation of biological diversity.

451 Advanced Human Evolution (3)
(Same as Anthro 451)

453 Life Science Concepts (3)
Prerequisites: completion of general education requirements or consent of instructor. Biological principles using science processes appropriate for elementary teachers. No credit for Biological Science major. (2 hours lecture, 2 hours activity)

461 Marine Invertebrate Biology (4)
Prerequisites: completion of biology lower-division core. Evolution, classification, phylogeny, morphological and physiological adaptations of marine invertebrate animals. Dissection, identification and observation of extant animals. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

462 General Parasitology (4)
Prerequisites: completion of biology lower-division core. Survey of various animal parasites with an emphasis on the morphology, physiology, and genetics of human protozoans and helminthes. Other topics will include vectors and common parasites of domestic animals. (3 hours lecture, 3 hours lab per week)

466 Behavioral Ecology (3)
Prerequisites: completion of biology lower-division core. Current problems in the evolution of animal behavior; the origin and maintenance of social systems and behavioral interactions of animals.

467 Entomology (4)
Prerequisites: completion of biology lower-division core. Anatomy, physiology, evolution and biology of insects and other terrestrial arthropods.

Dissection, collection, identification and observation of living arthropods. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

468 Comparative Animal Physiology (4)
Prerequisites: completion of biology lower-division core and Chemistry 120B. Comparative study of physiological and biochemical processes among representative animals. (3 hours lecture, 3 hours laboratory, weekend field trips may be required)

470 Cellular Neurobiology (3)
Prerequisites: Biology 303 or 309, and 362. Processes of cell communication, particularly in nervous systems. Molecular biology of neurons, model sensory and motor systems, and cellular basis for behavior.

472A Advances in Biotechnology Laboratory (3)
(Same as Chemistry 472A)

472B Advances in Biotechnology Laboratory (3)
Prerequisite: Biology/Chemistry 472A. Second semester exploring biotechnology techniques for gene product analysis: DNA sequencing, site-directed mutagenesis, predicting amino acid changes, protein overproduction, enzyme function assays, protein identification/preparation by gel techniques, immunoblotting. (1 hour discussion, 6 hours laboratory) (Same as Chemistry 472B)

473 Bioinformatics (3)
Prerequisites: Chemistry 301B, 302 and Biology 309, Biology 314 or Chemistry 421; or consent of instructor. Provides a research-based, problem-solving experience using the tools and algorithms of molecular and computational biology to analyze genetic and protein sequences retrieved from appropriate databases. (2 hours lecture, 3 hours computer laboratory) (Same as Chemistry 473)

474 Natural History of the Vertebrates (4)
Prerequisites: completion of biology lower-division core. Natural history of the vertebrates. Observation, identification, behavior, ecology and distribution of the vertebrates. (2 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

475 Ichthyology (4)
Prerequisites: completion of biology lower-division core. The systematics, evolution, morphology, physiology, ecology and behavior of fishes. (2 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

476 Herpetology (4)
Prerequisites: completion of biology lower-division core. The biology, structure, physiology, ecology, distribution, identification, collection,

evolution and behavior of amphibians and reptiles. (2 hours lecture, 6 hours laboratory or fieldwork; weekend field trips may be required)

477 Advances in Biotechnology (3)
(Same as Chemistry 477)

478 Mammalogy (4)
Prerequisites: completion of biology lower-division core. The systematics, evolution, morphology, physiology, ecology and behavior of mammals. (2 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

479 Ornithology (4)
Prerequisites: completion of biology lower-division core. Anatomy, physiology, evolution, behavior, and ecology of birds. Laboratory and fieldwork in identification, anatomy, observational techniques and community composition. (2 hours lecture, 6 hours laboratory/fieldwork; weekend field trips may be required)

480 Advanced Topics in Undergraduate Biology (1-3)
Prerequisites: upper-division students majoring in biological science and consent of instructor. Current topics, updating of concepts, recent advances and unification of the principles of biology. May be repeated for credit.

480E SCERP Proseminar (1)
Prerequisites: selection as a Southern California Ecosystems Research Program (SCERP) Fellow. Increase the experience and skills of SCERP Fellows in working on problems in environmental biology. Discussion of publications, development and presentation of SCERP research. Offered Credit/No Credit only. May be repeated for credit. Not available for graduate degree credit.

480M MARC Proseminar (1)
Prerequisite: selection as MARC Fellow. Intended to increase the contact of MARC Fellows with minority scientists of national repute who will present seminars. Fellows will read and discuss relevant primary literature, attend the seminars, and meet with speakers before and after the seminars. May be repeated for credit. (Same as Chemistry and Psychology 480M)

482 Capstone Studies in Biology (2)
Prerequisite: consent of instructor; for Biological Science majors with senior standing. Individualized practical experience related to the study of biology or pursuit of a biology career that reflects paradigms of the discipline. Emphasis on application and integration of biological concepts and skills through library research, applied projects or community service activities. Not available for graduate degree credit.

495 Biological Internship (3)
Prerequisites: successful completion of 90 units, including all core requirements, and consent of instructor. Biological, ecological, and health-

related fields. Ninety (90) hours of practical experience in student's chosen field of interest with public or private agencies or businesses. May not be repeated for credit. (1 hour lecture/discussion, 6 hours laboratory work experience)

496 Biology Tutorials (1-3)
Prerequisites: completion of biology lower-division core and consent of instructor. Supervised experience in biological science teaching through tutoring or assisting in a laboratory or field class. No credit toward biological science major.

498 Senior Thesis (2)
Prerequisite: 6 units of Biology 499L (two units may be taken concurrently). Thesis committee must approve research plan at least two semesters prior to enrollment in this course. Requires preparation, presentation and defense of a formal thesis.

499L Independent Laboratory Study (1-3)
Prerequisite: junior or senior standing with consent of instructor with whom the student wishes to pursue independent laboratory study in biology. May be repeated for credit.

500A Professional Aspects of Biology (1)
Prerequisites: graduate standing and concurrent enrollment in Biology 500B. Discussions concerning research protocol, scientific methodology and communication techniques. Ethics and social responsibilities of professional biologists. (1 hour discussion)

500B Professional Aspects of Biology (1)
Prerequisites: graduate standing and concurrent enrollment in Biology 500A. Individualized project work and experiences in scientific writing. Required of all students upon admission to the graduate program. (3 hours project work)

500C Professional Aspects of Biology: Teaching Effectiveness (2)
Prerequisites/corequisites: graduate standing; must have received a Graduate Teaching Associate appointment. This course is designed to assist graduate students in becoming effective classroom teachers and understanding the scholarship of teaching in higher education. Graduate Teaching Associates will learn pedagogy and a variety of teaching alternatives while concurrently teaching in a laboratory/discussion setting.

505T Seminar in Molecular, Cellular, Immunological and Physiological Biology (3)
Prerequisite: graduate standing Selected advanced topics. May be repeated for credit.

517T Seminar in Ecological and Organismic Biology (3)
Prerequisite: graduate standing. Selected advanced topics. May be repeated for credit.

520T Seminar in Microbiology (3)
Prerequisite: graduate standing. Selected advanced topics. May be repeated for credit.

547 Advanced Ethnobotany (3)
Prerequisites: Graduate Standing. An ethnobotanical investigation of plants and human culture. Students will develop the skills to conduct original ethnobotanical research through voucher collections, plant identification, participant observation, interviews, experimentation and critique of scholarly research. (2 hours lecture. 3 hours laboratory, weekend field trips may be required).

580 Advanced Topics in Graduate Biology (1-3)
Prerequisites: graduate standing in biology and consent of instructor. Current research topics, experimental design and problem solving in biological systems. May be repeated for credit.

598 Thesis (1-3)
Open to graduate students with consent of instructor with whom the student is conducting graduate thesis research.

599 Independent Graduate Research (1-3)
Open to graduate students with consent of instructor with whom the student wishes to pursue independent study in biology.

Biology Graduate Student Handbook

Master of Science Program

Cal State Fullerton

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Draft 26 February 2007

The Master of Science Program in Biology at Cal State Fullerton

Why pursue the Master of Science in Biology?

This is an incredible time to be a biologist. Every day, new research findings are presented, from the level of single molecules to whole ecosystems. A master's degree in Biology allows you to contribute to this research, to share this knowledge through teaching, or to apply it in public service or private industry. Many of our students use their M.S. as a stepping stone to doctoral or health degree programs. Others enter the workforce immediately, in fields as diverse as biotechnology, government service, environmental consulting, and teaching. The Cal State Fullerton M.S. in Biology is a rigorous, research-based program that can be completed in 2-3 years, and will prepare you for a variety of careers in exciting and competitive fields.

What is distinctive about Cal State Fullerton's program?

We offer a strong, research-focused and thesis-based M.S. degree with graduate students working closely with their faculty mentor from the first day of their entry into the program. Our diverse faculty conducts research at all levels of biological organization, reflecting the five concentrations of study available within the program. Faculty members are supported by grants and contracts from foundations and government agencies, and, with their students, use state-of-the-art equipment in their labs and in the field. For field work, the region is blessed with an incredible variety of accessible habitats including deserts, mountains, shrublands, wetlands, rocky coasts, kelp forests, and offshore islands. The many academic institutions, biotechnology laboratories, consulting firms, and government agencies in the area offer a rich intellectual environment for students engaged in M.S. research.

What is required for admission?

Students seeking admission to the M.S. program in Biology must have: a B.S. degree in biology or related area from an accredited college or university; a GPA of 3.0 in all biology or biology-related courses (e.g. Biochemistry) and a GPA of 2.5 in all supporting course work in chemistry, physics, and mathematics. Students must submit their scores from one of the following: Graduate Record Examination (GRE) General test, Medical College Admission Test (MCAT), or Dental Admission Test (DAT). No absolute score is required for admission, but the scores are used in the evaluation procedure. To be admitted to the program, an applicant must be accepted by a full-time Biology faculty member who agrees to serve as the student's thesis adviser. Therefore, prospective applicants normally should contact potential faculty thesis advisers to inquire about openings in their laboratories prior to submitting an application. For more information visit our website http://biology.fullerton.edu.

What are the research interests of the faculty?

The Department of Biological Science is one of five departments in the College of Natural Sciences and Mathematics at Cal State Fullerton. The Department has 25 full-time faculty, most of whom are actively engaged in research. The research interests of the faculty can be broadly divided into five concentrations:

1. BIODIVERSITY, ECOLOGY, and CONSERVATION BIOLOGY

This M.S. degree concentration allows students to gain experience in the research methods used to study the evolution and ecology of organisms found in terrestrial, freshwater, and coastal ecosystems. Research is conducted at the level of individual organisms, populations, communities, and ecosystems. Faculty members offer courses and active research experiences in taxonomy and phylogeny, vertebrate and invertebrate ecology, evolutionary ecology, biogeography, behavioral ecology, plant ecology and ethnobotany, plant-animal interactions, and conservation biology. Much of this research is conducted in

the diverse natural environments that surround Cal State Fullerton, including research on threatened and endangered species and human impacts on these environments.

Graduate Faculty in Biodiversity, Ecology, and Conservation Biology: Sandra Banack, Douglas Eernisse, William Hoese, Michael Horn, Anne Houtman, Eugene Jones, William Presch, Darren Sandquist, Jochen Schenk, Paul Stapp, and Sean Walker

2. MARINE BIOLOGY

This M.S. degree concentration is designed to provide students with research skills and expertise in the study of coastal marine organisms and ecosystems. Our program takes advantage of the proximity of coastal marine habitats ranging from wetlands and estuaries, rocky intertidal reefs, sandy shores, kelp forests, and soft-bottom systems to human-made harbors. Access to laboratory space in Los Angeles Harbor and use of several ocean-going vessels are provided through affiliation with the Southern California Marine Institute, which in turn provides opportunities to use laboratory and living space at the University of Southern California's Wrigley Institute for Environmental Studies on Santa Catalina Island.

Graduate Faculty in Marine Biology: Kathryn Dickson, Douglas Eernisse, Michael Horn, Steven Murray, and Danielle Zacherl

3. CELL and DEVELOPMENTAL BIOLOGY

This M. S. degree concentration provides students with the opportunity to study animal and plant development, microbiology, fertilization processes, cancer biology, and neurobiology. Research is conducted at the cellular, molecular and organismal levels. Campus facilities include modern laboratories with state-of-the-art instrumentation, in addition to facilities for animal and plant growth, mammalian tissue culture, and several types of microscopy. Most faculty in this concentration are members of the Center for Applied Biotechnology Studies.

Graduate Faculty in Cell and Developmental Biology: Merri Lynn Casem, Esther Chen, David Drath, Robert Koch, Nilay Patel, Nancy Pelaez

4. MOLECULAR BIOLOGY and BIOTECHNOLOGY

This M. S. degree concentration is designed for students seeking to develop skills and expertise to conduct molecular research using cutting-edge technologies to solve basic research problems relevant to genetics, medicine, agriculture, and the environment. Emphasis is placed on molecular research in prokaryotic and eukaryotic organisms under the close guidance of a faculty mentor. Research areas include: molecular studies of muscle development, bacterial virulence, pathogenesis, regulation of gene expression, plant environmental stress, and genetic recombination using the latest techniques in molecular biology, bioinformatics, gene manipulation, and biotechnology.

Graduate Faculty in Molecular Biology and Biotechnology: Amybeth Cohen, Rodrigo Lois, Nilay Patel, Marcelo Tolmasky, and Frederick Whipple

5. BIOLOGY PEDAGOGY RESEARCH

This M. S. degree concentration is designed to produce graduates with an interdisciplinary background in biology and pedagogical research. Our graduates have advanced expertise in a biological discipline as well as in educational theory and research methodologies. Graduates of our program are broadly trained

in teaching and research processes and go on to Ph.D. programs or careers as community college instructors or K-12 teachers.

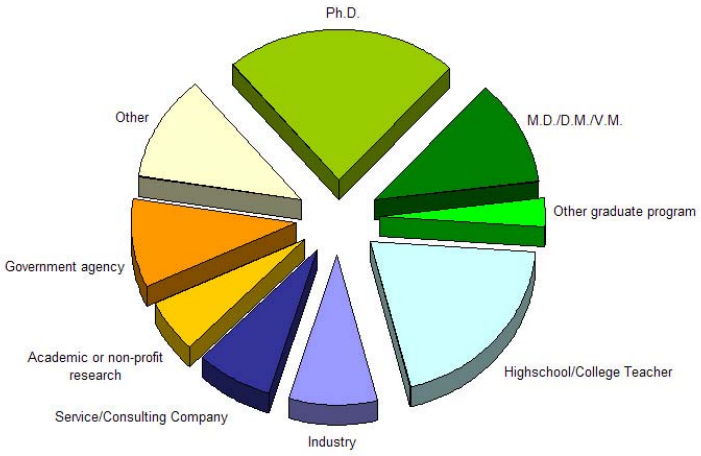
Graduate Faculty in Biology Pedagogy Research: Merri Lynn Casem, William Hoese, Anne Houtman, and Nancy Pelaez

What kinds of financial support are available?

The Biology Department offers teaching assistant or research assistant positions to virtually all of our graduate students. Applicants indicate their interest in teaching assistantships as part of their departmental application to the M.S. program. In addition, a number of small scholarships are available each year. Non-resident tuition waivers may be available for some out-of-state and foreign students. For additional information about financial aid, contact the CSUF Office of Financial Aid at (714) 278-3125 or www.fullerton.edu/financialaid/.

What are Biology M.S. alumni doing now?

Most of our M.S. graduates enter Ph.D. programs, pursue health-professions degrees, become high school or college teachers, or take positions in industry, government agencies, or consulting firms. [See pie diagram below]



Where can I get more information?

For more information about our M.S. Program in Biology, contact the Graduate Program Adviser by e-mail at BioGradAdv@fullerton.edu or call the department office at (714) 278-3614. You also are welcome to visit the main office of our department located in McCarthy Hall 282, or to write to the Graduate Program Adviser, Department of Biological Science, California State University, Fullerton, 800 North State College Blvd., Fullerton, CA 92834-6850. For more information, visit our website http://biology.fullerton.edu.

Information for New M.S. Students in the Department of Biological Science

FAQs

- **How do I get keys?**
- **Will I have office space and a desk?**
- **How do I get work-related mail?**
- **Do I have an email account?**
- **How do I make photocopies and send faxes?**
- **Who are the primary departmental support staff and what are their roles in the department that pertain to graduate students?**
- **What other common resources and facilities are available in the department for graduate students?**
- **I've been awarded a teaching assistantship (TA). Can I choose what courses I teach?**
- **What is BIOL500A/B?**
- **What is BIOL500C?**
- **What are variable unit courses (BIOL580/599/598) and how do I sign up for them?**
- **How many units should I take each semester?**
- **What funds are available to support my research?**
- **I heard that I need laboratory safety training to teach and work in a lab. How do I do this?**
- **I would like to use a departmental vehicle for my field research. How do I do this?**
- **My research will likely involve live, vertebrate animals or human subjects. Are there special policies and guidelines that I should know about?**
- **Can I borrow journals from the Pollak Library?**
- **What is the Biology Graduate Student Club (BGSC)?**
- **What other departments, offices and organizations should I know about?**

How do I get keys?
Within a week of arriving on campus, ask your thesis adviser (or teaching supervisor) to submit a request for keys for you. This is done by completing a pink form, located in the wall file near MH282-A. Normally, you will be assigned a key to the outside door to the building (MH and/or DBH), a key to the department office, and key(s) to your research lab and office space. TAs may also be given keys to teaching labs. The form must be signed by a faculty member and submitted to Ernestine. You must pick up your keys at Campus Police, usually about a week later (call ahead, X2912, to be sure they are ready).

Will I have office space and a desk?
All teaching assistants will have access to a desk where they can hold office hours with their students. Many faculty members provide desk and work space for students in their research labs. If you are not a TA, desk space may be available elsewhere; ask your adviser.

How do I get work-related mail?
All graduate students have a mailbox in the Biology department office (MH-282). Mailboxes are organized into full-time faculty, staff, part-time faculty and graduate students, by the color of the name tag. Graduate students are further divided into TAs, GAs and students without department

positions. Mail is delivered and picked up once a day, usually between 8-9 a.m. Off-campus mail must have a department mailing label and be placed in the blue mailbag. On-campus/intramural mail is placed in manila envelopes in the wooden slot. Departmental mailing labels, envelopes and letterhead should be used for official departmental business only.

Will I have a university email account?
All registered students will have a university email account on the university server (exchange.fullerton.edu) which will be set up for you. In addition, TAs will be given a faculty account to be used primarily for teaching-related correspondence (you will lose this account when you are not a TA or GA).

How do I make photocopies and send faxes?
There are two photocopiers in MH-282. They are primarily dedicated to supporting teaching, office administration and faculty research, and require entry of a 4-digit code. TAs may be given a code for the courses they teach. Graduate students can make copies for their own personal/research purposes (ask Ernestine or Jeanne for the cost per page). Ernestine can assign you an account and access code. The balance of your personal account must be paid each semester.

The photocopier in MH282E is also a FAX machine. You can send personal faxes but must record all the information in the log (burgundy binder) near the machine, including the account to which the FAX should be billed. Personal faxes are billed at a rate of $1 per page. Instructions for using the fax machine are in the front of the burgundy binder.

Who are the primary departmental support staff and what are their roles in the department that pertain to graduate students?

Biology Graduate Adviser (biogradadv@fullerton.edu)
- *<u>not</u> a staff member, but a full-time faculty member who coordinates the Biology Graduate Program*
- *may change between semesters; check in the department office*
- *usually teaches BIOL500A/B*
- *signs most of the departmental forms related to the Grad Program*

Jeanne Crawford (MH-282; X4227, jcrawford@fullerton.edu)
- *schedules MH282-A (conference room), Computer Lab (MH-289) and other Biology classrooms*
- *responsible for scheduling and postings of department seminars*
- *handles salmon forms for enrollment in BIOL580/598/599*
- *receives completed forms related to academic field trips*
- *orders textbooks*

Ernestine Hood (MH-282; X4234, ehood@fullerton.edu)
- *administers contracts for TAs, GAs and part-time instructors*
- *works with Biology Graduate Adviser on current graduate student issues*
- *handles key requests*

Dayna Melton (MH-377; X2780, dmelton@fullerton.edu)
- *oversees operations of Stockroom, including purchasing supplies and Vehicle Checkout*
- *oversees budget and dispersion of state funds, including departmental research funds awarded to students*
- *receives some forms related to travel and field trips*

Trung Nguyen (MH-319A; X2460, trnguyen@fullerton.edu)
- *IT support for classroom and research laboratory computers*
- *manages departmental servers*

John Luong (MH-003A); X2463, jluong@fullerton.edu)
- *maintenance and repair of department equipment*
- *helps to design and build research tools and equipment*

Ed Read (Greenhouse Complex; X2766, eread@fullerton.edu)
- *manages operations and maintenance of department greenhouse*
- *provides plants used in some courses*

Steve Karl (MH-013; X2565, skarl@fullerton.edu)
- *supervises use of confocal, electron and fluorescence microscopes*
- *repairs and maintains teaching and research microscopes*
- *assists with set-up of physiology labs*

John Chappell (MH-513A; X5388, jchappell@fullerton.edu)
- *oversees all laboratory animal care and use, including use of animal rooms*
- *responsible for vertebrate and marine animals used in courses*
- *serves on university Institutional Animal Care and Use Committee*

What other common resources and facilities are available in the department for graduate students?

Ice machines (located in MH-385 and DBH-161A)
Dry ice (DBH-143)
Liquid nitrogen (DBH-143, DBH-161A; contact Beena Matthews in Chemistry X3509)
Autoclaves (MH-385, DBH-143, DBH-172; contact Andy Craddock for use)
Poster Printing Room (MH-385A)
Stockroom (MH-377; Dayna Melton)
Greenhouse Complex
- *Greenhouse Facilities (contact Ed Read)*
- *Marine Storage Shed (contact Danielle Zacherl)*
- *Storage containers for field gear*

Herbarium (MH-229; contact Jochen Schenk or Gene Jones)
Vertebrate and Invertebrate Teaching Collections (MH-207 complex; MH-237; contact Paul Stapp or Sean Walker)
Conference Room (MH-282A; contact Jeanne Crawford to schedule)
Computer Laboratory (MH-289; contact Jeanne Crawford to schedule)
Numerous Animal Rooms and Facilities in MH and DBH (contact John Chappell)

I've been awarded a teaching assistantship. Can I choose what course(s) I teach?
When you applied for admission, you were asked to list some of the courses that you were interested in teaching. The department makes every attempt to have TAs and GAs teach in their area of specialty or in non-majors courses such as BIOL101. TAs are assigned to courses based on the needs of the department, requests by full-time faculty, and requests of TAs. If there is a course you would like to teach, contact the faculty member in charge to see if there are any openings, and request the course when you receive the survey towards the end of the semester.

Expectations of TAs and GAs vary among courses and instructors. Many courses have written statements of expectations, including specific policies for participating in lectures, grading, handling student issues, etc. Most courses with large enrollments have mandatory weekly TA/GA prep meetings, and have lab coordinators (staff), with whom you will sometimes work closely to prepare for lab.

What is BIOL500A/B?
BIOL500A and BIOL500B (Professional Aspects of Biology) are two courses taught back-to-back, usually on Monday evenings, that serve several important functions. First, they introduce new students to the department and its policies pertaining to graduate students. Second, it is the primary mechanism by which students develop their Study Plan (a list of courses that the student will take during their program) and Research Proposal. Third, it helps students develop professional skills, including using library resources, writing research proposals, and giving oral and poster presentations (it also meets the university writing requirement). Finally, it helps you begin to forge peer relationships that you can depend on throughout your program.

New M.S. students will enroll in BIOL500A and BIOL500B in their first or second semester on campus, usually as specified in the acceptance letter.

What is BIOL500C?
BIOL500C is Professional Aspects of Biology: Teaching Effectiveness. All TAs must have completed or be concurrently enrolled in BIOL500C to teach in the department. BIOL500C meets on Thursday and Friday the week before instruction begins for a given term. At that time, students will also receive training in laboratory safety from Environmental Health and Instructional Safety, which is required of all instructors.

What are variable-unit courses (BIOL580/598/599) and how do I sign up for them?
Most graduate students enroll in one or more of the variable-unit courses each semester. These courses allow you to earn credit for work related to your graduate studies and allow your thesis adviser and the department to get credit for the time and resources that he/she dedicates to you each semester. You should meet with your adviser to discuss which courses you should take and for how many units. Before you can enroll online, you must first complete a "salmon" form available in the department office, which must be signed by your thesis adviser, the Department Chair, and the Biology Graduate Adviser. You will be given a permit to enroll, which must be done online no later than the end of the first 2 weeks of the semester. Be sure to use the correct course schedule number associated with your thesis adviser. The first section of BIOL580 in the Course Schedule is reserved for the weekly departmental seminar, which is supervised by a full-time faculty member. Don't forget that you cannot take more than 6 units of BIOL598 during your entire graduate program at CSUF.

Enrollment in at least one of the variable-unit courses is required to use a departmental vehicle for research purposes. It also makes you eligible for departmental research funds.

How many units should I take each semester?
The number of units you take will be determined in consultation with your thesis adviser and is based on the courses on your Study Plan and the type and amount of work you are doing toward your research. The minimum number of units you can take to maintain continuous enrollment is 1 unit, but most students enroll in multiple units of BIOL580, BIOL598 and/or BIOL599 each semester during their first 2 years on campus, so that typical full loads are 6-9 units per term (you will need to take an average of 7-8 units per semester to complete the 30 units on your Study Plan in 2 years).

When you have completed all of the units listed on your Study Plan, successfully completed your first and second committee meetings, have applied for graduation, and have only to complete your thesis and defense, you may enroll in GS(Graduate Studies)700 through Extended Education. This option is designed to allow students who have left campus to maintain continuous enrollment status without paying full fees. Students enrolled in GS700 in this way have no university benefits except library privileges, and usually will not be eligible for teaching assistantships or other department support. Enrollment in GS700 must be approved by your thesis adviser and the Biology Graduate Adviser prior to online registration.

What funds are available to support my research?
Your thesis adviser and the more senior graduate students in your lab will be the best sources of information on grants, scholarships and other funding opportunities available to support research in your discipline. Websites of the College of Natural Sciences and Mathematics (http://nsm.fullerton.edu/) and the Office of Financial Aid (http://www.fullerton.edu/financialaid/scholar/scholarships_default.htm) provide information on scholarships and aid programs at the college and university level.

In most semesters, the department makes available limited funds ($50-150) to support student research. Requests for short proposals for these funds are solicited in the middle of the semester from the Biology Graduate Adviser. Awarded funds are administered by Dayna Melton.

The College of Natural Sciences and Mathematics InterClub Council coordinates the allocation of student body-generated funds (ASI) for graduate student travel, especially to present papers at scientific meetings. ASI also awards small grants (up to $450) to students that can be used for research supplies; applications are due in Fall semester. Contact one of the Biology Graduate Student Club officers for more information on how to apply.

I heard that I need laboratory safety training to teach and work in a lab. How do I do this?
All students working in laboratories or in the field, and all teaching associates, are required to attend a laboratory safety training course taught by Environmental Health and Instructional Safety. New students who are TAs will receive this training during BIOL500C. Other sessions are held during the semester. Look for poster announcements or contact Sue Fisher (X2507) or Skip Hines (X5938) for dates of other training sessions.

I would like to use a departmental vehicle for my field research. How do I do this?
The department has specific policies regarding the use of its four departmental vehicles, and its policies and procedures for taking field trips, which includes independent research conducted by graduate students. These procedures are outlined in two separate documents that are available on the departmental website:

- *Policy on Departmental Vehicle Use*
- *Guidelines and Procedures for Academic Field Trips*

To drive a vehicle on university business, you must be a state employee (TA or GA) or registered as a Volunteer. You also must have on file with Dayna Melton a DMV Driver Record Information form, a Travel Authorization form, and an updated Defensive Driving Certificate. To use your own vehicle on state business, you must also complete an Authorization to Use Private Vehicle Form. If you plan to drive unsupervised, e.g. for your research, you must also be enrolled in BIOL598 or BIOL599. Additional forms are required for course-related field trips. If you plan to travel for research or course field trips often, you should complete the necessary paperwork with Dayna as soon as possible upon arriving on campus. See the Guidelines for more information.

Departmental vehicles are reserved by signing them out in the Stockroom. You must be approved as a driver to use a vehicle (see above). You must give your contact information and list you and your thesis adviser's name on the sign-out sheet. Be sure you understand the policies regarding reserving and using the vehicles.

My research likely will involve live, vertebrate animals or human subjects. Are there special policies and guidelines that I should know about?
If your M.S. thesis research involves human participants or live, vertebrate animals, you must obtain the proper approval for their use based on federal regulations and University policy. Before conducting the research, the project must have received approval from the Institutional Review Board (IRB) for human participants or the Institutional Animal Care and Use Committee (IACUC) for live, vertebrate animals. If you plan to use human participants or animal subjects in your research, first check with your thesis adviser to find out if he or she has already received approval for your work. If not, you can find valuable information the IRB or IACUC application process and the forms you will need at http://ogcerv.fullerton.edu, under Rules and Regulations. If you have further questions, please contact the Office of Grants and Contracts in MH-112 (X2106).

Can I borrow journals from the Pollak Library?
The Pollak Library has a wide range of academic journals, many of which are available online (see the library website: http://library.fullerton.edu/). There also are a variety of searchable databases through the library, as well as the ILIAD and LINK+ inter-library loan programs for borrowing materials from other institutions. To make photocopies at the library, you must purchase a copy card and use their temperamental copy machines. Copies are also more expensive than in the departmental office. Anyone with a CSUF Faculty/Staff ID can check out journals for 24 hours; this is done at the Periodicals Desk on the 2nd floor. Faculty can also authorize, by proxy, students who are not faculty/staff to check out journals by completing a "proxy authorization form" available from the Circulation Desk on the 1st floor.

What is the Biology Graduate Student Club (BGSC)?
The Biology Graduate Student Club is a student organization that serves graduate students in the Department of Biological Science by hosting seminar speakers, coordinating social events, running the snack shop in MH-280, and increasing communication between students and other members of the department. Visit the BGSC website http://biology.fullerton.edu/orgs/bgsc/ for more information about the club, its officers, and how to become involved. There also are many useful links and other resources on the website.

What other departments, offices and organizations should I know about?
Graduate Studies Office (X2618)
Office of Financial Aid (X3125)
Office of Grants and Contracts (X2106)
Auxiliary Services Corporation (X3415)
Office of Environmental Health and Instructional Safety (X2733)
NSM InterClub Council
Titan Student Union and Associated Students of CSUF, Incorporated (ASI)
Student Health and Counseling Center (X2800)

Biology M.S. Study Plan

Guidelines and Procedures: Each student is to prepare a graduate Study Plan during BIOL500A/B and submit the form for approval before 9 units have been completed. Students fill in the green draft form, obtain the signature of their thesis adviser, and submit it to the instructor of BIOL500A/B for approval. List the three (or more) members of your thesis committee on the form. Their signatures will be required on the final copy to be submitted to the Graduate Studies Office. The approved copy is then submitted to the Department Administrative Support Coordinator, who will prepare the official document. The final Study Plan (on white paper) will be given back to the student to obtain all required signatures (those of all committee members and the Biology Graduate Adviser) and is then sent to the CSUF Graduate Studies Office. Once the Graduate Studies Office reviews and approves the Study Plan, the student becomes a classified graduate student. One may not graduate from a CSUF master's degree program unless classified standing has been achieved.

Checklist for completion of the Study Plan:

- ✓ Have you decided on your Study Plan after careful consultation with your thesis adviser?
- ✓ Does your Study Plan list the courses that best prepare you for your thesis work?
- ✓ Do you have a total of 30 units? (It may be acceptable to have 31 units, or in rare cases 32 units, but never 29 or fewer units.)
- ✓ Do you have a minimum of 15 (half of the total) 500-level units?
- ✓ Does your Study Plan include BIOL500A and BIOL500B? (NOTE: these courses meet the graduate writing requirement and must be included in your Study Plan.)
- ✓ Have you listed at least two seminar courses (6 units)? These are courses with the following course numbers: BIOL505, 517, and 520. Additional seminar courses can be used to meet the 30-unit requirement. (NOTE: This applies to students who started in the program in Fall 2004 or later.)
- ✓ No more than 2 units of BIOL580 (Advanced Topics in Graduate Biology) may be listed.
- ✓ Do you have some BIOL598 and some BIOL599 units on your Study Plan without exceeding the maximum number of units allowed (6 each) for these two courses? [Note: You **cannot** enroll in more than the number of units of BIOL598 on your Study Plan during your time as a graduate student at CSUF, with a maximum allowed of 6 units. However, you may enroll in additional units of BIOL580 and BIOL599 but these will not be counted toward graduation or your Study Plan.]

Note: Your Study Plan will list any Conditions of Acceptance (coursework, GRE scores) that must be met before you can be "classified" (these were indicated on your acceptance letter). It is your responsibility to meet these conditions by the deadlines listed (usually within 2 semesters of admittance), and to keep your adviser and committee informed of the status of these conditions.

GRADUATE THESIS AND THESIS COMMITTEE GUIDELINES
[Approved 5/20/05; effective Fall 2005]

(last revised 01/28/07)

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Section I. Guidelines for the First Thesis Committee Meeting

The **purpose** of the first committee meeting is for the student to present and discuss his/her proposal for the thesis research project, and to obtain agreement from the committee that it is a reasonable thesis project to pursue. The meeting should be designed to ensure the soundness and feasibility of the thesis research design and ideally will provide the opportunity for the student to make necessary changes in the direction of the research in its early stages. It also is an opportunity for the committee to outline the expectations for completion of the thesis project and the student's degree program.

The **outcome** of the meeting will be approval of the proposal as presented or committee recommendations for modifications, which, if substantive, may require an additional committee meeting.

It is expected that the first committee meeting will occur in the semester after the student has completed BIOL500A/B (Professional Aspects of Biology). Barring unforeseen circumstances, the student shall have his/her first committee meeting no later than the end of the fourth semester. If a student does not complete this requirement, he/she will be placed on administrative probation and may be disqualified from the MS program after one semester on probation.

A. Selecting your Thesis Committee and Preparing for the First Committee Meeting:

The student shall have selected his/her committee members in consultation with the thesis adviser and obtained consent of the committee members to serve. The committee shall consist of the thesis adviser plus a minimum of two additional CSUF faculty members, at least one of which must be from the Biology Department. Additional committee members (usually only one) can be added at the adviser's discretion. This member may be external to the Department or to the University.

The student shall obtain permission from his/her adviser before scheduling the first committee meeting.

Normally, the student will have successfully completed BIOL500A/B, will have an approved Study Plan, and the thesis proposal produced in BIOL500A/B will have been expanded/revised. The thesis proposal prepared for the first committee meeting will follow BIOL500A/B proposal guidelines. [Note: The format for BIOL500A/B Proposals can be found at http://biology.fullerton.edu/. Select "Graduate Program" and click on "Upon Entering the Program" and scroll down to "Research Proposal".]

A copy of the adviser-approved thesis proposal should be given to all committee members **two weeks** before the first committee meeting.

The student will prepare an oral presentation (~15-30 minutes) and review this presentation with the thesis adviser prior to the meeting. It is expected that each committee member will critically read the thesis proposal prior to the meeting. If a committee member finds major problems with the proposal, he/she should attempt to discuss these with the adviser and student before the meeting.

The student is responsible for scheduling the meeting (place and time), and the adviser will guide the student in how to go about scheduling this meeting. There is no expectation that the student will provide refreshments for the committee.

B. The First Committee Meeting:

The meeting will begin with an oral presentation (~15-30 min) on the proposed research by the student. Questions from the committee will focus on the proposed research, experimental design, and the conceptual background relevant to the thesis project. The student should be able to establish that the project is feasible and that he/she is prepared to undertake the project successfully.

The committee members also will review the study plan and, if necessary, suggest changes to be made.

The first committee meeting should last no more than 2 hours. It will conclude with an agreement between the adviser, committee members, and student regarding the proposal, determined by consensus of the committee. The outcome and committee recommendations will be recorded on the appropriate form. The possible outcomes are:

1. Project approval by committee (the proposal represents an appropriate and feasible/realistic project to obtain a M.S. thesis);

2. Project approval by committee with modifications of the thesis proposal, not requiring a second meeting; or

3. Substantive modifications of thesis proposal requiring an additional committee meeting.

The thesis adviser will (a) summarize the recommendations of the committee on the yellow form and return the form to the Biology Department Administrative Coordinator who will record the outcome and place the form in the student's file; (b) discuss with the student the recommendations of the committee and how to implement them; and (c) ensure that the student has an action plan for completing the research.

C. After the First Committee Meeting:

Once the proposal is approved by the committee, the thesis adviser will monitor the student's progress to ensure satisfactory progress towards the degree and help solve any problems encountered. If substantive modifications were required at the first committee meeting (see outcome 3 above), the adviser should ensure that the student makes them in a timely fashion so that a revised proposal can be presented to the committee for approval.

If, after consultation with the thesis adviser, the student and adviser decide that the proposed thesis project is not feasible, modifications to the project will have to be made. Depending on the magnitude of the changes, they should be discussed with committee members and/or the student must schedule another committee meeting to present and discuss the new project.

Section II. Change of Adviser and Replacement or Addition of Committee Members

If a student wishes to change his/her thesis adviser or committee members, the student should first discuss this with the thesis adviser. If there is an irresolvable conflict, the student also should discuss the situation with the Biology Graduate Adviser. If a student decides to change advisers, he/she must (a) find a new adviser who agrees to serve and (b) repeat the procedures for the first committee meeting. The Biology Graduate Adviser (or his/her designee) will serve as the student's interim adviser and assist the student in identifying a new adviser. A memo from the Graduate Adviser noting the change in adviser should be added to the student's file. If a student cannot find a new adviser within one academic semester (summer not included) after changing advisers, the student will be subject to removal from the graduate program.

If a committee member is to be added or replaced by another after the first committee meeting, the student shall first obtain the thesis adviser's approval of the need for addition or replacement and then the adviser's approval of the new committee member. The student shall first ensure that any committee member to be replaced is notified and then obtain consent from the new committee member to serve. The new committee member should then be supplied with a copy of the approved thesis proposal. The student should either meet with the committee member to discuss the proposed thesis research or convene another committee meeting depending on the wishes of the new committee member.

For any changes to the composition of the thesis committee, the Study Plan must be revised and the revised form must be signed by the Thesis Adviser and Biology Graduate Adviser (form is available from the Administrative Support Coordinator). A copy of the revised Study Plan will be placed in the student's file and sent to the Graduate Studies Office.

Section III. Guidelines for the Second Thesis Committee Meeting

The **purpose** of the second committee meeting is for the student to present the data gathered and progress made for the thesis project to date, and to obtain agreement from the committee (1) that research plans for the remaining parts of the project are appropriate and feasible, and (2) for an approximate timeline for finishing and defending the thesis. The meeting will provide the opportunity for the student to make necessary changes and will be an opportunity for the committee to outline the expectations for the completion and oral defense of the written thesis.

The **outcome** of the meeting will be approval of the progress report, thesis research plan, and approximate timeline as presented, or committee recommendations for modifications. If major modifications are recommended, or if research progress has been insufficient as determined by the consensus of the committee, then an additional committee meeting may be required with the same purpose as that of the second committee meeting.

It is expected that the second committee meeting will occur by the third semester after the student has completed BIOL500A/B. Barring unforeseen circumstances, it is expected that the student will have his/her second committee meeting prior to the end of the sixth semester after entering the program. If a student does not complete this requirement, he/she will be placed on administrative probation and may be disqualified from the M.S. program after one semester on probation.

A. Preparing for the Second Committee Meeting:

The student shall obtain permission from his/her adviser before scheduling the second committee meeting.

Normally, the student will have made substantial progress with the research plan agreed upon during the previous committee meeting and will have collected a substantial amount of data. The student will prepare a thesis progress report of at least two pages in length plus appended data tables or figures as appropriate. This progress report should include a brief review of the conceptual background, hypotheses and rationale, experimental design, materials and methods, and results to date. The student should also prepare an expected timeline for completion of the thesis research. A copy of the adviser-approved thesis progress report and timeline for completion should be given to all committee members **two weeks** before the meeting.

The student will prepare an oral presentation (~15-30 minute) focusing on the data collected to date and will review this presentation with the thesis adviser prior to the meeting. It is expected that each committee member will critically read the thesis progress report prior to the meeting. If a committee member finds major problems with the thesis progress report, he/she should attempt to discuss these with the adviser and student before the meeting.

The student is responsible for scheduling the meeting (place and time). There is no expectation that the student will provide refreshments for the committee.

B. The Second Committee Meeting:

The meeting should begin with an oral presentation (~15-30 minute) by the student on the research that has been completed to date and the plan to complete the thesis project. Questions from the committee should focus on the research progress, methods, and data analysis. The student should review the research progress that has been made and be able to discuss plans for the remaining research and data analysis.

The committee members will review the timeline for finishing the degree, progress made on the research and the Study Plan and, if necessary, suggest changes to be made.

The committee will outline the expectations for the completion of the thesis project, oral defense of the written thesis, and the public presentation, and will discuss the format and potential subject areas for the oral defense. The area of concentration for the thesis defense will be identified. This will focus on the area of the thesis research but also will encompass related subject matter.

The second committee meeting should last no more than 2 hours. It will conclude with an agreement between the adviser, committee members, and student regarding the remaining research plan and approximate timeline for finishing the thesis, determined by consensus of the committee. The outcome and committee recommendations will be recorded on the appropriate form. The possible outcomes are:

1. Approval by the committee of the thesis project and the plans for its completion, including the projected timeline;

2. Approval by the committee of the thesis project and the plans for its completion with minor modifications (including a revision of the timeline), but not requiring an additional committee meeting; or

3. Substantive modifications of the thesis research plan requiring additional and substantial data gathering or major modifications in methods of data analysis. Such modifications will require a revision of the plan for completion, including the projected timeline, and an additional committee meeting.

The thesis adviser will (a) summarize the recommendations of the committee on the form and return the form to the Biology Department Administrative Coordinator who will record the outcome and place the form in the student's file; (b) discuss with the student the recommendations of the committee and how to implement them; and (c) ensure that the student has an action plan for completing the research, including a timeline for completion.

C. After the Second Committee Meeting:

Once the research plan and timeline have been approved by the committee, the thesis adviser will monitor the student's work to ensure satisfactory progress towards the degree and help solve any problems encountered. If modifications in the research plan were required at the second committee meeting, the adviser should ensure that the student makes them in a timely fashion.

If, after consultation with the thesis adviser, the student and adviser decide that the research plan that was approved at the second committee meeting is not feasible, modifications in the project and/or in the timeline will have to be made. Depending on the magnitude of the changes, they should be discussed with the committee and/or the student must schedule another committee meeting to present and discuss the modifications to the project and/or the timeline.

Assuming that the student has made good progress toward his/her degree, the student should officially file for a Graduation Check (forms available at Admissions and Records LH-114). This must be completed several months in advance of the expected graduation date (usually early January for spring or summer graduation; early August for winter).

Section IV. Guidelines for the Thesis Defense and Public Presentation

The **purpose** of the thesis defense and the public presentation is for the student to demonstrate his/her competency on the subject matter of the thesis and to fulfill university requirements for a culminating experience for the M.S. degree. University requirements specify that each graduate program is to include a final evaluation or culminating experience that marks the end of the program. In Biology, the culminating experience consists of the following:

1. Completion of a research thesis acceptable to the adviser and committee;

2. Satisfactory performance on an oral examination commonly known as the thesis defense; and

3. A public presentation of the thesis.

At this time, the student should check to ensure that he/she has officially filed for the expected date of graduation (submitted graduation check paperwork) and that his/her study plan is complete and no outstanding grades (e.g., SP, RP, or I) remain.

A. Preparing for the Oral Examination or Thesis Defense:

By the second committee meeting, the student and his/her committee will have identified an area of concentration that will serve as the basis for the thesis defense. This area will be centered on the thesis research but also will encompass related subject matter as determined by the thesis committee. The student should discuss how to prepare for the defense and the public presentation with his/her adviser. It is especially important that the student prepare for the thesis defense so that he/she can demonstrate the extent of his/her knowledge and understanding of the area of concentration.

There will be two routes (A and B) for completing the Thesis Defense and Public Presentation. The route selected will be at the discretion of the adviser, in consultation with the student. Regardless of the route chosen, it is the responsibility of the student to submit the completed Thesis Defense and Oral Presentation Notice Form (p. 29), with the title of the defense and the scheduled date, time and location, to the Biology Department Administrative Coordinator at least 5 working days prior to the date of the defense. An electronic copy of this form is available from the Biology Department Administrative Coordinator.

Section V. Route A: Combined Public Presentation and Defense

The student will work with his/her adviser to produce a complete and nearly final draft of the thesis. This final draft is to contain all thesis sections and is to be prepared according to university thesis guidelines (see Graduate Thesis Regulations Student Handbook, available in the Graduate Studies Office). Once a complete final draft is nearly finished, the student should arrange with his/her adviser and committee to schedule the thesis defense. A 3- to 4-hour time block should be scheduled for the public presentation (1 hour) and defense (2-3 hours in duration).

Students should realize that producing a complete and nearly final draft of the thesis is a time-consuming process (see Section VIII). Hence, students should plan well in advance and allocate sufficient time to complete this important phase of the graduate program. Different advisers will have different standards for determining whether a thesis draft is of sufficient quality to be nearly final and to be passed on to the student's thesis committee. Each student should work closely with his/her thesis adviser to ensure that these standards are met.

For Route A, the student will ordinarily first make a public presentation, field questions from the audience, and then undergo questioning by the thesis committee on the thesis and the area of concentration during the thesis defense examination. **All thesis defenses are to be scheduled during the normal course of the Fall and Spring semesters.** Students should realize that the deadline for submitting the final copy of the completed thesis to the Graduate Studies Office comes early in the semester. Extraordinary circumstances might dictate the need for the

presentation and defense to take place during intersession or the summer. Scheduling during these periods is at the complete discretion of the adviser and committee members, and students should not expect to complete this final step in the thesis process during intersession or summer.

Once the presentation and defense are scheduled, the student should provide his/her committee members with an adviser-approved, complete, nearly final draft of the thesis **two weeks** prior to the presentation/defense date. The student should then use the two weeks prior to the defense to study and prepare for the public presentation and the defense of the area of concentration.

A1. The Public Presentation:

The public presentation is to take place only when the thesis is considered to be complete and in nearly final form. Ordinarily, this means that each committee member will have had the opportunity to review at least one earlier draft of the thesis prior to the near-final draft that is to be distributed to the committee **two weeks** prior to the defense. The student should be sure to work closely with any committee member who identified significant issues during review of earlier thesis drafts while developing the final thesis copy. The expectation is that the completed thesis will either be signed by the adviser and committee members prior to or shortly after the presentation/defense. Hence, the student will have very little time to respond to comments and suggestions for revision from committee members following the presentation/defense. This will ordinarily require that the student is able to dedicate much of his/her time during the days following the presentation/defense to produce a final acceptable copy of the thesis. The expectation is that any revisions suggested by committee members following the presentation/defense will be minor.

The presentation is to be scheduled for one hour, although the length of the presentation may vary. The expected duration of the presentation is 30 to 45 minutes. Following the presentation, members of the audience will be provided the opportunity to ask questions about the thesis work. The thesis presentation should be geared for a more general audience but should contain the complete substance of the thesis work. The adviser and all committee members are expected to attend the public presentation. There is no expectation that the student will provide refreshments for the presentation.

A2. The Oral Examination or Thesis Defense:

The thesis defense is normally to take place immediately following the public presentation. Because the public presentation has occurred, ordinarily the student will not be asked to make a second presentation at the defense; whether a presentation is to be made at the thesis defense will be at the adviser's discretion.

Students will be asked questions during the defense mostly about topics related to the thesis and the agreed upon area of concentration. Questions on topics outside these areas, however, are not inappropriate, although it is understood that the student may be less well prepared in areas other than those targeted for the examination.

The expected time for the defense is 2-3 hours, although some defenses may either end prior to three hours or exceed this time limit at the discretion of the adviser and the committee members. There is no expectation that the student will provide refreshments for the defense.

A3. Outcomes of the Presentation and Oral Examination or Thesis Defense:

Satisfactory performance on the presentation and thesis defense will be determined by consensus by the adviser and committee members. The criterion for deeming the performance satisfactory will be that the student demonstrated adequate expertise in the area of concentration and all relevant facets of the thesis research and was able to make a clear public presentation of his/her thesis work.

If the performance on the presentation or the defense is determined to be unsatisfactory, the student will be given the opportunity to repeat whichever activity was found to be deficient. If the student should fail to make a satisfactory public presentation or perform unsatisfactorily on the thesis defense examination a second time, he/she will be placed on administrative probation and disqualified from the program (i.e., he/she will not be allowed to complete the degree). Students will have the opportunity to petition the Biology Graduate Committee for the opportunity to complete the presentation or defense a third and final time.

The thesis adviser will complete a goldenrod form, signed by each committee member, indicating the outcomes of the presentation and the thesis defense examination. The form will be returned to the Biology Department Administrative Coordinator who will record the outcomes and place the form in the student's file. Satisfactory performance indicates that the student is ready to finalize the thesis. If the student performance on the presentation or defense examination is deemed to be unsatisfactory, this will be noted and a tentative timeline will be decided within which the student should repeat these activities. The adviser and committee members will inform the student of identified deficiencies in his/her presentation or examination performance. These deficiencies are to be summarized by the adviser and recorded on the form.

Section VI. Route B: Separation of Defense and Public Presentation

The student will work with his/her adviser to produce a complete "draft" of the thesis. This "draft" is to contain all thesis sections, including the discussion, and is to be prepared according to university thesis guidelines (see Graduate Thesis Regulations Student Handbook, available in the Graduate Studies Office), although completion of the following sections is not required at this time: acknowledgements, table of contents, list of tables and list of figures. Once a complete draft is nearly finished, the student should arrange with his/her adviser and committee to schedule the thesis defense. A 3-hour time block should be scheduled for the defense, which should be 2-3 hours in duration.

Students should realize that producing a complete thesis draft of sufficient quality to schedule the defense is a time-consuming process (see Section VIII). Hence, students should plan well in advance and allocate sufficient time to complete this important phase of the graduate program. Different advisers will have different standards for determining whether a thesis draft is of sufficient quality to be passed on to the student's thesis committee. Each student should work closely with his/her thesis adviser to ensure that these standards are met and that the defense can be scheduled.

All thesis defenses are to be scheduled during the normal course of the Fall and Spring semesters. Students should realize that the deadline for submitting the completed thesis to the Graduate Office comes early in the semester. Extraordinary circumstances might dictate the need for the defense (and presentation) to take place during intersession or the summer. Scheduling during these periods is at the complete discretion of the adviser and committee members, and students should not expect to complete the thesis process during intersession or summer.

Once the defense is scheduled, the student should provide his/her committee members with an adviser-approved, draft of the thesis **two weeks** prior to the defense date. The student should then use the two weeks prior to the defense to study and prepare for the defense of the area of concentration.

B1. The Oral Examination or Thesis Defense:

The thesis defense is to take place prior to the public presentation. Under all but the most extraordinary of circumstances, there should be a least one day between the defense and the public presentation (i.e., the defense could take place one day and the presentation on the next).

The defense is to begin with a presentation by the student, the length of which is to be determined by the adviser in consideration of the wishes of the committee. Because a public presentation of the thesis will follow, some defense presentations may be as short as 15 minutes; others may be as long as 45 minutes.

Students will be asked questions during the defense mostly about topics related to the thesis and the agreed upon area of concentration. Questions on topics outside these areas, however, are not inappropriate, although it is understood that the student may be less well prepared in areas other than those targeted for the examination.

The expected time for the defense is three hours, although some defenses may either end prior to three hours or exceed this time limit at the discretion of the adviser and the committee members.

The adviser and committee members are to provide students with their comments on the written thesis draft either before or at the time of the thesis defense. Any serious deficiencies or issues should be clearly identified at this time.

There is no expectation that the student will provide refreshments for the defense.

B2. Outcome of the Oral Examination or Thesis Defense:

Satisfactory performance on the thesis defense will be determined by consensus by the adviser and committee members. The criterion for deeming the performance satisfactory will be that the student demonstrated adequate expertise in the area of concentration and all relevant facets of the thesis research.

If the performance on the defense is determined to be unsatisfactory, the student will be given the opportunity to repeat the examination, with a timeline decided by the thesis committee. If the student fails the examination a second time, he/she will be placed on administrative probation

and disqualified from the program (i.e., he/she will not be allowed to complete the degree). Students will have the opportunity to petition the Biology Graduate Committee for the opportunity to take the defense a third time.

The thesis adviser will complete a goldenrod form indicating the outcome of the thesis defense examination, which will be signed by each committee member. The form will be returned to the Biology Department Administrative Coordinator who will record the outcome and place the form in the student's file. Satisfactory performance indicates that the student is ready to finalize the thesis and to schedule the public presentation. If the student performance on the presentation or defense examination is deemed to be unsatisfactory, this will be noted and a tentative timeline will be decided within which the student should repeat these activities. The adviser and committee members will inform the student of identified deficiencies in his/her examination performance. These deficiencies are to be summarized by the adviser and recorded on the form.

B3. The Public Presentation:

The public presentation should normally take place within one semester of the thesis defense and preferably no later than three weeks following the defense. The expectation is that the completed thesis will be signed by the adviser and committee members prior to the public presentation. Hence, the student will normally have only a short time between the defense and the public presentation to complete work on the thesis. This will ordinarily require that the student is able to dedicate much of his/her time during this period to producing a revised and acceptable copy of the thesis. The revised thesis should be given to each committee member at least **three days** prior to the public presentation. While developing the final thesis copy, the student should be sure to work closely with any committee member who identified a significant issue during review of thesis drafts. This "final" copy of the thesis should carry the adviser's signature and be deemed acceptable by the adviser for meeting the requirements for the final thesis product. The expectation is that any revisions suggested by committee members at this reading will be minor.

The public presentation is to be scheduled for one hour, although the length of the presentation may vary. The expected duration of the presentation is 30 to 45 minutes and will be followed by questions from the audience. This presentation should be geared for a more general audience than the presentation at the thesis defense. The adviser and all committee members are expected to attend the public presentation. There is no expectation that the student will provide refreshments.

Section VII. Final Steps Towards The Degree

Following a successful public presentation and thesis defense, the student should have in hand a copy of the thesis signed and approved by his/her adviser and committee members. Multiple copies of the cover page, on paper suitable for binding, should be signed. The student should ensure that the thesis is submitted to the thesis reader in the Graduate Studies Office in the required format (see Graduate Thesis Regulations Student Handbook, available in the Graduate Studies Office) and by the deadline specified by the university. It is the student's responsibility to ensure that the thesis is completed with proper formatting and that its contents are accurate.

The reader will review the thesis for formatting and return it to the student to make any necessary revisions. The student will return it the Graduate Studies Office for final approval. After the thesis is approved by the Graduate Studies Office, he/she will deliver a final, signed copy to the Titan Bookstore for binding, archiving on microfilm and abstracting, by the deadline specified by the university (typically, the last day of final's week). At this time, the student shall prepare a final, hard-bound copy of the thesis for his/her thesis adviser and for the Biology Department, and also provide one complete, final copy to each of the other committee members. Copies to be supplied to committee members may be hard bound or spiral bound. Hard-bound copies can be made relatively inexpensively through the Center for Oral and Public History (714 278-3580) on the 3rd floor of the Pollak Library.

Section VIII. Projected Timeline

This timeline is provided so that students can be made fully aware of the time ordinarily required to complete the final steps of the graduate program. This timeline is applicable for either the Fall or Spring semester.

Prior to start of semester: The student should file an Application for a Graduation Check (forms available at Admissions and Records LH-114), which must be completed <u>several months</u> in advance of the expected graduation date (usually early January for spring or summer graduation; early August for winter graduation).

4th Week of the Semester – Student's final thesis draft is to be given to the adviser. This draft will of course represent previous interchanges between the adviser and student. However, this final draft is to represent the complete thesis and should be in a near-final state from the student's perspective.

8th Week of the Semester – Final, adviser-approved thesis draft is to be circulated to the student's committee members. This draft is to represent what the student and his/her adviser believe to be a near-final draft of the thesis. [NOTE: IF THIS DEADLINE IS NOT MET, THE STUDENT'S GRADUATION SHOULD RESCHEDULED FOR THE FOLLOWING SEMESTER.]

10th Week of the Semester – The presentation and defense (Route A) or defense (Route B) should take place by this time. For students taking Route B, the defense might take place earlier in the semester pending the availability of a complete, adviser-approved final draft of the thesis for circulation to committee members. For Route B, once the defense has been successfully completed, the presentation may be given up to the 15th week of the semester.

12th Week of the Semester – The final, adviser-approved copy of the thesis should be circulated to committee members for signature.

13th Week of the Semester – The final, formatted and bookstore-ready copy of the thesis (with signed thesis title page) is to be turned in to the Graduate Studies Office to the thesis reader.

16th Week of the Semester (finals week) – The final thesis (printed onto high-quality paper) is to be turned in to the Bookstore. When available, final bound thesis copies are to be distributed by the student to the Biology Department, the thesis adviser, and the committee members.

Section IX. Checklists

A. First Committee Meeting

1. Select Committee Members with Adviser Consultation ☐
2. Develop the Study Plan with Adviser Consultation ☐
3. Schedule the First Committee Meeting with Adviser's Permission ☐
4. Submit a Revised (following BIOL500A/B), Adviser-approved Thesis Proposal to the Committee Members two weeks in advance of the scheduled Committee Meeting ☐
5. Prepare the Oral Presentation with Adviser Consultation ☐
6. Complete First Committee Meeting Form indicating meeting outcomes ☐

B. Second Committee Meeting

1. Schedule the Second Committee Meeting with Adviser's Permission ☐
2. Submit a Written Thesis Progress Report, approved by the Thesis Adviser, to the Committee Members two weeks in advance of the scheduled Committee Meeting ☐
3. Prepare Oral Presentation with Adviser Consultation ☐
4. Identify Area of Concentration for the Thesis Defense ☐
5. Select Route A or B for the Thesis Defense ☐
6. Complete Second Committee Meeting Form indicating meeting outcome ☐

C. Thesis Defense and Public Presentation

ROUTE A: Oral Examination or Thesis Defense and Public Presentation (same day as the Thesis Defense)

1. Check that a Graduation Check (with correct graduation date) has been filed ☐
2. Ensure that Study Plan is complete and any SP, RP, or I Grades are/will be changed ☐
3. Submit a draft of the Thesis to the Thesis Adviser ☐
4. Schedule the Thesis Defense and Public Presentation with Adviser's Permission ☐
5. Submit a revised draft of the Thesis, approved by the Thesis Adviser, to Committee Members Two Weeks in advance of the scheduled Defense and Presentation. ☐
6. Obtain comments from Committee Members on the revised Thesis draft ☐
7. Prepare for the Thesis Defense of the Area of Concentration ☐
8. Prepare the Public Presentation with Adviser Consultation ☐
9. Prepare a revised, final Thesis, approved by the Thesis Adviser, to Committee Members three days in advance of the Public Presentation ☐
10. Complete the Defense and Public Presentation ☐
11. Complete the Thesis Defense/Public Presentation Form indicating outcome ☐
12. Secure Signatures of the Adviser and Thesis Committee Members on the Thesis ☐

C. Thesis Defense and Public Presentation (continued)

ROUTE B: Oral Examination or Thesis Defense (prior to Public Presentation, to be held on a future date)

1. Check that a Graduation Check (with correct graduation date) has been filed ☐
2. Ensure that Study Plan is complete and any SP, RP, or I Grades are/will be changed ☐
3. Schedule the Thesis Defense with Adviser's Permission ☐
4. Submit a Complete Draft of the Thesis, approved by the Thesis Adviser, to the Committee Members two weeks in advance of the scheduled Thesis Defense ☐
5. Prepare the Oral Presentation with Adviser Consultation ☐
6. Obtain Comments from Committee Members on the Thesis draft ☐
7. Complete Defense and submit the Thesis Defense/Public Presentation Form, indicating outcome. ☐

Public Presentation (Same Semester as, Preferably Within Three Weeks of, the Thesis Defense)

1. Submit a Revised, Final Draft of the Thesis to the Thesis Adviser ☐
2. Schedule the Public Presentation with Adviser's Permission ☐
3. Submit a Revised, Final Thesis, approved by the Thesis Adviser, to the Committee Members three days in advance of the Presentation ☐
4. Secure Signatures of the Adviser and Thesis Committee Members on the Thesis ☐
5. Complete the Public Presentation ☐
6. Complete the Thesis Defense/Public Presentation Form indicating outcome ☐

D. Submitting the final Thesis

1. Final formatting and submission of the Thesis to the Graduate Studies Reader ☐
2. Respond to formatting and other issues raised by the Reader ☐
3. Final submission of completed Thesis to Bookstore ☐
4. Submit Thesis for binding for copies for the adviser, committee and department ☐
5. Deliver hard bound Thesis copies to the adviser, Biology department, and committee members (spiral bound adequate for committee) ☐

Section X. Thesis Defense and Public Presentation Notice Form
(*You may ask Ernestine Hood for this form via e-mail)*

Dear Biology Graduate Student:

The Department of Biological Science requires that an announcement of your thesis defense be distributed to the Biology full-time faculty a minimum of **5 business days prior to** the date of your defense.

You are expected to make your arrangements, and then to provide complete information about your thesis defense to Ernestine Hood so she can prepare the formal announcement notice. You may submit your request to Ernestine either on paper or via e-mail, but you must use this department form.

PLEASE COMPLETE THE SPACES BELOW

Today's Date	
YOUR FULL NAME ***Please print if handwritten***	

Please include your full middle name

TYPE OF DEFENSE (check one) **Route A:**	**Public Presentation, followed immediately by Thesis Defense (not public) on the <u>same</u> day**	
Route B:	**Thesis Defense (not open to public), followed by Public Presentation on a <u>different</u> day**	

Exact title of thesis, include caps, italics, etc.

Route A		**Route B, Part 1.**	
Day and Date		**Day and Date**	
Time of Defense		**Time of Defense**	
Bldg / Room #		**Bldg / Room #**	
		Route B, Part 2.	
		Day and Date	
		Time of Presentation	
		Bldg / Room #	

Thesis Adviser	
Committee Member	
Committee Member	
Committee Member	

CSUF Department of Biological Science
Master of Science Program in Biology

GS700 Enrollment and Leave of Absence Policies

February 2000 (revised 1 September 2005)

Graduate students must maintain continuous enrollment during their tenure in the Master's program at CSU Fullerton. This requirement means that, once a student is admitted to the Biology Department's graduate program, he/she cannot drop out for a semester without officially obtaining a leave of absence from the University. Students enroll through regular university registration procedures and pay listed graduate student fees while completing courses required for the Study Plan and while working on and completing their thesis.

GS700

A student may elect to enroll in GS700 through regular registration or through Extended Education when he/she is in the very final stages of producing his/her written thesis. This procedure allows the student to maintain continuous enrollment while completing the final phases of our graduate program. If enrollment in GS700 is through regular university registration procedures, the student will pay full fees and receive all student benefits. If, however, enrollment is through Extended Education, the student will pay a reduced fee and **receive no university benefits other than library privileges.** The principal advantage of enrolling in GS700 is financial because enrollment costs are less than those required for regular university registration. This Extended Education route is the most common form of GS700 enrollment by Biology graduate students.

Considerations for Enrolling in GS700

Enrollment in GS-700 is not automatic and requires both departmental and university approval. Moreover, enrollment in GS-700 through Extended Education assumes that the student is no longer a user of departmental and university resources, including supplies, equipment, and services. THIS MEANS THAT GRADUATE STUDENTS ENROLLED IN GS-700 THROUGH EXTENDED EDUCATION ARE NOT ELIGIBLE TO RECEIVE DEPARTMENTAL SUPPORT FOR SUPPLIES, MATERIALS, AND SERVICES.

Conditions for GS700 Enrollment

Students are expected to understand fully the conditions required for GS700 enrollment before submitting the form for departmental approval. For students enrolling in GS700 through Extended Education, the student should consult the enrollment request form to determine if he/she is eligible. To be eligible for GS700 (through either regular university registration procedures or Extended Education), the following conditions must be met to obtain departmental approval:

1) **Study Plan**. Students must have received credit for all coursework required for the Study Plan including BIOL500A, B (meets Graduate Writing Requirement), and all BIOL580, 598, and 599 units. This means that letter grades must have been received for all courses except BIOL580, 598, and 599 for which RP grades may have been assigned. Incomplete grades given for courses listed on the study plan should be completed before enrolling in GS700, but a student may request exemption from this requirement with the approval of his/her thesis adviser.

2) **Laboratory and Field Work**. All thesis laboratory or field work must be completed (i.e., the student is not collecting data in the lab or field in support of his/her thesis research). The only exception to this condition would occur if the student is off-campus and engaged in the final stages of data collection.

3) **Use of Facilities**. Access to departmental or university services and facilities (e.g., computers, laboratory equipment, field gear) is not required other than the use of library (including electronic) resources.

4) **Adviser Assistance**. Assistance from the student's thesis adviser and committee members has been reduced to levels required to produce the final version of the written thesis. This usually means that both first and second committee meetings have been completed.

5) **GA/TA/Student Assistant Employment**. The student is not employed in a work-study program but is eligible to be employed as a GA or TA.

Enrollment Procedures

To enroll in GS700 through Extended Education, a graduate student must file the blue GS700 Enrollment Request Form. **This form can be obtained from the Graduate Studies Office (MH-103)** and must be renewed each semester. The form contains a series of boxes to be checked to ensure that all conditions for enrollment have been met. No such form is required for enrollment in GS700 through regular university procedures (i.e., with full fee payment). To obtain departmental approval for enrollment in GS700 through Extended Education, the student must do the following:

1) **Adviser Approval**. Have his/her thesis adviser indicate approval of GS700 enrollment through Extended Education by the initialing the form on the line to be signed by the Graduate Program Adviser.

2) **Verification of Enrollment Conditions**. Have the Graduate Program Adviser review the student's record, check the appropriate boxes, and sign on the designated line to verify eligibility. **The student should not check the boxes**.

3) **Submission of Completed Form**. Return the completed GS700 Enrollment Request Form to the Graduate Studies Office (MH-103) to receive the registration card.

Leave of Absence (adapted from University Catalog)

Graduate degree or credential students may request a leave of absence for up to one year. Conditionally classified or classified graduate students qualify for a leave if they are in good academic standing and have completed at least six credit hours' work toward the degree in residence at Cal State Fullerton. Forms to request a leave of absence are available at the Admissions and Records information counter or in the Graduate Studies Office.

Any one of the following circumstances may be grounds for requesting a leave of absence:

- Illness or disability (permanent or temporary) or similar personal exigencies including pregnancy which make it impossible or inadvisable for a student to register for classes.
- Activities which enhance a student's professional career objectives.
- Active duty in the armed forces of the United States.
- Other reasons at the discretion of the Director of Graduate Studies.

After review by the Graduate Studies Office, the academic unit (where applicable), and the Registrar's Office, a response is mailed to the student.

A first-time leave of absence of one semester only will normally be granted upon request for students who qualify and will not require an application for readmission to the university. Registration materials for the semester following the leave will be sent to the student.

Students requesting a subsequent leave or a leave longer than one semester are required to provide appropriate documentation (e.g., doctor's recommendation, verification of employment). Such requests must also be endorsed by the Biology Graduate Program Adviser.

A leave granted to a degree objective student preserves the election of curriculum rights regarding catalog requirements. However, leaves of absence do not change the time limit for completion of the degree.

CSUF Department of Biological Science
Master of Science Program in Biology

Policy of Good Standing

To continue to be in good standing, a graduate student must:

1. Be in compliance with the "Graduate Academic Standards" listed in the University Catalog. Requirements include
   a. A minimum grade of C (2.0) in all courses attempted while enrolled in the graduate program.
   b. A grade-point average of at least 3.0 (B) in all 400- and 500-level courses attempted as a graduate student.
   c. No more than one repetition of any course in which an unsatisfactory grade of less than C (<2.0) was received.
   d. Timely progress in completing the coursework portion of the Study Plan within 5 years (7 seven years if petition to the Graduate Studies Office is approved), starting with the first course on the study plan.
   e. Continuous enrollment except by approved Leave of Absence.
   f. Demonstrating a level of professional competence commensurate with the standards of Biological Science in all teaching and research activities (also see 2 below).
   g. Not engaging in Academic Dishonesty (see "University Regulations" in the catalog).
   h. Not engaging in inappropriate behavior as defined in the catalog under "Student Conduct".

2. Be in compliance with the standards of the Master's Program in Biology of the CSUF Department of Biological Science (these maybe more restrictive than University policies). Requirements include:
   a. Meeting the conditions for admission to the Master's Program.
   b. Achieving classified status (by submitting a study plan to the Graduate Studies Office) within two semesters of entering the graduate program.
   c. Meeting the graduate writing requirement (by earning a grade of B or better in BIOL500A/B) within two semesters of entering the graduate program.
   d. Having a productive working relationship with a Thesis Adviser, including progress on the research satisfactory to the Thesis Adviser and the Thesis Committee.

Failure to meet the criteria for Good Standing will result in being placed on Academic and/or Administrative-Academic Probation and may result in disqualification from the program (consult Graduate Studies for policies and procedures http://www.fullerton.edu/graduate/standards.htm). Any student on probation also must meet with the Biology Graduate Program Adviser before being allowed to register for classes the following semester.

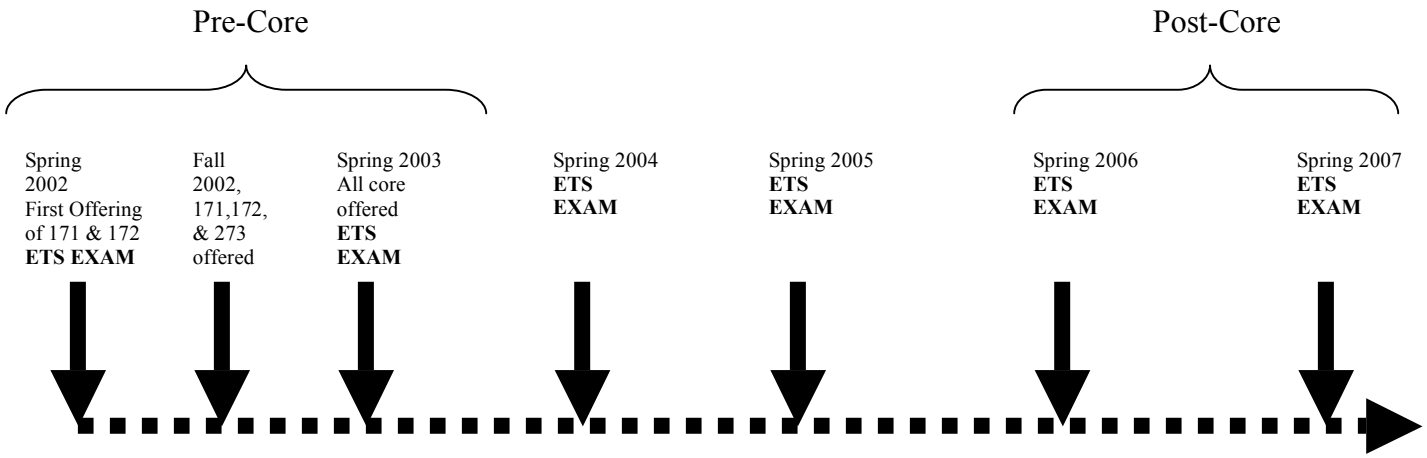
Report on ETS Results

Things Evaluated in this Report.

The department of Biological Science significantly revised its curriculum and starting in 2002 new core classes were offered (see timeline below).

The objective here is to statistically analyze the results of the Major Field Test in biology from 2002 – 2007. There are 4 different questions of interest in this analysis.

1) Based on total score, are there significant shifts over time and/or between the pre-post core periods or differences among chosen concentrations/interests.
2) Based on subcategory score (e.g. cellular biology, molecular biology, organismal biology, and population biology, evolution, and ecology), are there significant shifts over time and/or between the pre-post core periods or differences among chosen concentrations/interests.
3) Are there significant linear trends over time in the total scores or subcategory scores.
4) Are the same trends evident after standardizing the data for the national average scores (i.e. are our trends different than the national trends).



Methods of Analysis

Analyses were done using analysis of variance (ANOVA) or analysis of covariance (ANCOVA). Two-factor ANOVA's were used to test for effects of year, concentration/interest, and the interaction between year & concentration/interest (indicating differential changes in scores based on interest) for total score and for subcategory scores. Since GPA is correlated with total score and subcategory score (J. Kandel, unpub. Data) cumulative GPA was used as a covariate in a two-factor ANCOVA to examine effects of year, concentration/interest, and the interaction between year & concentration/interest while holding GPA constant. Since I believe we are interested in any differences that might arise or trends that indicate changes over time since the implementation of the core, I utilized linear contrasts to test for a linear trend in the scores or subcategory scores and to test they hypothesis that there are differences pre versus post-core. In addition, when multiple comparisons were done, the least conservative method was utilized, Fisher's protected least significant difference test (t-test).

Results

Total Score

There was a significant effect of concentration/interest ($F_{(2,691)}$=4.41, P=0.0125) with molecular students having the significantly higher scores than the others (Figure 1). There was not a significant effect of year ($F_{(5,691)}$=1.35, P=0.2397), however there was a significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,691)}$=5.67, P=0.0175; Figure 2) and a significant decrease between pre and post core periods ($F_{(1,691)}$=4.96, P=0.026; Figure 2)

When controlling for GPA, there was a significant effect of concentration/interest ($F_{(2,690)}$=3.75, P=0.0241) with molecular students having the significantly higher scores than the others (Figure 3). There was not a significant effect of year ($F_{(5,690)}$=1.83, P=0.1051), however there was a significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,690)}$=6.52, P=0.0109; Figure 4) and a significant decrease between post and pre core periods ($F_{(1,690)}$=7.71, P=0.0056; Figure 4). GPA was a significant predictor of total score ($F_{(1,690)}$=224.4, P<0.0001).

Subcategory Scores

Cellular Biology

There was a significant effect of concentration/interest ($F_{(2,691)}$=17.63, P<0.0001) with cell and molecular students having the significantly higher scores than BEC/MB (Figure 5). There was a significant effect of year ($F_{(5,691)}$=3.61, P=0.0031) and there was a significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,691)}$=13.1 P=0.0003; Figure 6) and a significant decrease between pre and post core periods ($F_{(1,691)}$=19.81, P<0.0001; Figure 6).

When controlling for GPA, there was a significant effect of concentration/interest ($F_{(2,690)}$=20.46, P<0.0001) with cell and molecular students having the significantly higher scores than BEC/MB (Figure 7). There was a significant effect of year ($F_{(5,690)}$=4.78, P=0.0003) and there was a significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,690)}$=19.1, P<0.0001; Figure 8) and a significant decrease between pre and post core periods ($F_{(1,690)}$=14.05, P=0.0002; Figure 8). GPA was a significant predictor of cell subcategory score ($F_{(1,690)}$=199.1, P<0.0001).

Molecular Biology

There was a significant effect of concentration/interest ($F_{(2,691)}$=20.17, P<0.0001) with molecular students having the significantly higher scores than the others (Figure 9). There was a significant effect of year ($F_{(5,691)}$=6.42, P<0.0001) and there was a significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,691)}$=22.4, P<0.0001; Figure 10) and a significant decrease between pre and post core periods ($F_{(1,691)}$=25.70, P<0.0001; Figure 10).

The relationship between GPA and molecular sub-category score varied significantly across concentration/interest ($F_{(2,688)}$=6.74, P=0.0013). This means that we cannot easily correct for GPA differences across the different concentration/interest groups (see Table 1 for slope estimates for each concentration/interest). When controlling for GPA, there was a significant effect of Year and GPA in all concentrations (Table 1) and there was a significant linear trend for a decrease in total scores from 2002-2007 in all concentrations (Table 1, Figure 11, 12, 13) and in all cases there was a significant decrease from pre to post core ($F_{(1,691)}$>6.2, P<0.02 for all cases).

Organismal Biology

There was a significant effect of concentration/interest ($F_{(2,691)}$=3.15, P=0.0434) with BEC/MB students having the significantly higher scores than cell students but not molecular students (Figure 14). There was not significant effect of year ($F_{(5,691)}$=1.08, P=0.3715) and no significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,691)}$=0.35 P=0.5531; Figure 15) and no significant decrease or increase between pre and post core periods ($F_{(1,691)}$=0.6512, P=0.4200; Figure 15).

When controlling for GPA, there was a significant effect of concentration/interest ($F_{(2,690)}$=3.17, P=0.0425) with cell students having the significantly lower scores than BEC/MB but not molecular students (Figure 16). There was a not a significant effect of year ($F_{(5,690)}$=1.05, P=0.3890) and no significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,690)}$=0.73, P=0.3945; Figure 17) and no significant decrease or increase between pre and post core periods ($F_{(1,690)}$=1.06, P=0.3029; Figure 17). GPA was a significant predictor of cell subcategory score ($F_{(1,690)}$=121.4, P<0.0001).

Population Biology, Evolution, and Ecology

There was a significant effect of concentration/interest ($F_{(2,691)}$=11.19, P<0.0001) with BEC/MB and molecular students having the significantly higher scores than cell students (Figure 18). There was not significant effect of year ($F_{(5,691)}$=0.50, P=0.7761) and no significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,691)}$=0.94

P=0.3312; Figure 19) and no significant decrease or increase between pre and post core periods ($F_{(1,691)}$=1.15, P=0.2826; Figure 19).

When controlling for GPA, there was a significant effect of concentration/interest ($F_{(2,690)}$=12.75, P<0.0001) with cell and molecular students having the significantly lower scores than BEC/MB (Figure 20). There was a no significant effect of year ($F_{(5,690)}$=0.84, P=0.5204) and no significant linear trend for a decrease in total scores from 2002-2007 ($F_{(1,690)}$=1.58, P=0.2093; Figure 21) and no significant decrease or increase between pre and post core periods ($F_{(1,691)}$=1.73, P=0.1886; Figure 21). GPA was a significant predictor of cell subcategory score ($F_{(1,690)}$=117.4, P<0.0001).

Standardizing for the National Average

Total Score

Cellular Biology

Molecular Biology

Organismal Biology

Population Biology, Evolution, and Ecology

Summary

Except in the organismal and population biology, evolution, and ecology subscores, there has been significant trends toward decreased performance and significant decreases comparing pre-core versus post-core.

Student interested in molecular biology score highest overall on the ETS exam even after correcting for differences in GPA. Cell and BEC/MB students perform at approximately the same level.

Although student interest/concentration impacted subcategory scores there was no evidence (e.g. a significant interaction between Year and Student Interest/Concentration) that students were gaining more concentration specific knowledge after our implementation of the core.

The overall summary of the analyses are : 1) ETS scores are decreasing and 2) concentration/interest predicts subcategory scores and 3) there was no significant interaction between year & concentration/interests of students indicating that scores are decreasing across the board regardless of what concentration/interest the students have.

Table 1: Slopes and Statistics for ANCOVA's by concentration/interest looking at the effect of Year.

	F, P	GPA Slope (SE)
BEC MB		
Year	$F_{(5,180)}$=6.07, P<0.0001	
Linear Trend	$F_{(1,180)}$=15.32, P=0.0001	
GPA	$F_{(1,180)}$=11.86, P=0.0007	4.98 (1.45)
Cell		
Year	$F_{(5,374)}$=2.35, P=0.0404	
Linear Trend	$F_{(1,374)}$=4.88, P=0.0278	
GPA	$F_{(1,374)}$=93.08, P<0.0001	9.66 (1.00)
Molecular		
Year	$F_{(5,124)}$=2.88, P=0.0171	
Linear Trend	$F_{(1,124)}$=13.50, P=0.0003	
GPA	$F_{(1,124)}$=54.68, P<0.0001	12.39 (1.67)

Figure 1: Mean Total Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

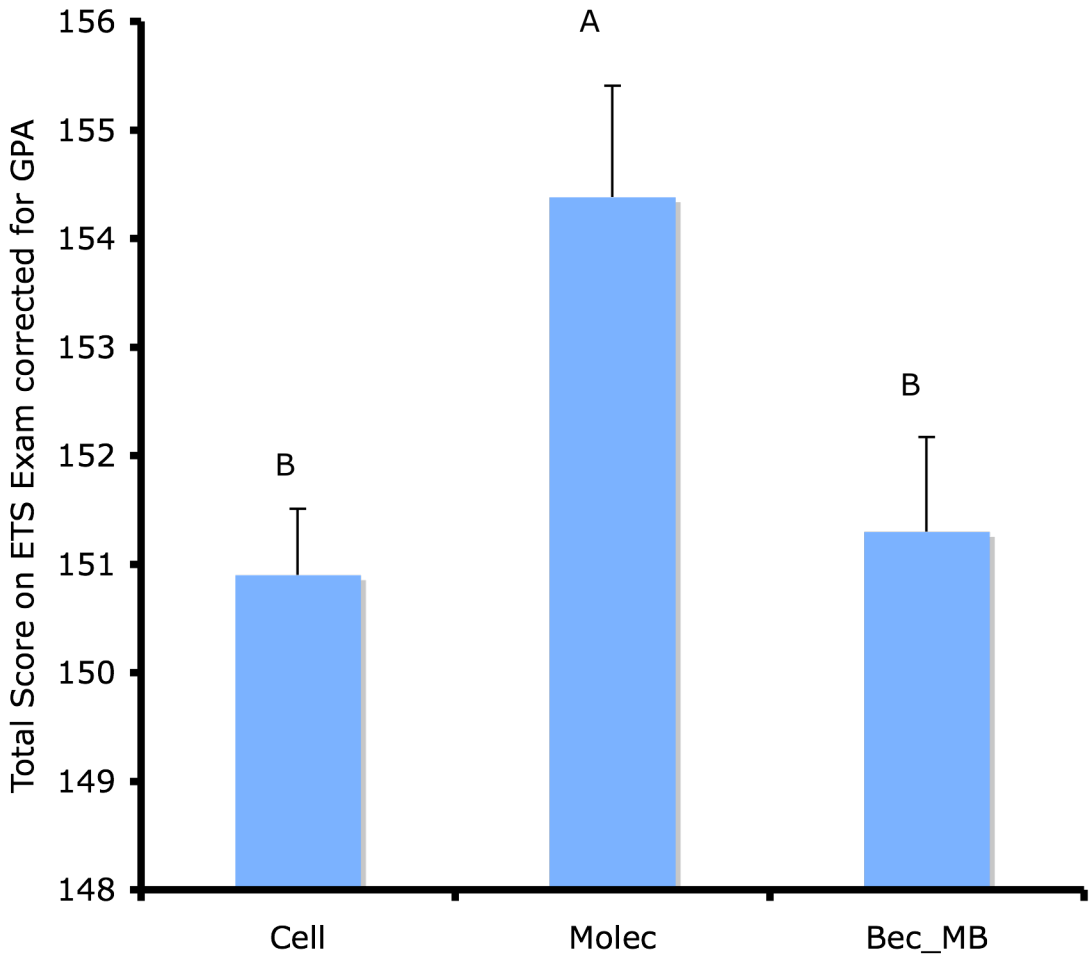


Figure 2: Mean Total Scores + 1 S.E. for the different years the ETS was administered. Different letters denote significant differences among groups utilizing t-tests. These are only shown to help illustrate the trend across years.

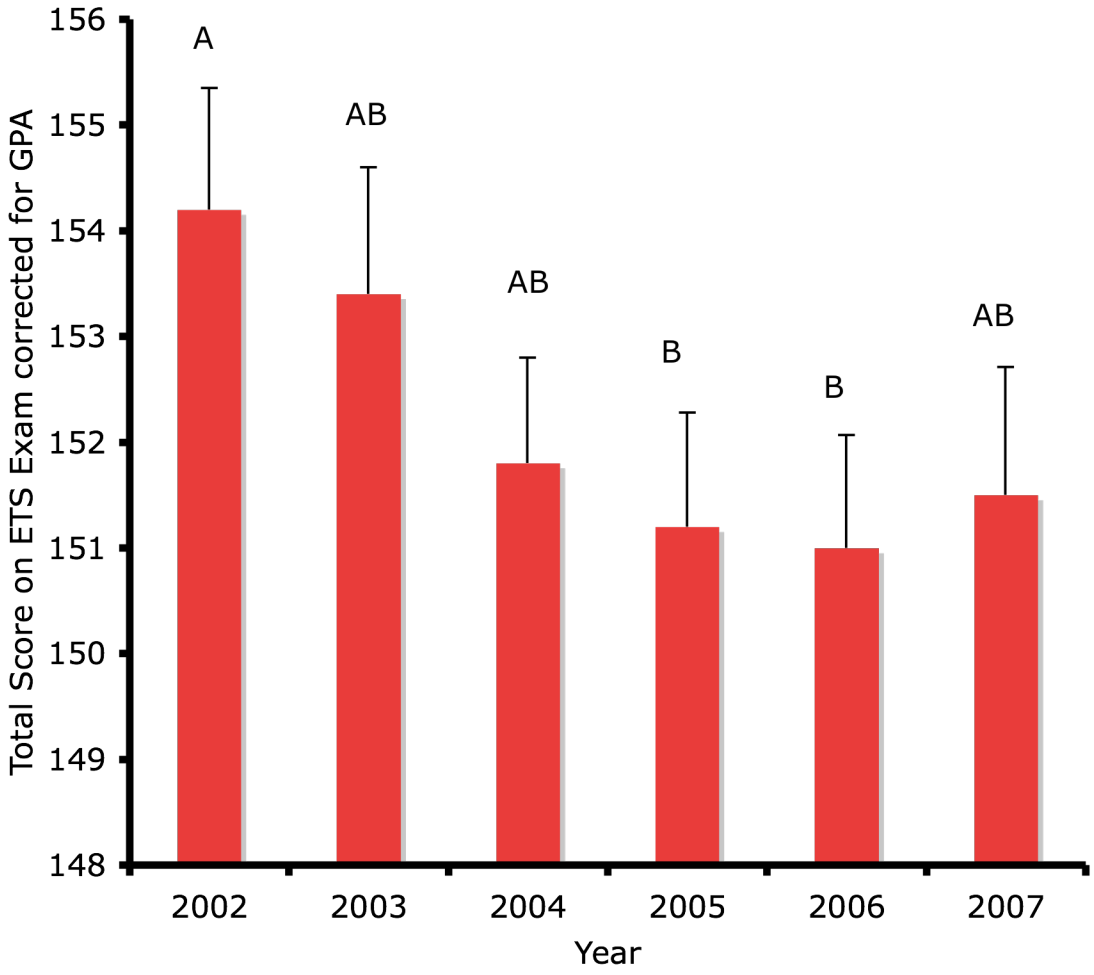


Figure 3: ANCOVA adjusted Mean Total Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

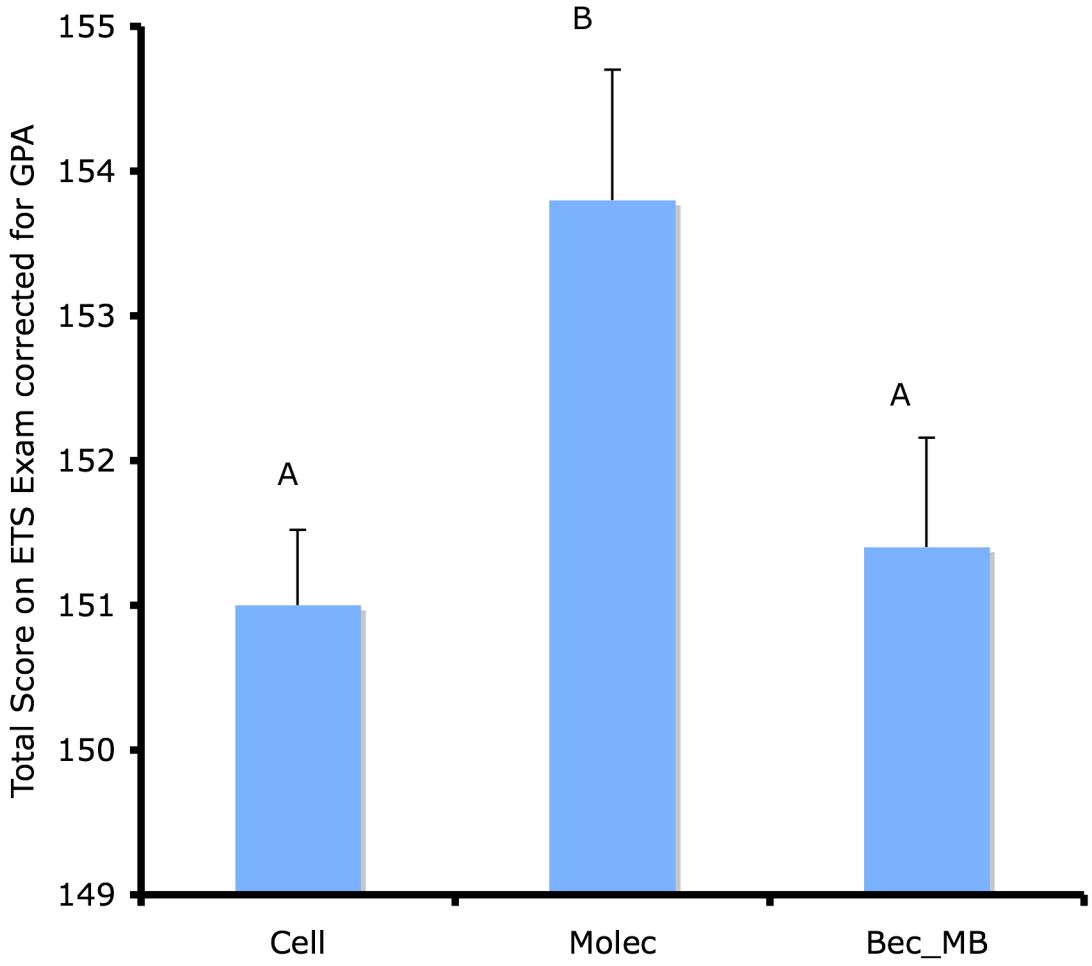


Figure 4: ANCOVA adjusted Mean Total Scores + 1 S.E. for the different years the ETS was administered. Different letters denote significant differences among groups utilizing t-tests. These are only shown to help illustrate the trend across years.

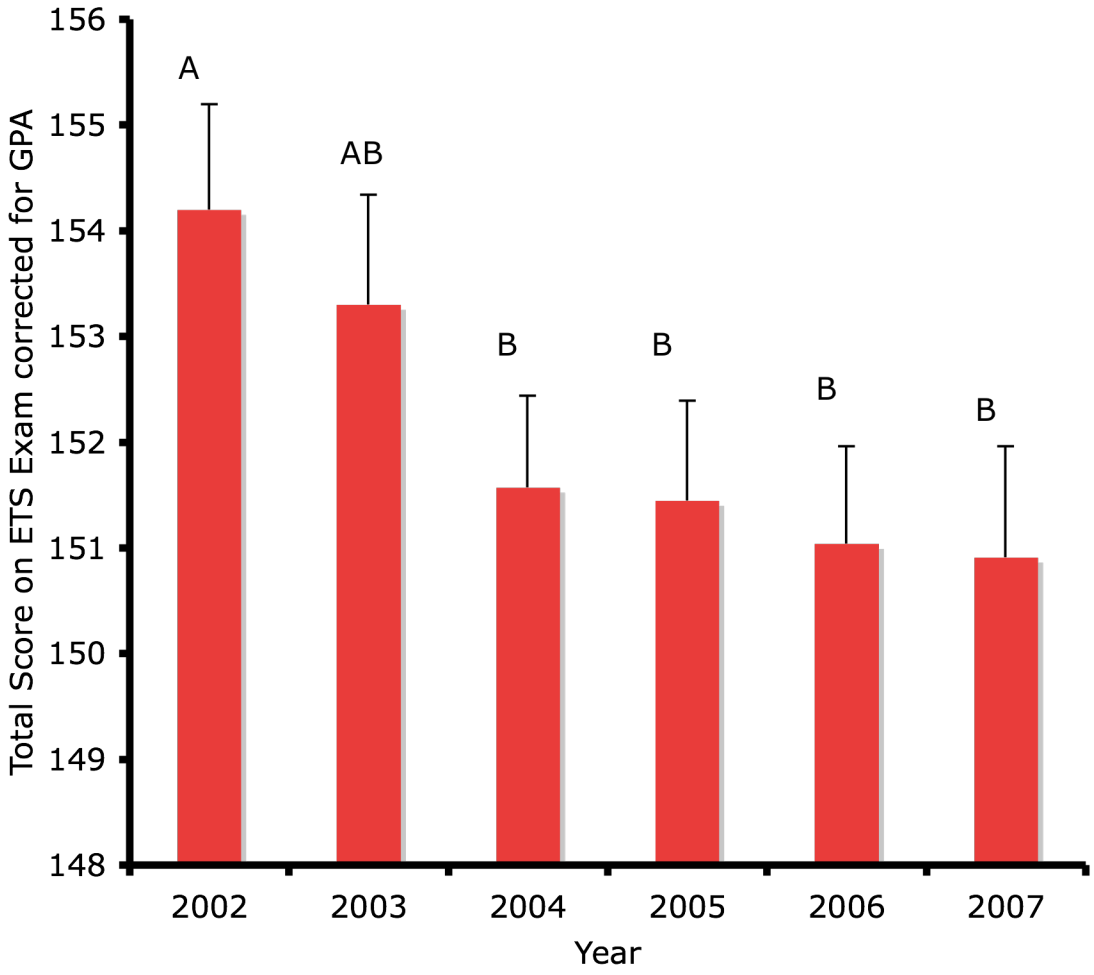


Figure 5: Mean Cell subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

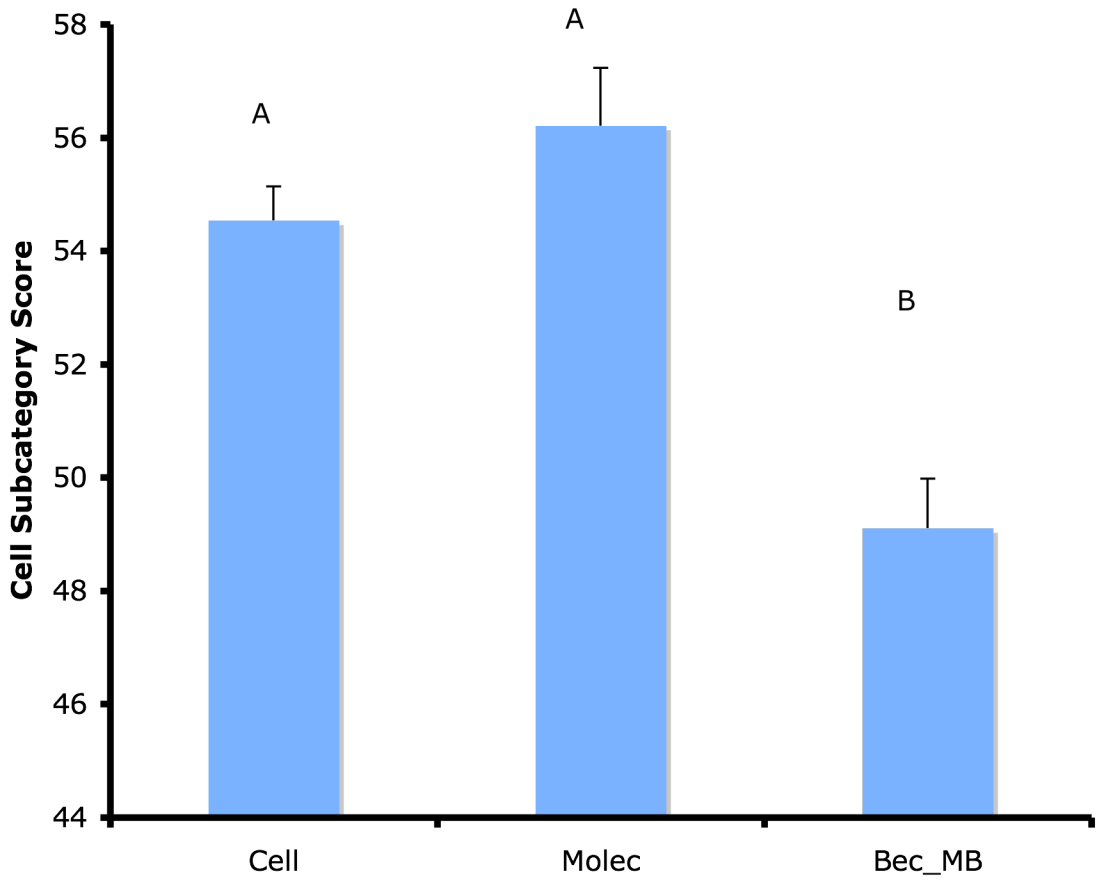


Figure 6: Mean Cell subcategory Scores + 1 S.E. for the different years the ETS was administered. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

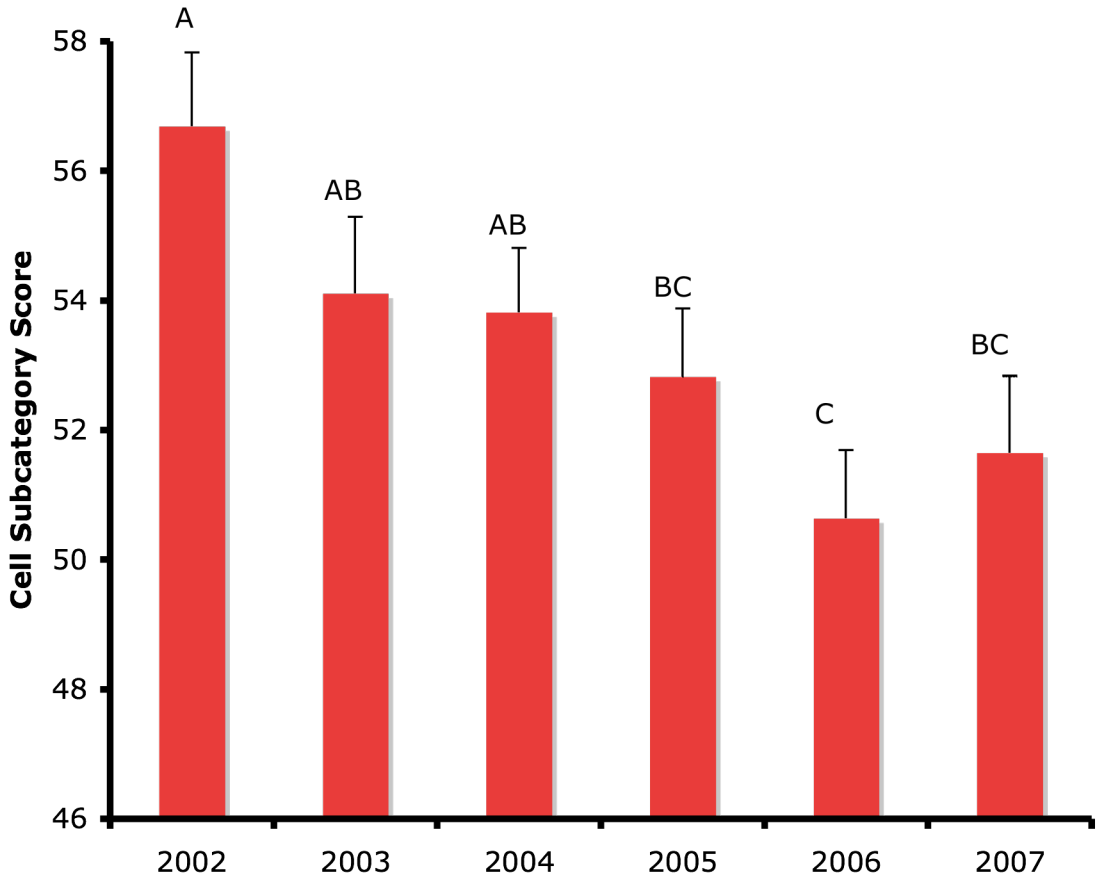


Figure 7: ANCOVA adjusted Cell subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

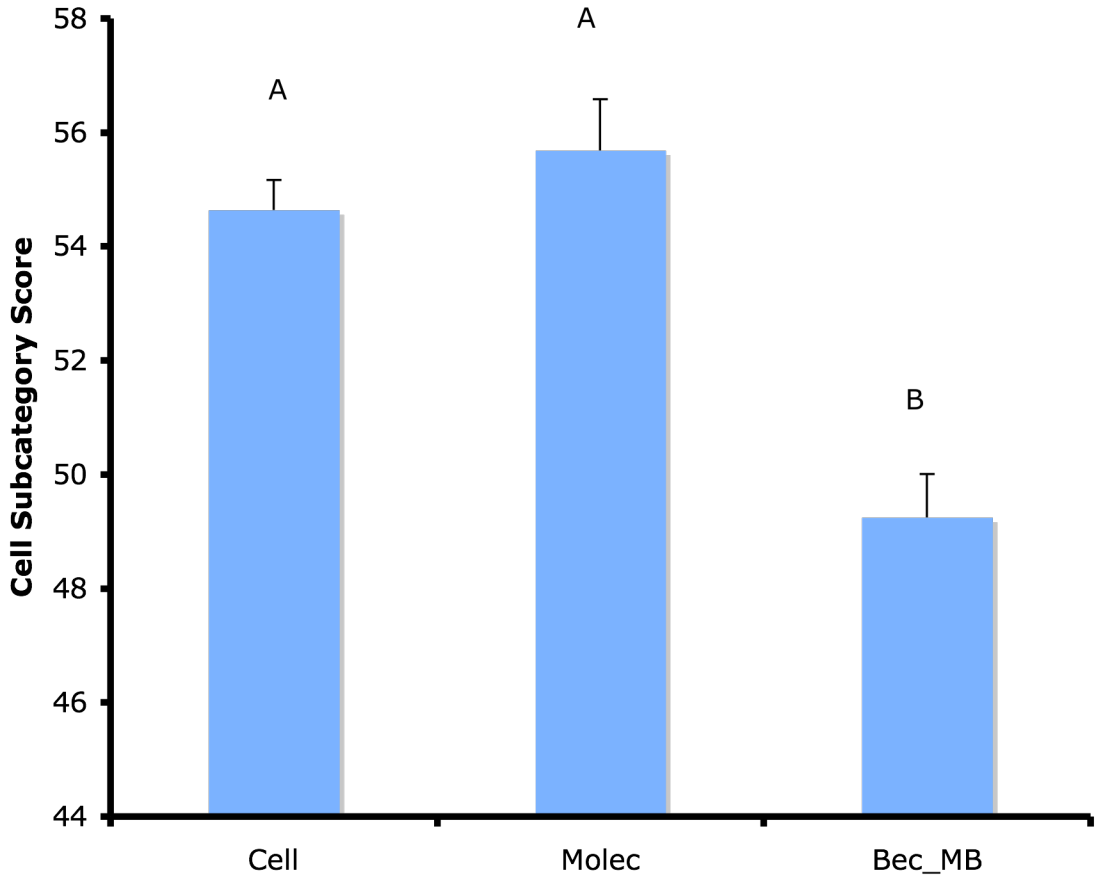


Figure 8: ANCOVA adjusted Cell subcategory Scores + 1 S.E. for the different years the ETS was administered. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

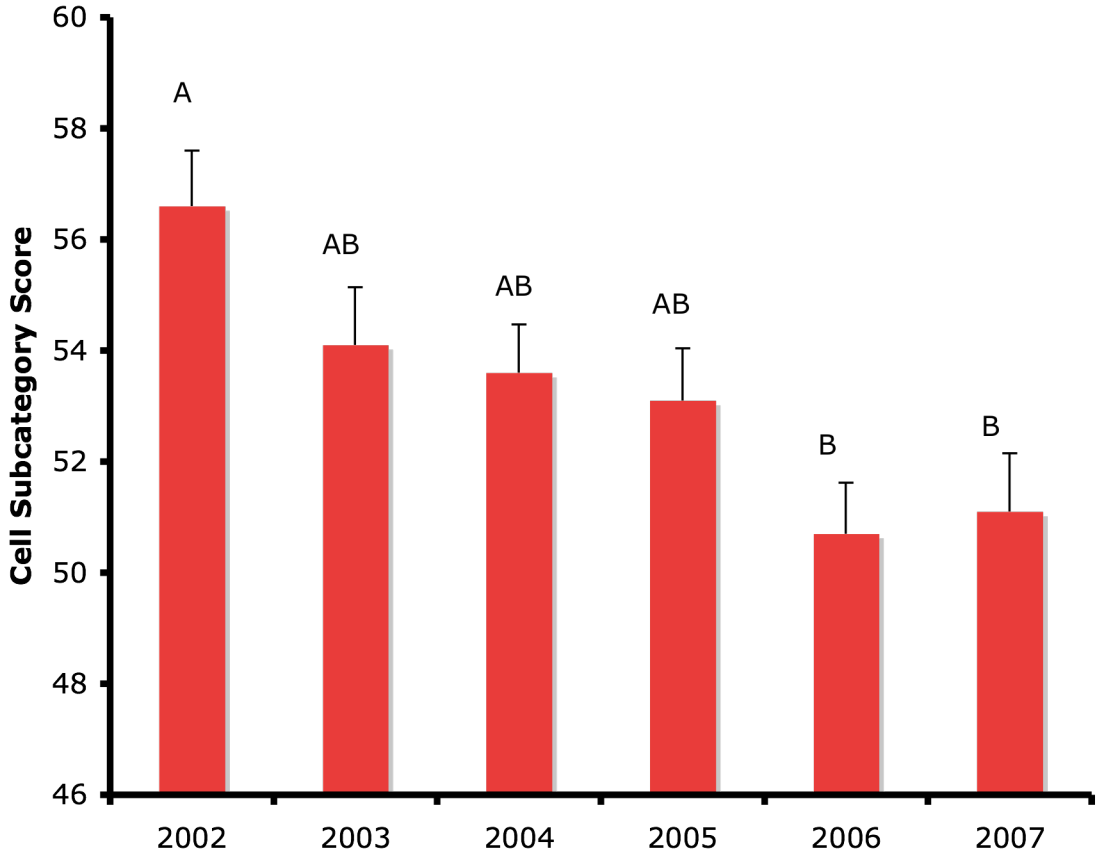


Figure 9: Mean Molecular subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

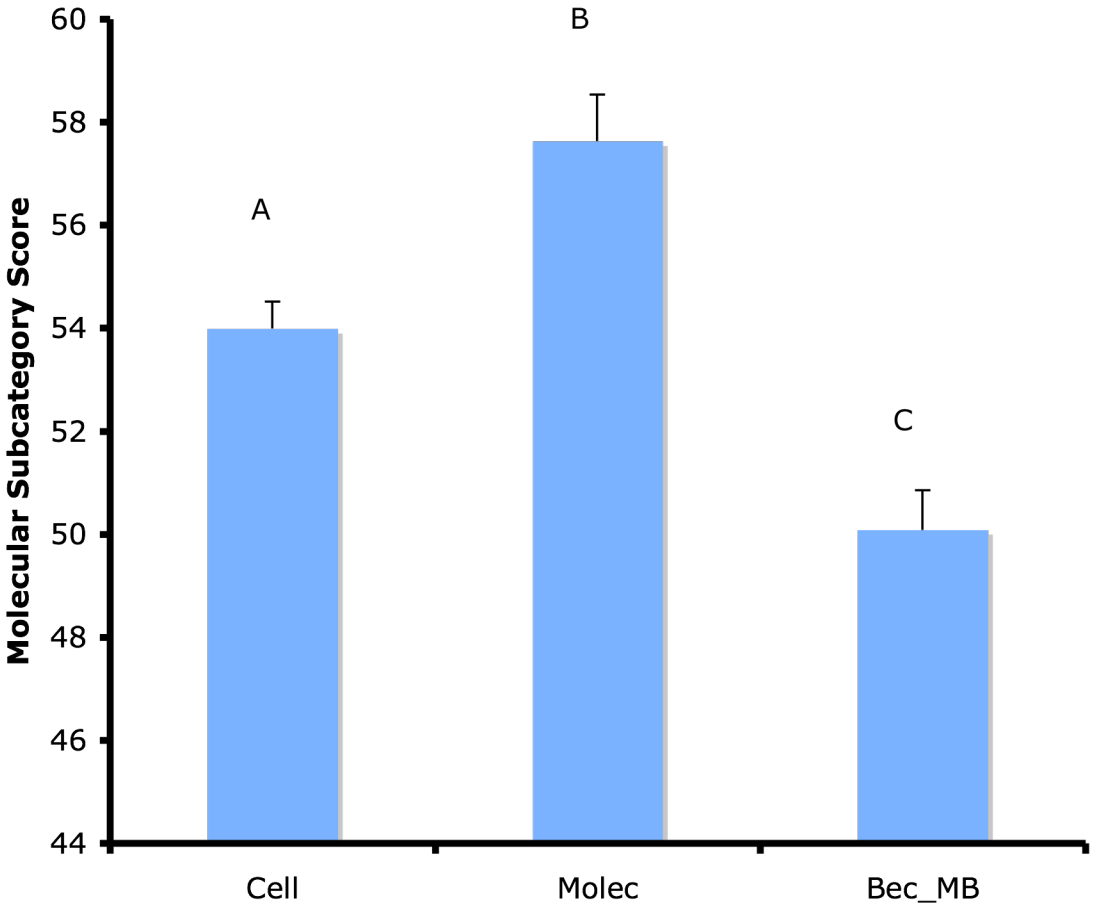


Figure 10: Mean Molecular subcategory Scores + 1 S.E. for the different years the ETS was administered. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

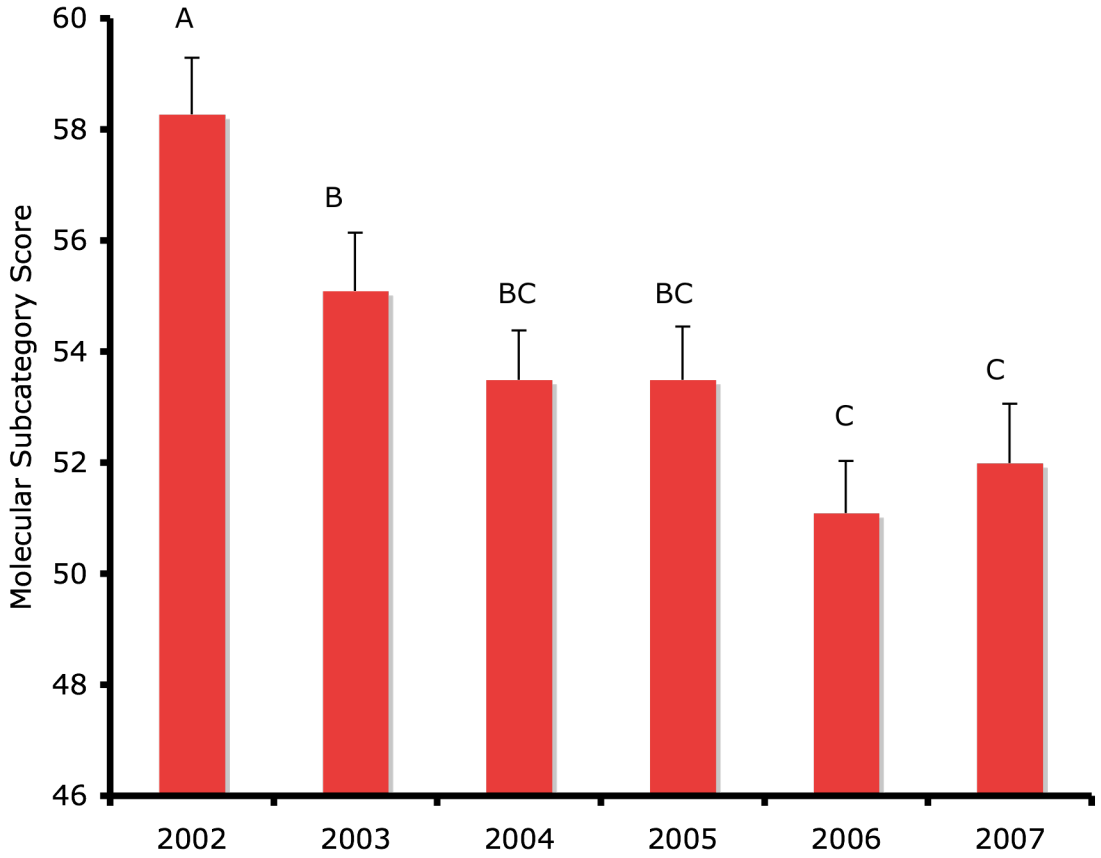


Figure 11: ANCOVA adjusted Molecular subcategory Scores + 1 S.E. for the different years the ETS was administered for the students interested or in the Cell concentration. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

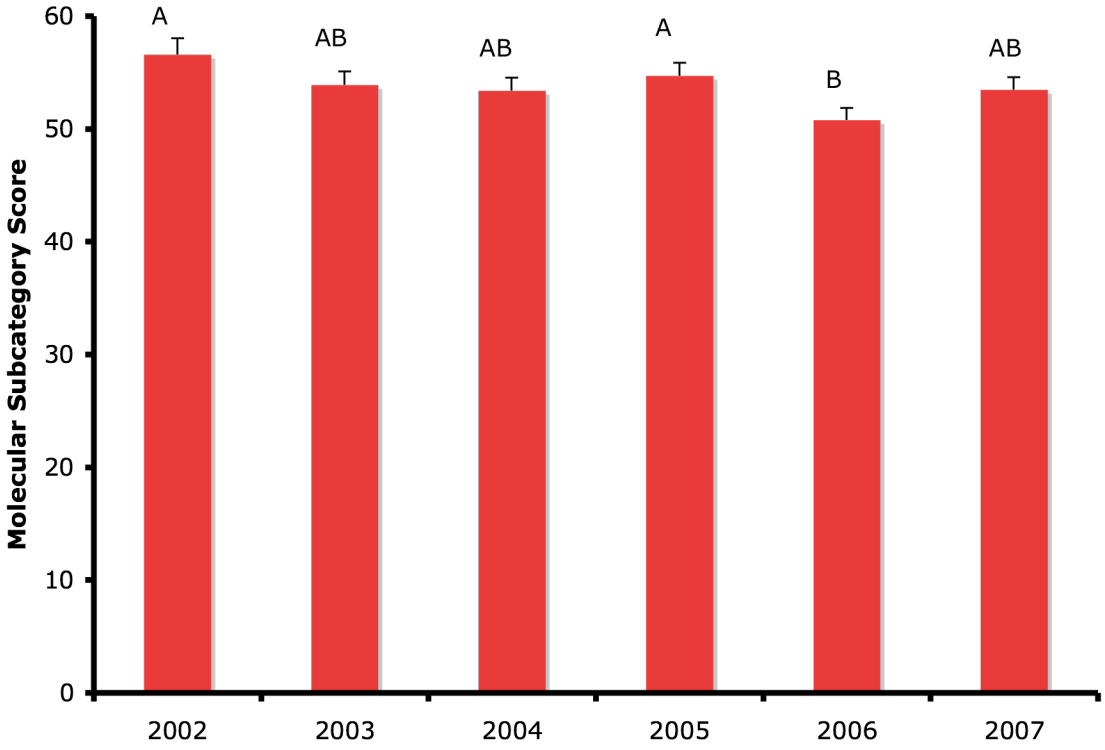


Figure 12: ANCOVA adjusted Molecular subcategory Scores + 1 S.E. for the different years the ETS was administered for the students interested or in the Molecular concentration. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

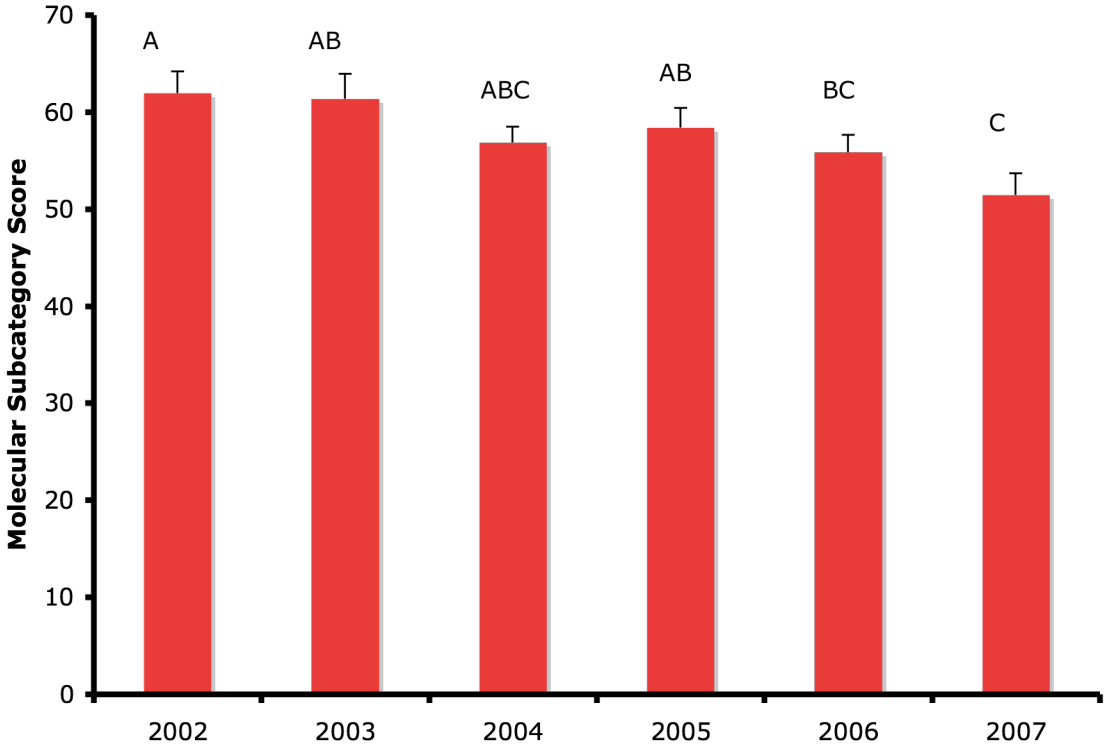


Figure 13: ANCOVA adjusted Molecular subcategory Scores + 1 S.E. for the different years the ETS was administered for the students interested or in the BEC/MB concentration. Different letters denote significant differences among groups using Fishers protected least-significant difference test.

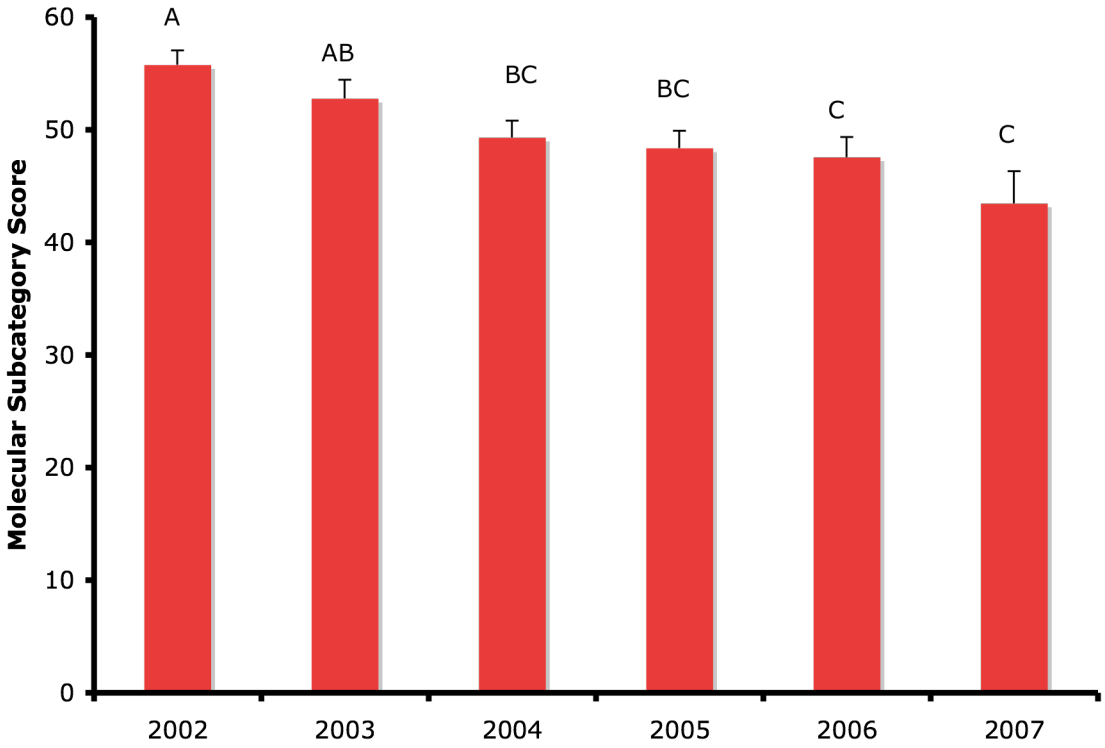


Figure 14: Mean Organismal subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

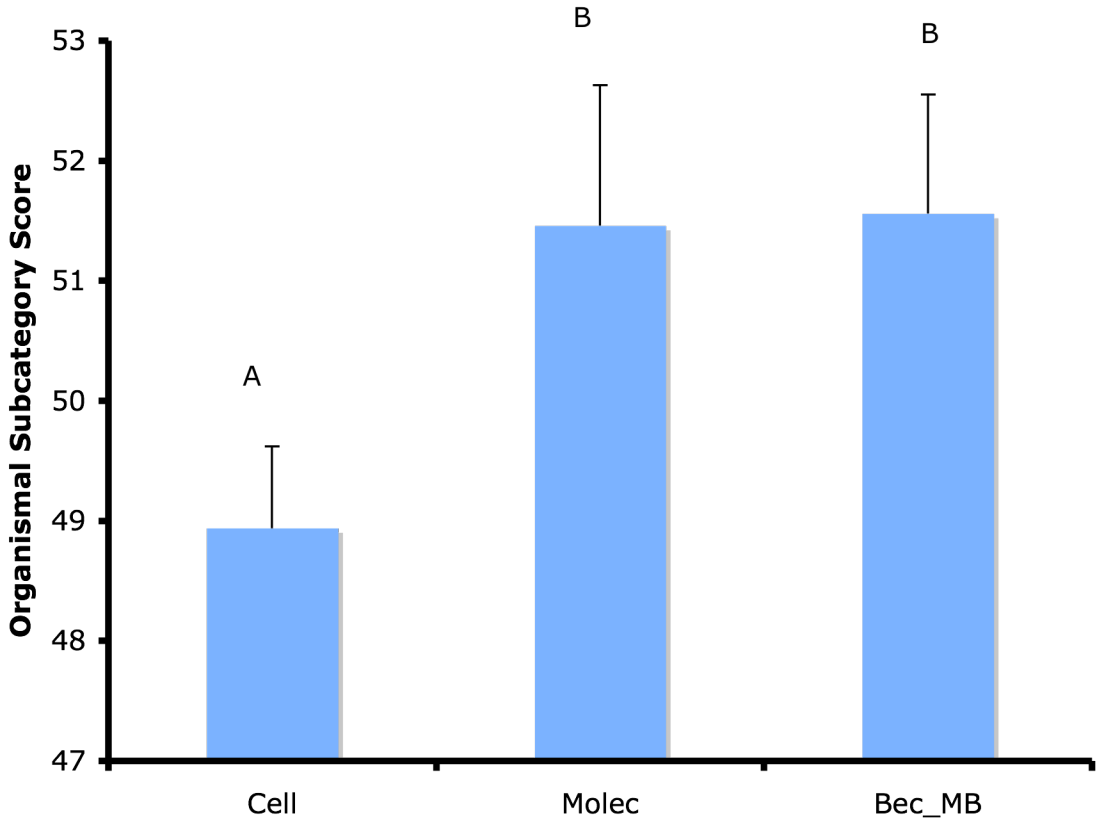


Figure 15: Mean Organismal subcategory Scores + 1 S.E. for the different years the ETS was administered.

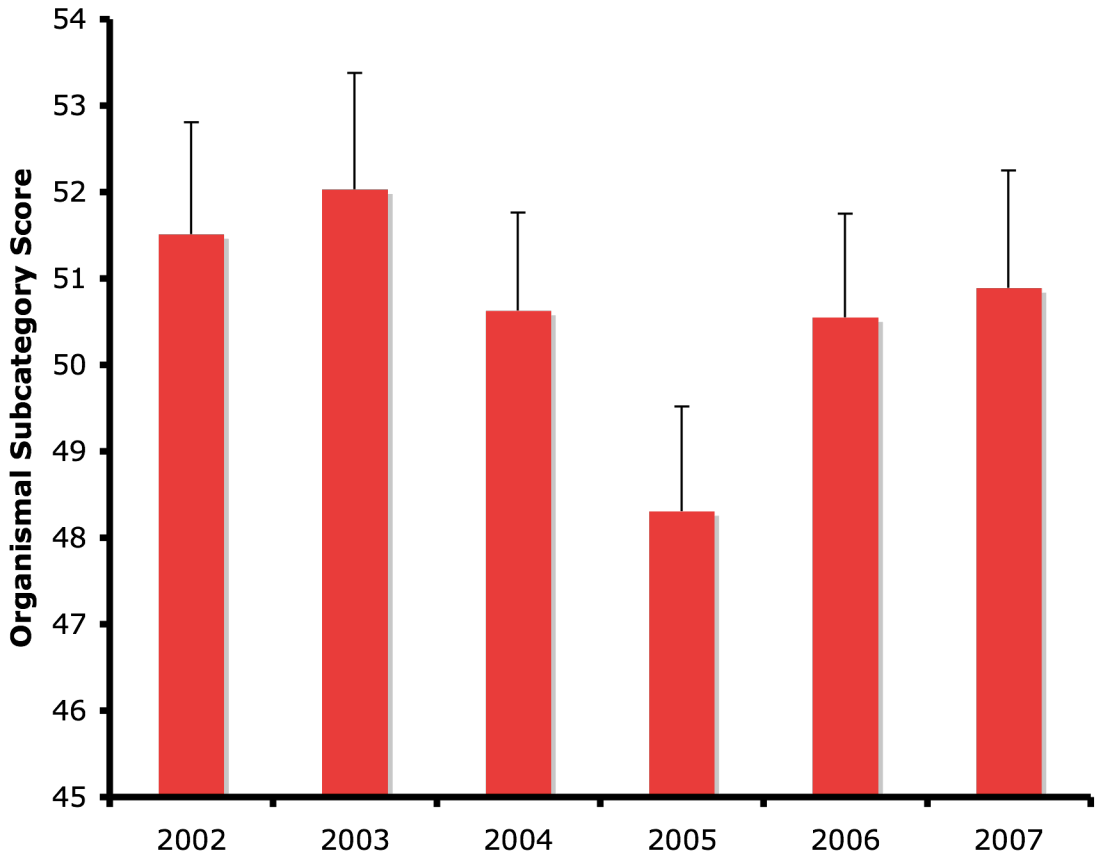


Figure 16: ANCOVA adjusted Organismal subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

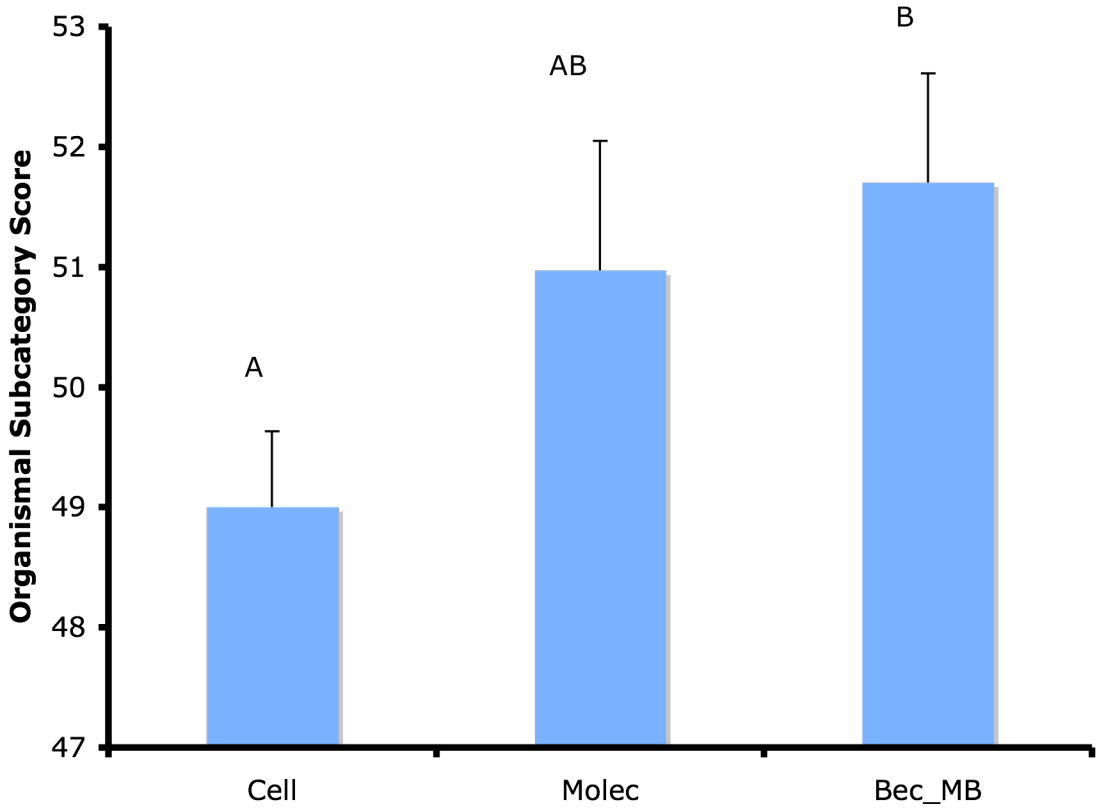


Figure 17: ANCOVA adjusted Organismal subcategory Scores + 1 S.E. for the different years the ETS was administered.

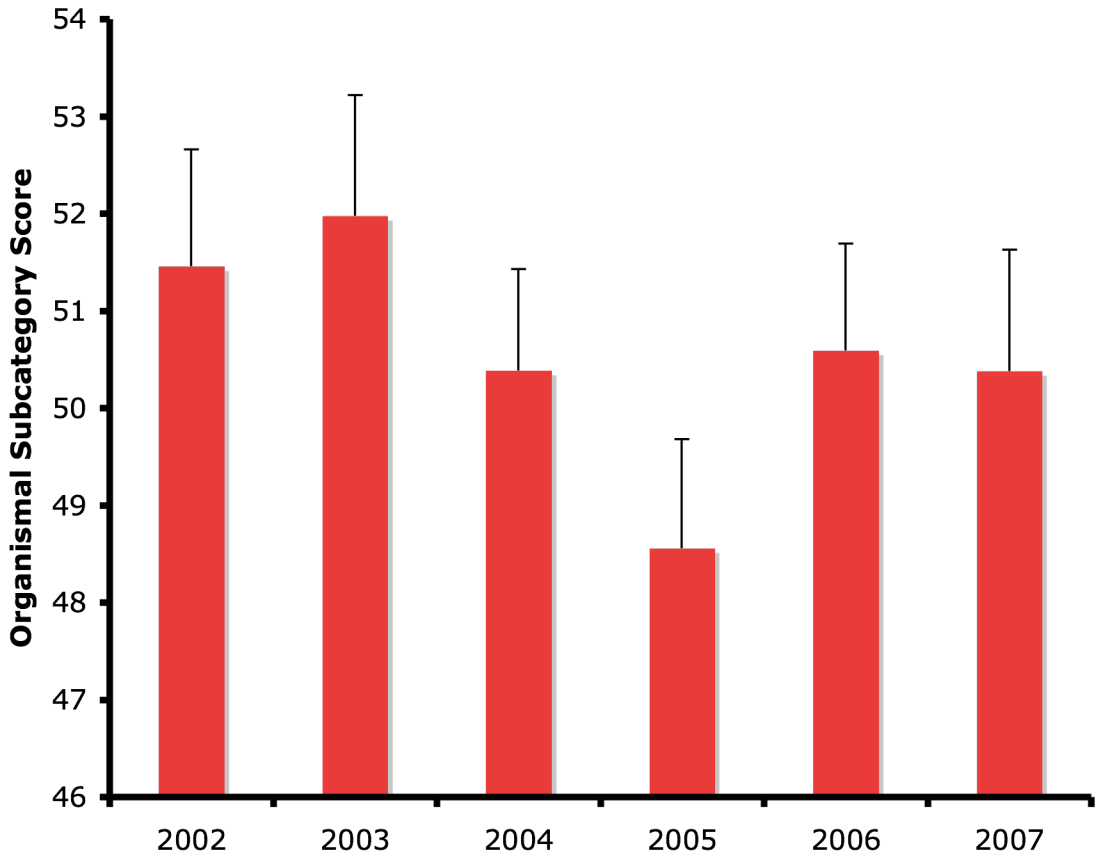


Figure 18: Mean Population Biology subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

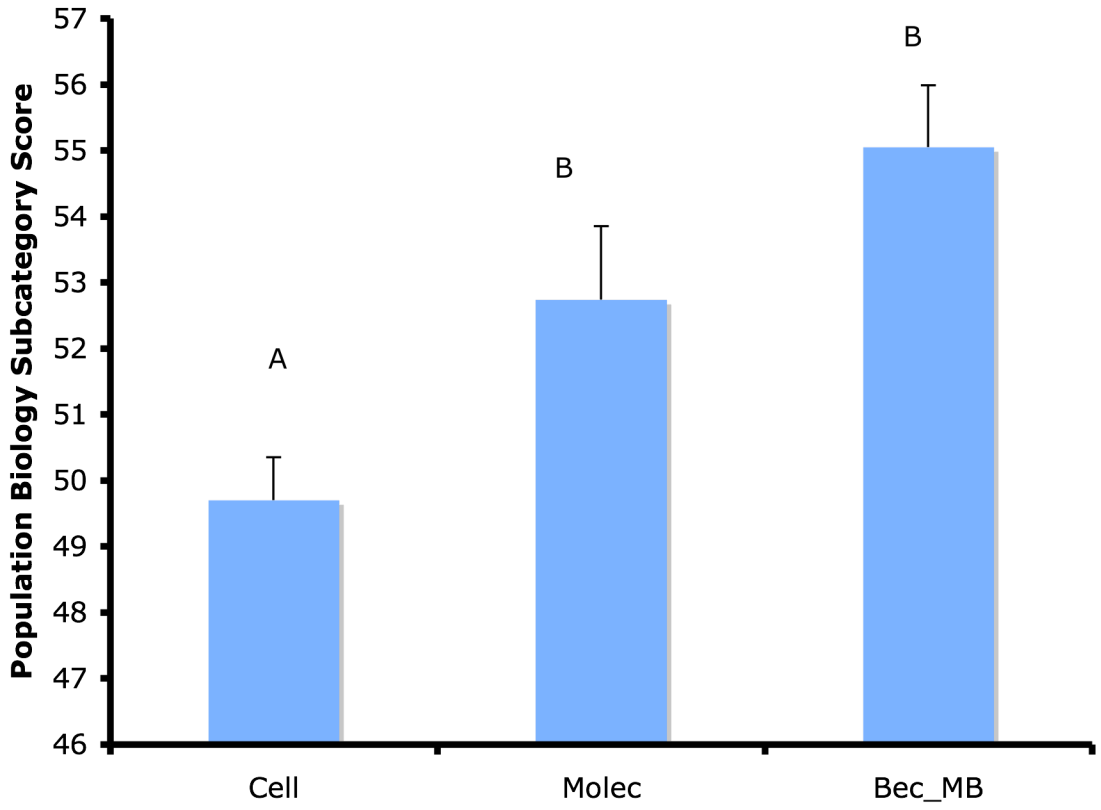


Figure 19: Mean Population Biology subcategory Scores + 1 S.E. for the different years the ETS was administered.

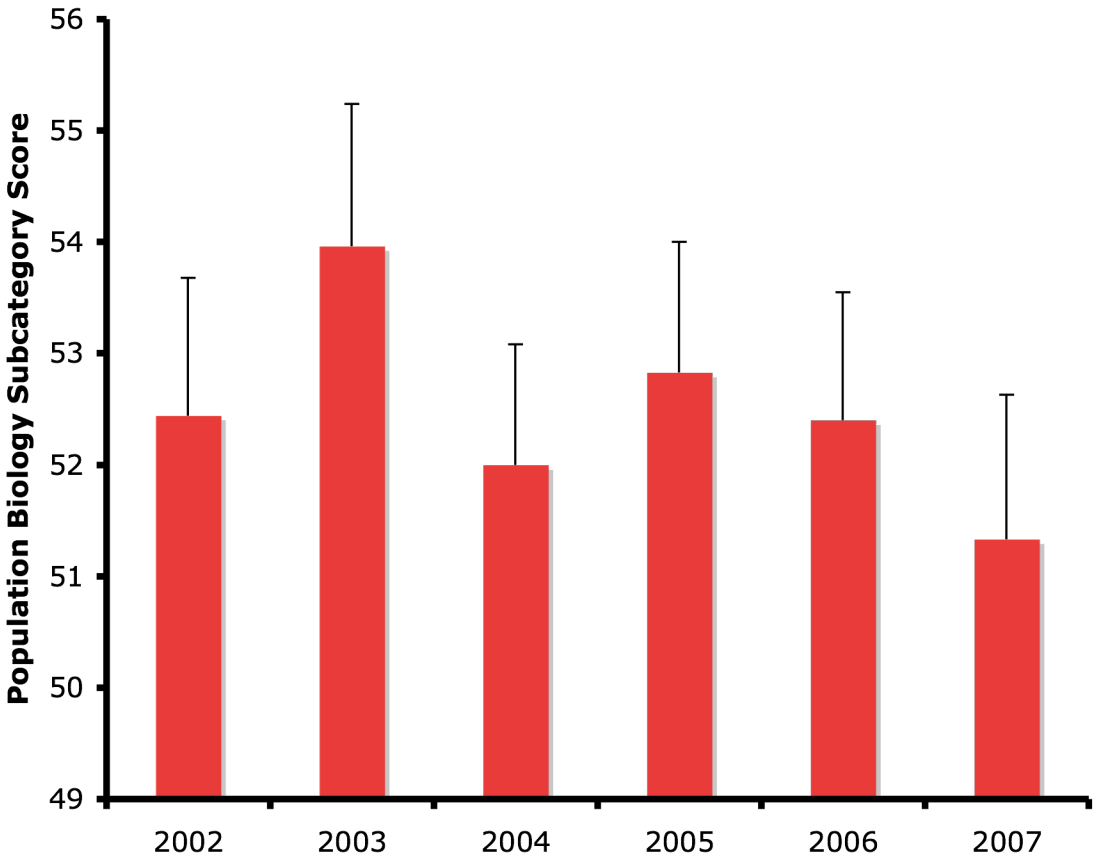


Figure 20: ANCOVA adjusted Population Biology subcategory Scores + 1 S.E. for the different concentration/interest groups. Different letters denote significant differences among groups utilizing Fisher's protected least significant difference test.

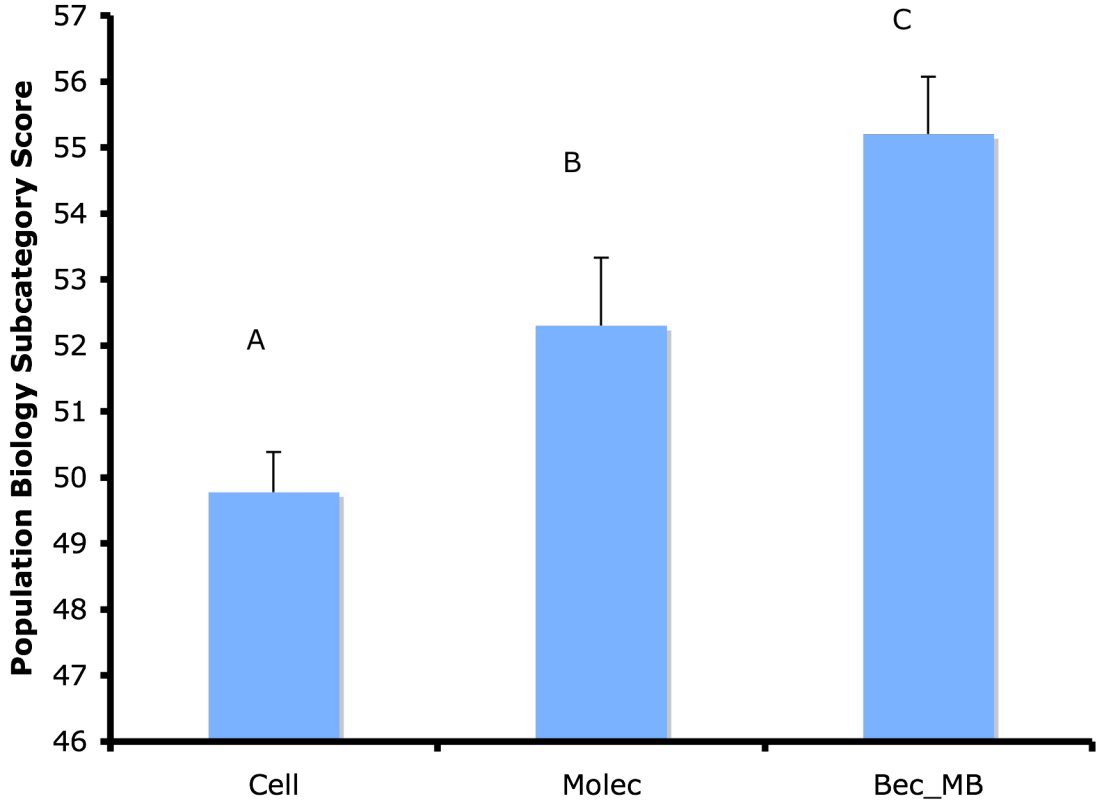
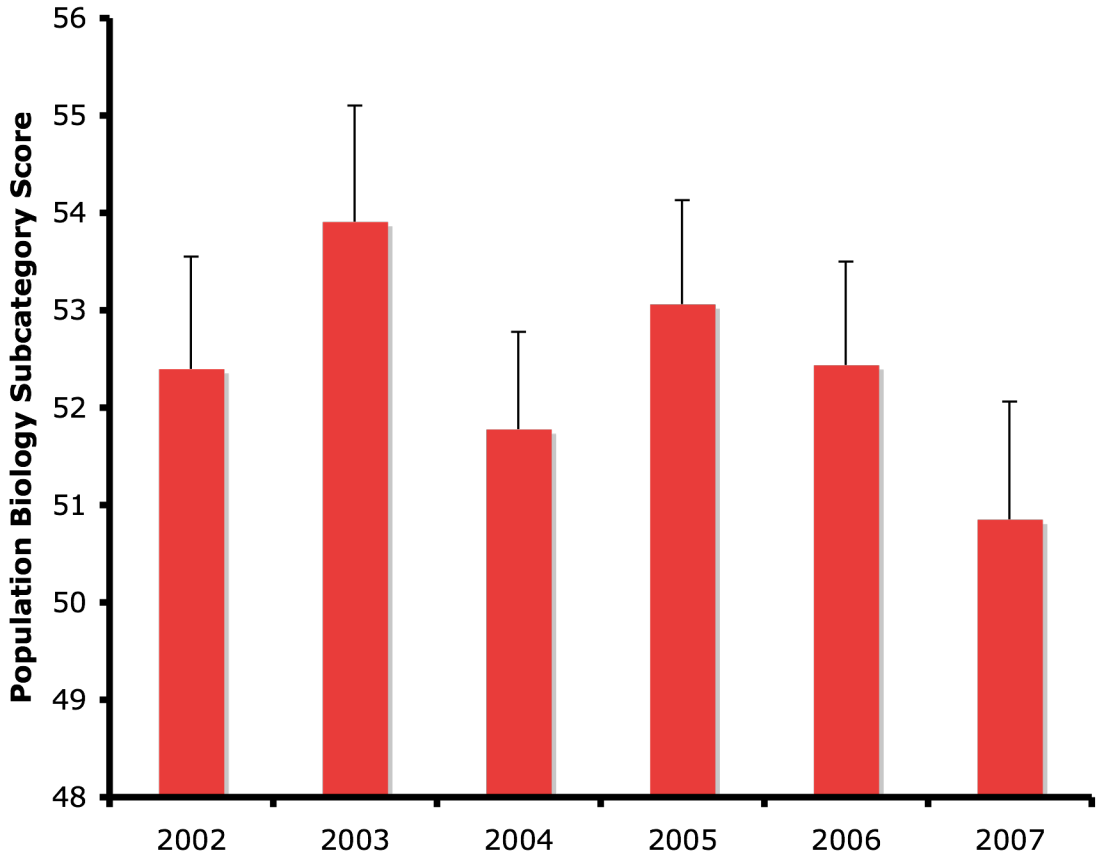
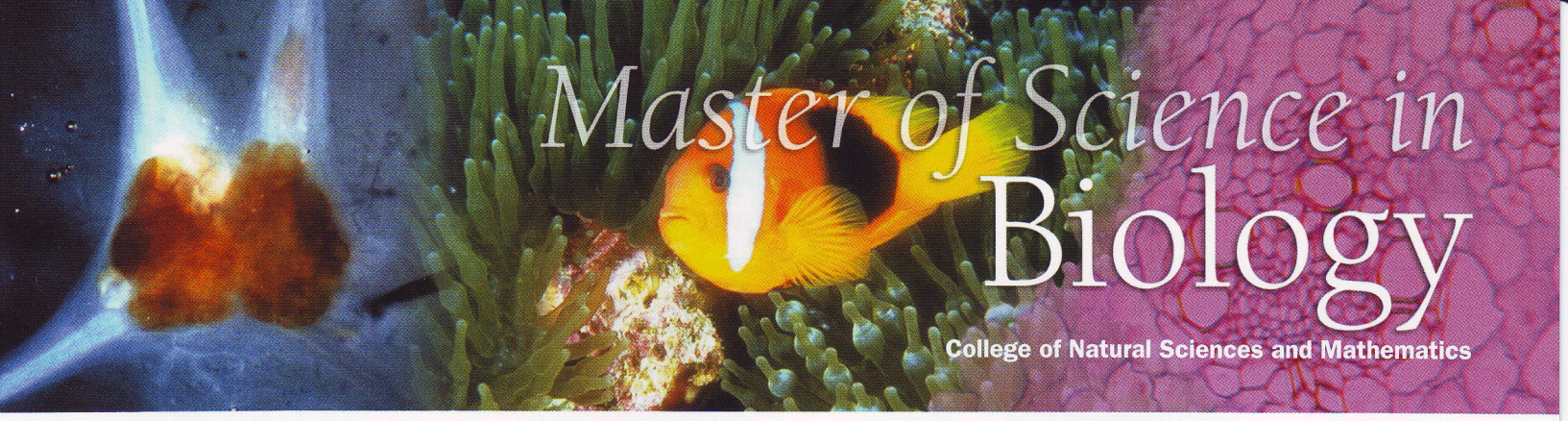


Figure 21: ANCOVA adjusted Population Biology subcategory Scores + 1 S.E. for the different years the ETS was administered.





Master of Science in Biology

College of Natural Sciences and Mathematics

Why pursue the Master of Science in Biology?

This is an incredible time to be a biologist. Every day, new research findings are presented, from the level of single molecules to whole ecosystems. A master's degree in biology allows you to contribute to this research, to share this knowledge through teaching, or to apply it in public service or private industry. Many of our students use their M.S. as a stepping stone to doctoral or health professions programs. Others enter the workforce immediately in fields as diverse as biotechnology, government service, environmental consulting and teaching. The Cal State Fullerton master's degree in biology is a rigorous, research-based program that can be completed in two to three years and prepares you for a variety of careers in exciting and competitive fields.

What is distinctive about Cal State Fullerton's program?

We offer a strong, research-focused and thesis-based M.S. degree with graduate students working closely with their faculty mentor from the first day of their entry into the program. Our diverse faculty conduct research at all levels of biological organization reflecting the five areas of study available within the program. The faculty are supported by grants and contracts from foundations and government agencies, and with their students use state-of-the-art-equipment in their laboratories. For field work, the region is blessed with an incredible variety of accessible habitats including deserts, mountains, shrublands, wetlands, rocky coasts, kelp forests and offshore islands. The many academic institutions, biotechnology laboratories, consulting firms and government agencies in the area offer a rich intellectual and career environment for students engaged in M.S. research.

What is required for admission?

Students seeking admission to the Master of Science Program in Biology must have: a B.S. or B.A. degree in biology or related area from an accredited college or university; a GPA of 3.0 in all biology or biology-related courses (e.g., biochemistry) and a GPA of 2.5 in all supporting course work in chemistry, physics and mathematics. Students must submit the scores of one of the following: Graduate Record Examination (GRE) General test, Medical College

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The California State University

Admission Test (MCAT), or Dental Admission Test (DAT). No absolute score is required for admission, but the scores are used in the evaluation procedure. To be admitted to the program, a student must be accepted by a full-time faculty member in Biology who agrees to serve as the student's thesis adviser. For more information, visit our website at http://biology.fullerton.edu.

What are the requirements to complete the degree?

The study plan for the M.S. in Biology includes 30 units of adviser-approved graduate work; at least one-half of the total units must be at the 500-level. All study plans must include the following:

Biology 500 A and B Professional Aspects of Biology (2 units)
Biology 598 Thesis (1-6 units)
Biology 599 Independent Graduate Research (1-6 units)
At least two graduate seminars

A thesis acceptable to the adviser and thesis committee, covering a research problem, as well as a final oral examination on the thesis research, are required to complete the degree program.

What are the research interests of the faculty?

Five Research Areas

1. Biodiversity, Ecology and Conservation Biology

This M.S. degree area allows students to gain experience in the research methods used to study the evolution and ecology of organisms found in terrestrial, freshwater and coastal ecosystems. Research is conducted on individual organisms, populations, communities and ecosystems. Faculty members offer courses and active research experience in taxonomy and phylogeny, vertebrate and invertebrate ecology, evolutionary ecology, biogeography, behavioral ecology, plant ecology, ethnobotany, plant-animal interactions, and conservation biology. Much of this research is conducted in the diverse natural environments of the Los Angeles/Orange County region, including research on threatened and endangered species and human impacts on these environments.

Graduate faculty in biodiversity, ecology, and conservation biology: Sandra Banack, Douglas Eernisse, William Hoese, Michael Horn, Anne Houtman, William Presch, Darren Sandquist, Jochen Schenk, Paul Stapp and Sean Walker.

2. Marine Biology

This M.S. degree area is designed to provide students with research skills and expertise in the study of coastal marine organisms and ecosystems. Our program takes advantage of the proximity of coastal marine habitats ranging from wetlands and estuaries, rocky intertidal reefs, sandy shores, kelp forests, and soft-bottom systems to human-made harbors. Access to laboratory space in Los Angeles Harbor and use of several ocean-going vessels are provided through affiliation with the Southern California Marine Science Institute, which in turn provides opportunity for use of laboratory and living space at the University of Southern California's Wrigley Institute for Environmental Studies on Santa Catalina Island.

Graduate faculty in marine biology: Kathryn Dickson, Douglas Eernisse, Michael Horn, Steven Murray and Danielle Zacherl.

3. Cell and Developmental Biology

This M.S. degree area provides students with the opportunity to study animal and plant development, microbiology, cell signaling pathways, cytoskeleton dynamics, fertilization processes, cancer biology, and neurobiology. Research is conducted at the level of organisms and at the cellular and molecular levels. Campus facilities include modern laboratories with state-of-the-art instrumentation, in addition to facilities for animal and plant growth, mammalian tissue culture, and several types of microscopy. Most faculty in this program are members of the Center for Applied Biotechnology Studies.

Graduate faculty in cell and developmental biology: Merri Lynn Casem, Esther Chen, David Drath, Robert Koch, Nilay Patel and Nancy Pelaez.

4. Molecular Biology and Biotechnology

This M.S. degree area is designed for students seeking to develop skills and expertise to conduct molecular research using cutting-edge technologies to solve basic research problems relevant to genetics, medicine, agriculture and the environment. Emphasis is placed on molecular research in prokaryotic and eukaryotic organisms under the close guidance of a faculty mentor. Research areas include: bacterial virulence, pathogenesis, regulation of gene expression, plant environmental stress, and genetic recombination using the latest techniques in molecular biology, bioinformatics, gene manipulation and biotechnology. Most faculty in this program are members of the Center for Applied Biotechnology Studies.

Graduate faculty in molecular biology and biotechnology: Esther Chen, Amybeth Cohen, Rodrigo Lois, Marcelo Tolmasky and Frederick Whipple.

5. Biology Pedagogy Research

This M.S. degree area is designed to produce graduates with an interdisciplinary background in biology and pedagogical research. Our students gain advanced expertise in a biological discipline as well as in educational theory and research methodologies. Graduates of our program are broadly trained in teaching and research processes and go on to Ph.D. programs or careers as community college instructors or K-12 teachers.

Graduate faculty in biology pedagogy research: Merri Lynn Casem, William Hoese, Anne Houtman and Nancy Pelaez.

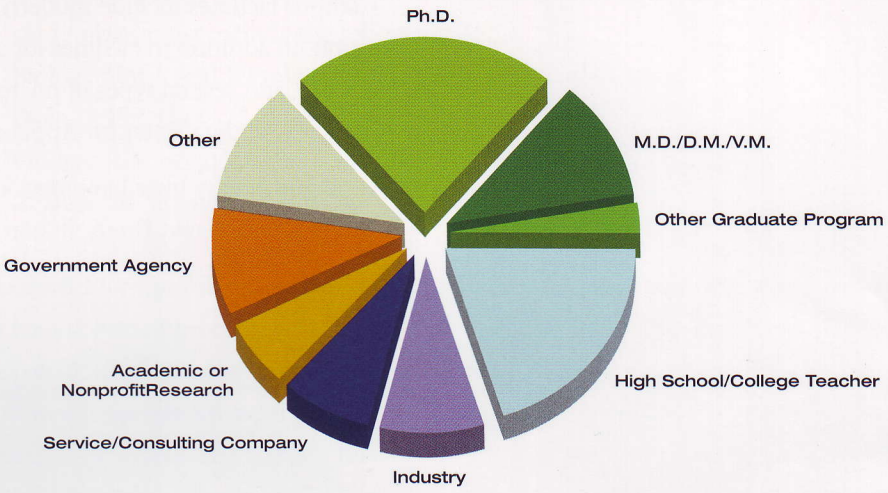
What kinds of financial support are available?

The Department of Biological Science offers teaching associate and graduate assistant positions to virtually all of our graduate students. Grant-supported research assistantships may also be available. These positions and assistantships provide a basic salary that helps to meet the costs of a graduate education. In addition, a number of small scholarships are available each

year. Non-resident tuition waivers may be available for some out-of-state and foreign students. For additional information about financial aid, contact the Office of Financial Aid at (714) 278-3125 or www.fullerton.edu/financialaid/.

What are Biology M.S. alumni doing now?

Most of our M.S. graduates enter Ph.D. programs, pursue health-profession degrees, become high school or college teachers, or take positions in industry, government agencies or consulting firms. [See diagram below.]



Where can I get more information?

For more information about our Master of Science Program in Biology, contact the graduate program adviser by email at BioGradAdv@fullerton.edu or by phone at 714-626-8700. You also are welcome to visit our department located in McCarthy Hall 282, or to write to: Graduate Program Adviser, Department of Biological Science, California State University, Fullerton, 800 North State College Blvd., Fullerton, CA 92834-6850.

BIOLOGY BUDGET RETROSPECTIVE (FY 2004-05 TO 2007-08) AND PROJECTION (FY 2008-09 TO 2012-13)

INCOME

	2004-05	2005-06	2006-07	2007-08	2008-09 HIGH	2008-09 LOW C	2009-10	2010-11	2011-12	2012-13
PTF BLANKET TOTAL	$781,894	$945,546	$966,191	$832,298	$325,153	$423,521	$347,128	$425,020	$548,100	$642,341
ONE-TIME ADJUSTMENTS	$83,242	$294,475	$347,777	$510,237	$427,379	$427,379	$341,904	$341,904	$341,904	$341,904
STAFF ADJUSTMENTS	$35,046	$35,046	$130,004	$15,000	$0	$0	$0	$0	$1	$2
OE BASELINE	$97,590	$97,590	$97,590	$117,590	$117,590	$117,590	$117,590	$117,590	$117,590	$117,590
ASC RELEASE TIME	$54,086	$132,468	$103,282	$67,450	$65,000	$65,000	$50,000	$50,000	$50,000	$50,000
VPAA RELEASE	$211,653	$25,725	$127,747	$146,070	$146,070	$146,070	$146,070	$146,070	$146,070	$146,070
PTF Settlement Costs-Proposed Baseline	$107,229		$113,100	$143,228	$177,047	$177,047	$161,986	$163,606	$165,242	$166,894
EQUIPMENT		$103,787	$257,280	$0	$0	$0	$0	$0	$0	$0
STATE GRANT INCOME	$179,531	$55,195	$69,162	$34,203	$21,112	$21,112	$21,000	$21,000	$21,001	$21,002
CARRYFORWARD *	$315,549	$293,568	$0	$526,704	$668,651	$668,651	$638,756	$413,359	$356,254	$151,860
LOTTERY FUNDS	$0	$0	$0	$203,996	$138,900	$138,900	$60,000	$70,000	$75,000	$80,000
TOTAL INCOME	**$1,865,820**	**$1,983,400**	**$2,212,133**	**$2,596,776**	**$2,086,902**	**$2,185,270**	**$1,884,434**	**$1,748,548**	**$1,821,161**	**$1,717,663**
MAX POTENTIAL CARRY FORWARD	$540,567	$296,710	$323,600	$668,651	$635,179	$638,756	$413,359	$356,254	$151,860	$65,156
	*3-yr CF plan required	*Only YR 1 of CF provided	*CF from 3-yr plan used for Univ reserve	*portion of CF sweep returned						

EXPENSES

PTF SALARIES	$401,961	$481,704	$478,407	$557,335	$466,430	$487,155	$492,026	$496,947	$501,916	$506,935
TA SALARIES	$331,422	$429,285	$380,962	$504,946	$464,576	$484,761	$489,608	$494,504	$499,449	$504,444
GA SALARIES	$55,355	$66,975	$67,606	$81,422	$13,459	$33,189	$33,521	$33,856	$34,194	$34,536
SA SALARIES	$10,277	$22,835	$49,377	$45,334	$11,334	$22,667	$22,894	$23,123	$23,354	$23,588
FACULTY/STAFF Stipends	$0	$0	$23,301	$25,000	$0	$0	$0	$0	$0	$0
Special Faculty Adjustments	$0	$77,255	$0	$0	$0	$0	$0	$0	$0	$0
Unaccounted staff salaries	$0		$48,550	$0	$0	$0	$0	$0	$0	$0
Settlements (06-07)	$107,229	$121,784	$84,997	$86,626	$143,228	$143,228	$177,047	$161,986	$163,606	$165,242
VPAA Contingency (1%)	$30,302	$31,377	$33,922	$36,950	$31,408	$33,255	$30,000	$30,000	$30,001	$30,002
SEPARATION SAVINGS TO VPAA	$0		$0	$0	$0	$0				
Budget reduction	$0	$46,448	$25,803	$40,029	$0	$0				
OPERATING EXPENSES SUBTOTAL	$253,307	$268,606	$509,822	$342,995	$194,163	$206,133	$143,553	$103,653	$248,355	$232,965
RESEARCH ACTIVITIES SUBTOTAL	$135,400	$140,420	$185,787	$207,489	$127,126	$136,126	$82,426	$48,226	$168,426	$154,794
TOTAL EXPENSES	**$1,325,253**	**$1,686,690**	**$1,888,534**	**$1,928,125**	**$1,451,722**	**$1,546,513**	**$1,471,075**	**$1,392,294**	**$1,669,302**	**$1,652,506**

ESTIMATES OF REVENUES BASED ON FTES TARGET AND FTEF ADJUSTMENTS

BASELINE FTEF FUNDING	**2007-08**	**2008-09 high**	**2008-09 low**	**2009-10**	**2010-11**	**2011-12**	**2012-13**
Baseline FTES	857	829	841	841	860	860	860
Baseline FTEF	43.3	41.8	41.8	37.9	40.0	41.5	43.4
FTEF baseline FT + Chair	24	29	29	30.0	31.0	31.0	31.0
Chair allocation	0.75	0.75	0.75	0.8	0.8	0.8	0.8
Unfilled Positions to PTF Blanket	19.30	12.80	12.80	7.91	9.00	10.50	12.43
Total Unfilled Positions	20.05	13.55	13.55	8.66	9.75	11.25	13.18
PTF Position Value	$45,156	$48,720	$48,720	$48,720	$48,720	$48,720	$48,720
PTF BUDGET @ BASELINE WORKLOAD	$905,378	$660,156	$660,156	$422,128	$475,020	$548,100	$642,341
Baseline FTES (original)	896						
Baseline FTES (revised)	849						
Baseline FTEF	41.8						
budget reduction target		$335,003	$236,635	$75,000	$50,000		
new FTEF @ $48,720	-1.5	-5.50	-3.89				
new additional Baseline FTEF Funding	-$73,080	-$335,003	-$236,635	-$75,000	-$50,000		
FINAL 07-08 Baseline FTEF Funding	**$832,298**	**$325,153**	**$423,521**	**$347,128**	**$425,020**	**$548,100**	**$642,341**

Student Learning Outcomes for the Biology Curriculum at California State University, Fullerton

Student Learning Outcomes for Skills in the New CSUF Biology Core Program

Operate specific scientific equipment and trouble shoot problems during operation.

Demonstrate mastery of specific scientific techniques.

Utilize appropriate data collection techniques during scientific investigations.

Identify and communicate critical and insightful relationships among fundamental biological concepts, everyday life, and societal issues.

Master computer applications for computational and communication needs.

Integrate the knowledge acquired in biology related support disciplines to enhance understanding of fundamental biological concepts.

Explain the unifying role of evolution in biology.

Interpret and analyze data.

Use statistical analyses in the interpretation of scientific investigations.

Retrieve information from a variety of sources including libraries and the web.

Design biological experiments.

Demonstrate effective learning strategies.

Critique scientific literature.

Communicate information effectively through oral and written presentations.

Express positive opinions about biological concepts to others.

Support societal issues that are based on biologically sound principles.

Identify and evaluate ethical issues in biology.

Student Learning Outcomes specific to each of the four new courses in the CSUF Biology Core Program

BIOL 171: Evolution and Biodiversity

1. Demonstrate competence with relevant scientific thinking skills

1A. Create a list of skills, qualities of a scientist
1B. Demonstrate observations skills
1C. Generate questions and hypotheses from simple observations
1D. Test predictions through experimentation

2. Demonstrate competence with relevant scientific manipulative skills and equipment

2A. Prepare a smear for microscopic observation
12B. Isolate a bacterium in pure culture

3. Demonstrate competence with relevant scientific communication skills

3A. Set up and maintain a lab/field notebook/journal
3B. Access information from print and electronic journals
3C. Communicate orally
3D. Communicate in writing
3E. Use a computer to
Access information
Organize and analyse data
3F. Prepare and present results
3G. Read and interpret the scientific literature

4. Recognize similarities and differences among taxa at all hierarchical levels

4A. Compare attributes at the level of Domain, Kingdom etc
Describe similarities among all organisms
Identify differences between each "group" beginning with domains
Differentiate between "closely related" versus sharing similarities due to common adaptations (homology versus ecological similarities)
4B. Explain why evolution is a branching process (with exceptions – eg. endosymbiosis)
4C. Use dichotomous keys
4D. Construct and interpret phylogenetic relationships
4E. Congruency of different data sets (morph vs development vs genetic)
4F. Describe the relationship between form and function
List the basic challenges that all organisms face
Compare and contrast how 2 (or more) organisms solve similar problems eg. Surface/volume
Describe the physical limitations imposed by environment
4G. Recognize characteristics of the major phyla/divisions
Identify any organism with the appropriate resources
Recognize immediately "major" phyla/divisions
4H. Describe the "life history" of a representative organism

5. Demonstrate an understanding of evolutionary theory

5A. Differentiate between and explain macro and micro evolution
Provide evidence of microevolutionary changes in natural populations
Describe evidence for macroevolution in the fossil record, anatomical comparisons, and molecular comparisons
Distinguish between homologous and analogous traits
5B. Explain how a complex structure such as the eye evolved
5C. Discuss the history of evolutionary theory
Explain the theories of how, under what circumstances and when life originated
Define what is "living"
5D. Discuss the emergence of multicellularity
5E. Explain the role of natural selection in evolution
Describe how and when natural selection operates
Define adaptation and provide examples
5F. Discuss the limits of selection as an agent of evolution
5G. Define species and speciation mechanisms
Compare definitions of species and distinguish species from subspecies
Compare reproductive isolation mechanisms
5H. Provide examples of speciation among natural populations
5I. Interpret the link between natural selection and speciation
5J. Discuss Hardy-Weinberg principles
List assumptions that influence nonrandom inheritance over time
Do simple problems?
5K. Discuss the evolutionary and ecological role of extinction
5L. Relate evolution to the subdisciplines of biology

6. Evaluate and appreciate the complexity and fragility of the world and its flora, fauna, and microbes

6A. Recognize, measure, and appreciate the breadth of biodiveristy
Define biodiversity
6B. Compare the variation among select groups of organisms
6C. Discuss basic principles of conservation biology
6D. Argue the implications of loss of biodiversity
6E. Establish a bioethic

7. Value being a biology major

7A. Appreciate the value of activities and assignments
7B. Develop a clear understanding of the biology major at CSUF
7C. Work cooperatively in groups

BIOL 172: Cellular Basis of Life

Abbreviations for themes: EV = evolution; UD = Unity & Diversity; SD =Dynamics of Biological Systems

1. Analyze critically the importance of membranes to cells. (EV, UD, SD)

1.A. Analyze critically the importance of cell membranes to cellular compartmentalization.

1.B. Analyze critically the importance of cell membranes to metabolic processes.

1.C. Analyze critically the importance of cell membranes to intracellular homeostasis by controlling transport processes.

1.D. Analyze critically the importance of cell membranes to cell signaling

1.E. Analyze critically the importance of cell membranes to cell specializations

2. Describe the flow of information within cells, between cells, and between the environment and cells. (EV, UD, SD)

2.A. Describe in a general way how signal transduction occurs and list several potential outcomes.

2.B. Explain how intra- and extracellular signals can affect gene expression

2.C. Describe the function of endomembrane systems in post-translational modification, sorting of proteins, endosomal compartmentation, lysosomal degradation, and endocytosis and exocytosis.

2.D. Connect the concept of information flow with the regulation of metabolic pathways.

3. Examine the flow of energy within cells, between cells, and between the environment and cells. (EV, UD, SD)

3.A. Compare metabolic pathways across a variety of organisms (autotrophs, chemotrophs, etc.).

3.B. Relate metabolic processes to biogeochemical cycles.

3.C. Assess the role of photosynthesis in the evolution of life on earth.

4. Apply the principles of homeostasis to processes that maintain cell functions. (EV, UD, SD)

Early in course:

4.A. Define the concept of homeostasis

4.B. Explore the biological confines of cell survival

Late in course:

4.C. Connect signaling pathways with cellular processes

5. Integrate fundamental chemical principles to cellular structure and functions. (EV, UD)

Early in course:

5.A. Define hydrophobicity, hydrophilicity, bonding, ionization, monomeric vs.

polymeric states

5.B. simple vs. complex molecules

Later and throughout course:

5.C. Connect chemical structures to cellular structure & function

6. Evaluate how cells behave as individuals compared to their role as members of a tissue. (EV, UD, SD)

6.A. Compare and contrast the role of different cytoskeletal elements in controlling cell shape, organelle & protein movement, and cell motility.

6.B. Differentiate the role of cytoskeleton as a supporting framework compared to its role as a means of movement.

6.C. Define the elements of extracellular matrices and their roles

6.D. Discuss the association of the cytoskeleton with the extracellular matrix and its impact on cell behavior

6.E. Define the types of cell-cell and cell-matrix junctional and non-junctional adhesions and their role in tissue formation & function and cell migration.

7. Critically discuss the dynamics of cellular reproduction in reference to the cell cycle, mitosis, meiosis, growth and apoptosis. (EV, UD, SD)

7.A. Relate cell cycle and mitosis to growth and specialization (Early in course)

7.B. Compare and contrast mitosis vs. meiosis with respect to stages and tissues involved. (Late in course)

7.C. Understand apoptosis in the context of normal tissue function and organization especially with respect to development.

8. Critically discuss the origins of life and the evolution of prokaryotic and eukaryotic cells and multicellularity. (EV, UD, SD)

8.A. Define the unifiying characteristics of living organisms. (Early)

8.B. Synthesize the idea of self-replication, catalysis and compartmentalization of self-replicating molecules into protosomes. (Early)

8.C. Compare and contrast characterisitics of prokaryotic and eukaryotic cells (Mid)

8.D. Appraise advantages and disadvantages of multicellularity (Late)

9. Apply principles of cell biology to selected developmental processes. (EV, UD, SD)

Describe how the following cellular functions are required to accomplish selected developmental processes:

9.A. cell membrane function

9.B. signal transduction

9.C. signaling pathways

9.D. basic gene expression

9.E. endosomal and lysosomal vesicular pathways

9.F. cytoskeletal reorganization

9.G. cell cycle

9.H. cell motility
9.I. cell-cell recognition
9.J. cell-cell adhesion
9.K. cell-extracellular matrix interactions

10. Integrate the concept of a cell into the hierarchical organization of living systems (from atoms to the biosphere). (EV, UD, SD)

10.A. Describe how the complexity of molecular structure contributes to the formation of cellular component.
10.B. Explain how cell structure controls specialization of cellular function.
10.C. Compare and contrast common structures and special structures in different cell types.
10.D. Discuss how a collection of specialized cells can interact with each other and the extracellular matrix to form a tissue.
10.E. Explain, in general terms, how tissues form organs, organs form systems, systems form organisms, organisms form populations, populations form communities, communities form…

11. Relate cell structure to function. (EV, UD, SD)

11.A. Explain how cell structure controls specialization of cellular function.
11.B. Compare and contrast common structures and special structures in different cell types.
11.C. Discuss how a collection of specialized cells can interact with each other and the extracellular matrix to form a tissue.

BIOL 273: Genetics and Molecular Biology

Abbreviations for organizing principles and themes: EV = Evolution, UD = Unity & Diversity, SD = Biological Systems Dynamics, HI = Human Impact, PS = Process of Science

1. Inheritance: Autosomal and Sex-linked Traits
Construct, analyze and predict genetic outcomes based on pedigree or segregation and recombination data as they relate to individuals and populations. (UD, EV, HI)

1A. Using manipulatives, demonstrate the chromosomal events of meiosis including segregation.
1B. Using manipulatives, demonstrate the chromosomal events of meiosis including linkage and independent assortment.
1C. Given the phenotypes and/or the genotypes of the parents, calculate the probability of particular genetic outcomes.
1D. Given the family history for a particular genetic condition, construct the pedigree (genetic history). From that pedigree, predict the mode of inheritance of the particular genetic condition.
1E. Predict the effects of genetic drift, nonrandom mating, gene flow, mutation and natural selection on large and small populations.
1F. Calculate the Hardy-Weinberg frequencies (genotypes and phenotypes) and appraise the range of its applicability.
1G Explain dominance, recessiveness, gene frequencies at Mendelian and molecular levels

2. Structure, Function and Biochemistry of Nucleic Acids
Discuss and analyze the structural features of DNA and RNA. (EV,UD, SD)
2A. Arrange the components of nucleotides to construct a single polynucleotide chain.
2B. Construct a double polynucleotide strand that displays base complementarity and the antiparallel nature of the double-stranded DNA.
2C. Compare the structure of DNA and RNA
2D. Predict the relative melting temperature of different DNA samples with differing GC content.
2E. Analyze and evaluate the data obtained by landmark experiments that provided evidence that DNA was the genetic material.
2F. Using models of DNA relate the 3 dimensional structure of DNA in anticipation of its functions in replication and transcription and its regulation.

3. Mechanism of DNA Replication
Model the duplication of DNA. (EV, UD, SD)
3A. Starting with a double-stranded, helical DNA molecule, prepare detailed diagrams that illustrate DNA replication/duplication, including all of the proteins necessary for this process. These processes should include:

3B. Initiation
3C. Unwinding
3D. Priming
3E. Straightening of the parental strands
3F. Duplication/replication of leading and lagging strands
3G. Polymerization process
3H. Primer removal
3I. Ligation
3J. Distinguish alternate modes of DNA replication depending on chromosome type e.g. bacterial and viral chromosomes.
3K. Describe the outcome of DNA replication in different kinds of chromosomes, including viruses, prokaryotic cells and eukaryotic cells.

4. Distribution of the Replicated DNA
Understand how different organisms solve the problem of distributing the replicated DNA. (UD, SD)

4A. In viruses
4B. In prokaryotic cells
4C. During mitosis in eukaryotic cells

5. Structure and Function of Chromosomes
Describe, model, analyze and depict the structure of chromosomes (UD, SD, HI)

5A. Using manipulatives, model the chromosomal events in mitosis.
5B. Recognize that different DNA sequence families have different functions
5C. Categorize the function of DNA sequences into the following
5C1 Regulatory
5C2 Coding
5C3 Unknown
5D. Recognize that DNA sequences may produce specific three-dimensional structures that can be recognized by other molecules.
5E. Recognize different DNA families
5E1. DNA sequences can be repetitive
5F. Examine the relationship between evolutionarily conserved sequences and their function
5F1. Role of SNPs

6. Mechanism and Regulation of Transcription/Translation
Describe, model and analyze the mechanisms of transcription and translation. (EV, UD, SD)

6A. Compare these events in prokaryotes and eukaryotes.
6B. Transcription: Starting with a double-stranded, helical DNA molecule, prepare detailed diagrams that illustrate transcription, including the key proteins necessary for this process. These processes should include:
6B1. Recognition of a gene
6B2. Initiation of transcription
6B3. Elongation of the RNA strand
6B4. Termination

6B5. RNA processing events

6C. Translation: Starting with a single stranded RNA, prepare detailed diagrams and related explanations that illustrate translation, including the key proteins and RNAs necessary for this process. These processes should include:

6C1. Recognition of an mRNA

6C2. Initiation of translation

6C3. Elongation of the polypeptide

6C4. Termination of translation

6D. Understand how the function of a protein is related to its structure, based on the properties of the amino acids that comprise the protein.

6E. Recognize the co-linear relationship between the polypeptide and the DNA sequence that encodes it.

6F. Appraise the relationship between the structure of a protein and its function with regard to amino acid sequence

6G. Inventory the diverse post-translational modification and discuss their importance in modulating protein function

7. Analyze and predict the effect(s) of mutational change(s) in any of the components of the transcriptional or translational machinery. (ES, UD, SD, PS)

7A. Identify the kinds of mutations that can occur, e.g., point mutations, chromosomal aberrations.

7B. Evaluate how mutational changes may lead to resultant phenotypes

7C. Recognize the significance of mutational changes in producing genetic variation in populations and the role of mutational changes in evolution.

8. Analyze and predict the effect(s) of regulatory change(s) in any of the components of the transcriptional or translational machinery. (EV, UD, SD)

8A Explain and illustrate the structural elements involved in regulation of gene expression and illustrate the interactions between the regulatory factors and sequence elements

8B. Recognize that proteins can interact specifically with three-dimensionally conformed macromolecules (including DNA, RNA and proteins)

8C. Describe the mechanisms by which proteins interact with other macromolecules or small molecules (including DNA, RNA, proteins).

8D. Distinguish between general (basal) regulatory elements and more specific regulatory elements involved in regulation of gene expression

8E. Predict the effects of the interaction between proteins and other molecules as a consequence of structural changes in one component.

8E1. Mutations in a repressor – cascading effects

9. Develop a model that incorporates the cascade of regulatory events that includes how an organism responds to developmental, environmental, metabolic, temporal and spatial signals. (UD, EV, SD, PS)

9A. Analyze and predict the effects of mutational changes in any of the components of the regulatory cascade from signal to protein expression

10. Recombinant DNA Technology

Recognize the relationship between in vivo and in vitro molecular genetic processes and the practical applications derived from them. (EV, HI, SD, PS)

10A. Demonstrate the ability to implement the fundamental skills of recombinant DNA technology.
10B. Calculate and make solutions of specific composition
10C. Accurately measure and dispense small volumes using appropriate pipettors
10D. Predict digest and map a plasmid
10E. Evaluate the similarity of sequence for a given protein determining the degree of homology
10F. Clone DNA into a vector using standard microbiological techniques to grow and maintain bacteria
10G. Separate DNA by electrophoresis
10H. Separate RNA by electrophoresis
10I. Separate proteins by electrophoresis
10J. Screen a library for a specific gene in a case study
10K. Apply the PCR process to amplify a target sequence (student DNA database)
10L. Design a set of primers that will amplify a specific sequence of DNA by PCR

BIOL 274: Principles of Physiology and Ecology

Learning Goals (from current syllabus):

This course will introduce you to the basic concepts of ecology and environmental physiology as part of the core requirements for Biology majors. You will learn about how organisms respond to changes in the physical environment on physiological, seasonal, and evolutionary time scales, and how these responses influence their interactions with other organisms. You will also discover the factors that produce the complex patterns of abundance of organisms both locally and on a global scale, and will come to appreciate the approaches used by ecologists to describe these patterns and to identify underlying processes. You will learn how to evaluate the quality of scientific data, and how basic ecological and physiological principles may be applied in the effective management and conservation of ecosystems. The intensive laboratory portion of the course will focus on southern California ecosystems and explore how organisms are influenced by and interact with their physical and biological surroundings. As much as possible, lecture and laboratory will be integrated so that concepts introduced in lecture will be reinforced by the lab activities. Through laboratory demonstrations and experiments, you will develop skills in testing hypotheses about natural phenomena, including designing studies, collecting and analyzing data, and interpreting and presenting results. Whenever possible, experiments will be conducted in field settings to help you appreciate the complexity of real systems and the challenges faced by ecologists and environmental physiologists in unraveling this complexity. Specific learning goals for each lab module and specific lecture components will be presented during the semester.

SLOs for Content/concepts:

- Student will use systems analysis to identify systems components and diagram their relationships

- Students will be able to compare and contrast different energy acquisition strategies (e.g., photosynthetic and chemosynthetic organisms, herbivores, predators, saprophytes)

- Students will be able to apply a systems analysis approach to energy flow within ecosystems and biogeochemical cycles (i.e., identify the systems components and how they interact in specific contexts).
- Students will be able to describe and evaluate ecosystem function based on limiting factors and organisms' physiological responses
- Students will be able to distinguish between physiological change, acclimation/ phenotypic plasticity, and adaptation
- Students will be able to describe how (mechanistically) natural selection could have given rise to a specific characteristic of a population of organisms
- Students will be able to predict what type of life history strategy would be more common in a given system, and explain their rationale
- Students will be able to apply population growth models and predict population size, given certain conditions
- Students will be able to define the niche of a given organism in a given ecosystem
- Students will be able to quantify species diversity in a given ecosystem and predict how a given disturbance will affect diversity
- Students will be able to determine the present successional stage for a given ecosystem; students will be able to predict how a given disturbance will affect a given ecosystem
- Students will be able to assess and analyze a community - identify the important component (biotic and abiotic) and their interactions
- Students will understand and be able to provide examples of relationships between structure and function

Lab SLOs (general lab SLOs from current syllabus; each individual lab module has specific SLOs associated with it):

- Understand and use scientific approaches to study questions in ecology and physiology
- Learn how to use and interpret primary scientific literature
- Gain skills in making observations and collecting and interpreting data in field and laboratory
- Become familiar with ecological systems, especially those in southern California
- Improve oral and written communication and data analytical skills

Skill SLOs:
Students who successfully complete BIOL 274 should be able to:

1. Utilize information from the previous three core courses in BIOL 274.

2. Demonstrate how to use certain field and lab techniques and know their limitations.

3. Design field and lab studies.

4. Apply field and lab techniques to solve problems related to an organism in its environment.

5. Collect, tabulate and graph, analyze (select appropriate statistical test), and interpret data:
   - fit curves to data
   - construct appropriate graphs from raw data and make conclusions from the graphs
   - statistically analyze data appropriately and make inferences from the data

6. Access and evaluate relevant literature.

7. Write effective scientific reports and papers.

8. Prepare and present effective oral scientific presentations.

9. Effectively use computer applications (word processor, spreadsheets, statistics, graphing, PowerPoint for presentations) and use the Internet for collaboration and as a source of information.

10. Think critically, solve scientific problems appropriate to the course content and level, and combine concepts to graphically represent relationships accurately.

SLOs for Biology Core (QUE Level 14): Post-Core Skills and Attitudes

(developed at a Biology faculty retreat)

Data Collection Techniques; Instrumentation, Procedural Skills

- Standard Technique and procedure
- pH Meter
- Microscope
- Balance
- Pipetter
- Sterile Technique
- Certain manipulable skills
- Microscopy
- Identification/classification
- Aseptic techniques
- Quantitative
  - standard curve
  - weighing and measuring
- Making solutions and dilutions
- Sampling of Population
- Maintain a lab notebook

Appreciate and value living systems, biological concepts and their interrelationships

- Comprehend and appreciate biodiversity
- Appreciation of communities
- Appreciation for importance of cellular organization
- Appreciation of biological trends
- Understand scientific basis of current knowledge

Mastery of basic computer skills, word processing, graphing, WWW

- Master fundamental computational and computing skills
- Graphics
- Fundamental computer skills
- Spreadsheet
- Word processing
- Graph building
- Use of statistics software
- Web browsers

Appreciation of related support disciplines to the biological sciences

- Chemical basis and physical basis of life and life processes
- Clear idea of basic mechanism living cells.
- Appreciation of chemistry in biology
- Carryover of knowledge from core -- emphasis
- Appreciation of physical laws in biology
- Make connections between and among scientific concepts and disciplines
- Integrate concepts

- Relationship between concepts
- Connections between concepts
- Ability to "see" the interrelationships between courses

Understanding of the unifying role of evolution in biology
- Understanding of evolutionary processes
- Appreciation of importance of evolution thought
- Appreciation of evolution as a mechanism giving rise to diversity
- Understanding of heredity mechanisms
- Development of an evolutionary perspective (comparison of patterns)

Data Analysis and Interpretation
- Ability to interpret data and information
- Master presentation of data and be able to analyze presented date (tables and graphs)
- Arrange simple data into graphs/tables
- Evaluate information
- Evaluate evidence
- Ability to evaluate graphs and tables
- Evaluate data
- Organize data
- Formulate appropriate generalizations
- Constriction and interpretation of cladograms

Role of statistics in designing effective biological studies
- Power of statistical method
- Understand basic statistics and the application of statistics to the scientific process
- Basic statistics
- Understanding of basic statistics - variability/variation, etc.

Information retrieval
- How to find scientific information (database)
- Annotation skills
- Library skills
- Web browsers, Web searching
- Use the library and other information sources effectively

Design of effective biological studies
- Make observations
- Able to make and describe/record observations
- Ability to formulate a hypothesis and devise a good test of it
- Understand controls
- Understanding science as a process
- Experimental design
- Scientific method
- Ability to design experiments
- State null hypotheses
- Study design
- Development of an inquiring attitude

- Appreciation of negative and positive control
- Begin to develop an ability to ask scientific questions and design scientific approaches to answer these questions.
- Field work limits and advantages of
- Collection of data
- Need for replication
- Careful note taking - lab/field books
- Healthy skepticism
- Understand the implications of scientific findings
- Understand different approaches to organizing information;
  - hierarchical (branching)
  - two dimensional
- Understand both observational (pattern and historical) and experimental approaches to science
- Understand
  - inductive reasoning
  - deductive reasoning
  - abduction

Possess learning skills strategies

- Active cognitive participation in lab
- Re-evaluate, revisit and self critique work
- Master basic learning skills
- Active listening in the classroom
- Note taking in lecture
- Read effectively (textbooks)
- Critical reading
- Develop skills for collaborative learning and problem solving
- Effective group work
- Develop independent thinking skills

Information evaluation

- Ability to evaluate literature critically
- Critical reading of scientific literature
- Ability to evaluate a scientific paper
- Understand components of scientific paper
- Read scientific paper critically
- Critique scientific literature

Communication skills

- Speaking and presentation
- Master effective written and oral communication skills
- Be able to communicate information to the class/others
- Ability to communicate effectively in oral presentations
- Writing skills
- Ability to write coherently e.g., a lab report
- Data presentation
- Ability to give a coherent scientific report - oral report, poster
- Learn about writing from reading scientific paper

- Make effective tables and graphs

Positive attitude toward biology

Ethics in biology
- Appreciation of attitudes, ethics of "using" living systems
- Some concept of ethics
- Ethics in research
- Ethical implications of the application of scientific information

Systemwide SLOs for Biology Majors (QUE Level 16)

(Developed at meeting of CSU Biology faculty held at CSUF in April 1999;
matched to CSU Fullerton new Biology curriculum as of 4/11/00)

KNOWLEDGE

Students must be able to explain* (i.e., expound, explicate, elucidate, and interpret) fundamental concepts and principles in the following areas of biological knowledge:

- biodiversity
- cell biology
- developmental biology
- ecology
- evolution
- genetics
- molecular biology
- organismal biology
- physiology

Student must be able to intrepret* the following unifying theme in the context of the above areas of biological knowledge:

- complexity of biological systems
- cycles
- feedback loops
- energy flow
- homeostasis
- information flow
- networks
- structure-function relationships

Students must demonstrate specialization and thus be able to explain* (i.e., expound, explicate, elucidate, and interpret) advanced concepts in one of the areas of biological knowledge noted above.

Students must be able to interpret* connections between:

- science and technology
- past scientific discoveries and current scientific progress
- academic requirements and careers or professional advancement
- scientific method including its limitations and the discovery of new knowledge
- bioethics/scientific integrity and the advancement of science

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**Webster's New World Dictionary of the American Language*, (D.B. Guralinik, ed), second college edition, Simon and Schuster, NY.
Explain implies making a clear or intelligible of something that is not known or understood [by the listener].
Expound implies a systematic and thorough explanation.
Explicate implies a scholarly analysis or exposition that is developed in detail.
Elucidate implies a shedding light upon by clear and specific explanation.
To **interpret** is to bring our meanings not immediately apparent [to the listener].

SKILLS

Communication

Students will be able to:

- communicate effectively orally.
- communicate effectively in writing.
- write in scientific format acceptable by scientific journals.

Teamwork

Students will be able to:

- work cooperatively in a group of diverse composition.
- solve problems in a group of diverse composition.

Finding biological information

Students will be able to:

- find, evaluate, use, and integrate published information.
- use databases and information technology.

Critical thinking and problem-solving

Students will be able to:

- make an argument and support it.
- recognize and use deductive and inductive reasoning.
- integrate concepts within and among disciplines.
- recognize patterns.
- identify unifying principles.
- solve problems
- distinguish between data and inferences based on data
- distinguish information from scientific versus pseudo- and non-scientific sources and methods

Use of the scientific method

Students will be able to:

- use deductive methods of inquiry.
- apply the scientific methods to problems by generating hypotheses and designing experiments to test these hypotheses.

Analytical and quantitative skills

Students will be able to:

- create data sets from observations.
- objectively analyze data.
- interpret data.
- use quantitative methods for the analysis of data.

Lab and field work

Students will be able to:

- use appropriate technology.
- use equipment properly.
- follow safety procedures.
- apply government regulations that govern their work.

ATTITUDES

Students will embrace lifelong learning by:

- being capable of self-directed learning.
- having a continual interest in biology.
- having confidence in their knowledge, skills, and abilities.

Students will value learning by:

- being open-minded.
- appreciating the value of knowledge.
- appreciating and respecting alternative possibilities and explanations.
- experiencing the joy of discovery.

Students will demonstrate knowledge of careers by:

- defining potential career paths.
- being aware of the requirements for career or professional advancement.

Students will be aware of impacts of biological issues on society by:

- valuing the support of science by society.
- appreciating the relevance of biology to society.
- recognizing the connectedness of science, society, and history.

Students will demonstrate an awareness of bioethics by:

- identifying and evaluating ethical issues in biology.
- appreciating the value of integrity.
- valuing ethical behavior.

Students will demonstrate appropriate stewardship and advocacy by:

- respecting biodiversity.
- contributing to the understanding of true science.
- helping the public make informed decisions.
- being responsible stewards of biological resources.

Students will demonstrate biological literacy by:

- distinguishing science from pseudoscience.
- recognizing that science is a way of viewing the world and is not just a collection of facts.
- understanding the limitations of science.
- applying scientific thinking to everyday problems.
- recognizing the impermanence of "truths".