PROPOSAL TO OFFER A NEW ACADEMIC PROGRAM/ MAJOR IN FALL 2004
(LONG FORM)

Proposed Name of Degree:	Master of Science Degree in Biotechnology and Bioinformatics
Options/ Emphases in the Degree:	Biotechnology, Bioinformatics
Faculty Proposing New Program:	Amy Denton, Assistant Professor of Biology Nancy Mozingo, Assistant Professor of Biology Ching-Hua Wang, Professor and Chair of Biology William Wolfe, Associate Professor of Computer Science William Cordeiro, Professor of Management, chair of Business and Economics

Review and Approval:

1. Curriculum Committee Approval:

Curriculum Chair: _____ Date: _____

2. Academic Senate Approval:

Chair, Academic Senate: _____ Date: _____

3. Administration Approval:

President (or designee): _____ Date: _____

PROCEDURE FOR SUBMITTING PROPOSALS FOR NEW DEGREE MAJOR PROGRAMS

A campus, in accordance with its approved academic master plan, submits detailed proposals for new degree major programs to the Office of Academic Program Planning for review and approval in the academic year preceding projected implementation. Approval of any degree major program is subject to campus assurances that financial support, qualified faculty, physical facilities and library holdings sufficient to establish and maintain the program will be available within current budgetary support levels. The proposal must follow the format below, and four copies should be sent to Academic Program Planning, Office of the Chancellor.

1. Definition of the Proposed Degree Major Program

a. Name of the campus submitting the request, the full and exact designation (degree terminology) for the proposed degree major program, and academic year of intended implementation.

Campus- California State University Channel Islands

Degree- Master of Science Degree in Biotechnology and Bioinformatics

Implementation- Fall, 2004

b. Name of the department, departments, division or other unit of the campus that would offer the proposed degree major program. Identify the unit that will have primary responsibility.

Biology and Natural Sciences/Physics Program, CSUCI

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

Amy Denton, PhD, Assistant Professor of Biology, CSUCI
Nancy Mozingo, PhD, Assistant Professor of Biology, CSUCI
Ching-Hua Wang, MD, PhD, Professor and Chair of Biology, CSUCI
William Wolfe, PhD, Associate Professor of Computer Science
William Cordeiro, PhD, Professor of Management, chair of Business and Economics

d. Objectives of the proposed degree major 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.

e. **Total number of units required for the major. List of all courses, by catalog number, title, and units of credit, to be specifically required for a major under the proposed degree program. Identify those new courses that are (1) needed to initiate the program and (2) needed during the first two years after implementation. Include proposed catalog descriptions of all new courses.**

REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN BIOTECHNOLOGY AND BIOINFORMATICS (33-35 units):

COMMON CORE COURSES (19 units):
BINF 500 DNA and Protein Sequence Analysis (3)
BINF 501 Biological Informatics (3)
BIOL 502 Techniques in Genomics and Proteomics (2)
BIOL 503 Biotechnology Law and Regulation (3)
MGT 471 Project Management (3)

BIOL 600 Team Project (4)
BIOL 601 Seminar Series in Biotechnology and Bioinformatics (1)

<u>For Biotechnology Emphasis</u> (14 units):

REQUIRED COURSES (7 units):
BIOL 504 Molecular Cell Biology (3)
BIOL 505 Molecular Structure (4)

ELECTIVES (7 units):
A minimum of 7 units chosen from the following courses and/or from the elective courses under the Computational Biology Emphasis:
BIOL 506 Molecular Evolution (4)
BIOL 507 Pharmacogenomics and Pharmacoproteomics (3)
BIOL 508 Advanced Immunology (4)
BIOL 509 Plant Biotechnology (4)
MGT 421 Human Resource Management (3)

<u>For Bioinformatics Emphasis</u> (15 units):

REQUIRED COURSES (9 units):
BINF 510 Database Systems for Bioinformatics (3)
BINF 511 Computational Genomics (3)
BINF 513 Programming for Bioinformatics (3)

ELECTIVES (6-7 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 445 Image Analysis and Pattern Recognition (3)
MGT 421 Human Resource Management (3)

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(1) To initiate the program in 2004, we need to offer the common core courses during the first year. The required and elective courses for each of the emphases would be offered during the second year. Our undergraduate degree programs offer all the prerequisite courses when needed. The Business and Economics program offers the management courses.
(2) All core courses and required courses in the emphases are needed during the first two years as well as several, not all, of the elective courses for both emphases.

COURSE DESCRIPTIONS:

PHYS/COMP/MATH 445 IMAGE ANALYSIS AND PATTERN RECOGNITION (3)
Three hours of lecture in the lab per week.
Prerequisite: PHYS/COMP/MATH 345 or consent of 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, and an individual project report will be completed.

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 fro HR management, legal compliance, job analysis, recruiting, selection, training, compensation and employee relations.

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 of timing and sequences, creation of monitoring and control processes, and development of analysis and reporting mechanisms.

BINF 500 DNA AND PROTEIN SEQUENCE ANALYSIS (3)
Three hours of lecture per week.
Prerequisite: BIOL 400 or permission of 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 of lecture per week.
Prerequisite: BIOL 431 or permission of 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.

BIOL 502 TECHNIQUES IN GENOMICS/PROTEOMICS (2)
Six hours of laboratory per week.
Prerequisite: BIOL 401 or permission of instructor
This laboratory course introduces students to the current techniques and methodologies in the fields of comparative and functional genomics and proteomics. Topics and techniques covered include genome sequencing, micorarrays, mutagenesis, transgenic plants and animals, single nucleotide polymorphism (SNP) discovery and analysis. Students will gain hands-on lab bench experience and will make on-site visits to high volume regional biotechnology facilities.

BIOL 503 BIOTECHNOLOGY LAW AND REGULATION (3)
Three hours of 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 of lecture per week.
Prerequisites: BIOL 300 or permission of 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 of lecture and three hours of laboratory per week.
Prerequisite: BIOL 400 or permission of instructor

This course will examine 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 506 MOLECULAR EVOLUTION (4)
Three hours of lecture and three hours of laboratory per week.
Prerequisites: BIOL 400 or BIOL 401 or permission of instructor
This course will examine 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 of lecture per week
Prerequisite: BINF 500, BIOL 504 or permission of 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 of lecture and three hours of laboratory per week.
Prerequisites: BIOL 300 or permission of instructor
This course will examine 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 of lecture and three hours of laboratory per week.
Prerequisites: BIOL 400 and BIOL 422 or permission of instructor
This course will examine 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.

BINF 510 DATABASE SYSTEMS FOR BIOINFORMATICS (3)
Three hours of lecture per week.
Prerequisite: COMP 420 or BINF 501 or permission of 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 of lecture per week.
Prerequisite: BINF 500 or permission of instructor.
This course applies the theories and algorithms taught in BINF 500 to real-life genomic data sets, with an emphasis on practical applications, hands-on analysis, integrated approaches and collaboration. Lecture and laboratory will explore the computational and engineering tools for analyzing genomic

data. The relationships between sequence, structure, and function in complex biological networks will be studied using quantitative modeling.

BINF 512 ALGORITHMS FOR BIOINFORMATICS (3)
Three hours of lecture per week
Prerequisite: BINF 500 or permission of 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.

BINF 513 PROGRAMMING FOR BIOINFORMATICS (3)
Three hours of lecture per week.
Prerequisite: COMP 462 or equivalent, BINF 501 or permission of 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 of lecture per week.
Prerequisite: MATH 151, BIOL 202, or permission of instructor.
Techniques in statistical inference and stochastic modeling required for the effective 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.

BIOL 600 TEAM PROJECT (4)
Prerequisites: 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)
Presentation and discussion of up-to-date research and development findings with guest speakers, visiting scientists and other industry professionals.

f. List of elective courses, by catalog number, title, and units of credit, that can be used to satisfy requirements for the major. Identify those new courses that are (1) needed to initiate the program and (2) needed during the first two years after implementation. Include proposed catalog descriptions of all new courses.

(1) Identify new courses to initiate the program:

The above are all new courses with the exception of PHYS/COMP/MATH 445. Since the students will be required to take the courses as a cohort, we will offer only a limited number of courses each semester.

(2) Courses needed for the first two years:

All core courses, required courses in the emphases and several elective courses are needed in the first two years of implementation of the program so that students can graduate after two years.

(Note: With regard to Sections 1e and 1f, a proposed program should take advantage of courses already offered in other departments when subject matter would otherwise overlap or duplicate existing course content.)

g. If any formal options, concentrations, or special emphases are planned under the proposed major, explain fully.

We plan to offer the professional MS degree in Biotechnology and Bioinformatics with an Emphasis in Biotechnology and an Emphasis in Bioinformatics. See the above requirements. The students enrolled in both emphases will be required to take a set of core courses to ensure they gain sufficient foundational knowledge and skills in the field of biotechnology and bioinformatics. Included in the core requirements are courses dealing with business operations, project management and biotechnology law and regulation. After completing these essential knowledge and skills courses, students will choose either a Biotechnology or a Bioinformatics emphasis. Among the requirements for these emphases are several required courses and various electives. Additionally, students in one emphasis could also take elective courses from the other emphasis, which provides more flexibility and versatility to our students. Finally, students are required to carry out a project in the biotechnology or bioinformatics field as a team and they are also required to take a seminar series in the fields of biotechnology and bioinformatics.

h. Course prerequisites and other criteria for admission of students to the proposed degree major program, and for their continuation in it.

- Applicants must have a BS/BA degree in Biology, Computer Science, Chemistry, Biochemistry, or Mathematics. Alternatively, they must have a BA/BS degree in any field and equivalent work experiences in one of the above fields. The prerequisite courses for the graduate level courses should be completed at the undergraduate level or before enrolling in the set required courses after conditional admission.
- Applicants seeking admission to the professional MS in Biotechnology and Bioinformatics program must be officially accepted into the CSUCI academic program.
- Applicants must declare themselves as graduate students in the professional MS degree program in Biotechnology and Bioinformatics.
- 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. No arbitrary grade point or test score will be used in the evaluation process. However, the following materials are required for our evaluation and admission process.
- Applicants must submit to the program their transcript from their undergraduate institution, 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 to the program their Test of English as a Foreign Language (TOFEL) scores for evaluation.

- A one page "Statement of Purpose" from the applicant and two letters of recommendations from people who are able to judge the applicant's capacity for both academic and professional success should be submitted to the program for evaluation.
- Applicants will be interviewed by the program admissions committee before admission to the program.
- Although a BS/BA in the natural or life science, computer science, or mathematics is likely to provide the most thorough academic preparation for our program, it is not a prerequisite for admission. Relevant work experience in fields of biotechnology, computing, pharmaceuticals, medical, environmental, and agricultural biotechnology, clinical trials, regulatory affairs, intellectual property law, management in biotechnology is looked upon favorably. However, as our program demands sophisticated technical training which requires a comparable level of requisite knowledge and skills, some deficiency in academic preparation among applicants who have relevant work experience may be offered conditional admission, contingent upon successful completion of prerequisite academic work specified by the admissions committee.
- For applicants with BS/A degree in biology or computer science/mathematics wanting to complete the Biotechnology Emphasis or the Bioinformatics Emphasis, the prerequisite courses should have been completed in their BS/A programs. The only exception is the prerequisite for the project management course, which could be completed before they enroll in this course. However, if applicants with BS/A degree in biology or computer science/mathematics wanting to complete the Bioinformatics Emphasis or the Biotechnology Emphasis, they would need to make up their deficiencies by taking all the necessary prerequisite courses that are detailed in the course descriptions to reach a comparable level of requisite knowledge and skills before they could enroll in the courses in the program. Permission of instructor could be given in lieu of prerequisite course(s) when comparable work experiences are taken into consideration.
- Once admitted, students must remain in good academic standing throughout the duration of their enrollment in CSUCI.
- Students must complete and fulfill the requirements of the degree program within a designated period specified by the university.

i. Explanation of special characteristics of the proposed degree major program, e.g., in terminology, units of credit required, types of course work, etc.

The special characteristics of this program are:

- The professional MS degree program encompasses biological sciences, computational sciences, chemistry, business and regulatory affairs. It dovetails into present and future professional career opportunities. It consists of training in emerging and interdisciplinary areas in biotechnology and bioinformatics. It takes 33-35 units to complete, which ensures that students could complete it in 2 years.

- The program provides students with a rigorous and comprehensive background in biotechnology and bioinformatics by requiring foundational core courses such as DNA & Protein Sequence Analysis, Biological Informatics and Techniques in Genomics and Proteomics. These courses will equip students from diverse academic backgrounds (such as biology, computer science, mathematics or chemistry) with a common set of knowledge and skills that are essential to the fields of biotechnology and computational biology.

- The laboratory techniques course (BIOL 502) will include visits to laboratories of regional biotechnology companies. These companies include Amgen, the world's largest biotech company with 7,000 employees; Ceres, a biotech company that recently joined Monsanto, the world's largest plant biotechnology company, Baxter, and Biosource International, which is a conglomerate company producing thousands of diagnostics and therapeutics using molecular and immunological techniques. These major biotech companies and numerous middle size and small biotech firms are located near our campus and they are staunch supporters of our

programs. Students will not only learn the scientific principles underlying modern technologies but also will be exposed to techniques and facilities that lead to high throughput sequence analysis, structure analysis, bioprocessing, manufacturing and other research and development efforts at these companies which are in the fore-front of the biotech world.

- The program contains several courses such as Project Management and Biotechnology Law and Regulation as required core courses for all the students in this program. Additional business course such as Human Resource Management is available for students to take as an elective as well. These elements were incorporated into the curriculum after extensive consultation with biotechnology businesses and industries in our region as well as our faculty in the Business and Economics degree program.

- The program offers two emphases: Biotechnology and Bioinformatics. The former represents an area that has experienced strong and sustained growth in our economy and such momentum will last well into the future. The latter promises tremendous potential growth in the future. After taking the common core courses, students will choose an emphasis in one of the above areas. Each emphasis contains a set of required courses with 7 units and a set of elective courses. In addition, students can take 6-7 units of elective courses in the area of their interests. Moreover, students could also take elective courses from the other emphasis to broaden their knowledge and skills.

- In order to engage our students and faculty with the real biotech world, the courses will be taught not only by our own faculty in biology, computer science, mathematics, chemistry, physics and business programs but also by industry and government professionals.

- Beyond the scientific knowledge and technological skills, we emphasize several key interpersonal skill areas: communication, teamwork, international perspective, critical thinking and adapting to change. While taking the 12-14 units in their emphasis, students will form teams and carry out a project together. Students with various backgrounds will be able to help each other in this team effort, cultivating their interpersonal skills in the above areas. The project may be derived from the biotech companies as real problems or questions that need to be solved. In the end, they will present their results to academic and industry scientists.

- The project is worth 4 units and is equivalent to a total of 12 hours of team work per week for one semester.

- There will be a seminar series with invited speakers from the biotech companies, regulatory agencies, academic and business communities. This will allow our students to be exposed to the most up-to-date research and development findings as well as current law and regulations and business practices.

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

N/A

k. Provision for meeting accreditation requirements, where applicable, and anticipated date of accreditation request.

N/A

2. Need for the Proposed Degree Major Program

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.

- None of the 4-year comprehensive CSU campuses currently offer a professional MS degree in Biotechnology and Bioinformatics.

- San Jose State University offers a professional Master program in Biotechnology, with a total of 30 semester-units to complete the program, including a paid internship.

- University of California at Santa Cruz offers a MS in Bioinformatics program which takes 52 quarter-units to complete the course work plus a thesis.

- UCLA and UCSB offer Cell, Molecular and Developmental Biology degree programs with largely doctoral graduate students. UCLA offers a Bioinformatics program that MS/PhD students can participate in. UCSB does not offer a Bioinformatics program.

- UCR offers a PhD program in Genetics with a subspecialization in Genomics/Bioinformatics.

- UCSD offers a PhD in Bioinformatics.

- The Keck Graduate Institute is developing a Master of Bioscience degree program which includes a career-oriented focus area in Bioinformatics and Computational Biology.

- The only other 4-year comprehensive university within the Ventura County, Cal Lutheran University, a private university, does not offer a Bioinformatics program.

b. Differences between the proposed program and programs listed in Section 2a above.

- CSUCI is the only four-year comprehensive university in Ventura County and in the Southern California region that will offer a professional Master of Science Degree in Biotechnology and Bioinformatics.

- All of the above bioinformatics programs offered by the UC campuses are mostly designed to attract PhD students and these academic programs do not contain business elements in their curriculum.

- The Biotechnology Master program at San Jose State University is a professional degree program but it does not contain Bioinformatics as an emphasis.

- To reflect the rapidly advancing biological and computational sciences, the Biology program at CSUCI is completely committed to the integration of newest concepts and technologies throughout our curriculum. We also have full support from faculty members of the Chemistry, Computer Science, Mathematics, Physics and Business and Economics programs at CSUCI as well as strong support from regional biotech companies.

- Our program offers the two emphases that are not only responsive to the tremendous present and long-term needs stemming from the local biotechnology industries but also forward-looking in preparing for potential needs in the field of bioinformatics.

- Most of the hires by the biotech industries are not PhD scientists. Instead, they are people with BS or MS training. The common practice of biotech companies is that they primarily recruit graduates with BS degrees as entry level research assistants or research associates. After several years of working experience, the companies will then send some of the research assistants or research associates to get a MS degree and promote them to managerial research scientist positions. For each PhD scientist they hire, they often need to hire 5 to 8 more research assistants or research associates with BS or MS trainings. Consequently, it stresses the need for a MS program in the region.

- Our program is designed to be flexible and versatile to our students' needs and regional job market fluctuation. Currently, many pure computational scientists are experiencing a hard time in getting and maintaining jobs. Biotechnology companies on the other hand, are making lots of hires and they find it's more productive to hire people who are well trained in hands-on lab skills in biotechnology. We anticipate that the job market for biotechnology will remain strong whereas for bioinformatics it will pick up in the near future. Consequently, we designed our program to accommodate both areas. Students are required to take the common core and are allowed to take courses across emphases. Doing so, graduates from the bioinformatics emphasis will have opportunities to learn lab skills and get direct exposure to the real biotech functionalities and facilities at local biotech companies. Hence, their skill sets are more versatile and their career options are widened.

- Despite the rigor of the curriculum, the program takes 33-35 units to complete, which ensures that students can indeed finish the program and graduate in 1-2 years. When completed, our graduates will be highly trained both in theories and with hands-on experiences and will have had direct exposure to the biotechnology corporate world. They will be ready to make immediate contributions to the biotechnology companies, thus launching rewarding careers in a burgeoning industry, or to make contributions to the public or private agencies, which will lead to equally satisfying career options.

- The program is well organized to include a common core, core for each of the emphases, as well as elective courses such as Molecular Structure, Molecular Evolution, Pharmacogenomics and Pharmacoproteomics, Advanced Immunology, Plant Biotechnology, Statistical Methods in Computational Biology, Bioinformatics Programming, Algorithms for Bioinformatics, and Human Resource Management. Many of the applied science courses have never been offered by any academic program in the region. Some of these courses are designed with extensive consultation with scientists in the biotechnology companies which reflect the expansive thinking and forward-looking vision of our program.

- Some of these courses will indeed be taught by the leading scientists in the biotechnology companies and experts in relevant agencies. Our students' training will be much more augmented and enriched due to the infusion of knowledge and experiences of these scientists and experts directly from the biotech industry.

- The program provides knowledge and skills of applied sciences as well as stressing the importance of business operations, project management, team work, and human resource management. Unlike conventional graduate degree programs, a thesis is not required in order to complete the degree. An internship is also not required for this degree. Both thesis work and internship work call for individual responsibility and solitary effort most of the time. To cultivate key interpersonal skills in communication, teamwork, critical thinking and adapting to change, coupled with international perspectives, our program requires students from different cultures and academic and non-academic backgrounds to form teams to carry out a real world project from the biotech industry.

- The common core and core courses of each of the emphases could be used as formative assessment venues whereas the team project course will be highly useful for summative assessment purposes as well.

- By inviting guest lecturers with unique experiences and global perspectives from the biotech industries and other relevant agencies, our students and faculty will be engaged in regular communications and networking with scientists in the biotech world. Through this venue, our students could obtain internship opportunities to further their career endeavors.

f. Professional uses of the proposed degree major program.

Students in the program will develop analytical, managerial and interpersonal skills as well as sophisticated expertise in biotechnology and bioinformatics, which will make them highly valued in such diverse vocations as scientific research and development, management in biotechnological, biomedical, and pharmaceutical industries, consulting, and biotechnology law and regulations, governmental agencies, environmental agencies, research institutes, consulting firms, research and clinical laboratories, private and public health organizations, and education.

g. 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.

The rough and conservative estimates for the first year, third year and fifth year enrollment are as follows:

Year 1: 15-20; Year 3: 30-40; Year 5: 50-60.

The expected number of graduates in:

Year 1: minimal to 10, depending on how many students are from industries as working part-time students;

Year 3: 20; Year 5: 50

3. Existing Support Resources for the Proposed Degree Major Program

a. Faculty members, with rank, appointment status, highest degree earned, date and field of highest degree, and professional experience (including publications if the proposal is for a graduate degree), who would teach in the program.

Ching-Hua Wang
Professor and Chair of Biology and Natural Sciences/Physics
PhD, 1986, Cornell University
MD, 1978, Beijing University Medical Center (Former Beijing Medical University)
CSU professor since 1990
Taught biology courses at undergraduate and graduate levels at CSUSB from 1990-2001.
Proposed the BS degree program in Biology at CSUCI in 2001 and has taught at CSUCI since 2002.
Extensive experience in the areas of immunology, virology, infectious diseases, and microbiology.

Louise H. Lutze-Mann
Associate Professor of Biology
PhD, 1983, University of New South Wales, Australia
Associate Professor at University of New South Wales
Taught biology courses from 1994-1995 at University of California San Francisco and from 1997-2001 at University of New South Wales.
Extensive experience in biochemistry, physiology, cancer biology, genetics, and molecular biology

Nancy Mozingo
Assistant Professor of Biology
PhD, 1993, Arizona State University
Taught biology courses at graduate and undergraduate levels at Miami University (Oxford, Ohio) from 1998-2002 before joining the CSUCI faculty.
Extensive experience in the field of developmental/cell biology.

Amy Denton
Assistant Professor of Biology
PhD in Botany, 1997, University of Washington

Taught biology courses at University of Alaska from 2000-2003
Extensive experience in the field of molecular biology, plant biotechnology, bioinformatics, molecular evolution, plant biology, comparative genomics, plant molecular systematics, population genetics, biogeography and historical demography.

Other CSUCI full-time faculty listed below are also involved in teaching some of the relevant pre- and requisite courses:

Geoff Dougherty
Professor of Physics
PhD in Biophysics, University of Keele, 1979
Professor of Medical Imaging since 1990
Extensive experience in medical imaging, image analysis, and bioengineering.

Philip Hampton
Professor of Chemistry, Chair of Liberal Studies Program
PhD in Chemistry, 1989, Stanford University
Chemistry Professor since 1991
Extensive experience in research and education in chemistry.

William P. Cordeiro
Professor of Management, Chair of Business and Economics
PhD in Executive Management, 1986, Peter F. Drucker Management School of the Claremont Graduate University
Management Professor since 1988
Proposed the BS degree program in Business at CSUCI
Extensive experience as employee and consultant in private and public organizations since 1969

William Wolfe
Associate Professor of Computer Science
PhD in Mathematics, 1976, City University of New York
Computer Science professor since 1988
Extensive experience in research and education in mathematics and computer science.

Peter Smith
Professor of Computer Science
PhD in Computer Studies, 1971, University of Lancaster (England)
CSU computer Science professor since 1981
Extensive experience in research and education in computer science

Jorge Garcia
Assistant Professor
PhD in Mathematics, 2002, University of Wisconsin-Madison
Mathematics professor at CSUCI since 2003
Experience in probability/statistics with research interests in stochastic integration and large deviations

Simone Aloisio
Assistant Professor of Chemistry
PhD in Analytical Chemistry, 2000, Purdue University
Highly experienced in research and education in chemistry

Ashish Vaidya
Professor of Economics
Ph.D. in Economics, 1990, University of California, Davis
Director of the MBA program at CSULA before joining faculty at CSUCI
CSU professor since 1991
Extensive experience in research and education in international trade, business economics and development economics

4. Additional Support Resources Required

b. Any special characteristics of the additional faculty or staff support positions needed to implement the proposed program.

- In addition to the faculty at CSUCI, it is our intension to hire laboratory and computational scientists, experts and managers in biotechnology companies and related regulatory agencies to teach a significant number of the courses in the curriculum. The response from our local biotechnology companies to our call for experts to teach our classes is overwhelming. So far, we have received the curriculum vitae from over a dozen such experts in our local biotech companies, including the Head of the Computational Division at Amgen and the Vice President of BioSource International. The specialty areas include molecular structure, proteomics, protein formulation, cancer biology, immunology, chemistry, small molecule drug design, information technology, computational science, team project, regulatory affairs as well as patent law. Most, if not all of the scientists and experts have PhD or doctoral or professional training from first-rate research institutions in the world and they have extremely valuable first-hand working experience in the biotech industry.

- We plan to hire a Program Coordinator, initially as a part-time position, to oversee the administration of the program, a staff person to assist the coordinator and the instructors of the program and a technician to assist in lab preparation. We are actively seeking a grant from the Alfred P. Sloan Foundation to support such hires. During 2004-2005 AY and beyond, we will seek to hire a structural biologist and a computational biologist to complement our current faculty in support of the program. These positions may not be state-funded positions.

c. The amount of additional lecture and/or laboratory space required to initiate and 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.

A science building at CSUCI was recently completed and is being used by the biology, chemistry, physics and geology programs. It has a total of 8 teaching labs with 2 of them completely computerized. Three of the labs are wet labs for biology and 2 are for chemistry and 1 is a designated bioinformatics computer lab.

Adjacent to the Science Building, is a Science Annex building currently under renovation which will house 3 additional biology teaching labs, 1 chemistry and 1 physics teaching labs as well as 3 large classrooms. One of the 3 biology labs is specifically designated as Biotechnology lab. There will be additional research labs included in the building as well. Over 4 million dollars are already committed from CSUCI for this capital outlay project. The anticipated completion date for this project is in Fall, 2004.

Currently, there is another renovation project to house a Molecular Structure Lab within the Science Building. This project will be completed in November, 2003. We have secured a donation from Amgen for an entire set of x-ray crystallography instruments to be used to determine structures of protein molecules as well as a small molecule x-ray crystallography instrument with a total value of $200,000. These state-of-the-art instruments will be used in our proposed molecular structure course for this program and Amgen scientists will be teaching this course for our program.

Since the above teaching labs are mostly used during the day to suit our undergraduate students' demand and the potential graduate students tend to be working adults and would most likely to attend graduate classes in the evenings and during weekends, we could easily use these labs for this MS program to accommodate the students' needs.

d. Additional library resources needed. Indicate the commitment of the campus to purchase or borrow through interlibrary loan these additional resources.

CSUCI's acquisition of library resources planned for the upcoming years should be sufficient to meet the needs of the program.

e. Additional 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.

We plan to offer our MS program through Extended Education as a self-sufficient program without funding from the State of California. A sustainable revenue source is essential to making that happen. We plan to obtain funding from the Alfred P. Sloan Foundation to initiate the program. The application process has already begun and funding, if awarded, will start in August, 2004, at the time we plan to initiate our program. This funding will help us to hire the necessary personnel to run the program, pay salaries, release time or summer compensation to instructors at CSUCI as well as from the biotech industry, and to acquire necessary equipment and supplies for the lab activities. We have developed a course, that is not related to this graduate program, to be offered at Amgen to its entry level scientists in Spring, 2004. Part of the funding from Amgen to finance this particular course will be used to help us to develop this program during Spring, 2004.

As CSUCI is the only 4-year public university in the county we have enjoyed tremendous support from the local communities, including the local biotech industries. In the last two years, with our tireless efforts in advancement, we have secured over $360,000 worth of scientific equipment and supplies from the local biotech companies, with Amgen being the largest donor. Most recently, we have secured another $200,000 worth of an entire set of instruments for molecular structure analysis from Amgen. We are optimistic in that as the quality of our programs is recognized along with our university development, our advancement effort will become even more successful.

A primary way, however, to support this program is via a tuition premium that students enrolled in the program will pay. We used the model of the professional Master's degree program in Biotechnology at SJSU to define the tuition. Most likely, if these students are coming from the biotech companies, the tuitions will be paid for by the companies. This tuition scale differs significantly from the state funded university tuition, which will provide funds to sustain the program. Our budget details ensure that the program will be self-sufficient even without the potential funding from the Sloan Foundation.

5. Abstract of the Proposal and Proposed Catalog Description

Attach an abstract of the foregoing proposal, not to exceed two pages, and a complete proposed catalog description, including admission and degree requirements.

Catalog Description of the Program

The Master of Science Degree 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 and bioinformatics with course work and experience in business management and regulatory affairs. The program includes a set of core courses with two emphases to choose from; biotechnology and bioinformatics. 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 the next century, the major driving force for biotechnology will be the strategic use of the data derived from large-scale genome sequencing projects. Bioinformatics turns raw data from genome sequencing and new experimental methodologies such as microarrays and proteomics into useful and accessible information about gene function, protein structure, molecular evolution, drug targets and disease mechanisms using computational analyses, statistics, and pattern recognition. Our approach also includes team projects drawn from biotechnology industries to focus on real-world problems and applications of biological and computational sciences 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 and bioinformatics. They will be ready to make immediate contributions to scientific research and development, management in biotechnological, biomedical 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.

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Admission Requirements

- Applicants must have a BS/BA degree in Biology, Computer Science, Chemistry, Biochemistry, or Mathematics. Alternatively, they must have a BA/BS degree in any field and equivalent work experiences in one of the above fields. The prerequisite courses for the graduate level courses should be completed at the undergraduate level or before enrolling in the set required courses after conditional admission.

- Applicants seeking admission to the professional MS in Biotechnology and Bioinformatics program must be officially accepted into the CSUCI academic program.
- Applicants must declare themselves as graduate students in the professional MS degree program in Biotechnology and Bioinformatics.
- 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. No arbitrary grade point or test score will be used in the evaluation process. However, the following materials are required for our evaluation and admission process.
- Applicants must submit to the program their transcript from their undergraduate institution, 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 to the program their Test of English as a Foreign Language (TOEFL) scores for evaluation.
- A one page "Statement of Purpose" from the applicant and two letters of recommendations from people who are able to judge the applicant's capacity for both academic and professional success should be submitted to the program for evaluation.
- Applicants will be interviewed by the program admissions committee before admission to the program.
- Although a BS/BA in the natural or life science, computer science, or mathematics is likely to provide the most thorough academic preparation for our program, it is not a prerequisite for admission. Relevant work experience in fields of biotechnology, computing, pharmaceuticals, medical, environmental, and agricultural biotechnology, clinical trials, regulatory affairs, intellectual property law, management in biotechnology is looked upon favorably. However, as our program demands sophisticated technical training which requires a comparable level of requisite knowledge and skills, some deficiency in academic preparation among applicants who have relevant work experience may be offered conditional admission, contingent upon successful completion of prerequisite academic work specified by the admissions committee.
- Once admitted, students must remain in good academic standing throughout the duration of their enrollment in CSUCI.
- Students must complete and fulfill the requirements of the degree program within a designated period specified by the university.

Degree Requirements

REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN BIOTECHNOLOGY AND BIOINFORMATICS (33-35 units):

COMMON CORE COURSES (19 units):
BINF 500 DNA and Protein Sequence Analysis (3)
BINF 501 Biological Informatics (3)
BIOL 502 Techniques in Genomics and Proteomics (2)
MGT 471 Project Management (3)

BIOL 600 Team Project (4)
BIOL 601 Seminar Series in Biotechnology and Bioinformatics (1)

For Biotechnology Emphasis (14 units):

REQUIRED COURSES (7 units):
BIOL 504 Molecular Cell Biology (3)
BIOL 505 Molecular Structure (4)

ELECTIVES (7 units):
A minimum of 7 units chosen from the following courses and/or from the elective courses under the Computational Biology Emphasis:
BIOL 506 Molecular Evolution (4)
BIOL 507 Pharmacogenomics and Pharmacoproteomics (3)
BIOL 508 Advanced Immunology (4)
BIOL 509 Plant Biotechnology (4)
MGT 421 Human Resource Management (3)

For Bioinformatics Emphasis (15-16 units):

REQUIRED COURSES (9 units):
BINF 510 Database Systems for Bioinformatics (3)
BINF 511 Computational Genomics (3)
BINF 513 Programming for Bioinformatics (3)

ELECTIVES (6-7 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 445 Image Analysis and Pattern Recognition (3)
MGT 421 Human Resource Management (3)

Proposed Course of Study

For Biotechnology Emphasis:

Year 1 (15 units)
Semester 1 BINF 500 DNA and Protein Sequence Analysis (3)
BINF 501 Biological Informatics (3)
BIOL 502 Techniques in Genomics and Proteomics (2)

Semester 2 BIOL 503 Biotechnology Law and Regulation (3)
MGT 471 Project Management (3)
BIOL 601 Seminar Series in Biotechnology and Bioinformatics (1)

Year 2 (18 units)
Semester 1 BIOL 504 Molecular Cell Biology (3)
BIOL 505 Molecular Structure (4)
Electives (3)

Semester 2 BIOL 600 Team Project (4)
Electives (4)

For Bioinformatics Emphasis:

Year 1 (15 units)

Semester 1 BINF 500 DNA and Protein Sequence Analysis (3)
BINF 501 Biological Informatics (3)
BIOL 502 Techniques in Genomics and Proteomics (2)

Semester 2 BIOL 503 Biotechnology Law and Regulation (3)
MGT 471 Project Management (3)
BIOL 601 Seminar Series in Biotechnology and Bioinformatics (1)

Year 2 (16-17 units)

Semester 1 BINF 510 Database Systems for Bioinformatics (3)
Electives (6-7)

Semester 2 BINF 511 Computational Genomics (3)
BIOL 600 Team Project (4)

Course Descriptions:

See above.