DRAFT

Mathematical and Computational Biology Graduate Program

Bylaws

January 31, 2005

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SECTION 1. PREAMBLE

The biological sciences are entering a new era in which scientific advancement requires a quantitative understanding of large-scale and complex systems. Advances in mathematical modeling, nonlinear and stochastic analysis, numerical simulations, statistics and other areas of mathematical sciences will play an increasingly important role in the future as tools to understand biological processes and to predict their outcomes[1] [2]. Thus, there is a tremendous need to provide quantitative training for biologists and biological training for mathematicians and computer scientists[1] [2]. While it is difficult for a single scientist (biologist, mathematician, or computer scientist) to develop the depth needed to address problems at the research frontier in an interdisciplinary way, collaborative efforts among groups of scientists with complementary skills who are also trained to understand the language of one another can and will make progress at the frontiers of research. The graduate program we envision in Mathematical and Computational Biology aims to provide this vital training for students, to foster interdisciplinary research collaboration and thus to provide the scientific community with scientists who possess the knowledge and skills to meet the major integrative biological challenges faced by our society.

Biology and mathematics have historically benefited from exchange and collaboration. A famous example is the pioneering work of the famous English logician and mathematician A. Turing on the chemical basis of morphogenesis in biology (1952). This work energized the field of developmental biology and lead to the development of new mathematics and new biological understanding. By mid twentieth century, a number of monographs [1-7] were published to record in a coherent way the substantial body of quantitative developments in the biological sciences. About that time, archival journals such as the Journal of Theoretical Biology, Biological Cybernetics, Journal of Mathematical Biology and the Bulletin of Mathematical Biology began to emerge, and they remain vibrant to this day. There have also been a sufficiently large group of active researchers in this field to support the continuous existence of the Society of Mathematical Biology for past forty years.

The field of mathematical biology has become far more sophisticated in methodology and biological contents since the mid twentieth century. While we can cite a number of significant texts in this area since that period to document this observation, it suffices to note the two volume treatise on mathematical biology by J.D. Murray [8,10] and the slimmer volume by M.A. Nowak and R.M. May [9] to illustrate the breadth and depth the field of mathematical biology has attained since the fledging days of the discipline. Coincidentally, these three authors all held at different times the Chair of Professor of Mathematical Biology at Oxford University. The existence of such a Chair since the early nineteen eighties provides a validation of the intellectual contents of this relatively new discipline. The institutional recognition of the intellectual contents of mathematical

[1] A. Hastings, P. Arzberger, B. Bolker, T. Ives, N. Johnson and M. Palmer. *Quantitative biology for the 21st century*. Quantitative environmental and integrative biology workshop. Sept 2000. San Diego.

[2] M.A. Palmer, P. Arzberger, J.E. Cohen, R.D. Holt, J.L. Morse, D.W. Sumners and Z.L.-Schulten. *Accelerating mathematical-biological linkages: Report of a joint NSF-NIH workshop*. Feb. 2003, NIH.

biology has since gone well beyond establishing endowed chair professorships and recruiting faculty in this field. Graduate degree programs have sprung up around the world in this area. Included in Appendices 3, 4 and 5 are several lists taken from the Website of the Society of Mathematical Biology.

At the same time, and concomitant with the increasing availability of high performance computing, the focus of the field of Mathematical Biology has broadened to include many research projects on complex biological phenomena not approachable previously. These include the simulation of complex molecular interactions, the numerical exploration of dynamic systems with large parameter sets, and the analysis of genome sequences and data based on the gathering of genome- and proteome-wide data. The descriptive term "Mathematical and Computational Biology" is gaining in usage, as there is increasing recognition of the importance of computation in the analysis of complex biological systems.

We support the use of this term, because it emphasizes the synergistic interaction between Mathematics and Computation. Mathematical analysis not only provides a guide to efficient computing, it also often provide definitive answers to generic biological issues--whereas computing, like experimentation, offers results to a specific scenario on any issue. For example, mathematical modeling and analysis can delimit the range of values of various biological parameters. Computing specific scenarios can suggest a likely solution to a problem and allow analysts to formulate and prove the appropriate theorems. The outcomes of the interaction between computation and analysis often guide biologists toward experiments that provide durable insights into biological phenomena.

The synergistic relationship between mathematical analysis and computation is now generally recognized and reflected in the design of federal research support initiatives that date back at least to the 1980's, with the initiation of a mathematical biology program in the Division of Mathematical Sciences at National Sciences Foundation. Although that program remained relatively modest until the end of the last century, it was followed by the three year old NSF-NIMGS (National Institute of General Medical Sciences) Joint Initiative on Mathematical Biology, which increased the joint NSF-NIH investment in the area several fold. Most recently, the NIGMS initiated a program to invest more than $25 million over the course of five years to establish Centers of Excellence in Complex Biomedical Systems Research (recently renamed “Centers of Excellence in Systems Biology”; see Appendix 5). In the words of Dr. Judith H. Greenberg, the acting director of NIGMS, "We anticipate that the new centers will develop creative approaches to address significant biomedical problems by combining the expertise of outstanding scientists working across disciplinary boundaries. We also expect these centers to lead the way in training the next generation of researchers in computational biology." Equally significant are two other three year old initiatives in the CISE Directorate of NSF, one on Collaborative Research in Computational Neuroscience (CRCNS) and the other on Quantitative Systems Biology (for innovative software for analyzing large-scale cellular biological systems). With such initiatives, the NSF and NIH investments have become a significant factor in promoting research in mathematical and computational biology. A three year planning grant from the NIGMS initiative on Complex Biomedical Systems and

several R01 type grants from the joint NSF-NIMGS Initiative on Mathematical Biology are currently supporting several labs at UCI.

Concurrent with the increased investment in research support for mathematical and computational biology are numerous calls for more high quality trained personnel for this type of collaborative approach to interdisciplinary research. We note various solicitations such as the NIH Mentored Quantitative Research Career Development Award (PA-02-127, 2002-2005) and the $35 Howard Hughes Medical Institute and the National Institute of Biomedical Imaging and Bioengineering of the National Institutes of Health (HHMI-NIBIB) to support graduate training programs that integrate the biomedical sciences with the physical sciences and engineering, as well as those of other sources of fellowship/ traineeship opportunities (see Appendix 7), indicate a serious shortage of the type of individuals needed for mathematical and computational approaches to research in the biological sciences. There is every indication that high quality interdisciplinary graduate programs and postdoctoral training opportunities are very much needed in this area.

Accordingly, it is an opportune time to build upon the individual and small group activities of the many of the participating faculty members of this proposal, and mount an organized, systematic and visible graduate program in computational and mathematical biology. We should do so to benefit from the economy of scale, to provide beneficial intramural and extramural support and recognition for our students, and to increase the number, quality and preparation of students trained at UCI.

In the following document, we provide the outlines of a proposed program that we believe will not only be an effective vehicle for training Ph.D. students in Mathematical and Computational Biology, but that is also unique in its approaches to integrating research-level mathematical analysis, scientific computing and fundamental biology.

References

[1] J.B.S. Haldane, The Causes of Evolution, 1932, Longmans, Green and Co., London.
[2] C. C. Li, Population Genetics, 1955, University of Chicago Press, Chicago.
[3] A.J. Lotka, Elements of Mathematical Biology, 1956, Dover Publications, New York.
[4] B.C. Goodwin, Temporal Organisation in Cells, 1963, Academic Press, New York.
[5] F.S. Grodins, Control Theory and Biological Systems, 1963, Columbia University Press, New York.
[6] T.H. Waterman and H.J. Morowitz (ed.), Theoretical and Mathematical Biology, 1965, Blaisdell Publishing Co., New. York.
[7]. J. M. Smith, Mathematical Ideas in Biology, 1968, Cambridge University Press, Cambridge, England.
[8] J.D. Murray, Mathematical Biology, I: An Introduction, 1993, Springer, New York.
[9] M.A. Nowak and R.M. May, Virus Dynamics: Mathematical Principles of Immunology and Virology, 2000, Oxford University Press, Oxford, England.
[10] J.D. Murray, Mathematical Biology, II: Spatial Models and Biomedical Applications, 2003, Springer, New York.

SECTION 2. INTRODUCTION AND STATMENT OF PURPOSE

The field of Mathematical and Computational Biology (MCB) is an inherently broad and multidisciplinary area of scientific pursuit and scholarship. It has intellectual links to numerous and diverse fields in biology, medical science, mathematics, physics, chemistry, engineering, and computer science. Although it is not a new field, it is becoming increasingly important to progress in the biological sciences. This reflects the increased focus of many biologists on system-level approaches, in which complex network architectures, non-linear dynamics, and large data sets must often be explored and understood.

The breadth, multi-disciplinarity, and growing importance of MCB make it an attractive and important area for graduate study. However, this breadth also creates challenges for Universities seeking to train graduate students in this discipline. In particular, the traditional organization of graduate training programs around single departments can limit the range of academic options a student may explore. On the other hand, it may be argued that training programs built around single departments are best for providing the focus that students/trainees entering such a broad field need.

In response to this dichotomy, this document proposes the formation of a new one-year MCB training program for PhD students. The MCB would function in concert with existing departmental training programs, such that a student successfully completing the one year of MCB training would then be automatically directed into a departmental program for the remainder of his/her PhD training. In this way, the MCB would serve not as a degree-granting program, but as a "gateway" program, broadly similar in structure to other gateway programs already operating at UCI (e.g. Interdepartmental Neuroscience Program; Program in Molecular Biology, Genetics and Biochemistry).

In fulfilling this function, the MCB would seek both to attract new, highly qualified students to UCI, and to provide them with an academic experience of the highest quality. In particular the MCB will:

- Provide students with an opportunity to begin their training in Mathematical and Computational Biology with a broad academic introduction;

- Provide students with an opportunity for individualized attention to curricular needs;

- Provide students with an opportunity to conduct initial research projects with a large and diverse group of faculty in a wide variety of departments;

- Provide students with an opportunity to choose and conduct thesis research in any of a large and diverse group of laboratories in a wide variety of departments;

- Provide UCI Faculty in Biological Sciences, Engineering, Medicine, Information and Computer Science, and Physical Sciences with enhanced opportunities to compete for and obtain training grants from extramural sources.

The following pages outline the bylaws of the proposed MCB program. We anticipate that the form of the MCB Gateway Program will evolve over time, as organizational lessons are learned and training disciplines change. Accordingly, these bylaws include mechanisms for evaluating the success of the program in fulfilling its goals, and mechanisms for adjusting both the composition and the administrative structure.

This document was drafted by a committee of faculty from the Departments of Developmental & Cell Biology, Molecular Biology and Biochemistry, Ecology and Evolutionary Biology, Mathematics, Physics, Biomedical Engineering, and Information and Computer Science and has been ratified by the faculty members of each of these departments.

SECTION 3. DEPARTMENT AND FACULTY PARTICIPATION IN THE PROGRAM

3.1. Department Participation

There are requirements for department participation in the MCB Program. Participation follows confirmation by the Executive Committee (see Subsection 4.1) that the following requirements have been met.

1) The Department must have an extant Ph.D. degree program with a significant mathematics component or with a significant biology component.

2) The department must agree and commit to admit into its Ph.D. program any student who successfully completes the (one year) course and lab rotation requirements of the MCB Program, who is accepted for Ph.D. training and dissertation research by a member of that department, and who fulfills such additional criteria as may be elaborated in full by the department (see item 5 below). It is expected that imposition of significant "additional criteria" by departments will occur sparingly, and will serve the purpose of ensuring that students do not enter the departments with gaps in their training that would further hinder their progress. Additional requirements are not meant to subvert the efforts of the admission committee, but rather to aid students in their progress.

3) The department must agree to extend to admitted MCB students whatever financial commitments (e.g. block grant fellowships, teaching assistantships, etc.), and stipend levels as are normally extended to other Ph.D. students in that department.

4) The department must agree and commit to remain participating in the MCB Program for at least three academic years. Withdrawal can only occur at the end of an academic year.

5) The department must agree and commit to provide at the beginning of each academic year a description of any additional academic requirements and/or curricular achievements (see item 2 above) that would be required of any student who moves from MCB program to that department at the end of the said academic year. These requirements may not be increased for said student(s) even if the department subsequently withdraws from the MCB program.

Agreement to all the above terms will be provided in writing by the department chair prior to joining the program. Any department not listed as a Founding Department (see below) may join upon invitation by the Executive Committee

As of the inception of the Math Biology Program, there are seven founding participating departments:

1) Biomedical Engineering
2) Computer Science
3) Developmental & Cell Biology
4) Ecology and Evolutionary Biology
5) Mathematics
6) Molecular Biology &Biochemistry
7) Neurobiology and Behavior
8) Physics
9) Statistics

Additional departments are invited to participate in the Program. Departments wishing to participate should apply by contacting the Chair of the Executive Committee.

Continued participation of any department is contingent on upholding these bylaws. After its initial three-year commitment to the program, any department may elect to withdraw from the Program but can do so only at the end of an academic year. Any students who have already joined a department at the time of its withdrawal from the program will remain Ph.D. students in that department, and any academic requirements (such as the counting of such students' coursework in the program toward departmental degree requirements) will remain in force.

3.2. Faculty Participation

UCI faculty who are members of the academic senate, and who fulfill all other campus requirements for serving as the primary mentor for a Ph.D. student, may participate in the Program. As of the inception of the Program, over 40 faculty members, all primary or secondary appointees in one of the founding departments, have been identified as participants. Their names are listed in Appendix I.

Additional faculty members may become participants in the program if both of the following two conditions are met:

1) They hold primary or secondary appointments in a participating department.
2) An application to become a participating faculty member is approved by the Executive Committee.

Participating faculty are responsible for serving on Student Advisory Committees and *ad hoc* committees when asked to do so by the Executive Committee (see Subsection 4.1 below). It is also expected that participating faculty will contribute to student recruitment efforts as needed.

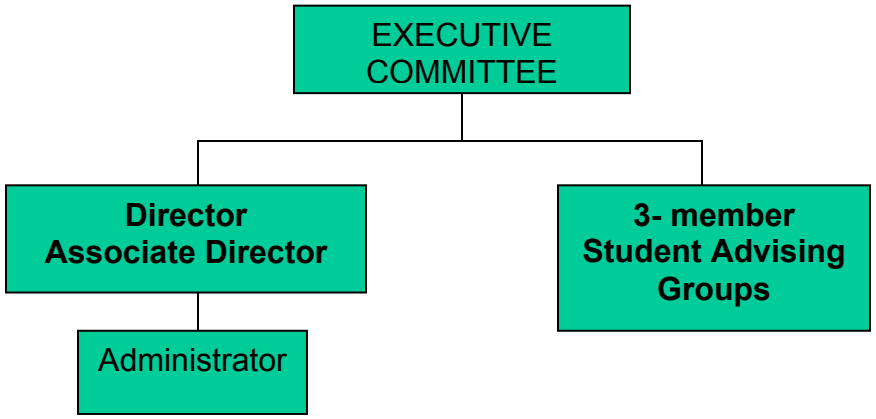
The Executive Committee will review, on a periodic basis, the appropriateness of the participation of faculty members in the program, and may decide to discontinue the participation of any faculty member at the end of an academic year. It is

expected that such discontinuations will occur only rarely and only after a thorough review and consultation. In addition, all participating faculty will be asked annually to indicate whether they wish to continue as participants in the program.

SECTION 4. GOVERNANCE

The program will be governed by an Executive Committee and a Program Director, who will be assisted by an Associate Director, a Program Administrator and faculty committees.

Organizational Structure



4.1. Executive Committee

The Executive Committee will serve as the primary governing body of the program.

4.1.1. Composition of the Executive Committee:

- Each participating department is responsible for providing a departmental representative to the Executive Committee of the MCB Program. The representative is to be appointed by the Department Chair to serve as a member of the Executive Committee for a three year term except at the inception of the Program (see below).

- Prior to the end of each academic year, Department Chairs (in consultation with their faculty) will be responsible for appointing new members to the Executive Committee for the following academic year as are needed to replace members whose term are expiring. Department Chairs may not themselves serve on the Executive Committee. At the program's inception, one third of the Executive Committee members will be assigned 2-year terms, and one third will be assigned 1 year terms, to allow for a staggered schedule of replacement.

- If a department has a small number of participating faculty members (3 or fewer) in any given year, it may withdraw its Executive Committee member, decline to contribute a member for that year, or join together with another department to provide a shared member.

- The Executive Committee periodically reviews procedures for making appointments to that committee. If adjustment should be needed (e.g., more strictly tying representation to relative numbers of faculty participants in different departments), the Executive Committee would recommend appropriate amendments to the bylaws.

- No faculty member who is already serving on the Executive Committee will be asked to give up his/her membership prior to the normal expiration of his/her term, solely because of changes to the bylaws.

4.1.2. Duties and Responsibilities of the Executive Committee

- Selects /reviews applications for faculty membership.
- Oversees student recruitment.
- Acts as the admissions committee for admitting students.
- Sets academic standards, and establishes any other requirements, for continued student enrollment in the program.
- Makes recommendations to the Dean of Graduate Studies concerning dismissal of students who fail to fulfill requirements of the program.
- Oversees management of funds.
- Creates ad hoc committees.
- Gives charges to committees, appoint members to committees, and receives and exercises approval authority over committee recommendations.
- Organizes and run plebiscites as needed.
- Arranges for and guide the continued evaluation of the program.
- Oversees/organizes events and program-wide activities, such as "town hall" discussions, retreats, etc.
- Meets as frequently as necessary to carry out the above duties.

4.1.3. Procedures of the Executive Committee

- Decisions/Resolutions of the Executive Committee will be passed by simple majority vote of the membership of said committee, or if a vote is taken at a regular meeting of the Executive Committee, by a simple majority of those present, provided that a quorum consisting of at least 50% of the committee is present.

- In the event that a vote leads to a tie, the program director will be empowered to cast a tie-breaking vote. Otherwise, the program director will not participate in Executive Committee voting.

- A tentative calendar of Executive Committee meetings will be established at the beginning of each academic year and provided to all Executive Committee members.

- In other matters, the Executive Committee will be expected to adopt procedures consistent with common parliamentary practice.

4.2. The Program Director

4.2.1. Recruitment and Appointment of the Program Director: In consultation with the Executive Committee, the Dean of Graduate Studies will recruit and appoint a Program Director for the MCB Program. The initial appointment will be for a three-year term, renewable for a second term assuming satisfactory performance. The program director will act as the Chief Executive Officer and Chief Financial Officer for the program.

4.2.2. Duties and Responsibilities of the Program Director:

- Serves as an ex officio member and Chair of the Executive Committee.

- Acts as the main liaison between the MCB Program and the UCI Administration, the Academic Senate, campus committees, and outside organizations.

- Coordinates any outside funding the program may obtain.

- Recruits, appoints and supervises the Program Administrator.

- Supervises the admissions process, including the making of offers of admission to student applicants.

4.3. Associate Director

- Prior to the start of each year, the Executive Committee will elect one of its members to serve as Associate Director for that year

- The Associate Director will chair Executive Committee meetings in the absence of the Director

- The Associate Director will assume responsibilities of the Director in the Director's absence

4.4. Committees

Prior to the start of each year the Executive Committee will appoint one Student Advisory Committee for every incoming student for that year (See Section 7). There will be no other standing committees, but the Executive Committee will appoint other committee on an *ad hoc* basis whenever needed.

4.5. Program Administrator

- A salaried staff member will be recruited and appointed as a program administrator by the Program Director. This individual will be responsible for the program operations and carrying out administrative duties associated with running the program, including but not limited to:

  - Recruiting
  - Admissions
  - Budget
  - Faculty Membership
  - Correspondence
  - Tracking students
  - Generating data for reports

- The program administrator will report to the Director.

- The program administrator will serve as secretary at Executive Committee meetings.

4.6. Plebiscites

Although the Executive Committee and Director will be responsible for most issues of program governance, two types of decisions will be made only through a vote by all participating faculty:

- Changes to the bylaws: Changes to the bylaws can be proposed either by the Executive Committee or by a supporting petition signed by at least 25% of the participating faculty. Once proposed, the Executive Committee will make the text of the proposed changes available to all participating faculty for a period of time sufficient for careful review. The Executive Committee will then schedule and hold a vote of the program membership (i.e. all participating faculty). A simple majority of those faculty members who cast votes will be required to ratify the proposed changes.

- Removal of officers: Either the Executive Committee, or any group of faculty obtaining a supporting petition signed by at least 25% of the participating faculty, can propose that an officer of the program (Program Director, Associate Director or members of the Executive Committee) be removed from office. Once proposed, the Executive Committee would notify the participating faculty, and provide adequate opportunities for faculty discussion and review. The Executive Committee would then schedule and hold a vote of the program

membership. A two-thirds majority of all participating faculty members (not just those who vote) would be required to remove an officer from office. Once an officer is removed, the same process that was initially used to appoint him/her will be used to appoint a successor. If there will be a significant delay in replacing an officer, the Executive Committee may select an interim officer from any of the participating faculty.

4.7. Program Calendar

The Program will follow the calendar of the academic year. All elections, appointments, etc. (with fixed terms) will normally take place no later than 3 months prior to the start of the academic year.

SECTION 5. CURRICULUM

The curriculum is designed to teach students at the beginning of their graduate studies the necessary mathematical, computational, and biological knowledge for successful research at the interface between these disciplines. The curriculum is designed to meet the needs of students with a variety of backgrounds provided that they had training in mathematics comparable to a year course in calculus and some elementary differential equations and linear algebra. Exceptional students not meeting these pre-requisite can be admitted to the program on the condition that they make up the deficiencies by taking courses during the summer preceding and/or the first quarter of their graduate study and pass with a grade B or better.

5.1. First Year Requirements

Core courses: All first-year students participate in six quarters of a four-unit MCB core course, three in biology and three in mathematical and computational methods for biology:

BIOLOGY	MATHEMATICAL AND COMPUTATIONAL BIOLOGY
1st Quarter: ***Biophysics and Physical Biochemistry*** ▪ Fundamentals of biological molecules ▪ Biophysics/physical biochemistry ▪ Enzyme mechanism and kinetics, ligand-receptor interaction ▪ Experimental methods ***(Physics and/or MB&B to take primary responsibility)***	**1st Quarter:** ***Statistics & Scientific Computing*** ▪ Statistical methodology ▪ Symbolic computation packages ▪ Visualization ▪ Molecular Dynamics ▪ Monte Carlo simulations ***(Mathematics to take primary responsibility for the entire sequence)***
2nd Quarter: ***Cell and Developmental Biology*** ▪ Cell structure and function ▪ Transcription/translation ▪ Transport ▪ Signaling ▪ The cell cycle ▪ Developmental biology ▪ Morphogenesis ***(Dev & Cell to take primary responsibility)***	**2nd Quarter:** ***Ordinary Differential Equations*** ▪ Initial value problems (theory, analytical & numerical methods) ▪ Dynamic systems/control theory ▪ Boundary value problems (theory, analytical & numerical methods) ▪ Applications: enzyme kinetics, cell cycle, signaling networks ▪ Solving non-linear equations ▪ Stochastic methods
3rd Quarter: ***Physiology, Pop. Biology, Evolution*** ▪ Neurophysiology ▪ Organ systems physiology (e.g. cardiovascular, ▪ Pulmonary) ▪ Population Biology and Genetics ▪ Evolution, and evolutionary theory ***(BME, N&B, and/or E&E to take primary responsibility)***	**3rd Quarter:** ***Partial Differential Equations*** ▪ Classification of PDE's ▪ Biological applications (diffusive transport, wave propagation in cells, pattern formation) ▪ Theory and analytical solution methods ▪ Numerical methods ▪ Stability analysis, eigenvalue problems ▪ Stochastic methods

Research Laboratory Rotations: Laboratory rotations constitute an important component of the first year training program, providing students with intensive introductions to experimental design and quantitative data analysis as well as introducing them to available research opportunities. Students are expected to conduct three rotations in different labs prior to choosing a thesis advisor. Because of the interdisciplinary nature of the MCB Program and the diversity of the participating students, it is important that students become familiar with both "wet" experimental biology labs as well as with mathematical/computational labs. Therefore students are expected to do at least one rotation in each environment. Students are also encouraged to pair up for interdisciplinary, collaborative work experiences. Summer research in participating labs can count towards the required rotations.

Research Seminar Series: Participating MCB faculty will present their research, including ample discussions with students. These presentations will be a key mechanism by which students become familiar with the various potential research areas prior to choosing a thesis advisor. All first year students are required to attend these seminars.

5.2. Continuing Training

Selection of a Thesis Advisor and Department: At the end of the first year, each student will choose a primary thesis advisor from among the participating faculty. The primary advisor's department will be responsible for awarding the degree and the student needs to satisfy the course, examination, and other requirements set by the department for students entering through the MCB Program.

To ensure interdisciplinarity of the thesis project, a student chooses a secondary thesis advisor from a department complementary to the primary thesis advisor's department. In general, a student with a primary advisor in a biology department is required to choose a secondary advisor from any of the other participating departments and vice versa. However, the Executive Committee can allow other combinations requested by a student and endorsed by both prospective advisors.

Students are required to report their progress at least twice a year to their secondary advisor. It is the primary advisor's responsibility to ensure compliance of the student with this reporting requirement. It is expected that the secondary advisor will serve as the outside member of the thesis committee.

Journal Clubs: Participating MCP students in closely related research areas are encouraged to organize journal clubs to meet regularly for discussion of relevant articles in research journals to broaden their research capacity and/or to seek dissertation research topics..

SECTION 6. SUCCESSFUL COMPLETION OF THE PROGRAM

Successful completion of the program requires:

1. Achieving a B+ (3.3) average in the core courses, and

2. Achieving satisfactory grades in all rotations, and

3. Identifying a participating faculty mentor willing to serve as thesis advisor, and

4. Completing any additional requirements mandated (in accordance with Section 3.1) by that faculty member's department.

Matriculation into a departmental Ph.D. program of a student who completes most but not all of these requirements at the end of one academic year may occur at the sole discretion of that department.

SECTION 7. TRAINEE ADMISSIONS AND RECRUITMENT

Potential graduate students of the MCB Program will apply through the Office of Graduate Studies (OGS) and indicate on their applications their interest in the Program.

The Executive Committee and the Director will receive the completed applications from the OGS and act as the admissions committee. The Executive Committee may choose to appoint a separate Admissions Committee to assist and advise on the selection of applicants. However, it is the responsibility of the Executive Committee to set academic standards for admission and establish any other requirements for continual student enrollment in the program.

Following an initial screening of the applicants, the Executive Committee will usually invite applicants for an interview at UCI. The Program Director will be empowered to present to an applicant an admission offer package, put together from the recommendations of the interviewing faculty and the Executive Committee, as well as a separate Admissions Committee if one has been constituted.

The Director is responsible for administering the funds necessary for advertising and recruitment. The Program Administrator will carry out the administrative duties associated with recruitment.

SECTION 8. TRAINEE ADVISING

8.1 Composition of Student Advisory Committees

Each student will be assigned an Advisory Committee by the Executive Committee upon enrollment in the MCB Program (prior to his/her matriculation from the one year MCB Program and transition to a PhD degree program in a participating department. The Advisory Committee will consist of two participating faculty members. The Committee Chair will be the student's thesis advisor when a participating faculty has been asked and agreed to accept that role. If an Advisory Committee member cannot complete his/her term, the Executive Committee will appoint a replacement. It is the responsibility of all participating faculty to serve, when asked, on at least one Advisory Committee each year.

8.2 Duties of Student Advisory Committees

Each committee will meet with its advisee, prior to his/her enrollment in the one year MCB Program, to discuss course and research related issues. Subsequent meetings will occur twice during the year, once at the end of the fall quarter and once in the end of the winter quarter. At each meeting, lab and course performance for the just completed quarter will be discussed and classes/lab rotations for the coming quarters adjusted as necessary.

In the event a student receives a grade lower than a B in any course during any quarter, or an unsatisfactory rotation grade, this will result in the student being recommended for academic probation. The committee will discuss the situation with the advisee and may also confer with relevant course director/s or rotation advisors regarding the trainee's performance. The committee will inform the Executive Committee of the academic probation, and recommend action(s) that should be taken to remedy the situation. Such recommendations may vary from proposing remedial work to expulsion from the program.

In the event that a trainee fails to successfully complete the program – as defined in Section 6 – the trainee will not be automatically assured admission to continued graduate training in each of the participating departments or any other academic unit at UCI.

8.3 Reporting

The chair of each advisory committee will report to the executive committee on the progress of each trainee twice a year.

8.4 Dissolution

The responsibilities of each Advisory Committee will be concluded when its student has completed all requirements and awarded the PhD degree or has left the degree program.

APPENDIX I POTENTIAL PARTICIPATING FACULTY

A current list of potential participating faculty is provided below, arranged by department of affiliation.

Anatomy and Neurobiology
- Ivan Soltesz
- Anne Calof

Biomedical Engineering
- James Brody
- Vittorio Cristini
- Steve George
- Noo Li Jeon
- Ghasaan Kassab
- Andrew Putnam
- Philip Sheu
- Bruce Tromberg
- Vasan Venugopalan

Chemistry
- Shaul Mukamel
- Douglas Tobias
- Gregory Weiss

Computer Science
- Pierre Baldi
- Dennis Kibler
- Rick Lathrop
- Eric Mjolsness
- Padhraic Smyth

Developmental and Cell Biology
- Lee Bardwell
- Steve Gross
- Lan Huang
- Taosheng Huang
- Arthur Lander
- Larry Marsh
- Tau-Mu Yi

Ecology and Evolutionary Biology
- Robin Bush
- Steven Frank
- Anthony Long
- Dominic Wodarz

Mathematics
- Natalia Komarova
- John Lowengrub
- Qing Nie
- Knut Solna
- Frederic Wan
- Jack Xin
- Hong-Kai Zhao

Microbiology and Molecular Genetics
- Wes Hatfield
- Marian Waterman

Molecular Biology and Biochemistry
- Melanie Cocco
- Harmut Luecke
- Ray Luo
- Alex McPherson
- Thomas Poulos
- Sheryl Tsai

Neurobiology & Behavior
- Frances Chance

Physics
- Philip Collins
- Mike Dennin
- Wilson Ho
- Thorsten Ritz
- Clare Yu

Physiology and Biophysics
- Nancy Allbritton
- Frances Jurnak
- Janos Lanyi
- Stephen White

Statistics
- Gang Liang
- Hal Stern

APPENDIX ii DATA TO BE GATHERED FOR ANNUAL INTERNAL REVIEW OF THE PROGRAM

Admissions.

- Number of applicants (domestic and foreign)
- Number accepted
- Number enrolled
- Qualifications of applicants, including previous institution, degree and year, GRE scores and GPA.

Academic Performance.

- Grades
- Comprehensive exam results
- Rotation reports
- Advising Committee reports
- Attrition rates

Student Outcomes.

- Honors
- Awards
- Publications
- Time to degree
- Subsequent employment

APPENDIX III MCB GRADUATE PROGRAMS in CALIFORNIA

Most universities in the United States offer graduate programs in fields related to mathematical and computational biology. Sometimes the student may have to search for individual professors with MCB research interests. Since MCB can be found in a number of guises, the following key words sorted by typical departments are offered to aid in your students' search:

Mathematics	Mathematical Biology, Pattern Formation and Complexity
Computer Science	Computational Biology, Bioinformatics
Biology	Theoretical Biology
Physics	Biological Physics, Nonlinear Dynamics, Complex Systems

(Beware the term "biophysics". This usually implies studies of molecular structure and function.) As indications of the growing interest and investment in this field, we show below MCB graduate programs in major research institutions in the State of California:

The UC System

UC Berkeley
Computational and Genomic Biology Graduate Program (a gateway program)
http://computationalbiology.berkeley.edu/

UC Davis
Center for Neurosciences
http://neuroscience.ucdavis.edu/about/
Neuroscience Graduate Program
http://neuroscience.ucdavis.edu/grad/
Institute for Data Analysis and Visualizatgion
http://www.cipic.ucdavis.edu/
Bioinformatics and Data Analysis Research Group
http://bioinfo.idav.ucdavis.edu/
Visualization and Graphics Research Group
http://graphics.idav.ucdavis.edu/
Research Focus Group (RFG) in Mathematical Biology
http://www.math.ucdavis.edu/~mogilner/RFG.html
Graduate Group in Ecology
http://ecology.ucdavis.edu/

UCLA
Department of Biomathematics
http://www.biomath.medsch.ucla.edu/GraduateProgram/

UC Riverside
Graduate Program in Genetics, Genomics & Bioinformatics
http://www.genetics.ucr.edu/

UC San Diego
Computational Neurobiology Training Program (in the Neurosciences Graduate Program) – http://biology.ucsd.edu/grad/CN_overview.html

UC San Francisco
Center for Computational Proteomics research
http://www.ccpr.ucsf.edu/center.html
Graduate Program in Biological and Medical Informatics
http://www.bmi.ucsf.edu/

UC Santa Barbara
Bioinformatics
http://www.cs.ucsb.edu/~ambuj/bioinformatics.html
Center for Bio-Image Informatics
http://www.bioimage.ucsb.edu/

UC Santa Cruz
Bioinformatics & Computational Biology at UCSC
http://www.cbse.ucsc.edu/research/research_bioinf.shtml

Other Major California Research Institutions

Caltech
Center for Computational Biology
http://www.compbio.caltech.edu/
Bioinformatics and Computational Biology Software
http://sea-urchin.caltech.edu/software/
Computational Physiology (Endocrinology)
http://www.galcit.caltech.edu/~ravi/biology.html

Stanford
Mathematical and Computational Biology Track (in Department of Mathematical and Computational Science)
http://www.stanford.edu/group/mathcompsci/academics.html
Computational Methods for Structural Biology
http://med.stanford.edu/school/structuralbio/

USC
Molecular and Computational Biology
http://www.usc.edu/dept/LAS/biosci/mcb/
Computational molecular biology and bioinformatics
http://www-hto.usc.edu/
Computational Learning and Motor Control Laboratory
http://www-clmc.usc.edu/
Computational Neuroscience and Neural Engineering
http://www.usc.edu/dept/nbio/ngp/research/res-comp.shtml

APPENDIX IV ADDITIONAL MCB EDUCATIONAL AND RESEARCH INFORMATION

We list below educational and research programs at selected non-California major research institutions. We do this in three separate categories: the remaining Pac-10 institutions, selected major research institutions in North America, and a few institutions in United Kingdom.

OTHER PAC-10 INSTITUTIONS

University of Arizona
Mathematical Biology (Department of Mathematics)
http://math.arizona.edu/research/mathematicalbiology.html

Arizona State University
Computational Biossciences
http://lifesciences.asu.edu/compbiosci/text/courses.htm
Southwest Consortium for Theoretical and Mathematical Biology (SCTMB)
http://mtbi.asu.edu/~swc/

University of Oregon
Bioinformatics
http://www.cs.uoregon.edu/research/index.html#link2
Institute of Neuroscience
http://www.neuro.uoregon.edu/ionmain/htdocs/grdbroch/cogn.html

Oregon State University
Northwest Alliance for Computational Science & Engineering
http://www.nacse.org/top/interfaces/teaching.html

University of Washington (Home of James D. Murray)
Computational Molecular Biology
http://depts.washington.edu/cmolbiol/
Computational Biology Research Group
http://compbio.washington.edu/
Mathematical Biology
http://www.amath.washington.edu/~mbjc/links.html

The Department of Bioengineering

The Center for Quantitative Science
The NSF Science and Technology Center for Molecular Biotechnology
(a genome center)

Washington State University (R.H. Dillon,)
Genomics, Proteomics, and Informatics
http://research.wsu.edu/missions_dc/genomics_proteomics_informatics/reinholdmann.html
Computational Neuroscience
http://www.vetmed.wsu.edu/depts-vcapp/neurosci/comp_neuro_curriculum.asp

IVY LEAGUE UNIVERSITIES

Brown University
Ecology and Evolutionary Biology
http://www.brown.edu/Departments/EEB/przeworski/research.htm
Computational Biology
http://www.brown.edu/Administration/Registrar/Concentration/Concentration-26.htm

Columbia University
Genomic Informatics
http://genome4.cpmc.columbia.edu/geno_info.html
Department of Biomedical Informatics
http://www.dmi.columbia.edu/
Biomedical Engineering
http://www.engineering.columbia.edu/students/academics/dept/bioe.php

Cornell University
Mathematical Biology Research Group in T & AM
http://tam.cornell.edu/MathBio.html
Computational Biology Program in CIS http://www.cis.cornell.edu/cb/graduate.htm
http://www.cis.cornell.edu/cb/undergrad2.htm

Dartmouth College
M.D. – Ph.D. Program in Computational Biology
http://www.cs.dartmouth.edu/~mdphd/
Biophysics at Dartmouth
http://www.dartmouth.edu/~biophys/

Harvard University
(Home of Martin Nowak)
Program for Evolutionary Dynamics
http://www.ped.fas.harvard.edu/nowak.htm
HMS Lipper Center for Computational Genetics
DFCI Department of Biostatistical Science
HSPH Biostatistics Department
HHMI HMS Genetics Computational Resources
HMS BBS Graduate Studies
HMS Lipper Center for Computational Genetics

University of Pennsylvania
Genomics and Computational Biology (GCB)
http://www.med.upenn.edu/gcb/index.shtml

Princeton University
(Home of Simon A. Levin, Founder of Society of Mathematical Biology)
The PEI (Princeton Environmental Institute) Center for Biocomplexity
http://www.eeb.princeton.edu/~simon/cbc/cbc.html - Simon Levin

Yale University
Computational Biology & BioinformaticS
http://www.yale.edu/graduateschool/academics/computationalBiology.html

OTHER SELECTED AMERICAN INSTITUTIONS

(Notes: Many of these excellent institutions have a variety of graduate programs that are worth investigating. The links shown below have either appeared through their connections with mathematical biology web sites, or related interests.)

Brandeis University
Mathematical Biology Program
http://www.bio.brandeis.edu/biomath/menu.html

Florida State University
Biomedical Mathematics
http://www.math.fsu.edu/%7Equine/biomed.html

North Carolina State University,
Biomathematics Graduate Program

Northwestern University
Computational Biology and Bioinformatics (CBB)
http://cbb.cs.northwestern.edu/

DIMAC (Center for Discrete Mathematics and Theoretical Computer Science)
Special Years on Mathematical and Computational Biology
http://dimacs.rutgers.edu/Workshops/index-mb.html
http://dimacs.rutgers.edu/SpecialYears/1994_1995/index.html
http://dimacs.rutgers.edu/SpecialYears/1997_DNA/
http://dimacs.rutgers.edu/Workshops/DNAMapping/index.html
http://dimacs.rutgers.edu/SpecialYears/2002_Epid/
http://dimacs.rutgers.edu/SpecialYears/2000_2003/

Santa Fe Institute

University of Texas, Austin, Center for Nonlinear Dynamics

Department of Mathematics - University of Utah

Virginia Tech, Department of Entomology

Washington University (Seattle), Center for Studies in Demography & Ecology, and Molecular and Cellular Biology Department

Rice University

Keck center for Computational Biology at Rice

University of Pittsburgh
Keck Center for Advanced Studies in Computational Biology

SELECTED FOREIGN INSTITUTIONS

Canada

- McGill University, Concordia University, University of Chicago, University of Ottawa, and University of Waterloo
  Center for Nonlinear Dynamics in Physiology and Medicine,

- University of British Columbia
  Institute of Applied Mathematics

United Kingdom

- Universities of Edinburgh, Strathclyde and Aberdeen, Heriot-Watts and Leeds
  Biomathematics and Statistics Scotland (BioSS),

- Oxford University,
  Centre for Mathematical Biology
  Mathematical Biology Group, Department of Zoology
  http://www.zoo.ox.ac.uk/newsite/groups/mathbiol/math-biol-frontpage.html
  http://www.zoo.ox.ac.uk/newsite/groups/mathbiol/may-bio.html

- University of St. Andrew, Scotland,
  Sea Mammal Research Unit

APPENDIX V

RESEARCH FUNDING
Complex Biological Systems Initiatives
http://www.nigms.nih.gov/funding/complex_systems.html

- Summary of the Initiatives
  http://www.nigms.nih.gov/funding/complex_summary.html
- Publicity Flyer (pdf)
- NIGMS National Centers for Systems Biology
  http://grants.nih.gov/grants/guide/rfa-files/RFA-GM-05-010.html
  Request for Applications GM-05-010, September 22, 2004
- NIGMS Funds Center for Quantitative Biology
  http://www.nigms.nih.gov/news/releases/quantitative_bio_center.html
  News Release, August 31, 2004
- NIGMS Centers of Excellence in Complex Biomedical Systems Research
  http://grants.nih.gov/grants/guide/rfa-files/RFA-GM-03-009.html
  Request for Applications GM-03-009, April 29, 2003
- Changing the Face of Biology: NIGMS Funds Centers of Excellence at Harvard and MIT Seeking to Unravel the Complexities of Living Systems
  News Release, September 15, 2003
- NIGMS Funds Complex Biomedical Systems Research Centers
  News Release, August 2, 2002
- Mentored Quantitative Research Career Development Award
  Program Announcement PA-02-127, July 10, 2002
- Genetic Architecture, Biological Variation, and Complex Phenotypes
  Program Announcement PA-02-110, May 29, 2002
- Joint DMS/NIGMS Initiative to Support Research Grants in the Area of Mathematical Biology
  http://www.nsf.gov/cgi-bin/getpub?nsf02125
  NSF 02-125, May 13, 2002
- NIGMS and NSF Grants Join Math and Biology
  http://www.nigms.nih.gov/news/releases/biomath.html
  News Release, August 22, 2002
- Integrative and Collaborative Approaches to Research
  http://grants.nih.gov/grants/guide/pa-files/PA-03-127.html
  Program Announcement PA-03-127, May 20, 2003

NIGMS Funds Complex Biomedical Systems Research Centers

Contact: Alisa Zapp Machalek, (301) 496-7301
August 2, 2002

To encourage computational approaches that will deepen understanding of biological processes, the National Institute of General Medical Sciences has established Centers of Excellence in Complex Biomedical Systems Research. NIGMS anticipates spending a total of $25.5 million over the course of five years to support the centers.

After decades of research, scientists have amassed a wealth of data on the characteristics and functions of individual biological molecules. The focus now is on investigating how these molecules interact. Central to this effort is modeling and predicting the behavior of complex biological systems, which draws on the expertise and approaches of quantitative scientists--including mathematicians, physicists, computer scientists, and engineers--as well as those of biologists.

"NIGMS is excited about the opportunity to nurture the growth of this important new area of biomedicine," said Dr. Judith H. Greenberg, acting director of NIGMS. "We anticipate that the new centers will develop creative approaches to address significant biomedical problems by combining the expertise of outstanding scientists working across disciplinary boundaries. We also expect these centers to lead the way in training the next generation of researchers in computational biology."

The new NIGMS centers are designed to support the development of multi-investigator teams that can address biomedical complexity through research, training, workshops, symposia and other forms of outreach. The awards promote innovation and permit a larger scope of activity than would be possible via research grants to individual investigators.

Two new center awards, totaling $4.5 million for the first year of funding, were made to:

- University of Washington, Friday Harbor Laboratories in Friday Harbor, San Juan Island, Wash. (Garrett M. Odell, Ph.D., principal investigator)--$2.1 million to investigate how groups of genes control a variety of key biological processes, including the development of embryos and the functional and mechanical organization of cell structure and motion. Outreach activities will include creating and disseminating to the scientific community software to visualize and model data, hosting guest researchers and teaching yearly apprenticeship courses to recruit undergraduate biology students to careers in computational biology.

- Case Western Reserve University in Cleveland, Ohio (Gerald M. Saidel, Ph.D., principal investigator)--$2.4 million to create the Center for Modeling Integrated Metabolic Systems (MIMS), an effort to mathematically model and simulate metabolism in skeletal muscle, brain and liver tissue in response to stresses associated with exercise, diet and oxygen supply. MIMS will extend its reach beyond Case Western Reserve by establishing a partnership with Cleveland State University, which has a substantial population of undergraduate students

who are members of minority groups that are underrepresented in biomedical research careers.

In addition, NIGMS will support three planning grants to lay the groundwork for future centers of excellence at:

- Boston University (Charles DeLisi, Ph.D., principal investigator)--to conduct a pilot study of the interactions between two signaling pathways controlling cell growth and death in human cells. The effort will also organize a large group of faculty members representing computer science, experimental and clinical science, and statistics to begin planning a cross-disciplinary educational program for undergraduates.

- University of California, Irvine (Arthur Lander, Ph.D., principal investigator)--to foster collaborations between research faculty members in cell biology, developmental biology, physiology and medicine. The group plans to devise software engineering principles to simulate large biological systems.

- University of New Mexico in Albuquerque (Janet Oliver, Ph.D., principal investigator)--to develop plans to establish the Center for Spatiotemporal Modeling of Cell Signaling Networks. The project's goals are to use computational modeling to understand complex cell signaling circuits and to disseminate knowledge and tools to the broader research community. The center will recruit new faculty to conduct computational biology research and provide training programs for undergraduate, graduate and postdoctoral students to learn how to conduct interdisciplinary research to analyze complex biological systems.

# # #

NIGMS has recently developed several programs and initiatives in the area of complex biological systems. For a complete listing, see http://www.nigms.nih.gov/funding/complex_systems.html

For more information about NIGMS' Center for Bioinformatics and Computational Biology, see http://www.nigms.nih.gov/news/releases/cbcb.html

For more information on NIH's Biomedical Information Science and Technology Initiative (BISTI), see http://grants1.nih.gov/grants/bistic/bistic.cfm

APPENDIX VI NIH and NSF TEAM UP TO LINK MATH AND BIOLOGY AT FEBRUARY 12 SYMPOSIUM

by Ann Dieffenbach (301) 496-7301
February 5, 2003

The future of biological research depends partly on mathematics.

Math is a key framework for organizing and making sense of the vast amounts of biological data that scientists have generated in recent years. For example, mathematical models are a powerful way to understand complex biological systems.

To bring more mathematicians into biological research, the National Institutes of Health and the National Science Foundation are partnering on a math-biology initiative. A component of this effort is an NSF-NIH symposium on "Accelerating Mathematical-Biological Linkages" on Wednesday, February 12, 2003. The symposium will highlight research opportunities at the math-biology interface and encourage collaboration between mathematicians and biological scientists.

As an illustration of the breadth of topics that mathematicians and biologists can address together, symposium sessions will cover conservation ecology, cell structure and function, and bioinformatics and computational problems. The keynote speaker will be Dr. Joel E. Cohen, head of the Laboratory of Populations at Rockefeller University and Columbia University and a MacArthur Foundation Fellow. His talk is titled "Mathematics Is Biology's Next Microscope ... Only Better; Biology Is Mathematics' Next Physics ... Only Better." Dr. Margaret Palmer, a professor of entomology and biology at the University of Maryland, College Park, will chair the symposium.

The symposium will run from 9:00 a.m. to 5:00 p.m. in Rooms E1/E2 of the Natcher Conference Center (Building 45) on the NIH campus in Bethesda, Md. The event is free, but registration is requested at http://www.bisti.nih.gov/mathregistration. The symposium agenda is at http://www.bisti.nih.gov/mathregistration/MathSchedule.pdf.

The partnership between NIH and NSF takes advantage of the strengths of each agency. NIH supports biomedical research and training, while NSF funds research and education in mathematics, biology and other areas of science and engineering.

The NIH sponsors of the meeting are the Office of the Director, the National Institute of General Medical Sciences and the National Center for Research Resources.

The NSF meeting sponsors are the Directorate for Biological Sciences and the Division of Mathematical Sciences in the Directorate for Mathematics and Physical Sciences.

APPENDIX VII EXAMPLES OF AVAILABLE FUNDING (Partial listing)

FUNDING FOR UNDERGRADUATE STUDENTS, TRAVEL & TEACHING

- SMB Landahl travel award
- AWM Travel Grants for Women: awm@math.umd.edu
- AWM Alice T Schafer Prize for female undergraduates
- AWM Louise Hay Award for Mathematics Education
- Graduate Student teachers: http://www.nsf.gov/cgi-bin/getpub?pr9912

FUNDING FOR MATH BIOLOGY GRADUATE STUDIES & POST-DOCS

The following agencies are known to fund Mathematical Biology research in North America

N.B. Specific disease foundations have varying tolerances for funding theoretical work, which can be ascertained through the organization itself. Ask, because the foundation may surprise you. From anecdotal evidence, agencies funding cancer, diabetes and even clinical research have supported mathematical research.

American Psychological Association/Neuroscience, US citizens. GS, PD, TG, M

GrantsNet, No citizenship requirements, GS, PD - searchable database

Human Frontier Science Program, (neuroscience). International exchange. PD

Lewis Thomas Fellowships in Computational and Physical Biology, Princeton. PD

Medical Research Council, Canadian citizens. GS, PD

Naval Research Laboratory Postdoctoral Fellowship Program, US citizens. GS, PD

National Institutes of Health, US citizens. GS, PD, M

National Science Foundation, US citizens. GS, PD, M

Natural Sciences and Engineering Research Council, Canadian citizens. GS, PD

The Program in Mathematics and Molecular Biology, no citizenship requirements. GS, PD

Santa Fe Institute Postdoctoral Fellowship in Complex Systems Studies, no citizenship requirements, PD

GS = Graduate Student Fellowships
PD = Post-doctoral
TG = Travel grants
M = Minority awards