THE UNIVERSITY OF MASSACHUSETTS
LIFE SCIENCES TASK FORCE

AMHERST | BOSTON | DARTMOUTH | LOWELL |WORCESTER

A University-wide Plan to Strengthen the Life Sciences and Promote Inter-campus Collaboration Over the Next Five Years

AUGUST 2008

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I. Executive Summary

The University of Massachusetts Life Sciences Task Force (UMass LSTF) was established in Academic Year 2007-2008 and charged with crafting a university-wide aspirant vision in the life sciences and promoting inter-campus collaboration. Its formation was the result of a recognition that there exists with the university no single entity better positioned to realize the potential created by continued investment in the life sciences and the economy of all the regions of the state. Therefore, the more expeditiously the university could develop a comprehensive, aspirant plan, the better positioned it would be to make a compelling case to the commonwealth, as well as to other entities, that investment in, and partnership with the five campuses, would advance the life sciences super cluster in Massachusetts and beyond.

The creation of the UMass LSTF represented an important—and timely—juncture for the university. Given the recent establishment of the position of Senior Vice President for the Health Sciences, the convening of a broad representation of senior administrators, faculty and staff, all of whom were committed to fostering university initiatives in the life sciences, provided the university an excellent opportunity to enhance inter-campus collaboration in the development of a life sciences strategy that capitalizes on a tremendous moment in the university's history—a moment when the commonwealth's emergent life sciences vision, highlighted by the passage of a ten-year, $1 billion Life Sciences Initiative in which the university is featured prominently as a partner of the commonwealth, intersects with a critical point in the future of life sciences research, as evidenced by the incredible potential of regenerative medicine, RNAi, biomaterials and nanotechnology, among other areas where the university has developed significant strengths.

Upon convening, the task force decided it most prudent to organize its efforts into six working groups, each responsible for crafting focused reports on life sciences thematic areas, represented as pillars, developed by the task force. Those pillars were: Shared Infrastructure and Additional R&D; Advanced Therapeutics; Nanotechnology; Technology Innovation Centers; Workforce and Policy Initiatives; and Health, Disease and Behavior.

Each of the working groups conducted thorough situational analyses of campus and university-wide research activities that occur within its thematic areas, and subsequent to the analyses, provided a series of recommendations to the task force. The complete sets of recommendations are included in Chapters III to VIII of this report.

Presented with these content-specific recommendations, the UMass LSTF identified common themes and endorsed them as "UMass LSTF Recommendations." The UMass LSTF further characterized those recommendations as mission or implementation related.

With respect to the former, the UMass LSTF has focused on recommendations that strengthen the university's historic roles in education, research and outreach, in the context of the life sciences. With respect to the latter, the UMass LSTF has focused on recommendations to enable the successful implementation of the university's life sciences mission.

Central to the recommendations of the UMass LSTF, which follow, is the task force's acknowledgement of, and support for, the mission of the commonwealth's public research university to provide an affordable and accessible education of high quality and to conduct programs of research and public service that advance knowledge and improve the lives of the people of the commonwealth, the nation and the world.

The university's mission is built, and continues to thrive upon, a foundation of excellence in teaching—in the classroom, the laboratory, the field and online. The UMass LSTF supports vigorously this mission, with a particular emphasis on the importance of teaching and scholarship, and wishes to reaffirm it in the context of the life sciences.

UMass LSTF Recommendations | Mission-related Recommendations

1) **Attract, Retain and Graduate University Students in STEM Degree Programs Who are Well-prepared for Professional Careers in Diverse Life Sciences Fields:**

   The UMass LSTF recommends that more resources and focus be given to support campus efforts to increase the number of students prepared for, recruited to, and successful in, STEM degree programs and the growing and dynamic life sciences industry.

2) **Focus on Existing University R&D Strengths in the Life Sciences:**

   The UMass LSTF recommends strategic focus and investment, broadly defined, in the following areas: regenerative medicine; stem cell biology; RNA biology; gene therapy; health and bioinformatics; computational and biostatistical sciences; tissue engineering; biomaterials; diagnostics; nursing; health, disease and behavior; clinical laboratory science; public health; natural products; and nanotechnology, as it is applied in therapeutics, clinical diagnostics and disease prevention.

3) **Develop a Network of University-led or Supported Regional Innovation Centers Across the Commonwealth:**

   The UMass LSTF recommends the development of regional technology innovation centers, which can provide the university with effective vehicles for linking its

research and educational capabilities with the innovation needs of the life sciences industry.

UMass LSTF Recommendations | Implementation-related Recommendations

4) Continue University-wide Support of Life Sciences Collaborative Efforts:

The UMass LSTF recommends that a system-wide steering committee, similar in broad, collaborative membership as the task force, be established to continue the excellent relationships that were nurtured during the work of the UMass LSTF. This committee should consider expanding the scope of life sciences to include non-biomedical areas, as well as helping to facilitate a chancellor-level discussion on how to move the university's comprehensive life sciences mission forward.

5) Establish the University of Massachusetts Center for Clinical and Translational Science:

The UMass LSTF recommends the establishment of the University of Massachusetts Center for Clinical and Translational Science (UMCCTS) as a new vehicle for collaborative clinical and translational R&D and education within the system.

6) Establish Life Sciences-specific Seed Funding:

The UMass LSTF recommends the establishment of life sciences-specific seed funding to promote inter-campus collaboration and to augment the highly successful President's Science and Technology Fund.

7) Establish the University of Massachusetts Core Facilities Steering Committee to Develop New Models for Inter-campus Sharing of Core Facilities:

The UMass LSTF recommends the establishment of the University of Massachusetts Core Facilities Steering Committee to develop and implement a plan to improve inter-campus sharing of university cores.

8) Develop Organized and Funded Programs of Inter-campus Retreats, Symposia, Seminars and Visiting Professorships:

The UMass LSTF recommends the development of a program of inter-campus retreats, symposia, seminar series and summer visiting professorships, to promote active and sustained interaction among university colleagues from the five

campuses, as well as to enhance partnerships with state and private institutions and industry.

9) **Undertake a Systematic Review of Administrative, Regulatory and Statutory Barriers that Inhibit Inter-campus Collaboration and Prevent the University from Acting in an Entrepreneurial Manner:**

   The UMass LSTF recommends a thorough review of the barriers, existing at multiple levels within the university system and between the university and external entities, which prevent the campuses from sharing and collaborating effectively with each other and with strategic partners.

10) **Pursue Capital and Operating Funding to Enhance University Life Sciences Infrastructure and Research Initiatives:**

   The UMass LSTF recommends that the university, acting with a single, unified voice, pursue aggressively capital and operating funding from the commonwealth and other funding agencies, as well as from industry partners, to enhance the university's life sciences infrastructure and to support the university's life sciences initiatives.

Taken together, the recommendations, put forward by the UMass LSTF, document that the university is poised to achieve its full potential as a world-class research university, particularly in the life sciences, dependent upon a commitment of the five campuses and its life sciences leadership to collaborate actively and to integrate the many resources and expertise that exist throughout the university system and in the government, private research institutions and life sciences industry of the commonwealth.

Most importantly, the recommendations make clear that there exists a willingness and desire of the members of the UMass LSTF—the life sciences leaders of the university—to continue to work together actively and collaboratively to implement strategies that advances the university's position as a world-class center of life sciences education, research and innovation.

II. Introduction

❖ FORMATION OF THE UNIVERSITY OF MASSACHUSETTS LIFE SCIENCES TASK FORCE

University of Massachusetts President Jack M. Wilson, Ph.D., in response to Governor Deval L. Patrick's May 2007 announcement of the commonwealth's 10-year, $1 billion Life Sciences Initiative, established the position of Senior Vice President for the Health Sciences to oversee and coordinate the five-campus system's efforts and initiatives in the health and life sciences. President Wilson's creation of the new Senior Vice President for the Health Sciences position signaled clearly to the university community and the Commonwealth of Massachusetts that the state's public research university would position itself as a leader in life sciences-related education, research and technologies.

President Wilson named Michael F. Collins, M.D. as Senior Vice President for the Health Sciences for the University of Massachusetts and Interim Chancellor of the University of Massachusetts Medical School in June 2007. During the summer months, Senior Vice President Collins visited each campus to: engage with leaders in the life sciences; more fully understand the breadth and depth of life sciences-related activities occurring on each campus; and discuss opportunities for inter-campus collaboration.

Emanating from those campus interactions was a desire to bring together leaders from throughout the university to develop a system-wide aspirant plan in the life sciences. The effort to convene a university-wide group was accelerated, in large part, by a tremendous moment in the university's history—a moment when the commonwealth's emergent life sciences vision, in which the university continues to be featured prominently as a partner of the commonwealth, intersects with a critical juncture in the future of life sciences research, as evidenced by the incredible potential of RNAi, stem cells, biomaterials and nanotechnology, among many other exciting advances.

Taking into account this "life sciences moment," it was decided by the president and campus chancellors that the best and most efficient structure from which to define the university's aspirant vision would be through the creation of the University of Massachusetts Life Sciences Task Force, referred to herein as the UMass LSTF. Moreover, the university leadership believed that the more expeditiously it could develop a comprehensive, system-wide life sciences aspirant plan, the better positioned the university would be to make a compelling case to the commonwealth, as well as to other entities, to invest in, and partner with, the five campuses to advance the life sciences super cluster[1] in Massachusetts and beyond.

[1] As defined in *Super Cluster: Ideas, perspective and updates from the Massachusetts life sciences industry*, PricewaterhouseCoopers, April, 2007

Subsequent to reaching consensus on establishing the UMass LSTF in September 2007, Senior Vice President Collins solicited recommendations for participation in the task force from the campus chancellors. After receiving five to seven recommendations from each campus, Senior Vice President Collins, in conjunction with the president and campus chancellors, worked to ensure that the composition of the UMass LSTF included expertise in all the multifaceted life sciences areas that were identified during the campus life sciences meetings.

The following members of the university community participated on the UMass LSTF:

UMass LSTF Chair	**Michael F. Collins, M.D.** Senior Vice President for the Health Sciences, University of Massachusetts Interim Chancellor, UMass Worcester
UMass LSTF Staff	**Brendan H. Chisholm** Director of Health Sciences Initiatives UMass Worcester
UMass Amherst	**John J. Cunningham** Deputy Provost **Steven D. Goodwin, Ph.D.** Dean, College of Natural Resources & Environment **Michael F. Malone, Ph.D.** Ronnie and Eugene Isenberg Distinguished Professor of Engineering; Dean, College of Engineering **Nancy L. Cohen, Ph.D., R.D., L.D.N.** Interim Dean, School of Public Health & Health Sciences **Paul T. Kostecki, Ph.D.** Vice Provost for Research **George M. Langford, Ph.D.** Dean, College of Natural Sciences and Mathematics **T.J. Mountziaris, Ph.D.** Professor and Department Head, Chemical Engineering
UMass Boston	**Winston E. Langley, Ph.D., J.D.** Interim Provost

UMass Boston	**Paul J. Fonteyn, Ph.D.** Provost and Senior Vice Chancellor for Academic Affairs **Andrew J. Grosovsky, Ph.D.** Dean, College of Science and Mathematics **Richard Antonak, Ed.D.** Vice Provost for Research **Joan Becker, Ed.D** Associate Vice Provost for Academic Support Services **Stephen P. Crosby, J.D.** Dean, McCormack Graduate School of Policy Studies **Greer Glazer, Ph.D, F.A.A.N., R.N., C.N.P.** Dean, College of Nursing and Health Sciences
UMass Dartmouth	**Anthony J. Garro, Ph.D.** Provost and Vice Chancellor for Academic Affairs **William Hogan, Ph.D.** Dean, College of Arts and Sciences **Robert E. Peck, Ph.D.** Dean, College of Engineering **Paul Vigeant** Assistant Chancellor for Economic Development **Louis J. Petrovic, Ph.D.** Assistant Vice Chancellor for Research Development
UMass Lowell	**Ahmed Abdelal, Ph.D.** Provost **Jacqueline Moloney, Ed.D.** Executive Vice Chancellor **Partha Chowdhury, Ph.D.** Interim Vice Provost for Research **David H. Wegman, M.D., M.P.H.** Dean, School of Health and Environment

UMass Lowell	**Stephen McCarthy, Ph.D.** Professor, Plastics and Engineering; Director, Massachusetts Medical Device Development Center **Carl W. Lawton, Ph.D.** Associate Professor, Chemical Engineering; Director, Massachusetts Biomanufacturing Center **Susan J. Braunhut, Ph.D.** The University Professor; Professor, Biological Sciences
UMass Worcester	**Terence R. Flotte, M.D.** Executive Deputy Chancellor and Provost & Dean of the School of Medicine **Anthony Carruthers, Ph.D**. Dean, Graduate School of Biomedical Sciences **Paulette Seymour Route, Ph.D., R.N.** Dean, Graduate School of Nursing **John L. Sullivan, M.D.** Vice Provost for Research **James P. McNamara, Ph.D.** Executive Director, Office of Technology Management **Judith K. Ockene, Ph.D.** Interim Vice Provost for Faculty Administration; Division Chief, Preventive and Behavioral Medicine
UMass President's Office	**Thomas J. Chmura** Vice President, Economic Development **Jeffrey Brancato** Associate Vice President, Economic Development **Marcellette G. Williams, Ph.D.** Senior Vice President for Academic Affairs, Student Affairs and International Relations **Abigail A. Barrow, Ph.D.** Director, Massachusetts Technology Transfer Center **Michael Goodman, Ph.D.** Director of Economic and Public Policy Research, Donahue Institute

Process and Work Plan

At the first meeting of the UMass LSTF, held in November 2007, President Wilson conveyed to the task force the central mission of its work: to develop an aspirant vision in the life sciences for the university over the next three to five years and to promote inter-campus collaboration in life sciences initiatives. Also at the first meeting, the UMass LSTF discussed, and reached consensus on, the structure from which to best organize the work of the task force. It was decided that the task force would create six working groups, each focused on a specific thematic area, or pillar, related to the life sciences and of particular interest to the university into the future. Those working groups were: Shared Infrastructure and Additional R&D; Advanced Therapeutics Cluster; Nanotechnology; Technology Innovation Centers; Workforce and Policy Initiatives; and Health, Disease and Behavior [visual depiction of these pillars found in Attachment 1].

From November to December 2007, the working groups of the UMass LSTF were populated with experts to ensure that they would provide the task force with substantive and actionable information. Subsequent to the organization of the working groups, the UMass LSTF requested that they convene to begin discussing and providing information on the following topics:

- Are all of the subject areas that should be included in the pillar accounted for?
- What is each of the campuses doing in those subject areas within the pillar?
- Are there examples of inter-campus collaborative efforts within the subject areas that could be used as potential models going forward?
- In a UMass aspirant vision for the life sciences, could you prioritize which subject areas are more critical for the future of life sciences efforts within the university?
- What would a university-wide aspirant vision in the pillar look like?
- How much would it cost?
- What would be the appropriate funding mechanisms?
- How would an aspirant plan in this pillar relate to aspirant plans in the other pillars?
- How could the subject areas within the pillar promote inter-campus collaboration?

Each of the working groups was then asked to present its progress and initial findings at the second meeting of the UMass LSTF, which occurred in February 2008. The six working group presentations provided the opportunity for the co-chairs of the working groups to consult with the task force membership, address inquiries and receive feedback. Following the second meeting of the UMass LSTF, the working groups were encouraged to continue to meet regularly and begin to write sections of their reports, with a particular focus on thinking actively about ways in which the five campuses could undertake more meaningful inter-campus collaborations.

At the third meeting of the task force in April 2008, the task force requested that the working groups present their preliminary findings and recommendations so that UMass LSTF members could begin to receive a more complete sense of the extent and scope of the findings and recommendations.

The final meeting of the UMass LSTF, which occurred in May 2008, focused on a discussion of the working group's final reports and the formulation of the task force's final report. Task force members were asked to provide input into the recommendations of the working groups, as well as to help structure the final task force report [timeline of the UMass LSTF process found in Attachment 2].

III. Shared Infrastructure and Additional R&D Working Group

❖ INTRODUCTION

The Shared Infrastructure and Additional R&D Working Group's charge was to identify research activities in the fields of stem cell biology and regenerative medicine, bioinformatics, tissue engineering, diagnostics, biomaterials and computational sciences on the five campuses that require, now or in the near future, major core facilities. The working group was chaired by Susan J. Braunhut, Ph.D., The University Professor and Professor of Biological Sciences on the Lowell campus.

Other members of the working group included:

- Richard Antonak, Ed.D, Vice Provost for Research on the Boston campus;
- Sankha Bhowmick, Ph.D., Associate Professor of Mechanical Engineering on the Dartmouth campus;
- Bridgette Budhlall, Ph.D., Assistant Professor of Plastics Engineering on the Lowell campus;
- Tom Costello, Ph.D., Chief Information & Facilities Officer on the Lowell campus;
- Bret Jackson, Ph.D., Professor of Physical Chemistry on the Amherst campus;
- Robert Peck, Ph.D., Dean of the College of Engineering on the Dartmouth campus;
- Dan Simovici, Ph.D., Professor of Computer Science on the Boston campus;
- John L. Sullivan, M.D. Vice Provost for Research on the Worcester campus; and
- Ralph Zottola, Ph.D., Associate Chief Information Officer on the Worcester campus.

In order to achieve its charge, the working group devised a work plan, the overview of which follows:

1) Compile a list of all core facilities on each campus that support and foster life sciences research activities;

2) Evaluate current practices of core usage, fee structure, and access for non-host institutional UMass investigators and non-UMass investigators;

3) Evaluate overlap, unique resources and identify needs across the five-campus cores; and

4) Develop strategies to improve awareness of cores, ease of use of cores and equitable fee structures.

The group reached consensus on recommendations by engaging in meetings, teleconferences, email correspondence and participation by representatives from all five campuses.

Situational Analysis

❖ STEM CELL INITIATIVE (REGENERATIVE MEDICINE)

The university will create a stem cell bank and registry to archive and distribute non-National Institutes of Health (NIH) approved lines of human embryonic stem cells, as well as for animal stem cells. The lines will be made available to investigators around the world to support basic and applied research on stem cell development and differentiation. The registry will centralize information on these, and future distinct lines, in a format that will provide a searchable database to the scientific community throughout the world.

The Worcester campus will lead the human embryonic stem cell effort, of which the bank and registry are components. The Amherst campus will lead the animal stem cell effort, including mice, of which the animal embryonic bank and registry are components. The Dartmouth campus has a GMP facility that could be leveraged in this effort, and there are funded regenerative medicine projects on the Boston and Lowell campuses that will utilize these resources. Also, stem cell biology courses are taught on the UMass Lowell campus.

Core facilities exist in animal medicine, flow cytometry, siRNA, microscopy imaging, deep sequencing, genomics and the creation of cell cultures to support these efforts on the Amherst and Worcester campuses. An upgraded flow cytometry facility is especially critical for enabling stem cell research throughout the university. In general, these core facilities and others should be competitively priced for university investigators outside the host institutions.

Currently, federal funding for human embryonic stem cell research is limited, and will not support those lines that the university plans to deposit and disseminate through its banking activities. Consequently, the core facilities that support these efforts require strong support from the commonwealth. The human embryonic bank and registry initiatives, which will be located on the Worcester campus, have secured state funding for first-year capital and operating support. However, the Worcester campus estimates that approximately $1.4 million in operating funds will be required to maintain and grow the bank's and registry's activities. Furthermore, the Amherst campus estimates that the

animal stem cell core and registry will require annual support of $200,000 per year. In order to generate some revenues from the these activities, the working group proposes that a fee structure be established similar to that used by NIH for shipping, handling and quality control of lines provided to the scientific community.

The stem cell bank and registry resources will be of value to investigators on all the campuses and will likely stimulate ongoing and additional research in the areas of regenerative medicine, stem cell biology and tissue engineering.

❖ BIOINFORMATICS, COMPUTATIONAL BIOLOGY AND COMPUTATIONAL SCIENCES

Computational sciences and informatics are essential to the success of the Massachusetts Life Sciences Initiative in that they are needed to support activities in medical modeling, imaging, cheminformatics, proteomics, metabolomics, genomics, artificial intelligence, systems biology and management of large clinical databases. Today, the conduct of science in all life sciences disciplines requires investigators to be able to access, analyze, mine and transfer large data sets.

The Amherst, Lowell and Worcester campuses have facilities and existing academic and research programs and faculty to support and encourage life sciences initiatives in informatics and computational sciences. The Boston and Dartmouth campuses have faculty and emerging strengths in these areas. Moreover, UMass Boston's Venture Development Center could support contact with the user community and provide training opportunities.

The university could benefit from system-wide enhancement of its IT infrastructure beyond desktop computing and basic networks. Although campus networks are in place with high quality data centers at several locations and instrumentation is generally above average across the system, there is no centralized link from which to coordinate the various resources that exist throughout the university. Furthermore, if specific expertise is needed for a project, there is no centralized service available to provide expertise profiles of investigators in the UMass system to investigators seeking collaborators from inside or outside the institution.

A high performance computing core service offered centrally to the entire university system is needed. This would consist of HPC systems, massive data storage, visualization systems, advanced instrumentation linked by high speed and a high capacity network. Critical missing pieces are Peopleware to work with researchers on programming, technicians to maintain and design security for these systems, massive and secure data

storage, shared special purpose instrumentation and a communications network. There is a software system called "Collexis" that could be purchased to increase substantially inter-campus collaboration. Once the software and the subscription is purchased, a UMass biomedical expert catalog list can be created and linked to other subscribers including the NIH, the World Health Organization, many top-tier private academic institutions and biotechnology-based companies. This software allows an institution to profile its investigators with regard to focus areas, publications, and expertise into a searchable database and permits effective networking within UMass and between UMass and other organizations.

Software, hardware and centralized coordinated planning are needed to provide a system-wide "footprint" to integrate and maximize capacity of the university computing functions. Furthermore, a HPC network would provide a linkage to other HPC systems outside the UMass system. The listing with Collexis would put UMass investigators within the broader life sciences "phone book." Additionally, facilities for enabling bioinformatics data analysis are critical to expand the research user base.

❖ TISSUE ENGINEERING AND BIOMATERIALS

The innovative design, manufacturing and characterization of novel biomaterials for biomedical applications and in basic life sciences research are major strengths within the university system. Biocompatible materials can be used to replace, restore or augment biological materials in biomedical applications, and also they may be used to create biosensors and create nanomachines, novel textiles, devices and instrumentation.

The Amherst and Lowell campuses have extensive, active and diverse faculty, as well as funded academic research programs in the areas of development, testing and application of biomaterials, high performance polymers, nano and biodevices, complex fluidics and MEMS and microsystems. The Amherst campus holds two National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship (IGERT) program awards for graduate student training in cellular engineering and nanotechnology, both of which have research and training components central to the design of cell and drug delivery systems. Graduate students training in the state-of-the-art interdisciplinary approaches will serve as a pipeline for workforce needs in Massachusetts. The Dartmouth campus has ongoing activities in the textile and materials areas, as well as the previously mentioned GMP facility. Also, the Boston campus has faculty with interest and emerging strengths in these areas. It is important to note that there exists an integrated Biomedical Engineering Ph.D. program with course offerings, faculty and quality graduate students in the program from the Boston, Dartmouth, Lowell and Worcester campuses to perform research and receive training in these areas.

The Amherst and Lowell campuses have historical precedence and international reputations in the areas of polymer science and biomaterials. Both the Amherst and Lowell campuses have individual centers and investigators (labs) that focus on one or more of these areas of research, but these centers are not organized into core facilities. The Amherst campus has existing and well-staffed central characterization facilities for polymeric materials, and many of these facilities support research efforts in biomaterials. These facilities are advertised on the Web, and fees for on-campus and off-campus users are listed. The Institute for Cellular Engineering (ICE) at UMass Amherst also is establishing central facilities to support biological and analytical characterization of materials used for tissue engineering. An aspect of ICE that may be used as a model for other campuses is the offering of formal training modules each summer for all central facilities. Recently, UMass Lowell has created a well-equipped and fully staffed Materials Characterization Laboratory with a model fee structure for the campus, non-host institution UMass investigators and investigators from other academic institutions and the private sector. Incentives have been created to encourage investigators to locate new equipment acquisitions within this core.

There is a significant reliance on state-of-the-art equipment and technical support for tissue engineering and biomaterials research. Yet the purchase, maintenance and operation of such equipment typically place it outside of the reach of individual investigators and groups throughout the university system. Therefore, urgent development of a strategy is needed to integrate current and future core facilities, on a system-wide basis, to provide all investigators involved in biomaterials and life sciences research with access to a wide range and diverse set of state-of-the-art instrumentation.

❖ DIAGNOSTICS AND MEDICAL DEVICES

The Massachusetts Life Science Initiative will support increased activity in the areas of medical diagnostics, animal imaging, bioelectronics and development of improved markers and prognostic indicators of human health and disease.

The Amherst, Lowell and Worcester campuses lead in the area of diagnostics and the development of medical devices. The Boston campus has been a leader in enhanced imaging and in the study of health disparities, and the Dartmouth campus in the detection of blood-borne toxins from infectious agents. The Lowell and Worcester campuses have partnered to create the Massachusetts Medical Device Development Center, and the Nanomedicine Institute represents collaboration between university investigators in the areas of antimicrobial surfaces, nanoparticles to enhance immune function in fighting disease and portable devices for medical diagnosis.

Each campus has some shared or core facilities to support the focused research areas, but these are not centralized and the fee structure for outside host institution use is not competitive. As an example, the Worcester campus has whole animal *in vivo* imaging capabilities, which would be utilized by a number of investigators if the fee structure were competitive and the facility more accessible. Core facilities are available for small molecule characterization, proteomics, genomics, deep sequencing, morphology and biomaterials. Additional core facilities in the areas of diagnostics and medical device development could be established and supported by a competitive fee-for-service structure.

Findings

Significant university strengths exist in stem cell research, diagnostics, tissue regeneration, bioinformatics, neurosciences and material and biomaterial sciences. However, there is little, if any, contact between investigators within the same focus area residing on different campuses, and there are no structured forums to encourage or facilitate these types of interactions.

Similarly, there exist well-equipped laboratories and sophisticated instrumentation within individual laboratories and core facilities on many of the campuses. However, no campus has yet to develop a universal "one service-one fee" structure. Rather, each campus operates their laboratories and core facilities differently. Fee structures on the campuses are either well described, not described, described for host institution users only, or for university users only. In many cases, the fee structures for a non-host institution user are prohibitive. [Attachment 3 is a database of cores and their fee structure for services]

With respect to the operation of laboratories and cores, there exists a shortage of critical technical staff to operate them. Forms for requesting services are not standardized and some cores do not have Web-based information about their specialized services. Moreover, provisions for shipping samples and adequate descriptions of expected results and analysis are not well defined for the benefit of potential users.

Finally, certain highly desired capabilities, such as a high performance computing capability at the university level, are unavailable at any of the university's core facilities. Those identified capabilities need to be prioritized and a strategy to acquire the necessary resources developed.

Recommendations

- **RECOMMENDATION 1**
  University Focus on Existing Areas of Research Strength

As a result of the information gleaned from the campus situational analyses, the working group recommends that the university focus its resources on existing areas of strength. Namely, the working group recommends investment in regenerative medicine, bio and health informatics, tissue engineering, diagnostics, biomaterials and computational sciences.

- **RECOMMENDATION 2**
  Establish the University of Massachusetts Core Facilities Steering Committee

The working group strongly recommends establishing a core facilities steering committee, comprised of members from each of the campuses, to coordinate the core facility resources within the university system. This committee would be charged with identifying and prioritizing new instrument acquisition needs that are lacking throughout the five-campus system. The new equipment acquisition should focus on desirable capacities that are currently limited or not found within the current cores. Also, the steering committee would be charged with either soliciting applications for supplementation or select cores that would receive funds for staffing. The staffing of a core facility should, by design, address the care and use of sophisticated instrumentation and should provide, where appropriate, training to students at the undergraduate, graduate and post-doctoral level in the use of such equipment. Typically, such staffing would include a core manager, as well as an additional technical staff person.

Furthermore, this committee would be charged with implementing a plan to improve access and use of university cores, with particular focus given to reviewing: services; fees; governance; and the establishment of a Web-based portal listing of the core facilities within the five-campus system through the President's Office home page.

- **RECOMMENDATION 3**
  Support for the University of Massachusetts Center for Clinical and Translational Science

The working group supports the Advanced Therapeutics Cluster Working Group's recommendation for the establishment of the UMass Center for Clinical and Translational Science. Centralizing the infrastructure to support clinical and translational research activities and offering on-campus rates for core facilities usage are needed strategies to

promote inter-campus collaboration. Moreover, providing seed funding through the 'UMass Life Sciences Moment Fund' that supports inter-campus pilot projects will further allow for cross-campus interaction.

- **RECOMMENDATION 4**
  Develop a University-wide High Performance Computing Capability

The working group supports the development of a high performance computing core service offered centrally to the entire university system. Such a capability would consist of HPC systems, massive data storage, visualization systems, advanced instrumentation linked by high speed and a high capacity network. Furthermore, the working group recommends that the university purchase the software system, "Collexis," to increase substantially inter-campus collaboration. The universities of Indiana and Pittsburgh could serve as models for this initiative.

- **RECOMMENDATION 5**
  Fund Inter-campus Retreats, Symposia or Seminar Series in each of the Focus Areas

The working group recommends funding for joint retreats, symposia and conferences for UMass investigators in each of the areas of stem cell research, diagnostics, tissue regeneration, bio and health informatics, neurosciences and material and biomaterial sciences. Bringing investigators together and providing time for open interaction is the best way to initiate or enhance inter-campus collaboration. Also, this funding could support the development of a five-campus lecture and seminar calendar and the establishment of the capability of using linked distance learning classrooms or real time video streaming from a university-based Internet site to broadcast high profile guest lecturers on one campus to the other campuses. Such a capability would leverage resources in these areas and support inter-campus interaction, awareness and collaboration in life sciences research activities.

Metrics

The working group recommends that after one year, there should be an evaluation of these supplements. Through the offices of sponsored research, increases in extramural funding requests and acquired research funds that propose, use and budget costs of core usage should be monitored. Cores should be required to record user contact information and at the end of one year, as well as solicit satisfaction rating from users. The University of Massachusetts Core Facilities Steering Committee would be asked to monitor the hits of the Web-based listing of core facilities, and monitor evidence of new inter-campus collaboration and attendance at inter-campus retreats, symposia and conferences. If seed

funds are used to encourage inter-campus collaboration, as a stipulation of the award, investigators would be required to provide evidence that an extramural proposal, manuscript and /or patent disclosure was generated after the award period as part of their final report. Also, there should be an assessment of the usefulness of the Collexis subscription in the form of inter-campus and outside collaborations that resulted from the publication of the experts listing.

Resources

The working group proposes the following resources for its recommendations.

1) The human embryonic stem cell bank and registry will require supplemental funds and yearly expenditures**.** The Worcester campus estimates that it will require annual support of $1 million per year for the bank and $400,000 per year for the registry.

2) The cost of maintaining the animal embryonic stem cell core and registry on the Amherst campus is estimated at $200,000 per year.

3) The Amherst campus' upgraded flow cytometry facility would require $600,000 for development and $150,000 per year in operational costs.

4) The proposed University of Massachusetts Core Facilities Steering Committee would require at least $500,000 in the first year and annual operating support of $150,000 for five years for each core selected as a system facility. The investment would provide funding for equipment and fit-out, as well as competitive salaries for managerial and technical staff.

5) The proposed University of Massachusetts Core Facilities Steering Committee would review the need for clean rooms across the five-campus system and either solicit applications from the campuses or select those campuses with demonstrated needs to receive funds for renovation of laboratory space to create a clean room. The cost of renovating an existing small laboratory to a BL-3 lab would include building a room within a room that is tightly sealed and has HEPA-filtered exhaust. The total cost for such a facility is between $240,000 and $500,000 for each clean room created. It is anticipated that there is a need for three such facilities, on the Amherst, Dartmouth and Lowell campuses.

6) The proposed University of Massachusetts Core Facilities Steering Committee would develop and oversee the implementation of a plan for a common high performance computing capacity across the five campuses. This cyber-infrastructure should incorporate existing resources, as well as several additional components, such as a centralized high

performance computing operating system to be a uniform shared service across the entire university, and the necessary staffing to ensure its security and stability. It is estimated that the cost of creating such a system would be $3 million in the first year for hardware acquisition and set up. In subsequent years, approximately $150,000 per year would be needed to support a manager. Also, purchasing and subscribing to the Collexis product, a search engine that can data mine and create expert profiles of investigators in life sciences throughout the UMass system, would cost $106,400. The acquisition of visualization software and hardware for data mining and analysis would require $750,000.

7) The creation of a system-wide seminar series, which would include a system-wide AV multimedia staff person to manage a calendar of events (retreats, symposia and President's lecture series) for live video streaming on the Internet and archiving, would require an initial $500,000 investment to update distance classrooms on each campus and a $150,000 annual investment for a staff person/coordinator.

Conclusion

There are exciting and innovative research efforts in the life sciences taking place on all five campuses of the University of Massachusetts system. Yet, these efforts can be unequivocally strengthened and made nationally competitive through investments in new and synergistic inter-campus collaboration in the fields of regenerative medicine, stem cell biology, bio and health informatics, tissue engineering, diagnostics, biomaterials and computational sciences. If the five-campus system functioned as one collaborative entity, it would be possible to coordinate the use of existing and future core facilities, optimize resources, and reduce redundancy to the benefit of all campuses. New investments in increased opportunities for interactions of principal investigators in common focus areas would similarly enhance interdisciplinary and complementary efforts, and thus contribute to increased innovation and competitiveness of the entire system. The working group believes that increasing the use and access to staffed core facilities will be of great benefit to the system and the region. The group further believes that linking the system with a common high performance computing network would strengthen ongoing research efforts and inter-campus collaboration across the university system.

IV. Advanced Therapeutics Cluster Working Group

❖ INTRODUCTION

The Advanced Therapeutics Cluster (ATC) Working Group was charged with developing an aspirant plan for the next three to five years that focuses most directly on the translation of fundamental discovery into novel therapeutics and promotes inter-campus collaboration within that specified area.

The ATC Working Group included colleagues from each of the five campuses and was co-chaired by Terence Flotte, M.D., Executive Deputy Chancellor, Provost and Dean of the School of Medicine on the Worcester campus, and Steve Goodwin, Ph.D., Dean of the College of Natural Resources and the Environment on the Amherst campus, and staffed by Brendan Chisholm, Director of Health Sciences Initiatives on the Worcester campus.

Other working group members included:

- Sam Black, Ph.D, Chair of the Department of Veterinary and Animal Sciences on the Amherst campus;
- Anthony Carruthers, Ph.D., Dean of the Graduate School of Biomedical Sciences on the Worcester campus;
- Andrew Grosovsky, Ph.D., Dean of the College of Mathematics and Science on the Boston campus;
- James P. McNamara, Ph.D., Executive Director of the Office of Technology Management on the Worcester campus;
- Melissa Moore, Ph.D., Professor of Biochemistry & Molecular Pharmacology on the Worcester campus;
- Tariq Rana, Ph.D., Professor of Biochemistry & Molecular Pharmacology on the Worcester campus;
- Bal Ram Singh, Ph.D., Professor of Chemistry and Biochemistry on the Dartmouth campus;
- Gary Stein, Ph.D., Chair of the Department of Cell Biology on the Worcester campus;
- John Sullivan, M.D., Professor of Pediatrics and Molecular Medicine and Vice Provost for Research on the Worcester campus; and
- Xingwei Wang, Ph.D., Assistant Professor of Electrical and Computer Engineering on the Lowell campus.

As a starting point for its efforts, the ATC Working Group relied heavily on past university efforts within the advanced therapeutics space, including the university's Stem

Cell Working Group's report of February 2007, "A Strategy for Advancing Stem Cell Research and Regenerative Medicine at the University of Massachusetts," and the Worcester campus' January 2008 proposal to the Massachusetts Legislature, "The University of Massachusetts Medical School Advanced Therapeutics Cluster: Investing in the Future of Medical Education, Research and Patient Care and the Economy of Worcester County." With respect to the former, the report called for a $66.4 million investment over six years to support academic program development, core user facilities available to all university faculty, research program development and facility renovation and construction. With respect to the latter, the Medical School, in an effort to advance its identified research thrusts and using the Massachusetts Life Sciences Initiative as the opportunity and funding mechanism, developed a proposal that called for a $90 million investment to promote RNAi, Stem Cell and Gene Therapy-based therapeutics. That proposal, it should be noted, was successfully included in the recently enacted legislation.

In the context of the aspirant plan, the ATC Working Group recognized that in the coming years, translational efforts aimed at the development of therapeutics would likely focus on the three interrelated areas of scientific inquiry: RNAi; stem cells; and gene therapy. But because of the dynamism of the field, such efforts may also grow to include other rationally designed therapeutics, including those derived from combinatorial chemistry, *in vitro* evolution and additional innovative methods for target identification and validation. Moreover, the development of other core resources to assist in target validation, including tools such as tissue and DNA banks, as well as the development of more useful preclinical models of human disease, may be required for advanced therapeutics-related initiatives.

Consequently, the ATC Working Group decided it most prudent to organize the scope of its efforts around concepts and goals rather than limiting itself to the three aforementioned content areas. Consensus was reached on the following definition that set the parameters for the group's efforts and guided the work plan:

The ATC Pillar will describe those research and educational initiatives that have as their primary goals the translation of fundamental discoveries into innovative therapeutic products.

Utilizing this definition, the ATC Working Group conducted a brief survey of the five campuses to identify advanced therapeutics-related activities—including T1 (bench-to-bedside), T2 (bedside to community), and T3 (dissemination to practice) projects—from which to identify university strengths, weaknesses, needs and opportunities within the pillar. Subsequent to that analysis and taking into account state and national research trends, the group was in a position to develop a series of recommendations to strengthen advanced therapeutics within the five-campus system and promote sustained collaboration between the campuses.

Situational Analysis

A university focus on translating fundamental discoveries into therapeutics created to treat human diseases clearly intersects with, and is responsive to, the goals of both the Massachusetts Life Sciences Initiative and the NIH Roadmap for Medical Research. It is responsive to the Massachusetts Life Sciences Initiative because it will lead to the invention of new therapeutic products based on university science that will impact positively patient outcomes while yielding economic dividends.

The NIH, through its Roadmap, has developed a strategy to promote the application of scientific knowledge and techniques to patient care. Central to that strategy is the NIH's goal of awarding, over the course of the next few years, sixty Clinical and Translational Science Awards (CTSA) to academic medical centers. This initiative is designed to lower barriers to collaboration between medical and scientific disciplines and to encourage innovative approaches to solve complex medical problems. The Worcester campus, in conjunction with other campuses of the university and its clinical partner, UMass Memorial Health Care, is in the process of developing a proposal to secure one of the sixty CTSAs, which would bring to the university $20 million in multi-year NIH funding. Developing a university-wide plan in advanced therapeutics would give the university a significant competitive advantage in the application process for a highly coveted and competitive CTSA.

Currently across the five-campus system, the university has in place active programs and initiatives within the advanced therapeutics cluster space. The campus overviews that follow highlight some of those programs and initiatives, but should not be considered an exhaustive or complete inventory of the numerous initiatives, large and small, undertaken throughout the university system.

❖ Amherst Campus

The Amherst campus has activities related to advanced therapeutics on a diversity of fronts. Many of these ongoing activities will be integrated within a new Life Sciences Facility, which received $95 million through the Massachusetts Life Sciences Initiative. Although planning for the facility is not yet complete, the campus expects it to include a flow cytometry core, an animal stem cell core, a computational biology and bioinformatics core, a cell culture facility and a microscopic imaging facility. In support of the programmatic development of this new facility, the Amherst campus was awarded a "New Faculty Matching Grant" from the Massachusetts Life Sciences Center. This

grant will enable the campus, and specifically the College of Natural Sciences and Mathematics, to recruit a senior faculty member in the area of systems biology.

Examples of these research activities within the ATC space include work on synthetic antimicrobial materials, in which Amherst faculty investigators are currently developing antimicrobial macromolecules (AMMs) which offer a bridge between pharmaceutical antibiotics and antiseptic materials. These novel AMMs can mimic the biological activity of the natural host-defense peptides (HDPs) and hold promise for novel therapeutics and new materials to prevent the spread of infectious disease. Further examples include active research initiatives on protein engineering and natural product synthesis. Faculty on the Amherst campus already have strong interdisciplinary collaborations with investigators at UMass Worcester who focus on the large number of devastating and currently intractable human diseases that can be traced directly to the failure of a particular protein to fold properly, such as Alzheimer's disease and variants of "mad cow" disease.

The Amherst campus also has a strong foundation in creating new polymeric molecules, formulating and characterizing DNA-polymer complexes, and genetic/protein engineering methods to modify viral carriers. Moreover, scaffolding and tissue engineering is occurring on the campus in response to the severe shortage of organs for transplantation. Tissue engineering has received significant attention in meeting supply demands. In general, these devices serve to regenerate tissues and are typically composed of 3-D polymeric scaffolds which attempt to initially replace the natural extracellular matrix and cells of the desired type (a specific cell type or stem cells). Regenerative medicine using polymeric scaffolds seeded with patient cells are now at or near clinical use. Further, the campus has ties with the Pioneer Valley Life Sciences Institute (PVLSI), located at Baystate Medical Center in Springfield, Massachusetts. This partnership has resulted in several funded interdisciplinary projects underway including islet cell transplantation for diabetes treatment.

The Amherst campus has a very active stem cell research program. Current translational research on mammalian development and control of inherited and acquired diseases focuses on gamete/embryo developmental biology and developmental immunology and immunopathology. This includes the engineering stem cell lines from adult somatic cells, therapeutic control of lymphocyte development and death and therapeutic inhibition of tissue degradation. Ongoing research examines native and genetically engineered stem cells from normal and diseased animals. The program is currently able to provide well-characterized non-human stem cell lines for research on embryonic/fetal/adult stem cell culture, transitions and transplant properties.

Furthermore, investigators at the campus are engaged in research to develop cancer therapies. Among the translational research focused on cancer therapies are examinations of the effects of parity and p53 activity on mammary cells, the persistent induction of oncogenic signaling in mammary stem cells in response to TGFbeta, and the role of

estrogen receptor beta in suppressing growth and tumorigenesis in preneoplastic lesions and the development of bacteriolytic strategies for treatment of aggressive tumors, in collaboration with PVSLI.

Moreover, the Amherst campus has engineered assemblies of signal transduction proteins. Researchers have developed a novel method for regenerating the membrane-associated protein teams that give rise to the salient functions of the intact signaling system. The approach, called template-directed assembly, is a semi-synthetic method that combines protein engineering, synthetic chemistry and nanometer scale particles to create the functional signaling teams in the test tube. The approach is simple and applicable to a wide variety of signaling pathways.

Additionally, there are significant programs in the field of plant sciences and engineering on the Amherst campus. The Plant Biology Graduate Program serves as a catalyst to bring together researchers from across the campus in life sciences and engineering and physical sciences in collaborative, interdisciplinary projects centered on genomic and population analysis of plants and cell cultures for supply of plant-derived therapeutics.

Finally, the Amherst campus runs a new graduate training program in cellular engineering through the Institute for Cellular Engineering, supported by a $3.5 million investment from the NSF. Graduate students are being effectively trained in interdisciplinary approaches in systems biology, cell and drug delivery and protein engineering, which directly impact research and workforce development in advanced therapeutics.

❖ Boston Campus

Although at this juncture the Boston campus does not have any active advanced therapeutics-related initiatives, the institution is very much interested in developing such initiatives, and to that end, has proposed the establishment of a Center for Personalized Cancer Therapy (CPCT), in conjunction with the Dana Farber/Harvard Cancer Center. This T1 related effort will primarily focus on the identification of highly specific sub-categories for major types of tumors. Pioneering cancer research demonstrates that many sub-categories remain indistinguishable using conventional clinical tests, and that the availability of such information could lead to the development of a new generation of cancer therapies.

Once fully established, CPCT will have an immediate impact on supporting the basic research needed to accomplish a detailed sub-categorization of important tumor types. The Boston campus anticipates a rapid translational impact since CPCT will use cutting-edge, but existing technologies to identify new biomarkers that will enable more detailed tumor classification. Each new finding will have the potential for rapid utilization in development of a clinical test kit. Useful biomarkers should be identified within a five-

year timeframe, and partnerships with industry during this timeframe would be established to provide a framework for translational research efforts in the development of test kits.

It should be noted that the CPCT concept received substantial support from the final version of the Commonwealth's Life Sciences Initiative. In that legislation, the Boston campus received $10 million for the development of the center. Moreover, the campus was awarded a "New Faculty Matching Grant Award" from the Massachusetts Life Sciences Center to help in the recruitment of a new faculty member to fill the Brann Chair in Science and Mathematics. This new faculty recruit will facilitate the growth and development of the campus' biomedical research activities and partnerships, including the CPCT.

❖ Dartmouth Campus

The Dartmouth campus has made considerable investments in advanced therapeutics-related infrastructure and resources. Most notably, the Dartmouth campus operates, and through the Commonwealth's Life Sciences Initiative will acquire, the Advanced Technology and Manufacturing Center (ATMC), which is a 60,000-square-foot building that has as it primary focus advancing engineering projects in collaboration with faculty and industrial partners. However, the ATMC also contains wet laboratories that house UMass Dartmouth faculty groups and nascent companies engaged in T1-related projects in biotechnology and biomedicine. Two such noteworthy projects within this space and currently active at the ATMC are: *Chitosan Microspheres for Sustained Drug Release* and *Antibody-Nanoparticle Conjugates for Rapid Detection of Residual Antibiotics*.

With respect to the former, UMass Dartmouth faculty members are researching the mechanism of sustained drug releases and the possibility of localizing the treatment. Preliminary results have demonstrated that encapsulated tetracycline is effective in inhibiting *E. coli* growth and initial burst can be avoided with the microsphere drug delivery system. With respect to the latter, UMass Dartmouth faculty members, in response to an increasing number of reports on the misuse and overuse of antibiotics, are collaborating to develop a urine test for antibiotics, which when properly designed will allow for the detection of multiple antibiotics on a single testing strip.

The Dartmouth campus also has constructed a $17 million Botulinum Research Center (BRC) to support the campus' botulinum research group, which is the national leader in the field. The 22,000-square-foot biotech research building includes 4,500 square feet of BSL3/ABSL3 lab space, 1,200 square feet of GMP enabled space and 2,000 square feet of animal facilities. The BRC houses research labs focused on T1-related projects in protein chemistry, biosensors, drug discovery and drug delivery and formulation. Current annual external funding for the BRC is over $1.2 million with strong support from the

Department of Defense, Department of Homeland Security, Natick Army Research Center, CDC, FDA, USDA and many other federal agencies. Furthermore, the BRC has created strong linkages with local large and small biotechnology firms and with university colleagues throughout the system to facilitate new product and technology development.

To further expand its foundation in T1 efforts, the Dartmouth campus is in the planning stage of developing a $10 million Biomanufacturing Center. This facility will provide emerging life sciences companies with a platform from which to demonstrate the effectiveness and scalability of new products.

❖ Lowell Campus

The Lowell campus, historically, has been quite active in advanced therapeutics research efforts. Those efforts have included projects and initiatives across the translational research pipeline—T1 (bench-to-bedside), T2 (bedside to patients), and T3 (dissemination to practice).

In T1-related projects, the Lowell campus has collaborated with other university campuses to link enabling engineering technologies to clinical and medical technologies. Such collaborations have focused on drug and therapeutic delivery systems, disease detection and therapy assessment, tissue scaffolds and biosensors. Examples of these inter-campus collaborations include the Massachusetts Medical Device Development Center (M2D2), a partnership with the Worcester campus. M2D2 serves as a lifeline for the commonwealth's smaller medical device companies, offering inventors and executives easy, affordable, and coordinated access to world-class researchers and resources on the Lowell and Worcester campuses. The center is supported by a $4 million appropriation from the state.

Another example of inter-campus collaboration is the UMass NanoMedicine Institute, a partnership of Lowell with the Amherst and Worcester campuses. The institute focuses on engineering functionalized nanomaterials for disease detection.

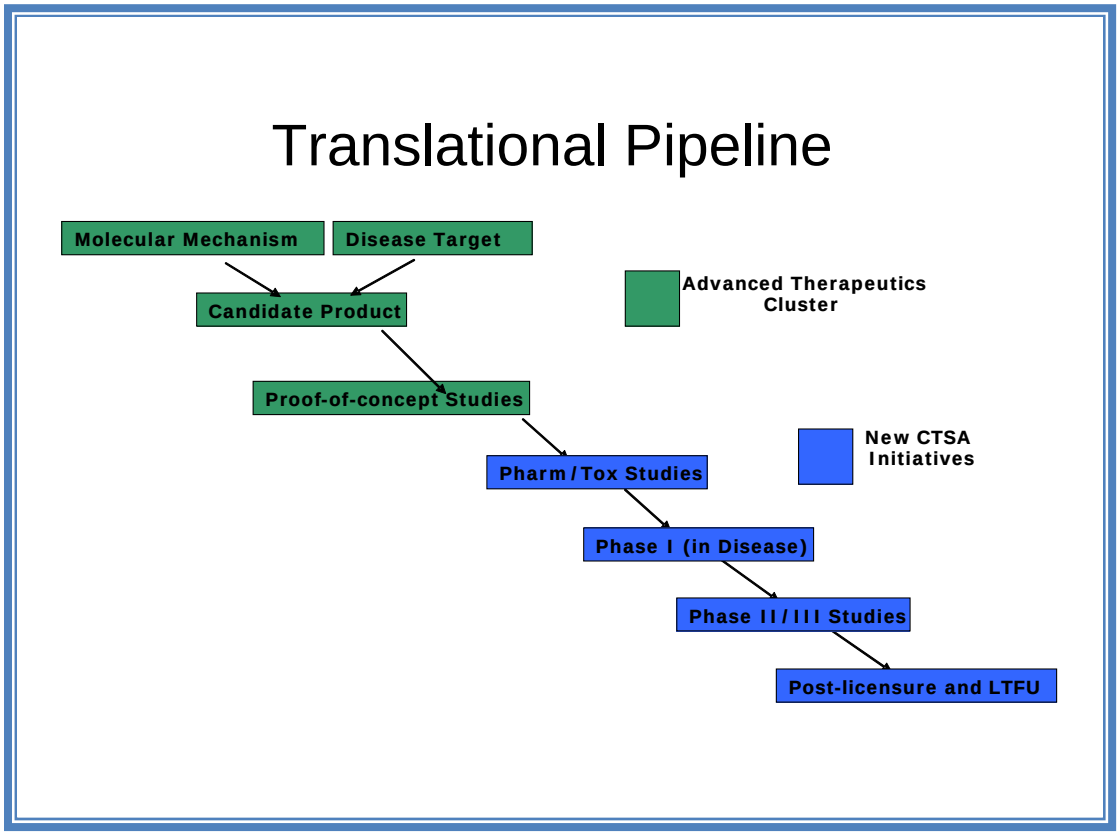
Other Lowell campus-specific initiatives within the bench-to-bedside space include the UMass Lowell Nanomanufacturing Center, initiated through a three-university $12.4 million NSF center grant and a $5 million Massachusetts Center of Excellence grant, and in conjunction with a major Army program, to develop biochemical sensors. Furthermore, the Lowell campus is home to the Massachusetts Biomanufacturing Center, which provides process development for biopharmaceutical applications. The Lowell campus has received $10 million from the commonwealth's Life Sciences Initiative to build upon its strong foundation in nano and biomanufacturing. The Lowell campus also has been awarded a "New Faculty Matching Grant" from the Massachusetts Life Sciences Center to assist the campus in the recruitment of a new faculty member in Chemical Engineering

who will focus on biomanufacturing science and engineering and works as a member of the aforementioned Biomanufacturing Center.

In addition, the Lowell campus has unique expertise in critical T2 efforts such as the Healthy Elder Living Program, the Environmental Protection Agency-funded Children's Environmental Health Project, and the $5 million NIOSH-funded Center for the Promotion of Health in the New England Workplace.

❖ Worcester Campus

The Worcester campus has a growing life sciences research enterprise. Traditionally, the research enterprise, which supports approximately $190 million in annual research expenditures, has focused heavily on basic science discoveries. However, the Worcester campus has indicated that it will build off its outstanding basic science foundation to advance those discoveries to the point of therapeutics applications. The Medical School, as the following visual depicts, is currently engaged in two complementary initiatives: the Advanced Therapeutics Cluster Initiative and the Clinical Translational and Science Award Initiative. By combining the two initiatives, the Worcester campus envisions strengthening its T1, T2 and T3 capabilities.



The Advanced Therapeutics Cluster (ATC), which received $90 million in the Commonwealth's Life Sciences Initiative, will bring together an interdisciplinary group of research faculty and physician scientists in three interconnected research clusters—stem cell biology, RNA biology and gene therapy—to promote novel approaches to the development of innovative therapeutics. Specific thematic areas of emphasis for the ATC on the Worcester campus are those aligned with the clinical centers of excellence: cancer; heart and vascular diseases; musculoskeletal diseases; and diabetes. In addition to these, three other thematic areas include immunology/infectious diseases, addiction research and neurodegenerative diseases.

The robust nature of the neurodegenerative disease program is reflected by the pioneering work on the use of RNAi, delivered either directly or in the context of a recombinant adeno-associated virus gene therapy vector to treat Huntington's disease in rodent models. This work was performed by Dr. Neil Aronin and our most recently awarded Howard Hughes Medical Institute (HHMI) Investigator, Dr. Phillip Zamore. Furthermore, the Worcester campus has an advanced therapeutics program directed to treat amyotrophic lateral sclerosis (ALS), led by Dr. Tariq Rana and our newly recruited Chair of Neurology, Dr. Robert Brown.

Work in the musculoskeletal and diabetes areas of advanced therapeutics is highlighted by the recent discovery of an oral RNAi delivery vehicle by Drs. Michael Czech and Gary Ostroff. This technology, based on a yeast cell wall glucan, has the potential to block macrophage-mediated inflammation in diseases such as rheumatoid arthritis, inflammatory bowel disease and diabetic vascular disease.

Advances toward therapy in cancer include the use of RNAi-based screening for the identification of a novel drug target to treat malignant melanoma. This new drug (IGFBP7), identified by another of the Worcester campus' HHMI investigators, Dr. Michael Green, along with the Czech-Ostroff oral RNAi vector, will be further developed in the context of the Worcester campus' new collaborative relationship with the Charles River Laboratories (CRL). CRL will serve as an industrial research collaborator for FDA-GLP grade toxicology studies on UMass advanced therapeutics of all kinds, as they advance toward phase 1 clinical trials.

Additional capabilities necessary for the development of advanced therapeutics will be provided by two new programs for which directors have just been recruited. These include the Program in Bioinformatics, headed by Dr. Zhiping Weng, and the Gene Therapy Center headed by Dr. Guangping Gao.

These new programs are built on the foundation of the world's strongest RNA research community, led by Dr. Craig Mello, the 2006 Nobel Laureate. Other key leaders in RNA

on the Worcester campus include Drs. Czech, Rana, Aronin and HHMI investigators Drs. Green and Zamore, as well as Dr. Allan Jacobson, whose novel drug for enhancing read-through of stop codons has just been successful in a phase II trial on cystic fibrosis. Joining them this year have been HHMI Investigator Dr. Melissa Moore and Dr. Victor Ambros, a member of the National Academy of Sciences and the 2008 recipient of the Gairdner Award and the Benjamin Franklin Medal.

The newly established Quantitative Health Sciences Department on the Worcester campus will oversee the clinical and translational research efforts, particularly T2- and T3-related efforts. The Worcester campus' recent awarding of the National Children's Study grant to the Children's Medical Center and the build-up of the UMass Cancer Center provide more evidence of the campus' commitment to advance findings from the clinical research setting to the broader community.

Also, it should be noted that the Worcester campus, through the operations of the Massachusetts Biologic Laboratories (MBL), has extensive experience in drug development and manufacturing. MBL is the only publicly owned, not-for-profit, FDA-approved manufacturer of vaccines and other biologics products in the United States. Some of MBL's products include monoclonal antibodies for SARS, rabies, hepatitis C and C. difficile.

Findings

Taken together, the campus situational analyses finds that the university has very robust—or emerging—research initiatives in biomaterials, drug delivery, disease detection, regenerative medicine, tissue engineering, nanotechnology and RNAi. Moreover, the university has demonstrated a unique ability to partner with commercial entities and to leverage its considerable resources to advance product development in areas such as medical devices, vaccines and biomaterials.

Certain inter-campus collaborations already exist that could be used as potential models. Specifically, the growing relationship between the Lowell and Worcester campuses through M2D2 demonstrates how two campuses with different, but complementary, expertise can partner to address the feasibility of promising medical devices. Moreover, the Nanomedicine Institute, a partnership between the Amherst, Lowell and Worcester campuses, shows how clinical and medical expertise at the medical school can be leveraged to further strengthen world-class nanotechnology research efforts on the Amherst and Lowell campuses.

The ATC Working Group believes that the university has an opportunity to strengthen its foundation in both discovery and application; in other words, across the translational

pipeline. Over the next five years, the university's efforts within this space should be guided by concepts and goals, not by specific technologies. Therefore, a focus on any one particular therapeutic approach such as gene therapy, regenerative medicine or RNAi should be a means by which the university translates fundamental discovery into novel therapeutics that can impact positively the health and well-being of others.

Recommendations

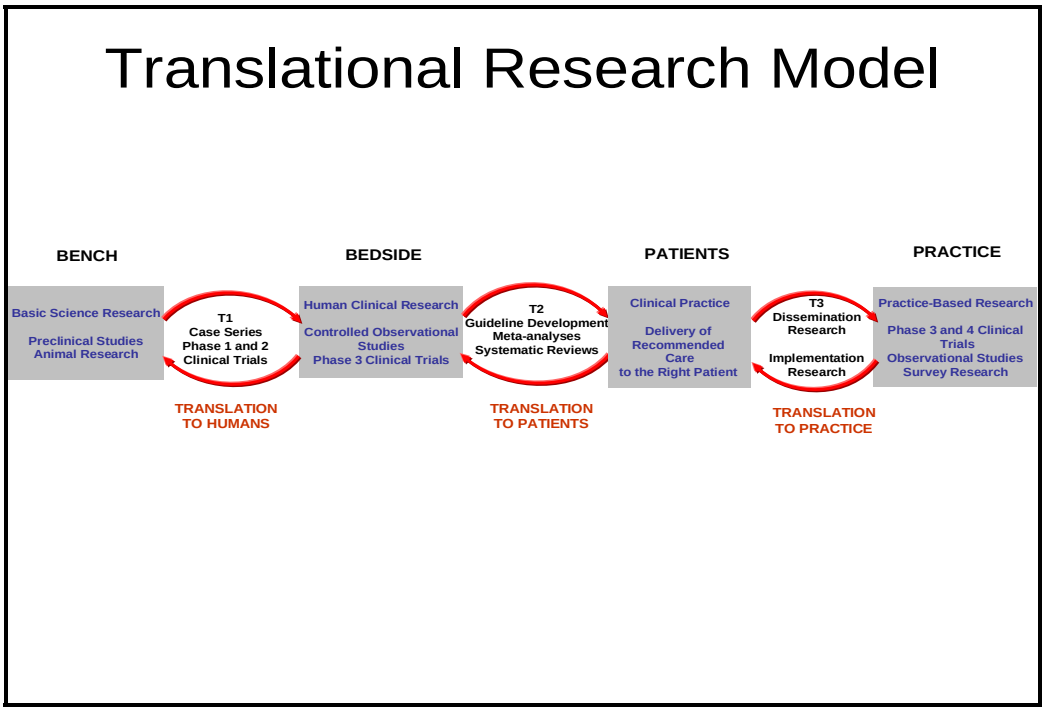
- **RECOMMENDATION 1**
  Establish the University of Massachusetts Center for Clinical and Translational Science

The NIH Roadmap, referenced above, has reaffirmed that social contract implicit in the acceptance of NIH funding: namely, that the research community, in accepting taxpayer dollars, is obliged to be responsive to the needs of the U.S. population. In a similar manner, the community of UMass investigators, while retaining the prerogatives of academic freedom, nonetheless shares a responsibility to the citizens of the commonwealth to be responsive to their needs.

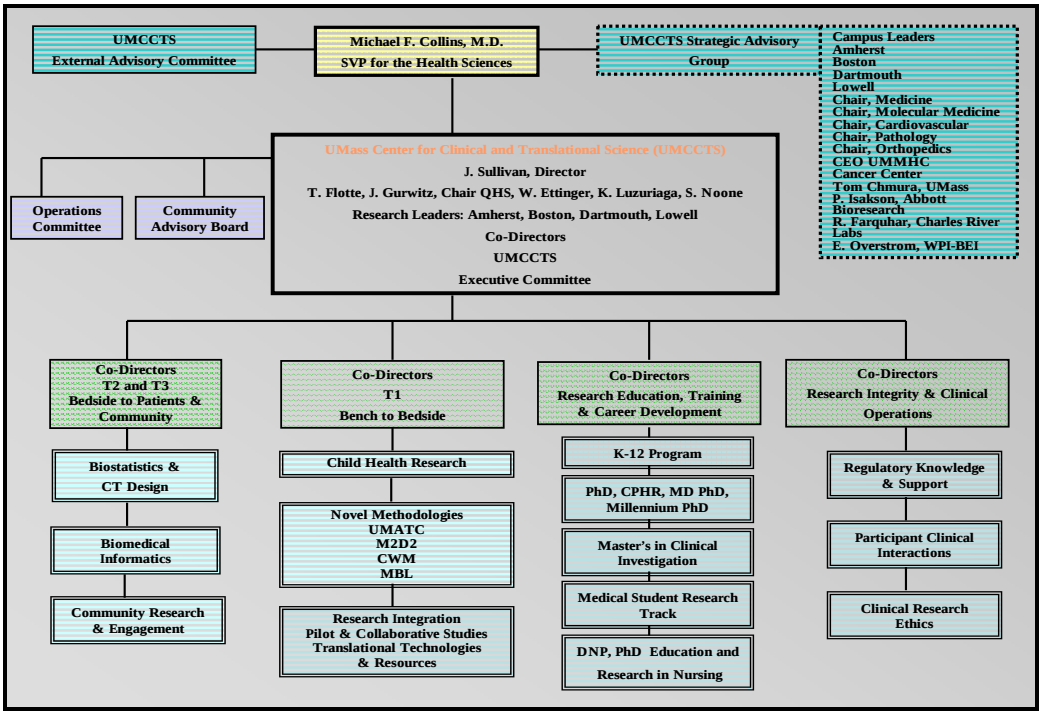
The NIH CTSA program is designed to enhance the beneficial impact that NIH-funded discovery has on the general public. In response to the call for CTSA applications, the University of Massachusetts, and specifically its Medical School, has begun to construct a set of research and educational resources to serve as a research home for clinical and translational investigators and to facilitate outreach to the community.

The ATC Working Group recommends that the university system more fully develop and permanently embed within the system a five-campus network to be known as the University of Massachusetts Center for Clinical and Translational Science (UMCCTS), which will be overseen by the Senior Vice President for Health Sciences. Once actualized, the UMCCTS will facilitate the design, conduct and analysis of patient-oriented and population-oriented research and dissemination in all its forms. Moreover, it will serve as a home for education in the field of clinical investigation and will support faculty development in this area.

The UMCCTS will support all translational research efforts to enhance the impact of scholarly endeavors that benefit the human condition. Thus, it will include, but not be limited to, the T1 (bench-to-bedside), T2 (bedside to community), and T3 (dissemination-to-practice) realms. The following visual depicts the scope of activity envisioned in the UMCCTS:



The configuration of the UMCCTS reflects its five-campus nature and the domains which must be served in order to be responsive to the CTSA RFA. The major elements of this structure are depicted below:



The four primary domain areas within the UMCCTS will include quantitative and population-oriented programs, pilot and thematic programs, educational programs and regulatory and trials support.

All faculty members within the university system who participate in any form of translational research, as defined above, will be eligible to become UMCCTS members. Membership in the center will allow university faculty members to be eligible to access core and educational resources at an on-campus fee rate. Cores may include, but not be limited to, bioinformatics, repositories and tissue banks. However, a further analysis is warranted to reach consensus on those cores and resources that could effectively be utilized at a particular campus and those that necessitate development and utilization on each campus. Such an analysis could be conducted by a university-wide Cores Steering Committee, as recommended by the Shared Infrastructure and Additional R&D Thrusts Working Group. Moreover, faculty members would be eligible to apply for pilot grant funding, and participate in an annual scientific meeting, as well as share in certain common informatics and library resources.

By recommending the UMCCTS concept, the ATC Working Group believes that it will serve to facilitate a greater efficiency and productivity of university investigators across the five campuses, as they strive to make the greatest possible impact in translational research and the broader life sciences.

- **RECOMMENDATION 2**
  Establish the "UMass Life Sciences Moment Fund"

The ATC Working Group, in its survey of inter-campus collaborations, found that establishing such collaborations are largely motivated by either a need for expertise on another campus, as evidenced by M2D2, or through a pool of dedicated funds that spur cross-campus collaboration, as increasingly seen by projects funded by the President's Science and Technology Fund.

In calling for the establishment of the UMCCTS, the ATC Working Group recognized the need to create seed funding to promote inter-campus collaboration and the use of shared core facilities and resources. Therefore, in conjunction with the Medical School, the ATC Working Group is recommending the creation of a $1 million UMass "Life Sciences Moment Fund."

This fund, overseen by the Senior Vice President for the Health Sciences and provided by the Worcester campus, would augment the existing and highly successful President's Science and Technology Fund; however, unlike the President's fund, this new fund would support projects that are inter-campus in orientation, each with a collaborator from the

Worcester campus and directed towards projects related to advanced therapeutics and translational research, as well as research efforts that link enabling engineering technologies to clinical and medical technologies. The fund is envisioned to be used broadly within the advanced therapeutics and translational research field. That is to say, portions of the fund could be directed to support inter-campus ATC-related research pilot projects or post-doctoral fellowship grants.

The $1 million strategic investment in clinical and translational research activities under the advanced therapeutics umbrella necessitates clear metrics to assess the impact of the investment for the university system. Therefore, the ATC Working Group proposes the following metrics to review the efficacy of the $1 million fund: the number of new inter-campus collaborations established as a result of the fund; the extent to which those collaborations can be leveraged to acquire subsequent extramural funding; the extent to which those collaborations advance relationships with biotechnology and pharmaceutical companies; drug development milestones, including IND applications sought; Phase 1 trials undertaken; number of publications with authors from two or more university campuses; and impact on education and training initiatives and the workforce.

- **RECOMMENDATION 3**
  Annual Scientific Meeting of UMCCTS Members

The ATC Working Group, in conjunction with the other working groups, recommends that a structure be developed by which university colleagues can convene to promote inter-campus collaboration. To that end, the ATC Working Group calls for the establishment of an annual scientific meeting for all university faculty engaged in the UMCCTS. Participation in this annual scientific meeting would be a precondition for membership in, or use of, the UMCCTS. Therefore, the recipients of the ”UMass Life Sciences Moment Fund” and those faculty members and students accessing cores and other educational resources at on-campus rates, would be asked to present their research findings at the annual meeting, which would be held at a different campus each year. The ATC Working Group believes that creating a structure that brings university colleagues and collaborators together regularly, will further lay the foundation for sustained inter-campus interaction and research collaboration.

- **RECOMMENDATION 4**
  Aggressively Pursue Funding Opportunities through the Commonwealth’s Life Sciences Initiative

The university is very fortunate to have played a prominent role in the Commonwealth’s Life Sciences Initiative. Indeed, since the announcement of the ten-year, $1 billion initiative by Governor Deval L. Patrick in May of 2007, commonwealth leaders have

signaled their strong desire to partner with the state's public university to strengthen Massachusetts' global leadership position in the field. This willingness to partner with the university has been evident by the number of university initiatives that are directly, or in part, related to clinical and translational research and are included in the final version of the Massachusetts Life Sciences Initiative.

The recently enacted legislation specifies more than $200 million for new university initiatives, including $95 million for a life sciences complex on the Amherst campus, $90 million for the Advanced Therapeutics Cluster new campus facility on the Worcester campus, $10 million for a nano and biomanufacturing center on the Lowell campus and $11.4 million for the ATMC facility associated with the Dartmouth campus and $10 million for the Center for Personalized Cancer Therapy at the Boston campus.

The Commonwealth's Life Sciences Initiative presents the university with a tremendous opportunity to further its clinical and translational research efforts. The ATC Working Group is pleased that the university made such a compelling case to the Massachusetts Legislature to invest in the state's public research university and supports every effort to have these funds released.

Resources

The ATC Working Group recommends $1 million per year over the next three to five years to support the "UMass Life Sciences Moment Fund." This fund would be an investment made by the Worcester campus, but the working group encourages the other campuses to direct a portion of their funds to support translational research efforts. To further support the UMCCTS concept, the working group recommends a university investment of $200,000 per year over the next three to five years. Such an investment will ensure the successful development of the UMCCTS to oversee the growth and coordination of shared resources and translational research efforts. Finally, to support the annual scientific meeting, the ATC Working Group recommends $20,000 per year over the next three to five years.

Developing the UMCCTS will enable university investigators to leverage investment from the university to secure additional extramural funding from agencies such as the NIH, the Commonwealth of Massachusetts and various philanthropic individuals and foundations interested in funding translational research efforts.

Conclusion

An outstanding environment exists to translate fundamental discoveries into novel therapeutics that can positively impact patients and populations. The university has developed a solid foundation from which it can leverage its resources to advance basic science discoveries into therapeutics. Through a centralized UMass Center for Clinical and Translational Science, the university can bring together a multitude of experts and technologies to develop innovative approaches to solving complex medical problems. The platforms, technologies and motivations exist to leverage the full weight of the university's resources to make substantial contributions to patient outcomes. What does not exist, and what the ATC Working Group calls for, is structure and investment.

V. Nanotechnology Working Group

❖ INTRODUCTION

The physical, mathematical and computational sciences and engineering provide an important foundation for biomedicine and, more broadly, for the life sciences. Many of the biomedical community's technologies and tools result from advances in other fields and highly synergistic interdisciplinary collaborations that have yielded enormous benefits to researchers, clinicians, patients and society. Examples include x-ray crystallography, nuclear magnetic resonance (NMR) spectroscopy, mass spectroscopy, computational biology and computerized axial tomography (CAT) scanning. One imperative for continued growth and development of the university's life sciences research portfolio is advancing collaboration across disciplines.

Nanoscale science and engineering represents a unique set of opportunities. More commonly known as *nanotechnology*, it refers to the ability to control matter at the atomic or molecular scale, generally 100 nanometers or smaller (for comparison, an average human hair is 100,000 nanometers in diameter). From a scientific perspective, the enormous excitement that exists around nanotechnology results not only from the ability to manipulate materials at this scale, but also, more importantly, from the fact that the physical properties that govern matter at this scale differ from those at bulk.

The university has significant research capabilities in this area, and the charge to the Nanotechnology Working Group was to explore opportunities for building collaborations between investigators and across campuses to enhance and strengthen research in the life sciences. The working group was led by senior administrators and faculty with significant experience in building inter-campus partnerships. Paul Kostecki, Ph.D., Vice Provost for Research on the Amherst campus, and Stephen McCarthy, Ph.D., Professor of Plastics and Engineering and Director of the Massachusetts Medical Device Development Center on the Lowell campus, served as co-chairs. Vice Provost Kostecki was succeeded as co-chair by Lakis Mountziaris, Ph.D., Professor and Department Head of Chemical Engineering and Director of the NanoMedicine Institute on the Amherst campus.[2] The working group was staffed by Jeffrey Brancato, Associate Vice President for Economic Development for the university.

[2] L. Mountziaris replaced P. Kostecki as Co-Chair of the Nanotechnology pillar in April 2008, in order to provide specific expertise and experience in the relevant collaborative research in his role as Director of the UMass NanoMedicine Institute

Other members of the working group included:

- Richard Antonak, Ed.D., Vice Provost for Research on the Boston campus;
- Paul Calvert, Ph.D., Professor of Materials Engineering on the Dartmouth campus;
- Todd Emrick, Ph.D., Assistant Professor of Polymer Science & Engineering on the Amherst campus;
- Rudolf Faust, Ph.D., Professor in Polymer Chemistry on the Lowell campus;
- Douglas Golenbock, M.D., Professor of Medicine and Molecular Genetics & Microbiology on the Worcester campus;
- Zhiyong Gu, Ph.D., Assistant Professor of Chemical Engineering on the Lowell campus;
- Shaw Ling Hsu, Ph.D., Professor of Polymer Science & Engineering on the Amherst campus;
- Eicke Latz, Ph.D., M.D., Assistant Professor of Infectious Diseases and Immunology on the Worcester campus;
- John Mordes, M.D., Professor of Molecular Medicine on the Worcester campus;
- Robert Nicolosi, Ph.D., Professor & Director of the Center for Health & Disease Research on the Lowell campus; and
- Babs Soller, Ph.D., Professor of Anesthesiology on the Worcester campus.

Situational Analysis

Research in the field of nanotechnology that is relevant to the life sciences is broadly distributed across the university's campuses, and is found in organized centers as documented below.

Nanoscale Science and Engineering Centers:

- Center for Hierarchical Manufacturing (Amherst);
- Center for High-rate Nanomanufacturing (Lowell); and
- Nanomanufacturing Center of Excellence (Lowell).

Advanced Materials Centers:

- Materials Research Science and Engineering Center (Amherst);
- Center for UMass-Industry Research on Polymers (Amherst); and
- Center for Advanced Materials (Lowell).

UMass Centers with life sciences thrusts:

- The Institute for Cellular Engineering (Amherst);
- The Pioneer Valley Life Sciences Institute (Amherst and BayState);
- The Center for Health and Disease Research (Lowell);
- The Center for Complex Environmental Systems (Lowell); and
- The UMass Center for Clinical and Translational Science (Worcester).

In an effort to combine nanotechnology, life sciences and medical research efforts, the UMass President's office established the UMass NanoMedicine Institute**,** which fosters interdisciplinary collaborations on diagnostics, therapeutics and disease prevention among researchers from the Amherst, Lowell and Worcester campuses. Another multi-campus center, M2D2, a collaboration between the Lowell and Worcester campuses, focuses on translational research and medical device development.

Significant relevant research assets also exist in individual investigator and small group programs within departments in the engineering colleges at Amherst, Lowell, and Dartmouth and in science departments on all campuses. The university's capabilities are substantial, and include nationally recognized leaders and programs that receive significant funding from federal agencies, especially from the NSF and NIH, the commonwealth, private foundations and industry.

Most of the nanotechnology and advanced materials centers include biological applications among their research thrusts. However, collaborations are typically within a single campus and do not extend to UMass Worcester's biomedical research portfolio. The UMass NanoMedicine Institute and M2D2 are bridging this gap. Given that the Worcester campus comprises roughly 80% of the system-wide life sciences research expenditures, a number of significant multi-campus collaborative opportunities can be developed by fostering collaborations between Worcester researchers and their peers on the other campuses.

Exploration of leveraging these areas of expertise in the life sciences is timely. The Worcester campus, in preparation for securing an NIH CTSA has identified partnerships like these as a priority.

Findings

The working group undertook a survey of faculty that, while relatively small in number (n=22), provided helpful insight with respect to understanding the interface between

nanotechnology and the life sciences. Based on those results, a useful framework began to emerge (see Table 1).

Table 1. Matrix of Interactions

		Life Sciences Applications						
		Therapeutics				**Clinical Diagnostics**	**Disease Prevention**	
		Tissue Engineering	*Drug Delivery*	*Tumor Treatment*	*Blood Purification*	*Biosensors*	*Antimicrobial Applications*	*Vaccine Develop ment*
Nanotechnology Capabilities	**Nanoparticles**		X	X		X	X	X
	2-Dimensional Structures	X	X	X	X	X		
	3-Dimensional Structures	X				X		
	Characterization	X	X	X	X	X	X	X

❖ LIFE SCIENCES APPLICATIONS FOR NANOTECHNOLOGY

As shown in the matrix, based on the responses from the survey, the life sciences applications for nanotechnology were organized into seven categories. These categories were then grouped into three clusters, which are therapeutics, clinical diagnostics and disease prevention. The following is a summary of the activities and investigators within each category.

❖ THERAPEUTICS

Tissue Engineering – Polymer Scaffolds

These technologies include: electrospun nanofibers and web formation from various polymeric solutions or melts; nanofibers (diameter ranging from 40 nm -200nm); 3-dimensional digital printing of modified fibrous substrate to enhance ink-reception, which can be any bioactive or biomaterials including cells and scaffolds for cartilage replacement therapy. Investigators within these technologies include: Kim, Fowler, and Calvert

(*UMass Dartmouth);* Chen and McCarthy (*UMass Lowell);* and Crosby, Bhatia, Tew, and Santore (*UMass Amherst).*

Drug Delivery -- Polymer Encapsulation and Self Assembly

These technologies include: self-assembling nanoemulsions for the delivery of pharmaceuticals; hydrophilic molecular self-assembly of fullerene-derived nanospheres as biologically active free scavenging agents and PDT drugs; polymer coatings for drug eluting coronary stents; and core-shell nanoparticles to protect photosensitive biomolecules. Investigators within these technologies include: Bhatia, Bermudez, Hayward, Santore, Roberts, Rotello and Winter (*UMass Amherst);* Nicolosi, McCarthy, Chiang, and Faust (*UMass Lowell);* and Calvert and Mello *(UMass Dartmouth).*

Tumor Treatment

These technologies include: targeted intratumoral delivery; using an antibody to a tumor marker attached to a supraparamagnetic nanoparticle and magnetic field to selectively kill human cancer cells *in vivo* in a mouse model while sparing surrounding normal tissue; reactive nanocomposite heaters; and manipulating the surface properties of nanoparticles to overcome the diffusion limitations that prevent standard chemotherapeutics from reaching effective concentrations in tumors. Investigators within this technology include: Chen and Braunhut (*UMass Lowell);* and Forbes (*UMass Amherst).*

Blood Purification

This technology includes the development of magnetic nanoparticles that selectively bind to viruses in blood and allow separation by a magnetic field. Investigators within this technology include: Finberg and Latz (*UMass Worcester);* and Rotello, Emrick and Mountziaris (*UMass Amherst).*

❖ CLINICAL DIAGNOSTICS

Biosensors

These technologies include: point-of-care diagnostics using fluorescent nanostructures; diagnostic tools to analyze immune stimulatory activities in patient fluids; genetic screening using active fluorescent nanostructures; powerful miniaturized sensors for protein and bacterial identification; nanosensors for detection of toxic or infectious agents; gel-based glucose sensors; nanomaterials for enhancing protein analysis in complex mixtures; and phage-based biosensors for airborne infection. Investigators within these technologies include: Mountziaris, Davis, Maroudas, Emrick, Bermudez, Barnes, Dubin, Kaltashov, Thayumanavan, Watkins, Russell, Santore, Vachet, and Rotello (*UMass Amherst);* Latz (*UMass Worcester);* Sandman and Gu (*UMass Lowell);* and Calvert, Singh and Mello (*UMass Dartmouth).*

❖ DISEASE PREVENTION

Antimicrobial Applications

These technologies include: bioavailability and toxicity of nanoparticles to microbial communities; molecular self-assembly of fullerene-derived nanospheres as antibacterial agents; and antimicrobial textiles. Investigators within these technologies include: Ergas, Tew, and Santore (*UMass Amherst);* Fan (*UMass Dartmouth);* and Rooney-Varga, Zhang and Chiang (*UMass Lowell).*

Vaccine Development

This technology includes engineered nanocarriers that are used to develop a new vaccine technology for the malaria parasite. Investigators within this technology include Golenbock and Latz *(UMass Worcester)*, Bhatia, Bermudez, Emrick, Dubin, Kaltashov, Thayumanavan, Watkins and Russell *(UMass Amherst).*

❖ NANOTECHNOLOGY CAPABILITIES

As shown in the matrix, as the vertical axis, the nanotechnology capabilities were organized into four categories. These categories are nanoparticles, 2-dimensional structures, 3-dimensional structures and characterization. The matrix in Table 1 identifies the overlap of the various nanotechnology capabilities with life sciences applications. This model is valuable on two levels. First, although it may be incomplete, it begins to map—to some extent—the relationship between useful tools and technologies derived from physical science- and engineering-based research at the nanoscale and fields within the life sciences where they can be applied. A more robust effort to describe these relationships would undoubtedly assist in developing a strategic framework to guide planning and prioritizing for future growth of the life sciences research enterprise.

Looking ahead, the working group believes that there would be significant value in undertaking a more thorough inventory and using the information collected to help set strategic priorities for the research enterprise, develop programming to build a seamless UMass community of researchers across the five campuses with a shared interest in bio-nanotechnology and enable investigators to identify collaborators to pursue opportunities that would be difficult to do alone.

Perhaps more importantly, each category on the matrix represents the expertise and interests of one or more researcher(s) or research group(s) at UMass. For example, there are a number of researchers and groups at Amherst, Dartmouth and Lowell working on the production of polymer and other fibers at nanoscale dimensions (typically 40-200

nm). One important potential use for these types of materials and structures is as scaffolds on which tissues can be grown, both *in vivo*, as well as in the laboratory. Success in the field of tissue engineering, as in many others, demands multi-disciplinary collaboration. The UMass campuses, working together, are in a position to advance this kind of achievement.

Recommendations

- **RECOMMENDATION 1**
  Support Efforts to Integrate Nanotechnology into the Life Sciences

To support translational research and industry-university collaborations that promote new economic development by integrating nanotechnology into the life sciences, the working group recommends an industry-university collaborative grants program on nano-bio applications. Further, the group recommends the establishment of the nano-bio expertise database and an Industrial Liaison Office, as well as an annual nano-bio networking conference to foster industry-university collaboration. Finally, the group recommends support for technology incubators to help new start-up companies.

- **RECOMMENDATION 2**
  Develop University-wide Nanotechnology for Life Sciences Core Facilities

The working group recommends the development of system-wide, nanotechnology-based core facilities, including a bioconjugation core and a characterization core that will enable the application of innovative nanostructured materials in the life sciences and medical research.

Bioconjugation is the critical step of the interface between material and biological sciences. Only successful conjugations will lead to a new application. Specialized equipment is needed to engineer, purify and control the quality of materials consisting of biologics and nanomaterials. Moreover, specialized expertise is needed to tackle the many problems that appear when these two materials are physically linked. A bioconjugation core would serve as an ideal platform from which university investigators could access nanomaterial to use in their biomedical applications. Such a core would facilitate the access of scientists to novel materials and novel technologies and would serve as a base for inter-campus collaboration, as well as speed up any type of science involving the use of nanomaterial in biomedical sciences.

These cores could be integrated with the UMass Nanomedicine Institute to serve the needs of the entire UMass system and Massachusetts industry.

- **RECOMMENDATION 3**
  Invest in Research at the Interface of Nanotechnology and the Life Sciences

The working group believes that effort should be given to identifying research at the interface of nanotechnology and the life sciences. Once identified, such research should be a priority for investment by existing and future UMass and commonwealth funding programs and seed funds for development of multi-investigator, cross-disciplinary proposals.

- **RECOMMENDATION 4**
  Create Opportunities for Interactions between Nanoscale Science & Engineering Faculty and Life Sciences Faculty

The working group recommends that opportunities for interactions and networking between faculty working in the field of nanoscale science and engineering and the life sciences be created. Such opportunities could include funding for research symposia, conferences, exchange visits and laboratory rotations for graduate and postdoctoral researchers.

- **RECOMMENDATION 5**
  Eliminate Numerous Administrative Barriers that Discourage Inter-campus Collaboration

The university should make efforts to eliminate the numerous administrative barriers that discourage inter-campus collaboration, such as user fees, library restrictions and other policies that prevent the campuses from sharing and collaborating effectively with each other and with strategic partners.

Resources

The resources required to develop core facilities to support nanotechnology for life sciences applications would be $2 million for equipment and supplies, $1 million per year for the establishment of seven faculty lines and start-up costs to support system-wide research efforts that focus on the application of nanostructured materials to clinical diagnostics, novel therapeutics, disease prevention and nanotoxicology.

In order to promote industry-university collaborative grants, the working group requests $1 million per year. Moreover, the nano-bio database and Industrial Liaison Office, which would include two technical staff, would require an investment of $100,000 per year.

Conclusion

The working group believes that significant potential exists at the university to leverage nanotechnology research capabilities and assets to develop the university's life sciences research programs. Appropriate effort and support should be invested in fostering collaboration between researchers from different campuses by developing a strategic plan for growing research, technology development and education and workforce retraining programs to benefit the commonwealth.

VI. Technology Innovation Centers Working Group

❖ INTRODUCTION

The Technology Innovation Centers Working Group was charged with assessing the current and potential role of UMass campuses in developing such centers and with generating recommendations to promote such development.

The working group was co-chaired by Carl Lawton, Ph.D., Professor of Chemical Engineering and Director of the Mass BioManufacturing Center on the Lowell campus, and Paul Vigeant, Assistant Chancellor for Economic Development, on the Dartmouth campus. Thomas Chmura, Vice President for Economic Development for the university, staffed the working group.

Other members of the working group included:

- Michael Malone, Ph.D., Dean of the College of Engineering on the Amherst campus;
- Marla Michel, Director of Industry Liaison and Development on the Amherst campus;
- William Brah, Executive Director of Venture Development Center on the Boston campus;
- John Ciccarelli, Assistant to the Chancellor for Economic Development on the Boston campus;
- Louis Petrovic, Ph.D., Assistant Vice Chancellor for Research Development on the Dartmouth campus;
- Stephen McCarthy, Ph.D., Professor of Plastics and Engineering and Director of the Mass Medical Device Development Center on the Lowell campus;
- James P. McNamara, Ph.D., Executive Director of the Office of Technology Management on the Worcester campus;
- Sheila Noone, Ph.D., Director of Clinical Research on the Worcester campus; and
- Abigail Barrow, Ph.D., Director of the Mass Technology Transfer Center at the President's Office.

The working group convened two meetings and engaged in a variety of email and telephone exchanges.

Situational Analysis

The concept, initially put forward by Governor Deval L. Patrick as part of the Commonwealth's Life Sciences Initiative, calls for the development of regional innovation centers that would provide infrastructure and services to promote and support regionally important elements of the life sciences sector (e.g., medical devices, manufacturing). Such centers may provide technology commercialization, incubator and accelerator, and workforce development activities.

The intent of such centers is to promote innovation and the growth of the life sciences industry throughout the commonwealth. Accordingly, they can serve as effective vehicles for linking the university's research and teaching capabilities, highlighted in other pillars, with the innovation needs of industry.

The development of these centers is consistent with trends in other states, which have long supported such initiatives, often at their state universities. Indeed, it could be argued the commonwealth is a relative latecomer to recognizing the need to encourage and support such initiatives around the entire state.

Based on experience to date, key characteristics of technology innovation centers would include: responsiveness to clearly identified industry needs and interests; strong university-industry links; a focus on translational research and commercial applications; shared facilities, equipment, services and incubators; attention to workforce development; support from local governments and the life sciences community; and external support for capital and operating funds.

❖ AMHERST

Amherst is in the early stages of developing its concept for a regional innovation center, with plans at the campus and in Springfield, and in conjunction with the Pioneer Valley Life Sciences Initiative (PVLSI), to foster the further development of a partnership between Amherst and Baystate Medical Center. Moreover, the Amherst campus has successfully initiated the Institute for Cellular Engineering (ICE), which has resulted in shared facilities and $3.5 million in federal funding for workforce development, including graduate and undergraduate training programs in cellular engineering and biochemical engineering. Efforts are proceeding to build an industrial consortium of sponsors through ICE.

Amherst is continuing to develop its physical infrastructure on the campus. Plans are emerging for a major life sciences research facility that would accommodate

interdisciplinary research, industry partnerships and teaching and learning opportunities. Through the commonwealth's Life Sciences Legislation, the Amherst campus has received $95 million to help support this plan. As it evolves, it is envisioned that the campus would begin to host industrial researchers on campus as part of an effort to promote translational research. As commercial opportunities and spin-off companies emerge from this initiative, links will be made with an innovation accelerator planned for Springfield.

The PVLSI was originally seeded with contributions from Amherst and Baystate, and expenses continue to be shared by both institutions. Also, the PVLSI received funding from the President's Science and Technology (S&T) Fund, setting the stage for a $3 million John Adams Innovation Institute grant that helped to develop a focus on apoptosis (research on programmed cell death), resulting in the Mass Center of Excellence in Apoptosis Research. To date, the PVLSI has largely been a joint research effort that has secured more than $21 million in sponsored activity to the region.

Recently, a new director of business development has been hired and planning is underway for developing one floor of the PVLSI building in Springfield as an innovation accelerator. The accelerator would provide the wet lab infrastructure needed for young companies to develop their products and prepare for clinical trials. An additional $5-6 million investment has been secured for PVLSI in the Life Sciences legislation.

❖ BOSTON

The Boston campus is developing a collaborative venture with Dana-Farber/Harvard Cancer Center to establish a Center for Personalized Cancer Therapy (CPCT). The CPCT will be launched in fall 2008 within lab suites of the new Venture Development Center (VDC) at the Boston campus. The VDC is a new partnership facility developed with $5 million of support from the 2006 Massachusetts Economic Stimulus bill. The VDC is seeking additional funding from the U.S. Economic Development Administration.

Through the development of core facilities, the CPCT is envisioned to serve more than 800 cancer researchers and others in both academia and industry throughout the region. Personalized cancer therapy is seen as a high priority R&D area with considerable commercial potential. Its location within the VDC will help to accelerate the innovation process and provide a potential home for new start-up ventures. An additional $10 million investment has been secured in the commonwealth's Life Sciences legislation.

❖ DARTMOUTH

Dartmouth is developing its regional innovation center around a proposed bioprocessing facility in Fall River. The facility would provide large scale bioprocessing services to biotech companies and potential bioenergy companies that would enable them to test their processes at scale. Also, it would provide education and training services and applied research in bioprocessing. This is seen as a complement to the biomanufacturing facility currently in development on the Lowell campus, which will focus on process development.

The 2006 Massachusetts Economic Stimulus bill provided $10 million of funding in the MORE Program of the Executive Office of Housing and Economic Development for the bioprocessing facility. The campus, with the assistance of an industry consultant, has gathered additional industry input and is updating business and financial plans for the center, which it hopes will convince the commonwealth to release these funds in 2008. Moreover, the campus is pursuing a John Adams Innovation Institute grant.

The facility would likely be located in a new life sciences R&D park in Fall River, and the Fall River Economic Development Corporation is considering additional financial support for the initiative. As capital funds are approved, the campus will seek equipment donations from industry and utilize industry service fees as part of its operating revenue strategy.

❖ LOWELL

The Lowell campus is clearly the most developed campus in terms of its concept for a regional innovation center that will serve as a shared-use facility for two key segments of the life sciences industry. The campus' concept is focused on support for entrepreneurs and inventors in bringing medical devices from ideas to commercialization and for biotech companies in moving products from bench to production. Both were developed with extensive consultation with their respective industries. These initiatives, along with others in development (e.g., nanomedicine), would provide the core of a regional life sciences innovation center in Lowell. They would be housed in a renovated facility on the Lowell campus that is adjacent to a campus-run high tech business incubator.

Lowell's medical device initiative, M2D2, has been developed in partnership with the Worcester campus and MassMedic, the medical device industry council of Massachusetts. It was launched with a President's S&T grant and has been supported by $650,000 of John Adams Innovation Institute grants before receiving a major $4 million state grant at the recommendation of the Massachusetts Life Sciences Center. Also, it has begun to

generate Small Business Technology Transfer and Small Business Innovation Research grants and hopes to secure industry service fees as well.

The Massachusetts BioManufacturing Center (BMC), Lowell's biomanufacturing initiative, has been developed in partnership with the Mass Biotech Council, as a complement to Dartmouth's Bioprocessing Facility. Similar to M2D2, it started with a President's S&T grant and then secured a John Adams Innovation Institute grant. Also, it received approximately $15 million in state support (both cash and bonding) from the 2006 Massachusetts Economic Stimulus Legislation. Furthermore, it has received over $500,000 in equipment donations from private industry and collects industry fees for its services.

❖ WORCESTER

The Worcester campus has a history of developing core facilities that support life sciences research and development, which have been made available to both academia and industry (e.g., NMR, MRI, mass spectrometry). Currently, there are thirty core facilities at the Medical School, and it has a collaborative relationship along these lines with Charles River Laboratories, a preclinical services company based in Shrewsbury.

The campus has received about $8 million in first-year capital and operating support from the Massachusetts Life Sciences Center to establish a human embryonic stem cell bank and registry that would be a state-wide and regional resource for academia and industry. An additional $6 million is required to continue operations in years two and three, and the Worcester campus is actively pursuing the funding in partnership with the Massachusetts Life Sciences Center.

In addition, the commonwealth's Life Sciences Initiative contains $90 million for the Advanced Therapeutics Cluster (ATC) facility that will focus on RNAi, stem cells and gene therapy, but would support all R&D on therapeutics at the Medical School. Moreover, the campus is seeking a $20 million, multi-year NIH grant for a CTSA. As these additional sources of funding firm up and specific plans for the ATC and CTSA are developed, likely there will be other facilities and resources that could be made available to industry (e.g., a GMP manufacturing facility).

Other institutions such as Massachusetts Biomedical Initiatives, which is a regional life sciences economic development group that currently operates incubators in Worcester, and Worcester Polytechnic Institute, are potential partners of the Medical School in developing regional initiatives.

Findings

Given the location of its campuses around the commonwealth, UMass is ideally positioned to play a leadership role in the development of such innovation centers in Massachusetts. Thus, the university should have a goal to position itself as a strategic resource for the development of such regional life sciences innovation centers around the state, either as the lead or as a principal partner with other institutions, such as Baystate Medical Center in Springfield and Massachusetts Biomedical Initiatives in Worcester. Furthermore, where it makes sense, as in the case of the Lowell and Worcester campuses collaboration on medical device development, inter-campus collaboration should be pursued.

Currently, all UMass campuses are active in either developing a regional innovation center or have plans to do so. Typically, such centers involve partners from other UMass campuses, private institutions and the life sciences industry.

To date, UMass campuses have received approximately $35 million in state funding to support the development of various regional innovation centers. This funding has come through the President's S&T Fund, John Adams Innovation Institute grants, the 2006 Massachusetts Economic Stimulus Bill and the Massachusetts Life Sciences Center.

In addition, more than $40 million, primarily in capital funding, is identified for regional innovation centers linked to UMass, and located in Boston, Fall River, Lowell, New Bedford, Springfield, and Taunton, in the commonwealth's Life Sciences legislation.

Recommendations

The university is extremely well-positioned to play a leadership role in the development of a network of regional innovation centers in every geographic region in the commonwealth. These centers offer the university effective vehicles for linking its resources with the innovation needs of industry, for making major contributions to regional economic development and for generating substantial new resources.

- **RECOMMENDATION 1**
  Secure Capital Support

The university will need to continue to aggressively pursue capital support to enable the successful development of these innovation centers. Typically, this runs in the $5-15

million range. The commonwealth's Life Sciences legislation and past and future economic stimulus bills are the most likely source of such funds.

- **RECOMMENDATION 2**
  Pursue Operating Support

Such centers typically require operating subsidies of $1-2 million annually for three to four years until they can become self-sufficient. In addition to state sources (e.g., life sciences bill, next economic stimulus bill), there exist opportunities with federal sources (e.g., NIH, EDA), local economic development agencies and private industry (e.g., equipment donations, fee for service arrangements).

- **RECOMMENDATION 3**
  Understand Industry Needs

To achieve the commonwealth's economic development objectives for these innovation centers, campuses will need to develop a strong understanding of regional industry needs for their proposed infrastructure and services and design their centers to respond to those needs. Internal studies, research groups, such as the Donahue Institute, and consultants with deep industry knowledge and connections can be useful resources. Also, these exercises can help in the development of appropriate metrics such as technology commercialization, start-ups, grants awarded and jobs created.

- **RECOMMENDATION 4**
  Develop Needed Staff and Organizational Capabilities

The track record at campuses such as Boston with its Venture Development Center and Dartmouth with the Advanced Manufacturing Center suggests the need for specialized talent and experience among center staff to successfully operate regional innovation centers. Some campuses may need to develop new kinds of staffing and organizational capabilities to carry out this new role.

- **RECOMMENDATION 5**
  Determine the Need for New Policies, Practices and Legislation

Regional innovation centers must be operated in an entrepreneurial manner to be effective. This may require changes in some university policies and practices (e.g., fee-for-service arrangements) and even state law (e.g., expedited construction and leasing arrangements) to facilitate the effective development and operation of new initiatives.

- **RECOMMENDATION 6**
  Develop a State-wide "Network" of Regional Innovation Centers

Steps can be taken, through the UMass President's Office and organizations such as the Massachusetts Technology Transfer Center, to help in the development of a true state-wide network of innovation centers that promote collaboration, resource sharing and access to specialized equipment and core facilities.

Resources

As the recommendations make clear, securing both capital and operating support is critical for the successful development of such innovation centers. The working group proposes an initial infusion of capital investment of somewhere between $5-15 million. Moreover, the development of such centers will necessitate early operating support, perhaps for three to four years, until the centers become self-sufficient. Approximately $1-2 million annually would meet the need.

Conclusion

The working group recommends that the university should position itself as a strategic resource for the development of such centers, either as the lead institution or as a principal partner with other life sciences institutions. Such centers can serve as an effective mechanism for linking the research and education resources of the university with the innovation needs of the life sciences industry.

Although the university has some history in developing and managing such facilities, this is a relatively new type of initiative for most UMass campuses. Successful development of such centers will require careful planning, close consultation with industry and the development of the necessary staff and organizational capabilities.

In addition to capital support, such centers will typically need operating subsidies from the commonwealth, federal government, local development agencies and private industry until such time as they can be self-supporting. Moreover, changes in university policy and practice and even Massachusetts law may be necessary to facilitate the effective development and operation of new entrepreneurial initiatives such as these centers.

VII. Workforce and Policy Initiatives Working Group

❖ INTRODUCTION

The Workforce and Policy Initiatives Working Group was charged with developing an aspirant plan for the university on workforce and policy initiatives, specifically addressing what the university effort should be, how campuses should collaborate and the extent of resources needed for the university to realize this plan. Greer Glazer, Ph.D., F.A.A.N., R.N., C.N.P., Dean of the College of Nursing and Health Sciences on the Boston campus, and David Wegman, M.D., M.P.H., Dean of the School of Health and Environment on the Lowell campus, served as co-chairs of the working group. Paulette Seymour Route, Ph.D., R.N., M.S., Dean of Graduate School of Nursing on the Worcester campus, staffed the working group.

Other members of the working group included:

- Karen Bean, Commonwealth Medicine on the Worcester campus;
- Joan Becker, Ed.D., Associate Vice Provost for Academic Support Services on the Boston campus;
- Jennifer Davis Carey, Ed.D., Senior Director for Training, Education and Dissemination Unit for the Center for Health Policy and Research of Commonwealth Medicine on the Worcester campus;
- Stephen Crosby, J.D., Dean of the McCormack Graduate School of Policy Studies on the Boston campus;
- Kay Doyle, Ph.D., Professor, Program Director & Department Chair of Clinical Laboratory & Nutritional Sciences on the Lowell campus;
- Sharon A. Grundel, M.Ed., Manager of Workforce Development for MassAHEC Network on the Worcester campus;
- Lynn Griesemer, Ed.D., M.P.A., Executive Director of the Donahue Institute;
- Deborah Harmon Hines, Ph.D., Vice Provost for School Services on the Worcester campus;
- Richard Maguire, Director of Human Resources on the Worcester campus; and
- Karen Melillo, Ph.D., Professor & Department Chair of Nursing on the Lowell campus.

Beginning in January 2008, the working group completed a six-month project to develop an aspirant plan for the university around life sciences workforce and policy initiatives to ensure that the university system's and state's workforce needs are met in the future with enhanced collaboration between higher education, K-12 education, business, government and philanthropy. The working group set out to compile information related to workforce and policy initiatives to answer the following:

- What was each campus doing?
- Was any campus leading in this area?
- Did any of the research efforts benefit from the President's S&T Fund?
- Were there examples of inter-campus collaborative efforts that could be used as potential models for collaboration, going forward?
- In a UMass aspirant vision for the life sciences, what are the most critical concerns for the future life sciences efforts within the system?
- What are the university system's strengths and weaknesses in these areas?

The data points were compiled by reviewing current campus efforts, inter-campus efforts, STEM/pipeline initiatives and trends in the life sciences workforce in Massachusetts and the U.S.

The work was guided by the following assumptions:

- The foundation of the life sciences initiative is the availability of an adequately educated and sufficient number of professionals and research scientists;
- The workforce must be sufficiently diverse to mirror and serve the broad needs of the population;
- Healthcare disparities reduction will best be accomplished with a diverse and culturally competent life sciences workforce; and
- Investments in infrastructure must be coupled with broad investments in workforce and in workforce development for the disciplines and professions essential to the life sciences.

Situational Analysis

❖ CURRENT ASSESSMENT OF CAMPUS EFFORTS

The University of Massachusetts has a wide array of life sciences degree programs and pathways, ranging from the bachelor's to the doctoral levels (please refer to Attachment 4). All of the campuses serving undergraduates offer degree programs in traditional life sciences areas within core programs in biology, chemistry, physics, mathematics, engineering and computer science. Also, each institution offers courses and degrees integral to its unique focus and mission. Enhancing the facilities, buildings, and equipment on all of the campuses, however, would improve the quality of the programs offered.

A review of public program offerings related to traditional life sciences revealed that there were very few part-time degree programs available outside of working or primary childcare provision hours. Many transitional workers, primary caregivers or those already working in related fields, therefore, cannot access these essential degrees. Further, the cost of these programs may put them out of reach to working women and diverse communities who are essential to this initiative.

A workforce educated in traditional life sciences programs alone cannot achieve the goals of the Massachusetts Life Sciences Initiative. Success in the life sciences will depend on a sufficient healthcare and prevention workforce. Fortunately, the necessary complement of healthcare and health promotion professional programs is, for the most part, available on the university's five campuses. Key among these are programs in nursing, public health, exercise and health science, clinical laboratory sciences and work environment.

Conferring nearly fifteen percent (14.8%) of the commonwealth's postsecondary degrees and certificates in 2005, the University of Massachusetts contributes significantly to the state's life sciences talent pool. The Amherst campus (864) and the Lowell campus (635) ranked fourth and seventh respectively among the top ten Massachusetts post-secondary institutions in life sciences degree production. Degrees conferred at the Dartmouth campus (253), the Boston campus (177) and the Worcester campus (27) contributed to a total of 1,946 system-wide.[3] However, these numbers substantially underestimate the total contribution of the university to the life sciences workforce when a broader definition of life sciences workforce components is considered. If degrees in medicine, nursing and public health disciplines are added, the system total is increased by 727 (Amherst, 221; Boston, 184; Dartmouth, 114; Lowell, 77; and Worcester, 131).

❖ TRENDS IN THE TRADITIONAL LIFE SCIENCES WORKFORCE

The University of Massachusetts Donahue Institute's Life Sciences Talent Initiative report provides a context for trends in the traditional workforce and related policy considerations. The report concluded that:

1) The life sciences industry provides enormous economic value to the commonwealth in addition to generating high-quality jobs for residents;

2) Demand for highly qualified talent is growing in traditional R&D and downstream business sectors;

3) Massachusetts has excellent higher education and workforce training programs in life

[3] UMass Donahue Institute Life Sciences Talent Initiative Technical Report, April 2008

sciences fields, but they need to be better coordinated and responsive to the needs of industry;

4) More Massachusetts residents need to take advantage of higher education opportunities in the life sciences; and

5) Massachusetts needs to be more proactive in marketing life sciences careers to young residents and adult workers in transition.

The UMass LSTF decided that the life sciences workforce should be understood to include critical healthcare professions, as well as research, development and manufacturing. This broader life sciences workforce was not assessed by the Talent Initiative, but Massachusetts' success in the life sciences will depend upon a sufficient healthcare and prevention workforce. Shortages in the related professional workforce (clinical-, laboratory- and prevention-related) are significant and expected to worsen without direct attention. For example, the healthcare industry has the highest number of vacancies of industry in Massachusetts. Nearly half of these 17,621 fourth quarter 2006 vacancies are for registered nurses. These shortages are expected to triple by 2020.[4] Current programs in clinical laboratory science are preparing only half of the anticipated need nationally[5], but the number of degree programs in Massachusetts has been dramatically reduced since the 1980s.

The expansion of the biotechnology industry in New England has been accompanied by the development of biocontainment facilities at biosafety levels 3 and 4. Growth in these facilities has not been matched by a commensurate increase in the numbers of professionals qualified to manage and ensure safety. Rare accidents, such as the recent laboratory exposures at Texas A&M University and the foot and mouth disease outbreak in the U.K., which may have originated from a research laboratory, underscore the need for a highly trained and well-regulated workforce. There is a significant need for increased training for the mid-level managers who direct daily operations at the facilities, the laboratory staff and the biological safety officers. Currently, there are no biosafety academic programs in Massachusetts.

While many nations and states compete with Massachusetts in the life sciences, the two best examples of the commonwealth's competitors are California and North Carolina. Each has adopted expansive legislation to support the life sciences industry and importantly, the formation within public higher education of research and curriculum structures to meet the needs of industry. It is imperative that Massachusetts meet and

[4] Massachusetts Health Care Chartbook, prepared by Executive Office of Workforce Development and Commonwealth Corporation, Fall 2007.

[5] Kibak P. "The Worsening Shortage of Lab Staff". Clinical Laboratory News (2008) 34:1-3

exceed the efforts of these other states in order to maintain this industry as a leading edge in the state's innovative economy.

Several factors threaten the commonwealth's ability to continue to provide the appropriately educated workforce that industry demands in the near future. These include: the need to address inadequacies in the preparation of students arriving from the K-12 pipeline and to develop programs in key demand areas; improvement of bachelor-level programs by creating retention programs, especially for minorities; an integrated science curriculum; lab research experiences; and co-ops. In general, the higher education system needs to improve its coordination and create a meaningful relationship with industry.

Findings

Workforce efforts in the life sciences must address the pipeline of K-12 students, retention and graduation in collegiate programs, student diversity, gaps in programming, inter-campus collaboration and policy considerations.

❖ Increasing the STEM Pipeline and Improving Undergraduate Retention

The working group recognizes that to increase enrollment in STEM majors, there is a need to invest resources into sparking and sustaining students' interest in STEM careers as early as possible so that students can begin to take the requisite coursework in high school. This is especially true for underrepresented students. It is equally important to connect students to role models and mentors who can help them begin to develop the necessary resolve to do the hard work required to succeed in these fields.

In addition to offering a full complement of academic programs in STEM fields at the undergraduate and graduate levels, the University of Massachusetts and the campuses have developed a number of initiatives aimed at increasing the number of students in the STEM pipeline, many of which address the issue of diversity (please refer to Attachment 5). While there are more than fifty programs and initiatives across the campuses for K-12 students and teachers, the programs and their respective databases are not coordinated across the system. Also, there is wide variation in the extent to which the programs track student progress through secondary school, into and through postsecondary education and into the workforce. As a result, it is difficult to assess the extent to which the

programs are increasing the number of students who enter the STEM pipeline and ultimately pursue STEM-related careers.

There are a handful of programs at the campuses that are aimed at enhancing the preparation of community college students for STEM careers. There is variation in the extent to which these programs track student progress from community college through baccalaureate and graduate degrees and into the workforce. Given the large number of students, especially from minority, low income and first generation backgrounds who attend community colleges, this component of the STEM pipeline is an area where improved articulation and increased programming could have a significant impact on the number of students pursuing STEM careers.

While the working group understands that increasing the number of students enrolled in STEM majors is necessary to increase degree production, it also understands that without strong academic preparation, advising, and mentoring[6] students are less likely to be retained or to graduate with a STEM degree. Furthermore, a strong foundation in mathematics is crucial for success in STEM and the lack of an adequate preparation in mathematics is a significant factor in the failure of many students, especially from underrepresented backgrounds, to pursue and complete a STEM degree[7]. Therefore, it is essential that in addition to making investments in efforts to increase the number of students interested in STEM careers, investments must also be made in efforts to increase student retention in STEM degree programs.

All of the campuses have begun to develop programs aimed at enhancing the preparation and retention of students at the postsecondary level. The bulk of these programs (27) are focused on undergraduates and range from topical seminars and workshops to ongoing academic preparation programs that offer opportunities for STEM career awareness, skill development and mentored research experiences. As an example, there are approximately ten NSF-sponsored Research Experience for Undergraduates (REU) programs active on the Amherst campus, which help to recruit 150 new undergraduates to the campus each summer. These programs introduce undergraduate students to cutting-edge research in fields such as cellular engineering, nanotechnology and energy, and serve as tools to both

[6] Muraskin, L. and Lee, J. 2004. Raising the graduation rates of low-income college students. Washington, D.C.: The Pell Institute for the Study of Opportunity in Higher Education. Sharp, L., Kleiner, B., and Frechtling, J. 2000. A Description and analysis of best practice findings of programs promoting participation of underrepresented undergraduate students in science, mathematics, engineering, and technology fields. Washington, D.C.: National Science Foundation. Tinto, V. 2004. Student retention and graduation: facing the truth, living with the consequences. Washington, D.C.: The Pell Institute.

[7] National Research Council. 2003. BIO2010: Transforming Undergraduate Education for Future Research Biologists. Committee on Undergraduate Biology Education to Prepare Research Scientists for the 21st Century. National Academies Press.

encourage and support student interest, as well as to inspire students to obtain advanced STEM degrees.

Another such example and of note is the NSF's Louis Stokes Alliance for Minority Participation, which is focused on doubling baccalaureate degree production in STEM fields among underrepresented students. The Amherst campus is the lead institution in an alliance that includes the University of Connecticut, the University of Rhode Island, Northeastern and Worcester Polytechnic Institute. The Boston campus leads an alliance that includes the Dartmouth and Lowell campuses, Wentworth and Bristol, Middlesex, Roxbury, and Bunker Hill Community Colleges. Also, several of the campuses sponsor programs for graduate students. These include mentored research experiences and scholarship support. While these initial efforts to improve retention are laudable, significantly more resources and attention needs to be focused on increasing the number of students who are retained and persist to graduation in STEM fields.

❖ POLICY CONSIDERATIONS FOR THE LIFE SCIENCES INITIATIVE

The $1 billion investment in life sciences in Massachusetts requires evaluation. The principal policy consideration should be the evaluation of the effectiveness of the strategies and tactics implemented within each pillar. For example, the working group proposes to evaluate the impact of programs on both teachers and students in sample workforce pipeline programs, as well as proposes a database that tracks the actual impact and outcomes of various STEM programs. Similarly, return on investment in infrastructure should be evaluated.

While some of the major policy considerations will be determined by the Massachusetts Legislature, the governor and the Massachusetts Life Sciences Center Board as they design and implement the life sciences legislation, there will be opportunities to inform and refine this legislation during a ten-year period. The policy initiatives in life sciences are further shaped by federal and state regulations, the UMass Trustees and campus faculty senates.

The working group proposes to build an evaluation component for the overall life sciences investment, which will be made pursuant to the commonwealth's Life Sciences legislation. The evaluation plan for this $1 billion investment of public monies will help the administrators of the program guide investment decisions and provide feedback to the legislature and governor on the utility and strategy of future investments.

❖ MODELS FOR INTER-CAMPUS COLLABORATION

Several models of inter-campus collaboration provide examples for future collaboration among programs for the development of the life sciences workforce.

The Biomedical Engineering and Biotechnology Ph.D. program is an inter-campus effort among the Boston, Dartmouth, Lowell and Worcester campuses and was developed by an interdisciplinary committee of administrators and faculty from those campuses. The committee met on a regular basis to develop the curriculum and program policies. Program courses offered at each campus can be taken by any program student at any of the campuses. Also, some of the courses are offered online (i.e. bioethics, mathematics courses) for students at all campuses to take electronically. Cross-campus course registration is available with course credits documented on the student's "home campus" transcript via the ISIS system. Courses are developed and taught through inter-campus collaboration.

Moreover, the nursing programs on the campuses, which have an outstanding record of serving the commonwealth by developing first-rate professionals at both undergraduate and graduate levels, have collaborated frequently and often with impressive results. The Boston and Lowell campuses have, since 1996, built a very productive and well-received joint Ph.D. program in nursing with a focus on health policy at Boston and health promotion at Lowell. Also, the Boston, Lowell and Worcester campuses have worked in a close collaboration to address a national directive that by 2015 all advanced practice academic preparation in nursing must be at the doctoral level. The three campuses worked together in preparing Doctor of Nursing Practice proposals, an effort assisted by the UMass President's Office, which arranged for a combined external review of all three proposals. Also, this effort was greatly assisted by leaders on the Amherst campus, who initiated their program transition a year earlier, and by leaders on the Dartmouth campus, who plan to follow the other four campuses by offering this doctorate level program within the next three years. This collaborative effort was able to leverage the cross-campus knowledge and take advantage of the variety of models, thereby making the UMass programs national leaders in this transition.

Further, it should be noted that the leadership of the nursing programs across the university collaborated on a proposal for the UMass President's office entitled, "UMass System Response to Nursing Workforce and Policy Initiative: Human Capital – Ph.D. and Post-Doctoral Education of Nurses Across 5 Campuses," under the Massachusetts Life Sciences Initiative ($600K per campus) – October 2007.

The $3.5 million NSF IGERT Program grant that the Amherst campus was awarded to establish a new graduate training program in cellular engineering, which will be run through the Institute for Cellular Engineering (ICE), offers the university a unique model on structuring interdisciplinary graduate training programs to meet workforce

development needs. This new program involves more than thirty faculty and sixty graduate students in ten departments and four interdisciplinary graduate programs. Efforts are being placed towards developing novel laboratory curricula to train students and industry personnel in interdisciplinary research approaches and experimental/theoretical techniques such as those associated with drug delivery, cell modeling, microscopy, molecular analysis and biophysical characterization of proteins. The IGERT program in cellular engineering joins existing Amherst interdisciplinary graduate programs in nanotechnology (NSF IGERT supported) and CBI (Chemistry-Biology Interface; NIH sponsored). These programs are developing common curricula and industrial partnerships to capitalize on the state-of-the-art training students obtain at various STEM interdisciplinary boundaries.

Recommendations

Recommendations focus on building capacity, enhancing infrastructure, developing incentives to increase academic-industry partnerships, enacting curricular revision, furthering pipeline initiatives, addressing database needs and contributing to overall evaluation and assessment.

▪ RECOMMENDATION 1
Increase the Number of Practitioners and Research Scientists Qualified in Select Areas Critical to the Life Sciences

The working group recommends increases in the number of practitioners and research scientists should focus on the areas of nursing, clinical laboratory scientists, public health, clinical research management, computer science, biosafety, regulatory engineering and quality control. Thoughtful attention to reducing unnecessary duplication is essential. Furthermore, it is essential that diversity and retention be high priorities in developing this expanded workforce.

The working group proposes building capacity in these areas by:

- Establishing and strengthening student retention efforts including advising and academic support to improve graduation rates at all campuses;
- Doubling the number of graduates in each of these areas over the next five years with priority given to women, the racially and ethnically diverse and the economically disadvantaged and with special attention given to the current issues relating to the securing of H1B visas for international students;
- Improving university-wide marketing and recruiting efforts to attract students to

life sciences degree programs;

- Establishing program-specific post-doctoral traineeships, at least two per campus in nursing, two in clinical laboratory science, two in public health science and two in computer science per campus program;
- Recruiting talented world-class researchers and practitioners;
- Developing new programs for biosafety at undergraduate and graduate levels; and
- Addressing retraining, re-skilling and state-of-the-art education of the existing workforce.

The working group recognizes that the following resources will be required to accomplish the stated objectives:

a. Retention programs that use research-based practices including summer bridge programs, increased use of developmental advising for STEM majors, and increased use of supplemental instruction and other forms of academic support in STEM courses with high failure rates ($1 million per campus per year over five years).
b. Undergraduate scholarships and graduate assistant stipends sufficient to attract and keep the top students at all levels. Provide summer stipends for undergraduate research experiences, full tuition, fees and stipends for graduate students approximating NIH or NSF funding levels as appropriate ($100,000,000 over five years).
c. Post-doctoral fellowships approximating NIH or NSF funding as appropriate ($9,900,000 over five years @ $90,000/stipend).
d. Permanent funding for new faculty lines to account for recruitment, start-up, and department program expansion and refinement (20 faculty @ $500K/faculty = $10,000,000).
e. Sufficient administrative and support staff to ensure program success. For program sustainability, staff are required for administration, laboratory technology, internship/coop placements, and development of research opportunities (two new staff/campus $70,000/staff - $700,000/year for five years).
f. Part-time/continuing education models to accommodate full and part-time learners who are transitioning careers, are unemployed or who are closing competency/skill gaps while working full time.

▪ RECOMMENDATION 2
Enhance Infrastructure to Provide Quality Education in the Targeted Areas for an Expanded Student Body on all Campuses

The working group recommends updating and expanding state-of-the-art laboratory space and equipment, office space and appropriate information technology resources for each of the programs. These enhancements should be managed through enhancements to

existing offerings where possible. New construction will, however, be required on the Boston and Lowell campuses. Funding will primarily be provided through bonding, but private funds will be sought to name buildings and areas.

a. Renovations on all five campuses assuming: shell and core ($400/ft^2), interior fit-up ($167/ft^2), furniture, fixtures and building equipment ($100/ft^2), ($152 million for new construction and $30.7 million per campus for renovation - $305.5 million).

- **RECOMMENDATION 3**
  Establish Incentives that Increase Academic-Industry Partnerships

The working group feels strongly that developing and sustaining university partnerships with industry is of strategic importance. Therefore, the working group supports and encourages a chancellor-level discussion to address issues that impede, and identify strategies that facilitate such partnerships. Moreover, the working group supports increased and sustained university efforts to pair students with mentors, so that every student has the opportunity for a genuine hands-on education in each of the identified fields. A core value in this effort should be close attention to diversity and cultural competence in the various settings.

a. Paid co-ops and internships in the students' designated disciplines funded through industry partners ($18.5 million/year across the campuses).
b. Research opportunities for undergraduates as well as graduate students.
c. Incentives to increase public/private partnerships between UMass and industry in the commonwealth and beyond.

- **RECOMMENDATION 4**
  Enhance Community Service Learning Experiences

The working group believes that curriculum in each of the disciplines must be aligned with the realities of the life sciences needs by addressing workforce needs with practice and experience embedded throughout. Community Service Learning experiences, formally recognized with college-credited coursework, afford important reality-based practice, especially when provided in culturally diverse settings that encourage differing perspectives. Also, it is essential that there be multiple opportunities to engage in research throughout the curriculum at all levels ($1,000,000/year funded by the President's Office with competitive applications conditioned on collaboration across all relevant campuses by program).

- **RECOMMENDATION 5**
  Extend the University's Reach to Strengthen K-12 STEM Initiatives

The working group suggests that the university, as the commonwealth's public research university, should give more focus to strengthening K-12 STEM initiatives, which truly reflect the cultural range of the communities that people live in and demonstrate an understanding of cultural competence. Moreover, the university should provide incentives to promote the establishment of community-academic partnerships that support diversity, offer academic enrichment programming to ensure academic success and sponsor work-based experiences with a career development component to middle and high school students, in preparation for post-secondary education in STEM and life sciences disciplines.

a. Support for endeavors and incentives that encourage mentoring and community engagement with programs that bridge connections for college students with youth and youth with educational/career opportunities in STEM and life sciences fields.
b. Funding for best-practice and sustainable models that have demonstrated high impact based on outcomes to be replicated across campuses and funded through state, municipal and industry support ($2 million/year/campus for five years).

- **RECOMMENDATION 6**
  Increase Flexibility and Resources for Life Sciences Degree Programs to Provide Full Access to Education for the Life Sciences Workforce

The working group recommends a focus on continuing part-time education in the life sciences that mirrors the existing high quality, full-time undergraduate and graduate education programs in both the content of the course work and the level of academic rigor. Exploration of tuition reduction and assistance for those students seeking training in key life sciences areas should be examined.

Moreover, the working group recommends the creation or augmentation of part-time and continuing education, career-focused life sciences degree programs in diverse communities that have been identified as containing large transitioning or unemployed populations. The Boston, Dartmouth, Lowell and Worcester campuses are geographically well positioned for such an initiative. Attention should be paid, however, to creating partnerships among the university, the state colleges and community colleges to provide access to such areas across the commonwealth. Also, partnerships should be created with biotech and pharmaceutical companies to fund scholarship and internship programs for those interested in the life sciences and prospective employees.

These initiatives could be driven with private and public partners including organizations such as the Massachusetts Division of Workforce Development, the Commonwealth Corporation, as well as EMD Serono and Shire Pharmaceutical, both of which are expanding Massachusetts operations.

- **RECOMMENDATION 7**
  A University-level Leader Designated with the Responsibility for Overseeing Life Sciences-related Information

The working group recommends that at the university system level, a leader should be designated with responsibility for the coordination, articulation, evaluation, creation and management of analysis and dissemination of information in on-line databases that facilitate collaboration in the above life sciences-related areas. The University of Massachusetts will establish or access, where possible, databases for the purpose of tracking life sciences programs, as well as STEM programs that address diversity and the students who have participated in such programs.

Databases to be created include:

a. On-line Program Database populated by program directors, listing: targeted students (grade level, STEM, under-represented, disadvantaged, etc.), admissions/selection criteria, program start/end dates, program description, contact information, and program Web link. The program database would list all UMass K-16 STEM-related programs, but should include programs from non-UMass K-12 schools, community and state colleges. The database will be updated annually by the program directors.
b. On-line Student Database allowing the tracking of students in programs listed above.
c. The establishment and maintenance of this database funded by the university system in collaboration with the Department of Education requiring IT equipment network ($600,000); IT services, Web design and maintenance ($850,000); IT staff data administrator/Web ($800,000) (five-year total of $3.75 million).

- **RECOMMENDATION 8**
  Build an Evaluation Component for the Massachusetts Life Sciences Initiative

The working group recommends building an evaluation component for the overall life sciences that will guide investment decisions and provide feedback to the legislature and governor on the utility and strategy of future investments. These resources should be

included in the Commonwealth's Life Sciences Initiative funding ($2 million/year for five years).

- **RECOMMENDATION 9**
  Reduce Barriers to Seamless Articulation within UMass

The working group recommends reducing barriers to seamless articulation within UMass and the creation of incentives to facilitate seamless articulation between UMass campuses, as well as state and community colleges, in order to make efficient use of resources devoted to these initiatives. This recommendation requires administrative leadership and policy changes and should be resource neutral.

Resources

Please refer to the Recommendations Section for information on resources.

Conclusion

The university is building on an excellent array of programs and initiatives across the five-campus system. It is apparent that better coordination and collaboration, not only between campuses but among K-12, business, philanthropic organizations and government will catapult the university to national prominence. The commonwealth's Life Sciences Initiative depends on an educated, diverse and talented workforce that is broadly defined to include those engaged in healthcare and prevention. The University of Massachusetts, in partnership with the Commonwealth of Massachusetts, has the opportunity to lead the nation in developing, growing and sustaining the life sciences workforce—and talent—of the future.

VIII. Health, Disease and Behavior Working Group

❖ INTRODUCTION

The Health, Disease and Behavior Working Group was charged with identifying an aspirant vision for the life sciences related to advancement of health, wellness and environmental research across the UMass campuses. The working group was composed of two to three individuals from each campus, working together to advance inter-campus engagement, partnerships and collaboration. Nancy Cohen, Ph.D, R.D., L.D.N., Interim Dean of the School of Public Health and Health Sciences on the Amherst campus, and Judith Ockene, Ph.D., Interim Vice Provost for Faculty Affairs on the Worcester campus, served as co-chairs of the working group. Ed Beard, Ph.D., Senior Advisor to the Senior Vice President for Academic Affairs, Student Affairs and International Relations at the President's Office, staffed the working group.

Other members of the working group included:

- John Cunningham, Deputy Provost on the Amherst campus;
- Patty Freedson, Ph.D., Chair of the Department of Kinesiology on the Amherst campus;
- Anthony Garro, Ph.D., Provost and Vice Chancellor for Academic Affairs on the Dartmouth campus;
- Laura Hayman, Ph.D., Associate Dean for Research for the College of Nursing and Health Sciences on the Boston campus;
- Winston Langley, Ph.D., J.D., Interim Provost of the Boston campus;
- Robin Robinson, Psy.D., Ph.D., Associate Professor of Sociology and Crime & Justice Studies on the Dartmouth campus;
- Milagros Rosal, Ph.D., Associate Professor of Medicine on the Worcester campus;
- Sharon Sousa, Ed.D, Associate Professor of Community Nursing on the Dartmouth campus;
- Eugene Rogers, Ph.D., Professor of Clinical Laboratory and Nutritional Sciences on the Lowell campus; and
- David Wegman, M.D., M.P.H, Dean of the School of Health and Environment on the Lowell campus.

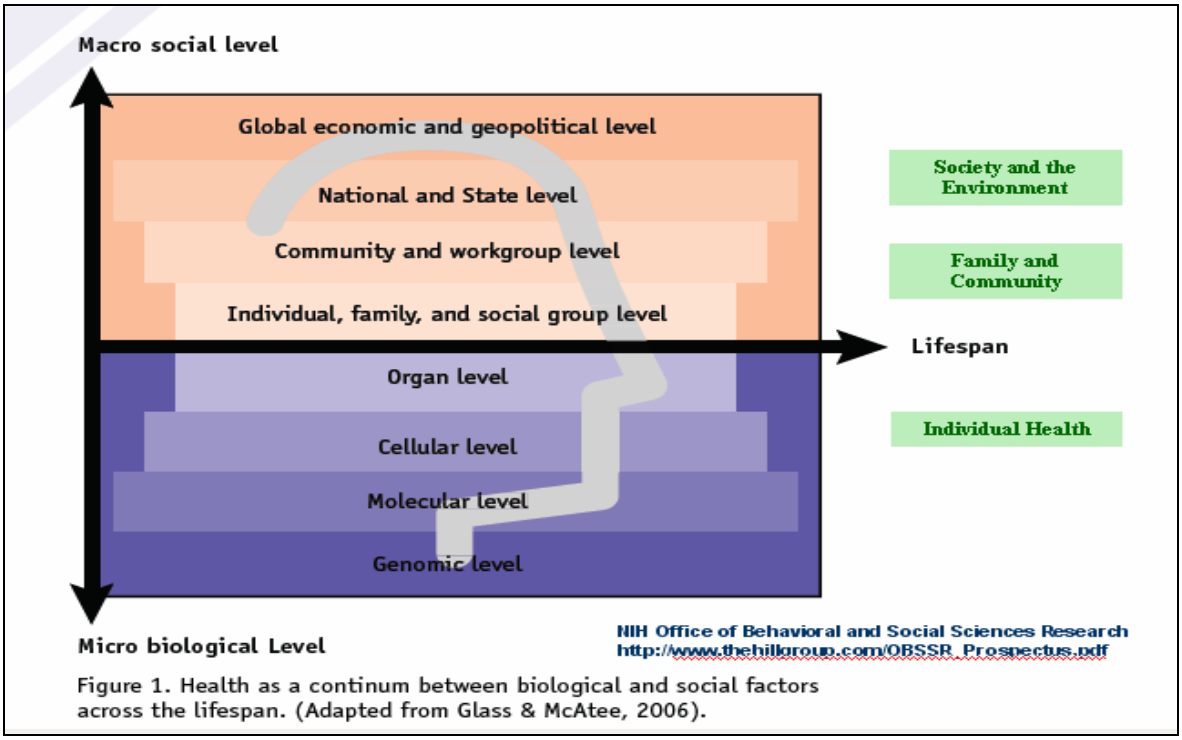
The group completed its work using meetings, conference calls, email and a strong sense of commitment to the importance of the effect of behavior and environment on health and disease. The group adapted a theoretical model integrating research activities in this pillar, conducted a situational analysis of campus efforts and national trends and developed

recommendations for furthering life sciences research to develop innovative approaches to improving health and quality of life and reducing healthcare costs for Massachusetts individuals and businesses.

Situational Analysis

Using a social-ecological approach (see Figure 1), the Health, Disease and Behavior Working Group focused on the creation, application, dissemination and translation of new knowledge and technologies related to the environment and to health practices that optimize health and quality of life and reduce healthcare costs in the commonwealth.

Figure 1: Social Ecological Model Presented in the National Institutes of Health Office of Behavioral and Social Sciences Research Prospectus, January 2008 (14).



There is much evidence suggesting the need for such a focus. The following evidence is a small selection of what is currently known (please refer to Attachment 6 for the sources of the following information):

- The cost of chronic illness treatment and lost productivity is $34 billion in Massachusetts (1);
- Massachusetts ranks 40th in the U.S. for burden of chronic disease, and 32nd for preventable hospitalizations (1);
- In 2005, Massachusetts hospitalizations for congestive heart failure, diabetes and asthma totaled $190 million (1);
- Half of all deaths in the U.S. are attributable to tobacco use, poor diet, and physical inactivity (2-3);
- Potentially modifiable risk factors and behaviors account for more than 90% of the risk for coronary heart disease (4);
- Obesity is at epidemic proportions, with concurrent rises in diabetes and other co-morbidities (5-7); and
- Translational research in the life sciences can improve health, quality of life, and economic development. Massachusetts individuals and businesses are at an economic disadvantage unless the spiraling costs of healthcare can be controlled (8-15).

Individual, family and community-based behavior change interventions and changes to the environment and exposures can improve health and development, chronic disease management and quality of life, and knowledge of gene/behavior interactions can reduce healthcare costs and improve workforce productivity. In addition, innovative technologies and information systems in the areas of health, disease and behavior can improve health and influence the quality and cost of healthcare services.

The five-campus situational analysis included the following activities:

- Implementation of a survey of health, disease and behavior research on each campus;
- Integration of the information under each of the areas of research included in the pillar to determine the nature and extent of inter-campus engagement, partnerships and collaboration in the areas within the pillar; and
- Evaluation and identification of combined areas of strength and needs for core facilities and mechanisms to advance inter-campus engagement, partnerships and collaborations across campuses.

Findings

The university-wide situational analysis revealed six major fields of research strengths across campuses, with specific areas of research within each field. Research within these

fields—quality of life; nutrition and physical activity; health behavior and behavior change; human development; genetic and environmental interactions; and impact of emerging technologies on human health and the environment—cover the spectrum of studies that fit within the social-ecological model, including cellular/molecular, physiological/biochemical and other studies of individuals; community, family and population studies; and research addressing larger social and physical environmental factors. The following are areas of campus research strengths.

❖ QUALITY OF LIFE

- *Reproductive Health*
  - Faculty at Amherst, Lowell and Worcester are studying various aspects of the quality of life and health in women including menopause and premenstrual syndrome, as well as family planning and male reproductive health.

- *Muscle Structure, Function and Disorders*
  - Faculty at Amherst and Lowell are conducting research projects related to muscle function and biomechanical properties in diverse populations and the reduction of risk for musculoskeletal disorders integrated with reduction of risk for cardiovascular disorders in the workplace with funding from a variety of sources including the NIH, NIOSH, U.S. Army and the Multiple Sclerosis Society.

- *Speech, Language and Hearing in Special Needs Populations*
  - Faculty at Amherst, Boston and Worcester are conducting NIH and NSF-funded studies on various aspects of autism spectrum disorders, as well as language, reading and aphasia and hearing in diverse populations including children with special needs.

- *Public Health and Quality of Care*
  - Faculty at Amherst, Boston and Lowell are examining public health outcomes related to state public health infrastructure and educational approaches to public health issues.

- *Urban Cultural and Family Issues*
  - Faculty at Boston, Dartmouth, Lowell and Worcester are studying various aspects of the long term effectors of trauma and violence against women and girls particularly as related to the justice system, the sexual victimization of children and programs for enhancing parenting behavior, especially for parents with mental illnesses.

- *Chronic Conditions, Chronic Illnesses and Their Management*
  - Faculty at all five campuses are involved in a large variety of projects addressing different aspects of chronic illnesses and chronic conditions including: hypertension and kidney disease; obesity; diabetes; asthma; mental retardation; sleep deprivation and aging; and the impact of healthcare disparities on these conditions.

❖ NUTRITION AND PHYSICAL ACTIVITY

- *Obesity and Diabetes*
  - Many faculty at Amherst, Boston, Dartmouth, Lowell and Worcester are engaged in well-funded studies involving the growing epidemic of obesity, including research on prevention, cellular and metabolic studies and policies and diabetes prevention and treatment.

- *Nutrition and Food Safety Interventions in Individuals, Communities, and Policies*
  - Researchers at Amherst, Boston and Worcester, with significant funding from the USDA and state funds, address nutrition and food safety interventions in children and older adults, low income families, child care centers, and schools, dietary change and women's health and the impact of dietary interventions on patients with co-morbid conditions.

- *Micronutrients, Food Components, and Technologies to Improve Health and Prevent Disease*
  - Faculty at Amherst, Dartmouth and Lowell, using animal and epidemiologic studies, are examining the impact of vitamins, minerals such as iron, and other dietary components such as linoleic acid, S-adenosyl methionine, folic acid and anti-oxidants, and the impact of statins on health and disease.

- *Physical Activity and Diet Assessment*
  - With more than $3 million of support from NIH, faculty at Amherst and Boston are developing novel approaches to monitoring physical activity in diverse populations including urban children and adolescents, children with disabilities and older adults, as well as evaluating dietary assessment tools in multiple groups.

❖ HEALTH BEHAVIOR AND BEHAVIOR CHANGE

- *Mental Health, Stress, Violence, Depression and Substance Abuse*
  - Faculty at Amherst, Boston, Dartmouth and Worcester are studying various aspects of mental health as it relates to chronic diseases, substance abuse, violence and its after effects, gender and sexuality, family and social networks, suicide risk and delinquent behavior.

- *Health Interventions and Behavior Change*
  - Faculty at Amherst, Boston, Lowell and Worcester are engaged in a broad array of interventional studies related to improvement of smoking cessation, women's health, cancer prevention, nutrition and obesity and chronic conditions such as asthma.

- *Occupational Health*
  - The Lowell campus has a strong, well-funded occupational health program with a broad array of projects including: health and safety training; immigrant workforce issues; healthcare workforce safety; ergonomics and musculoskeletal disorders; isocyanate exposure in auto body shops; air toxic exposure in asthma; chemical exposures in the home; nail salon hazards and health effects; building strategies for environmental health; and sustainable buildings and green communities.

- *Socio-cultural Context for Health and Health Disparities*
  - Faculty at Amherst, Boston, Dartmouth and Lowell are studying the effect of various aspects of culture on mental health, health practices and health disparities; the impact of racial and ethnic approaches to community health; racial and ethnic disparities in mental health policies and chronic diseases; and the impact of social environments on health.

❖ HUMAN DEVELOPMENT

- *Aging and Health*
  - Researchers across all five campuses are studying the impact of aging on a broad array of health conditions including: muscle function; balance and coordination; memory and overall health; wellness and diet; apo-lipoprotein E polymorphisms; and Alzheimer's disease.

- *Sexual Differences in the Nervous System, Cells, Cognition and Behavior*
    - Researchers in the Department of Psychology at Amherst have received approximately $500,000 from NIH in the past year to examine the nervous system at the cellular through whole organism levels.
    - The Departments of Psychology and Sociology, Anthropology, and Crime & Justice Studies in the College of Arts and Sciences at Dartmouth are investigating sexuality; metacognition; development of relationships; and the demographics of fertility.

- *Language, Literacy, Learning, Social Development and Disorders in Infants and Children*
    - Faculty at Amherst, Boston, Lowell and Worcester are engaged in a broad range of studies addressing developmental issues including: visual search efficiency in development; social/emotional/behavioral problems and competencies in infancy and early childhood; learning processes/experiences for children with chronic conditions and disabilities; oral language skills and literacy in preschool children; fetal/early life origins of adult chronic conditions; developmental disorders; and disabilities in children and infant mortality.

❖ GENETIC AND ENVIRONMENTAL INTERACTIONS

- *Responses to Infectious and Environmental Agents*
    - Researchers at Amherst and Lowell are using modeling and metabolic techniques to examine health responses to the environment. They are examining communicable diseases (HIV and TB) and their relation to genetic, endocrine, immune, nutritional, and toxicological indicators in global and domestic settings with more than $3 million of NIH funding.

- *Gene/behavior/environment Interactions in Emerging Communicable and Chronic Diseases*
    - Faculty across all five campuses are engaged in research projects investigating the interaction of genetics and environmental factors in a broad range of diseases and conditions such as autism, asthma, Parkinson's disease, Alzheimer's disease, schizophrenia, botulism, cancer, atherosclerosis and obesity.

❖ IMPACT OF EMERGING TECHNOLOGIES ON HUMAN HEALTH AND THE ENVIRONMENT

- *Technologies for Patient-centric Care*
  - Faculty at Amherst, Dartmouth and Worcester are developing new technologies to improve patient monitoring and clinical decision making, as well as healthcare workforce training.

- *Environmental Sensing*
  - Faculty at Boston, Dartmouth and Lowell are involved in a range of projects involving the development of new environmental sensing technologies including: multifunctional bio/chemical warfare sensors; immunological-based biosensors for detection of oil pollution in coastal waterways; factors involved in preservation and restoration of coastal estuaries; development and application of modeling and software technologies to enhance decision-making regarding resource and environmental issues; and physical and chemical oceanography.

- *Water Purification; Soil Ecology and Environmental Reclamation*
  - Faculty at Amherst and Dartmouth are engaged in the development of new technologies for water purification, transport of dangerous materials and environmental development.

- *Nanomaterial Toxicity and Handling*
  - Faculty at the Lowell campus are studying best practices for safe manufacturing and handling of nanomaterials, and the potential toxicity to human health and the environment.

Recommendations

The university's life sciences research in health, disease and behavior, focused on the strengths noted above, will result in many benefits to the commonwealth, including improved population health, reduced healthcare expenditures and improved workforce productivity. To this end, the Health, Disease and Behavior Working Group recommends the following initiatives:

- **RECOMMENDATION 1**
  Creation of an Inter-Campus Integrated Data Analysis System

The Health, Disease and Behavior Working Group recommends the creation and maintenance of an Inter-campus Integrated Data Analysis System that will support efforts in biostatistics, bioinformatics, and qualitative research analyses in health, disease, and behavior (HDB). Currently, data design and analysis is conducted through Biostatistical Consulting Centers at the Worcester and Amherst campuses, along with expertise provided in individual research groups and centers, such as the Center for Survey Research on the Boston campus. By developing a system that can enhance the capabilities of the campuses to serve those outside of their home units, as well as provide staff and electronic communication support at each campus, so that data transmission and discussions can occur securely and easily among campuses, the university will be able to capitalize on existing expertise and address future, growing needs. This system will require staffing, space, hardware and software support and distance communications infrastructure to enable inter-campus mixed model analyses, statistical analyses of microarrays and exposures or health and treatment outcomes, qualitative analysis services such as transcription and computerized qualitative analyses, electronic survey design and other analytical tools.

- **RECOMMENDATION 2**
  Development of Coordinated Centers for Translational Human Research

Currently, human studies on each campus rely on individual laboratories and relationships, with little inter-campus support for subject recruitment, assessment, and biological sample analyses. While access to human subjects and certain biological sample analyses will need to be performed within a campus, other analyses can be more cost-effective if a single campus is able to perform the work. Thus, the Health, Disease and Behavior Working Group calls for a system of linked translational research centers, with laboratory and subject assessment core resources identified along with a system for user access that will be highly useful to enable HDB research to expand. Laboratory space, equipment, supplies and staffing for human subject recruitment, assessment, exposure and intervention modification, sample collection and analysis will be important to expand. Core facilities including those with genomics/proteomics/metabolomics, cell culture, behavioral assessments, and imaging will be very important to develop.

- **RECOMMENDATION 3**
  Establishment of a UMass Faculty Expertise Database System

The Health, Disease and Behavior Working Group recommends the establishment of a UMass Faculty Expertise Database System, which will help to identify faculty interests, expertise and current research activities. In order to foster ongoing inter-campus collaboration, a searchable database of faculty expertise will need to be developed and maintained. A database that is integrated with other campus databases such as grants and contracts can allow frequent updates as new proposals are submitted and grants received.

- **RECOMMENDATION 4**
  Increase Access to Library Resources

The Heath, Disease and Behavior Working Group recommends that the university should make efforts to increase access to library resources for faculty and students across the system. While some campuses such as Amherst and Worcester have access to expansive library databases, others do not have full access to journals and materials related to HDB. Improved access to library materials across campuses will be very important in facilitating research growth and development.

- **RECOMMENDATION 5**
  Annual Two-Day UMass Conference

The working group recommends the organization of an Annual Two-day UMass Conference on Health, Disease, and Behavior Translational Research. In order to foster collaboration among UMass system researchers and industry partners, an annual conference is needed to highlight and share UMass expertise and study results, develop partnerships and plan collaborative research.

- **RECOMMENDATION 6**
  Funding for Health, Disease and Behavior Pilot Studies, Fieldwork and Demonstration Project Grants

The working group calls for funding for HDB Pilot Studies, Fieldwork and Demonstration Project Grants to encourage inter-campus collaboration. This program, designed to provide small grants for pilot, field and demonstration data in HDB research to enable competitive proposals for larger funded studies and technology development, can be modeled after the President's Science and Technology Fund.

- **Recommendation 7**
  Investment in Academic Programs

The working group recommends broad investment in academic programs to further HDB research and training through recruitment of ten additional faculty members in research strength areas across campuses.

Resources

The recommended investment in health, disease and behavior research over a five-year period is initially estimated to be approximately $62 million. Through funding for business and resource plan development, a more thorough cost estimate will be developed.

In order to develop an Inter-campus Integrated Data Analysis System, a full analysis of existing capacities and a business plan to build on this capacity and to develop a sustainable revenue-generated model will be needed. It is estimated that $100,000 is needed to develop the plan, with approximately $5-10 million required for development of the integrated system hardware, software, communications and staffing support.

Similarly, development of a system of Coordinated Centers for Translational Human Research will require inventory of existing capacities, as well as preparation of a plan to strategically build the human subject assessment and analytical capabilities. It is estimated that $200,000 is needed to develop the plan, with $25 million in facilities and equipment and technical staffing needs (excluding building costs) across campuses.

The UMass Faculty Expertise Database System will require funds for equipment, software, and annual maintenance of approximately $1.5 million over five years.

It is recommended that a library resource review team develop a resource plan for library database and material access across campuses.

To convene the Annual Two-day UMass Conference on Health, Disease, and Behavior Translational Research, funding for keynote speakers and travel, conference services, refreshments, materials and audiovisuals will be required. It is estimated that $350,000 will be needed to support this effort over five years.

It is estimated that approximately $2-5 million per year is required for funding of HDB pilot studies and field and demonstration project grants, with an additional $7.5 million for academic program investment in new faculty recruitment and startup costs.

Conclusion

Life sciences research in health, disease and behavior will emphasize cellular/molecular, physiological/biochemical and behavioral factors in individuals, families and community-based, population, socio-cultural and environmental studies that create and translate new knowledge and develop new technologies to optimize health and quality of life and minimize the risk and cost of disease. Investment in health, disease and behavior research at UMass focused on university strengths in quality of life, nutrition and physical activity, health behavior, human development, gene-environment interactions, and the impact of emerging technologies on human health and the environment will result in many benefits to the commonwealth. By developing sustainable products from this research, including new technologies, therapies, policies and other interventions, UMass can provide economic benefits to the commonwealth in terms of improved health and concurrent reduced healthcare costs, quality of life and economic development and productivity.

IX. UMass LSTF Recommendations

❖ INTRODUCTION

The recommendations offered by each of the six working groups include some important strategies and consistent themes to strengthen the university's position in their specified content areas. These recommendations offer the university actionable items through which to implement a university-wide vision in the life sciences over the next five years.

The UMass LSTF was asked to carefully review the recommendations put forward by the working groups and to extract common themes that emerged. In turn, those common themes have been endorsed by the UMass LSTF as key recommendations emanating from the collective effort of the working groups. These overarching recommendations, which summarize convergent themes, have been further characterized as mission- or implementation-related. With respect to the former, the UMass LSTF has focused on recommendations that strengthen the university's historic roles in education, research and outreach, in the context of the life sciences. With respect to the latter, the UMass LSTF has focused on recommendations to enable the successful implementation of the university's life sciences mission.

These framing recommendations are enhanced by the detailed and specific recommendations at the end of the six chapters above. The UMass LSTF strongly urges thorough review of all the recommendations put forward by the working groups.

UMass LSTF Recommendations | Mission-related Recommendations

As the commonwealth's public research university, the University of Massachusetts' mission is to provide an affordable and accessible education of high quality and to conduct programs of research and public service that advance knowledge and improve the lives of the people of the commonwealth, the nation and the world. The UMass LSTF supports vigorously this mission and wishes to reaffirm it in the context of the life sciences.

❖ UMass LSTF Recommendation 1
Attract, Retain and Graduate University Students in STEM Degree Programs Who are Well-prepared for Professional Careers in Diverse Life Sciences Fields

The task force recognizes that academic and professional achievement in the life sciences requires increasing the number of students prepared for, recruited to, and successful in, STEM degree programs and the growing and dynamic life sciences industry. All of the campuses have begun to develop programs aimed at enhancing the preparation and retention of students in STEM fields at the postsecondary level. Without strong academic preparation, advising and mentoring, students are less likely to remain engaged or to graduate with a STEM degree. The majority of these programs focus on the undergraduate level and include topical seminars, workshops, ongoing academic preparation programs, skill development and mentored research experiences.

The UMass LSTF supports these campus efforts and recommends that substantially more resources and focus be given to increasing the number of students who are recruited, retained and graduate in STEM fields, and subsequently, who become the future talent of the life sciences industry. These efforts include: strengthening K-12 initiatives to attract more students into STEM fields; undertaking special strategies to improve retention and graduation rates of STEM students, such as summer bridge programs, developmental advising for STEM majors and increased use of supplemental instruction in STEM courses with poor success rates; hiring new STEM faculty, as well as administrative and support staff; improving the undergraduate curriculum by integrating the life sciences with other disciplines; providing additional experiential learning experiences through expanded use of co-ops and internships; and developing new kinds of graduate degrees that target high demand areas and link the life sciences with business and management. The recently completed "Life Sciences Talent Initiative," prepared by the university's Donahue Institute, may help to inform—and direct—the university's effort in this most important area.

❖ UMass LSTF Recommendation 2
Focus on Existing University R&D Strengths in the Life Sciences

As a result of the situational analyses conducted by each of the working groups, the UMass LSTF has developed a clearer understanding of the myriad life sciences research activities and initiatives, with a particular emphasis on biomedical research and practice, existing throughout the university system. From that understanding, the UMass LSTF recommends strategic focus and investment, broadly defined, in the following areas: regenerative medicine; stem cell biology; RNA biology; gene therapy; health and bioinformatics; computational and biostatistical sciences; tissue engineering; biomaterials; diagnostics; nursing; health, disease and behavior; clinical laboratory science; public

health; natural products and nanotechnology, as it is applied in therapeutics, clinical diagnostics and disease prevention.

University focus and investment in these specified areas may be achieved by undertaking strategies that include, at a minimum, the following: recruitment of faculty and technical staff expertise; development of shared core facilities to support life sciences-related research, such as a high performance computing system; purchase of state-of-the-art equipment in needed areas; renovation of existing, and construction of new lab and teaching space; and seed funding to promote inter-campus collaboration.

❖ UMASS LSTF RECOMMENDATION 3
Develop a Network of University-led or Supported Regional Innovation Centers Across the Commonwealth

The UMass LSTF recommends that the university position itself as a strategic resource for the development of regional technology innovation centers throughout the state. These centers can provide regional infrastructure and services to support the growth of key elements of the life sciences industry. Regional infrastructure may include established university resources such as the Massachusetts Medical Device Development Center or emerging resources such as the Massachusetts Human Embryonic Stem Cell Bank.

As such, the development of regional technology innovation centers can provide the university with effective vehicles for linking its research and educational capabilities with the innovation needs of the life sciences industry, much in the same way as agricultural experiment stations and extension services served the needs of the agricultural industry in the early days of land grant universities.

Developing these centers will require: a clear understanding of industry's needs; the development of appropriate staffing capabilities and organizational models; improving business-like administrative policies and practices; and strengthening state-wide linkages through organizations such as the Mass Technology Transfer Center. While considerable funding already has been allocated to begin development of some of these centers, additional opportunities are likely to emerge through the commonwealth's Life Sciences Initiative and future economic stimulus initiatives.

❖ UMass LSTF Recommendation 4
Continue University-wide Support of Life Sciences Collaborative Efforts

While acknowledging and appreciating the uniqueness of each campus, especially within the life sciences, the UMass LSTF supports vigorously the concept of developing a system-wide steering committee, overseen by the Office of the President, to coordinate and support inter-campus efforts that enable the successful development of the university's education, R&D and outreach missions in the life sciences. Although a number of new committees are recommended for establishment, the UMass LSTF recommends that a steering committee similar in broad, collaborative membership as the task force be established to continue the excellent relationships that were nurtured during the work of the UMass LSTF. This committee should consider expanding the scope of life sciences to include non-biomedical areas, as well as helping to facilitate a chancellor-level discussion to move the university's comprehensive life sciences mission forward.

The UMass LSTF recommends the following to ensure that such development is undertaken strategically, collaboratively and effectively:

❖ UMass LSTF Recommendation 5
Establish the University of Massachusetts Center for Clinical and Translational Science

The UMass LSTF recommends the establishment of the University of Massachusetts Center for Clinical and Translational Science (UMCCTS) as a new vehicle for collaborative R&D and education within the system. Specifically, the UMCCTS will facilitate the design, conduct and analysis of patient-oriented and population-oriented research and dissemination in all its forms. Furthermore, it will serve as a home for education in the field of clinical investigation and will support faculty development in this area.

❖ UMass LSTF Recommendation 6
Establish Life Sciences-specific Seed Funding

The UMass LSTF recommends the establishment of life sciences-specific seed funding to promote inter-campus collaboration. As a model, already the Worcester campus has agreed to invest $1 million over two consecutive budget cycles to establish the "UMass Life Sciences Moment Fund." This fund, overseen by the Senior Vice President for the Health Sciences and functioning as an integral component of the UMCCTS, augments the President's highly successful S&T Fund; however, unlike the President's fund, this new

fund would support projects that are inter-campus in orientation, each with a collaborator from the Worcester campus and directed towards projects related to advanced therapeutics and translational research.

❖ UMASS LSTF RECOMMENDATION 7
Establish the University of Massachusetts Core Facilities Steering Committee to Develop New Models for Inter-campus Sharing of Core Facilities

The UMass LSTF recommends the establishment of the University of Massachusetts Core Facilities Steering Committee. This committee would be charged with developing and implementing a plan to improve inter-campus sharing of university cores. Such a plan would focus on the organization, governance, fee structure, use and access of university cores. Furthermore, the committee would be charged with identifying and prioritizing new instrument acquisition needs that are lacking throughout the university system.

❖ UMASS LSTF RECOMMENDATION 8
Develop Organized and Funded Program of Inter-campus Retreats, Symposia, Seminars and Visiting Professorships

The UMass LSTF recommends the development of a program of inter-campus retreats, symposia, seminar series and summer visiting professorships to promote active and sustained interaction among university colleagues from the five campuses, as well as to enhance partnerships with state and private institutions and industry. There is strong consensus among the members of the UMass LSTF that additional structure and effort are necessary to bring together university faculty investigators engaged in research efforts in the life sciences fields, in conjunction with key industry partners, for meaningful interaction and exchange. By providing university investigators with the opportunity to highlight and share expertise and study results, new and exciting faculty-faculty and faculty-industry partnerships will surely emerge.

❖ UMASS LSTF RECOMMENDATION 9
Undertake a Systematic Review of Administrative, Regulatory and Statutory Barriers that Inhibit Inter-campus Collaboration and Prevent the University from Acting in an Entrepreneurial Manner

The UMass LSTF recommends a comprehensive review of the administrative, regulatory and statutory barriers that impede inter-campus collaboration in the life sciences and prevent the university from acting in an entrepreneurial manner. Unfortunately such barriers exist at multiple levels within the university system and between the university and external entities, and several have been identified through the situational analyses.

Examples within the university include the lack of shared library resources among the five campuses, the absence of seamless articulation agreements between the campuses; and examples outside the university include construction processes and licensing arrangements. These problems currently prevent the campuses from sharing and collaborating effectively with each other and with strategic partners.

❖ UMASS LSTF RECOMMENDATION 10
Pursue Capital and Operating Funding to Enhance University Life Sciences Infrastructure and Research Initiatives

The UMass LSTF recognizes that any plan developed to strengthen the life sciences throughout the university is limited by the extent of life sciences infrastructure that exists on the five campuses to support research initiatives. Consequently, the task force recommends a number of capital projects to augment and improve existing university infrastructure in the life sciences. Those infrastructure improvements include: the Life Sciences Complex on the Amherst campus; the Massachusetts Stem Cell Bank and Registry Facility and the Advanced Therapeutics Cluster Facility on the Worcester campus; the Center for Personalized Cancer Therapy on the Boston campus; Biomanufacturing Centers on the Dartmouth and Lowell campuses; and various system-wide cores including health and bioinformatics, bioconjugation, high computing and genomics, among other smaller capital projects.

Fortunately, as this is the "life sciences moment" in Massachusetts highlighted by a ten-year, $1 billion life sciences initiative, the university has arguably become the "life sciences institution" with more than $200 million in capital funding secured for those aforementioned capital projects through the initiative. The UMass LSTF recommends that the university continue to act with a single, unified voice—as it did during the year-long legislative process to pass into law the Massachusetts Life Sciences Initiative—to pursue aggressively capital and operating funding from the commonwealth through an emerging higher education bond bill, and other funding agencies, including the Massachusetts Life Sciences Center, the NIH, the NSF, as well as from industry partners (please refer to Attachment 7 for an overview of the capital and operating aspirant requests from the working groups).

X. Conclusion

The University of Massachusetts Life Sciences Task Force was created at, and accelerated by, a tremendous moment in the university's history—a moment when the commonwealth's emergent life sciences vision, with the university featured prominently as a partner, intersects with a critical juncture in the future of life sciences research. The work of the task force, importantly, has been sustained by a recognition on the part of its membership—the university leaders in the life sciences—that opportunities exist to strengthen the university-wide foundation in the life sciences with a commitment by all five campuses to work together and leverage campus-specific expertise to reach system goals.

Indeed, each of the six working groups of the UMass LSTF concluded that significant and exciting opportunities are within reach to advance initiatives within their specific thematic areas, over the next five years, as long as the university enhances collaborative efforts.

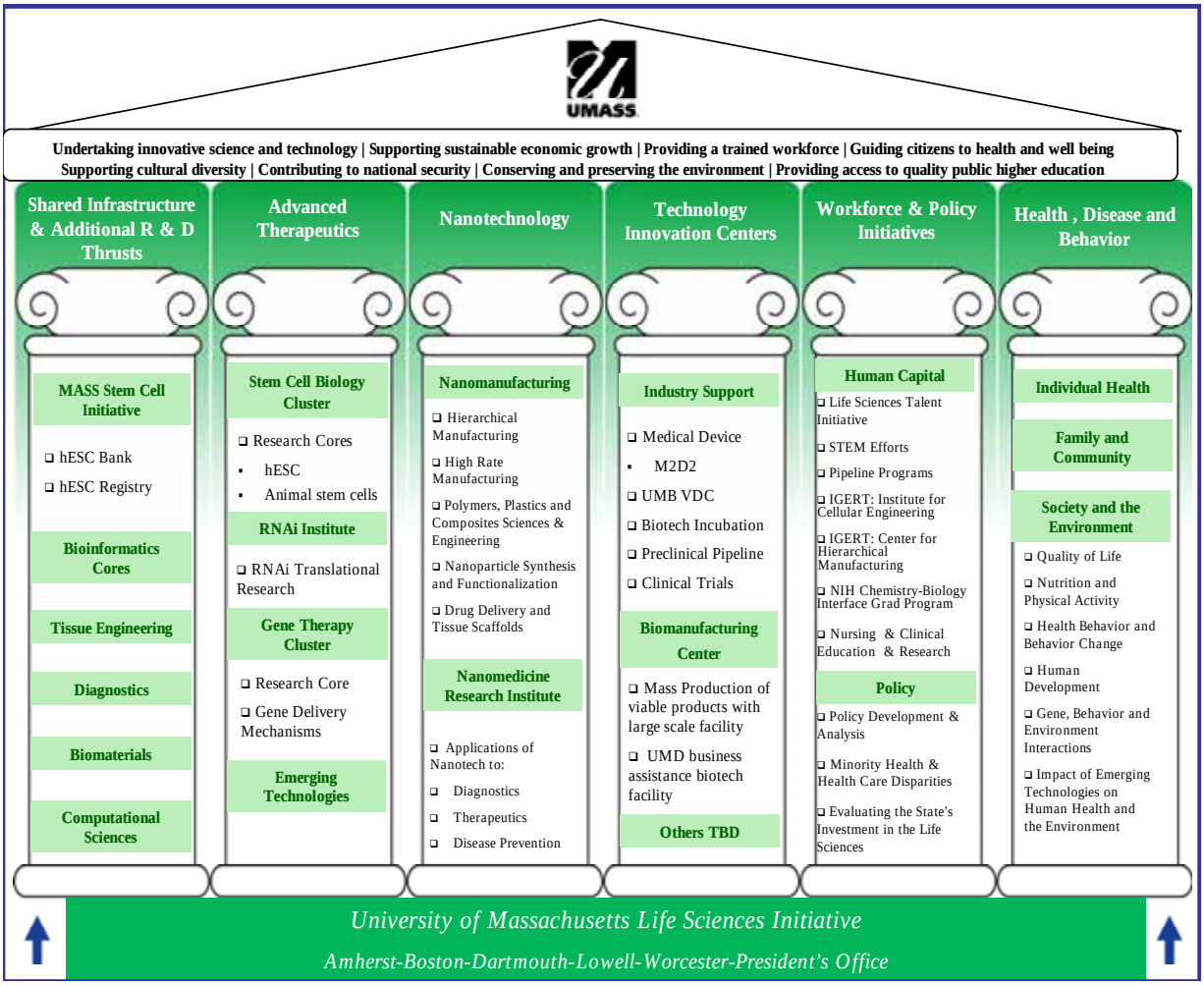
The Shared Infrastructure and Additional R&D Working Group recognizes that if the five-campus system functioned as one collaborative entity, it would be possible to coordinate the use of existing and future core facilities, optimize resources, and reduce redundancy to the benefit of all campuses. The Advanced Therapeutics Cluster Working Group asserts that the university can bring together a multitude of experts and technologies to translate fundamental discoveries into novel therapeutics. The Nanotechnology Working Group believes that potential exists to leverage the university's strength in nanoscience to further develop the life sciences throughout the system. The Technology Innovation Centers Working Group affirms that the university can link its substantial research and educational resources with the innovation needs of the commonwealth's life sciences industry. The Workforce and Policy Initiatives Working Group contends that better coordination and collaboration between the campuses and among K-12, business, philanthropic organizations and government will catapult the university to a national leadership position in life sciences workforce strategies. Finally, the Health, Disease and Behavior Working Group states that by developing sustainable products from university-wide health, disease and behavior research, including new technologies, therapies, policies, and other interventions, the university can provide economic benefits to the commonwealth in terms of improved health and concurrent reduced healthcare costs, quality of life and economic development and productivity.

Taken together, the findings and recommendations documented in this report reveal that the university is poised to make substantial and impressive advances in preparing its students for successful careers in the life sciences, strengthening and expanding its life sciences R&D base and developing and sustaining mutually productive linkages with outside entities. Those advances, however, are dependent upon a willingness of the five

campuses and its life sciences leadership to collaborate actively and to integrate the expertise and many resources that exist throughout the university system. The UMass LSTF has recommended a vision to do so. Moreover and most importantly, the members of the UMass LSTF have expressed a strong desire to come together to implement that vision to advance the university's position as a world class center of life sciences education, research and innovation.

XI. Appendix

❖ ATTACHMENT 1:
PILLAR VISUAL REPRESENTING THE SIX WORKING GROUPS OF THE UMASS LSTF



❖ ATTACHMENT 2:
TIMELINE OF THE UMASS LSTF PROCESS

University of Massachusetts
Amherst • Boston • Dartmouth • Lowell • Worcester • UMassOnline
www.massachusetts.edu

UMass LSTF Timeline

September 24, 2007
- President's Council agrees to create the UMass LSTF

October 2007
- Membership of the UMass LSTF is finalized

November 16, 2007
- 1st meeting of the UMass LSTF
- Charge discussed and task force decides to organize its work into 6 working groups

November-December 2007
- Working Groups populated with members from the University community

December 17, 2007
- Conference Call of the Working Groups' co-chairs and staff
- Working Groups' progress discussed

January 11, 2008
- Conference Call of the Working Groups' co-chairs and staff
- Working Groups' progress discussed

February 8, 2008
- 2nd meeting of the UMass LSTF
- Initial findings of the Working Groups presented

April 11, 2008
- Conference Call of the Working Groups' co-chairs and staff
- Working Groups' progress discussed

April 18, 2008
- 3rd meeting of the UMass LSTF
- Preliminary recommendations of the Working Groups presented

May 14, 2008
- Working Groups' reports completed and sent to the UMass LSTF

May 21, 2008
- 4th meeting of the UMass LSTF
- Final reports of the Working Groups discussed

June 9, 2008
- UMass LSTF report will be presented to the President's Council

June-July 2008
- Feedback from the University leadership will be incorporated into the final report

September 2008
- Report presented to UMass Board of Trustees' Committee on Science, Technology and Research

❖ ATTACHMENT 3:
DATABASE OF UNIVERSITY CORE FACILITIES

AMHERST CAMPUS

Flow Cytometry	LSRII Analysis w/o Operator	w/Operator	Cell Sorting	Training
UMASS	$35.00	$50.00	$60.00	$30.00
External	$55.00	$80.00	$100.00	$50.00

Yearly ($6,000.00)
1 hr for non-sterile, 2 hrs for sterile

Biological Microscopy Facility

Description	Unit	Cost
Optiphot Fluorescence Microscope Use	hr	$3.75
Spot/ Nikon E600 system	hr	$7.50
Zeiss 510 Meta Confocal Usage	hr	$17.50
MRC-600 Confocal microscope usage	hr	$7.50
SEM samples; fixation kit	ea	$15.00
Critical point dry	ea	$15.00
Sputter coater runs	ea	$15.00
SEM stubs prepared	ea	$1.00
SEM usage, beam time	hr	$22.50
Thermal (video) prints	ea	$0.25
TEM samples; fixation kit	ea	$15.00
TEM usage	hr	$22.50
TEM film	ea	$1.25
Sectioning (Staff time) (+ grid cost)	hr	$20.00
Grids are "at cost" ; many materials, styles, supports.		
Negative Stain preparations: >> time and materials		
Freeze-Fracture/Freeze-Etch	run	$31.25 (*Each "run" is a pump-fracture-shadow-replicate cycle.)*
Low temp substitution (Osmium extra)	run	$30.00
Plunge freezing (propane, etc.)	run	$30.00
Low-Temperature UV polymerization	run	$15.00
Cryo-fee (for all activities using LN2)	ea	$30.25 (*This is a "per day" fee to cover tanks, and LN2 used in sample handling.)*
Carbon evaporator runs	ea	$18.75
Platinum shadowing/evaporator runs	ea	$18.75
Liquid Nitrogen, bulk users (>30	liter	$0.65

liters/qtr.)		
Liquid Nitrogen, small draw, 4 liter min	liter	$1.00
Codonics color prints (8.5x11)	ea	$3.75
Codonics B&W prints (8.5x11)	ea	$3.00
Coodonics Transparencies (8.5x11)	ea	$4.25
CD-R disks, w/paper sleeve, blank	ea	$1.50
CD storage: paper sleeves w/window	per 10	$1.50
Shell vials (1 dram or 3 dram)	ea	$0.28
SEM specimen stub boxes	ea	$4.00
Grid boxes (Pelco, blue)	ea	$4.00
BEEM flat embedding molds	ea	$7.50
Microtome glass strips	ea	$4.95
Chemicals and Supplies (ask)	ea	$1.00
Staff assistance, per hr (training, project assistance)	hr	$20.00

Five College Faculty receive the Umass rate; Umass clients receive priority
Staff Assistance is not included in equipment, fixation, embedding charges, etc.
Assisted by Staff: add the hourly staff charge for actual time of work
Non-Umass: rate for equipment, services, staff assistance are double UMASS rate

Other Amherst campus cores without published rates

NMR (Nuclear Magnetic Resonance)
Mass Spectrometry/Molecular Weight Core
MRSEC (Material Research & Science Engineering Center X-Ray Facility)
W.M. Keck Microscopy Lab
FFMRI
Greenhouses
Clean Rooms
Stem Cell Core
Five College Astronomy Computing
Nucleic Acids Research Facility
Glass blowing facility
Machine Shop
Cell Culture Facilities

BOSTON CAMPUS

Environmental Genomics Center

Description	Price per sequence *(Not including labor)*	UMass Price
Sequencing (not including polymer waste)	$4.11	$6.50/sample
Sequencing (including polymer waste)	$4.53	$6.50/sample

	Price *(Not including MM1000 using 400 ladder)*	UMass Price
Fragment Analysis (per fraganal sample)	$2.03	$2.00/sample

Geographic Information Systems Service

Description	Price
Project Analyst	$50/hr
Seminars (including software & equipment)	
1-day	$2,000.00
3-day	$5,000.00
If software needs to be mounted and demounted	$300.00
Laboratory Research for Educators of Non-profit	
1/2 Day (4 hrs)	$300.00
1 Day (8 hrs)	$500.00
Large format printing (dependent on Color or B&W and size)	$80-$150
Large format scanning (maximum 36" width)	$5 per linear ft.

DARTMOUTH CAMPUS

Machine	Actual Cost	Rate	InHouse	Discount
Confocal Miscroscope	$125.88	$125.00	$100.00	20%
JPSA Laser	$121.19	$125.00	$100.00	20%
Atomic Absorption Spectrometer	$55.54	$80.00	$65.00	19%
Scanning Electron Miscroscope (SEM with EDS)	$96.30	$120.00	$100.00	17%
Gas and Liquid Chromatography (HPLC & GC)	$44.01	$50.00	$40.00	20%
UV-Visible and Infrared Spectrophomtometers (UV & IR)	$45.34	$50.00	$40.00	20%
C.N.C. Lathe	$47.13	$75.00	$60.00	20%
C.N.C. Mill	$41.53	$75.00	$60.00	20%

Personnel	Actual Cost	Rate	InHouse	Discount
ATMC Faculty Associate	$125.65	$120.00	$100.00	17%
Staff Engineer	$75.60	$80.00	$60.00	25%
Designer/Machinist	$56.26	$60.00	$45.00	25%
Administrative	$46.67	$45.00	$35.00	22%
Graduate Intern	$19.84	$20.00	$15.00	25%
Undergraduate Intern	$16.53	$17.00	$13.00	24%

Other Dartmouth campus core facilities without published rates

Confocal Miscroscope Facility

Animal Core Facility

LOWELL CAMPUS

Analytical Instruments (Direct Costs) Material Characterization core

Instrument	UML Academic Rate Self-Use *(non-Lowell but UMass investigator 2x)*	UML Academic Rate Staff-Assisted *(non-Lowell but UMass investigator 2x)*	Non-U Mass Rate Staff-Assisted
JEOL 7401F FE-SEM	$10/hr	$15/hr	$150/hr
AMRAY SEM	$10/hr	$15/hr	$100/hr
PHILIPS 120kV TEM	$10/hr	$15/hr	$150/hr
TOPCON 200kV TEM	$10/hr	$15/hr	$150/hr
PSIA XE-150 AFM	$10/hr	$15/hr	$150/hr
VEECO NANOSCOPE AFM	$10/hr	$15/hr	$150/hr
NANOINK DPN	$10/hr	$15/hr	$150/hr
SURFORCE SFA	$150/hr	$15/hr	$150/hr
WATERS MALDI-TOF	$10/hr	$15/hr	$150/hr
QUANTACHROME Hg POROSIMETER	$10/sample	$15/sample	$150/sample
QUANTACHROME N2 POROSIMETER	$10/sample	$15/sample	$150/sample
VG ESCALAB	$10/hr	$15/hr	$150/hr
OLYMPUS FV300 LCSM	$10/hr	$15/hr	$150/hr
ILLINOIS INST. 02 PERMEATION ANALYZER	$10/sample	$15/sample	$150/sample
WYKO NT2000 OPTICAL PROFILER	$10/hr	$15/hr	$100/hr

Sample Preparation Instruments (Direct Costs) Material Characterization Core

Instrument	UML Academic Rate Self-Use (2x UM)	UML Academic Rate Staff-Assisted (UM 2x_	Non-U Mass Rate Staff-Assisted
LEICA ULTRAMICROTOME	$1.50/sample	$3.50/sample	$17/sample
PORTER-BLUM ULTRAMICROTOME	$1.50/sample	$3.50/sample	$17/sample
GATAN 691 PIPS	$1.50/sample	$3.50/sample	$17/sample
FISCHIONE ION MILL	$1.50/sample	$3.50/sample	$17/sample
VCR DIMPLER	$1.50/sample	$3.50/sample	$17/sample
STRUERS DP-U4 POLISHER	$1.50/sample	$3.50/sample	$17/sample

Instrument	UML Academic Rate Self-Use (2x UM)	UML Academic Rate Staff-Assisted (UM 2x_	Non-U Mass Rate Staff-Assisted
DV-502 EVAPORATOR	$1.50/sample	$3.50/sample	$17/sample
DV DESK IV	$1.50/sample	$3.50/sample	$17/sample
SPUTTER COATER			
ISOMET LOW	$1.50/sample	$3.50/sample	$17/sample
SPEED SAW			
TOUSIMIS CPD	$1.50/sample	$3.50/sample	$17/sample
NAPCO VACUUM	$1.50/sample	$3.50/sample	$17/sample
OVEN			

**Non-UML UMass faculty & researchers are double UML academic staff-assisted rates.

M2D2 Core Facility

Instrument	UML Academic Rate Self-Use	UML Academic Rate Staff-Assisted	Non-U Mass Rate Staff-Assisted
22-120 ton capacity injection molding machines (9)	NA	NA	NA
¾² – 2 ½² single screw extruders (8)	NA	NA	NA
Co- and counter rotating twin screw extruders	NA	NA	NA
Co-injection blow molder	NA	NA	NA
Ultrasonic welders	NA	NA	NA
Thermoformers	NA	NA	NA
Rotational molder	NA	NA	NA
Blow molders (2)	NA	NA	NA
Blown film extruders (3)	NA	NA	NA
Compression molding	NA	NA	NA
Rapid prototyping	NA	NA	NA
CNC milling	NA	NA	NA
Universal testing machines (8)	NA	NA	NA
Instrumented impact testers (3)	NA	NA	NA
IZOD/Charpy impact testers	NA	NA	NA
Creep test stations	NA	NA	NA
Environmental chambers	NA	NA	NA
DSC, DMA, TMA, TGA	NA	NA	NA
Viscometers	NA	NA	NA
Capillary rheometers (5)	NA	NA	NA
Torque rheometers (4)	NA	NA	NA
Abrasion and flammability	NA	NA	NA
Dynamic mechanical spectrometers	NA	NA	NA
Complete ASTM testing capability	NA	NA	NA

Other Lowell campus core facilities without published rates
Research Nuclear Reactor Core
Bioaerosol containing Laboratory core
Luminex machine
Photonics Laboratory core

WORCESTER CAMPUS

❖ BIOINFORMATICS CORE FACILITY: "A DIABETES & ENDOCRINOLOGY RESEARCH CENTER"	
CORE DIRECTOR: Juerg Straubhaar	LOCATION: Biotech II

Bioinformatics is at the interface between biology, informatics, and mathematics. It analyzes and interprets, using methods from computer science, biological data in the form of gene sequences and cellular proteins and by this may contribute to new knowledge about the functioning of cells and living organisms.

Services include:

1. Microarray and proteomics experimental design, data acquisition, management & analysis
2. Downstream analysis of microarray experiments
3. Data mining and integration with public data resources
4. Statistical genetics and SNP analysis
5. Analysis pipeline scripting
6. Analysis of promoter sequences for transcription factor binding sites
7. Comparative genomics
8. Life science focused web-based database development

Rate Schedule (based on hourly usage)

	DERC	UMMS	External
Bioinformatics Consult	$40.00	$80.00	$120.00
Microarray Database Use	$4.00	$8.00	$12.00

❖ BSL – 3 CORE LAB	
CORE DIRECTOR: Hardy Kornfeld	LOCATION: S2-311

The BL3 Core Lab is a campus-wide facility for safe or moderate risk pathogens in vitro. It is a self-contained laboratory with space and equipment to handle hazardous pathogens with BL3 containment as described in the CDC/NIH publication "Biosafety in Microbiological and Biomedical Laboratories". The lab has been specifically approved by the USDA and CDC for research airborne viruses such as the Hong Kong chicken flu, and for select agent research. The laboratory has a dedicated ventilation system that maintains a negative pressure with respect to the adjacent corridor and rooms, and which provides HEPA filtration of exhaust air at a remote location on the roof.

Current Rate Schedule

Annual Registration	Internal @ $800 per Year External @ $1600 per Year

❖ CHEMICAL BIOLOGY SCREENING FACILITY (SMALL MOLECULE SCREENING FACILITY)	
CORE DIRECTOR: Hong Cao	LOCATION: LRB – 8th Floor

The facility headed by Dr. Hong Cao has allowed UMMS scientists a unique opportunity to apply the tools and principles of chemistry to understand the processes of living cells.

The screening facility assists researchers in developing high-throughput (HT) screening assays, performs HT screens of chemical libraries to identify new small molecules that can be used to probe biological processes of interest.

The facility coordinates the screening efforts of UMMS researchers, providing access to diverse chemical libraries and state-of-the art instruments including robotic compound transfer, liquid-handling equipment, imagers and plate readers. The information from all screens performed at the facility is collected and stored in a central database.

The Cheminformatics database allows researchers to rapidly evaluate and compare results of their screens and can also be used

in the future to classify the function of lead structures and biological target.	
Current Rate Schedule	
	$10,000 per Screen
Equipment Rate	
SAFIRA Plate Reader	$10/plate
Victor V Plate Reader	$10/plate
REMP Sealer	$1/plate
Genesis Work Station	$50/hr

❖ **CLINICAL TRIALS UNIT**	
CORE DIRECTOR: Sheila B. Noone, PhD	**LOCATION: Medical School – Room S7-714**
The Clinical Trials Unit (CTU), a dedicated ambulatory service unit for clinical study support and resources, is under the direction of the Director of Clinical Research in the Office of Research. The CTU works collaboratively with clinical investigators to ensure high quality and efficient study initiation and can provide support throughout the life cycle of a study. This includes: 1. Provision of dedicated space: includes 4 exam rooms, an infusion room with 2 recliners, open workstations for CTU users, a small laboratory for spinning, freezing, packaging, and shipping of study specimens; 2. Study coordination: four (4) fulltime, experienced research nurse coordinators who are able to recruit, screen, enroll and manage study conduct over the life cycle of the study or clinical trial Regulatory Support for study initiation through the services of one regulatory coordinator who can assist investigators with IRB submissions and FDA communications for IND and IDE	
Nursing Fee	*$55/hr*
Room Fee	*$40/hr **
** NIH Grants exempt*	
OCR Pharmacy Rate Schedule	
Start-up charges per new Clinical Trial	$750
Per-Subject charges are calculated based on individual trial requirements	

❖ **CRYSTALLOGRAPHY CORE FACILITY**	
CORE DIRECTOR: William Royer	LOCATION: LRB 9th Floor
The X-ray Crystallography Lab is a core facility with operations at UMASS Medical School's Lazare Research and Biotech II buildings. The laboratory provides facilities and resources for conducting research, advanced teaching, and comprehensive data processing. The facility is jointly funded by user fees, departmental contributions and the Office of Research. Facilities include two detectors (R-AXIS IV, MAR 180) and generators (RU-300 and RU-300HR). The in-house UNIX computing environment supports data processing, 3-D visualization and design. To allocate time on one of the detectors, see the online scheduler. There are six faculty members associated with the facility. Course work includes graduate classes and professional training.	
Current Rate Schedule	
Internal Customers	$8K/year*
External Customers	$400/day
**Covers service contracts, maintenance, computer upgrade & salaries*	

❖ **CLINICAL AND TRANSLATIONAL RESEARCH SUPPORT CORE: MENTAL RETARDATION/DEVELOPMENTAL DISABILITIES RESEARCH CENTER (MRDDRC)**	
Core Directors	Carol Curtin, MSW, E.K. Shriver Center, Waltham, MA

	Richard Serna, PhD, E.K. Shriver Center, Waltham, MA Edward Ginns, MD, UMass Medical School, Worcester, MA

The Clinical and Translational Research Support (CTRS) Core provides assistance to funded research projects involving human participants to ensure that they have sufficient numbers of well-characterized individuals to fulfill the projects' primary aims. The CTRS Core also provides access and information resources that will support investigators of all types who have clinical and/or translational research interests.

The Core currently provides the following services:

1. Recruitment of participants;
2. Assessment/characterization of participants;
3. Tracking of recruited participants across multiple projects and maintenance of a database of specialized populations;
4. Coordination of interactions with the UMMS IRB, which includes assisting investigators to submit clear and complete applications and follow-up IRB communications.

Core D Fee Structure - Revenue Account

Draft #1 1/29/2008

		Full Fees	50% MRDDRC Users	60% UMMS Internal	75% Academic External	100% Corporate External
Participant Characterization Services						
Level A	*per hour:*	$ 50	$ 25	$ 30	$ 38	$ 50
Level B	" "	$ 75	$ 38	$ 45	$ 56	$ 75
Level C	" "	$ 100	$ 50	$ 60	$ 75	$ 100
Level D	" "	$ 125	$ 63	$ 75	$ 94	$ 125
Level E	" "	$ 150	$ 75	$ 90	$ 113	$ 150
Level F	" "	$ 175	$ 88	$ 105	$ 131	$ 175
Level G	" "	$ 200	$ 100	$ 120	$ 150	$ 200
Recruitment Activities						
School-based	*per participant*	$ 10	$ 5	$ 6	$ 8	$ 10
Community-based	*to be recruited:*	$ 20	$ 10	$ 12	$ 15	$ 20
IRB interactions						
Flat Fee	*First Year:*	$ 500	$ 250	$ 300	$ 375	$ 500
	Yrs 2 & beyond:	$ 250	$ 125	$ 150	$ 188	$ 250
Participant Compensation						
Hourly rate	*per hour:*	$ 20	$ 10	$ 12	$ 15	$ 20

❖ DEEP SEQUENCING CORE

CORE DIRECTOR: Ellen Kittler, PhD	LOCATION: Biotech II

The Deep Sequencing Core provides a next-generation sequencing platform for investigators using Massively Parallel Signature Sequencing (MPSS), also known as Parallel Sequencing by Synthesis, or "Deep Sequencing.".The core analyzes genomic DNA, DNA fractions (e.g. Chromatin Immunoprecipitation), cDNA and RNA samples by generating libraries of small tagged fragments which are simultaneously sequenced in parallel using a Solexa (Illumina) 1G Genome Analyzer. Deep Sequencing generates a large number of short overlapping sequences as well as quantifying the occurrence of each individual sequence within the

library. The Deep Sequencing Core also provides assistance with sample preparation and bioinformatics analysis.

To set up a project with the Deep Sequencing Core, please contact us at Nemo@umassmed.edu

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Deep Sequencing Corer Rates:
On Web Page: Nemo@umassmed.edu

❖ DIGITAL IMAGING CORE FACILITY

CORE DIRECTOR: Paul Furcinitti | LOCATION: Biotech II

The Core Digital Imaging Facility provides high-resolution multi-mode light microscopy services to UMass Medical School researchers and investigators at other academic and commercial institutions. Services include wide-field and spinning disk confocal microscopy, fluorescence recovery after photobleaching measurements, live cell imaging, digital deconvolution of microscopy images and image analysis. Training and technical assistance are provided in a user friendly environment. The facility is hosted by the Program in Molecular Medicine and is located in 2 Biotech, 373 Plantation St., Suite 114. Hours of operation are 9:00 AM - 5 PM, Mon. to Fri. Rates and other information is available at our website www.umassmed.edu/digitalimages. Phone 508 856-0045 or e-mail Paul Furcinitti at paul.furcinitti@umassmed.edu to discuss your application and schedule time on our light microscopes.

2009 Rates

	Internal	Academic	External	(Volume Discount)
Microscopy	$26.00	$40.00	$55.00	$20.00
Confocal Micro	$31.50	$42.00	$65.00	
Computer	$21.00		$45.00	
Training/Tech Assist	$42.00		$85.00	
CD-ROM	$0.62		$0.62	
DVD	$1.75		$1.75	

❖ DNA SEQUENCING CORE FACILITY

CORE DIRECTOR: Harold Hills | LOCATION: Biotech I

The DNA Sequencing Facility performs automated fluorescent DNA sequencing on an Applied Biosystems 3130XL Genetic Analyzer as a service for UMass and external researchers. We strive to produce good quality sequence with a rapid turn around time. We routinely obtain ~800+ bases of reliable sequence per reaction. This can vary considerably with template and primer quality and composition. The cycle sequencing reactions are routinely performed by the DNA sequencing staff. If you wish to run the reactions yourself, you will only be charged for instrument usage. Please see the order form that can be downloaded from our web site.DNA Sequencing Facility:

Current Rate Schedule

Sequencing reaction	$9/Internal Rate	$10/External Rate (academic & commercial)

❖ ELECTRON MICROSCOPY CORE FACILITY: "A DIABETES & ENDOCRINOLOGY RESEARCH CENTER"	
CORE DIRECTOR: Gregory Hendricks, Ph.D.	LOCATION: Room SA-114

The Core Electron Microscopy Facility provides state-of-the-art methodologies and instrumentation for researchers at UMass Medical School and the surrounding research community. It is located in the lower level of the Medical School (SA-114). The facility is equipped with one scanning and three transmission electron microscopes together with the ancillary equipment required to carry out all key ultrastructural procedures from the tissue to the molecular level.

Dr. Gregory Hendricks, who provides in-depth expertise in EM methodology, manages the facility. The facility is co-directed by Drs. George Witman and Roger Craig of the Department of Cell Biology, who have many years of EM experience.

The facility provides full service in specimen preparation, microscopy and interpretation of results, all at very reasonable rates. Training and use of all the equipment are also available and encouraged

Electron Microscopy Facility rates (effective FY09)

	Scope (SEM) Time "Customer Drives"	Scope (TEM) Time "Customer Drives"	Scope Time " SEM Tech Drives"	Scope Time " TEM Tech Drives"	Tech Time "Prep & Billable Consultation"
User	**Rate**	**Rate**	**Rate**	**Rate**	**Rate**
DERC	$10.00	$7.50	$35.00	$33.50	$26.00
Cell Biology	$10.00	$7.50	$55.00	$54.50	$47.00
UMMS	$35.00	$26.00	$80.00	$73.00	$47.00
Academic Offsite	$65.00	$65.00	$150.00	$150.00	$85.00
UMMHC	$110.00	$110.00	$110.00	$245.00	$135.00
Off campus/commercial	$110.00	$110.00	$245.00	$245.00	$135.00

❖ ENZYME FREEZER PROGRAM (EFP)	
CORE DIRECTOR: Harold Hills	Location: Biotech I, 1st Floor

The Enzyme Freezer Facility maintains an onsite freezer program at several points on campus. We supply restriction enzymes, modifying enzymes, kits for DNA preparation and cleanup and related reagents from eight different vendors.

Rates

Rates are for individually packaged items – see website for details

❖ FLOW CYTOMETRY CORE FACILITY: "A DIABETES & ENDOCRINOLOGY RESEARCH CENTER"	
CORE DIRECTOR: Richard Konz	LOCATION: UMMS 5th Floor

The Flow Cytometry Facility provides a wide variety of cytometry services for internal and external investigators with state-of-the-art cell sorting and analyzing capabilities. We currently have three FACSCailburs, two 4 laser LSRIIs, a 3 laser FACSVantage SE DiVa cell sorter, a 3 laser Digital Dako MoFlo XDP hi-speed cell sorter, an all digital 3 laser 11 color FACSVantage SE DiVa cell sorter and a 14 color, 4 laser FACSAria dedicated to BSL3 cell sorting. One LSR II and one Calibur are dedicated for customer use, after training, which we can provide.

FY 2009 Effective 1 July 2008

	FACS Analyzer W/O operator	FACS Analyzer W/operator	FACS Sorting	Training	BSL-3	Confocal
Internal Non-DERC users	30.00	48.00	68.00	44.00	150.00	25.00

Internal DERC users	22.00	35.00	50.00	44.00	125.00	25.00
External Academic		100.00	100.00	200.00		
External Users		130.00	130.00	130.00	250.00	

❖ FLY KITCHEN

CORE RESEARCHER: Birgit Koppetsch	LOCATION: Biotech I

The Fly Kitchen provides for production of drosophila. Available items include bottles with food, vials with food, grape juice plates, apple juice plate and larval trays.

CURRENT RATE SCHEDULE: (based on trays unless otherwise noted)

Narrow Vials (with food)	$19.50	Narrow Vials (Empty)	$7.25
Wide Vials (with food)	$24.00	Wide Vials (Empty)	$11.80
Bottles (with food)	$16.00	Bottles (Empty)	$6.50
Narrow Vials (food only)	$11.50	Trays	$1.00
Bottles (food only)	$8.50	*NOTE: Outside Academic Rates - see Core Director*	

❖ GENOMICS CORE FACILITY: "A DIABETES & ENDOCRINOLOGY RESEARCH CENTER;" "A MENTAL RETARDATION AND DEVELOPMENT DISABILITIES RESEARCH CENTER"

CORE MANAGER: Phyllis Spatrick	LOCATION: Room S5-116 School

The Genomics Core Facility at UMass Medical School is an excellent resource for the UMass and Worcester area research community featuring high-density microarray technology for both GeneChip and glass slide array processing.

- sample preparation and Affymetrix instrumentation for Expression, Gene ST, Exon, and Tiling Arrays, as well as SNP chip and CustomSeq array hybridization and scanning.
- glass slide array scanning using the Agilent G6525BA Scanner. Expression, ChIP-chip, miRNA and DNA microarray.
- Glass slide hybridization capabilities with the BioMicro MAUI Hybridization System
- Genespring GX Analysis Software available

CURRENT RATE SCHEDULE ($/hr):

	UMass Worcester	DERC/MRDDRC	External Academic	External Biotech
Purchase test chip(optional)	$100	$100	$100	$100
cDNA synthesis and cRNA IVT	$250	$175	$300	$400
Hybridization, wash and scan	$160	$75	$192	$240
Fragmentation	$15	$8	$18	$25

❖ HUMAN EMBRYONIC STEM CELL CORE FACILITY

CORE DIRECTOR: Gary Stein/Jane Lian	LOCATION: S3-308 North

The HESC Core facility will provide, to UMASS investigators on all campuses, undifferentiated stem cells; two NIH approved cell lines, H1 (male) and H9 (female), on mouse feeder layers. Our support services include:

- Quality controlled undifferentiated stem cells plated
- Protocols for monitoring HESCs during studies
- Advice on experimental design

No Rates for FY'08-09 – funded by outside funds

❖ IVIS ANIMAL IMAGING CORE

The Xenogen® IVIS imaging system allows the detection of light-emitting cells within a living organism. This represents a significant advance in that the presence of cells of interest can be ascertained without sacrificing an animal. The system

comprises a light-tight imaging chamber, a high-sensitivity cooled charge coupled device (CCD) camera, a cooling system for the camera, and proprietary software that controls all of the system components. Access to the system is by login of registered users, the list of which is maintained by Brian Lewis.
Rate
$40/hour

❖ **MBCL ~ OLIGO & GENOTYPING CORE**	
CORE DIRECTOR: Ellen Kittler	LOCATION: Biotech 2
The Molecular Biology Core Labs (MBCL) operate the UMassMed OLIGONUCLEOTIDE discount program which provides DNA, RNA, RNA:DNA hybrid, modified and fluorescently labeled Oligos to UMassMed research labs. The MBCL also provides discounts on siRNA duplexes and reagents from several vendors. These are available to UMassMed laboratories only (vendor agreements prohibit us from providing these to non-UMassMed parties). Oligonucleotides may be ordered through our website at http://oligo.umassmed.edu or by sending us an email at oligo@umassmed.edu with your order information or questions. The MBCL also operates a GENOTYPING Service (open to non-UMassMed parties). Using an ABI3730xl we perform various types of genotyping and DNA Fragment analyses including SNP (single-nucleotide polymorphism), AFLP (amplified fragment length polymorphism or PCR fragment sizing), LOH (loss of heterozygosity), and microsatellite analysis over a sizing range of 20 to 1200 bases. For more details contact us at 856-6137 or by email to oligo@umassmed.edu	
Prices depend on product(s) ordered – see website for details	

❖ **MACHINE SHOP**	
CORE DIRECTOR: Art Allard	LOCATION: Shrewsbury Campus
The UMMS Machine Shop is a support service dedicated to assisting research in a technical/mechanical manner. Although all types of basic laboratory apparatus are manufactured and repaired on a regular basis, we specialize in design and fabrication of equipment that is not commercially available. No job too big or too small, too simple or too complex.	
Rate schedule	
UMMS	$52/unit
UMMHC	$75/unit
External	$100/unit

❖ PROTEOMICS AND MASS SPECTROMETRY

CORE DIRECTOR: Jim Evans	LOCATION: Biotech I

A resource that offers a wide variety of state-of-the-art proteomic and small molecule mass spectrometric analyses. It is equipped with six chromatography (GC, HPLC and UPLC)-mass spectrometry systems (Q-TOF, linear and 3D ion trap, triple quadrupole and MALDI-TOF) for qualitative and quantitative, large and small molecule analyses. Quantitative shotgun proteomics by ICAT, iTRAQ and MSE techniques are well established in the facility. Gel spot/band protein identification and characterization are performed by MALDI-TOF, capillary LC-MS/MS and NanoMate-LC-MS/MS. Protein characterization capabilities include post-translational modification identification and location (phosphorylation, sulfation, acylation, ubiquitination and many others), static and dynamic protein folding studies (cross-linking and H/D exchange), and disulfide location. A wide variety of small molecule analyses can be performed including lipidomics, metabolomics, fatty acids, carbohydrates, organic structure determination, pharmacokinetics, and stable isotope labeled metabolism studies. Linked scan triple quadrupole MS/MS is well a developed capability for many qualitative and quantitative trace component analyses.

Established methods include:

- Protein MW and sample purity analysis by LC-high resolution Q-TOF MS
- Exact mass measurement (<3 ppm) and elemental composition determination
- Gel band protein ID by MALDI-TOF and nanoscale HPLC-MS/MS
- MSE, iTRAQ and ICAT for quantitation of large numbers of proteins in complex mixtures
- Location of phosphorylation and other posttranslationally modified sites
- Location of disulfide bonds
- Quantitation of isodipeptide cross-linking
- Determination of protein conformation by H/D exchange and cross-linking.
- Lipidomics
- Metabolomics
- Pharmacokinetics (stable isotope steady-state and non-steady state)

FY09 Rate Calculations

UMMS PROTEOMICS & MASS SPECTROMETRY FACILITY RATES

SERVICE	**UMMS USERS**	**MRDDRC USERS**	**ACADEMIC USERS**	**COMMERCIAL USERS**
	RATE / HOUR			
Director's Time (Consultation, Data Analysis)	$65	$33	$86	$132
Technician Time	$41	$21	$53	$69
Mass Spectrometry (Instrument Use)	$164	$82	$213	$278
Unassisted Operation	$80	$40	$103	not available
	RATE / ANALYSIS			
Gel Band Protein ID (by LC-ESI-MS or Maldi-Tof-MS)	$343	$172	$566	$692
5 or more bands (10% discount)	$309	$154	$509	$669
10 or more bands (20% discount)	$275	$137	$453	$554
Computer time (for extended searches)	$11/hr	$5.50/hr	$15/hr	$22/hr

ICAT and MudPit are priced individually, based on sample complexity.
Rates range from $1000 to $5000.
Rates effective July 1, 2008.

❖ MORPHOLOGY CORE: "A DIABETES & ENDOCRINOLOGY RESEARCH CENTER"	
CORE DIRECTOR: Bruce Woda	LOCATION: UMMS, 2nd Floor

Established in 1981, the Morphology Core Facility is a DERC (Diabetes and Endocrinology Research Center) Research Core Laboratory. Major funding for the Morphology Core is provided by a Diabetes and Endocrinology Research Center grant from the National Institutes of Health. Dr. Bruce Woda, MD , Professor of Pathology Department is the core director.

The Morphology Core Facility is a state-of-the-art, fully equipped histology lab that provides histology services in support of investigators at UMass Medical School, including

- routine histological preparations. * special stains,
- immunohistochemistry. * frozen sections.

The core provides advice on techniques that are appropriate in submitting and evaluating morphologic preparations.

Rates

FY'09 FEE STRUCTURE

Service Light Microscopy (Price per slide or block)	DERC	Non-DERC
Conventional Histology	$4.40	$8.80
Special Stains	$5.50	$9.90
Paraffin unstained	$3.50	$4.00
Embedding Only (per block)	$1.20	$1.80
Crytomy	$0.75	$2.25
Immunohistochemistry	$6.00	$10.80

Includes an average 10% price increase

❖ NEW ENGLAND CENTER FOR STROKE RESEARCH (NECSTR)	
CORE DIRECTOR: Matt Gounis	LOCATION: Medical School, "A" Level

This facility is imaging and image guided therapeautic intervention. Services include:

1. Fully equipped sterile angiosurgical suite to support fluoroscopy guided intervention
2. Hemodynamics laboratory for in vitro investigation into the efficacy cardiovascular devices.
3. Xper CT for 3-D reconstruction of vascular tree and soft-tissue imaging.

Rate Schedule	
Internal UMMS	$986.00
External/Corporate	$1,800.00

❖ PLATELET FUNCTION LAB	
CORE DIRECTOR: Alan Michelson, MD	LOCATION: S5-853 & S5-859

Ongoing Platelet Function Assays billed from the department as completed for each customer.

The Platelet Function lab performs a variety of standardized platelet function assays on a fee-for-service basis in response to specific requests from investigators at other academic institutions, pharmaceutical companies, or medical device companies, usually as a component of a larger study.

UMass Cardiovascular: Baringhaus (Lilly-SWAP Lab work) laboratory work billed at $3120 per patient (est 3 patients)
Lilly-laboratory training billed at $5200 per contract

Lilly analysis billed at $10 per tracing est of 200 Brigham & Women's: Malhotra per sample x 3 agonists x 2 assays for 16 (est) subjects University of Copenhagen: $9 per sample x 850 = $7650, $60

❖ **PROTEOMICS FRACTIONATION CORE FACILITY**	
CORE DIRECTOR: Sunny Tam	LOCATION: Fuller Building, Shrewsbury

The Proteomic Fractionation Group (PFG) at UMass Medical School is a state-of-the-art proteomics laboratory that serves both UMass and external investigators in their proteomic study design and experimental needs. The focus of the lab is the sample preparation of complex protein mixtures derived from whole organisms, tissues, cells, sub-cellular fractions or partially purified proteins.

By fractionating complex protein mixtures, the quantitative detection of a broad range of proteins is enabled by two-dimensional gel electrophoresis (2-DE) or mass spectrometry. Technologies and expertise of the Protein Fractionation Group include,

- abundant proteins separation from biological fluids
- sub-cellular fractionation
- liquid phase iso-electric focusing
- differential protein labeling
- liquid chromatography
- 2-DE, differential staining and robotic excision
- quantitative immunoblot and 2DE gel image analysis
- protein and lysate array analysis

The laboratory has developed protein fractionation strategies that consistently deliver high-quality results to meet the needs of our sponsors. Thus far, the group has actively participated in projects such as biomarkers discovery from diseased clinical or animal model biofluids, protein phosphorylation changes in signal transduction pathways, protein purification and characterization, protein drug interaction, novel sample preparation technology validation and applications, and protein assay development.

Rate Schedule	
UMMS price per Single Gel	$600.00
UMMS price per Triplicate Gel	**$**825.00
Non-Profit Price per Triplicate Gel	$1,200.00
Industry Price per Triplicate Gel	$1,800.00
**NOTE: Above rates may vary with sample difficulties*	

❖ **PROTEOMICS MASS SPEC LAB – SHREWSBURY: " A DIABETES & ENDOCRINOLOGY RESEARCH CENTER"**	
CORE DIRECTOR: John Leszyk	LOCATION: Fuller Building, Shrewsbury

The lab is equipped with the latest instrumentation for protein/peptide mass spectral analysis. Our equipment includes a Shimadzu Biotech Axima TOF^2 (Matrix Assisted Laser Desorption tandemTime -of-Flight (MALDI-TOF-TOF) mass spectrometer, and Axima QIT (Quadrupole Ion Trap Matrix Assisted Laser Desorption Time-of-Flight (MALDI-QIT-TOF) mass spectrometer. In addition to these we have a Finnigan Electrospray LCQ Deca Ion Trap mass spectrometer (ESI LC/MS/MS). The lab provides highly sensitive protein identifications from 1D and 2D gels as well the identities of site-specific modifications for both academic and corporate clientele.

Rate Schedule		
	Protein ID	MALDI TOF Mass Analysis
External Corporate	$600.00	$125.00
External Academic	$500.00	$75.00

UMMS	$300.00	$50.00
UMMS - DERC	$100.00	$25.00

❖ shRNA CORE LIBRARY

CORE DIRECTOR: Michael Green	LOCATION: LRB 6TH Floor

UMMS has purchased the complete collections of human and mouse retroviral and lentiviral short hairpin RNA (shRNA^{mir}) libraries from Open Biosystems, and has negotiated with them to distribute individual clones to UMMS researchers (ONLY) at a reduced price. Through Open Biosystems, individual clones can be purchased at a price of $195.00 per clone (or 3 or more clones for $95.00 each), and control clones for $250.00. Through the UMMS shRNA Library Core Facility, all clones will be permanently available at a base rate of $50.00 per clone.

The UMMS shRNA Library Core offers three control clones for either retroviral or lentivral library (at a price of $50.00 each):

Retroviral:	Lentiviral:
1. Non-silencing	1. Non-silencing
2. eGFP	2. GAPDH
3. Lucifierase	3. Empty vector

Complete information regarding the control clones as well as the human and mouse shRNA libraries can be found on the Open Biosystems website. In addition, please refer to the recent *Nature Methods* and *Nature Genetics* Technical Report for information on the libraries.

Current Rate Schedule

Clone	$50	DNA Prep Service	$20
Non-Silencing Option	$50	Library Screening	$4,000
UMass Med Delivery	$5	Other UMass Delivery	$10

❖ TISSUE BANK

The UMass Memorial Cancer Center's Tissue Bank is an institutional Core facility aimed at improving the research endeavors of the basic, clinical, and translational scientists of the Cancer Center. The overarching goal of the facility is help facilitate the science underway to improve the understanding of the underlying causes of the different types of cancer through the use of human tissue.
One vital component of the Tissue Bank is the archival collection of formalin-fixed, paraffin embedded tissue samples that can be connected to clinical information dating back to 1993. These samples are stored in the files of the UMMHC Pathology Department.

The second major component of the Tissue Bank is a dynamic tissue collection, annotation, storage and distribution service, which collects fresh tissue samples for rapid processing/snap freezing immediately after surgery. When possible, surrounding healthy normal tissue samples are also processed and stored for reference purposes.

In addition to routine histology, fresh tissue for cell culture, frozen sections, unstained slides with DNA and RNA extractions are available. Looking to meet the complex needs of the research community, tissue micro arrays will be available from the bank in the near future.

Rates

Fresh Tissue Sample Collection	$20.00
Frozen Tissue Sample	$40.00

Frozen Section (H&E)	$10.00
Frozen Section, Unstained	$5.00
Paraffin Block	$1,500.00
H&E Paraffin Section	$8.00
Unstained Paraffin Section	$6.00
Review of Slides (per hour)	$115.00
Chart Review (per hour)	$30.00

❖ **TISSUE CULTURE SUPPLY CENTER**	
CORE DIRECTOR: Paul Dobner	LOCATION: Biotech I
The Tissue Culture Supply Center offers a wide range of commercially prepared media (Invitrogen/GIBCO, MediaTech, Hyclone, Sigma) and sera to all UMASS investigators at steeply discounted prices. Tissue culture media can either be conveniently ordered for next day delivery or picked-up in the Tissue Culture Facility for immediate use (commonly used media products only). Please visit our website (http://www.umassmed.edu/tissueculture/index.aspx)for a complete listing of products and prices, and contact information. Tissue Culture Supply Center: Depends on product(s) requested; contact facility for details	

❖ **TISSUE CULTURE FACILITY / MEDIA CENTER**	
CORE DIRECTOR: Paul Dobner	LOCATION: Biotech I
The UMass Tissue Culture Facility and Media Center offers a variety of cell culture support and media preparation services to UMass investigators, as well as investigators from other institutions. These services include the preparation of specialized media for both tissue culture and microbiological applications, a variety of standard cell culture procedures, monoclonal antibody production, cell transfection and isolation of stably transfected clones, programmed cell freezing, frozen cell storage, primary cell culture, and mycoplasma testing. Please visit our website (http://www.umassmed.edu/tissueculture/index.aspx) for a complete listing of services and prices, and contact information. The TCF/Media Center also offers a full line of commercially prepared tissue culture media and serum from several vendors at steeply discounted prices to UMASS investigators through the Tissue Culture Supply Center (see next page).	
Tissue Culture Services	
Routine cell line maintenance (in 2 x T-25 flasks including supplies and labor) UMMS $140.00/month Outside UMASS Price $220.00/month	
Programmed cryopreservation of cell line (10 vials, including supplies and labor) UMMS $80.00/10 vials Outside UMASS Price $100.00/10 vials	
Cell storage in liquid nitrogen Prices for UMASS investigators 1-50 vials, $10.00/month 51-100 vials, $15.00/month 101-150 vials, $20.00/month 151-200 vials, $25.00/month, and so on	
Mycoplasma test (GIBCO Myco Tect Kit Assay) 1 sample, price: $60.00 (UMMS)/ $70.00 (Outside) 2 samples, price/sample: $40.00 (UMMS)/ $60.00 (Outside) 3 samples, price/sample: $30.00 (UMMS)/ $50.00 (Outside)	

4 or more samples, price/sample: $25.00 (UMMS)/ $40.00 (Outside)
Other services (e.g. hybridoma production) Cost based on materials and labor $40.00/hour /$70.00/hour (Outside)

FY09 Rate Calculations

CHARGES FOR SERVICES

Transgenic Services (per construct)	Price
Pronuclear injection mouse C57Bl/6 inbred strain	$5,700
Pronuclear injection mouse FVB inbred strain	$4,000
Pronuclear injection mouse specified inbred strain	*please inquire*
Pronuclear injection mouse B6xSJL hybrid strain	$3,500
Lentiviral injection mouse C57Bl/6 inbred strain	$2,400
Lentiviral injection mouse specified inbred strain	*please inquire*
Pronuclear injection rat SD outbred strain	$2,000
Pronuclear injection rat specified inbred strain	*please inquire*
Lentiviral injection rat SD outbred strain	$2,000
Lentiviral injection rat specified inbred strain	*please inquire*
Gene Targeting Services (per construct)	
ES cell clone isolation per electroporation	$2,500
Transduction of Cre into ES cell clone	$400
Allele jumping in ES cells (per clone)	$500
Chimeric Mouse Production (per ES clone)	
Injection into mouse C57Bl/6 blastocysts	$4,000
Cryopreservation Services (per line)*	
Embryo vitrification	$1,610
Regeneration of cryopreserved line	$300
Sperm cryopreservation	$300
Other Services*	
Strain rederivation (embryo transfer per line)	$1,000
Breeding of mice to assess germline transmission (per r $150	
Backcross standard (per generation)	$150
Backcross embryo transfer (per generation)	$1,000
In Vitro fertilization (hybrid strain)	$1,250

❖ VETERINARY PATHOLOGY CORE
The goal is to foster and enhance scientific projects that involve animal models of cancer, transgenic and knockout technology, with the objective to publish innovative and academically sound research in the premiere scientific literature. The services will entail a board-certified mouse pathologist with demonstrated expertise in mouse embryology traveling to the Department of Cancer Biology located on the fourth floor of the Lazare Medical Research building on the University of Massachusetts Medical School campus for consultation period of approximately three hours/week.
Rates
$40/ 45 minute consultation session

❖ ATTACHMENT 4:
UNIVERSITY LIFE SCIENCES DEGREE PROGRAMS AND RESEARCH CENTERS

AMHERST CAMPUS

Degree Program	Degree
Animal Biotechnology and Biomedical Sciences	MS/PhD
Animal Science	BS
Applied Mathematics	MS
Biochemistry and Molecular Biology	BA/BS/MS
Biology	BS
Biostatistics	MS/MPH/PhD
Chemical Engineering	BS/MS/PhD
Chemistry	BA/BS/MS/PhD
Communication Disorders	BS/MA/AuD/PhD
Community Health Education	MS/MPH/PhD
Computer Science	BS/MS/PhD
Computer Systems Engineering	BS/MS/PhD
Electrical Engineering	BS/MS/PhD
Entomology	MS/PhD
Environmental Biology	BS
Environmental Health Sciences	MS/MPH/PhD
Epidemiology	MS/MPH/PhD
Food and Environmental Biotechnology	BS/MS/PhD
Health Policy and Management	MS/MPH/PhD
Industrial Engineering	BS/MS/PhD
Kinesiology	BS/MS/PhD
Mathematics	BA/BS/PhD
MBA/Environmental Engineering	MBA/MS
MBA/Industrial Engineering	MBA/MS
Mechanical Engineering	BS/MS/PhD
Microbiology	BS/MS/PhD
Molecular and Cellular Biology	BS/MS/PhD
Neuroscience and Behavior	BS/MS/PhD
Nursing	BS/MS/MS-MPH/PhD/DNP/CNL
Nutrition	BS/MS/MPH/PhD
Organismic and Evolutionary Biology	MS/PhD
Physics	BA/BS/MS/PhD

Plant and Soil Science	MS/PhD
Plant Biology	BS/MS/PhD
Plant Biology	PhD
Plant, Soil and Insect Sciences	BS
Psychology - Neuroscience	BS/MS/PhD
Polymer Science and Engineering	PhD
Public Health Sciences	BS
Statistics	MS/PhD
Research Centers	
Silvio O. Conte Center for Polymer Research	
Materials Research Science and Engineering Center	
MassNano Tech	
The Center for Process Design and Control	
The National Science Foundation Center for e-Design and Realization of Engineering Products and Systems	
The UMass Amherst Institute for Cellular Engineering	
Biomedical Innovation Laboratory	
The Center for Research and Education in Women's Health	
The Institute for Global Health	
The Biostatistics Consulting Center	
The Northeast Regional Environmental Public Health Center	
The Center for Research on Families	

BOSTON CAMPUS

Degree Program	Degree
Applied Physics	MS
Biochemistry	BS/Certificate
Biology	BS/MS
Biomedical Engineering and Biotechnology	PhD
Biotechnology and Biomedical Science	MS
Biotechnology Certificate Program	Certificate
Chemistry	BA/BS/MS/PhD
Computer Science	BA/BS/MS/PhD/Certificate
Computer Science - Information Technology	BS
Database Technology	Certificate
Electrical Engineering	BS
Engineering Physics	BS
Environmental Biology	PhD
Industrial Engineering	BS
Information Design and Development	Certificate
Information Technology	MS/Certificate
Mathematics	BA/BS
Mechanical Engineering	BS
Molecular, Cellular and Organismal Biology	PhD
Physics	BA/BS
Research Centers	
Center for Green Chemistry	

DARTMOUTH CAMPUS

Degree Program	Degree
Biology	MS
Marine Biology	MS
Biomedical Engineering and Biotechnology	PhD
Chemistry	BS/MS/PhD
Medical Laboratory Science	BS
Mathematics	BA/BS
Computer Engineering	BS
Electrical Engineering	BS/MSEE/PhDEE
Electrical or Computer Engineering	BS/MS
Computer Engineering	MSCPE
Communications Certificate	Certificate
Digital Signal Processing Certificate	Certificate
Acoustics Certificate	Certificate
Electrical Engineering Systems Certificate	Certificate
Computer Systems Engineering Certificate	Certificate
Mechanical Engineering	BS/MS
Physics	BS/MS
Materials and Textiles	BS
Textile Technology	MS
Textile Chemistry	MS
Computer Science	BS/MS/Certificate
Computer Networks and Distributed Systems	Certificate
Software Design and Software Development	Certificate
Management Information Systems	BS
Research Centers	
Center for Molecular Diagnostics	
Business Innovation Research Center (BIRC)	
Center for Rehabilitation Engineering	
James J. Kaput Center for Research and Innovation in Mathematics Education	

LOWELL CAMPUS

Degree Program	Degree
Applied Mathematics	BS/MS
Applied Statistics	Certificate
Biochemistry	PhD
Biological Sciences	MS
Biomedical Engineering and Biotechnology	MS/PhD
Biotechnology and Bioprocessing	Certificate
Chemical Engineering	BS/MS/PhD/D.Eng
Chemistry	BS/MS/PhD
Clinical Lab Sciences	BS/MS
Clinical Pathology	Graduate Certificate
Computer Assisted Manufacturing	Certificate Program, short-term
Computer Engineering Technology	Certificate Program, short-term
Computer Science	BS/MS/ScD/Certificate
Design and Manufacturing	Certificate
Elastomers	Certificate
Electronic Engineering Technology	AS/BS
Electronics Technology	Certificate Program, short-term
Integrated Engineering Systems	Certificate
Manufacturing Technology	Certificate Program, short-term
Marine Science and Technology	MS/PhD
Materials Science and Engineering	Certificate
Mathematics	BA (in development)/BS/MS
MBA	minor
Mechanical Engineering	BSE/MSE/PhD/D.Eng
Mechanical Engineering Technology	AS/BS
Medical Plastics Design & Manufacturing	Certificate
Modeling, Simulation and Control of Systems and Processes	Certificate
Nanotechnology	Certificate
Physics	BS/MS/PhD
Plastics Design	Certificate
Plastics Engineering	BS/MS/PhD/D.Eng
Plastics Engineering Fundamentals	Certificate
Plastics Materials	Certificate
Plastics Processing	Certificate
Polymer Science	MS
Polymer Science/Plastics Engineering	PhD

Research Centers
Center for Complex Environmental Systems
Center for Cellular Neurobiology and Neurodegeneration
Center for Biological Sciences Computing
Photonics Center
Center for Advanced Materials
National Science Foundation Center for High-rate Nanomanufacturing
Nanomanufacturing Center of Excellence
Center for Electromagnetic Materials and Optical Systems
Center for Man/Machine Intelligence, Networking and Distributed Systems
Institute for Plastics Innovation
Biodegradable Polymer Research Center
Massachusetts Bioprocess Development Center
Center for Advanced Composites and Textile Research Laboratory
Radiation Lab
Center for Biomolecular & Medical Informatics
Center for Industrial Competitiveness
Center for Intelligent Biomaterials
Massachusetts BioManufacturing Center
Center for Green Chemistry
Massachusetts Medical Device Development Center
UMass Lowell Robotics Lab
Computational Physics and Nanomaterials Laboratory
Toxics Use Reduction Institute
Center for Sustainable Energy

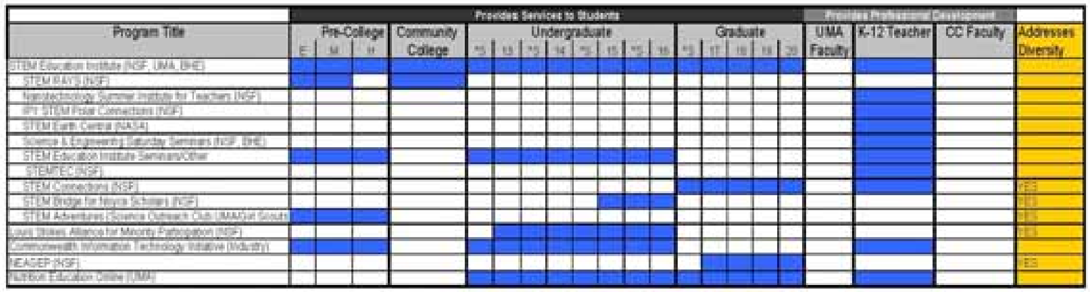
WORCESTER CAMPUS

Degree Program	Degree
Biochemistry & Molecular Pharmacology	PhD
Biomedical Engineering & Medical Physics	PhD
Biomedical Sciences	MD/PhD
Cancer Biology	PhD
Cell Biology	PhD
Cellular & Molecular Physiology	PhD
Clinical and Population Health Research	PhD
Immunology & Virology	PhD
Interdisciplinary Graduate Program	PhD
Molecular Genetics & Microbiology	PhD
Neuroscience	PhD
Research Centers	
Center for AIDS Research	
Center for Comparative NeuroImaging	
Center for Infectious Disease & Vaccine Research	
Diabetes & Endocrinology Research Center	
Shriver Center	
Program in Gene Function & Expression	
Program in Neuroscience	
Program in Immunology & Virology	
Program in Molecular Medicine	
Interdisciplinary Graduate Program	

❖ ATTACHMENT 5:
UNIVERSITY STEM PIPELINE PROGRAMS

AMHERST CAMPUS

UMass Amherst's Pathway to Increase Access to STEM Fields with Diversity-Specific Initiatives Noted

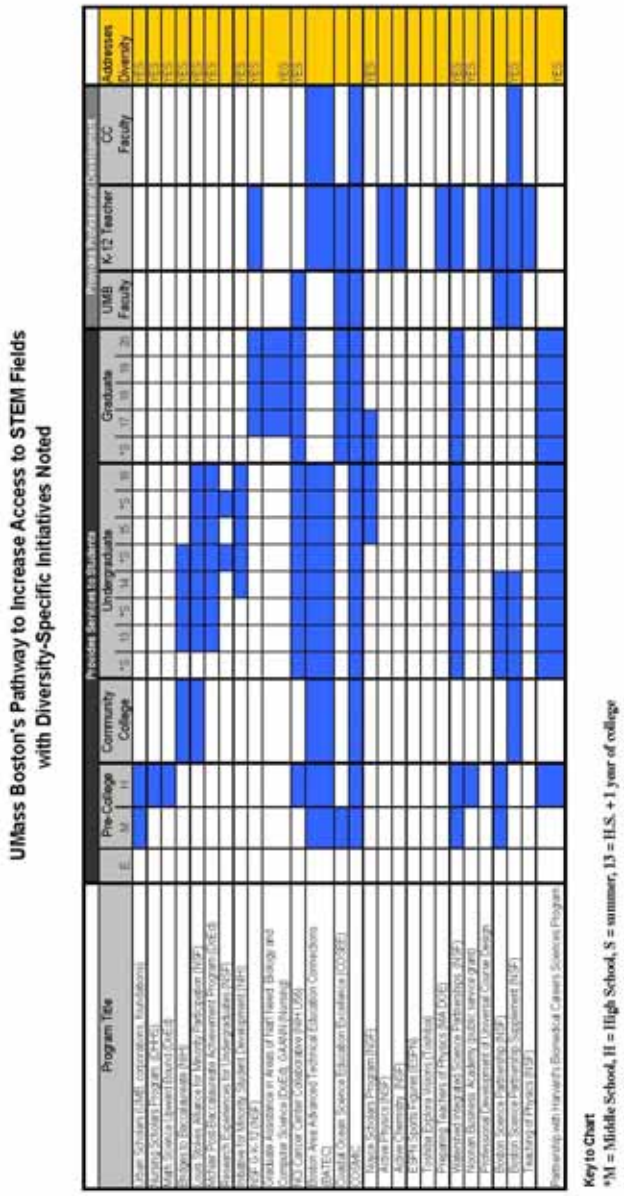


	Provides Services to Students																	Provides Professional Development			
Program Title	Pre-College			Community College	Undergraduate								Graduate					UMA Faculty	K-12 Teacher	CC Faculty	Addresses Diversity
	E	M	H		*S	13	*S	14	*S	15	*S	16	*S	17	18	19	20				
STEM Education Institute (NSF, UMA, BHE)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		
STEM RAYS (NSF)	■	■		■																	
Nanotechnology Summer Institute for Teachers (NSF)																			■		
IPY STEM Polar Connections (NSF)																			■		
STEM Earth Central (NASA)																			■		
Science & Engineering Saturday Seminars (NSF, BHE)																			■		
STEM Education Institute Seminars/Other	■	■	■		■	■	■	■	■	■	■	■							■		
STEMTEC (NSF)																			■		
STEM Connections (NSF)													■	■	■	■	■		■		YES
STEM Bridge for Noyce Scholars (NSF)										■	■	■									YES
STEM Adventures (Science Outreach Club UMA/Girl Scouts)	■	■	■																		YES
Louis Stokes Alliance for Minority Participation (NSF)						■	■	■	■	■	■	■									YES
Commonwealth Information Technology Initiative (Industry)	■	■	■		■	■	■	■	■	■	■	■							■		
NEAGEP (NSF)														■	■	■	■				YES
Nutrition Education Online (UMA)					■	■	■	■	■	■	■	■	■	■	■	■	■		■		

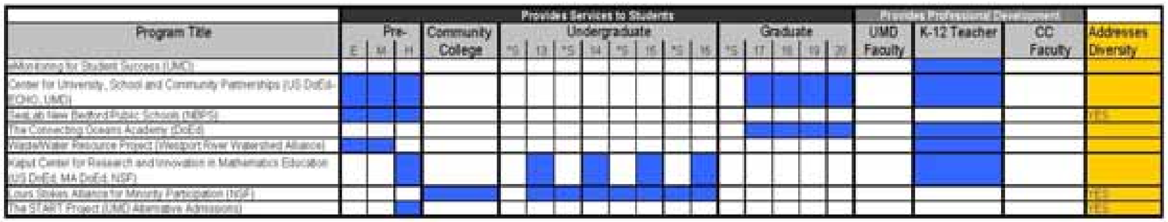
Key to Chart

*E = Elementary School, M = Middle School, H = High School, S = summer, 13 = H.S. + 1 year of college

BOSTON CAMPUS



UMass Darthmouth's Pathway to Increase Access to STEM Fields with Diversity-Specific Initiatives Noted

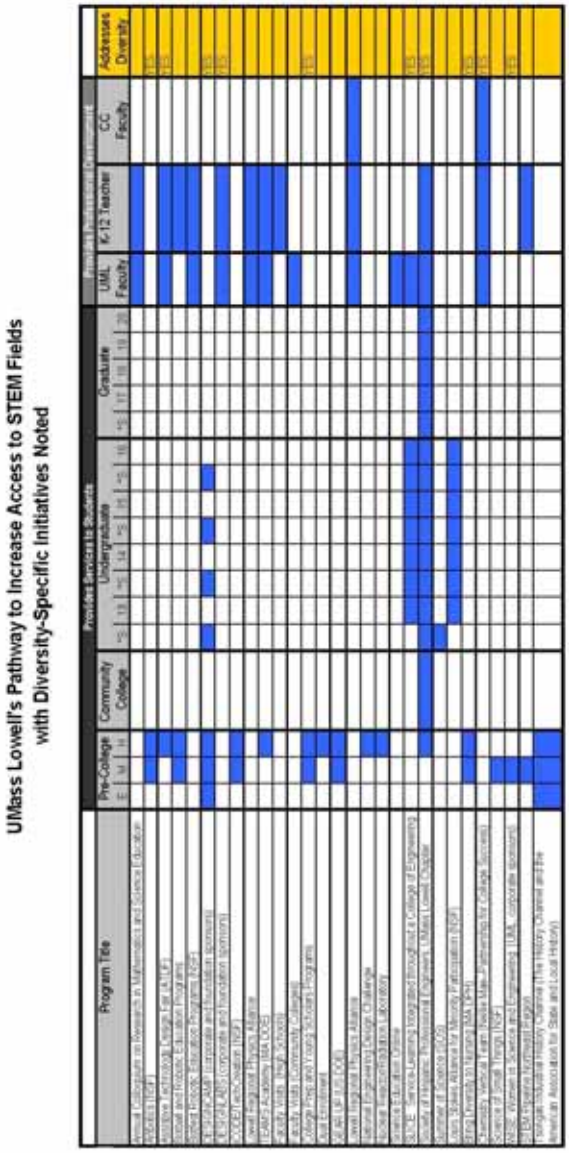


	Provides Services to Students																	Provides Professional Development			
Program Title	Pre-			Community College	Undergraduate								Graduate					UMD Faculty	K-12 Teacher	CC Faculty	Addresses Diversity
	E	M	H		*S	13	*S	14	*S	15	*S	16	*S	17	18	19	20				
eMonitoring for Student Success (UMD)																			■		
Center for University, School and Community Partnerships (US DoEd-ECHO, UMD)	■	■	■											■	■	■	■		■		
SeaLab New Bedford Public Schools (NBPS)	■	■	■																		YES
The Connecting Oceans Academy (DoEd)														■	■	■	■		■		
WasteWater Resource Project (Westport River Watershed Alliance)	■	■																	■		
Kaput Center for Research and Innovation in Mathematics Education (US DoEd, MA DoEd, NSF)			■			■		■		■		■							■		
Louis Stokes Alliance for Minority Participation (NSF)				■		■	■	■	■	■	■	■									YES
The START Project (UMD Alternative Admissions)			■																		YES

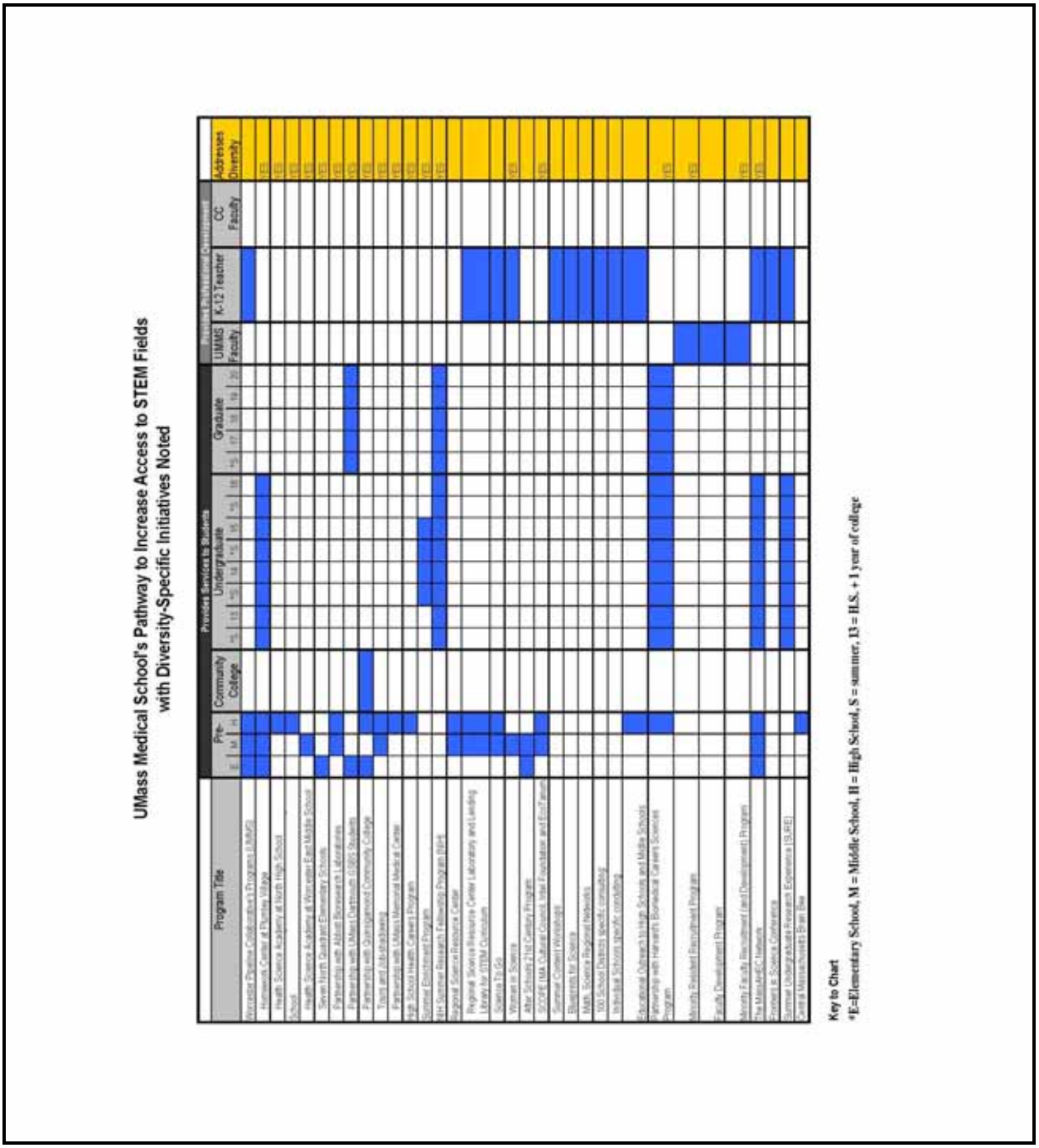
Key to Chart

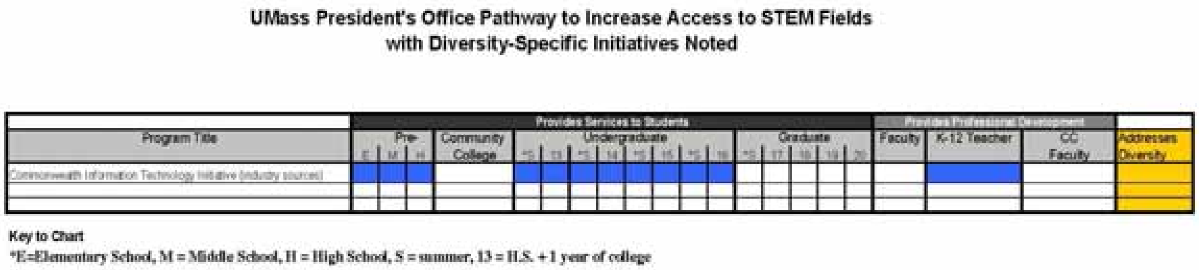
*E=Elementary School, M = Middle School, H = High School, S = summer, 13 = H.S. + 1 year of college

LOWELL CAMPUS



WORCESTER CAMPUS





UMass President's Office Pathway to Increase Access to STEM Fields with Diversity-Specific Initiatives Noted

	Provides Services to Students																	Provides Professional Development			
Program Title	Pre-			Community College	Undergraduate								Graduate					Faculty	K-12 Teacher	CC Faculty	Addresses Diversity
	E	M	H		*S	13	*S	14	*S	15	*S	16	*S	17	18	19	20				
Commonwealth Information Technology Initiative (industry sources)	🟦	🟦	🟦		🟦	🟦	🟦	🟦	🟦	🟦	🟦	🟦							🟦		

Key to Chart
*E=Elementary School, M = Middle School, H = High School, S = summer, 13 = H.S. + 1 year of college

❖ ATTACHMENT 6:
UMASS LSTF HEALTH, DISEASE AND BEHAVIOR WORKING GROUP'S REFERENCES

University of Massachusetts
Amherst • Boston • Dartmouth • Lowell • Worcester • UMassOnline
www.massachusetts.edu

UMass LSTF
Health, Disease and Behavior Working Group's References

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❖ ATTACHMENT 7:

SUMMARY OF ESTIMATED CAPITAL AND OPERATING ASPIRANT FUNDING REQUESTS FROM THE WORKING GROUPS[8]

Shared Infrastructure and Additional R & D		
Investment Area	**Estimated Capital (000s)**	**Estimated Annual Operating (000s)**
Human Embryonic Stem Cell Bank and Registry (Worcester)	0	1,400
Animal Stem Cell Bank and Registry (Amherst)	0	200
Flow Cytometry Facility (Amherst)	600	150
UMass Core Facilities Steering Committee	500	150
BL-3 Clean Rooms	1,500	0
High Performance Computing	3,856	150
System-wide Seminar Series	500	150
Working Group Total	6,956	2,200

Advanced Therapeutics Cluster		
Investment Area	**Estimated Capital (000s)**	**Estimated Annual Operating (000s)**
UMass Life Sciences Moment Fund	0	1,000
UMass Center for Clinical and Translational Science	0	200
Annual Meeting	0	20
Working Group Total	0	1,220

[8] Taken together, the working groups' budgets provide a general framework from which to quantify the UMass LSTF aspirant vision. In the coming academic year, further budget analysis is necessary to more fully define capital and operating funding requests.

Nanotechnology		
Investment Area	Estimated Capital (000s)	Estimated Annual Operating (000s)
Nanotechnology Core Facilities	2,000	0
Faculty Lines (7)	0	1,000
Industry-University Collaborative Grants	0	1,000
Industrial Liaison Office/Nano-Bio Database	0	100
Working Group Total	2,000	2,100

Technology Innovation Centers		
Investment Area	Estimated Capital (000s)	Estimated Annual Operating (000s)
Development of Innovation Centers	15,000	2,000
Working Group Total	15,000	2,000

Workforce and Policy Initiatives		
Investment Area	Estimated Capital (000s)	Estimated Annual Operating (000s)
Retention Programs	0	5,000
Undergraduate Scholarships/Graduate Stipends	0	20,000
Post-Doctoral Fellowships	0	2,000
Faculty Lines	10,000	0
Administrative and Support Staff	0	700
Infrastructure Enhancement	306,000	0
Paid Co-ops and Internships	0	18,500

Student Research Opportunities	0	1,000
K-12 STEM Initiatives	0	10,000
University Life Sciences Database	1,450	800
Evaluation Component	0	2,000
Working Group Total	317,450	60,000

Health, Disease and Behavior		
Investment Area	Estimated Capital (000s)	Estimated Annual Operating (000s)
Inter-campus Integrated Data Analysis System	10,100	0
Coordinated Centers for Translational Human Research	25,200	0
UMass Faculty Expertise Database	0	300
Annual 2-Day Conference on Health, Disease and Behavior	0	70
Health, Disease and Behavior Pilot Studies	7,500	5,000
Working Group Total	42,800	5,370

Grand Total	
Estimated Capital (000s)	Estimated Annual Operating (000s)
384,206	72,890