# Computational and Systems Biology Initiative

## Goals and Priorities

The Computational and Systems Biology Initiative (CSBi) includes faculty, students, and staff from across MIT in an effort to link biology, computer science, and engineering in the study of complex biological phenomena. CSBi's mission is to advance research and education in the emerging field of systems biology and to pursue high-impact collaborations with companies engaged in biomedical and pharmaceutical research.

CSBi is currently active in four main areas:

- Multi-investigator research projects that integrate systematic experimentation and computational modeling
- Development of new technologies, particularly those involving microfabricated devices and sensors, for monitoring biological processes
- Creation of a new curriculum to educate the next generation of undergraduate and graduate students
- Outreach to a broad industrial and academic community interested in systems biology

The priorities for CSBi in 2005 include the following:

- Expanding the number and scope of CSBi-associated interdisciplinary research projects and promoting the active involvement of junior faculty
- Expanding and enhancing the CSB PhD program and securing a continuing source of funds for first-year students entering the program
- Building our annual symposium on systems biology into a central event in the calendars of systems biologists worldwide
- Encouraging economically disadvantaged, minority and female students to consider careers at the biology-engineering interface
- Strengthening ties with recently established research entities in the Boston area including the Broad Institute, the Bauer Center, and Systems Biology at Harvard Medical School

## Education and Training

In February 2004, the MIT faculty unanimously approved CSBi's new PhD program in computational and systems biology. This new curriculum has been developed under the direction of Professor Bruce Tidor (EECS and BE) and is the first of its kind in the United States. The program will serve as a blueprint for subsequent interdisciplinary education programs at MIT. The first class of four students will arrive at MIT in September 2004. Also in the 2003–2004 academic year, CSBi faculty taught the three recently developed Foundations courses in systems biology for the first time. These courses are a cornerstone of the new PhD program and include:

- Foundations of Bioinformatics and Computational Biology: this course provides broad coverage of the field with equal emphasis on sequence, structure, and systems analysis. The focus is on fundamental concepts rather than on the application of specific tools, the goal being to encourage and train students in the development of new methods.
- Foundations of Measurement in Biology: in this course, optics, structure, and microfabricated systems are discussed, as are sampling theory and data transformation. The goal is to train students in the fundamental physics and information theory behind experimental measurement with an eye to overcoming current limitations.
- Algorithms for Computational Biology: this course is a case-based study illustrating the power of tailoring questions in computational biology to the capabilities of contemporary algorithms and computer hardware.
- Topics in Computational and Systems Biology: the goal of this course is to use detailed discussions of selected research papers in the area of computational and systems biology to help students design new research projects.

CSBi awarded five graduate-level studentships and four postdoctoral fellowships under the auspices of the Merck-CSBi fellowship program. Awardees came from seven academic units in the Schools of Science, Engineering, and Management at MIT.

## Research

CSBi continues to play a leading role in the formation of new multi-investigator cross-disciplinary research programs. One such program focuses on systems and computational approaches to stem cell/tissue biology. This program is directed by Professor Paul Matsudaira (Whitehead and BE) and is being considered for funding by the Singapore-MIT Alliance (SMA II). In addition, CSBi and the MIT Center for Cancer Research (CCR) collaborated on a new cancer biology program currently under consideration for funding by the National Cancer Institute.

The NIH-funded Center of Excellence program in cell decision processes (CDP), under the direction of Professor Peter Sorger (Biology and BE), wrapped up its first year with a retreat involving sixty researchers from 15 centers, labs, and groups across the Institute. The CDP project is aimed at developing computational models of cell decision processes in human cells.

## Technology Development

The goal of the CSBi Technology Platform is to develop state-of-the-art technologies for systems biology research and to make them available to the research community at MIT. Key technology areas include high-performance computing, modeling and bioinformatics, imaging and image informatics, molecular genetics (microarrays and RNAi), microsystems, and proteomics. During the past year, CSBi hired six CSBi research scientists in all the key areas of the CSBi Technology Platform. These scientists are charged with integrating the technology development efforts and helping researchers across MIT gain access to complex, newly emerging technologies. To that

end, user groups and workshops have been established in mature technology areas such as high-performance computing, microarray technologies, and imaging. CSBi research scientist were also active in CSBi education and outreach efforts, hosting summer students and helping to teach lab courses in several departments.

### Junior Faculty Startup

In 2003-2004, CSBi helped to provide startup funds for two newly recruited junior faculty members, Forest White and Phil Bradley. Professor White (BE) is already leading the proteomics efforts at MIT and is interested in the quantification of dynamic changes in protein modifications using advanced protein mass spectrometry. Professor Bradley (Mathematics) is interested in computational biology and will start at MIT in fall 2004.

### Outreach

On January 8–9, 2004, CSBi sponsored and hosted the third Annual Symposium in Systems Biology at MIT. The second day of the meeting featured the directors of other leading systems biology efforts in the U.S. In addition, CSBi cosponsored the first International Meeting on Synthetic Biology, held at MIT on June 10–12, 2004. CSBi also launched its successful summer internship program for underrepresented minority students (six students) and provided significant support to the EECS Women in Technology Program aimed at bringing women into science and engineering.

### Leadership

In the summer of 2004, Professor Bob Sauer (Biology) assumed the position of chair of the CSBi Steering Committee. The previous chair, Professor Douglas Lauffenburger (BE and Biology) remains an active member of the committee. Professors Rafael Raif (EECS) and Chris Kaiser (Biology) joined the committee as representatives of their departments (a complete list of the current membership of the CSBi Steering Committee can be found at http://csbi.mit.edu/).

### Finances and Funding

CSBi administers a large federal grant in support of the CDP center ($16 million over a five year period) and has applied for several additional multi-investigator grants to federal and other funding sources. CSBi is also supported by a $4.25 million grant from an anonymous foundation for the CSBi Technology Platform and $2 million for the Merck-CSBi fellowship program in systems biology. EECS and CSBi were also honored to receive endowment support from an MIT alumnus for a new career development chair in computational biology.

**Peter Sorger, Director and Professor of Biology and Biological Engineering**
**Brigitta Tadmor, Executive Director**

*More information about the Computational and Systems Biology Initiative can be found online at http://csbi.mit.edu/.*