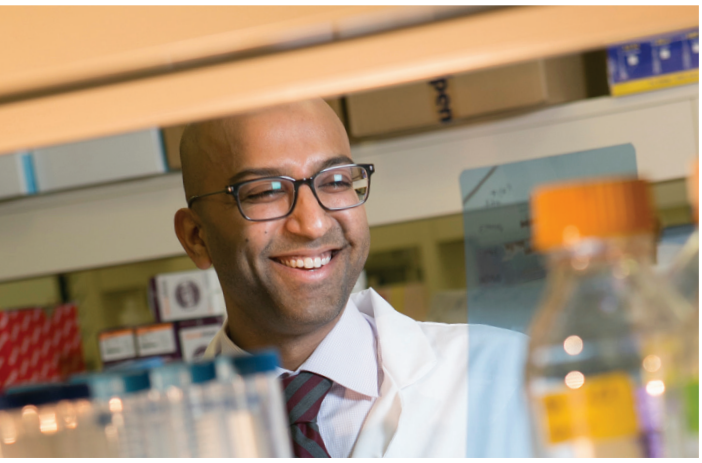
Strategic Plan 2018-2023



RESEARCH

EDUCATION

CLINICAL CARE

COMMUNITY

Stony Brook
School *of* Medicine

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On the cover: Sandeep Mallipattu, MD, DCI-Liebowitz Associate Professor of Medicine, and Chief, Division of Nephrology and Hypertension, Stony Brook University School of Medicine, whose research focuses on identifying mechanisms involved in the progression of chronic kidney disease.

School of Medicine Strategic Plan: Our Vision and Mission

Stony Brook Medicine has achieved a great deal since the publication of its last strategic plan – establishing partnerships with more community doctors and affiliations with hospitals and healthcare systems throughout the region; expanding its ambulatory and specialty care footprint geographically; diversifying and raising the quality of its student body and workforce; growing its research portfolio, particularly within the scientific disciplines identified in the previous strategic plan; and improving internal communications and the fiscal stability of its academic and clinical departments. And, Stony Brook Medicine will open two new buildings – a 150-bed hospital tower, the new home of Stony Brook Children's Hospital, as well as the Medical and Research Translation Building, which will be the new home of Stony Brook University Cancer Center, placing Stony Brook at the cutting edge of both research and healthcare delivery.

Over the next five years, we will build on this progress in the clinical enterprise, our research and educational initiatives, and our community outreach. This ambitious – yet achievable – plan sets forth the goals of Stony Brook Medicine for the next five years and the ways by which we will achieve them. This strategic plan was formulated based on the participation of approximately 150 faculty members across its four sections, as well as being based on the responses to questionnaires returned from 350 faculty members. And while the plan is organized as its predecessor, in the order of research, education, clinical and community outreach, and the relative length of each section very different, this should not be construed as reflecting relative importance or attention paid.

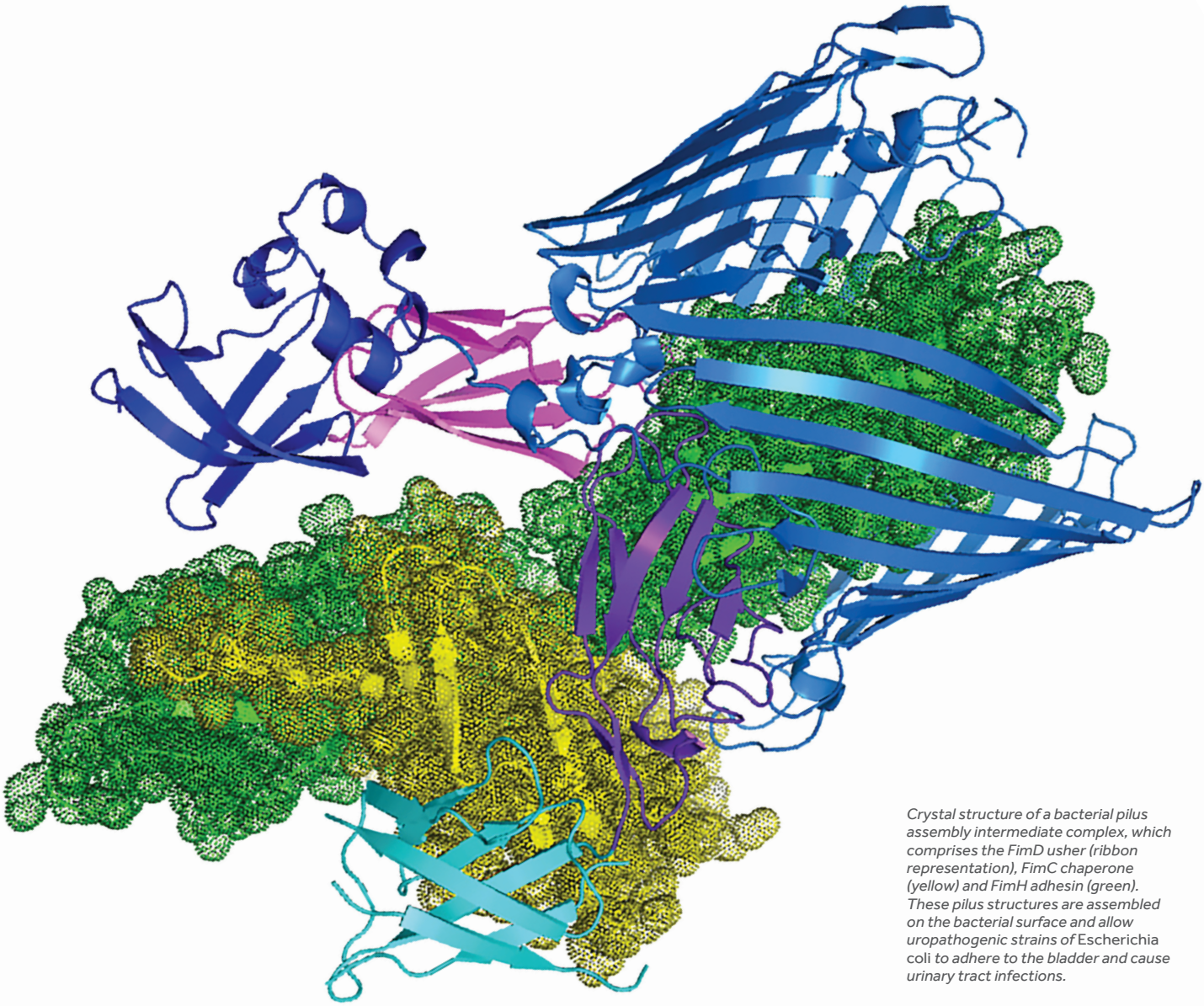
The 2018-2023 Stony Brook Medicine Strategic Plan begins with vision and mission statements that will help guide us as we continue to build upon our recent achievements.

VISION

Over the next five years, Stony Brook Medicine will become an integrated health system at the intersection of academic and community-based medicine, distinguished by unparalleled excellence and innovation in clinical care, as well as a commitment to advance population health. Stony Brook Medicine will lead the region in pushing forward the frontiers of biomedical research, by marrying engineering and medicine, bringing new insights into the origins of human health and disease, and translating that new knowledge into advanced diagnostics, treatments and prognostication for our patients. And Stony Brook Medicine will train a new generation of compassionate and caring physicians, who excel in both the art and science of medicine.

MISSION

Stony Brook Medicine will play a role as both a regional population health manager and broader destination for select high-demand clinical services. Stony Brook Medicine will work to have one, unified and inclusive culture where a diversity of physicians, administrators and staff across all Health Sciences schools work toward the same end. Stony Brook Medicine aspires to be recognized regionally and nationally for its innovative approach to the science of medicine, unparalleled quality outcomes and patient experience, and for the healthcare professionals we produce.



Crystal structure of a bacterial pilus assembly intermediate complex, which comprises the FimD usher (ribbon representation), FimC chaperone (yellow) and FimH adhesin (green). These pilus structures are assembled on the bacterial surface and allow uropathogenic strains of Escherichia coli *to adhere to the bladder and cause urinary tract infections.*

The **Research Enterprise**

Proposed Research Themes and Their Integration into Educational Activities, Community and the Clinical Enterprise

Several major and minor research themes are proposed for strategic development in the School of Medicine. Innovation in medical education, clinical care and community engagement will be integrated around these research themes. The current status of each theme within the School is reviewed, and strengths and weaknesses are duly noted. Feasible timelines are suggested along with anticipated resource needs and specific recommendations for fostering the success of each theme.

An Integrated Program in Infectious Diseases and Immunology

OVERVIEW

Stony Brook University is recognized for its leadership in microbiology and infectious disease research. The Department of Molecular Genetics and Microbiology, along with the Center for Infectious Diseases, has a history of excellence with outstanding scholarship focused on viral, bacterial and fungal pathogens, and the host response to infection with these agents. Clinical infectious disease research is a critical component of Stony Brook Medicine, and ties between clinicians and basic scientists have been strengthened with the recruitments of Dr. Vincent Yang as Chair of the Department of Medicine and Dr. Bettina Fries as Chief of the Division of Infectious Diseases. Immunology is a key discipline that ties together basic and clinical research and impacts multiple areas within the School of Medicine. Immunology is a key discipline that ties together basic and clinical research and impacts multiple areas within the School of Medicine. Immunology is critical to advancements in understanding the host-pathogen interface, cancer biology, and gastrointestinal disorders among many other disorders of human health. With the recent recruitments of two assistant professor-level immunologists to the Department of Molecular Genetics and Microbiology, a number of clinical and translational investigators to the Department of Medicine and the development of a state-of-the-art animal biosafety level 3 (BSL3) laboratory (Laboratory for Comparative Medicine) and an animal and human imaging capacity that is second to none, Stony Brook Medicine can now be characterized as possessing a nascent critical mass of investigators and infrastructure, poised to become a world-class program.

The Theme on Infectious Diseases and Immunology has the goal of building on our existing excellence in microbiology and infectious diseases, strengthening our expertise in immunology, and enhancing ties between the basic and clinical sciences to further cross-disciplinary efforts that generate both fundamental knowledge and the translational research required to improve healthcare treatments and outcomes.

Maintenance of existing strengths in infectious diseases, along with the addition of faculty in underrepresented areas, such as immunology, emerging multidrug-resistant bacteria and vector-borne diseases, will allow us to build upon our creative programs in this realm of biomedicine. Integration of the infectious disease enterprise with new faculty who excel in immunology and related fields will create an extraordinary nucleus of excellence that will positively impact multiple areas within the University. By linking infection research with immunology, synergistic new areas of investigation into microbial pathogenesis will be developed. Research on pathogenesis and host responses to infection will be the bridge to translational research in the clinical departments, providing a foundation for studies on disease treatments and drug discovery, and the development of novel therapeutics. A major goal of this theme is to generate the faculty expertise and institutional resources necessary to grow multi-investigator (program project) collaborative research efforts. These could be directed in several areas: microbial pathogenesis and host responses to infection (taking advantage of new immunology expertise); BSL3 pathogens and vector-borne organisms (taking advantage of the Laboratory for Comparative Medicine); and development of novel therapeutic strategies to prevent/treat infections and combat antimicrobial drug resistance.

CURRENT STATUS

The Department of Molecular Genetics and Microbiology, the Center for Infectious Diseases and the Departments of Medicine and Pediatrics have made major contributions to infectious disease research at Stony Brook Medicine. This research orientation is founded upon a multidisciplinary approach to infection that includes studies on both the pathogens and the

elicited host responses. There has been a commitment to the promotion of collaborative scientific interactions and the development of interdisciplinary activities among basic and clinical scientists. Stony Brook has had a distinguished history in the study of infectious diseases that serves as the starting point for this theme. Investments by Stony Brook Medicine in the areas of imaging, informatics, and metabolomics provide critical resources for our continued success. Construction of the Laboratory for Comparative Medicine has been completed. This state-of-the-art facility will permit the study of highly virulent organisms in vivo, coupled with unique resources for aerosol delivery of infectious agents and experimental therapeutics, animal imaging and the study of vector-borne diseases. This facility will enable exciting new research and will serve as an important regional resource.

Faculty members who focus on infectious disease research have been very productive over the past several decades as measured by securing extramural research funds to the School of Medicine. While the research funding levels for infectious diseases represents an important benchmark supporting the strength of this theme, it is equally important to stress the significance of the investigations that have been carried out within the School. Previous accomplishments notable for their worldwide impact include the discovery of the etiologic agent of Lyme disease, the first sequence of the entire poliovirus genome and the subsequent assembly of a synthetic infectious viral particle and the large clinical trial of integrase inhibitors against HIV infection.

Although the infectious disease enterprise at Stony Brook has thrived, immunology remains underdeveloped and a critical mass is lacking. Therefore, this theme seeks to build upon an outstanding Infectious Disease enterprise and expand our current investments in Immunology. The basic tenet is that regardless of scientific background and hence "academic home," an integrated approach to infection and immunity is critical for success at Stony Brook Medicine. Emerging pathogens and multidrug-resistant bacteria represent serious threats to health worldwide; multidrug-resistant, Gram-negative bacteria are particularly problematic. Investment is needed to bring Stony Brook to the forefront in these areas. Support for infrastructure is also needed to build clinical and translational infectious diseases research, including the establishment of a bio-repository for human samples. Strengthening our existing core facilities and making them more accessible to researchers will be key to advancing our research and successfully competing for funding. This integrated theme will have considerable broad-based synergies with other central research areas and initiatives of the School of Medicine.

RECOMMENDATIONS

1. The Department of Molecular Genetics and Microbiology is currently being led by an interim chair. In keeping with the outstanding reputation and productivity of the Department, a search for a permanent chair must be a priority going forward. This person will become the Zhang Family Endowed Chair, which was established with the goal of supporting the growth of immunology research at Stony Brook University. The recruitment of new faculty members will be an integral part of the mission of the new Chair, as a number of senior faculty members are likely to retire during the duration of this strategic plan. Therefore, there is a need for recruitment, to bring junior faculty members to the Department of Molecular Genetics and Microbiology, and/or the Divisions of Infectious Diseases in the Departments of Medicine and/or Pediatrics.
2. Recruitment of faculty into the Theme in Infection and Immunology should be targeted to maintain the current expertise in viral, bacterial and fungal pathogenesis across Stony Brook Medicine. New hires should bolster immunology while building on and complementing the current areas of strength within the departments that make up the theme. Basic and physician-scientist faculty members with expertise in Gram-positive bacteria, multidrug resistance, particularly carbapenem-resistant Enterobacteriaceae, including *Klebsiella* and uropathogenic *E. coli*, and Lyme or other vector-borne diseases are also needed to complement existing expertise and build in critical and timely new areas of expertise. Hiring of new faculty should be coordinated between the relevant departments and centers as appropriate; the background of successful candidates should determine their appropriate departmental homes and secondary affiliations. Hiring should also be done with an eye toward enhancing utilization of the new Laboratory for Comparative Medicine.

Lab technologist Evelyn Takaki prepares specimens for testing.

3. To appropriately build immunology at Stony Brook, faculty expertise should be based on existing strengths, and so focus on several areas, including viral immunology, encompassing studies of T cell responses to chronic viral infection, the immunology of host-pathogen interactions, especially including the mucosal barrier, fungal immunology, strengthening existing fungal pathogenesis groups in the Department of Molecular Genetics and Microbiology and the Division of Infectious Diseases, as well as allow ties to groups working on gastrointestinal infections and immunology focused on biosafety level 3 (BSL3) pathogens, such as tuberculosis and tick-borne illnesses, which would take advantage of the Laboratory for Comparative Medicine.
4. Support for translational research and clinical trials is needed to take full advantage of the ongoing research and recruitment goals in the Division of Infectious Diseases and collaborating departments/centers. This includes establishment of a well-curated database with broad IRB approval. The goal will be to generate a bio-repository of human samples (e.g., blood cells, spinal fluid, and urine) and collections of clinical isolates of specific pathogens (e.g., carbapenem-resistant Enterobacteriaceae). There is a critical need for better IT support to facilitate better integration with bioinformatics (merging of inpatient and outpatient EMR data specifically with respect to microbiological diagnostics done outside of the Stony Brook University Hospital system). This is needed to advance our research by incorporating big data analysis. A robust clinical trials practice is key to advancing translational research, and recruitment of a junior faculty or clinical trials coordinator to conduct translational research on human subjects is desirable.
5. In recognition of the evolving focus of the department, a name change is proposed from "Molecular Genetics and Microbiology" to the more modern counterpart, "Microbiology and Immunology." This would more accurately reflect the diverse expertise of the existing faculty and the proposed changes moving forward.

POTENTIAL SYNERGIES AND INTEGRATION WITH OTHER STONY BROOK MISSIONS

Integration with other research programs:

Adding faculty members in the outlined areas of infectious diseases and immunology will provide the foundation for a world-renowned center of excellence on microbial pathogenesis and therapeutics, and foster links to collaborative projects and translational investigations. The recruitment of new immunologists will enhance synergy with other research areas in multiple departments of the School of Medicine. In particular,

the addition of new immunologists to the existing faculty will diversify the research orientation of the new Cancer Center, along with autoimmune diseases in other areas, such as rheumatological, neurological and gastrointestinal diseases. Expansion of this theme also synergizes with the Institute of Chemical Biology & Drug Discovery that has an active program in anti-tuberculosis drug development and bioimaging approaches for compound distribution and therapeutic monitoring. The new Laboratory for Comparative Medicine will foster interaction among regional institutions and with our public health and global medicine colleagues. The Laboratory for Comparative Medicine will house an insectarium, aerosol-delivery system, and animal imaging center that will be suitable for in vivo therapeutic studies with clinical departments and the New York State Department of Health.

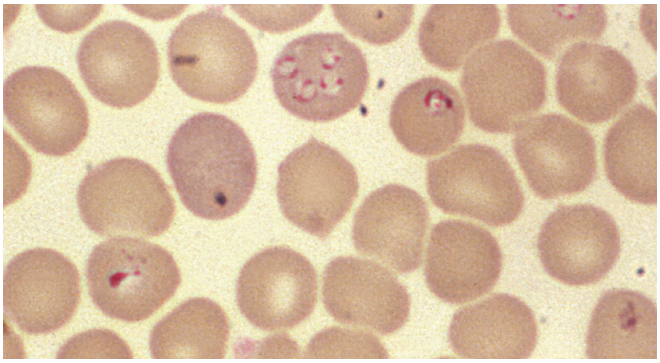
Translational research is a goal of this theme as we are already building a foundation for a strong presence in this area. Indeed, multiple collaborative research projects are ongoing between the Department of Molecular Genetics and Microbiology and the Department of Medicine, as well as with other clinical departments including Pediatrics and Pathology, and with members of the Stony Brook Cancer Center. This theme will seek to enhance translational research by fostering integration with physician scientists. There are also outstanding opportunities to expand global aspects of infectious diseases; numerous international sites are currently under consideration for clinical trials.

Integration with educational initiatives:

Infectious diseases and immunology has a prominent place in both medical and graduate student coursework. Traditional educational ties exist between the Department of Molecular Genetics and Microbiology, the Department of Medicine and additional Departments, including Biochemistry, Pathology and Pharmacology. These ties will be enhanced by this theme that builds upon existing strengths in host-pathogen interactions and includes immunology. The new expertise in immunology will facilitate updating of coursework in this fast-moving field. This theme will open new cross-disciplinary training opportunities for our PhD, MD and MD-PhD students, residents and fellows. As one of the most developed research programs within the School of Medicine, enhancement of this Theme should also permit the preparation of competitive training grant applications (NIH T32) to support expanded fellowship training programs in infectious diseases and immunology. And toward this end, the development of an umbrella graduate program spanning infectious diseases and immunology, cancer biology, genetics and pathology, physiology and pharmacology, biochemistry and structural biology, neurosciences, and engineering and informatics will catalyze not only the recruitment of outstanding students who have not yet "differentiated" into their field of career interest, but promote the interdisciplinary work needed to successfully accomplish the goals set out in this strategic plan.

Integration with the clinical mission:

New York City and Long Island serve as vital points of entry for established and emerging pathogens. The combination of a densely populated area, coupled with its proximity to a major port of entry to the country, provide the ideal setting for the introduction and development of new infectious diseases. This is particularly true of zoonoses. For example, the introduction of an infected individual led to the *Anopheles*-borne transmission of malaria to four boys in a summer camp in Suffolk County in 2010. Also, the tick-borne diseases of Long Island are well known. More than 30,000 persons on Long Island have contracted Lyme disease. Likewise, the introduction of West Nile virus into Long Island in 1999 and resulting deaths on Long Island due to the virus highlights the vulnerability of this region for emerging infectious diseases. Community outreach should also encompass programs to change opinions on antibiotics. Population-based studies in these and other areas of infection in collaboration with epidemiologists from the Department of Preventive Medicine, Division of Epidemiology with statisticians from the Department of Applied Mathematics, and with state health workers could provide additional opportunities that, in turn, would provide high scientific and community-wide visibility.



Erythrocytes infected with various stages of Babesia microti, *a hemoprotozoa transmitted by ticks. This organism is one of many tick-transmitted agents that are diagnosed and treated at Stony Brook University Hospital.*

Integrated Program in Cardiovascular Health and Disease

OVERVIEW

Cardiovascular research at Stony Brook University comprises basic, translational and clinical scientists housed within the School of Medicine's Divisions of Cardiology in the Departments of Medicine and Pediatrics, the Divisions of Cardiothoracic Surgery and Vascular Surgery in the Department of Surgery, as well as faculty in the Departments of Biochemistry, Biomedical Engineering, Neurobiology, Pharmacology and Physiology & Biophysics. These entities have largely been pursuing independent projects with notable exceptions being interactions between the section of electrophysiology and the Institute for Molecular Cardiology (housed in the Department of Physiology & Biophysics), and between the sections of Interventional Cardiology and Heart Failure and Biomedical Engineering. Over the past two years, recruitment of new Chiefs of Cardiology (Dr. Hal Skopicki) and Cardiothoracic Surgery (Dr. Joanna Chikwe) have set the stage for a robust enhancement of cardiovascular research within the School of Medicine. For example, we recently recruited several full-time clinical research faculty, a vascular biology physician-scientist (appointed as Associate Chief of Cardiology for Research) and junior faculty members in Electrophysiology and Interventional Cardiology who are developing independent research programs. In addition, a new research effort in Cardio-oncology was also recently launched. Finally, in Cardiothoracic Surgery, Dr. Chikwe has a strong clinical research background and is poised to translate those activities from her prior institution to Stony Brook Medicine.

The research program is enhanced by a strong clinical program organized within the Stony Brook University Heart Institute, including the Divisions of Cardiology and Cardiothoracic Surgery. The Heart Institute provides state-of-the-art diagnostic and therapeutic modalities related to noninvasive imaging, electrophysiology, congestive heart failure and stroke. Faculty within the Heart Institute provide clinical and research training to undergraduate, graduate, and medical students and residents. Funding related to cardiovascular research is moderate and is derived from a multitude of sponsors including National Institutes of Health, American Heart Association, the State of New York, industry and various internal grants. There are currently no training grants or career development awards. Moreover, what is clearly missing is integration of the research and clinical missions.

CURRENT STATUS

Strengths of the cardiovascular program include an outstanding group of basic research scientists from a number of departments and schools, modest funding in basic cardiovascular research, excellent clinical services, especially in electrophysiology and imaging, and world-class heart failure clinical trialists. Our major clinical competitors (Northwell Health and Catholic Health Services of Long Island) lack strong research programs in cardiovascular diseases, thus providing an opening for us to promote ourselves as the premier academic cardiovascular center on Long Island. The recent affiliation of Stony Brook University with Mount Sinai Health System will further our development as an academic cardiovascular center. In fact, this affiliation has already borne fruit with the recruitment of Drs. Joanna Chikwe and Henry Tannous and inter-institutional cardiovascular pilot grants.

Unfortunately, we must also acknowledge several weaknesses in the cardiovascular program. We lack research integration among the clinical and basic research departments. Translational and outcomes research infrastructures need strengthening, including having available training grants in cardiovascular diseases and an infrastructure for epidemiological and biostatistical analysis. And dedicated, state-of-the-art research space in which to work is needed.

RECOMMENDATIONS

1. Leverage the reputation of several faculty at Stony Brook University, including Dr. Hal Skopicki, Dr. Joanna Chikwe, Dr. Anne Hamik, Dr. Ira Cohen, Dr. Danny Bluestein and others as academic leaders and mentors to promote Stony Brook University Hospital cardiovascular medicine as a center for academic pursuit. The strengths of the cardiovascular service line and the departments should be promoted, and the resultant opportunities for further development of research excellence to outside institutions, potential trainees and faculty, as well as philanthropic funding agencies.
2. Recruit additional, synergistic faculty. Cardiovascular research would be strengthened with the addition of physician-scientists with interests that synergize with current research faculty (table below) and would bring us to a sustainable critical mass that will enhance grant funding.

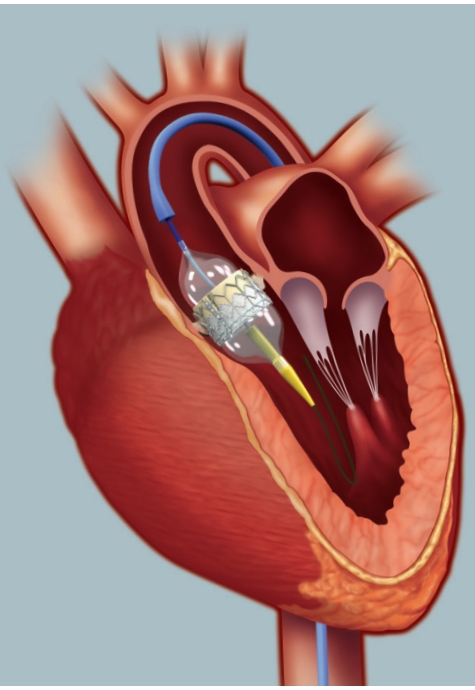
Research Focus	Current Faculty
Vascular biology	Lawson, Hamik, Lin
Molecular cardiology	Hamik, Lin, Cohen, Bloom
Clinical research outcomes	Kalogeropoulos, Parikh
Devices	Parikh, Rashba, Chyou, Bluestein
Clinical trials	Gruberg, Skopicki, Rashba, Chikwe, McLarty, Bilfinger, Tannous

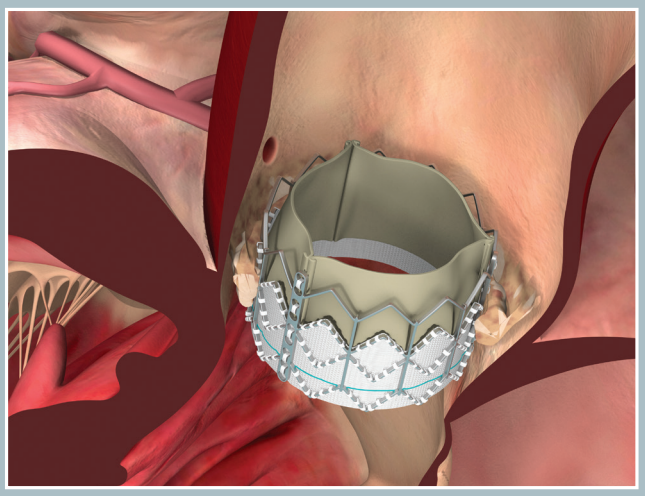
3. Rapidly complete renovation of space for faculty recruits. The research space allotted for cardiovascular research on floor 15 of the Health Sciences needs to be completed to allow for full productivity and to house research faculty in a thematically contiguous space.
4. Develop a cardiovascular imaging and invasive rodent research facility. The Stony Brook research community does not currently have a cohesive facility that will support rodent models of cardiovascular disease. This facility should provide state-of-the-art ultrasound imaging, invasive hemodynamics, telemetry and a full range of surgical procedures (i.e., coronary ligation).
5. Develop a cardiovascular clinical trials center. A robust cardiovascular clinical trials center holds promise for improved recognition for Stony Brook Medicine, faculty recruitment and retention, career satisfaction and academic productivity for clinical faculty; competitive advantage over other regional medical centers; provide research opportunities for trainees; and most importantly, access to novel therapies for the patients. This will require development of an administrative support and clinical coordinator infrastructure.
6. Initiate a cardiovascular research fund. Provide seed grants to promote collaborative research related to the cardiovascular system and/or fund the infrastructure required to support such projects. Several faculty have benefited from internal grants to initiate research programs that are now heading toward independent funding. These grants will also be instrumental in developing a reliable infrastructure to support investigator-initiated clinical research.
7. Develop collaborative research projects between cardiology/cardiothoracic surgery and basic science departments. Our new clinical and basic research faculty are developing collaborative interactions with Physiology & Biophysics, Biomedical Engineering, Radiology, Dermatology, Nephrology and Vascular Surgery. To make these collaborations sustainable, multi-PI grants need to be attained.
8. Create a local cardiovascular research group meeting and an annual symposium highlighting the Stony Brook cardiovascular faculty. Initial efforts on this front have led to the highly successful (>350 attendees) Long Island Heart 2017 two-day conference supported by the Heart Failure Society of American and the New York State Chapter of the American College of Cardiology. These efforts will strengthen collaboration and bring visibility to the research being conducted here.

POTENTIAL SYNERGIES AND INTEGRATION WITH OTHER STONY BROOK MISSIONS

Integration with other research:

Cardiovascular research is multidisciplinary in nature and incorporates investigations related to molecular electrophysiology, vascular devices, stem cells and vascular biology/thrombosis. Hence, further development of cardiovascular research would benefit multiple departments and programs. Moreover, several new





For patients with severe, symptomatic aortic stenosis who are at intermediate or greater risk for open heart surgery, Stony Brook University Heart Institute offers a minimally invasive procedure called transcatheter aortic valve replacement (TAVR).

faculty with research interests (Hamik, Parikh, Chyou) have formal affiliations with the Northport VA Medical Center. We should support their research activities to capitalize on the patient database and research funding available through the VA system.

Integration with educational initiatives:

Stony Brook University has strong undergraduate and graduate science programs. Hence, we should provide enhanced opportunities for research training and mentoring in cardiovascular science and medicine. Engaging residents and fellows in research track training experiences in cardiovascular science is central to the strategic plan. Institutional support that diminishes hurdles and provides distinctive motivation for research activity by clinical faculty will greatly aid in these goals.

Integration with the clinical mission:

Expertise in clinical care in cardiovascular disorders has been strong and broad based within the School. The Heart Institute supports the clinical activities of Cardiovascular Medicine and Cardiothoracic Surgery. Enhanced diagnosis and treatment of cardiovascular disorders is a major need in an aging community and it appears that the epidemic of obesity will continue to expand, such that despite considerable prior progress in reducing risk in other areas of prevention, more attention is now needed to understand and combat the epidemic of "super-sizing" contributing to diabetes and cardiovascular diseases. Thus, developing a nationally recognized research program in cardiovascular diseases has the potential to enhance our clinical reputation and expand our patient referral base. An expanded translational research program would considerably enhance the visibility of the clinical enterprise. The current climate in healthcare economics makes it increasingly difficult for primary clinical faculty to participate in research activities. By enhancing basic infrastructure for research, we will support collaborative efforts between the primary research and primary clinical faculty. Moreover, to provide a sustainable research enterprise, we must promote the excellence of the current clinical and research faculty into philanthropic support.

Integration with the community:

The development of a nationally recognized cardiovascular research program in conjunction with a comprehensive clinical enterprise, including a multidisciplinary clinic in cardiovascular medicine would represent unique opportunities for community engagement and philanthropy. Health fairs at the outlying Stony Brook medical clinics could be used to highlight cardiovascular research. Hosting an evening laboratory "show-and-tell" for the community would highlight our program and facilitate understanding by the local community of the relevance of supporting research.

Yusuf A. Hannun, MD, Director, Stony Brook University Cancer Center, discusses a research result with Can Sankel, PhD.

An Integrated Program in Cancer Research and Clinical Care

OVERVIEW

Based on current projections, as cardiovascular mortality wanes, because of better public health measures, cancer will become the leading cause of death in the U.S. by 2020. Cancer-focused research has become a major driver of cell biology, translational and clinical research, often helping to define the most important objectives and to establish the road map that often guides translational and clinical research. From a financial perspective, cancer is also rapidly emerging as the single most important consumer of healthcare resources and in the most advanced academic medical centers, cancer services contribute approximately 40 percent of the margin.

Stony Brook University and the School of Medicine highlighted cancer and development of the Stony Brook University Cancer Center as one of its major themes in the previous strategic plan. Most of the important objectives that were set have already been achieved over the past five years. A summary of the accomplishments includes:

1. The Cancer Center has one P01, one P20 and one U24 currently funded. At least three other multi-investigator grants are in the planning stages. Overall, Cancer Center investigators hold 57 peer-reviewed, individual-research awards (e.g., R01, R21, R37) approaching $25 million a year, and contribute ~250 distinct peer-reviewed scholarly publications each year.
2. New clinical hires into clinical oncology disciplines (including Medical, Surgical, Pediatric, Gynecologic and Radiation Oncology) have significant protected time. Most of our clinical faculty recruits have been provided with at least 25 to 50 percent protected time to pursue interests in clinical research. These new members of the Cancer Center (approximately 12), who now represent the majority of the clinical cancer faculty, have helped transform clinical oncology into an academically anchored clinical investigative workforce.
3. There has been tremendous growth in the number of cancer investigators over the past seven years. Each of these investigators belong to one of the three major research programs and seven specific themes of the Cancer Center that cut across departments, across schools in the Health Sciences and across campus. The three major programs within the Cancer Center overlap with research efforts in clinical and biomedical informatics, computer sciences, metabolism, inflammation, molecular biology, genetics and genomics, pathology, structural biochemistry, pathology, pharmacology, physiology, dentistry, nursing, mathematics, physics, chemistry and several other areas.
4. The Cancer Center has focused on three major shared facilities: biobanking and tissue analysis (TA), which has tripled the number of stored specimens compared to five years ago, biologic mass spectrometry, and biostatistics and data science. A fourth shared resource on cancer imaging, based on a major gift from Lalit and Kavita Bahl, is in the planning stages. An independent Cancer Clinical Trials Office has also been developed in accordance with National Cancer Institute (NCI) requirements.
5. Stony Brook University co-manages Brookhaven National Laboratory (BNL). The Cancer Center has several collaborations with investigators at BNL and has many collaborations with Cold Spring Harbor Laboratory (CSHL), including with the new Director of the CSHL Cancer Center, Dr. David Tuveson. In addition, CSHL is one of our primary, off-campus training sites, providing mentors and training for students enrolled in our Graduate Programs in Molecular Pharmacology, Molecular and Cellular Biology, and Genetics.
6. The Cancer Center now conducts annual retreats and an annual research symposium that includes three invited speakers each year. The themes have included drug discovery, cancer metastasis and cancer metabolism.

CURRENT STATUS

As a major academic cancer center, Stony Brook Cancer Center has an obligation to serve as a major site for cancer treatment on Long Island and an even greater obligation to drive cancer research. Tomorrow's cancer practice is driven by today's research. While the Cancer Center has made significant strides in the past five years, there remain significant goals and hurdles to the achievement of NCI designation, the top priority for the Cancer Center.

NCI designation is a complex process that requires significant accomplishments in the formation of advanced research programs, very active clinical trials and support of key shared resources. The initial phase aims at achieving a Clinical Cancer Center status. Subsequent development must be directed at achievement of an NCI-designated Comprehensive Cancer Center.

The goals and vision of the leadership of the Cancer Center are:

1. To conduct cutting-edge research that will advance our understanding of the origins of cancer and open new avenues for prevention and treatment.
2. To educate the next generation of cancer researchers and compassionate care providers.
3. To deliver world-class comprehensive care to patients with cancer, designed to prevent, cure or minimize the effects of the diseases on the population we serve.

Since 2012, the leadership of the Cancer Center sought to define areas of exceptional strength at Stony Brook University (SBU) upon which to build innovative and unique programs for the Cancer Center. SBU is a research-intense university with great strength in the area of STEM education and research, and fortuitously, the future of cancer research is being shaped to a significant extent by need for computational sciences and more innovative approaches from the physical and engineering sciences, areas where SBU excels. Moreover, SBU oversees the BNL, and over the years this relationship has resulted in many areas of profound collaboration, especially in imaging sciences. SBU boasts the development of the MRI, and investigators at BNL were at the forefront of developing PET technology. Over the years, faculty have actually moved from BNL to SBU, and several of those have now been "recruited" to the Cancer Center. Over the past five years, three distinct programs have been developed based on these intellectual resources. These are: 1) Program in Oncogenic Drivers and Mechanisms of Carcinogenesis; 2) Program in Imaging, Bioinformatics and Engineering Sciences (IBES); and 3) Program in Cancer Lipids and Metabolism. The Cancer Center now has obtained research funding that would place us at a level equal to about number 50 among the 69 currently designated NCI cancer centers. In addition, we have adopted three important shared resources: 1) tissue analysis, which includes biobanking and analysis of cancer tissues; 2) biological spectroscopy, which provides services in proteomics, lipidomics and metabolomics; and 3) biostatistics and data science.

Jennie Williams, PhD, Research Assistant Professor of Medicine, Division of Cancer Prevention, in her research laboratory.

RECOMMENDATIONS

The Stony Brook Cancer Center should continue the lengthy and structured process of attaining NCI designation, ultimately leading to submission of a Cancer Center Support Grant (CCSG). Toward this end, the following key objectives have been identified:

1. Strengthen the links between the Cancer Center and the physical, mathematical and engineering sciences on the contiguous main campus to enable the development of innovative approaches to address the greatest problems in cancer research.
2. Fully operationalize an efficient and robust clinical trials office and operations to advance cancer center clinical trials. This requires:
    a. Hiring an Associate Director for Clinical Research that will expand a structured translational Phase I clinical trials program

with a focus on collaborations with SBU basic scientists to bring forward translational efforts from bench to bedside in investigator-initiated trials and to recruit additional staff.

   b. Recruit several disease-specific clinical investigators who are thought leaders in their field.

   c. Recruit a cancer biostatistician (in collaboration with the Department of Family, Population and Preventive Medicine) who will oversee and participate in cancer clinical trials development and analysis and a data management specialist.

3. Continue to enhance major research programs and sub themes with key recruitments in imaging, metabolomics, DNA damage response, therapeutic development, genetics, molecular nutrition, and/or biomarker discovery and development.

4. Enhance key shared facilities.

   a. Biologic mass spectroscopy, including recruitment of an established investigator to lead the new MALDI imaging spectroscopy resource

   b. Cancer biostatistics and bioinformatics

   c. Tissue storage and analysis

   d. Imaging and radiochemistry

5. Stretch goals for population-based cancer research (should resources become available).

   a. Increase investment in population-based cancer research and cancer prevention and control

The Kavita and Lalit Bahl Center for Metabolomics and Imaging is Stony Brook University Cancer Center's one-of-a-kind metabolomics and imaging translational research program, which will have a permanent home in Stony Brook's Medical and Research Translation (MART) building (above).

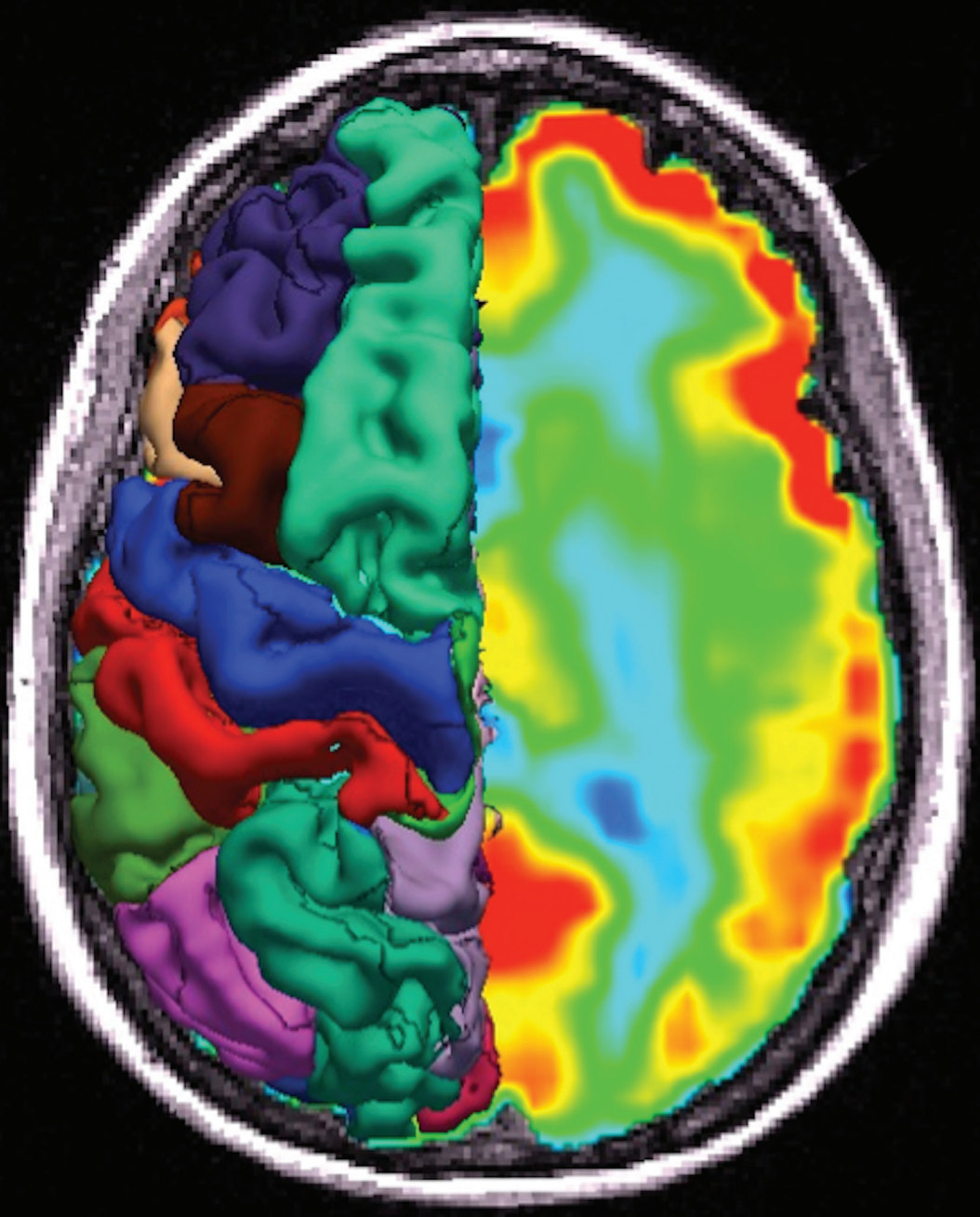
that include new faculty hires toward program development.

   b. Hire a leader in population science in collaboration with the Department of Family, Population and Preventive Medicine.

   c. Hire two to three junior investigators in cancer population sciences. These can be in collaboration with the Stony Brook University School of Social Welfare, Stony Brook University School of Nursing, Program in Public Health and Department of Family, Population and Preventive Medicine.

   d. Invest seed funding to expand on research that is focused on the World Trade Center population, nutrition research, cancer prevention and environmental hazards that lead to carcinogenesis.

Image analysis techniques allow extraction of many types of information from the human brain. The colors on the left indicate different brain regions, extracted from MRI. By delineating brain regions, Stony Brook researchers can measure aspects, such as regional volume and surface area, which can be affected in disease states. On the right is an example of a typical PET image, in which the colors distinguish aspects such as metabolism, receptor density or inflammation. Differences in these features are also hallmarks of disease.



An Integrated Program in Neurosciences

OVERVIEW

Neuroscience is currently a priority research area for most leading academic medical centers and for numerous research institutes worldwide. The field has been maturing at an exponential rate over the past 20 years, and insights into the fundamental nature of brain function are beginning to emerge.

A global effort to map brain connections has been launched, in the U.S. backed by a federal initiative likened to the Human Genome Project, the war on cancer or even the moon shot of the 1960s. Advances in neuroscience have already spurred a paradigm shift in artificial intelligence (AI), as brain-inspired AI approaches (using self-improving neural network designs) have achieved performance breakthroughs, such as AlphaGo, self-driving cars or web-based language engines. Translation of neuroscience advances into therapies has been slower, and diseases of the nervous system are still massively impactful across the globe, probably accounting for about one-third of all disease burden and health costs in the developed world, based on recent European data. But the advancing front of knowledge has begun to fill therapeutic research pipelines. Important new therapies have recently appeared in multiple areas, including stroke, depression, multiple sclerosis, Parkinson's disease, pain and epilepsy. Neuroscience has the public eye, and large philanthropic gifts have occurred, such as last year's $185 million gift for UCSF Weill Institute for Neurosciences.

CURRENT STATUS

Neuroscience thus continues to be a logical area of emphasis for the Stony Brook University School of Medicine. Besides its prominence in national and global research agendas, the neuroscience is an area of existing strength and accomplishment for multiple School of Medicine departments. In a 2013 assessment, 27 percent of total external Stony Brook Health Sciences grant funding was for neuroscience projects. Furthermore, it is intrinsically a broad and open field with fuzzy borders, drawing increasingly from other STEM fields where the University is well established. Several nearby universities are highly recognized for neuroscience prowess, but they do not dominate the field; breakthroughs routinely emanate from a large number of institutions.

While neuroscience research at SBU is currently strong, as noted in the previous School of Medicine Strategic Plan, it suffers from fragmentation with the faculty engaged in basic or clinical neuroscience research distributed across many School of Medicine and SBU departments. To begin to address this fragmentation, four core neuroscience departments (Neurobiology and Behavior, Neurology, Neurosurgery and Psychiatry) have established the Stony Brook University Neurosciences Institute, effectively a chair-level, voluntary organization that meets regularly to discuss opportunities to work together and hosts an annual symposium ("Meeting of the Minds") around a selected translational research theme. Many peer academic organizations have established neuroscience institutes that have resources and administrative authorities; in contrast, the Stony Brook Neurosciences Institute needs significant resources to be at the desired level. However, first steps have been taken to add programmatic content to the Neurosciences Institute: a new autism research center, with the Dean's office agreeing to support external recruitment of a center director, and the Departments of Neurobiology and Behavior, Neurology, Pediatrics, Psychiatry and Psychology agreeing to provide one faculty recruitment line apiece to get the center started.

At the end of 2013, with funding and a charge from the SUNY RF, the Neurosciences Institute organized a workshop convening more than 100 selected neuroscientists from across the SUNY system, and then organized and led a SUNY "Brain Network of Excellence" (BNE). Faculty engagement was excellent. A pilot grants program with approximately $1 million in SUNY funding

was established and funded a series of interdisciplinary research pilot initiatives selected for impact and potential ability to gain external grant funding. In addition, several project teams were formed to address infrastructural needs. However, the SUNY RF mandated that campus leadership terms be only one year long, so BNE leadership rotated in a matter of months to SUNY Buffalo. SUNY RF funding then faltered, and the BNE effort dissipated over the ensuing year. The brief success of the BNE effort however illustrated the power of relatively modest seed investment to strengthen neuroscience research within SUNY and specifically within SBU.

RECOMMENDATIONS

The School of Medicine should invest in developing the Neurosciences Institute into an effective matrix organization similar to the Stony Brook Cancer Center. The Neurosciences Institute Director and Co-Directors should be provided the financial and space resources needed to set up integrated basic and clinical neuroscience programs, as well as the ability to partner with the School of Medicine and other departments to recruit targeted faculty, enhance key core facilities and fund promising interdisciplinary and interdepartmental pilot projects.

1. The first task for NI leadership will be to engage departments beyond the current core departments in an inclusive fashion, using newly remodeled flexible laboratory space as a catalyst for broad participation.

   Based on experience at other peer academic institutions and with the Stony Brook BNE initiative, likely eight to 10 School of Medicine departments will want to participate regularly in the activities of a resourced Neurosciences Institute. Contiguous space encompassing at least one quadrant in the Basic Sciences Tower or Health Sciences Tower is needed.

2. The second task will be to work with this expanded list of Stony Brook leaders to set priorities for programmatic focus.

   A resourced Stony Brook Neurosciences Institute will immediately enhance neuroscience faculty connectivity across departments, and it would therefore be wise to reserve some resources to capitalize on opportunities emerging "bottom-up" from the larger Stony Brook neuroscience community over the next few years. Candidate priorities for initial top-down support include:

   a. Continued enhancement of neuroimaging capabilities, already an area of School of Medicine emphasis. Consideration might be given to setting up a magnetoencephalography (MEG) instrument to add a dimension of fast physiological detection to current fMRI and PET-based capabilities (likely cost around $2 million). This would immediately benefit research programs in several areas, including epilepsy, schizophrenia, autism and functional brain stimulation.

   b. New technologies for stimulating and recording from the human brain, as outlined in an earlier "B-CHIP" (Brain Computer Hybrid Interface Partnership) proposal submitted by the Neurosciences Institute to leadership at the SUNY College of Nanoscale Science and Engineering and Stony Brook University School of Medicine, and expanded upon in a proposal led by Lorna Role, PhD, that was submitted to the Simons Foundation.

   c. Neuroprotection. A research front likely to pick up momentum over the next decade is reducing pathological neuronal death in the setting of chronic neurodegenerative diseases, such as Alzheimer's disease, Parkinson's disease or ALS, and acute insults, such as stroke or trauma. Intriguing evidence now suggests that neurodegeneration may also drive the progression of some severe psychiatric diseases, such as schizophrenia, autism, or post-traumatic stress disorder. An initiative in this area would augment existing programs in all four core Neurosciences Institutes departments.

   d. The largest future research front in clinical neuroscience is likely to be in nervous system restoration – aiding recovery of function after central nervous system or peripheral nervous system damage has already occurred, using techniques such as stem cell transplantation or re-engaging developmental processes. Cognitive restoration in patients with Alzheimer's disease, or sensory-motor restoration after spinal cord injury, would be examples of specific research goals. The Neurosciences Institute should position Stony Brook to be a player as this major research front takes shape.

   e. Post-Traumatic Stress Disorder (PTSD)/Traumatic Brain Injury (TBI). These different, but overlapping areas are rising in health impact and very much in the

Mala Ananth, Neuroscience PhD candidate, points to cholinergic neurons, which are associated with short- and long-term memory, and are being studied for their role in Alzheimer's disease. These neurons were extracted from mice using techniques developed by Lorna Role, PhD, Department of Neurobiology and Behavior, and David Talmage, PhD, Department of Pharmacology. Using methods developed by Arie Kaufman, PhD, Chair of the Department of Computer Science, and his student, Saeed Boor Boor, these images are able to be displayed in Stony Brook University's Reality Deck, the world's first immersive gigapixel resolution display.

public eye, driven by military injuries and previously under-recognized sports injuries. A research summit hosted by the U.S. Army and Department of Defense in June 2017 noted the existence of several promising therapeutic approaches that need to be explored by academic medical centers.

f. Neurotherapeutics. Items b through e in this list represent specific neurotherapeutic areas well matched to current opportunities and Stony Brook capabilities. An alternative strategic stance for the Neurosciences Institute would be to develop an overarching neurotherapeutics center that would emphasize commonalities among different specifically-targeted therapeutic areas. Such a center might, for example, develop a small molecule high-throughput screening capability, biomarkers or streamlined micro-dose protocols for accelerating first-in-man testing of new agents across therapeutic areas.

3. The third task for a resourced Neurosciences Institute would be to develop suitable administrative processes to optimize its ability to coordinate and facilitate neuroscience research across the School of Medicine and University.

   The Neurosciences Institute will aim to be inclusive and make fully informed decisions, effectively serving as an arm of the School of Medicine Dean and Dean of Research in partnering with departments to aid interdepartmental collaborations, information flow, allocation of space, external fundraising and future strategic planning in the neuroscience sector.

POTENTIAL SYNERGIES AND INTEGRATION WITH OTHER STONY BROOK MISSIONS

Integration with other research:

Discussions should begin between leaders in the basic and clinical neuroscience community to determine how this organization can contribute to the development of a Community of Neuroscientists. Our vision would be to have a University-wide neuroscience organization that can provide a focus for neuroscience activities and initiatives that will satisfy students, faculty, fellows, and in some cases, the community. This organization could also reach out to from linkages with other communities

(engineers, mathematicians, the visual and performing arts, etc.) all of whom are interested in the brain and behavior. One would hope that this could result in the development of multidisciplinary activities.

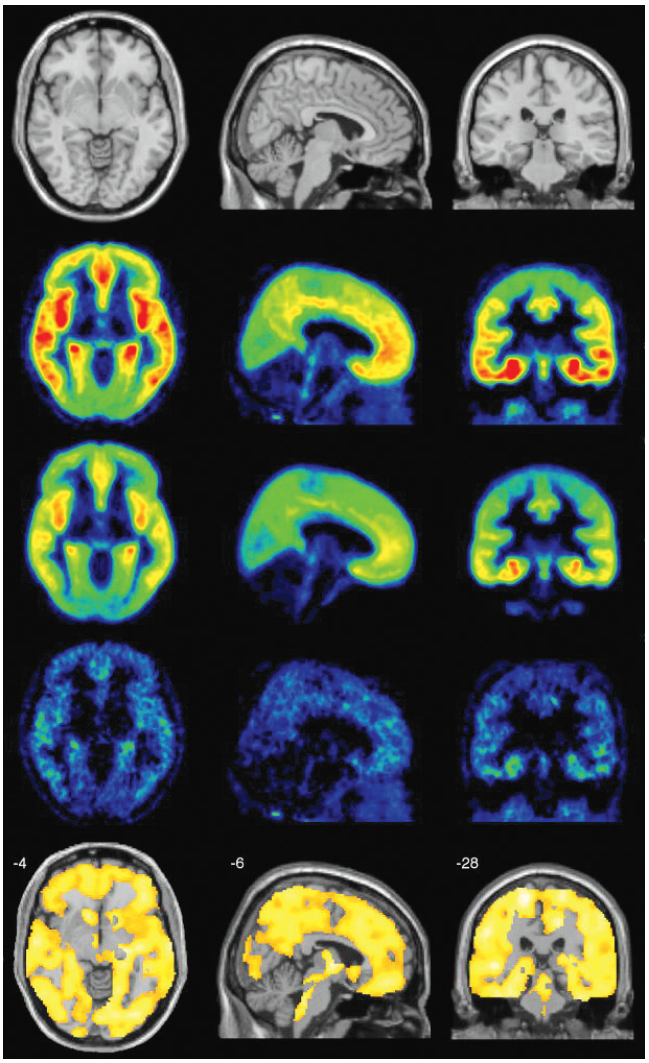
Integration with the clinical enterprise:

The Stony Brook University School of Medicine is well positioned to take a leading role in clinical care in neurosciences. The School of Medicine has now built a core group of clinical faculty members who are multidisciplinary and are addressing the needs of the aging population in our geographic area. Faculty and staff expertise exists in the Departments and Divisions of Neurology, Neurosurgery, Neuroradiology, Interventional Neurosurgery, Neuropathology, Ophthalmology and Anesthesiology. Stony Brook University Hospital already has an established Stroke Center. The hospital has invested heavily in state-of-the-art neuro-imaging and neuro-interventional laboratories to enable us to be the clinical leader in the region. Considerable favorable publicity and community support have resulted from early success in this area so there is ample opportunity to grow into a true multidisciplinary center of excellence. Collaboration with BNL could advance noninvasive neuro-imaging on both a clinical and an experimental level.

The Stony Brook Neurosciences Institute will fully integrate hospital services, research and educational missions to serve as a virtual neurosciences center. A disease-based model will be created with each service collaboratively providing efficient, effective and high-quality care. The Neurosciences Institute, with nationally recognized leaders, will be considered world-class.

Integration with educational initiatives:

There are numerous undergraduate offerings from the Departments of Neurobiology and Behavior, Psychology and Pathology. There are strong graduate programs in Neuroscience, Pharmacology (Neuropharmacology) and Psychology that would benefit from the presence of clinical/translational neuroscientists. An umbrella graduate program, as noted above in the Infection and Immunology section of the Strategic Plan, would similarly help catalyze the recruitment of very highly qualified students and interdisciplinary work. Medical students receive preclinical coursework in basic neuroscience and neuropharmacology and neuropathology, as well as clinical education in neurology, and elective rotations in ophthalmology, anesthesiology and neurosurgery



PET and MRI images of serotonin 1A expression in depression. The top row shows three views of an MRI image of the brain. The PET images in the second row show the distribution of the serotonin 1A receptor (in the same three views) in people with major depressive disorder (MDD) (averaged over 30 individuals with MDD). Red and dark yellow indicates a high density of the serotonin 1A receptor. The third row shows the distribution of the serotonin 1A receptor in healthy controls (averaged over 51 individuals). The differences between the two groups are indicated in the fourth row, where the color indicates the magnitude of serotonin 1A density differences, showing that individuals with MDD have higher serotonin 1A density, on average. [Image from: Mlller et al, Neuropsychopharmacology, *34 (10): 2275-84, 2009.]*

also have contact with the medical students through the electives. Postgraduate medical education and Continuing Medical Education (CME) provides another venue for faculty contribution to the educational mission. A residency program in Department of Neurosurgery is under development. At every level, there is strong demand for research experience in the neurosciences. Because of the high visibility of brain research in the general population, as well as interest in diseases of the brain, it is important to have many opportunities for students/fellows to participate in research lab activities.

An Institute for Engineering-Driven Medicine

OVERVIEW

The exponential growth of technology is ushering in a new era in medicine. Referred to by some as the "third revolution in medicine," this era is defined by the convergence of medicine with other life sciences, engineering, nanotechnology, applied mathematics, computational science and data science. Convergence science is radically transforming biosciences and has the potential to provide new insights into the origins of human disease and transformative technological breakthroughs in the way we diagnose and treat patients and advance public health.

The unprecedented opportunity that lies ahead is characterized by a blurring of the distinction between what now seems possible and what just a few decades ago was considered science fiction. Convergence science today is tackling questions such as: Can autonomous micro-machines (or nanobots) travel inside the human body to deliver medicinal loads to specific tissues or cells? Can computer chips be implanted in the brain to cure neurological diseases? Can lost limbs be regrown? Can cancers be detected at their earliest stages with simple noninvasive tests, and can their progression be predicted using computer modeling? Can big data and machine learning be used to understand the environmental contributions to disease, predict patient responses to drugs or other medical interventions, or track and help halt the spread of infectious diseases in large populations?

The convergence of engineering and medicine is changing medicine and has the potential to revolutionize healthcare and creates the need for new educational, research and technology transfer paradigms. Once a clinical problem that appears amenable to an engineering approach is identified, convergence science necessitates the fusion of multiple and seemingly widely disparate disciplines, including basic life sciences, physical sciences, computer science, applied mathematics and engineering, and to transform these new scientific insights into better diagnoses, treatments and prognoses, "bilingual" clinicians who understand the language of science and the language of medicine. Mechanisms need to be put in place that facilitate and provide funding for the rapid formation of transdisciplinary teams to undertake convergence science research in rapidly emerging and evolving healthcare challenges. Research needs to be seamlessly integrated in a translational innovation ecosystem that will enable commercialization and the more rapid transition of new technologies from the laboratory to clinical practice. Last, but not least, new educational paradigms are needed to prepare both scientists and clinicians of the future, who will need a robust understanding of the technology of convergence science to effectively develop and deliver emerging healthcare innovations to patients.

One such exciting avenue where medicine intersects with engineering is regenerative medicine, which the U.S. Department of Health and Human Services has called the "next evolution of medical treatments." As but one example of a relevant focus, consider the demand for lifesaving organ transplantation. At present, there is both an increasing incidence of organ failure among the growing and aging population in the U.S., and successes of transplantation due to medical advances, such as immunosuppression, that has dramatically improved post-transplantation outcomes, which has led to profoundly inadequate supply of suitable organs for transplantation. According to the most recent transplantation statistics maintained by the Organ Procurement and Transplantation Network (https://optn.transplant.hrsa.gov/) more than 115,000 people in the U.S., including 10,000 from New York alone, are on the national waiting list for lifesaving organs. This woeful shortage in organs has detrimental consequences. It deprives many patients of a better quality of life; it causes

substantial increase in the cost of alternative medical care, such as dialysis due to kidney failure; and often results in death, as ~8,000 U.S. patients, including 500 from New York, die each year waiting for organ transplants.

CURRENT STATUS

Stony Brook University is well positioned to become a leader in convergence science. We are fortunate to be the home of a premier School of Medicine and an excellent College of Engineering and Applied Sciences (CEAS), which have been actively recruiting many new leaders and faculty members with expertise in biomedical engineering, imaging across all scales, nanotechnology, biomedical informatics, medicinal chemistry, metabolomics and precision medicine. The School of Medicine and the CEAS have enjoyed a tradition of collaboration in the disciplines that make up convergence science. For example, the Departments of Biomedical Engineering and Biomedical Informatics are already structured as convergence science departments, housing faculty from both the School of Medicine and CEAS. And faculty members from many CEAS departments are already actively engaged in a myriad of research projects at the nexus of engineering and medicine.

Cross-cutting centers and institutes, such as, among others, the Laufer Center for Physical and Quantitative Biology, the Stony Brook University Cancer Center, the Stony Brook University Neurosciences Institute, the Center of Excellence in Wireless & Information Technology (CEWIT), the Institute of Chemical Biology & Drug Discovery (ICB&DD) and the Institute for Advanced Computational Science (IACS) bring together faculty along thrusts that are critical building blocks of convergence science. The New York State Center for Biotechnology, which is housed in the SBU Department of Biomedical Engineering, serves as a commercialization hub and an important catalyst in the development of new biomedical technologies and emerging companies in New York State.

Finally, Stony Brook University has recently received funding from the State of New York to build a new $75 million building that will house the Institute for Discovery and Innovation in Medicine & Engineering (I-DIME). This building can provide the physical space within which convergence science can flourish.

Based on the growing skills of our faculty and developing structural organization noted above, Stony Brook University is uniquely positioned to envision and impact the future of medicine in an era of quantitative medicine. To advance toward achieving this goal, we propose to develop the Institute for Engineering-Driven Medicine (IEDM), which will serve as the innovation ecosystem of convergence science by stimulating and enabling cross-cutting research, fusing life sciences, physical sciences and engineering; develop new educational programs to prepare the next generation of clinicians who will implement technological innovations into effective therapies for individual patients and communities; and stimulate regional economic development by translating new discoveries into products through a focus on commercialization and entrepreneurship.

Research thrusts of the IEDM will build upon current strengths so that the Institute's convergence research will initially focus on five major areas: Cardiology and Cardiovascular Disorders; Cancer; Neurosciences; Regenerative Medicine; and Digital and Wireless Medicine.

1. Cardiology and Cardiovascular Disorders

The Stony Brook IEDM will bring engineering in cardiovascular disease to a new realm, focusing on two particularly challenging areas: the imaging of molecular disorders of the heart and blood vessels, and the telemedicine monitoring of patients with complex heart disease. The Institute has tremendous potential to revolutionize cardiovascular care through innovative convergence research.

2. Cancer

Applying the principles of convergence science to cancer, one of the most exciting prospects of this initiative is that the data derived from engineered tumor models can be integrated with patient-specific data. The application of big data analytics on exascale supercomputers equipped with machine learning algorithms to initial (primary) and ongoing (metastatic) tumor histological analysis, to tumor genomics, proteomics and metabolomics, and followed with advanced scientific visualization techniques across all scales (cryo-electron microscopy, optical coherence tomography, OCT, during endoscopy, 7T and 9.4T rodent and 3T human simultaneous PET/MRI scanners and the development of a 7T human full-body simultaneous PET/MRI scanner) will lead to an unprecedented precision-medicine platform on which patient-specific models of cancer can be studied and the benefits of therapies outside traditional clinical trials can be evaluated.

Stony Brook Medicine retinal surgeon Khurram Chaudhary, MD, recently performed surgery to implant a new commercially available retinal device known as the "bionic eye" to provide artificial vision for patients with retinitis pigmentosa — the first of its kind on Long Island and across the New York metropolitan area.

One novel therapeutic approach that will characterize the efforts of the IEDM is based on nanotechnology, another discipline which amply illustrates the importance of convergence medicine. Nanomedicine is the intersection between nanomaterials and medical research. In one approach with which there is much Stony Brook experience (e.g., Laurie Krug, PhD), nanometer-scale therapeutic substances that interact with diseased tissue are fabricated, allowing access to pores in tumor vasculature, preferentially delivering the noxious cargo-carrying particles to the tumor.

3. The Neurosciences

The five-year strategic plan for Stony Brook Medicine emphasizes the neurosciences and the tools needed to better understand illnesses that range from disorders of cognition, movement, mood, behavior and addiction. Like that for cardiac disorders and cancer, the emphasis of the IEDM will be to use advanced engineering strategies to better understand the origins of these disorders and to fashion novel approaches to their treatment. A wide array of faculty members are already developing advanced imaging techniques to study these major disorders of health.

Another approach involves implantable brain devices that will be used for future diagnostics and therapeutic approaches. Given the investigational strengths in the Stony Brook University Departments of Neurobiology and Behavior, Biomedical Informatics, Biomedical Engineering, other CEAS Departments and the Neurosciences Institute, Stony Brook is well positioned to emerge as a leader in implantable brain devices and related technologies.

4. Regenerative Medicine

As discussed earlier, organs for transplantation are in very short supply and carry a burden of requiring long-term or lifelong immunosuppression to prevent organ rejection. Instead of depending on organ donors, patients can, in principle, receive bioengineered organs, tissues and cellular therapies that are specifically grown in a patient-specific manner in a laboratory. Regenerative medicine has the potential to be the transformative "magic bullet" for the replacement and restoration of diseased tissues and organs through a "grow your own" regeneration process that is theoretically inexhaustible, but more importantly, obviates the dependence on organ donation.

There are several primary departments with the School of Medicine and CEAS with faculty in the proposed area, including Dr. Wadie Bahou, a physician-scientist with expertise in stem cell hematology; Dr. Ira Cohen, a physician-scientist who works on cardiac stem cell research; Dr. Soosan Ghazizadeh, Director of the Stem Cell Gene Transfer and Viral Vector Core; Dr. Kenneth Kaushansky, a physician-scientist whose work focuses on hematopoietic stem cells and their development into blood cells; Dr. Yizhi Meng, who has an extensive background in biomaterials; Dr. Robert Patro, an expert in bioinformatics; Dr. Miriam Rafailovich, who works on polymers and nanobiomaterials; Dr. David Rubenstein, an expert in tissue engineering, specifically, the development of various biomaterials fabrication techniques and biological testing of the ensuing biomaterials scaffolds; Dr. Balaji Sitharaman, whose work focuses on the interface of bionanotechnology, regenerative and molecular medicine; and Dr. Helmut Strey, who works on micro and nanotechnologies for tissue engineering.

5. Digital and Wireless Medicine

Advances in wireless access, the internet, mobile technologies, cyber security, social networks and Internet of Things (IoT), have become relevant to the medical world. Yet, there is considerable room for growth, as the promise of digital medicine is only now being suggested. Led by the Departments of Biomedical Engineering, Computer Science, Electrical and Computer Engineering, and Applied Mathematics and Statistics,

innovation in this technology presents significant opportunities for advancement in engineering-driven medicine. Digital and wireless medicine offer solutions to many growing population healthcare concerns and presents exciting new opportunities for the future of medical care. It can drastically reduce medical errors, allow direct transmission of drug prescriptions, advance personal medicine, promote remote vital signs and drug compliance monitoring, and support implantable and swallow-able mini-sensors. As an example, Stony Brook University was the first to develop and market virtual colonoscopy and currently provides teleradiology analysis to determine the origin of chest pain at adjacent hospitals on Long Island.

We are only on the frontier of creating wireless health technologies that will revolutionize the medical world. We need considerably more investment in research and development to move promise to reality.

RECOMMENDATIONS

In collaboration with the CEAS, the School of Medicine will establish the Institute of Engineering-Driven Medicine, that will incorporate several centers. For example, the Center for Regenerative Medicine and 3D Bioprinting, which will be the first of its type in New York State, will be exclusively devoted to scientific and engineering research in regenerative medicine and its translation to clinical therapies. The center will serve as New York State's "go-to" source for replacement tissues and organs. Such a center will not only take a major step toward narrowing the gap between supply and demand for lifesaving tissues and organs in New York State, but it will also provide a nexus for industry engagement and new start-up companies. Likewise, a Center for the Future of Surgery will bring engineers and surgeons together in a space in which new ideas incubate, are reduced to practice, and then tested in both animals and humans. Toward developing the IEDM, specifically, it is recommended that we:

1. Create an educational platform for physicians and engineers to develop their "bilingual" skills.

   Many say you cannot over-communicate. In an emerging field such as engineering-driven medicine, where participants can come from highly divergent educational environments, communication across this divide is a major challenge. In addition to the forging of new interdisciplinary strategies for convergence medicine research, the IEDM will be a unique resource for graduate education and training young scientists and physicians to lead biomedicine in the 21st century. Stony Brook Medicine has already piloted a Scholars in Biomedical Sciences program whereby engineering and other basic science graduate students are provided clinical experiences to instill a notion of the critical questions that need to be addressed in clinical medicine (see: medicine.stonybrookmedicine.edu/sbms). Career opportunities for advanced degree graduates in engineering, biology and the physical sciences are rapidly evolving, and emphasize the need for communication between, understanding of and research efforts that fuse distinct disciplines. Faculty and staff of the IEDM will work to provide the courses and hands-on lab work to establish a unique curriculum that will target:

   a. For undergraduate students: The BS/MD (Scholars for Medicine program) could be expanded and preferentially focus on biomedical engineering.

   b. For medical students: Expand the current elective that couples medical and engineering students working together to craft engineering solutions to clinical problems, to create a medical school track that offers a joint MD/MS, or a year of research in the traditional MD program, or prioritize engineering in the Medical Scientist Training Program (MD/PhD).

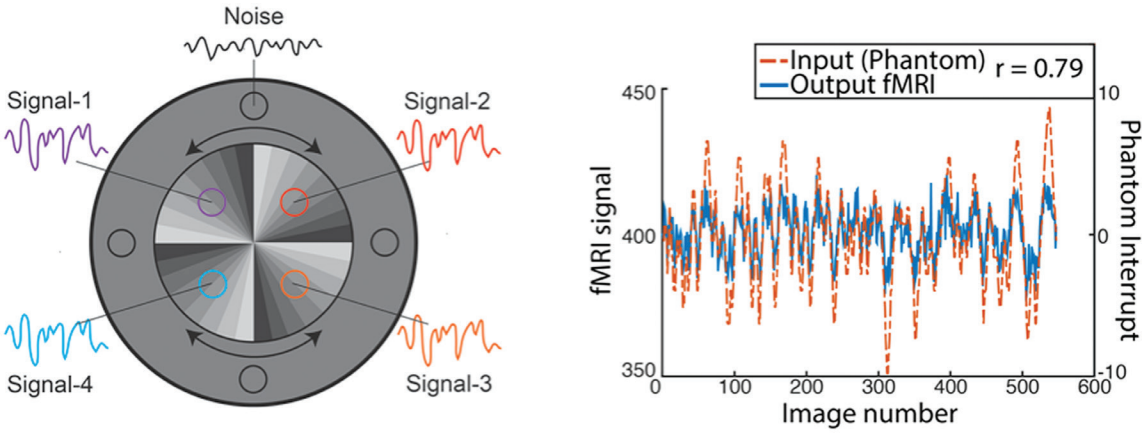
   c. For post-graduate medical residents: Create an engineering research post-doctoral fellowship.

   d. For engineering graduate students and post-doctoral fellows: Expand the Biomedical Scholars program (med into grad) and focus on engineering students.

2. Create a commercialization engine for intellectual property derived from the IEDM. This should build on the excellence already present in Center for Biotechnology.

3. The research to be conducted within the IEDM will lead to innovative digital medical devices and technologies that support patients and healthcare providers.

   These activities are expected to include advances and new products in wireless medicine, the cardiovascular system, radiology, clinical pharmacology, imaging modalities, virtual reality, telemedicine, wireless tracking, wireless ad hoc networks, home-care medicine, computational genetics and protein docking, implantable sensors and evidence-based medicine. Stony Brook University is already actively engaged



The "Dynamic Phantom" allows quantitative assessment and optimization of dynamic fidelity.

in commercialization and economic development of new technologies. The New York State Center for Biotechnology (CfB), recently designated as an NIH REACH Hub (PI: Clinton Rubin, PhD), has a long record of success in supporting collaborative research arrangements striving to accelerate the development of technologies in order to have a positive impact on human health and society. Stony Brook University is also the home of two other very successful centers of excellence focusing on technology: 1) the Center of Excellence in Wireless & Information Technology (CEWIT); and 2) the Center for Advanced Sensor Technologies (known as the Sensor CAT). The IEDM will leverage and build productive synergies between the CfB and CEWIT and the Sensor CAT to bridge the gap between basic convergence science and commercial application of new technologies that will revolutionize the future of healthcare.

4. Develop the financial support needed to launch the center.

   It is anticipated that ultimately the IEDM will become fiscally self-sustaining, as intellectual property is developed into royalty revenue streams. In order to launch the IEDM, even though many of the building blocks for developing a successful institute are already in place at Stony Brook University, a substantial financial investment will be required for developing an institute capable of transforming medicine and leading the way in the new era of technology-intense, innovative healthcare.

   Financial resources will be needed to: recruit a world-class researcher who will serve as the institute director and develop and execute its vision; an aspirational goal is to recruit five endowed chairs in CEAS and five endowed chairs in the School of Medicine who will provide intellectual leadership in the various research thrusts of the institute, requiring both endowment and current use start-up funds; create a Technological Advancement Fund, which will be used to develop the high-end instrumentation envisioned to catalyze advances in engineering-driven medicine; and endow a Convergence Medicine Venture Fund, which will be used to provide seed funding to support cutting-edge research initiatives. Both funds will be distributed annually through a competitive, peer-reviewed process to institute faculty. The emphasis will be on transdisciplinary, high-risk/high-reward research areas that have the potential to define the field and attract major sponsored grants that will sustain and grow the institute; establish a program of resident fellows to enable world-class researchers from all over the world to visit the institute and spend time collaborating with institute faculty; develop the necessary laboratory space and computational resources and infrastructure required to support institute research initiatives; and support the institute educational innovations and its entrepreneurial and economic development activities.

As outlined above, the IEDM is a natural outgrowth of the directions that faculty members and leaders at Stony Brook University have been pursuing for several years. Our track record in making technological and medical impacts is strong, and yet could be so much more, should the organizing principle of convergence medicine be given a jump start with the establishment of a well-supported Stony Brook University Institute of Engineering-Driven Medicine.

Medical oncologist Huda Salman, MD, Stony Brook University Cancer Center, is the Principal Investigator for the FDA-approved Investigational New Drug Application (IND) and clinical trial using a CAR-T cell immunotherapy approach in the treatment of relapsed and refractory T-cell leukemia and lymphoma.

An Institute for Stem Cell Biology and Regenerative Medicine

OVERVIEW

Stony Brook University has well-documented interests in stem cell research, exemplified by successful competition in many of the developmental initiatives put forth by the Empire State Stem Cell Board, the funding and regulatory body overseeing distribution of the 10-year, $550 million commitment to stem cell research within New York State. During the period from 2009 to present, Stony Brook has received over $16 million in support of stem cell research, highlighted by a $5.6 million Facilities Award that provided core and programmatic support relevant to stem cell biology and therapeutics. The interdisciplinary nature of the program was cemented by the New York State Facilities Award (funding period 2010 to 2016), which provided a much-needed, single point-of-entry presence that bridged four major academic units throughout the University (School of Medicine, College of Engineering and Applied Sciences, College of Arts and Sciences and School of Dental Medicine), 14 departments and 40 investigators. Highlights of the program included 1) launching of three Stem Cell Cores [(i) Stem Cell Processing and Education, (ii) Stem Cell Gene Transfer and (iii) Stem Cell Analysis]. These core services have been used by nearly 30 investigators across the University for the generation of gene transfer vectors, characterization of stem cell lines, training in stem cell manipulation, support services for genome editing, and generation and processing of stem cell lines. 2) Development of a formal Stem Cell Ethics presence with the initial appointment of Dr. Brooke Ellison as our Director of Stem Cell Ethics; 3) successful prior funding of an undergraduate stem cell STEM educational program (Institute for STEM Education) in conjunction with Dr. Keith Sheppard; 4) submission of two combined post/pre-doctoral training grants (Drs. Sirotkin and Colognato as PIs), using the Stem Cell Facility as the educational infrastructure; 5) successful launching of a Stem Cell Pilot/Feasibility Seed Program, 2012 to 2016. Current state of the program is jeopardized by termination of the NYS-funded Empire State Stem Cell Board, although statewide political efforts supporting continued NYS programmatic development remain an ongoing budgetary issue.

CURRENT STATUS

The current strengths of the stem cell program is its six-year history of involving investigators from four colleges; it has a formal statewide presence having been specifically supported by a New York State grant (include formal review by the New York State Stem Cell Board); it has previously been developed and configured to provide training and educational programs at multiple levels; there is a strong presence in bioethics presence; training grants have already been submitted and could readily be reconfigured; the NIH is clearly expanding its interest in cell-based therapies; and the public largely supports stem cell research (note that the bioethical issues have been largely addressed with the recent development of induced pluripotent stem cell technologies). The major concerns for the vitality of the program are lack of ongoing University-wide support, so the timing for reinvigoration of this initiative is obvious. There is currently no administrative support for this program, which is largely being maintained by non-stem cell supported personal funds.

RECOMMENDATIONS

1. Maintain and expand the viability of the Stony Brook Stem Cell Facility.

   New York State has expended considerable funds to support stem cell research at Stony Brook, and erosion of our presence would create logistical issues for future initiatives in stem cell research, and potentially undermine any subsequent opportunities from NYS for programmatic expansion. Relocating the current facility to a centralized site on campus is logical and should be pursued in renovated space that maintains the current presence that was approved by the New York State Stem Cell Board site visit team in 2012.

2. Reinvigorate the stem cell/regenerative medicine seed program.

   These prior awards were completed in conjunction with the School of Medicine TRO (Fusion) program and served as the nidus to support six to eight new investigators in stem cell research. These awards were specifically developed to promote the unique core services of the facility and to provide training and support to investigators wishing to pursue innovative directions related to stem cell research. As a major goal is to enhance the interdisciplinary nature of stem cell biology across the entire SBU campus, additional support for the Fusion Awards, with a stipulation that rewards interdisciplinary proposals, should be sought.

3. Utilize the presence of a formal stem cell program to submit stem cell-related training grant.

   Two formalized training grants in stem cell research supporting five pre-doctoral and two post-doctoral students have been submitted in the past (unsuccessfully because of lack of University matching funds). These applications should serve as useful templates for re-submission to federal (or possibly New York State) agencies.

4. Launch a quarterly lecture and annual symposium seminar series.

   These interdisciplinary educational series serve as critical fora for development of broader collaborations across the campus.

POTENTIAL SYNERGIES AND INTEGRATION WITH OTHER STONY BROOK MISSIONS

Integration with other research:

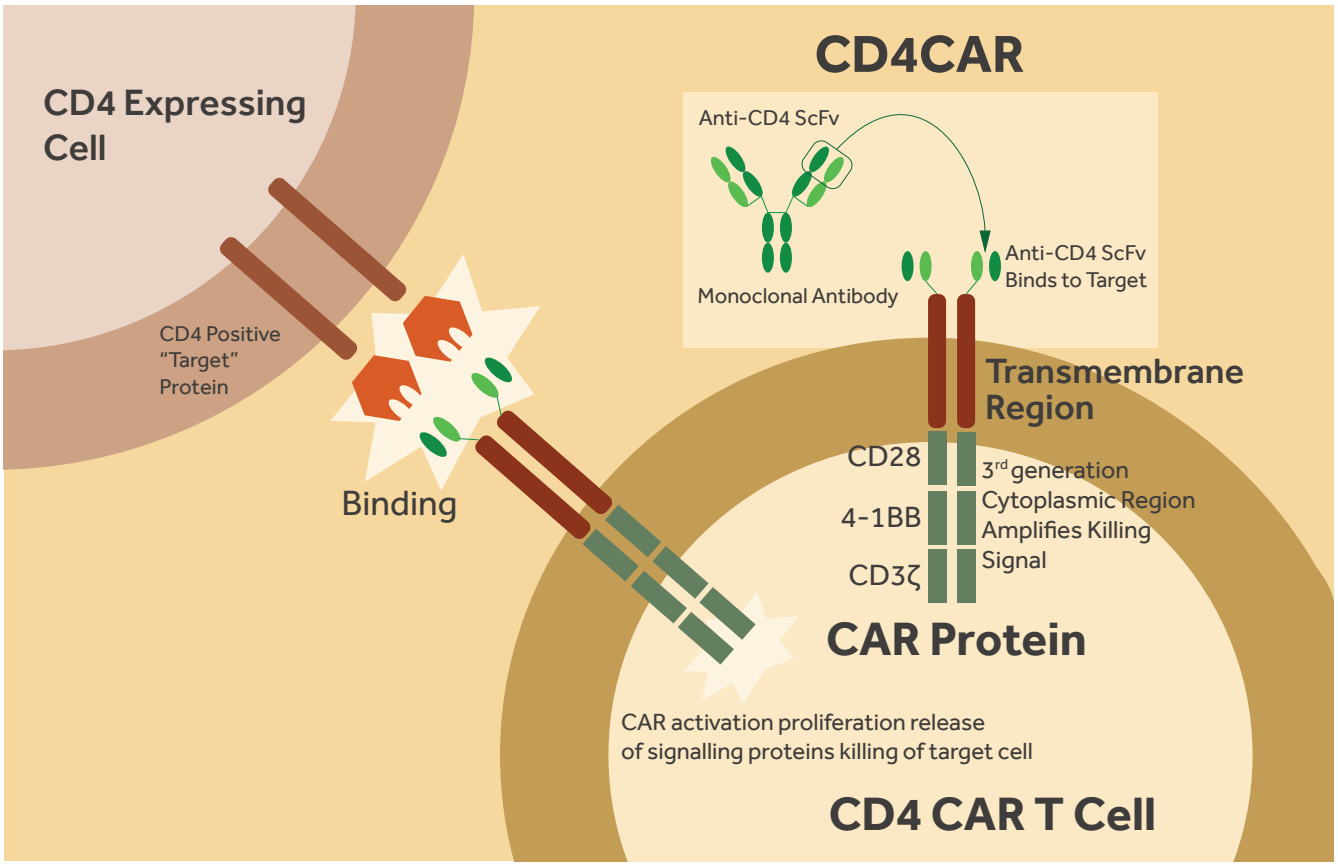
Stem cell research intersects with departmentally based research at most levels, thereby providing thematic opportunities for interdepartmental recruitments. This program has the potential to integrate with a pre-existing Human Skin Bank Center of Excellence GMP (Good Manufacturing Practice) Facility supported by New York State and the New York State Firefighters Association. This program serves as a critical piece of the resurgent in interest in engineering and medicine. Stem cell/regenerative research supports the bioimaging initiative; this collaboration extends between Brookhaven National Laboratory (BNL) and Cold Spring Harbor Laboratory (CSHL) investigators, thereby providing tri-institutional opportunities for synergy. Stem cell/regenerative medicine research has the potential to interface with the Center for Functional Nanomaterials at BNL for development of new biomaterials focusing on organ/tissue regeneration and wound healing and tissue repair.

Integration with educational initiatives:

As part of its commitment to stem cell research, NYSTEM has already funded educational and training programs at multiple levels. Stony Brook has successfully competed at one level (undergraduate) and has submitted a combined pre- and post-doctoral training grant as a second opportunity. The success of the Summer Undergraduate Award builds on comparable success by the Center for Science and Mathematics Education (CESAME), directed by Dr. Keith Sheppard. There are at least two additional training venues that will be developed with the growth and expansion of the center. First, isolation and maintenance of embryonic stem cells at the state of "stemness" requires optimized techniques currently best supported by our core facility. A 400-square-foot Education and Training Laboratory (supported by the Stony Brook Facilities grant) will be used as the centerpiece for hands-on training devoted to stem cell generation and manipulation. This four-day workshop will be provided biweekly as a broad educational resource to students and faculty, with full expectation that it will also serve as a training venue for biotechnology companies transitioning into technology commercialization. Second, we will use the stem cell program as an opportunity to expand upon a course focusing on Stem Cell Ethics and Policy, developed in conjunction with Dr. Brooke Ellison, a Suffolk County resident and nationally recognized authority on stem cell research, and Dr. Stephen Post (Director for Stony Brook's Center for Medical Humanities, Compassionate Care, and Bioethics).

Integration with the clinical enterprise:

While much of the research focusing on stem cells remains at the early stages of development, there are some areas where overlap with the clinical enterprise is more advanced. For example, Dr. Ira Cohen continues to lead efforts designed to develop stem cell-based platform therapies for lethal cardiac arrhythmias. This research builds on joint efforts with industry, and with a strong clinical cardiac electrophysiology group, and has the potential to recapitulate the functions of biological pacemakers in vivo, applying a strategy for stem cell therapies of tachyarrhythmias (atrial fibrillation and



CAR-T cell therapy, a type of immunotherapy called adoptive cell therapy, has proven its efficacy in clinical trials for various types of leukemia, lymphoma and myeloma. Stony Brook University Cancer Center is partnering with iCell Gene Therapeutics and the University of Louisville in an FDA-approved IND and clinical trial to target protein CD4 in the treatment of T-cell leukemia and lymphoma.

post-infarction ventricular tachycardia and fibrillation). Another example is Dr. Grigori Enikolopov (previously recruited from CSHL), who is developing novel stem cell imaging techniques as a tool to enhance our understanding of neurological disorders in humans, such as depression and post-operative cognitive dysfunction. The focus is on metabolomics (systematic study of the chemical fingerprints that specific cellular processes leave behind) of the brain (including neurotransmitters) that correlate with changes in neurogenesis.

Integration with the community:

Embryonic stem cell research initially emerged as one of the world's most controversial areas of biomedical research, raising complex scientific and ethical issues relevant to genetic engineering and cellular therapies. These issues are relevant to students, faculty and the public. We are fortunate in having a well-known member of the Stony Brook community as a nationally-recognized leader in stem cell ethics. Disabled from a childhood accident, Dr. Brooke Ellison has become a highly visible spokesperson and champion for stem cell research. Dr. Ellison has expressed a strong interest in serving as the community liaison for the Stony Brook Stem Cell Center. In this capacity, she will communicate with the media, educate legislators/staffers, function as our representative at public events, provide statements on ethical and policy-related changes in research and serve the community by building initiatives between groups and industry. These responsibilities will considerably expand the overall breadth of the program and provide a valuable opportunity to enhance our political visibility within the community and in New York State.

Biomedical researcher Chris Clarke, PhD, working in the Stony Brook University Cancer Center Laboratory.

Leading the Way in Biomedical Research

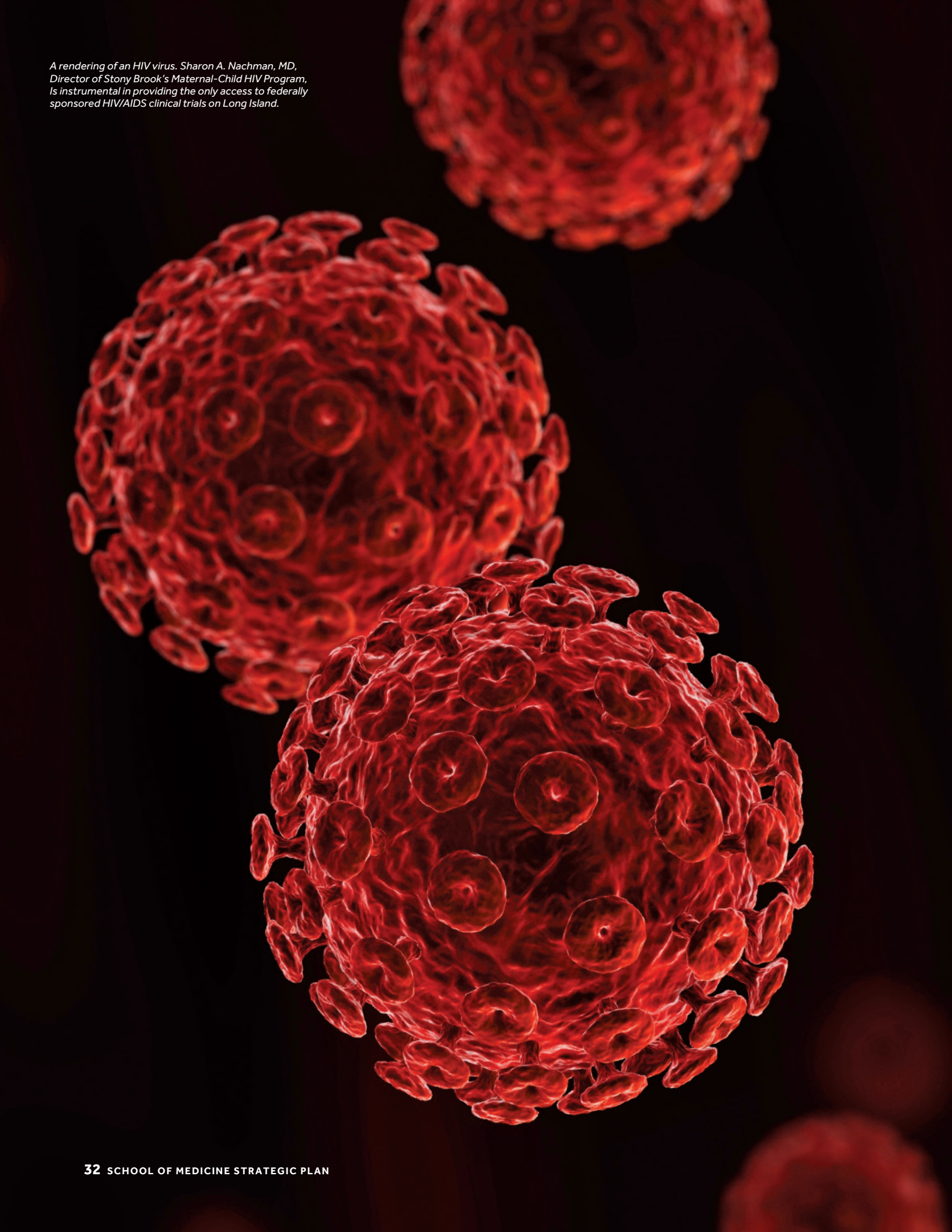
OVERVIEW

For the School of Medicine and its faculty to achieve and maintain a competitive edge in biomedical research with translational potential, a number of infrastructure tools will be required. Based on national trends, the School should consider enhancing infrastructure to support the following approaches: 1) expanded availability, accessibility and utilization of electronic databases for mining and analyzing health-related information and outcomes; 2) progressive focus on pharmacogenomic approaches for tailored therapeutics and personalized medicine; 3) interest in early detection and prevention in human diseases; 4) expanded emphasis on translating basic discoveries into clinically relevant diagnostics and therapeutics; and 5) invigorated scrutiny on assessing the economic impact of new devices and therapeutics for developing cost-effected strategies for optimizing population health. Many of the infrastructure needs delineated below are also highly relevant to the educational, clinical and community components of the strategic planning process.

CURRENT STATUS

In the past five years the following School of Medicine infrastructure has become (or is about to become) available for use by our faculty and faculty across the entire campus, including (a partial list):

1. Advanced imaging center, including cryo-electron microscopy, ultra-high resolution light microscopy (STORM), enhanced fluorescence microscopy, fMRI (the School of Medicine partners with Psychology on the Scan Center), ^{18}F PET tracer laboratory, ^{11}C PET tracer and other radioisotope laboratory, 9.4T and 7T rodent PET/MRI scanners, 3T human simultaneous PET/MRI scanner along with other PET and CT scanners.
2. Advanced protein structure determination capacity, including cryo-electron microscopy, NMR structure determination, proteomics and metabolomics via mass spectroscopy.
3. Construction of an animal biological safety laboratory level III (ABSL3) for high-level pathogen studies.
4. Construction of three floors of wet laboratory space for cancer biology in the Medical and Research Translation (MART) building.
5. Remodeling of 57,000 square feet of laboratory space in the Health Sciences Tower and Basic Sciences Tower.
6. Launched a Cancer Clinical Trials Office and recruited clinical research managers in anticipation of application for a Clinical Translational Science Award (CTSA).



A rendering of an HIV virus. Sharon A. Nachman, MD, Director of Stony Brook's Maternal-Child HIV Program, Is instrumental in providing the only access to federally sponsored HIV/AIDS clinical trials on Long Island.

Clinical Research

OVERVIEW

Continued development of the Stony Brook Clinical and Translational Science Institute (SBCTSI) will provide an infrastructure in keeping with the NIH vision for transforming the process of translational investigation. An extensive infrastructure of translational research resources, clinical facilities and biomedical informatics have begun to be assembled to facilitate clinical and translational research. Continuation of this strategy will lead to the development of expert care models and partnerships with affiliates and the local community, which in turn will lead to improved health and support the multidisciplinary teams pursuing bench-to-bedside technologies to advance patient and population-based health initiatives. The recent Stony Brook Medicine affiliation agreement with Southampton Hospital, and the pending (virtually identical) affiliation with Eastern Long Island Hospital provides additional clinical resources for streamlining translation. Furthermore, SBCTSI will train and cultivate the translational science workforce and engage more patients and communities in the translational process. SBCTSI will strive to obtain the federal Clinical and Translational Science Award (CTSA) and submit an application to National Center for Advancing Translational Sciences by September 2019 or 2020.

CURRENT STATUS

The SBCTSI is designed to establish a home that will support the transformation of clinical and translational research and education: This institute will provide data management, study coordinators, IND support, trials and recruitment process streamlining, and biomedical informatics support necessary for facilitating investigator-initiated research and data analysis. It should act to coordinate a comprehensive informatics infrastructure to facilitate bench-to-bedside-to-community practice and health policy research among affiliated institutions. In order to achieve CTSA designation, it is required that it develop education and training programs that rigorously prepare learners at different levels and from multiple disciplines to conduct interdisciplinary research leading to novel treatments, drugs, diagnostics and medical devices. And it should provide a single point-of-entry site for study design and biostatistical analyses.

RECOMMENDATIONS

1. Create an academic home (albeit distinct from a department with the power of primary recruitment and appointment).

   The SBCTSI will support the transformation of clinical and translational research and education.

2. Coordinate a comprehensive informatics infrastructure.

   In order to facilitate bench-to-bedside-to-community practice and health policy research, the SBCTSI will ensure data security and privacy; synergize and support research collaborations between informatics faculty and clinical and translational researchers and share new approaches with the national CTSA consortium. The Biomedical Informatics Core will integrate disparate but well-developed informatics expertise. Enhanced informatics service and research resources will be provided; create a central access point for research teams; and establish an infrastructure for interoperability and sharing (both locally and nationally). In addition, ensure data security and privacy, and synergize and support research collaborations between SBCTSI informatics faculty and clinical and translational researchers. This will support existing research and foster new innovative research by incorporating informatics capabilities, such as visualization, natural language processing and advanced imaging analysis. A Liaison to Trial Innovation Centers will develop a local trial innovation unit that streamlines and facilitates study start-up and implementation. They will work on accelerating IRB, budgeting, contracting and other start-up time lines through parallel, rather than sequential work steps, and process re-engineering.

3. Transform the culture of clinical and translational research education into a system that provides rigorous training opportunities for students, young investigators and other clinicians to conduct interdisciplinary, translational and collaborative research.

   The Clinical and Translational Research Training Program (CTRTP) will be the academic home for CTR education and training. New components of the education and training initiative include:

   a. A new T32 program to support trainees in the professional schools who will enter a joint professional degree/MSCR program.

   b. A new K12 program that will support young faculty who will earn advanced degrees in CTR and carry out mentored research as part of a structured program designed to lead to research independence.

   c. Establishment of the Clinical Training for Translational Scientists (CTTS) program to connect PhD students with clinical mentors and provide them with relevant clinical didactic preparation and experiences.

   d. Implementation of a novel program to train mentors.

   e. Training programs for research coordinators and nurses.

4. Encourage, prepare and incentivize researchers to develop interdisciplinary research collaborations leading to new treatments, drugs, diagnostics and medical devices, and provide the resources for their success.

   SBCTSI will supply basic and clinical investigators with the support and expertise they need to seamlessly translate basic science into clinical inquiry by establishing new key functions as briefly described below.

5. Create an environment that fosters Novel Methods and Pilot Project Programs.

   To encourage new investigators to apply novel methods in CTR that cross departmental and disciplinary boundaries, a pilot projects program is offered annually and funded entirely with institutional funds. This FUSION Seed-Grant Award provides up to five $80,000 ($40K x two years) awards. These awardees will utilize the funds to support interdisciplinary, basic and applied research, and/or community-based research with the potential to advance health, add value to clinically relevant diagnostic and therapeutic technologies, or to facilitate development of commercially promising biomedical intellectual property.

6. Develop greater understanding of regulatory requirements for clinical investigation.

   To assist investigators in meeting regulatory obligations, we will create the Translational Research Office of Support Services (TROSS), which will provide researcher-focused support to assist investigators in complying with internal and external regulatory requirements, preparing budgets and ensuring completion of compliance training for investigators and trainees.

7. Create a Research Design Incubator (RDI) designed to provide a centralized infrastructure for study design, epidemiology, biostatistics and research ethics support.

8. Create a Participant and Clinical Interaction Resource (PCIR).

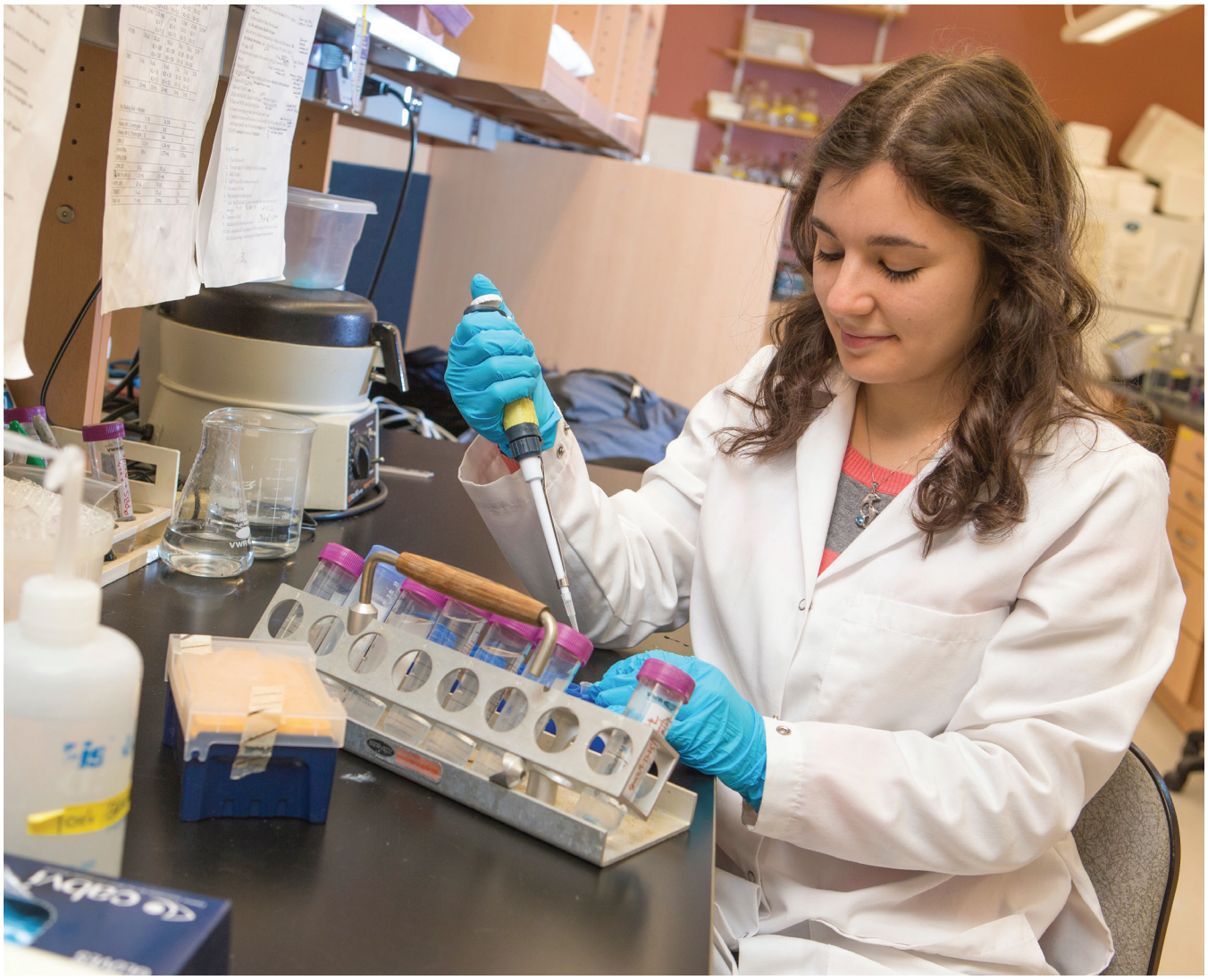
   The scope of SBCTSI activities will be expanded from a traditional inpatient discrete hospital unit to include satellite facilities in the Emergency Department, intensive care units, ambulatory practices and in the community setting. Unique resources, including a clinic on wheels, and the Mobile Dental Clinic of the Stony Brook University School of Dental Medicine will bring research studies to the community.

9. Create a Translational Technologies Core (TTC).

   The TTC will support clinical and translational research by making cutting-edge technologies more widely available and educating faculty and students about potential utilization of these cores in their research.

10. Transform existing programs and create new ones to engage the community and address disparities at all levels.

    Coordination, expansion and focusing of currently available outreach programs and strengthening ties with critical community leaders and agencies will be accomplished through the formation of the Community Engagement Research Core (CERC). Community partnerships will be fostered through interactive websites for the public, community focus groups, traveling workshops to provide information about being a research participant and outreach programs. A Community Advisory Board (CAB) will be established to seek input from the community, provide advice to CERC leadership and assist in the development and expansion



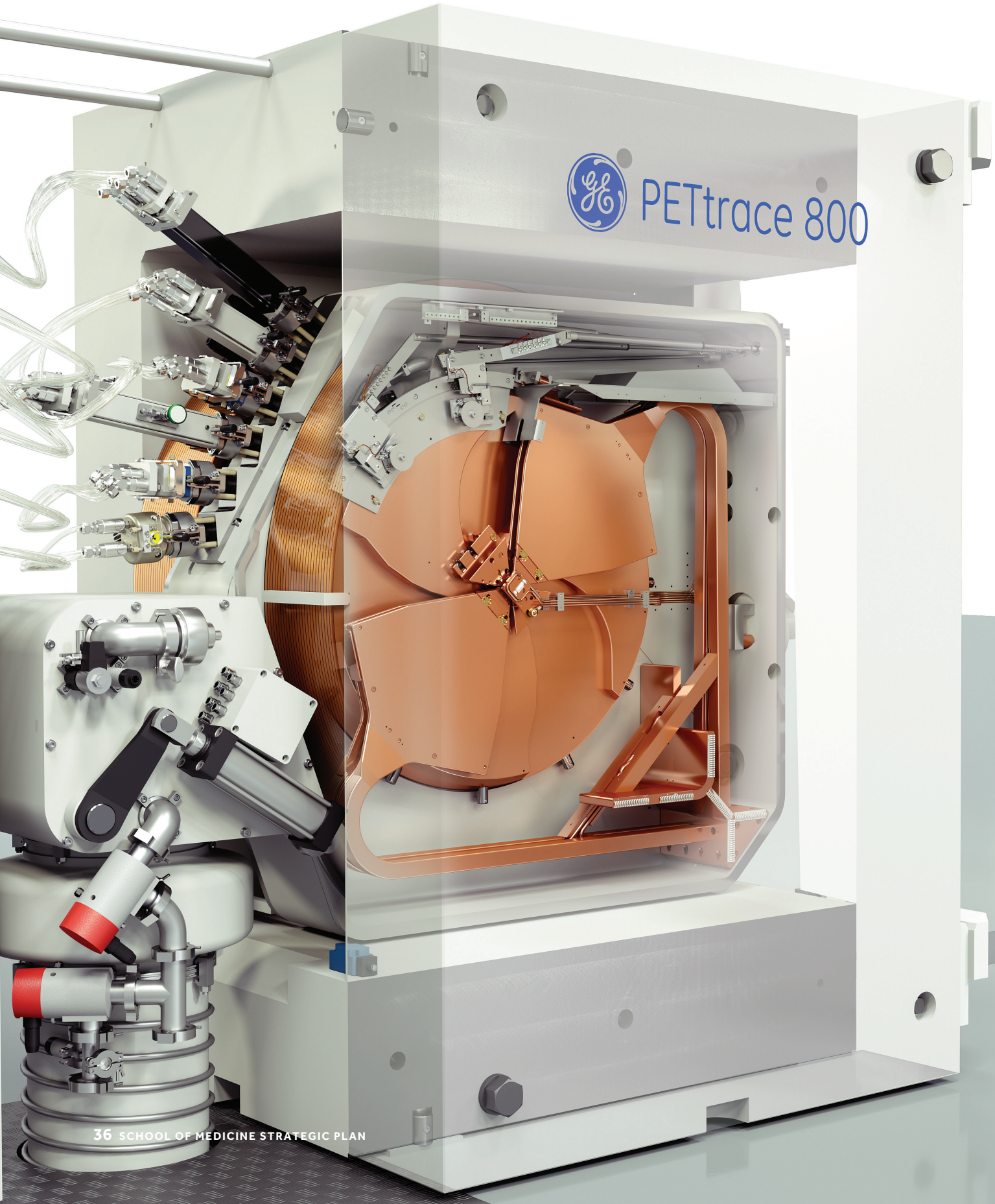
Student Alessandra Riccio working in the Prives pharmacological lab.

of community affiliations. In addition, SBCTSI will aggressively recruit minorities, women and the disabled to its training programs and faculty through a diverse range of outreach campaigns.

POTENTIAL FOR INTEGRATION WITH OTHER STONY BROOK MISSIONS

1. The NIH vision for development of regional centers that promote translational research
2. SUNY REACH, for development of an integrated program promoting the health of New Yorkers
3. Stony Brook University Institute for Engineering-Driven Medicine
4. Stony Brook Medicine Advanced Imaging Center/ Positron Emission Tomography (PET) Research Core
5. Stony Brook University Biomedical Informatics Core
6. Stony Brook University Cancer Center
7. Suffolk Care Collaborative (SCC), part of New York State's Delivery System Reform Incentive Payment (DSRIP) Program
8. Center for Public Health and Health Policy Research
9. The Stony Brook University College of Business to focus on health research economics

Stony Brook University Cancer Center uses leading-edge technology, such as the cyclotron (shown here), which will be housed in Stony Brook's Medical and Research Translation (MART) building, to enhance diagnostic capabilities and provide a resource for advancing cancer research.



State-of-the-Art Core Facilities

OVERVIEW

Expanded core facilities are designed to:

1. Provide sophisticated, competitively priced technological services in genomics, proteomics, metabolomics, microscopy and cell sorting to support cutting-edge biomedical research.
2. Provide scientific expertise to assist investigators in experimental design and data interpretation (the Research Design Incubator).
3. Make the use of these sophisticated technologies more accessible and streamlined through iLab operations software by Agilent.

RECOMMENDATIONS

1. Create a flow cytometry strategic plan.

   The flow cytometry core facility was recently upgraded to the latest cell sorting and analysis capabilities in the field. The director will undertake to establish a Core users group which will serve as a forum for further requests of new capabilities as they become available and through lectures to make new investigators considering flow cytometry in their research/grants to become aware of the core's extensive capabilities.

2. Create a biological mass spectrometry shared resource.

   Proteomics experiments have evolved from simple protein identification to the quantitation of proteins, metabolites, lipids and post translationally modified proteins, under differing biological or drug treatment conditions. Applications of this technology are highly relevant not only for biomarker development, but for whole cellular analysis focusing on functional endpoints, for example in the measurement of signaling networks and/or cellular metabolism. To provide optimal capabilities in analyte quantitation, the facility seeks to obtain two new mass spectrometers with enhanced speed and sensitivity, thereby allowing the user to optimally extract mass spectroscopic data from precious tissue/cellular samples. Instruments that will considerably enhance our capabilities in biomedical proteomics, lipidomics and metabolomics include:

   a. Thermo Orbitrap-HF or Sciex 5600+ – Either of these two instruments will dramatically enhance the spectroscopic capabilities and capacity by providing enhanced sensitivity and mass accuracy for global proteome characterization and quantitation of signaling networks mediated by post-translational modifications (i.e., phosphorylation, ubiquitination, etc.); the enhanced sensitivity and accuracy are major advantages in clinical situations where tissue availability is limiting.

   b. Sciex 5500 Linear Ion Trap – The current TSQ Access is used for small-molecule analysis, metabolite measurement, lipid identification and quantitation and pharmacokinetic analysis. The proposed instrument is solid and well-designed and will provide more precise peptide-based protein quantification required for high-throughput protein, metabolite and lipid analysis and biomarker-based discovery projects. In addition to these major instrumentation needs, supporting equipment will be required including high-pressure liquid chromatographic pumps for high-throughput peptide separation, mass spectrometry-related software to support the high-throughput functions and an upgraded computer cluster for data analysis and storage.

3. Create a genomics core facility.

   Next-generation sequencing technologies provide robust opportunities for gene discovery and the study of human genomic variability linked to human disease and/or treatment responses. Specific applications include whole transcriptomic sequencing, metagenomics, structural variance analysis and deep re-sequencing, as well-developed examples.

Joel Saltz, PhD, Chair of Biomedical Informatics at Stony Brook Medicine and a board-certified clinical pathologist, is at the forefront of a major breakthrough in the development of digital solutions for pathology slide specimens.

Stony Brook University is a founding member of the New York Genome Center (nygenome.org). Faculty members are able to use the Center at reduced rates to perform high-throughput analytic studies and can also take advantage of its informatics capabilities. In addition, the University is in the process of obtaining a platform for large-scale sequencing on campus. We have also filled a gap in having support personnel available for computational biological analyses and for software licenses that are required for optimal extraction and manipulation of complex genomic data sets, in concert with the new Department of Biomedical Informatics. In fact, it is envisioned that while we will continue to require genomic-level sequencing capacity for clinical analyses, once genomic-level sequencing is affordable and is used to make clinical diagnoses, one can make a compelling argument that the key to genomic research of the future will be to have intellectual resources invested in biomedical informatics rather than in the machines that provide sequence, as the latter is becoming immediately available online.

Biomedical Computational Science and Biomedical Data Science

OVERVIEW

Biomedical informatics comprises the intersection of computation, data science and artificial intelligence research, which have become primary drivers of progress in biomedicine. The American Medical Informatics Association defines biomedical informatics as "the interdisciplinary field that studies and pursues the effective uses of biomedical data, information and knowledge for scientific inquiry, problem solving and decision-making, motivated by efforts to improve human health."

The ability to proactively manage the health of patient populations, assess and maintain quality of healthcare delivery, and extract and synthesize information from clinical data are all predicated on fluent abilities to capture, aggregate and extract meaning from that data. Progress in precision medicine depends on high-throughput molecular analytics coupled with data science and computation needed to reduce theoretical discoveries to practice. Precision medicine encompasses computation, mathematics and engineering. Pathology and radiology images along with increasing flows of data from in-hospital, home sensors and patient reported outcomes represent primary sources of data about patients. Integration of image and sensor data capture, analytics and artificial intelligence with healthcare data platforms is proceeding quickly and promises to improve healthcare delivery, precision and quality of prevention and treatment.

The 2010 Strategic Plan envisioned the creation of a Department of Biomedical Informatics as the central organizing focus of biomedical informatics at Stony Brook. From the 2010 Strategic Plan:

It is envisioned that a new Department of Biomedical Informatics (DBMI) be created with two major purposes; first, the DBMI will be tasked with developing the tools necessary to decipher causative and epiphenomenal components of large genomic and proteomic studies of the origins of disease and its response to various therapies. Second, the new Department will be the driver of: 1) extracting useful information from a myriad of clinical sources, patient history and physical examinations, chemistry, hematology and other laboratory evaluations, all the major imaging techniques and pathological specimens, and 2) sharing insights of clinical practice so generated with clinicians in real time to impact the quality of clinical care delivery. It is envisioned that most or all faculty recruited to DBMI will be secondarily appointed in other departments, to facilitate ongoing collaborations.

CURRENT STATUS

In the intervening seven years, the Department of Biomedical Informatics was established and a founding chair and many new faculty members were recruited. The activities and objectives of the department align remarkably well with the vision set out in the 2010 Strategic Plan.

The department has a foot on each Stony Brook campus and is part of both the School of Medicine and CEAS. This integration allows for melding of the best ideas in engineering and medicine to drive innovation. Now in its fourth year, there are seven faculty members with primary appointments in the School of Medicine, and three faculty with primary appointments in CEAS. The faculty recruited have been primarily highly promising junior faculty; there are currently two professor-rank faculty, including the chair along with an associate professor-rank faculty. The remaining primary faculty are currently assistant professors. Eight of the faculty members are primarily research focused with two School of Medicine research assistant professor faculty having a primary service focus.

There are 11 School of Medicine secondary appointees, from the Departments of Pathology, Anesthesia, Emergency Medicine, Orthopedics, Surgery, Psychiatry, Family, Population and Preventive Medicine, Medicine and Radiology, and six CEAS secondary appointees. There is currently one post-doctoral fellow and approximately 30 graduate students.

The research, service, education and practice plan arms of the biomedical informatics strategic plan will integrate to create a synergistic relationship that will support the advancement of basic science, targeted personalized medicine, population health and education across the region.

A strong biomedical informatics research program is crucial to development of a top-ranked department of biomedical informatics. Strong biomedical informatics research will also be crucial for success of Stony Brook's plans for NCI Cancer Center designation and crucial to Stony Brook's effort to win a CTSA award. The Department of Biomedical Informatics is integral to both efforts and currently leads the Imaging Bioinformatics and Engineering Program in the Cancer Center. The Department of Biomedical Informatics currently has a number of high-profile research grants, including a multisite National Cancer Institute U24 cooperative grant and an NSF CAREER award.

Recruitment of highly talented junior faculty and engagement of these faculty in collaborative team science efforts, Cancer Center research and healthcare informatics research will drive a dramatic increase in grant funding over the next five years. Broadly defined, the two primary areas of current concentration are:

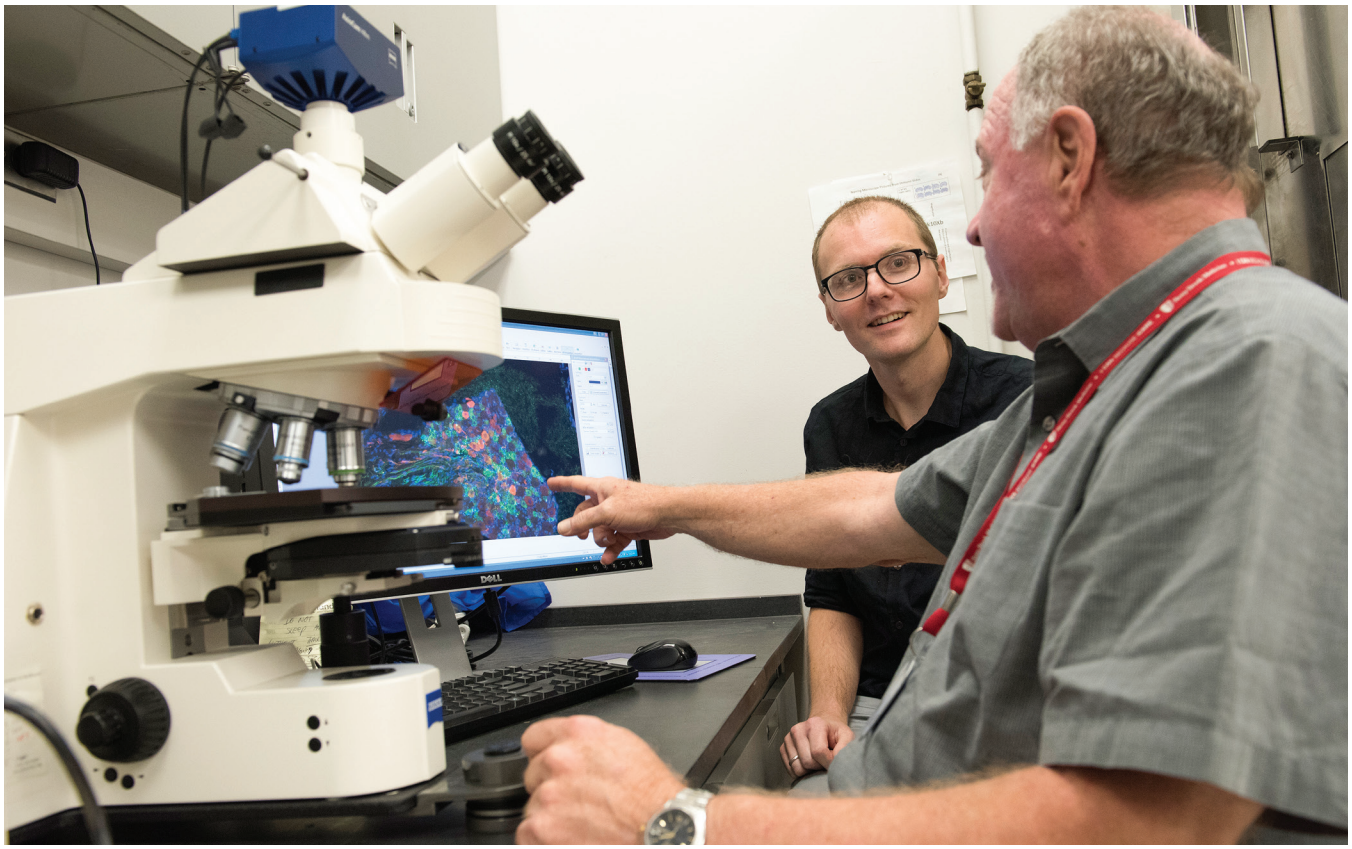
> The current primary research thrust of the department is multiscale imaging informatics, using multiple computing methods to extract, quantify and codify pathomics, molecular, sensor and radiomic data to drive translational research and clinical management. Large-scale integration of quantitative imaging data to clinical registries nationwide will allow a better understanding of which imaging features should drive therapy and influence outcomes. The department will develop methods, algorithms and tools necessary to decipher causative and epiphenomenal components of large "omic," tissue and imaging-based studies of the origins of disease and its response to various therapies.
>
> The department faculty drive data integration using cutting-edge tools to allow 1) extraction of useful information from a myriad of clinical sources (patient history and physical examinations, chemistry, hematology and other laboratory evaluations, all the major imaging techniques and pathological specimens); 2) sharing insights of clinical practice so generated with clinicians in real time to impact the quality of clinical care delivery; and 3) mining and understanding population-level data to drive resource allocation and inform health care decisions at a population level; for example, defining the population and collaborating to assess needs of the Stony Brook and national patient populations.

The department offers advanced graduate certificates and master's and doctorate level degrees have been approved by SUNY for Stony Brook University. The PhD program launched fall 2017 at a very limited scale with two funded PhD positions. A small number of master's and certificate students will enroll in academic year 2018. The department aims to expand the current PhD program to target a total enrollment of at least four to five new students each year. This will require a substantial increase in graduate student support. We aim to dramatically expand the master's and certificate programs through offering this program in Manhattan with tentative location of SUNY College of Optometry. This would leverage Stony Brook's proximity to Manhattan, attracting students from all over the New York metropolitan area to both the master's and certificate programs. A targeted enrollment of 125 students per year will attract PhD students and provide revenue to support biomedical informatics PhD students and academic infrastructure.

An ACGME-approved post-graduate fellowship in biomedical informatics is planned, building upon the current fellowship offered through the Departments of Biomedical Informatics and Pathology in academic years 2016 and 2017. The first fellow began in July 2016 and has been highly productive, and the second started in July 2017.

Within the School of Medicine, training will be provided to students and faculty to educate the community in clinical informatics as it applies to the practice of medicine at both a patient and population level. A core course for the rising second-year medical students has been approved and will begin in Spring 2018. A Clinical Informatics Boot Camp has been developed for interested medical providers, and electives are an ongoing part of the Stony Brook medical education. Resident-level courses are also under development.

The Department of Biomedical Informatics is both a clinical and basic science department. The department will assume a leading national role in developing patient-



Researchers Keith Studholme (front) and Martin Kaczocha, PhD (back), Department of Anesthesiology, review an image of sensory neurons that express the protein FABP5. They are actively developing medications to target and inhibit the protein to reduce pain.

facing informatics support to improve patient outcome, care and satisfaction, consultation and decision support to guide patients through the healthcare system and to help healthcare providers make critical decisions concerning patient care. Departmental faculty and staff currently contribute to a variety of healthcare quality efforts, collaborate with the clinical documentation group to improve Stony Brook risk adjustment and contribute in many ways to the DSRIP population health effort.

RECOMMENDATIONS

Going forward, the Department of Biomedical Informatics is ideally positioned to provide the following healthcare-related services:

1. Analysis of genetic/genomic/immunological data in light of clinical data to generate individualized assessments and recommendations for targeted therapies.
2. Support, deployment and development for patient-facing customized electronic health record linked reminder, decision support, telemedicine and wellness software that leverages the new FHIR standards.

   Note: FHIR-based methods will make it possible to create highly customized, vendor-independent, HIPAA-compliant extensions to core electronic health record systems.
3. Support for digital telepathology for sub-specialty sign-out and for clinical situations requiring very fast turnaround.

   This innovation will include pathology-related decision support enabled by digitization and addresses the consequences of the FDA decision to allow digital pathology for primary diagnosis.
4. Data analytics to capture, track and resolve radiology- and pathology-based incidental findings and diagnoses requiring follow-up.
5. Data analytics to improve identification and characterization of co-morbidities, complications and pre-existing conditions needed for population health management, properly nuanced healthcare quality assessments.

   This work will also contribute to information needed for value-based purchasing and risk adjustment.

6. Support, deployment and development for healthcare provider-facing, customized FHIR-based decision support, healthcare quality, population management methods.

7. The Department of Biomedical Informatics should take the lead in developing data and bioinformatics shared resources associated both with the Cancer Center and with the CTSA proposal effort.

   It is an overarching need in translational research to access and integrate disconnected information systems into a unified technological platform using a common data model and to support a variety of health system, "imaging" and "omic" data analytics. The Research Support Shared Service effort will:

   a. Store and federate data from specialized laboratories and core resources across the University and our partner institutions.

   b. Develop and manage a Clinical Data Warehouse and a Research Data Warehouse to allow rapid access to information about data and other research resources specifically relevant to human health and treatment outcomes.

   c. Provide informatics and data management consultation.

   d. Ensure data security.

   e. Support tools for education in biomedical informatics.

   f. Provide necessary informatics and research infrastructure support for the institutional CTSA.

   g. Serve as the data core for the Stony Brook Cancer Center and the CTSA proposal.

The software and services will provide for expanded opportunities in:

   a. Translating genomic knowledge into clinical studies.

   b. Imaging informatics.

   c. Comparative effectiveness research.

   d. Clinical quality assessment and improvement.

8. Financial support and sustainability.

   The department has been successfully launched with initial faculty recruited, graduate educational programs established, and research directions and external funding obtained. The Stony Brook Biomedical Informatics program competes with a variety of much larger and better funded institutions, such as Columbia, Pittsburgh, Harvard, Stanford and UCSD. Substantial funding will be required to develop a Department of Biomedical Informatics that will able to compete with these institutions. The ability to obtain income from clinical informatics and research informatics services and income from a large-scale Manhattan-based educational program are key components of the strategic plan. Funding from these sources will be employed for:

   a. Support for biomedical informatics research – faculty recruitment, seed funding for faculty research, funds to support conference presentations and biomedical informatics continuing education.

   b. Investment in development of new services to be provided by the Biomedical Informatics Practice Plan.

   c. Support for PhD training and informatics fellowship training.

Program in Biomedical Imaging

OVERVIEW

Stony Brook University is known for its scientific contributions in biomedical imaging sciences. As examples, Paul Lauterbur, PhD, 2003 Nobel Laureate, pioneered magnetic resonance imaging (MRI) while in the Department of Chemistry; positron emission tomography (PET) technologies were developed in collaboration with scientists at Brookhaven National Laboratories; and hyperpolarized MRI of the lung, virtual colonoscopy for early colon cancer screening, and low-dose x-ray tomosynthesis for early and more sensitive cancer detection are now all in widespread clinical application. Our faculty also made notable contributions in applying these imaging technologies to study anatomy, physiology, metabolism and function in health and disease, including in the areas of cancer, neuroscience, psychiatric/neurologic disorders, cardiovascular diseases and infection/immunology. The School is committed to solidifying and further strengthening the SBU position as a world-leading academic institution in biomedical imaging sciences. With this continuing commitment, we propose to establish a transdisciplinary Biomedical Imaging Program. We will recruit biomedical imaging faculty in strategic areas, acquire and develop innovative imaging technologies, enhance existing preclinical imaging resources and establish an exceptional training environment in biomedical imaging sciences. This program will strengthen bi-directional translation of basic and clinical research by providing structural, physiological, metabolic, molecular and functional imaging data at unprecedented sensitivity, spatial and temporal resolution. This program will also enhance synergistic collaboration among basic, translational and physician scientists across departments, institutes, centers and schools to advance biomedical imaging sciences and their applications for the improvement of human health. And the Program will serve all Stony Brook University School of Medicine strategic themes in cancer, neuroscience, cardiovascular health and immunology/infection, as well as strategic programs in biomedical informatics and engineering-driven medicine.

CURRENT STATUS

In recent years, the University has invested substantially in the following state-of-the-art research imaging equipment: a human PET/MRI 3T Siemens ($5.5 million), human 3T MRI Siemens Vera ($2.1 million), human 3T MRI Siemens Prisma ($2.5 million), an animal Inveon PET/SPECT/CT ($1.1 million), an animal 7T Bruker MRI ($2.5 million) with PET insert, an animal 9.4T Bruker MRI ($2.5 million) that accommodates the same PET insert, a cyclotron ($2.5 million) and an extensive radiochemistry infrastructure ($10 million). Moreover, the School of Medicine has invested substantially in recruiting the following faculty leaders: Ramin Parsey, MD, PhD (Chair of Psychiatry, PET/MRI imager); Mark Schweitzer, MD (Chair of Radiology, MRI expert); Anissa Abi-Dargham, MD (Vice Chair for Research, Psychiatry, PET imager); Tim Duong, PhD (Vice Chair for Research, Radiology, MRI expert); Peter Smith-Jones, PhD (Director of PET Radiochemistry, radiochemist); Mark Slifstein, PhD (Director of PET Research Core); Anat Biegon, PhD (Director of Research, Neurology, PET tracer validation); Paul Vaska, PhD (PET physicist) and other imaging scientist faculty members and radiochemists, including Christine DeLorenzo, PhD; David Hsu, PhD; Chuan Huang, PhD; Jared Van Snellenberg, PhD; Xiang He, PhD; Nashaat Turkman, PhD; and Eszter Boros, PhD.

As a result of these intellectual and instrumentation investments, the number of imaging grants that these resources have served and are serving in recent years has dramatically increased and is expected to grow even more rapidly. These biomedical imaging resources have made and continue to make positive impacts across many research and clinical disciplines. Therefore, we propose to create a new transdisciplinary Biomedical Imaging Program to further solidify and strengthen

our position as a world-leading academic institution in biomedical imaging sciences. To this end, we make the following recommendations

RECOMMENDATIONS

1. Recruit additional biomedical imaging faculty members.

   SBU has invested substantially in biomedical imaging and radiochemistry equipment. While SBU has a growing number of imaging users, further innovation in MRI technologies and support of the growing non-imaging scientist and clinician scientist user base require investment in additional MRI technical expertise. We propose to recruit a technical MRI physicist faculty member to develop and implement innovative MRI biomarkers in support of Stony Brook University School of Medicine strategic themes and programs.

   An adequate number of funded imaging users are needed to fully utilize and sustain the ongoing operating costs of imaging resources. We propose to recruit four faculty (PhD and/or MD) who are expert PET and MRI users in the areas of cancer, neurosciences, infection/immunology, cardiovascular diseases or neurological/psychiatric disorders.

   With the already-made investment in state-of-the-art preclinical imaging (MRI, PET, SPECT, CT, US and bioluminescence) equipment for small animal research and the departure of a few preclinical imaging scientists, additional preclinical imaging scientists are needed to support the rapidly growing user base of non-imaging scientists and physician scientists. To this end, we propose to recruit two preclinical MRI and PET imaging scientist faculty. These recruitments should facilitate and enhance translational research from benchtop to bedside across all School of Medicine strategic themes and programs.

   These faculty recruitments should spread across multiple School of Medicine departments and, where possible, in synergy with College of Engineering and Applied Sciences (Departments of Biomedical Engineering, Computer Science, Materials Science and Chemical Engineering, and Biomedical Informatics) and College of Art and Sciences (Departments of Psychology, Neurobiology and Behavior, Pharmacology, Chemistry and Physics). Specifically:

   a. Recruit a technical MRI physicist faculty member.

   b. Recruit several MRI and PET faculty members who focus in areas of cancer, neuroscience, immunology, cardiovascular health and utilize PET/MRI instruments.

   c. Recruit several preclinical MRI/PET faculty.

2. Establish a formal Preclinical Imaging Center.

   Preclinical imaging plays a vital role in bi-directional research translation from benchtop to bedside. SBU now has state-of-the-art and highly competitive MRI, PET, SPECT, CT, US and bioluminescence imaging equipment for small animal imaging but these resources are scattered and separately managed. It would be beneficial to consolidate these resources into a single administrative structure to promote our preclinical resources, facilitate usage, share expertise and reduce operating cost by economy of scale (e.g., administrative support and service contracts). The respective resources will continue to manage their own budgets. With existing preclinical imaging, additional investment cost to achieve this goal is minimal. There are only a few animal PET/MRI scanners in the world, and SBU has unique and competitive hardware PET expertise (e.g., custom-built wearable animal PET detectors). This animal PET/MRI scanner will also enable SBU to leverage the existing state-of-the-art radiochemistry resources and facilitate clinical translation onto the existing human PET/MRI scanner. Specifically:

   a. Consolidate preclinical imaging resources into a single administrative structure.

   b. Develop and build a second animal PET insert devoted to the animal 7T MRI scanner.

3. Acquire a whole-body 7T human MRI.

   The majority of the leading medical schools and academic health science centers utilize a whole-body 7T human scanner. MRI at 7T offers better sensitivity, spatial and temporal resolution, diagnostic image contrast, fiber-tracking and fMRI resolution, among others. MRS at 7T offers better sensitivity and spectral resolution for studies of neurotransmitters (e.g., GABA and glutamate) turnover rate and metabolic rates (i.e., glucose transport rate). With maturing MRI technology, such systems are now approved for clinical use in Europe and is under FDA consideration for clinical use in the United States.

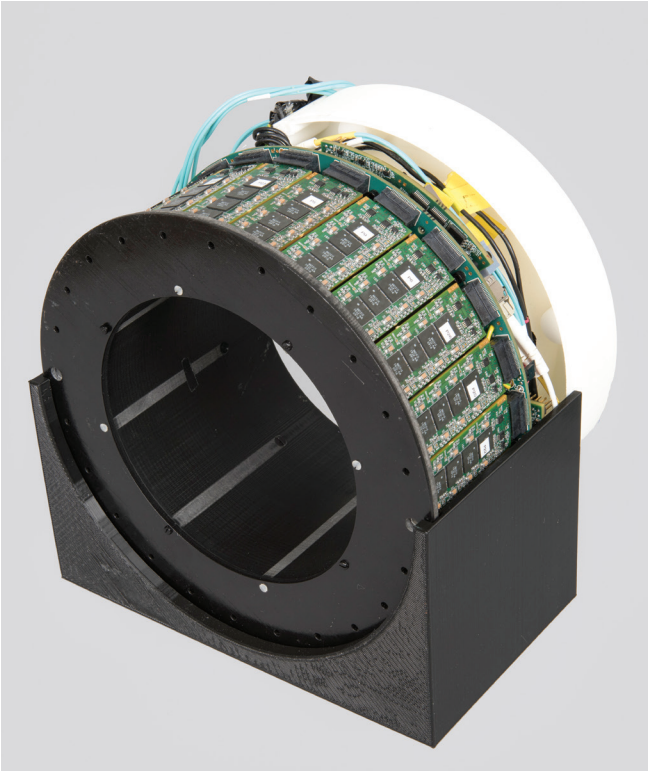
It is proposed to acquire a human whole-body 7T MRI and spectroscopy (MRS) system. While there are a variety of research applications, we will focus on two primary research areas: 1) development of advanced imaging and spectroscopic methods to achieve unprecedented spatial and/or temporal resolution for studies of health and disease and 2) applications of these methodologies to study structure, physiology, metabolism and function in humans as related to cancer, neurosciences and psychiatric/neurological disorders, including evaluation of innovative treatment strategies. This scanner will provide uncompromised structural, physiological, metabolic, molecular, and functional imaging data at unprecedented sensitivity, spatial and temporal resolution. This human system is at the same field strength as one of our animal scanners, streamlining clinical translation.

4. Develop a PET insert for the 7T human MRI.

   Simultaneous PET and MRI acquisition is widely recognized as one of the most profound recent advances in biomedical imaging. With novel radiotracers and pulse sequences, simultaneous PET/MRI provides synergistic functional, metabolic and molecular imaging information that neither approach alone obtained separately in time can achieve. The current commercial PET/MRI system has a field strength of 3T and ~4mm PET resolution. SBU has pioneered simultaneous PET/MRI instrumentation with compact MRI-compatible PET systems for small animals and for imaging human breast, arm and leg. We propose to develop a revolutionary advance in imaging technology of a whole-body PET insert for the human whole-body 7T MRI with a PET resolution of under 2 mm and time-of-flight capability to improve sensitivity. Together with our radiochemistry resources and animal PET/MRI scanner, we are well positioned to enhance bi-directional translational research between animals and humans with unparalleled capabilities.

5. Establish an exceptional training environment in biomedical imaging sciences.

   With the state-of-the-art imaging equipment and stellar faculty, we will be well positioned to provide an exceptional transdisciplinary training environment in biomedical imaging to train future leaders in this field. We will do so by establishing a venue to promote transdisciplinary biomedical imaging sciences and their clinical applications for graduate and medical students, post-doctoral trainees, residents, fellows and junior faculty. This effort will involve investigators across multiple disciplines, such as cancer, neurosciences, cardiovascular health, immunology, engineering, computer sciences, chemistry and pharmacology, among others. We will also establish a PhD degree track in biomedical imaging sciences by building on existing infrastructure. This program will compete for institutional NIH training (T32 and R25) grants and facilitate individual NIH training (F) and career development (K) awards.



The VersaPET is a custom-designed, high-resolution PET scanning system developed by Paul Vaska, PhD, Departments of Biomedical Engineering and Radiology, in collaboration with Brookhaven National Laboratory and funded by the Department of Energy. It is one of the first fully functional MR-compatible PET systems ever developed, a predecessor of the commercial Siemens PET/MRI in the Stony Brook University Cancer Center. The simultaneous PET/MRI capability and two-to-three-fold improvement in spatial resolution is being applied to studies of breast cancer and various animal models of disease.

POTENTIAL SYNERGIES AND INTEGRATION WITH OTHER STONY BROOK MISSIONS

Interactions with research programs:

The Biomedical Imaging Program stands to make meaningful and impactful contributions to cancer research at SBU by offering a means: 1) to develop useful

Radiology technologist Fernando Guerrero prepares a patient to undergo an MRI .

imaging biomarkers for early diagnosis of malignancy, 2) to longitudinally monitor cancer pathogenesis using imaging, 3) to evaluate efficacy of innovative cancer treatment strategies using imaging, 4) to provide imaging readouts in cancer clinical trials, 5) to study cancer lipids, metabolism and oncogenic drivers of carcinogenesis, 6) to facilitate the development of diagnostic, therapeutic, and theranostic imaging agents in cancer from benchtop to bedside, and 7) to help attract high-caliber cancer researchers. The Stony Brook Cancer Center has substantially invested and will continue to invest in imaging projects. In addition to NIH, the Cancer Center also attracts philanthropic funding, such as the Carol M. Baldwin Breast Care Center, the Kavita and Lalit Bahl Center for Metabolomics and Imaging, among others. The Biomedical Imaging Program will also contribute, in a meaningful and substantial way, to scientific research programs and advanced imaging shared resources within the Cancer Center's P30 NIH grant proposal in preparation.

With the establishment of the Neurosciences Institute, neurosciences is one of the strongest disciplines in SBU with a large number of NIH-funded investigators (from the departments of Neurology, Neurobiology and Behavior, Psychiatry, Radiology, Anesthesiology and Medicine). Innovative in vivo imaging could contribute to research advances in movement disorders, neurodegenerative diseases, and learning and memory in animal models, and should help to facilitate translation of many basic neurosciences discoveries into clinical practices. Psychiatry has a large number of NIH-funded investigators in the areas of depression, addiction, schizophrenia, bipolar disorders and autism spectrum disorders, among others. Psychiatry faculty are actively utilizing, and more importantly, contributing to biomedical imaging resources in a substantial way. Radiology has a

growing number of NIH-funded investigators in areas of innovative imaging technologies, imaging studies of cancer, acquired brain injuries, and metabolism and function in normal and disease. Radiology faculty are actively utilizing, as well as contributing, to biomedical imaging resources in a substantial way. Neurology has a growing number of funded investigators in areas of multiple sclerosis, epilepsy, stroke, traumatic brain injury and sleep apnea, among others. Neurology faculty is actively utilizing biomedical imaging in their research. Faculty in Neurology and Neurosurgery are conducting multicenter clinical trials in ischemic stroke with imaging readouts and under imaging guidance. Given that stroke is a major area of SBU emphasis, new imaging modalities will likely play a key role in the future acute and chronic management of stroke as neuroprotective and neurorestorative therapies come on line. Moreover, enhanced imaging capabilities will accelerate additional collaborations with faculty in the CEAS (Departments of Biomedical Engineering, Computer Science and Biomedical Informatics) and College of Art and Sciences (Departments of Psychology, Neurobiology and Behavior, and Chemistry) in areas of neurosciences.

The Stony Brook University Heart Institute provides state-of-the-art diagnostic and therapeutic modalities related to noninvasive imaging, electrophysiology, congestive heart failure and stroke. Radiologists and cardiologists are collaborating on developing innovative imaging techniques. The Biomedical Imaging Program should facilitate further development of advanced cardiac imaging technologies.

School of Medicine faculty work on identifying new drugs and tools to detect and locate pathogens in vivo in patients with infectious diseases, such as tuberculosis, as well as to improve understanding of molecular and metabolic pathways of infectious disease pathogenesis (Tonge of Chemistry and Smith-Jones of Psychiatry). Faculty are also investigating the role of immunology and inflammation in autism, epilepsy, brain injury, cancer, chemotherapy, multiple sclerosis and neurodegenerative diseases using PET, MRI and nuclear medicine (Biegon of Neurology, Tsirka of Pharmacology and Huang of Radiology).

The University has a strong presence in medical information technologies, big data and machine learning. Faculty members in the Department of Biomedical Informatics pioneer innovative pathology informatics methods, whole-slide virtual microscope system, pioneering pathology computer-aided diagnosis techniques and methods for decomposing pathology images into features and linking those features to cancer "omics," response to treatment and outcome. The Biomedical Imaging Program is expected to contribute to building imaging database, and as such these two programs are expected to work closely together. The Program in Biomedical Informatics will also continue to contribute to biomedical imaging resources in a substantial way.

Biomedical imaging is a multidisciplinary field, where engineering plays an indispensable role. Active research activities that involve CEAS faculty are: PET engineering technologies (Biomedical Engineering), synthesis and testing of molecular contrast agents (Biomedical Engineering, Material Science and Chemical Engineering), image analysis and image visualization, image feature extraction, machine learning (Computer Science, Biomedical Engineering). Hence, the Biomedical Imaging Program is expected to enhance existing collaborations and build new ones with faculty in the CEAS and CAS.

Interactions with the educational enterprise:

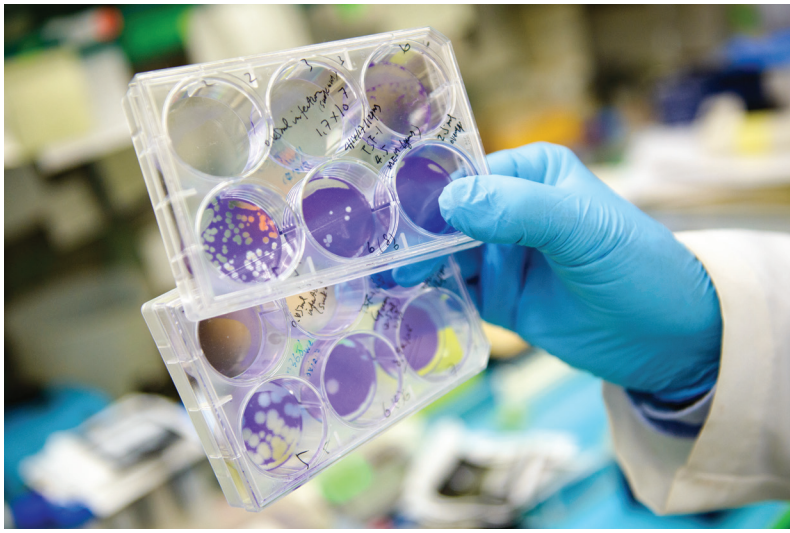
A principal mission of the Program in Biomedical Imaging will be to cultivate the interdisciplinary interaction between the medical and the physical sciences by introducing biomedical graduate students, as well as post-doctoral and medical fellows, to the exciting challenges at the convergence of medicine, biology, physics, chemistry, engineering and computational sciences. The Program in Biomedical Imaging, along with the campus-wide Bioimaging Institute will be the intellectual center for several new developments in graduate education, with the goal of developing a cross-disciplinary, hierarchical curriculum focusing on bioimaging. Funding sources, in the form of training grants, would include T32 proposals to the NIH, GAANN grant applications to NSF and fellowship support requests through the Department of Energy, Department of Defense and NASA.

Virologist Eckard Wimmer, PhD, a SUNY Distinguished Professor in the Department of Molecular Genetics and Microbiology at Stony Brook University School of Medicine, and research scientist Yutong Song, PhD, examine an agar plate containing Zika virus.

Drug Discovery and Analysis

OVERVIEW

Although pharmaceutical companies are best staffed and equipped to manage late stages of drug development, the initial stages (target identification, initial and lead compound isolation and characterization) are progressively being completed by academicians, with subsequent University/biotechnology partnerships. Target identification, chemical compound development and initial ADME/T (absorption, distribution, metabolism, excretion and toxicology studies) are frequently expected as initial feasibility steps (or in parallel) in the drug discovery pipeline prior to University-biotechnology/ pharmaceutical licensing and partnering agreements. Stony Brook University is well positioned to further expand on this theme through the Institute of Chemical Biology and /Drug Discovery (ICB&DD), coupled with commercialization that is spearheaded by the Office of Technology Licensing and Industry Relations.



A virus grown from the laboratory of Eckard Wimmer, PhD, Department of Molecular Genetics and Microbiology at Stony Brook University School of Medicine.

CURRENT STATUS

The ICB&DD currently has well-established programs in cancer, antibacterial, antifungal, anti-inflammatory and antinociceptive drug development. A solid collaboration with Scripps Research Institute, Florida, has provided additional expertise in assay design, high-throughput screening (HTS), in vitro and in vivo pharmacokinetics and metabolism, and drug design, supporting three projects in the Cancer Center. Scripps has more than 600,000 compounds and a strong robotic screening platform with a record of technical success in new drug discovery. The recent strong collaboration with Mount Sinai further enhances medicinal chemistry and drug development capabilities.

The ICB&DD facilities and collaboration with Scripps Research Institute:

1. Provide a single infrastructure for high-throughput technologies related to target validation, compound screening, chemical synthesis and compound optimization.
2. Provide expertise in assay development, HTS, and in vitro and in vivo drug optimization.
3. Provide initial partnering opportunities with biotechnology/pharmaceutical partners.

The expanded ICB&DD core facilities synergize with:

1. The Laufer Center for Physical and Quantitative Biology
2. The Stony Brook Center for Biotechnology
3. The animal BSL3 and bioimaging initiatives in collaboration with BNL
4. Development of an NCI-designated Cancer Center
5. Center for Infectious Diseases
6. Center for Structural Biology and the National Synchrotron Light Source at BNL

Students at Stony Brook University School of Medicine engage in learning within the classroom, as well as in a variety of clinical settings.

The **Educational Enterprise**

The education component of the strategic plan is the anchor that supports the clinical and research missions. The education strategic plan is focused on six areas:

1. Faculty development
2. A three-year medical curriculum
3. Interprofessional education
4. Professional identity formation and student wellness
5. Entrustable professional activities
6. Technology in education, especially telemedicine

FACULTY DEVELOPMENT – SHAPING 21ST CENTURY MEDICAL EDUCATION

Stony Brook Medicine will provide its teaching faculty with the knowledge and skills to thrive in the classroom, laboratory, and in clinical settings. This will be done through the following goals:

1. Provide all teaching faculty with the skills and tools necessary to create novel student-centered learning experiences.
2. Provide faculty who teach in a clinical setting the targeted skills training that allows for the seamless integration of patient care and teaching responsibilities.
3. Develop and support a group of leading faculty through membership in the Miriam and David Donoho Academy of Clinical and Educational Scholars.
4. Showcase exemplary teaching faculty to create a culture of medical education that places a high value on training the next generation of physicians.
5. Provide faculty members with access to electronic resources as a means to get just-in-time training and information, as well as contacting the faculty development team.

THREE-YEAR MEDICAL SCHOOL CURRICULUM TRACK

We have attained Liaison Committee on Medical Education (LCME) and New York State Education Department (NYSED) approvals for a three-year MD (3YMD) curriculum track that parallels our standard LEARN curriculum, and once obtained, will select a minority of our medical school matriculants for the program. These selected students will complete the requirements for the MD in three years and then have the option of entering (by way of conditional acceptance at time of admission to the program) in a Stony Brook University School of Medicine residency program of their choosing. The rationale for establishing this three-year curriculum track includes the following:

1. 3YMD will be an attractive option for students because it will save them both time and money.
2. 3YMD students will enter a direct pipeline into a specified School of Medicine residency program, thus benefiting both the student and the residency program. The rationale is that as a relatively "rare" three-year graduate, the majority of non-Stony Brook Medicine residencies may view our 3YMD graduates as "insufficiently trained" for their residencies.
3. 3YMD students will establish a longitudinal mentoring relationship with a School of Medicine residency program of their choice beginning the first summer of the program.
4. 3YMD students will enter the physician workforce a year in advance, thus enhancing physician access for patients.

Students in the 3YMD track will be required to begin their coursework in the summer preceding the start of classes for students entering the four-year LEARN track. Upon completing this preliminary summer coursework, 3YMD students will enroll in the same courses and clerkships as students in the LEARN track. 3YMD students will be required to complete additional coursework and participate in graduate medical education (GME)-mentored courses during the summer between their first and second years. The successful completion of two summers of required academic credits allows students in the 3YMD track to meet the minimum of 130-week requirement for an MD degree, as designated by the LCME, in three years.

INTERPROFESSIONAL EDUCATION (IPE), INCLUDING SERVICE LEARNING AND GLOBAL HEALTH

One key element of the educational mission of the School of Medicine is to establish collaborations with the Schools of Nursing, Dental Medicine, Pharmacy and Pharmaceutical Sciences, Social Welfare, and Health Technology & Management within Stony Brook Health Sciences. The main goal of our collaboration is to build the core of a shared interprofessional education (IPE) curriculum that will be relevant to all the professional schools and that can be built upon to further the educational goals of an individual school's curriculum.

Learning these core principles together will result in the preparation of all of our future health professionals to assume meaningful roles in the delivery of team-based, patient-centered care that is grounded in profession and education-specific, evidence-based best practices. Our purpose is to enhance interprofessional collaboration and sharing of health professions education resources between the health professional schools at Stony Brook. We envision this will be accomplished through service learning opportunities, global health initiatives and integrative learning experiences.

PROFESSIONAL IDENTITY FORMATION AND STUDENT WELLNESS

In order to ensure that students at Stony Brook University School of Medicine understand their responsibilities as advocates for their patients and that they are able to manage stress, the professional identity subcommittee recommends the following:

1. Establish a working group made up of faculty and students to inventory professional identity formation curricula.
2. Develop an approach to measuring professional identity formation.
3. Promote greater visibility and a stronger culture of professional identity formation by engaging all students and faculty with the continuous enhancement of our professional identity formation curriculum in clinical settings.
4. Create a systematic and sustainable well-being, resilience and "virtue of self-care" approach for students across all LEARN phases, with an emphasis on mental health.
5. Examine the application process to Stony Brook Medicine with professional identify formation dimensions in mind.

ENTRUSTABLE PROFESSIONAL ACTIVITIES (EPA)

An entrustable professional activity (EPA) was defined by Olle ten Cate in 2013 as a "unit of professional practice, defined as tasks or responsibilities to be entrusted to the unsupervised execution by a trainee once they have attained a sufficient clinical competence." Each EPA is an observable, specific task or unit of work, which is composed of multiple competencies. The EPAs are not evaluated on a typical grading scale but rather should be described in terms of the amount of supervision required by a learner, ranging from pre-trustable to entrustable. Evidence for entrustment decisions is gathered through multiple observations, which include written testing, simulation testing, case-based discussion and short- or long-practice observations. To optimize safe and effective patient care at Stony Brook Medicine, we must ensure that each graduate is prepared for core initial duties as an intern. To facilitate the transition from undergraduate medical education (UME) to graduate medical education (GME) and to ensure that each graduate is entrusted to perform the core activities for entering residency, valid assessments of student trustworthiness, knowledge, skills and attitudes are measured by the 13 core EPAs for entering residency.

1. Gather a history and perform a physical examination.
2. Prioritize a differential diagnosis following a clinical encounter.
3. Recommend and interpret common diagnostic and screening tests.
4. Enter and discuss orders and prescriptions.
5. Document a clinical encounter in the patient record.
6. Provide an oral presentation of a clinical encounter.
7. Form clinical questions and retrieve evidence to advance patient care.
8. Give or receive a patient handover to transition care responsibility.
9. Collaborate as a member of an interprofessional team.
10. Recognize a patient requiring urgent/emergent care and initiate evaluation/management.
11. Obtain informed consent for tests and/or procedures.
12. Perform general procedures of a physician.
13. Identify system failures and contribute to a culture of safety and improvement.

All graduates of Stony Brook University School of Medicine should be expected to perform the 13 EPAs on day one of residency without direct supervision regardless of specialty choice.

TECHNOLOGY IN EDUCATION

There are two facets to technology in medical education – technologies as educational tools to support and

facilitate learning, and the learning of technologies that are used in the practice of medicine. The integration of technologies into the medical education curriculum must be flexible and responsive to the rapidly changing technology landscape. The overarching goals are:

1. **Education –** the use of ultrasound as a tool for learning with a focus on normal structure and function, e.g., Wigger's diagram in cardiology.
2. **Technological Competency –** the use of ultrasound as the new stethoscope, e.g., bedside ultrasound can pick up more pneumonia than a physical exam or CAT scan. Technological competency includes "knobology," proper probe selection, etc.
3. **Telemedicine –** Telemedicine or telehealth involves the use of technological innovations in communications of patient data to a remote healthcare provider, with the goal of removing geographic and temporal boundaries to monitoring individuals under our care. Telemedicine is viewed as a key component in ensuring access to healthcare services not only in isolated geographic areas, but by virtue of wearable devices that transmit healthcare data, continuous monitoring of patients' responses to medical interventions. As such, more than a rudimentary knowledge of telemedicine will be required of the physicians of the future. The School of Medicine has pioneered several aspects of clinical telemedicine, such as real-time acquisition of coronary computerized tomographic angiography (CCTA) at remote hospitals in the evaluation and management of patients presenting to the emergency room with chest pain. The School has launched an elective in telemedicine, and it is envisioned that experience with the elective will allow a more robust integration of this soon to be essential tool of modern medicine.

Kimberly Noel, MD, Director, Stony Brook Medicine Telehealth and Deputy Chief Medical Information Officer, explains to a student, wearing an Oculus® headset during a telehealth training session, how to talk to a patient about cardiovascular risk using virtual reality. The image on the right side of the screen reflects different anatomic views of lung tissues, which are represented on the left in virtual reality. Telehealth may introduce new technologies, such as virtual reality, to help patients understand their own anatomy and disease, and offers new ways for clinicians and patients to interact. It also allows for new methods of acquiring patient data, which facilitates the delivery of healthcare anywhere, anytime.

Stony Brook Medicine surgeon Ruslan Safarov, MD, performs trauma surgery.

The **Clinical Enterprise**

The clinical strategic plan focuses on three broad goals over the next five years: building a more geographically and clinically diverse healthcare network, integration of all clinical elements and delivering value. These goals are interdependent – each goal must be accomplished for all the goals to be achieved.

BUILDING A GEOGRAPHICALLY AND CLINICALLY DIVERSE HEALTHCARE NETWORK

The overarching principles that underlie the development of the Stony Brook Medicine Care Network are:

1. Expanding the network by formalizing relationships with health systems, hospitals, long-term care and rehabilitation facilities and urgent care providers across Long Island and in New York City. In addition, over the course of the next five years, we will expand the Stony Brook Medicine ambulatory footprint by establishing ambulatory care sites that are geographically distributed, visible and convenient for all patients in the region.
2. Providing services that are well coordinated, patient-centric and accessible to the more than 1.6 M residents of Suffolk County. There will be an emphasis on the growth of a strong primary provider base that is operating in the model of the Patient Centered Medical Home (PCMH) and is closely aligned with highly specialized and expert faculty, who deliver care that no others in the region can provide.
3. Growth of population health infrastructure and capabilities by leveraging our experiences with the Delivery System Reform Incentive Payment (DSRIP) program along with the development of a robust care coordination program, which will allow us to be ready to assume risk for the health outcomes of populations of individuals.

Specific components of the expanded care network are:

Acute Care Partners – The addition of ELIH to the Stony Brook Medicine network will be completed while simultaneously exploring formal affiliations with Brookhaven Hospital and a NYC system. With two partner hospitals on the East End of Long Island, Stony Brook Medicine will pursue a high-priority integration and growth plan to secure our market share dominance on the East End and to extend the high-quality care of Stony Brook Medicine to North and South Fork residents. These integration strategies include an expanded presence in emergency medicine, radiology, cardiology and oncology,

Caregivers from Stony Brook Medicine's state-designated Regional Perinatal Center – the highest designation there is. Doctors from across Suffolk County refer their most challenging cases to the center, which is staffed and equipped to handle the complete range of needs for mother and baby.

as well as telemedicine programs that will be jointly staffed and administered with our partners. We will develop new, and strengthen existing relationships with community-based organizations across the continuum including with nursing homes and will identify and implement an urgent care strategy that will permit care close to home.

New Clinical Programs – With the creation of a Vice President for Clinical Program Development position at Stony Brook Medicine, we will strategically address gaps in service within priority programs (e.g. cancer, cardiovascular, surgery) and identify and advance selected clinical focus areas to become regionally distinguished. Using a data driven approach focused on fulfilling our commitment to provide high quality care close to home, we will extend the reach of Stony Brook Medicine care through growth of exiting clinical programs and establishment of new ones that will meet the needs of our community, and support our research and education missions. Significant investments will be made in cancer care, telemedicine and cardiology and cardiothoracic surgery while at the same time continuing to invest in our regional programs of distinction including our Regional

Perinatal Center, Level I Trauma Center, and behavioral and metal health programs.

Development of the Ambulatory Practices – The ambulatory footprint, which currently comprises 79 practice sites, will be refined to be more geographically distributed, visible, and convenient for all patients in the county and region. Consolidation of practice sites in the core market that surrounds Stony Brook University Hospital will be planned for with the development of a large multispecialty practice building either on campus or in close proximity. The primary care presence will be expanded through growth of Stony Brook Community Medicine in close collaboration with the clinical chairs and full time faculty. In support of the East End strategy, a cancer center and urgent care will be planned for and operationalized. Strategic placement of Ambulatory Surgery and Imaging Centers in new markets also will be pursued.

Population Health Management – We will deploy innovative care delivery models to transition to managing broader populations including leveraging opportunities within the Schools of Nursing, Health Technology and Management, Dental Medicine, Pharmacy and Social Welfare to contribute to a robust integrated care model with physician extender availability. Similarly, we will carefully consider how to capitalize on the investments made in the DSRIP platform as a means of jump-starting a population health management infrastructure.

Integration

Stony Brook Medicine will integrate its own system components to function as a highly cohesive and integrated clinical enterprise. In order to do this, we must establish system-level organization; align Stony Brook University Hospital, Stony Brook Community Medicine ("the captive physicians") and the Faculty Clinical Practice (Clinical Practice Management Plan; CPMP) with regard to strategic decision-making, fiscal incentives and operational efficiency (e.g. standardized care site operations and adherence to evidence based best clinical practice guidelines); and formalize an approach to enhance communication across the enterprise.

Over the next five years, Stony Brook Medicine will complete its' transform from a siloed system into one with full leadership engagement and a unified commitment to one strategic direction. Every department will leverage its strengths to enhance patient care, and the organizational structure will lend itself to cohesive decision making and effective communication enterprise-wide. These changes will require the culture of the organization to embrace adaptability, accountability and transparency.

Clinical growth will be guided by an enterprise-wide logic, rather than based on the needs of single service lines or individual departments with limited integrated planning. In addition, we will ensure that information technology investments are appropriately leveraged to maximize population health management capabilities, faculty collaboration and the patient and health provider experience.

This integration will be driven by leveraging existing and developing new alignment models, including the formation of a clinically integrated network (CIN). Over the next two years we will formalize the CIN structure, identify best practices and care guidelines for CIN participation, complete the initial measurement period, build the IT infrastructure to support integration and begin to hold providers accountable for performance relative to care guidelines.

Delivering Value

Stony Brook Medicine will differentiate itself by leading quality, patient safety, and customer service performance at a competitive price. The clinical enterprise will achieve top-decile performance in a range of healthcare quality and patient-centered metrics that will make Stony Brook Medicine a preferred partner and deliver demonstrable value to patients and payers alike.

- Physician engagement and retention
- Enhanced communication strategies
- Throughput optimization
- Promoting a culture of excellence and accountability
- Technology accelerated care (e.g. analytics, reporting, dashboards, benchmarking, quality information systems, risk stratification, clinical documentation improvements, etc.)

Achieving the Stony Brook Medicine Vision

Accomplishing our strategic goals will require the coordinated efforts of all of the Stony Brook Medicine health providers, employees, trainees and administrators. Success is everybody's job and the Stony Brook Medicine

Yuehjien Gu, MD, Director of the Neurocritical Care Unit, and Ela Wirkowski, MD, a neurointensivist, review a patient's MRI tractography, a 3D modeling technique used to visually represent neural tracts using data collected by diffusion-weighted images. The scan is being used to assess the integrity of corticospinal pathways from primary and secondary cortical motor areas after stroke.

leadership will provide the tools needed to accomplish the goals including:

Enhanced Information Technology and Analytics – Robust information technology platforms to support the CIN, population health activities, performance improvement and risk-based contracting will be created.

Employee Engagement – Initiatives with a commitment at the highest level to redouble efforts to improve engagement through communication, involvement in decision making, wellness programs and providing work environments that contribute to productivity and efficiency will be deployed.

Community Engagement – To ensure that Stony Brook Medicine is meeting the needs will be accomplished by expanding the team that works with our community partners to build on the DSRIP experience of engagement of community based organizations and providers who complement and support health system population health initiatives.

Research and Innovation – As a major academic medical center that is part of a world class university we will provide our patients with access to cutting edge clinical trials and rapidly translate clinical research results into new treatments for our patients.

Patient Engagement – Stony Brook Medicine will build systems that support delivering an outstanding patient experience close to home, with timely scheduling of appointments and delivery of care in the patient and family centered model of care.

A Program of **Community Outreach**

School of Medicine faculty and students participate in the American Medical Association's annual "Doctors Back to School" Day, where they visit Brentwood and Longwood High Schools to share their experiences and inspire students to pursue careers in medicine.

OVERVIEW

A critical component of Stony Brook Medicine's Strategic Plan is community outreach. As the only academic medical center in Suffolk County, and as a safety net provider that is part of a public university system, it is incumbent upon Stony Brook Medicine to help understand social determinants of health and health disparities that significantly impact health outcomes at the local, national and global level. Moreover, it's the responsibility of Stony Brook Medicine to work to craft solutions to the lack of access to, inconsistent quality of and the cost of healthcare in our entire community.

Studies indicate that medical students and residents provided with community service learning experience are more likely to specialize in primary care disciplines and are better prepared to work in interprofessional healthcare teams. Medical education is increasingly focused on community engagement by developing rigorous service learning curriculums that prepare all levels of students to apply their clinical, biomedical and behavioral knowledge to understanding the needs of the community and improve population health. Community engagement is based on scholarship that incorporates teaching, research and service. Academic medical centers across the country are increasingly making community engagement and population health improvement a core value, enabling the institution to develop strategies to provide the highest level of patient care while addressing academic and regulatory requirements. The Community Outreach Strategic Plan is integral to the School of Medicine's mission of translational and clinical research, outstanding medical education and clinical care, allowing the institution's scholarly assets to be used to address the health needs of the Long Island population that it serves.

CURRENT STATUS

The Community Outreach Strategic Planning Committee included faculty, administration, residents and students from the School of Medicine, as well as faculty from the Schools of Nursing and Health Technology & Management. Over several months, the committee reviewed current Stony Brook Medicine's community outreach activities and partnerships and community outreach activities at other medical schools. It explored the potential for improving community engagement and reducing health disparities in Suffolk County and Long Island, using resources currently available at Stony Brook Medicine, including both the expertise that now exists within the faculty, and our leadership position in the Suffolk County regional New York State Delivery System Reform Incentive Payment (DSRIP) program, known as the Suffolk Care Collaborative (SCC).

Jedan Phillips, MD (left), Department of Family, Population and Preventive Medicine, and a student from the School of Medicine at Stony Brook's Health Outreach and Medical Education (HOME) clinic, a student-run free clinic in Islip Terrace providing medical examinations, health education and social services to underserved and uninsured residents of Suffolk County.

The following recommendations focus on six areas of opportunity that now exist within the School:

1. Having developed significant faculty expertise in medical humanities, the School of Medicine stands ready to improve the formal education that incoming Stony Brook medical students and residents receive about the populations that they serve in Suffolk County, including information on health disparities and cultural competency training.

2. Based on faculty affiliations with numerous healthcare organizations throughout Suffolk County, we are now well positioned to increase opportunities for faculty, residents and medical students to work within the community to improve care for vulnerable patient populations.
3. Encourage and coordinate opportunities for medical students to participate in varied community-based service learning collaborations with the other professional schools to improve community education and population health.
4. With the increased recognition that robust conclusions from clinical research requires a broad base of participants, and the CTSA need for community input into the questions being asked in clinical studies, it is time to increase community partnerships and education about community participatory research, clinical trials and service activities conducted at Stony Brook Medicine.
5. With the strong Stony Brook Medicine emphasis on a diverse student body and workforce, the School has an opportunity to enhance the pipeline of the next generation by increased support for healthcare education and college preparation, as well as, workforce opportunities for Suffolk County high school graduates from underserved communities.
6. And a renewed recognition of the community outreach accomplishments of Stony Brook Medicine faculty, students and staff for their outreach achievements should help promote the integration of their efforts with the goals of their department or the institution.

RECOMMENDATIONS

To meet these six objectives over a five-year period, the Stony Brook University School of Medicine strategic plan calls for to an implementation plan designed to *educate, empower* and *resource* community outreach activities and partnerships.

1. In the realm of education, engage the expertise of the Department of Biomedical Informatics to strengthen the training of all incoming medical students and residents and foster a better understanding and engagement of the communities that they will be expected to serve. As an example of the approach, a three-hour module for medical students in Phase 1 of the curriculum should be developed: "Biomedical Informatics – Understanding Our Population through Data," will introduce the population of Suffolk County through a data-driven approach. Students will interactively explore various data sources about Suffolk County and thus paint a picture of the diversity of the population in which they live and study. They will gain an understanding of local prevalence of diseases, co-morbidities, social determinants of health and health risks in the community. The course will be in three parts: an introductory lecture, hands-on data exploration in groups and final initial portrait of "who is Suffolk County."
2. The Suffolk Care Collaborative (SCC) will establish academic partnerships with the School of Medicine to offer a community-based care-coordination "selective" for medical students in Phase 3 of the LEARN curriculum. The SCC will partner with primary care residency programs to offer community-based electives in primary and behavioral health integrative care coordination and chronic disease management.
3. Establish partnerships between the School of Medicine and the Schools of Dental Medicine's and Social Welfare's current community outreach and educational programs, allowing medical students to gain experience as part of an interprofessional healthcare team.
4. In order to *empower* engagement within our community, the School of Medicine should adopt an institution-wide culture of Community Commitment, by requiring each academic department to select a specialty-related health disparity faced by their population of patients or the Long Island community and develop a departmental plan to decrease that healthcare disparity over the next five years. This empowerment can also take on an educational flavor, by specifically calling upon departmental residents to be a major part of the approach to the healthcare disparity. Such plans should be based on data provided by the Department of Biomedical Informatics and other data sources on health disparities. This specific goal will require that we provide cultural competency training for all faculty, residents and students. (This approach would address some of the recommendations from the Clinical Learning Environment Review (CLER) site visit related to health disparities).

School of Medicine student Christopher Mazzeo performs magic at Stony Brook University Cancer Center's National Cancer Survivors Day. Mazzeo is a student volunteer with MagicAid, a program that was started at Stony Brook and is dedicated to providing kind and compassionate care to patients through the art of magic.

5. Establish a diverse Community Research Advisory Council with some members selected from our community-based partners including the Suffolk County Department of Health.
6. The School should attempt to create increased healthcare job opportunities for non-college bound high school graduates from underserved communities by collaborating with the School of Health Technology & Management to provide scholarships for students to enter certificate programs, such as EMT, Phlebotomy, Digital Lab Technician.
7. We should increase community outreach activities for veteran groups; Suffolk County has the largest number of living veterans in New York State.
8. In order to better resource our community outreach efforts, we should develop a website that fosters coordination and communication among researchers, faculty and students engaged or interested in community-based research and service.
9. Build a focused community engagement profile using Biomedical Informatics data that would encourage community participation in clinical trials.
10. And we should establish an interprofessional "Speakers Bureau" to publicize and educate diverse populations about Stony Brook Medicine research and clinical trials that could be directly beneficial to individuals, families and their communities.

Closing Remarks

Much work by the faculty and staff of the Stony Brook University School of Medicine went into crafting the principles and specifics detailed in this 2018-2023 Strategic Plan. While completion of every aspect of the plan is unlikely, the energy and commitment of the faculty and staff of the School at advancing the goals of our prior strategic plan was remarkable, giving much confidence in our achieving an equally impressive performance in accomplishing the goals and details herein. Since we launched the prior strategic plan, the School has grown substantially: our faculty has increased from ~650 to more than 900; our grant portfolio has grown substantially; more than 40 percent of the physicians now practicing in Suffolk County call Stony Brook their alma mater; our physical infrastructure has increased by 50 percent and grown far more complex and advanced; and our impact on research, education, clinical care and community engagement are the best they have ever been. However, one change that is not encouraging is the fiscal environment in which we now live. While the NIH and NSF budgets have increased slightly this year (2018), they have not kept up with inflation and are not close to having kept up with "biomedical inflation," the term I use for the incredible costs of the advanced technology needed to recruit, retain and make productive our research-intense faculty members and departments. Likewise, the ability of an academic medical center to garner revenue from its hospital(s) and ambulatory clinical practices in order to cross-fund research and education have diminished substantially, driven in large measure by extreme competition in the "business of medicine." And while Stony Brook is a state institution and had become accustomed to receiving strong financial support, with the nationwide practice of substantial reductions in the funding of public higher education, New York State's contribution to the School of Medicine now represents only three percent of our current budget. Hence, we must do more with less. But the enthusiasm, skills, intellect and determination exhibited daily by the faculty and staff of the School of Medicine will prevail, and we will continue our meteoric rise in impacting the art and science of medicine.

The main lobby of Stony Brook University Hospital, Long Island's premier academic medical center. With 603 beds, Stony Brook serves as the region's only tertiary care center and Level I Trauma Center for adults and children, offering world-class care in every specialty and access to groundbreaking clinical trials.


Stony Brook Medicine