CSU Channel Islands
Pilot Conversion Form
Program to be Converted:
Master of Science in Biotechnology and Bioinformatics
September 23, 2010

CSU Degree Program Proposal Template

---

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

√ Pilot Conversion

2. **CPEC COVER PAGE (required for graduate programs only)**

The California Post-Secondary Education Commission now requires for each graduate program proposed, a table of contents cover page that lists the following review criteria and that identifies the page numbers on which those criteria are addressed in the proposal. The criteria include:

CRITERION PAGE

- **Student demand……25**
This can be demonstrated with surveys of student intention to enroll in the program. Include current and projected enrollments of related existing programs at the proposing campus or feeder institutions.
- **Societal Needs……..20,24**
The proposal should establish that there will be sufficient employment opportunities for graduates of the proposed program. Workforce demand projections can be helpful in establishing the balance between graduates and employment opportunities. Letters from regional employers are helpful, as well. Workforce data are available at: http://www.calstate.edu/app/workforce_data.shtml
- **Appropriateness to Institutional and Segmental Mission……...3, 4**
Describe how the proposed degree program fits with the campus, school/college, and departmental missions.
- **Number of Existing and Proposed Programs in the Field……...20**
Demonstrate how the proposed program differs from or is similar to existing programs in the state.
- **Total Costs for the Program……..27, 30**
Are there sufficient funds available to support the resources that are required in order to initiate and maintain the program, including: the number of new faculty required; equipment; library resources; and classroom, office, and laboratory facilities. Identify the source of the funds required to support the program, both initially and in the long run.
- **Maintenance and Improvement of Quality…….9, 10**
Submit formal assessment plans that address program goals and student learning outcomes. Goals should be measurable; plans should be manageable, and data should be meaningful.

Goals should be related to institutional and program mission, and to the curriculum. See the CSU assessment site for further information:
http://www.calstate.edu/acadaff/sloa/index.shtml

- **Advancement of Knowledge……20, 24**
  Describe how the program will contribute to the growth and development of intellectual and creative scholarship.

3. Program Identification

a. Campus: CSU Channel Islands

b. Full and exact degree designation and title (e.g. Master of Science in Genetic Counseling, Bachelor of Arts with a Major in History).

Master of Science in Biotechnology and Bioinformatics

c. **Total number of Units Required.** A justification is required later in the proposal for any proposed undergraduate program requiring more than 120 semester units, 180 quarter units.

34-35 semester units

d. Date the Board of Trustees approved adding this program projection to the campus Academic Plan.

Approved in March 2004.

e. Term and academic year of intended implementation (e.g. Fall 2007). Fall 2004.

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

Academic Affairs/Extended University/Biology Program

g. Name, title, and rank of the individual(s) primarily responsible for drafting the proposed degree major program.

Ching-Hua Wang, Professor of Biology, Director of MS Biotechnology and Bioinformatics
Amy Denton, Associate Professor and Chair of Biology
Nancy Mozingo, Associate Professor of Biology
Nitika Parmar, Assistant Professor of Biology
William Cordeiro, Professor of Management, Senior Associate Dean of School of Business and Economics
William Wolfe, Professor of Computer Science

h. Statement from the appropriate campus administrative authority that the addition of this program supports the campus mission and will not impede the successful operation and growth of existing academic programs. **(CPEC "Appropriateness to Institutional and Segmental Mission")**

i. Any other campus approval documents that may apply (e.g. curriculum committee approvals).

The MS Biotechnology and Bioinformatics degree was approved by the Academic Senate on March 9, 2004 and by President rush on March 12, 2004. See attached Exhibit 7.

j. Please specify whether this proposed program is subject to WASC Substantive Change review.
The MS in Biotechnology and Bioinformatics not subject to WASC Substantive Change review. CSU Channel Islands received its initial WASC accreditation in July 2007, subsequent to the implementation of the MS in Biotechnology and Bioinformatics, and thereby approving this program and its other initial undergraduate and graduate degrees

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

Program Code: 04991 for Biotechnology Emphasis
Program Code 04991 or 07994 for Bioinformatics Emphasis

Assigned by Chancellor's Office October 23, 2006 (Exhibit 1).

4. Program Overview and Rationale

a. Rationale, including a brief description of the program, its purpose and strengths, fit with institutional mission, and a justification for offering the program at this time. The rationale may explain the relationship among the program philosophy, design, target population, and any distinctive pedagogical methods. **(CPEC "Appropriateness to Institutional and Segmental Mission")**

The Master of Science in Biotechnology and Bioinformatics is a professional degree program designed to meet the needs of biotechnology industry and related public and private agencies and organizations. The program combines rigorous scientific training in interdisciplinary areas in biotechnology, bioinformatics, biomedical engineering and stem cell technology with course work and experience in business management and regulatory affairs. The program includes a set of core courses with four emphases to choose from: biotechnology, bioinformatics, biomedical engineering and stem cell technology and laboratory management, and several elective courses.

Consistent with the CSU Channel Islands mission, the Master's program "facilitates learning within and across disciplines through integrative approaches", "emphasizes experiential and service learning", and "graduates students with multicultural and international perspectives". The purpose of the program is to meet the need for a well-trained workforce in the field of biotechnology to produce a pipeline of talent and human capital that fosters growth and prosperity for the biotechnology industry in the State of California and the nation. The target populations are the working adults in the related industry and fresh graduates from bachelor's programs, who are ready to take on graduate level curriculum.

Our research revealed that the unfortunate economic climate notwithstanding, biotechnology and life science industry continues its expansion and advancement. The need for a well-trained workforce in this vast field compels higher education institutions to rethink their program offerings and to develop novel and pertinent academic programs. Established in 2001, CSUCI is located in the middle of a well-known "101 High Tech Corridor", with hundreds of high tech and biotechnology companies along Highway 101. The community of Ventura County has long sought a public educational institution to meet the professional needs of local and regional biotechnology industry. Just like the BS in Biology program fills the need of the region at the undergraduate level, this program fills that need at the graduate level. An integral part of the program is an active culminating component that distinguishes this program from others in the region. Students enrolled in the program are required to complete either a Team Project or an Internship program instead of a traditional thesis. Under the guidance and mentorship of our faculty and the researchers at local biotechnology companies and research universities and institutions, the graduate student candidates carry out research on a biotechnology or life-science-related project either as a member of a team or as a graduate intern. This experience allows students to apply the concepts and knowledge learned in their coursework in real-world research projects.

Distinctive features of the Master's are that courses are grounded in the latest research and cutting-edge practice and candidates engage in active learning consistent with the principles of adult learning. The program design is geared toward the needs of working professionals who are place-bound. Another distinctive feature is the strong partnership between CSU Channel Islands and local biotechnology industry. The strengths of the program are embedded in the curriculum design and implementation. The philosophy for starting the program was to design an academic program at the graduate level that combines the modern scientific theories and current applications in the field of biotechnology. The program is adaptive to the fast changing field of biotechnology and is highly flexible in its implementation. Instructional faculty members of the program include science faculty members from the biology and chemistry programs at CI as well as experts from the biotechnology industry. All the non-lab classes are offered at the Extended University Campus in Thousand Oaks, which is close to the hub of the biotechnology industry. All classes are scheduled during the evenings and weekends to accommodate the needs of working adults.

The establishment of the pilot MS in Biotechnology and Bioinformatics program has made the program an instant hit. Since inception of the program in fall 2005, there have been 278 students applied for the program, 200 students admitted into the program and 148 students actually enrolled in the program. As of Spring 2010, there have been 65 students graduated from the program. All of the graduates from the program have either been employed by the biotechnology industry or have gained entry into professional or graduate programs. This program is also associated with the MS Biotechnology and MBA dual degree program which started in Fall 2007. For the dual degree program, we have 85 applicants since its inception, enrolled 50 students and graduated 20 students.

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

Program Description
The Master of Science in Biotechnology and Bioinformatics is a professional degree program designed to meet the needs of biotechnology industry and related public and private agencies

and organizations. The program combines rigorous scientific training in interdisciplinary areas in biotechnology, bioinformatics, biomedical engineering and stem cell technology with course work and experience in business management and regulatory affairs. The program includes a set of core courses with three emphases to choose from: biotechnology, biomedical engineering and stem cell technology and laboratory management, and several elective courses.

Biotechnology is centered in the laboratory and employs sophisticated molecular biology techniques for applications in human and animal health, agriculture, environment, and specialty biochemical manufacturing. In this century, the major driving force for biotechnology will be the strategic use of the data derived from large-scale genome sequencing projects. This requires well-trained individuals in the fields of biotechnology and bioinformatics. Biomedical engineering is an interdisciplinary field, fusing molecular and cellular life sciences with contents in engineering analysis, design, and synthesis approaches, business management, bioethics, law and regulation, and globalization of biotechnology. It introduces the principles and applications of bioinformatics, biomechanics, biorobotics, biomaterials, nanotechnology, genetics, cellular, tissue and organ engineering, biomedical instrumentation and devices, biosensors, and medical imaging in biological systems. Stem cell technology and laboratory management introduces the current knowledge and highly specialized technical skills in the stem cell field and trains technical and managerial personnel in stem cell research and development. Our approach also includes team projects drawn from biotechnology industries to focus on real-world problems and applications of biological sciences, internships and to inculcate interpersonal as well as problem-solving skills using multiple perspectives.

Graduates from this program will develop analytical, managerial and interpersonal skills along with sophisticated expertise in biotechnology, bioinformatics, biomedical engineering or stem cell technology. They will be ready to make immediate contributions to scientific research and development, management in biotechnological, biomedical, biomedical engineering, and pharmaceutical industries, biotechnology law and regulations, governmental or environmental agencies, research institutes, consulting firms, research and clinical laboratories, private and public health organizations, or education.

Admission Requirements

1. Applicants must have a BS/BA degree in Biology, Computer Science, Chemistry, Biochemistry, or Mathematics. Alternatively, applicants with a BA/BS degree in any field and equivalent work experiences in one of the above fields may be granted conditional admission, and they must fulfill all conditional requirements before they can be fully classified.
2. Applicants seeking admission to the professional MS in Biotechnology and Bioinformatics program must be officially accepted into the CI academic program.
3. Applicants must declare themselves as graduate students in the professional MS degree program in Biotechnology and Bioinformatics.
4. Applicants for the Stem Cell Technology and Laboratory Management Emphasis must commit to the stem cell technology internship requirement.
5. Applicants will be evaluated by the Program Admissions Committee which will consider the applicants in the context of the total applicant pool using our general admission standards, including all academic work, GPA, test scores, relevant work experience and other factors that may have a bearing on the individual's potential for success. The following materials are required for our evaluation and admission process:

• Applicants must submit their transcript(s) from their undergraduate institution(s), Graduate Record Examinations (GRE) General Test scores or the Medical College Admission Test (MCAT) scores.
• Applicants who have received their undergraduate degrees from a university where English is not the language of instruction, or have studied fewer than two years at a university where instruction is in English, must submit their Test of English as a Foreign Language (TOEFL) scores for evaluation.
• Applicants must submit a one page "Statement of Purpose" and two letters of recommendations from people able to judge the applicant's academic capacity.

Degree Requirements

Common Core Courses – 12 units

BINF 500 DNA & Protein Sequence Analysis (3)
BIOL 503 Biotechnology Law and Regulation (3)
BIOL 504 Molecular Cell Biology (3)
MGT 471 Project Management (3)

Bioinformatics Emphasis -23 units

Required Courses - 17 units

BINF 501 Biological Informatics (3)
BINF 510 Database Systems for Bioinformatics (3)
BINF 511 Computational Genomics (3)
BINF 513 Programming for Bioinformatics (3)
BIOL 600 Team Project (4)
BIOL 601 Seminar in Biotechnology and Bioinformatics (1)

2. *Electives - 6 units*

A minimum of two courses chosen from the following and/or from the elective courses under the Biotechnology Emphasis, with at least one course in the BINF category:
BINF 512 Algorithms for Bioinformatics (3)
BINF 514 Statistical Methods in Computational Biology (3)
PHYS/COMP/MATH445 Image Analysis & Pattern Recognition (3) GE-B1, B4, UDID (3)
MGT 421 Human Resource Management (3)
BIOL 490 Special Topics (1-3)

Biotechnology Emphasis - 22 units

1. *Required Courses - 15 units*

BINF 514 Statistical Methods in Computational Biology (3)
BIOL 502 Techniques in Genomics & Proteomics (3)
BIOL 505 Molecular Structure (4)
BIOL 600 Team Project (4)
BIOL 601 Seminar in Biotechnology and Bioinformatics (1)

2. *Electives - 7 units*

A minimum of two courses chosen from the following elective courses and/or from the required courses for the other emphases of the program:

BINF 511 Computational Genomics (3)
BIOL 490 Special Topics (1-3)
BIOL 500 Introduction to Biopharmaceutical Production Operations (3)
BIOL 506 Molecular Evolution (4)

BIOL 507 Pharmacogenomics and Pharmacoproteomics (3)
BIOL 508 Advanced Immunology (4)
BIOL 509 Plant Biotechnology (4)
BIOL 516 Clinical Trials and Quality Assurance (3)
MGT 421 Human Resource Management (3)

Biomedical Engineering Emphasis - 23 units

1. *Required Courses - 15-17 units*

BME 500 Biological Systems and Biomechanics: Principles and Applications (3)
BME 501 Fundamentals of Tissue Engineering and Biomaterials (3)
BIOL 601 Seminar in Biotechnology and Bioinformatics (1)
BIOL 604 Biotechnology across National Boundaries (2)
Select either BME 502 or PHYS 464 (3-4 units)
BME 502 Biomedical Instrumentation and Devices: Technology and Applications (3)
or
PHYS 464 Medical Instrumentation (4)
Select either BIOL 600 or 603 (3-4 units)
BIOL 600 Team Project (4)
or
BIOL 603 Biotechnology Internship (3)

2. *Electives - 6-8 units*

A minimum of two courses chosen from the elective courses for the Biotechnology Emphasis and/or from the required courses for the other emphases of the program. If students complete a total of 17 units of required courses, they could take a total of 6 units of electives. The overall units for the emphasis will be 35 units, including the common core. Required and elective courses.

Stem Cell Technology and Laboratory Management Emphasis - 22 - 23 units

1. *Required Courses 19 units*

BIOL 502 Techniques in Genomics and Proteomics (3)
BIOL 510 Tissue Culture Techniques and Stem Cell Technology (3)
BIOL 511 Advanced Stem Cell Technology (3)
BIOL 512 Advanced Topics in Regenerative Medicine (1)
BIOL 513 Cell Culture Facility Management (3)
BIOL 602 Stem Cell Technology Internship (1.5 x 4, 6)

**BIOL 602 course is offered quarterly at 1.5 units, which is repeatable for a total of 6 units for a year-long project.*

Electives 3-4 units

A minimum of one course chosen from the elective courses for the Biotechnology Emphasis and/or from the required courses for the other emphases of the program.

Graduate Writing Assessment Requirement

Writing proficiency prior to the awarding of the degree is demonstrated by successful completion of BIOL 504 with a grade of B or higher.

5. Curriculum

a. Goals for the (1) program and (2) student learning outcomes. Program goals are very broad statements about what the program is intended to achieve, including what kinds of graduates will be produced. Student learning outcomes are more specific statements that are related to the program goals but that more narrowly identify what students will know and be able to do upon successful completion of the program.

General Objectives

- Provide students with the opportunity to earn a professional MS degree in Biotechnology and Bioinformatics from California State University.
- Prepare students with analytical, business and managerial skills along with sophisticated expertise in biotechnology and computational sciences for a diverse set of vocations. Qualified graduates will be able to engage in research, development and management in biotechnology, work in the pharmaceutical industry or conduct scientific research, teaching or consulting in public and/or private organizations.
- Provide a value added education in biotechnology and bioinformatics to enhance career advancement opportunities.

Learning Objectives

Students who successfully complete the Biotechnology Emphasis in the Master of Science Degree program will be able to:

- Work in cross-disciplinary teams to address questions of relevance to the biotechnology industry through the design and implementation of databases that integrate computational biology and empirical analyses.
- Explain techniques used to make biological inferences from protein and nucleic acid sequences.
- Identify biologically relevant problems in biotechnology, biomedical, and agricultural research.
- Outline the state and Federal regulatory processes that govern the biotechnology industry.
- Explain fundamental principles which underlie modern techniques in biotechnology.
- Demonstrate proficiency in performing fundamental molecular biology techniques.

Students who successfully complete the Bioinformatics Emphasis in the Master of Science Degree program will be able to:

- Work in cross-disciplinary teams to address questions of relevance to the biotechnology industry through the design and implementation of databases that integrate computational biology and empirical analyses.
- Explain techniques used to make biological inferences from protein and nucleic acid sequences.
- Identify biologically relevant problems in biotechnology research.
- Outline the state and Federal regulatory processes that govern the biotechnology industry.
- Explain fundamental principles which underlie modern techniques in biotechnology.
- Demonstrate basic skills in programming, design and management of bioinformatics databases.

Students who successfully complete the Biomedical Engineering Emphasis in the Master of Science Degree program will be able to:

- Work in cross-disciplinary teams to address questions of relevance to the biotechnology industry through the design and implementation of databases that integrate computational biology and empirical analyses.

- Explain techniques used to make biological inferences from protein and nucleic acid sequences.
- Identify biologically relevant problems in biotechnology research.
- Outline the state and Federal regulatory processes that govern the biotechnology industry.
- Explain fundamental principles which underlie modern techniques in biotechnology.
- Demonstrate basic skills in performing fundamental biomedical engineering techniques.

Students who successfully complete the Stem Cell Technology and Laboratory Management Emphasis in the Master of Science Degree program will be able to:

- Work in cross-disciplinary teams to address questions of relevance to the biotechnology industry through the design and implementation of databases that integrate computational biology and empirical analyses.
- Explain techniques used to make biological inferences from protein and nucleic acid sequences.
- Identify biologically relevant problems in biotechnology research.
- Outline the state and Federal regulatory processes that govern the biotechnology industry.
- Explain fundamental principles which underlie modern techniques in biotechnology.
- Demonstrate proficiency in performing fundamental stem cell research techniques.

b. Plans for assessing program goals and student learning outcomes. Some planners find it helpful to develop matrices in which student learning outcomes and required courses are mapped, indicating where content related to the learning outcomes is introduced, reinforced, and practiced at an advanced level in required courses. **(CPEC "Maintenance and Improvement of Quality")**
Program Assessment Plan is attached in which curriculum is aligned with the program goals and objectives and program assessment activities are described.

c. Total number of units required for the major; total number of units required to graduate.

34-35 semester units are required to complete the degree.

d. Include a justification for any baccalaureate program that requires more than 120-semester units or 180-quarter units.

Not Applicable.

e. If any formal options, concentrations, or special emphases are planned under the proposed major, identify and explain fully. Optional: You may propose a CSU degree program code and CIP code for each concentration that you would like to report separately from the major program, if the option is approximately equivalent to a degree currently listed on the CSU application-booklet degree program table. If you do not find an appropriate CSU degree program code at: http://www.calstate.edu/app/documents/HEGIS-CIP2000_102406.xls , you can search CIP 2000 at http://nces.ed.gov/pubs2002/cip2000/ to help identify the code that best matches the proposed curriculum.

The Master of Science of Biotechnology and Bioinformatics Program offers four emphases:
Bioinformatics
Biotechnology
Biomedical Engineering
Stem Cell Technology and Laboratory Management

Biotechnology is centered in the laboratory and employs sophisticated molecular biology techniques for applications in human and animal health, agriculture, environment, and specialty biochemical manufacturing. In this century, the major driving force for biotechnology will be the strategic use of the data derived from large-scale genome sequencing projects. This requires well-trained individuals in the fields of biotechnology and bioinformatics. Biomedical engineering is an interdisciplinary field, fusing molecular and cellular life sciences with contents in engineering analysis, design, and synthesis approaches, business management, bioethics, law and regulation, and globalization of biotechnology. It introduces the principles and applications of bioinformatics, biomechanics, biorobotics, biomaterials, nanotechnology, genetics, cellular, tissue and organ engineering, biomedical instrumentation and devices, biosensors, and medical imaging in biological systems. Stem cell technology and laboratory management introduces the current knowledge and highly specialized technical skills in the stem cell field and trains technical and managerial personnel in stem cell research and development.

The Program Code for the program is 04991

f. A list of all courses *required* for the major, specifying catalog number, *title*, units of credit, and prerequisites or co-requisites (thereby ensuring that there are no "hidden" prerequisites that would drive the total units required to graduate beyond the total reported in 4c above).

See the following course descriptions for the catalog number, title, units, and prerequisites or co-requisites. The prerequisite courses should be completed by the applicants in their undergraduate programs. BIOL 501 is a prerequisite course that combines foundational knowledge and lab skills of cell biology and molecular biology into one course and is required for those students who are deficient in cell biology and/or molecular biology background. All the following required courses, with the exception of courses in Management and Physics, are specifically developed for this gradaute program. These courses are either required in the program core, or one of the emphases. All the courses at 500 and 600 levels are graduate level courses. Courses below 500 are used by undergraduate programs as well.

BINF 500 DNA AND PROTEIN SEQUENCE ANALYSIS (3)
Three hours lecture per week
Prerequisite: BIOL 400 or consent of the instructor
This course will introduce the computational aspects of biological inference from nucleic acid and protein sequences. Pairwise sequence comparison and multiple sequence alignment will be studied in detail. Additional topics include: RNA structure prediction, conserved sequence pattern recognition (sequence profile analysis), phylogenetic analysis algorithms, sequence data as a means to study molecular evolution, models and algorithms for genetic regulation, contig assembly, PAM and BLOSUM matrices, protein three dimensional structure prediction.

BINF 501 BIOLOGICAL INFORMATICS (3)
Three hours lecture per week
Prerequisite: BIOL 431 or consent of the instructor
This course describes relational data models and database management systems with an emphasis on answering biologically important questions; teaches the theories and techniques of constructing relational databases to store various biological data, including sequences, structures, genetic linkages and maps, and signal pathways. Topics include: relational database query language SQL and the ORACLE database management system, summary of currently existing biological databases, web based programming tools, data integration and security, future directions for biological database development.

BINF 510 DATABASE SYSTEMS FOR BIOINFORMATICS (3)
Three hours lecture per week
Prerequisite: BINF 501 and COMP 420, or consent of the instructor
This course is an applied, hands-on sequel to BINF 501, designed for students with interests in careers as professional programmers, analysts, designers, and managers involved in design or implementation of large bioinformatic systems. Covers concepts and methods for the design, creation, query and management of large enterprise databases, functions and characteristics of the leading database management systems. Topics include: object oriented database systems, distributed database systems, advanced database management topics, web application design and development, data warehouse systems, database mining.

BINF 511 COMPUTATIONAL GENOMICS (3)
Three hours lecture per week
Prerequisite: BINF 500 and BINF 514 and consent of the instructor
Develops theories and statistical methods introduced in core coursework using real-life genomic data sets, with an emphasis on practical applications, hands-on analysis, integrated approaches and collaboration. Introduces students without computer science backgrounds to the major concepts in programming for problem-solving in bioinformatics.

BINF 513 PROGRAMMING FOR BIOINFORMATICS (3)
Three hours lecture per week
Prerequisite: BINF 501 and COMP 462 or equivalent, or consent of the instructor
This course will provide theory and practical training in the development of programming tools and data processing systems for use in genomic/sequence analysis. There will be a strong emphasis on the development of fully-functional web-based applications under the client/server model. Students will be required to complete a term project which will involve the development of a complete client/server application directed toward a relevant bioinformatics task.

BINF 514 STATISTICAL METHODS IN COMPUTATIONAL BIOLOGY (3)
Three hours lecture per week
Prerequisite: BIOL 203, MATH 151 or consent of the instructor
Techniques in statistical inference and stochastic modeling required for the interpretation and utilization of genomic data, including biological sequence alignment and analysis, sequence structure and function prediction, database searching, gene expression profiling, statistical genetics, phylogenetic inference and genetic epidemiology.

BINF 514 STATISTICAL METHODS IN COMPUTATIONAL BIOLOGY (3)
Three hours lecture per week
Prerequisite: MATH 151, BIOL 203 and Consent of Instructor
Develops theoretical background and practical skills in statistics and probability required for the interpretation and utilization of genomic data. Topics include biological sequence alignment and analysis, sequence structure and function prediction, database searching, gene expression profiling, statistical genetics and phylogenetic inference.

BIOL 500 INTRODUCTION TO BIOPHARMACEUTICAL PRODUCTION OPERATIONS (3)
Three hours lecture per week
An introduction to biopharmaceutical production systems and processes. Topics include manufacturing, unit operations and supporting infrastructures, product distribution, quality assurance and control, facility engineering and maintenance, utility operations, regulatory compliance, and laboratory support.

BIOL 501 FUNDAMENTALS OF CELLULAR AND MOLECULAR BIOLOGY (4)
Four hours lecture per week
Study of essential topics in cellular and molecular biology. Topics include: structure and function of biological macromolecules, membranes and cellular organelles; cell signaling, synthesis of DNA, RNA

and proteins; gene organization, transcription and expression; basic molecular biology laboratory techniques.

BIOL 502 TECHNIQUES IN GENOMICS/PROTEOMICS (3)
One hour lecture and six hours laboratory per week
Prerequisite: BIOL 400, BIOL 401 or BIOL 501 and consent of the instructor
Provides students with theoretical foundations and practial skills needed for general bioinformatics, genomics, and proteomics analysis. Intensive lab sessions, emphasize applied techniques. Field trips to various local biotechnology facilities will augment the training.

BIOL 503 BIOTECHNOLOGY LAW AND REGULATION (3)
Three hours lecture per week
Individual and organizational responsibility in R&D and commercial aspects of biotechnology. Topics include: intellectual property, privacy, government and industrial regulation, liability, ethics, and policy responses to societal concerns in the U.S. and abroad. Case studies involving gene therapy, cloning, and biomaterials in the medical and health sector, and farming and crop modification in the agricultural sector will be explored in detail.

BIOL 504 MOLECULAR CELL BIOLOGY (3)
Three hours lecture per week
Prerequisite: BIOL 300 and BIOL 400 or BIOL 501 and consent of the instructor
This course will examine molecular and mechanistic aspects of cell biology. Topics include: cell biochemistry and biosynthesis, cell signaling, regulation of the cell cycle and membrane trafficking.

BIOL 505 MOLECULAR STRUCTURE (4)
Three hours lecture and three hours laboratory per week
Prerequisite: BIOL 504 and consent of the instructor
Examines the structural biology of proteins. Topics include general principles of protein structure, the biochemical function of proteins, the relationship of protein structure to its function and experimental approaches to determining and predicting protein structure and function.

BIOL 510 TISSUE CULTURE TECHNIQUES AND STEM CELL TECHNOLOGY (3)
One hour lecture per week
Six hours laboratory per week
Prerequisite: BIOL 504
Examines theory and concepts of animal and plant cell and tissue culturing. Focuses on stem cell technology including types of stem cells, ethics of stem cells, pluripotency, culture methods, characterization, monitoring tools such as imaging and differentiation strategies.

BIOL 511 ADVANCED STEM CELL TECHNOLOGY (3)
One hour lecture per week and
Six hours laboratory per week
Prerequisites: BIOL 427 and BIOL 510
A laboratory intensive course focused on the technical aspects of human embryonic stem cell technology. Develops specific technical skills to successfully culture, characterize and maintain pluripotent human embryonic stem cell lines.

BIOL 512 ADVANCED TOPICS IN REGENERATIVE MEDICINE (1)
One hour seminar per week
Prerequisite: BIOL 511
A seminar series involving presentations and discussions of current knowledge of embryonic and adult stem cells and factors that regulate their growth and development. Emphasizes how advances in cell and molecular biology and tissue engineering can be applied to the use of stem cells in regenerative medicine. Discusses social and ethical impacts of stem cell technology.

BIOL 513 CELL CULTURE FACILITY MANAGEMENT (3)
Three hours lecture per week

Prerequisite: BIOL 510
Processes and procedures of managing a cell culture facility. Topics include biosafety standards, record keeping, database organization, personnel management, inventory administration, storage of laboratory reagents and supplies, cell line banking and maintenance, equipment selection and maintenance, and essential concepts for troubleshooting common cell culture problems.

BIOL 600 TEAM PROJECT (4)
Four hours activity per week
Prerequisite: Program approval
In this course, students will work individually and in teams to analyze, research, discuss and report on subjects relevant to the biotechnology industry.

BIOL 601 SEMINAR IN BIOTECHNOLOGY AND BIOINFORMATICS (1)
One hour seminar per week
Discussion of up-to-date research and development findings with guest speakers, visiting scientists and industry professionals.

BIOL 602 STEM CELL TECHNOLOGY INTERNSHIP (6)
Eighteen laboratory hours per week
Prerequisite: BIOL 511
A required two-semester project where students conduct original research in an active stem cell research laboratory at various off campus institutions. Culminates in a final written report and oral presentation.
Graded Credit/No Credit

BIOL 603 BIOTECHNOLOGY INTERNSHIP (0-0)
Three hours seminar per week
Consent of Instructor required for Enrollment
A one-semester project where students conduct original research in an active research laboratory at various off campus institutions. Culminates in a final written report and an oral presentation at the Program Colloquium.
Graded Credit/No Credit

BIOL 604 BIOTECHNOLOGY ACROSS NATIONAL BOUNDRIES (1-3)
Two hours lecture per week
Consent of Instructor Required for Enrollment
Addresses international efforts in biotechnological innovation, education, global commercialization and impact of biotechnology. Explores collaborations among science, education, industry and government in the age of globalization, ethical standards, international law and regulation in biotechnology and inter- and cross-cultural issues in business operations. An optional element of this course is a field trip to international businesses and education systems. The course has a lecture component (2 units) and a field trip component (1 unit). Students completing the lecture, the field trip, or both the lecture and the field trip components may get 2, 1 or 3 credit units, respectively.

BIOL 610 CAPSTONE PROJECT FOR MS/MBA DUAL DEGREE (6)
Six hours seminar per week
Prerequisite: Biology or Business and Economics Program Approval
Culminating experience in the MS/MBA dual degree program. Students participate in lectures, discussions, case analysis and independent research. Includes a major project involving research, analysis, synthesis and presentation of a topic related to the global biotechnology industry.
Same as BUS 610

BME 500 BIOLOGICAL SYSTEMS, BIOMECHANICS AND BIOROBOTICS (3)
Two hours lecture and three hours laboratory per week
Prerequisites: BIOL 210 and BIOL 211 or BIOL 424; PHYS 200 and PHYS 201 or BIOL/PHYS 315; and BIOL 300 or CHEM 318 or CHEM 460; and BIOL 400 or BIOL 501

Covers structural and physiological foundations in biomedical engineering, including molecular and cellular, cardiovascular, musculoskeletal and neural systems, and principles and applications of biomechanics and biorobotics in biological systems.

BME 501 FUNDAMENTALS OF TISSUE ENGINEERING AND BIOMATERIALS (3)
Two hours lecture and 3 hours laboratory per week
Prerequisites: BIOL 504; PHYS 200 and PHYS 201 or BIOL/PHYS 315
Covers molecular, cellular, tissue and organ engineering and societal and ethical issues in regenerative medicine. Also considers major types of biomaterials including metallic, ceramic, polymeric, biodegradable, composite, nano- and other replacement materials and techniques and procedures used in biomedical engineering.

BME 502 BIOMEDICAL INSTRUMENTATION AND DEVICES: TEHCNOLOGY & APPLICATION (3)
Two hours lecture and three hours laboratory per week
Prerequisites: MATH 150; PHYS 200 and PHYS 201 or PHYS 315 or BIOL/PHYS 434
Covers biosignaling processes, instrumentation and devices in measuring, recording, monitoring and diagnosis, modern medical imaging analysis systems, nanodevices, therapeutics, and design and development principles of instruments and devices for diagnostics and therapeutics.

MGT 471 PROJECT MANAGEMENT (3)
Three hours lecture per week
Prerequisite: MGT 307
Presents the principles of project management, which is a special form of work organization that focuses on a one-time objective. Discusses all aspects of project management: definition of objectives, selection of team and other resources, establishing timing and sequences, creation of monitoring and control processes, and development of analysis and reporting mechanisms.

PHYS 464 MEDICAL INSTRUMENTATION (4)
Three hours lecture and two hours lab activity per week
Prerequisite: PHYS/BIOL/HLTH 434
The detection, acquisition, processing and display of diagnostic clinical images. The course will concentrate on the fundamentals of the design of the instruments and the use of appropriate reconstruction algorithms in (computed) radiography, (digital) fluoroscopy, computed tomography, ultrasound, magnetic resonance imaging and radionuclide imaging. Activities will include image reconstruction examples, investigation of recent innovations, and two trips to local radiology departments.

g. List of *elective* courses that can be used to satisfy requirements for the major, specifying catalog number, title, units of credit, and prerequisites or co-requisites. Include proposed catalog descriptions of all new courses. For graduate program proposals, identify whether each course is a graduate or undergraduate offering.

Note: With regard to Sections 4f and 4g, a proposed program should take advantage of courses already offered in other departments when subject matter would have considerable overlapping content.

See the following course descriptions for the catalog number, title, units, and prerequisites or co-requisites. The prerequisite courses should be completed by the applicants in their undergraduate programs. BIOL 501 is a prerequisite course that combines foundational knowledge and lab skills of cell biology and molecular biology into one course and is required for those students who are deficient in cell biology and/or molecular biology background. All the following elective courses, with the exception of courses in Management and Physics, are specifically developed for this gradaute program. All the courses at 500 and 600 levels are gradaute level courses. Courses below 500 are used by undergraduate programs as well.

BINF 512 ALGORITHMS FOR BIOINFORMATICS (3)
Three hours lecture per week
Prerequisite: BINF 500 or consent of the instructor
This course will cover advanced theory in the area of biological informatics and will build on concepts introduced in BINF 500. Topics include: methods to support construction and application of combinatorial biochemical libraries, applications of algorithmic information theory, string matching, dynamic programming, prediction of three-dimensional protein structure from peptide sequence.

BIOL 490 SPECIAL TOPICS (1-3)
Three hours seminar per week
Prerequisite: consent of the instructor
In-depth analysis of current topics in biology. Topics vary each semester. Repeatable by topic.

BIOL 506 MOLECULAR EVOLUTION (4)
Three hours lecture and three hours laboratory per week
Prerequisite: BIOL 504 and consent of the instructor
Examines evolutionary change at the molecular level. Topics include: The driving forces behind the evolutionary process, the effects of the various molecular mechanisms on the structure of genes, proteins, and genomes, the methodology for dealing with molecular data from an evolutionary perspective and the logic of molecular hypothesis testing.

BIOL 507 PHARMACOGENOMICS AND PHARMACOPROTEOMICS (3)
Three hours lecture per week
Prerequisite: BINF 500, BIOL 504 and consent of the instructor
Structural and functional genomics with an emphasis on how these fields operate in drug discovery and optimization. Topics include: genetics of the human response to prophylactic and therapeutic agent, impact of genetic variation on therapeutic efficacy, disease mechanisms, proteomics of genetic and communicable disease, drug action and toxicity, structure encoding, lead discovery and optimization, parallel synthesis, screening virtual libraries.

BIOL 508 ADVANCED IMMUNOLOGY (4)
Three hours lecture and three hours laboratory per week
Prerequisite: BIOL 504 and consent of the instructor
xamines cellular and molecular aspects of the immune system. Topics include: molecular genetics and molecular structure of immunoglobulin, T cell receptor, and the MHC antigens; the functions and dysfunctions of the components of the immune system; applications of immunological technologies in modern scientific research and development.

BIOL 509 PLANT BIOTECHNOLOGY (4)
Three hours lecture and three hours laboratory per week
Prerequisite: BIOL 504 and consent of the instructor
Examines the scientific and technical advances which underlie the production of genetically modified crops. Topics include: plant genome organization and gene expression, plant tissue culture and genetic transformation, genetic manipulation to confer resistance to herbicides, pests and disease and strategies for engineering stress tolerance and the improvement of crop yield and quality.

BIOL 516 CLINICAL TRIALS AND QUALITY ASSURANCE (3)
Three hours lecture per week
Prerequisite: BIOL 503
An introduction to the foundational knowledge and skills necessary to successfully conduct clinical trials for new drugs, biologics, and medical devices, including in vitro diagnostics. Topics include a broad overview of the product development process in the pharmaceutical, biopharmaceutical, and medical device industries, the regulatory and operational requirements for clinical study setup and management, monitoring, data management, and closure of clinical trials, the principles of Good Clinical Practice (GCP), and the applications of quality control and quality assurance. The integration of quality assurance throughout the medical product development process will be discussed.

MGT 421 HUMAN RESOURCE MANAGEMENT (3)
Three hours lecture per week
Prerequisite: MGT 307
Examines principles, methods and procedures in the management of human resources. Topics include developing planning objectives for HR management, legal compliance, job analysis, recruiting, selection, training, compensation and employee relations.

PHYS 445 IMAGE ANALYSIS AND PATTERN RECOGNITION (3)
Three hours lecture in the lab per week
Prerequisite: PHYS/COMP/MATH 345 or consent of the instructor
The course addresses the issue of analyzing the pattern content within an image. Pattern recognition consists of image segmentation, feature extraction and classification. The principles and concepts underpinning pattern recognition, and the evolution, utility and limitations of various techniques (including neural networks) will be studied. Programming exercises will be used to implement examples and applications of pattern recognition processes, and their performance on a variety of diverse synthetic and real images will be studied.
Same as COMP 445, MATH 445
GenEd: B1, B4, Interdisciplinary

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

Not Applicable. Program began in fall 2005.

i. Attach a proposed course-offering plan for the first three years of program implementation, indicating, where possible, likely faculty teaching assignments.

Not applicable. Program began in fall 2005. The Master Course Schedule is attached.

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

The MS Biotechnology and Bioinformatics degree satisfies the CSU requirement for a culminating experience in the following manner. For the Biotechnology, Bioinformatics and Biomedical Engineering Emphases, all students complete either BIOL 600 Team Project or BIOL 603 Biotechnology Internship. For the Stem Cell Technology and Laboratory Management Emphasis, students complete BIOL 602 Stem Cell Technology Internship.

Enrollment in all the above courses requires program approval. In BIOL 600, students work individually and in teams to analyze, research, discuss, and report on subjects relevant to the biotechnology industry. In BIOL 602, which is a required two-semester project, student conduct original research in an active stem cell research laboratory at various research universities and institutions. BIOL 603 is a one-semester course where student conduct original research in an active research laboratory. The Program has formed formal agreements with research institutions and biotechnology companies, including UCLA, UC Berkeley, UC Santa Barbara, UC Davis, University of Southern California, Amgen, Celavie Biosciences, the Scripps Research Institute, City of Hope Beckman Research Institute, to host our graduate student interns. All courses culminate in an individual final written report and an oral presentation at the Biotechnology Program Colloquium.

Candidates admitted to the Masters of Science in Biotechnology ad Bioinformatics and advanced to candidacy select either BIOL 600 Team Project or BIOL 602 or 603 Stem Cell Technology Internship or Biotechnology Internship for their culminating experience.

k. Admission criteria, including prerequisite coursework.

Admission Requirements

1. Applicants must have a BS/BA degree in Biology, Computer Science, Chemistry, Biochemistry, or Mathematics. Alternatively, applicants with a BA/BS degree in any field and equivalent work experiences in one of the above fields may be granted conditional admission, and they must fulfill all conditional requirements before they can be fully classified.
2. Applicants seeking admission to the professional MS in Biotechnology and Bioinformatics program must be officially accepted into the CI academic program.
3. Applicants must declare themselves as graduate students in the professional MS degree program in Biotechnology and Bioinformatics.
4. Applicants for the Stem Cell Technology and Laboratory Management Emphasis must commit to the stem cell technology internship requirement.
5. Applicants will be evaluated by the Program Admissions Committee which will consider the applicants in the context of the total applicant pool using our general admission standards, including all academic work, GPA, test scores, relevant work experience and other factors that may have a bearing on the individual's potential for success. The following materials are required for our evaluation and admission process:

- Applicants must submit their transcript(s) from their undergraduate institution(s), Graduate Record Examinations (GRE) General Test scores or the Medical College Admission Test (MCAT) scores.
- Applicants who have received their undergraduate degrees from a university where English is not the language of instruction, or have studied fewer than two years at a university where instruction is in English, must submit their Test of English as a Foreign Language (TOEFL) scores for evaluation.
- Applicants must submit a one page "Statement of Purpose" and two letters of recommendations from people able to judge the applicant's academic capacity.

l. Criteria for student continuation in the program.

Admission Status

The Program may admit any applicant as a **Classified Graduate Student** who:

1. Has met all general admission requirements as a classified graduate student into CSUCI academic program, including a baccalaureate degree from an accredited institution of higher learning and a Grade Point Average of at least 2.5 in the last 60 semester units of coursework;
2. Has obtained a BS/BA degree in Biology, Computer Science, Chemistry, Biochemistry, or Mathematics;
3. Has completed all prerequisite courses specified by the program;
4. Has satisfactory scores on the GRE General Test, the MCAT, or the DAT;
5. Has satisfactory scores on the TOEFL (only applicable to applicants who have received their undergraduate degrees from a university where English is not the language of instruction, or have studied fewer than two years at a university where instruction is in English);
6. Has fulfilled the conditions for classified standing within the timeframe specified at admission (only applicable to those who have been admitted as conditionally classified graduate students);

7. Has obtained satisfactory scores from one of the following tests to demonstrate Writing proficiency in English:
   Upper-division Writing Proficiency Examination
   The Verbal and Analytical Writing sections of the General GRE test
   All sections of the TOEFL test, including Listening, Writing, Reading and Essay
8. Has a complete application folder containing the required materials evaluated by the Program Graduate Admissions Committee.

The Program may admit any applicant as a **Conditionally Classified Graduate Student**. Conditional admission is made on a case-by-case basis at the discretion of the Program Graduate Admissions Committee. In all cases, conditional admission is based on the judgment that following the completion of the course work to overcome admission deficiencies, the student is ready for advanced graduate work. Students are expected to fulfill the conditions prior to proceeding with graduate level courses that require prerequisite courses. Conditional admission is most frequently granted when:

1. The undergraduate degree is in a field other than the degrees specified above but the applicant is judged to be capable of making up deficiencies through additional course work or other means;
2. The GPA is below standards, but the student is judged to be capable of completing advanced course work and graduate studies;
3. Scores of GRE, MCAT, or DAT are judged to be unsatisfactory or are unavailable because they have not been taken or posted. If admitted, students are required to submit the appropriate scores within a timeframe specified at admission;
4. No more than 12 units of work prior to attaining classified status will be applied to a master's program.

Advancement to Candidacy Requires

1. Passing the Writing Proficiency prior to Advancement to Candidacy;
2. Satisfactory academic performance in the program with a minimum grade point average of 3.0;
3. Attainment of classified graduate student's status;
4. Completion of 12 units of required courses specified in the degree program at CSUCI;
5. Obtaining approval of advancement to candidacy by the Program Graduate Committee prior to proceeding with BIOL 600 course work.

Writing Proficiency for Graduation

Writing proficiency prior to the awarding of the degree is demonstrated by successful completion of BIOL 504 with a grade of B or higher.

Graduation Requirements

A classified graduate student will be able to graduate from the MS in Biotechnology and Bioinformatics program after completion of the following requirements:

1. Advancement to candidacy;
2. Attainment of Writing Proficiency for Graduation;
3. Satisfactory fulfillment of all degree requirements as described in the University Catalog.

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

Not Applicable.

n. If there is a Lower-Division Transfer Pattern (LDTP) for this major, indicate the relationship between the LDTP and the requirements presented in this proposal. Information on LDTP is available at: http://www.calstate.edu/AcadAff/ldtp.shtml

Not Applicable.

o. Advising "roadmaps" that have been developed for the major.

The road maps for each of the emphases are attached.

p. Provision for meeting accreditation requirements, if applicable, and anticipated date of accreditation request (including the WASC Substantive Change process).

Accreditation Note:

No special accreditation exists in the field.

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

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

6. Need for the Proposed Degree Major Program
(CPEC "Societal Need," "Number of Existing Programs in the Field," and "Advancement of the Field")

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

No university among the CSU System and the neighboring public and private educational institutions offers such a comprehensive program.

San Jose State University and Fresno State University offer a Master of Biotechnology degree program. CSU Los Angeles, CSU Pomona and Fullerton offer a joint Master's in Biotechnology degree program for Applied Biotechnology Studies. Sacramento State offers a 20-month Professional Science Master's program in Stem Cell Research, funded with a grant. San Diego State University offers a Master's of Science in Bioinformatics and Medical Informatics program and a separate MS in Bioengineering Program. San Francisco State University offers a Master of Science in Biomedical Science: Concentrations in Biotechnology and Stem Cell Science. Cal Poly San Luis Obispo offers a MS Specialization in Stem Cell Research funded by CIRM grant and a separate MS Biomedical Engineering program. .

b. Differences between the proposed program and programs listed in Section 6a above.

The program at CI combines both biotechnology and bioinformatics into one academic graduate program. Additionally, the CI program offers several distinctive emphases within the degree program.

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

No other closely related program exists at CI.

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

An Advisory Board was established prior to the development of the degree program. The Board has included representatives from local biotechnology companies, research and educational institutions, community organizations, community colleges, the local military base, and Workforce Investment Board, graduate students and faculty. The Board provided crucial input in program design and the method of implementation for the MS Biotechnology and Bioinformatics degree program. The Board was instrumental in proposing the concept and the development of the MS Biotechnology and MBA dual degree program. Due to the need for the campus to develop health science programs, we recently added representatives in the health care industry to the Board. Regular meetings are held by the Board to provide input in program development and promotion. The Board members also helped the Program to organize special events to provide networking opportunities and advice on transition from graduate program to careers in industry and professional pursuit for our students.

The following are the current members of the Board:
Biotechnology General
Casey Capparelli, MBA
Executive Director, Product Development
Amgen, Inc.

Matthew D. Arnold, MS, MBA (Chair of Advisory Board)
Director, Operations Risk Management
Amgen, Inc.

Timothy D. Osslund, Ph.D.
Principal Scientist
A & FS
ATO Analytical Sciences
Amgen

Peggy Pence, Ph.D.

President and CEO
Symbion Research International

Santiago Homsi, Jr., CIR
Sr. Recruiting Representative
Baxter Healthcare Corporation

Stem Cell Technology

Dennis O. Clegg, Ph.D.
Professor and Chair, Department of Molecular, Cellular and Developmental Biology
Co-Director, Center for Stem Cell Biology and Engineering
University of California Santa Barbara

Jeanne F. Loring, Ph.D.
Professor of Developmental Neurobiology
Director, Center for Regenerative Medicine
The Scripps Research Institute

Biomedical Engineering
Jonathan Lasch, PhD
Director & CEO
Alfred Mann Institute for Biomedical Engineering
University of Southern California

Health Care
John Bibby, MBA, SPHR
Vice President
Human Resources
St. John's Regional Medical Center
St. John's Pleasant Valley Hospital

Edward H. O'Neil, PhD, MPA, FAAN
Professor and Director
Center for the Health Professions
UCSF

Sue Tatangelo, MA
Chief Resource Officer
Camarillo Health Care District

Ming K. Heng, MD., FRACP, FAHA
Clinical Professor of Medicine, UCLA/Consulting Cardiologist
Board Certified Internal Medicine and Cardiovascular Disease
Centers for Family Health
Community Memorial Health System

Robert Gonzalez, MD
Medical Director
Ventura County Healthcare Agency

Workforce Development Agency
Cheryl Moore
Executive Director
Workforce Investment Board of Ventura County

Military
Bryan Burdick
Education Specialist,
Navy College Office
Naval Base Ventura County

Community College
Patricia Fausset, PhD
Director of the Central Coast Biotechnology Center
Department of Sciences
Ventura College

Student Representative:
Parissa Keshavarzian
Graduate student
CSU Channel Islands

Faculty as Ex Officio Members:
Ruben Alarcon, PhD.
Assistant Professor of Biology
CSUCI

Amy Denton, PhD.
Chair and Associate Professor of Biology

Karen Jensen, PhD.
Associate Professor of Nursing

Nancy Mozingo, PhD.
Associate Professor of Biology

Nitika Parmar, PhD.
Assistant Professor of Biology

William E. Wagner III, PhD.
Assistant Professor of Sociology

Ching-Hua Wang, MD., PhD.
Professor of Biology
Director of MS Biotechnology and Bioinformatics
Special Assistant to the Provost

e. Applicable workforce demand projections and other relevant data.

The MS in Biotechnology and Bioinformatics degree program falls within the categories of STEM (Scientific, Technology, Engineering, and Mathematics) fields. STEM occupations are the sixth-largest cluster and will also provide the sixth-largest share of job openings in the U.S. economy over the next decade. In 2008, STEM occupations accounted for about 7.3 million jobs, or about 5 percent of the 147 million in the U.S. economy. By 2018, they are projected to increase to 8.6 million jobs, or 5.3 percent of the nation's 162 million total positions. The STEM occupations are broadly represented in all industries, but are most concentrated in the Professional and Business Services (21 percent) and Information Services (14 percent) industries, to which the graduates of our program will belong. This cluster of occupations is forecast to provide 2.8 million job openings through 2018, including 1.2 million net new jobs and an additional 1.6 million replacement openings. It is important to note that the STEM occupations generate the technological changes that shape all other occupations.

The share of workers with at least some college or better in STEM occupations has always been high. Almost 83 percent of STEM employees had at least some postsecondary education in 1983, and that number climbed to 92 percent in 2008 and is projected to remain there through 2018. STEM occupations, along with several other occupational clusters, ranked at the top for their concentrations of postsecondary workers in 2007 and will hold onto that ranking in 2018. By 2018, 26.4% of the workers in the STEM fields will need Master's degrees or better. In life sciences, the master's degree requirement will be 28%. Life and Physical Sciences occupations account for a tiny share (0.6%) of total employment, amounting to about 873,000 jobs in 2008 but are expected to add almost another 130,000 positions by 2018. This occupational category will provide 263,000 total job openings by 2018: 129,000 net new jobs and 134,000 openings from retirements. The educational attainment of Life and Physical Sciences occupations is concentrated in Bachelor's and Master's degrees (73 percent), but there is a significant demand for Doctoral degree jobs, 17 percent in 2008, climbing to 23 percent in 2018.

Life Sciences occupations include Biologists, Zoologists, Agricultural and Food Scientists, Conservation Scientists, and Medical Scientists. Medical Scientists represent the largest share of Life Sciences occupations and will experience the greatest growth between 2008 and 2018, increasing by almost 50,000 over the period. Medical Scientists search for new treatments, and thereby expand the demand for healthcare. With retirements, job openings for Medical Scientists will total more than 70,000. By 2018, 1.77m new jobs will be created that require Masters' degrees or better and nearly 3 m replacement jobs will require Master's or better degrees.

The unfortunate economic climate notwithstanding, biotechnology and life science industry continues its expansion and advancement. The need for a well-trained workforce in this vast field compels higher education institutions to rethink their program offerings and to develop novel and pertinent academic programs. Our program covers the two largest sectors for employment in biopharmaceuticals and medical devices, instruments, and diagnostics. Together, the two sectors represent 190,000 positions, or 70%, of the biotechnology and life science industry's jobs in California. The overall job growth in this field will be a key part of economic recovery for the state and the nation.

APP Resources and Web Sources:

California Biomedical Industry 2009 Report, California Healthcare Institute and PricewaterhouseCoopers.

Yarris, L. C. Workforce Shortages Cloud the Future for California's Life Science, 2008

Industries: BASIC Study Finds Challenges and Opportunities. San Francisco, CA: Bay Area, 2009

Science and Innovation Consortium. Retrieved July 21, 2009 from: Http://www.bayareabasic.org.

http://www.calstate.edu/app/resources.shtml, 2010

US Department of Labor, Bureau of Labor Statistics, 2010

California Labor Market Information, 2010

Labor Forecast, 2010

Georgetown Center on Education and the Workforce Jobs Projections, 2010

The Path Forward, at www.fgereport.org, 2010

f. If the program was proposed to meet society's need for the advancement of knowledge, please specify the need and explain how the program meets that need.

The Master of Science in Biotechnology and Bioinformatics is designed to foster the ability to apply knowledge and skills in the research and development efforts in the general field of biotechnology. The Program is meeting that need by producing graduates educated with cutting-edge knowledge and skills in the field of biotechnology and providing opportunities for experiential learning and application of the knowledge and skills in real-world projects through the program.

7. Student Demand (CPEC "Student Demand")

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

Student demand for the MS in Biotechnology and Bioinformatics program as well as the dual MS Biotechnology/MBA program can be revealed by the number of applicants for the programs. Since program inception in Fall 2005, the MS Biotechnology and Bioinformatics program has received 278 applications.

The MS Biotech has admitted the following number of students each term since inception:

MS Biotechnology

Fall 2005 – 27
Spring 2006 – 2
Fall 2006 – 40
Spring 2007 – 4
Fall 2007 – 48
Spring 2008 – 7
Fall 2008 – 52
Spring 2009 – 11
Fall 2009 – 50
Spring 2010 – 16
Total Admits – 200

Many of our students joined our program from our own university, universities within and beyond California. Among the 200 admitted graduate students in the MS Biotechnology degree program, only 18 have been international students. Among the 57 admitted students in the dual degree program, 9 have been international students.

Since Fall 2005, the MS Biotechnology program has graduated 85.

b. Issues of access considered when planning this program.

All of the classes for the programs are offered in the evenings and weekends, allowing working adult students to enroll and complete the programs. For the non-lab courses, the program utilizes the Extended University Teaching Facility located in Thousand Oaks, which is close to the biotechnology industry hub in the region, allowing easy access of working adults to the program. The tuition and fees charged to the students are comparable to those charged by sister campuses and are well under those charged by private institutions in the nation, ensuring financial accessibility of the program.

Students could apply for financial aid and scholarship fund raised by the program from Amgen. In the last two years, a total of $95,000 was raised from Amgen to support student scholarships for the program. Each of the qualified students enrolled in the program could receive $2,000 of Amgen scholarship. A total of 10 Amgen Scholarships have been awarded in the last two years. A grant of $1,755,906 was awarded to CI from California Institute for Regenerative Medicine (CIRM) to support stem cell technology training program. The CIRM grant offers internship stipends of $35,750 to each student recipient enrolled in the Stem Cell program. With the availability of the CIRM grant, a total of 30 students will be supported with the generous internship stipends during the funding period. The Extended University offers a $5,400 scholarship each to up to 15 additional students enrolled in the stem cell research training program. These scholarships, stipends as well as financial aid packages enhance program accessibility.

Among the students enrolled in the program, a significant number of them are entry level scientists who have completed undergraduate education and are working at local biotechnology companies. Many of them receive tuition reimbursement from the companies to support their professional development and continuing education, which has further facilitated the accessibility of our program.

The MS Biotechnology and Bioinformatics program has admitted a diverse population of students, reflecting the demographics of the State of California. Among the graduates of the MS Biotechnology and Bioinformatics program, there were 32.3% White, 30.8% Asians, 9.2% Hispanic, 7.8% African and African American, 4.6% Pacific Islander, and 3.1% Vietnamese, with the rest of the students declined to state. This represents that at least 24.7% of the graduates served by the program were underrepresented minorities (URM), according to the standards of the National Science Foundation and the National Institutes of Health. Among the graduates of the dual degree program, 25% were White, 15% Asian, 15% Hispanic, 10% African/African American, and 10% Vietnamese, with the others declined to state. This indicates that at least 35% of the graduates served by the dual degree program were URM students. Considering the graduate level of the program, this provides strong evidence of accessibility of the program.

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

In the preceding three years, the FTEs of biology majors in the undergraduate biology programs are:
Fall 07 - 215.61
Fall 08 - 246.2
2009-2010 - 250.44

In the last three years, the numbers of graduates from the undergraduate biology programs at CI are:
Fall 06- 29
Fall 07- 49
Fall 08- 80
Fall 09 number is not available in the PeopleSoft System at the time of this report.

d. Professional uses of the proposed degree program.

The program prepares graduates with analytical, business and managerial skills along with sophisticated expertise in biotechnology and computational sciences for a

diverse set of vocations, including entry and advanced levels of research and development scientists in the field of biotechnology. Qualified graduates will be able to engage in research, development and management in biotechnology work in the pharmaceutical industry or conduct scientific research, teaching or consulting in public and/or private organizations. The program also prepares graduates who wish to enter professional or doctoral programs in life sciences. For those who are working at biotechnology industry, the program provides a value added education in biotechnology and bioinformatics to enhance their career advancement opportunities.

e. The expected number of majors in the year of initiation and three years and five years thereafter. The expected number of graduates in the year of initiation, and three years and five years thereafter.

See above (a) for historical figures.

8. Existing Support Resources for the Proposed Degree Major Program
(CPEC "Total Costs of the Program")

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

Extended University is mandated to operate self-supported programs maintained through student fees and other non-State funds. Per EO1000 and a formalized University MOU, Extended University fully reimburses the State for all expenses incurred in the operations of special session degree programs. As such, this program is estimated to have sufficient funds available through student fees to maintain and grow the program in the future (statement from Dean of Extended University attached – Exhibit 9).

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

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

Full-time Faculty:

Ruben Alarcon, PhD., Assistant Professor of Biology, CSU-CI

William Cordeiro, PhD., Professor of Management, Senior Associate Dean of School of Business and Economics, CSU-CI

Amy Denton, PhD., Associate Professor and Chair of Biology, CSU-CI

Geoff Dougherty, PhD., Professor of Physics, CSU-CI

Blake Gillespie, PhD., Assistant Professor of Biochemistry, CSU-CI

Nancy Mozingo, PhD., Associate Professor of Biology

Nitika Parmar, PhD., Assistant Professor of Biology, CSU-CI

Tom Schmidhauser, PhD., Adjunct Professor of Biology, CSU-CI

Jaye Smith, PhD., Associate Professor of Management, School of Business and Economics, CSU-CI

William Wolfe, PhD., Professor of Computer Science, CSU-CI

Greg Wood, PhD., Assistant Professor of Physics, CSU-CI

Ching-Hua Wang, MD., PhD., Professor of Biology, Director of MS Biotechnology and Bioinformatics, CSU-CI

Chunnian Zhao, PhD., Adjunct Professor of MS Biotechnology and Bioinformatics, CSU-CI

Part-time Faculty:

Andreas Kyriacou, PhD., Biotechnology and Instrumentation Consultant. Thousand Oaks, CA

Thomas Schulze, PhD., PMP, President, TAON™ Biopharma Consulting Inc., Thousand Oaks, CA

Matthew Arnold, MS., MBA., Director, strategic planning and operations, International Research & Development, Global program manager for Denosumab oncology, Associate director, Licensing Operations, Senior project manager for Neulasta® product development, Amgen, Inc., Thousand Oaks, CA

Bill Tawil, PhD., MBA., Director, Global Business Expansion; Director, Global Marketing – Orthobiologic, BioSurgery, Baxter Healthcare Corporation, Westlake, CA; Adjunct Professor, Bioengineering Department, UCLA

Nick Alexandrov, PhD., Manager of Computational Biology, Senior Computational Scientist, Ceres Inc., Thousand Oaks, CA.

Kristin Hiibner, JD., PhD., Partner, Sheldon Mak Rose & Anderson PC, Pasadena, CA

Daniel Mytych, PhD., Principal Scientist, Clinical Immunology, Amgen, Inc., Thousand Oaks, CA

Zin Htway, BS, MBA, ASCP, IAC, California DHS, State of Hawaii DHS, Senior Cytotechnologist, Los Robles Hospital and Medical Center, Thousand Oaks, CA

Jonathan G. Lasch, Ph.D., Alfred E. Mann Institute for Biomedical Engineering, Director and Chief Operating Officer, University of Southern California. Los Angeles, CA

Tim Osslund, Principal Scientist, Analytical and Formulation Science, Amgen, Inc., Thousand Oaks, CA

Douglas Lane, MBA, Principal, Experigen Management Company, Los Angeles, CA

Peggy Pence, PhD., PhD, RAC, RAPS Fellow, President and CEO, Symbion Research International, Inc., Newbury Park, CA

Extended University fully reimburses the State for faculty teaching in the special session degree program. Faculty members teach either through overload within the 125% parameters or receive course buy-out at a rate set by the V.P. of Finance and Administration. In addition to tenure track staff, the program is supported by part-time faculty hired on a course-by-course contractual basis. As the program grows, additional faculty resources will be funded by student fees.

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

The program offers its lecture/discussion courses at an 8,419 square foot state-of-the-art facility in Thousand Oaks. The complex is comprised of six 25-40 person classrooms, a 60-person lecture room, a large conference room, student lounge, kitchen break room, and faculty workspace and administrative offices. Ample parking is provided free to students and bathrooms are located in an adjacent hallway. University personnel staff the facility during the daytime for student recruitment and advising and in evening hours when classes are held. In addition to the courses, the program hosts special events, lectures, and social gatherings for the students at the facility.

The laboratory courses are held on the campus in a facility specifically built and designed for the biotechnology laboratory courses. This includes a laboratory with equipment/instruments for molecular biology, structural biology, stem cell technology, and tissue culture experimentations such as laminar flow hoods, CO2 incubators, freezer, refrigerators, ice machine, centrifuges, microscopes, spectrometers, PCR machines, image analysis systems, shakers and nano-drop. There is also a computer lab set up for bioinformatics courses. An adjacent lab is used for prepping purposes as well.

c. A report provided by the campus Library, detailing resources available to support the program (discussion of subject areas, volume counts, periodical holdings, etc. are appropriate).

Student fees provide sufficient resources through Extended University to reimburse the State for the use of required library resources. As the program grows, additional library resources will be funded by student fees.

d. Existing academic technology, equipment, and other specialized materials currently available.

The Thousand Oaks location where the courses are held supports high-speed wireless access and all of the classrooms include full audio visual equipment for faculty use.
Student fees provide sufficient resources through Extended University to reimburse the State for any additional use of needed academic technologies.

9. Additional Support Resources Required
(CPEC "Total Costs of the Program")

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

a. Any special characteristics of the additional faculty or staff support positions needed to implement the proposed program.
CSUCI is providing support for a part-time administrative support to the program and the Extended University is recruiting an Instructional Support Technologist to provide technical support to the program. The part-time faculty the program has recruited to teach for the program includes senior scientists and experts from the local biotechnology industry and relevant fields. (see detailed information above) The Extended University has been providing all the administrative support to the program since inception.

b. The amount of additional lecture and/or laboratory space required to initiate and to sustain the program over the next five years. Indicate any additional special facilities that will be required. If the space is under construction, what is the projected occupancy date? If the space is planned, indicate campus-wide priority of the facility, capital outlay program priority, and projected date of occupancy.

Not applicable.

c. A report written in consultation with the campus librarian, indicating any additional library resources needed. Indicate the commitment of the campus either to purchase or borrow through interlibrary loan these additional resources.

Not applicable.

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

Not applicable.