

Rice University Bioscience and Human Health Task Force: Recommendations for Achieving Excellence in the Biosciences.

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I. Executive Summary. It is difficult to understate the importance of biosciences for the future development of the United States, Rice University and for global development. Knowledge discovered through bioscience research will play a significant role over the coming years in improving human health, developing new and cleaner sources of energy, and technological innovation that will be applied to wide array of human endeavors.

The Bioscience and Human Health Task Force was asked to define focused areas in the biosciences that would draw on Rice's excellence in a wide array of fields across campus, and Rice's proximity to the world's largest contiguous medical center, to achieve preeminence in areas of biosciences that can lead to transformative change in human health and medicine. To do so, Rice must continue to build on its strengths in discovery science and engineering while also identifying emerging areas for the future. From this foundation the Task Force created a vision that drove our discussions: "The Task Force envisions a future where medicine is personalized and affordable with targeted and patient specific therapies. It is built from the bottom-up with a strong understanding of life and materials and is based on a deep understanding of the human mind, culture and ethics with a global reach. Furthermore, Rice has unique strengths not found in most medical centers in health economics, policy, and in areas of medical humanities that will help us understand the historical, cultural and ethical issues that pervade the provision of health care and cultural definitions of human health."

Using this vision as a guide, the Task Force followed a transparent and inclusive process. This process involved a detailed survey of the faculty, Task Force members acting as representatives of their units, and the iterative development of strategic plans in six themes by task force members working along with faculty members across the campus. At each stage of development, the Task Force sought input from faculty, Deans, and Chairs. The Task Force identified six areas that enjoyed exceptional faculty support and presented the clearest opportunities for excellence. The initiatives share a common emphasis on research and scholarship that reflects the uniqueness of Rice and our location within Houston and the Texas Medical Center (TMC).

Biosciences and Human Health Task Force Initiatives					
<u>Regenerative and Restorative Medicine (R2M)</u>	<u>Tools for Affordable Healthcare: The Road to Better Health and Wellness</u>	<u>Physical, Systems and Synthetic Biology (PSSB)</u>	<u>Health Informatics</u>	<u>Mind and Brain</u>	<u>Society, Culture and Medicine</u>

The Task Force believes that with focused, strategic, and realistic investments in initiative-specific combinations of new faculty, research infrastructure, postdoctoral fellowships, new umbrella graduate programs, and organizational leadership, that Rice could develop these initiatives into areas of excellence and possibly preeminence over the next five years.

The Task Force chose these initiatives based on several factors: 1) building on Rice's strengths as an institution, but also identifying new areas that will generate the intellectual capital for future innovation; 2) broad enthusiasm by Rice faculty; 3) the cross-disciplinary potential of the initiative; 4) the reality that discovery research and traditional academic scholarship underlie our research strength; 5) leveraging assets in the TMC; and 6) initiatives had to be in areas where Chairs and Deans seemed willing to commit resources. The Task Force identified 31 departments/units at Rice that would participate in a significant way in one or more of these initiatives.

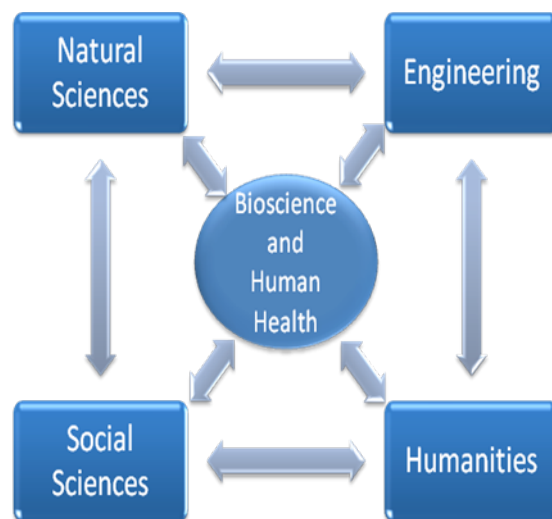
The Task Force unanimously recommends these six initiatives as those that the Rice community should consider for further analysis and discussion. Taken together, they build across the Rice community in a manner that will be exceptionally synergistic for the biosciences and lead to an environment of scholarship that is truly transformative. We believe that these initiatives should catalyze further debate and refinement by the Rice community and can form a foundation for increasing Rice's academic profile and should be attractive for fundraising from a wide array of sources.

II. The Initiatives: Building on our strengths of the present and identifying emergent strengths for the future.

What is Rice's vision for achieving excellence in Biosciences and Human Health?

On a broad scale, Rice excels in fundamental science, engineering, humanities and social science research. In order to capture our vision for the future, Rice must leverage its strengths with the institutions that do translational and clinical medical research, but not try to become them. Furthermore, Rice prides itself on basic discovery research across the sciences, engineering, humanities and social sciences and thus discovery research must be at the heart of the initiatives. Truly transformative ideas from discovery science lay the foundation for new treatments, technologies and policies.

To reach our goal of achieving preeminence in areas of biosciences that can lead to the envisioned future of human health and medicine, Rice must continue to build on its strengths while also identifying emerging areas. Rice has a renowned foundation in materials research¹. From this foundation Rice has built excellence in nanotechnology, new sensors, biomaterials used in tissue engineering, materials that enhance diagnostic and treatment of diseases. This has helped lead to the Rice Bioengineering Department being recognized by US News and World Report as having a top 10 graduate program. Rice has also developed excellence in computational sciences across the campus and, partly because of a new partnership with IBM, has a powerful computational infrastructure to support computational research in the life sciences². These strengths played to the to the development of the Task Force's vision - We envision a future where medicine is personalized and affordable with targeted and patient specific therapies. It is built from the bottom-up with a strong understanding of life and materials and is based on a deep understanding of the human mind, culture and ethics with a global reach. Furthermore, Rice has unique strengths not found in most medical centers in health economics, policy, and in areas of medical humanities that will help us understand the historical, cultural and ethical issues that pervade the provision of health care and cultural definitions of human health.



¹ For example, Rice was ranked #1 in the Times (of London) Higher Education analysis of citations per paper

²Academic Analytics (in 2008) ranked four of Rice's graduate programs in these areas in the top 10 (Computer Science #1; Electrical Engineering #1; Computer Engineering #4; and Computational Science #10. IBM recently confirmed Rice's strength in moving computational life sciences forward by investing over \$9M in a partnership relating to the use of its newest supercomputer for biomedical research (BlueBioU project)

II.A. Building on strengths in materials.

From our pre-existing strengths in materials and basic discovery science, the Task Force sees several areas for growth that broadly encompass two important areas of human health that complement the work of our colleagues in the TMC:

- 1) **Regenerative and Restorative Medicine (R2M) Initiative.** The R2M initiative links basic strengths in developmental biology, with materials, bioengineering, sensor development and a host of economic, social, cultural and ethical issues that surround regenerating tissues.
- 2) **Tools for Affordable Healthcare: The Road to Better Health and Wellness**
Advanced tools for appropriate affordable health care that build on Rice strengths in materials and nanotechnology with strengths in engineering and economics, social policy, and cultural understanding of how new technologies are accepted and used in various cultures.

II.B. Areas of Emergent Strength: Building the Future.

In addition to current areas of strength the Task Force has identified critical areas of emergent strength that will lay the foundation for future success across the biosciences. These emergent areas provide vitality and new intellectual force that will translate across campus much in the same way that basic materials discoveries in nanotechnology laid the foundation for a wealth of new initiatives in many departments outside Chemistry. Each of these emergent areas were developed by groups of enthusiastic faculty and met the Task Force criteria for expansive ideas that included many departments while remaining focused on specific and measurable research objectives. These emergent areas also complement rather than duplicate ongoing research efforts in the TMC and allow us to make the best use of our talented and diverse faculty.

II.C. Building on strength in computational and quantitative sciences.

- 3) **Physical, Systems and Synthetic Biology Initiative (PSSB)** is a new area that takes a systems or 'holistic' approach to complex biological phenomena such as cancer and drug resistance. This new area is an integration of biology with chemistry, physics, mathematics and computer science to study the emergent properties of biological systems not revealed by the individual components. The area of Physical, Systems and Synthetic Biology is rapidly becoming one of the most important areas of life sciences this century and will directly impact biomedicine and biotechnology.
- 4) **Health Informatics Initiative** The ability to manage, utilize, and find patterns in the vast array of patient and societal health information is a major computational challenge that builds on Rice expertise and is badly needed by the medical community. Rice has an historical strength in computational sciences. This gives Rice strong physical infrastructure and skills to help develop the basic computational tools to drive personalized medicine and

biological insights. Additionally, the use of such data, and its costs, raise large ethical, economic, policy and social issues that play to Rice's strengths in the medical center.

II.D. Emerging areas building on strength outside science and engineering.

The Task Force also identified two additional emergent areas that build on strengths in areas outside of the natural sciences and engineering but complement those strengths in addition to the strengths across the TMC.

- 5) **Mind and Brain Initiative** The mind and the brain are major frontiers in medicine. The TMC is filled with strong research programs in biologically-based neuroscience and in clinical research in psychiatry. Yet what links these two areas, an understanding of cognition and self, is the link between understanding the biology of neurons and clinical treatment of the mind. This focus on cognition is an emerging area that can tie intellectual communities across Rice and leverage the clinical research efforts of the TMC.
- 6) **Society, Culture and Medicine.** Humanistic scholarship approaches the questions surrounding human health and biomedicine on its own terms. These approaches can transform our perspectives of ourselves and thus how we deal with designing health care systems. But, those questions sometimes need to be the core of study and not an appendage to scientific ideas (e.g., the research to understand how societies accept new technologies must be framed in the scholarly methods and approaches of cultural anthropologists). This is a unique strength that Rice brings to the medical community.

III. Defining the Rice research environment: Rice University must complement, and not compete, with the TMC: The TMC is an incredible asset to biosciences at Rice. The collaborations and research opportunities afforded to both faculty and students are outstanding. Rice brings unique strengths to the TMC and the Task Force felt that the new initiatives should complement rather compete or emulate TMC research areas.

1. The Task Force recognized that Rice must leverage its proximity to, and membership in, the Texas Medical Center (TMC) and not try to compete directly with TMC institutions.³ The Task Force believes that investment by Rice in key areas that leverage Rice's distinctive strength across the natural sciences, engineering, humanities, social science and business with the TMC's biomedical enterprise is a strong strategy for Rice to take toward preeminence in the Biosciences and Human Health area.

³ The TMC is the world's largest contiguous medical center. Its member institutions annually conduct approximately \$1,000,000,000³ a year in biomedically oriented research; are staffed by approximately 20,000 physicians, scientists, researchers and other professionals with advanced degrees in the life sciences, in addition to 2,000 international visiting scholars, scientists, researchers and other workers, and 75,000 students. Rice University has a research volume of approximately \$100,000,000 with around 800 faculty.

2. Given the size and scale of the TMC research portfolio, what is the appropriate scale of "preeminence" in academic programs for Rice? How does Rice make important contributions to some of the big problems in biosciences such as global health, cancer and cardiovascular disease? As in so many things, valuable insights can come from looking at our experiences as a university and combining them with our vision for the future. For example, both nanotechnology and computation are Rice strengths that have their origins in discovery science and innovation. Transformative ideas and applications are the currency of universities. Selective investments in areas with the potential to be transformative are the basis for success in academia. Thus, the themes ultimately recommended by the Task Force tried to balance the issue of scale by: (1) inherently recognizing that each theme will take extensive collaboration and leveraging the resources in the TMC; (2) each theme is based on inherent strengths that Rice has or can reasonably attain; and (3) each theme draws on intellectual resources across the Rice campus. Rice will not become, nor should it desire to become, a world renowned cancer center like M.D. Anderson, rather we should partner with the TMC to innovate unique ideas based on our strengths in areas like materials, computation, social sciences and humanities.

IV. How did the BSHH Task Force identify these initiative areas?

For Rice to play a significant role in reaching our vision for a strong biosciences community, the Task Force sought to identify our current strengths as an institution and new areas that will generate the intellectual capital for future innovation. The initiatives identified by the Task Force grew out of conversations with individual faculty, Deans, Chairs, Institute and Center Directors as well as a survey of the entire faculty to solicit their ideas and level of enthusiasm. After ideas were identified, the Task Force then went on to focus on areas in which faculty, Chairs and Deans were willing to commit energy and resources to build interdisciplinary programs across departments and schools that included new faculty, curriculum and research infrastructure.

Two fundamental principles that the Task Force adhered to from the beginning were: (1) there would need to be a high degree of enthusiasm, interest and support among existing Rice faculty in order for an initiative to be successful, even if a given initiative would involve recruiting new intellectual talent to campus; and (2) At the early stage of identifying themes, the Task Force felt that it was important to be inclusive-- to gather as many ideas as possible and to try to integrate those ideas into our recommendations, not to exclude them unless such exclusion was strongly supported by rigorous analysis of data.

Guided by these principles, the Task Force sought to survey the faculty regarding: (1) the potential themes in Bioscience and Human Health that made the most sense for Rice; (2) the enthusiasm for faculty to participate in various themes; (3) potential competitor institutions in various themes; and (4) general comments from the faculty on barriers to achieving success in a given theme, and comments about the process. To produce a focused survey, task force members first informally discussed possible focal themes with faculty, chairs, and deans, particularly in their representative units (Task Force members were asked to act as representatives of

their constituencies). Based on that data, a survey was constructed that enumerated several potential "themes" and was sent to all faculty. The survey also asked for ideas that may have been overlooked or for general comments to aid in the process of defining the areas of interest. The responses (over 200) were compiled and posted on the web with provisions for feedback either anonymously through the website or directly to a Task Force member.

After analyzing the results of the survey, BSHH developed a set of white papers/strategic plans that are included as appendices to this report. The white papers/strategic plans were based on the following additional principles:

- Initiatives have to develop a vibrant intellectual community that can discover new ideas and principles, translate those new ideas and principles into the next generation of applications for medicine and biotechnology and understand the social and cultural impacts of these advances.
- For Rice to play a significant role in reaching this vision, Rice must not only build on our strengths as an institution, but also invest in new areas that will generate the intellectual capital for future innovation.
- BSHH focused on areas in which Deans and Chairs demonstrated a willingness to commit resources to build interdisciplinary programs across departments and schools that included new faculty, curriculum and research infrastructure.
- Rice prides itself on basic discovery research across the sciences, engineering, humanities and social sciences and thus discovery research must be at the heart of the initiatives. Truly transformative ideas from discovery science lay the foundation for new treatments, technologies and policies.

Based on these results, the task force worked through a process that identified six themes based on an integration of ideas received from faculty members. BSHH members constructed strategic plans for each theme (see Appendices) based on Rice's distinctive strengths and future potential. These papers addressed: (1) Where are we now? -- how strong are we? Are there any metrics we can use to compare? What is our current status? (2) What do we need to do to get to the next level? (3) Do we have the leadership here at Rice or would we need to bring it in from the outside? (4) What are the key departments at Rice for this initiative and have those departments identified the area as a priority? After careful analysis the Task Force decided to put all six themes forward to the campus.⁴

⁴ BSHH was originally tasked with developing two- three initiatives. We envisioned that we would narrow to this number by conducting a data-driven analysis of all the ideas, drawing on key quantitative metrics such as publication impact, research funding, facilities, faculty awards, unique facilities, etc. and through this analysis we would be able to articulate a convincing rationale for narrowing further. During the course of our analysis we recognized that: (1) such a data-driven analysis was not going to be possible given the time constraints; (2) such a data-driven analysis was going to be difficult given the diversity of ideas we received and the difficulty in getting comparative data from other institutions; (3) narrowing themes beyond the six without a convincing data-driven analysis, could be counter-productive in moving forward in the campus process; and (4) we simply felt we had

V. How will the success of these initiatives be measured? We defined success as making Rice University an internationally recognized center for a specific area of scholarship. We want students from Boston to Beijing to think of Rice as the place to go for these areas. We want scientists and engineers from across the world to think of Rice as a center for these focused areas of research much as they think of Rice now and associate it with materials and nanotechnology research. We want foundations and government funding agencies to identify these areas of research with Rice such that Rice faculty in collaboration with their TMC partners can build large and successful research portfolios.

The diverse scholarship underlying each initiative means that we cannot use a 'one size fits all' set of metrics, however, it is clear that in most cases the number and quality of grants, publications, patents and graduate and postdoctoral trainees are important measures of success. Most importantly though is the notion of international and national recognition for programs of distinction at Rice. While it is difficult to measure international prestige in specific programs the quality of students and postdoctoral fellows will reflect our success, and in turn, the ability to attract the best and brightest will further add to our success.

VI. The next step. Although each of these initiatives have unique implementation plans and require different scales of resource investment there are several general themes that emerged across nearly all the areas. **1) Faculty Hiring.** Any meaningful programmatic development of these initiatives will require increased faculty participation and hiring. We recognize that in this difficult budgetary period resources are limited and therefore one of the central goals of this Task Force was the identification and development of initiatives where our resources would have the greatest impact both near and long term. **2) Postdoctoral fellowships.** There is a recognition that talented postdoctoral fellows are a critical component to research success. As government funding levels will likely remain static over the next several years we have the opportunity to capitalize on the increasingly large pool of outstanding scientists, engineers and scholars. A university wide Rice Fellows Program could link task force initiatives and build a community of scholars that would immediately accelerate our success. One of the distinct differences between Rice and universities like Harvard, Yale, Berkeley and Princeton is the absence of prestigious fellowship programs that bring the best and brightest to work with our faculty. In addition, postdoctoral fellows act as powerful ambassadors for building the international reputation of Rice. Upon completion of their fellowships these scholars will build their own research programs throughout the world but will always associate their success with Rice as will the schools, agencies and companies that employ them. **3) Research Infrastructure.** In some cases there are specific infrastructure requirements but all of these ideas require sufficient administrative resources to accompany their development. We want faculty to develop and lead in the most creative and efficient manner without further encumbering them. The reward for leadership should be the opportunity to build with the necessary resources for success. To lead an initiative, vision,

developed a set of six really compelling ideas that were of the quality that they deserved a deeper analysis and broader discussion across the campus

creativity and time are required. We should not squander these limited faculty resources on burdensome administrative tasking when professional staff in appropriate Institutes, Centers, departments and offices can do a better job in the construction and administration of research. 4) **Curricular Innovation.** Some of themes explicitly mention the need to think about curricular innovation with respect to new courses; new educational partnerships across campus and between the campus and the TMC; and the potential development of cross departmental graduate programs.

VII. Recommendations. We unanimously recommend these proposed themes as we believe they are truly meritorious. Taken together, they build across the Rice community in a manner that will be exceptionally synergistic for the biosciences and lead to an environment of scholarship that is truly transformative. One of the primary Task Force considerations was to build initiatives that could have outstanding success within 3-5 years. We believe that this group of initiatives are expansive, intellectually ambitious and worthy of investment.

VIII. Initiative Summaries. We have included additional descriptions of these initiative areas to foster further discussion of their scholarly impact. They are ordered as in the main text. Each plan was written from conversations with their constituencies and reflects the unique voice of the participating faculty. The more detailed strategic plan for each initiative are provided as Appendices.

Bioscience and Human Health Task Force: Summary of Regenerative and Restorative Medicine Initiative

The basis of the initiative

Regenerative and Restorative Medicine is a rapidly growing multidisciplinary field involving the life physical and engineering sciences that seeks to repair, replace or enhance biological function that has been lost due to congenital abnormalities, injury, disease, or aging either through 1) regeneration of tissues or organs, or 2) development of functional substitutes. When the functional outcomes that restore quality of life are incorporated into this field, restorative medicine completes the cycle.

Where are we now?

Rice scientific expertise and technologies in regenerative medicine and its related basic science discipline developmental biology already exist but are not well integrated. Broadly defined, this includes work at the cutting edge of nanotechnology (6 departments), bioimaging/optics (4 departments), tissue engineering, neuroscience and developmental biology (5 departments), biocomputing/statistics/quantitative biology (11 departments), biomarkers development (5 departments) and therapeutics/medicinal chemistry (8 departments). Research efforts are complemented by Rice strengths in health policy at the Baker Institute, in cognitive science, and in the medical humanities since regenerative medicine involves controversial and complicated social issues (e.g., stem cells). Institutions in the Texas Medical Center provide vast resources for translating work at Rice into clinical application.

Potential participating departments

Biochemistry and Cell Biology, Bioengineering, Business, Chemical and Biomolecular Engineering, Chemistry, Psychology, Computational and Applied Mathematics, Computer Science, Ecology and Evolutionary Biology, Electrical and Computer Engineering, Kinesiology, Mechanical Engineering and Materials Science, Music, Physics, Policy Studies, Sports Management, Statistics.

Needs over the next five years

- Development a fully functioning, staffed regenerative medicine vivarium
- Infrastructure for training of research staff in human subject protections, bloodborne pathogens, and biosafety
- Research agreements with partner institutions in the TMC
- Expanded library resources
- Establish strong leadership team
- Consider moving developmental and neuroscience teams to space in BRC
- Postdoctoral training program (externally funded) with IBB and with TMC
- Develop Faculty hiring strategy via a steering committee representing the various disciplines and departments involved.
- Develop a graduate level interdisciplinary curriculum in developmental, physiological and tissue sciences
- Develop interdisciplinary undergraduate program with concentration in this area.

Bioscience and Human Health Task Force: Summary of the Tools for Affordable Healthcare Initiative

The basis of the initiative

Have you noticed computers that get more powerful – and less expensive – every year? There's no reason the same can't be true for healthcare tools. This is the basis for the "Tools for Affordable Healthcare" initiative. The goal is to that will bring better and more cost-effective diagnostics, biomaterials and advanced image contrast agents to the world and is based on the pioneering work in the development of, programmable sensors and scalable personalized health devices by Rice researchers. This initiative also incorporates key aspects of economics and business. Economic evaluation is an essential tool for assessment of the costs and benefits of novel medical devices and contrast agents. Economics research is also crucial for studying the broad range of issues influencing the development and dissemination of new medical technologies in both the developed and underdeveloped parts of the world. Additionally, the success of translating these scientific advances into practice is contingent on a strong set of business and management skill.

Where are we now?

Rice's Bioengineering Department is ranked in the top 10. Rice 360 and Beyond Traditional Borders provide for student engagement in the development and dissemination of technologies for affordable health care. Rice University scientists have developed "programmable bio-nano-chip sensors" capable of sophisticated measurements of present in bio-fluid samples, such as blood, urine and saliva. Last year alone, \$13M in research funding for these programs was secured and six new clinical trials were launched. Rice has also developed a strong track record in health economics through the Baker Institute and the economics department, and a strong program in the Jones School in Health Care and Entrepreneurship.

Potential participating departments

Bioengineering, Chemistry, Jones School of Business, Baker Institute, Economics, Electrical and Computer Engineering, Physics, Biochemistry and Cell Biology, Chemical and Biomolecular Engineering, Computer Science, Statistics and Rice 360°.

Needs over the next five years

- Complete the construction of Microfluidics Microfabrication Collaborative (MIMIC) rapid prototype facility
- Hire an Executive Director for the initiative
- Complete hiring of two science-engineering junior faculty; hire three junior faculty members with expertise in health economics, and Hire a faculty in business with expertise in healthcare and biotechnology
- Create collaborations/conferences/short courses to nucleate new projects – these should leverage the TMC
- Create a Rice University Center on Scalable Personalized Health

- Create the Rice Advanced Diagnostics Center

Bioscience and Human Health Task Force: Summary of Physical and Systems Biology (PSSB) Initiative

The basis of the initiative

PSSB is a new discipline that combines approaches of systems and synthetic biology with Rice's traditionally strong biophysical research area to build a complete and quantitative approach to the study of highly complex biological problems. This is a highly interdisciplinary area that combines biology with chemistry, physics, mathematics and computer science. PSSB is rapidly becoming one of the most important areas of life sciences this century and is an area of explosive growth. Within the next 50 years we are likely to see a dramatic shift in manufacturing and medicine to much more biologically based technologies and discoveries. While the recent period has been called the Information Age the next period will be a Biological one in which bacteria and cells are engineered to produce new medicines, biofuels and materials. Before we can reliably re-engineer cells, we must understand how to speak the language of life. While DNA is the language of all life, as scientists we struggle to read and write stories of any real sophistication. PSSB is at the heart of reading, understanding and using this elegant language to construct and deconstruct genetic circuits that will allow us to determine how cells operate, interact with each other, and adapt to their environment. PSSB provides the basis and actionable strategies for understanding the entire range of biomedical and biotechnology related problems from human diseases and their treatment, to biologically inspired materials for biotechnology including the production of novel medicines and biofuels.

Where are we now?

26 faculty have identified themselves with this initiative across many departments. Rice has an outstanding core group of young Assistant and Associate Professors across the Schools of Natural Sciences and Engineering. We are comparable in size to some of the best units in the country. It is very unusual for Rice to have a faculty group of comparable size to such institutions as Harvard and Princeton. This occurred because the departments of Biochemistry and Cell Biology, Bioengineering, and Chemical and Biomolecular Engineering all identified PSSB as an area of importance and began hiring in those areas independent of each other.

Potential participating departments

Biochemistry and Cell Biology, Bioengineering, Chemical and Biomolecular Engineering, Chemistry, Computer Science, Ecology and Evolutionary Biology, Statistics

Needs over the next five years

- Recruit at least one to two professors at the Associate/Full Professor level and continue hiring of junior faculty member
- Postdoctoral Fellows Program in Physical, Systems and Synthetic Biology.
- Ph.D. Graduate Program in Physical, Systems and Synthetic Biology.

- Actively engage in national conference and community networking.
- Further develop undergraduate curriculum

Bioscience and Human Health Task Force: Summary of Health Informatics Initiative

The basis of the initiative

Health informatics is a discipline dealing with the acquisition, organization, storage, and analysis of clinical or medical data associated with the healthcare of individuals or populations. The volume of this data is increasing dramatically due to a proliferation of methods for generating this data. Electronic databases of medical records and clinical trials are becoming ubiquitous. Medical sensors and mobile medical devices are generating streams of new and under-utilized data.

Health informatics incorporates a wide range of activities and disciplines. Just at Rice, these include: 1) Privacy and security analysis for data and databases; 2) Machine learning method to spot trends to healthcare data; 3) Data mining techniques to improve healthcare practice; and 4) Database methods for organizing healthcare data

Where are we now?

Most health informatics programs are based in medical schools or health science centers. This presents Rice with four opportunities : 1) given the relative lack of involvement from the computer science and engineering community, much of the work in the area has been mostly limited to software development, or to the application of standard, widely-used computational methods to problems in the field and have not coordinated with development of both cutting-edge hardware and software for health informatics; 2) Rice's research environment is highly complementary to that of medical and public health; 3) Rice has departments and institutes that cover the computer science, engineering, social science, business, and policy elements of health informatics; and 4) Rice's geographic proximity to the Texas Medical Center allows direct access to the data that might otherwise be restricted and provides a highly motivated set of consumers of expertise on health informatics.

Potential participating departments

Key Departments: Bioengineering, Computer Science, Electrical and Computer Engineering and Statistics. Other Departments: Anthropology, Economics, Sociology, Linguistics and the Baker Institute

Needs over the next five years

- Hire a senior national leader in health informatics
- Hire approximately four junior faculty members in this area
- Develop graduate and undergraduate programs in health informatics
- Secure an externally funded national center in health informatics

Bioscience and Human Health Task Force: Summary of Mind and Brain Initiative

The basis of the initiative

The mind and the brain are major frontiers in medicine. The TMC is filled with strong research programs in biologically-based neuroscience and in clinical research in psychiatry. Yet what links these two areas, an understanding of cognition and self, is the link between understanding the biology of neurons and clinical treatment of the mind. This focus on cognition is an emerging area that can tie intellectual communities across Rice and leverage the clinical research efforts of the TMC.

Where are we now?

Current research at Rice dealing with the mind and brain is very active but lacks a unifying multidisciplinary mechanism. Tied in with these research efforts is a growing interest at Rice in the neurological basis of cognition. Fifteen years ago, the Psychology department had one faculty in cognitive neuroscience; now it has seven. Faculty in Biochemistry and Cell Biology, Bioengineering, Electrical and Computer Engineering and Mechanical Engineering and Material Science conduct research in cognitive neuroscience. Several departments are dedicating new faculty hires in this area. For instance, the Linguistics Department has an upcoming replacement position designated for Laboratory Phonology, an inter-disciplinary activity that involves both cognition (the perception and production of speech) and the physical side (the organs of speech and hearing). Several faculty have secured seed funding from the Dunn Foundation for a Center for NeuroEngineering. But, because research is dispersed across campus and numerous departments, a coherent assessment and prediction of Rice's standing in the area of mind and brain is challenging.

Potential participating departments

Psychology, Linguistics, Bioengineering, Electrical Engineering, Computational and Applied Mathematics, Philosophy, Economics, Political Science, Anthropology, English and Music

Needs over the next five years

- Create an organizational unit patterned after the Humanities Research Center
- Hire an Executive Director with a strong vision of for the Mind and Brain center and a long-term commitment to developing it
- Provide staff support with administrative, granting and fund-raising duties
- Strategic senior and junior faculty hires with strategic input from director of center
- Four 3-year post-doctoral fellowships
- Seed funding for inter-disciplinary and inter-institutional collaborations
- Dedicated office and research space located conveniently to the TMC. The BRC would be ideal for this purpose.

Bioscience and Human Health Task Force: Summary of Medicine, Culture and Society Initiative

The basis of the initiative

There are profound multidirectional interactions between developments in medicine and its underlying life sciences and developments in the culture and structure of society, with each shaping and being shaped by the other. For example, developments in reproductive medicine have greatly modified the structure and meaning of sexuality, marriage and the family while changing interpretations of the good life and of dignified death have profoundly affected the practice of medicine at the end of life (e.g., the rise of palliative care). The goal of this initiative is to create a center that systematically teaches about, and studies, these interactions.

Where are we now?

Rice's major advantage is our proximity to, and already existing relations with, the Texas Medical Center and other prestigious cultural institutions in Houston. These include: M.D. Anderson (already working with Marcia Brennan on Palliative Medicine and Kirstin Matthews on medical research and society), Baylor's Center for Medical Ethics (already in a formal relation with Rice Philosophy), Texas Children's Hospital (already working with Kirsten Ostherr on medical media projects and Rachel Kimbro on nutrition projects), UTHSC's McGovern Center (already working with several faculty members in Religion and English) and UTMB's Institute for Medical Humanities (already working with Kirsten Ostherr). There are also real possibilities of continued interaction with the Museum of Fine Arts Houston and with The Menil Collection, along the lines of the collaborative research symposia and lecture series recently undertaken by Marcia Brennan.

Potential participating departments

Anthropology, Art History, English, History, Philosophy, Psychology, Religious Studies, Sociology and from the staff of the Baker Institute.

Needs over the next five years

- Strengthen and expand current undergraduate course offerings that take innovative multidisciplinary approaches.
- Enhance research efforts of individual faculty members working in this area by providing new resources
- Promote more collaborative research projects among faculty members and expand research into new areas through seed funding
- Hiring several (three) strategic junior faculty in this area
- Develop opportunities for postgraduate (MD/PhD and postdoctoral) training by providing stipends in a focused program
- Develop special activities that give Rice national prominence, such as sponsoring national/international conferences and working groups addressing specific issues and bringing notable scholars to Rice