## RESOURCES

Follow the 398 application instructions in Part I, 4.7 Resources.

The **Johns Hopkins Institute of Clinical and Translation Research** serves the entire Johns Hopkins University medical research community. The services are provided at multiple sites on several Johns Hopkins campuses. The campuses include the East Baltimore campus (where Johns Hopkins Hospital, Bloomberg School of Public Health, School of Nursing are located), the Bayview Medical Campus (where the Bayview Medical Center and National Institute on Drug Abuse, and National Institute on Aging are located), the Carey Business School in downtown Baltimore and the Johns Hopkins University (where the Whiting School of Engineering and School of Arts and Science is located). Although separated on geographically distinct campuses (at most 7 miles apart), these services have been integrated under the ICTR to facilitate discovery by investigators in the School of Medicine, Bloomberg School of Public Health and School of Nursing as well as the Whiting School of Engineering, Zanvyl Krieger School of Arts and Sciences, and the Carey Business School.

### Environment

**Overview: Johns Hopkins University** is one of the world's leading academic institutions (http://www.jhu.edu/). Eminent professors mentor top students in the arts and music, the humanities, the social and natural sciences, engineering, international studies, education, business and the health professions. Those same faculty members, and their research colleagues at the university's Applied Physics Laboratory, have each year since 1979 won Johns Hopkins more federal research and development funding than any other university. The university has nine academic divisions and campuses throughout the Baltimore-Washington area. The Krieger School of Arts and Sciences, the Whiting School of Engineering, the School of Education are based at the Homewood campus in northern Baltimore. The Schools of Medicine, Public Health, and Nursing share a campus in east Baltimore with The Johns Hopkins Hospital. The Carey Business School is in downtown Baltimore. The Peabody Institute, a leading professional school of music, is located on Mount Vernon Place in downtown Baltimore. The Paul H. Nitze School of Advanced International Studies is located in Washington's Dupont Circle area. The Applied Physics Laboratory is a division of the university co-equal to the nine schools, but with a non-academic, research-based mission. APL, located between Baltimore and Washington, supports national security and also pursues space science, exploration of the Solar System and other civilian research and development. Johns Hopkins also has a campus near Rockville in Montgomery County, Md., and has academic facilities in Nanjing, China, and in Bologna, Italy. It maintains a network of continuing education facilities throughout the Baltimore-Washington region, including centers in downtown Baltimore, in downtown Washington and in Columbia. When considered in partnership with its sister institution, the Johns Hopkins Hospital and Health System, the university is Maryland's largest employer and contributes more than $10 billion a year to the state's economy.

JHU has earned a reputation for research excellence. Thirty-seven winners of Nobel Prizes have had an association with The Johns Hopkins University, either as graduates of Johns Hopkins or as faculty of the university before, at the time of or subsequent to their receipt of the prize, including 17 recipients of the Nobel Prize in Medicine or Physiology. Current faculty members include 60 Institute of Medicine Members, 4 Lasker Medical Research Award Recipients, and 26 National Academy of Science Members.

Health-related research is a particular strength across the institution with annual research funding of $1.4B from the National Institutes of Health, private foundations, and industry collaborations. Multiple Schools of the University are active in clinical and translational health-related research which provides a dynamic environment that fosters ground-breaking discoveries and unparalleled training for the next generation of C-T investigators. This section first describes each of the six JHU Schools that are most engaged in C-T research, followed by a description of a sampling of the key multidisciplinary Centers and Institutes which play a critical role in the C-T research, drawing on faculty and resources from multiple schools across the university to create a synergistic environment for discovery.

**School of Medicine (http://www.hopkinsmedicine.org/som/index.html)**

When the Johns Hopkins University School of Medicine was founded in 1893, the unusual mandate was that the field of medicine was to be treated as a form of graduate study and include scientific research, and physicians and scientists were thought of as one and the same. Despite tremendous growth, advances in technology and changing pressures in healthcare, the link between medicine and scholarship remains unbroken. The School of Medicine includes 2551 full-time and 1291 part-time faculty members. It annually ranks as the top one or two schools in terms of research grants from the National Institutes and consistently is ranked among the top two medical schools in the nation by U.S. News & World Report. In 2009, it launched a new curriculum, Genes to Society, centering on our advanced understanding of the genetic underpinnings of human diseases. Its key concepts include human variability, risk and the ability to refine disease diagnosis and improve outcomes. The School of Medicine has approximately 1,000,000 sq feet of research space across the multiple locations. In an effort to promote clinical research and provide more convenient access to research participants, we have expanded the number of research sites. Several of our large outpatient clinical centers like Greenspring Station now have research space. The Johns Hopkins ProHealth Center is a free standing facility that includes a research metabolic kitchen used for conducting feeding studies. The main basic science buildings (Ross Building and Miller Research Building) are immediately adjacent to the hospital. A popular café acts as a frequent spot for researchers and clinicians to interact. Within the School of Medicine, there is access to computational resources and regulatory expertise to complete most research.

**Bloomberg School of Public Health (http://www.jhsph.edu/)**

The Johns Hopkins Bloomberg School of Public Health (also referred to as The Bloomberg School or JHSPH) is the oldest and largest public health training facility in the world, and a leading international authority on the improvement of health and prevention of disease and disability. The school's mission is to protect populations from illness and injury by pioneering new research, deploying its knowledge and expertise in the field, and educating scientists and practitioners in the global defense of human life. Overall, the school is ranked first in public health according to U.S. News and World Report. The Bloomberg School has 530 full-time and 620 part-time faculty, and 2,030 students from 84 countries. It is home to over fifty Research Centers and Institutes with research ongoing in the U.S. and more than 90 countries worldwide. The School ranks #1 in federal research support from the National Institutes of Health (NIH), receiving nearly 25 percent of all funds distributed among the 40 U.S. schools of public health.

In the 1990s, the School recognized the need for additional space to accommodate the increase in faculty size and student enrollment, allow growth to continue, and encourage interdisciplinary collaboration by consolidating into one building faculty who were housed in different locations. The master plan called for phased expansion, with additions built as funds were raised. In order to minimize costs, the architects ensured that the foundations; plumbing, heating, cooling, and electrical systems; and overall design of each addition fit together seamlessly. Construction, from 1996 to 2004, doubled the size of the Wolfe Street Building, from approximately 357,000 to 759,000 square feet.

Among the 10 Departments of the JHBSPH, the Department of Biostatistics and the Department of Epidemiology have a particularly prominent role in the ICTR.

- **Department of Biostatistics** (Karen Bandeen-Roche, PhD, Chair): The Department of Biostatistics in the Bloomberg School of Public Health is led by Translational Core Director Dr. Karen Bandeen-Roche. Established in 1917, this is the oldest autonomous department of its kind in the world, and is among the most productive Departments of Biostatistics in research and in training of masters and doctoral students. The Department aims to promote effective statistical reasoning and applications in health research. It currently includes 37 full-time faculty, 40 part-time faculty, 42 doctoral candidates, 14 master degree students, 10 postdoctoral fellows and 12 staff. Sixty percent of the department's Ph.D. graduates over the last 5 years have gone on to tenure-track academic positions, including at the Universities of Minnesota, Pennsylvania, and Washington, Stanford and Johns Hopkins. Faculty members spend roughly half their research time each on developing statistical methods and on applications of substantive importance. Methodological research is conducted on a broad array of topics, including foundations of inference, clinical trials, longitudinal data analysis, latent variable modeling, spatial statistics, nonparametric smoothing

methods for very large data streams, and statistical genetics and genomics. The department has major applications in aging, basic science, environmental health, epidemiology, health services research, ophthalmology, psychiatry, neurology, pediatrics, and oncology. The Department of Biostatistics offers educational programs leading to the Ph.D., Sc.M, and M.H.S. degrees and more than 65 graduate courses in various learning formats. Approximately half of the courses are designed for students outside of biostatistics; the other half are for students in biostatistics or related fields. In addition to course work, the department supports weekly seminars and "working groups" in which students and faculty interested in a particular topic meet biweekly for an informal seminar or discussion. Currently, working groups are active in aging, causal inference, environmental epidemiology, genomics, medical imaging and spectra, and longitudinal/multivariate data analysis. Students learn the application of statistics by collaborating with faculty in research on health or in brief consultation through The Johns Hopkins Biostatistics Center, the Department's unit devoted to consultation. The result is an active, engaging intellectual environment.

- **Department of Epidemiology** (David Celentano, PhD, Chair): The Department of Epidemiology has a longstanding commitment to high quality post-graduate education and has traditionally awarded more doctorates in epidemiology than any other department in the world. It is now organized into 9 program areas: cardiovascular, clinical, infectious disease, occupational/environmental, cancer etiology and prevention, methodology, genetic, clinical trials, and aging. The Department confers 2 Master degrees—of Health Science (M.H.S.) and Science (Sc.M)—as well as the Ph.D. and Doctorates of Science and Public Health. Department of Epidemiology faculty conduct research on a broad array of topics including: the prevention and treatment of cardiovascular and renal diseases, cancer, diabetes, and other chronic conditions; identification of genetic factors which contribute to major chronic and infectious diseases; the epidemiology of acute and chronic infectious diseases; social epidemiology; and comorbidity, frailty and physical disability in older persons. The Department of Epidemiology houses the Center for Clinical Trials.

**School of Nursing (http://nursing.jhu.edu/)**

The Johns Hopkins Hospital and the nursing training program both opened in 1889. In the ensuing decades, founders M. Adelaide Nutting, Isabel Hampton Robb, and Lavinia Dock established what would become the national model for nursing education. After turning out generations of exceptional nurses, in 1983 the School of Nursing was established as the eighth division of the Johns Hopkins University—and opened its doors to students in 1984. In 1998, the School moved to a new state-of-the-art education and research building on the East Baltimore campus, the Anne M. Pinkard Building. Today the School of Nursing continues to redefine nursing education through a unique combination of academic rigor, extraordinary nursing scholarship, and unparalleled opportunities for nursing graduates.

The Johns Hopkins University School of Nursing has 72 Full-time and 130 Part-time faculty. The faculty bring in more than $8.5 million per year in research and sponsored project funding. They are ranked 1st in research funding from NIH as compared to other Schools of Nursing. In addition, the JHSON is ranked among the top nursi ng PhD programs in the U.S. by the National Research Council and was named a Center of Excellence in Nursing Education in 2010 by the National League for Nursing

The School of Nursing structure is six levels and 88,500 square feet. It consolidates the School's teaching, research and administrative activities. Space is provided for faculty, clerical, research staff and data management personnel. The School contains a 90-seat flexible space classroom, two adjoining 63-seat classrooms; two 110-seat lecture halls (one with capability for distance learning); three 12-bed practice laboratories (one with capability for distance learning); research space with state-of-the-art laboratories; one 40-seat computer classroom; one 45-seat classroom (with capability for distance learning); two 18-seat seminar rooms; two 15-seat group study rooms; three 16-seat computer/ interactive video labs; and a 230-seat auditorium. The entire building is equipped with MediaSite webcast technology.

The Johns Hopkins University School of Nursing maintains a local area network consisting of 29 physical and 15 virtual Microsoft (MS) Windows servers and approximately 500 MS Windows XP workstations, five MS Windows Vista systems and four Apple Macintosh systems. Network peripherals and systems include a tape library device, monochrome and color printers, copier / scanning systems, storage area networks and network attached storage devices. In addition to the network systems and peripherals previously described, the school

maintains six computer labs. These labs consist of a 40-seat teaching lab, two 13-seat application labs, a 16 seat Doctoral Lab, another 10-seat application lab on the buildings lower level and final 9-seat application lab in the NIRC. The first floor café area, second floor lab area, third and fifth floor provide wireless network access for notebook and other computing devices.

The School of Nursing Center for Nursing Research (CNR) was developed to facilitate excellence in nursing research. The CNR provides both pre- and post-award services to faculty, students, and staff, , e.g., information on funding sources and grant application processes; including consultation on research design and conduct including data management and analysis; information on funding sources and grant application processes; advice on faculty development and continuing education in research; dissemination of research and funding information; and resources such as texts and conference rooms. The CNR coordinates research resources and a consultation service for grant submission within the School of Nursing and encourages leadership for nursing research within the School, University and community. The CNR and ICTR meet at least once a year to coordinate services.

**Whiting School of Engineering (WSE)**
**(http://webapps.jhu.edu/jhuniverse/academics/schools/whiting_school_of_engineering/)**

The WSE has prided itself on being a leader in innovation and research. Its national acclaim is demonstrated by its highly-ranked departments of Biomedical Engineering and Geography and Environmental Engineering by US News and World Report. WSE faculty members are leaders in their fields, oversee world-renowned laboratories, publish extensively in peer-reviewed journals, and receive wide recognition for their work through competitive funding, honors, and awards. WSE has 116 academic and 25 research faculty, 30 associated research scientists and engineers, and an additional 400 part-time faculty (working professionals) who teach in the Whiting School's Engineering for Professionals part-time programs. In 2010 – 2011, WSE faculty received six NSF CAREER Awards.

In 2010, the Whiting School received close to $60 million in federal research funding. The school's more than 20 major research centers and institutes include the recently-launched interdisciplinary initiatives: the Center for Cancer Nanotechnology Excellence, the Johns Hopkins Engineering in Oncology Center, and the Environment, Energy, Sustainability, and Health Institute. Also in 2010, WSE received a $30 million gift, the largest in the school's history, to fund the construction of a new, 56,000 square-foot research facility that will house new interdisciplinary initiatives; The Systems Institute will take a multi-disciplinary approach to reengineering entire systems of national importance including medicine health care delivery, network-enabled systems, information security, national infrastructure, and education. The Individualized Health Initiative, a university-wide effort, will bring together engineers, life scientists, and medical researchers to focus on bringing information science into the practice of medicine with an initial emphasis on cancer. The school encompasses over 275,000 square-feet of office and lab space in nine buildings on the Homewood campus, which includes state-of-the-art facilities and equipment

The School of Engineering's nine academic departments include the top-ranked Department of Biomedical Engineering. There are a large group of faculty in the Biomedical Engineering Department working in the area of cardiovascular electrophysiology, cardiovascular imaging, and systems biology. This includes Drs. Natalia Trayanova (whole-heart electromechanics), Rajat Mittal (cardiac fluid dynamics), Elliot McVeigh (cardiac functional and electrical imaging), David Yue (cardiac Ca channels and Ca handling), Dr. Andre Levchenko (systems biology, micro-fluidics and nano-devices for investigating protein networks and signaling pathways).

The Department of Biomedical Engineering runs the top-ranked Biomedical Engineering Undergraduate and PhD Program in the U.S. PhD students are given enormous flexibility in how they structure their education. Students are allowed to work with any mentor in the Johns Hopkins University. The PhD Program has more consecutive years of funding than any other T32 program supported by the NIGMS. A pre-doctoral program in human genetics was founded at JHU in 1957, and is now operated by the Institute for Genetic Medicine. Activities include courses in human genetics and medical genetics, a postdoctoral training program in human genetics, research conferences and journal clubs, as well as clinical conferences and an intensive summer course in mammalian genetics at The Jackson Laboratory in Bar Harbor, Maine.

**Zanvyl Krieger School of Arts and Sciences (http://webapps.jhu.edu/jhuniverse/academics/schools/krieger_school_of_arts_and_sciences/)**

The Zanvyl Krieger School of Arts and Sciences is the core institution of the Johns Hopkins complex of schools, centers, and institutes. Its mission is discovery--the creation of knowledge through scholarship and research, and the education of our students, undergraduate and graduate alike. The school's unique character derives from its commitment to choose carefully what is worth pursuing and to do so without compromise. The vision of founding president Daniel Coit Gilman continues to guide the school and is reflected in an environment that encourages independent research and creative thinking at all levels. The school's academic programs in the humanities, natural sciences, and social sciences are renowned for their excellence and intensity, and notable for the wide range of interdisciplinary opportunities they provide. The School offers over 60 undergraduate majors and minors and more than 40 programs of study at the graduate level and includes **286** full-time tenured and tenure-track faculty members.

**Carey Business School (http://carey.jhu.edu/)**

On December 4, 2006, Johns Hopkins University trustees, in response to a $50 million gift from William Polk Carey, voted to establish a new business school dedicated to producing innovative leaders with broad, interdisciplinary knowledge. The new Carey Business School opened January 1, 2007, continuing the Johns Hopkins tradition of bringing innovative business management programs to the ever-changing workplace. The Johns Hopkins University Carey Business School develops bold business leaders and transforms organizations, communities, and society through diverse perspectives, multi-disciplined education, and globally conscious entrepreneurship.

While Carey is a new school, the tradition of business education at Johns Hopkins began more than a century ago. Daniel Coit Gilman, Johns Hopkins' first president, established the tradition of opening some classes and lectures to the general public. These included the presentation of new and sometimes controversial ideas by Henry L. Gantt—class of 1880 and inventor of the Gantt Chart —who would become a major figure in the scientific management movement. In 1916, Hopkins added business and engineering courses to a separate division of the university offering collegiate-level instruction to part-time students. Energetic individuals such as Gantt fostered the growth of the new field of business administration and the concept of "working smarter" to enhance efficiency and profits. Following World War II, the Hopkins program produced more CPAs than any other school in Maryland.

The Master of Science in Management Science program, focusing on the application of new findings in quantitative analysis and general systems theory, became the first graduate level business degree at Hopkins in 1961. This evolved into the management and economics-focused Master of Administrative Science program, which first graduated students in 1974. By 1988, enrollment in the program had expanded rapidly. Ninety students completed the MAS program in 1979; by 1990, more than 400 MAS degrees were awarded. In 1991, concurrent with launching the Master of Science in Business degree, the school began offering Master of Science programs in Real Estate, Organization Development and Human Resources, Information and Telecommunication Systems for Business, Marketing, and Finance, as well as graduate certificate programs focusing on specific industries or fields. Major changes in the late 1990s were the offering of the Master of Business Administration degree and the collaboration with other Hopkins schools to offer Master's/MBA programs in Medical Services Management, Biotechnology, Nursing, and Public Health.

Currently, the Carey Business School offers the full-time Global MBA and the part-time Executive and Flexible MBA programs; several full-time and part-time Master of Science programs; eight joint- and dual-degree programs, most of them in conjunction with other Johns Hopkins divisions; a bachelor of science degree-completion program; and three certificate programs. The school's main campus is in the Harbor East section of Baltimore, at the Inner Harbor. Classes are also offered at campuses in Washington, D.C., Columbia, and Rockville. The school has 48 full-time faculty members and 180 adjunct professors, and approximately 1,700 students, nearly all of them in graduate programs.

## KENNEDY KRIEGER INSTITUTE

When the Kennedy Krieger Institute opened in 1937, it did so with an ambitious and novel mission: To be a place where physicians, educators, researchers, nurses, and therapists could provide the compassionate care, education, and support that children with developmental disabilities needed to unlock the potential they had inside—and to improve upon that potential through a commitment to research and training. Providing services for children with developmental concerns mild to severe, the Institute is also home to a team of investigators who are contributing to the understanding of how disorders develop while pioneering new interventions and earlier diagnosis. Our more than 70 years of experience has given us an unparalleled understanding of developmental disabilities that allows us to care for our patients throughout their lives, ensuring their success at home and in the community.

Research is a crucial component of the work at Kennedy Krieger Institute. They have multiple research centers dedicated to the mission of helping children and young adults with developmental disabilities to lead fuller, happier lives. In the Hugo W. Moser Research Institute, we're constantly working to unlock the mysteries behind developmental disorders so that we can better treat—and possibly cure—them. The F.M. Kirby Research Center for Functional Brain Imaging, has neurologists, radiologists, and other specialists working side by side to unearth the latest advancements in imaging technology. Other cores like the Intellectual and Developmental Disabilities Research Center, also brings scientists at Kennedy Krieger and Johns Hopkins University together to collaborate on the brain and its role in cognitive and behavioral function. Kennedy Krieger is committed to working with community partners to help people with developmental disabilities maximize their potential, enjoy success in community life, and lead fully inclusive, meaningful lives. This is accomplished through a wide range of community oriented programs, projects and services. The cornerstone of many of these efforts is the Maryland Center for Developmental Disabilities at Kennedy Krieger Institute. KKI has a medical staff of more than 200 physicians, representing more than 50 specialties, and a support staff of more than 2,400 employees. In FY 11, their total NIH funding was $15M.

## LIEBER INSTITUTE FOR BRAIN DEVELOPMENT

The mission of the Lieber Institute for Brain Development (LIBD) is to translate the understanding of basic genetic and molecular mechanisms of schizophrenia and related developmental brain disorders into clinical advances that change the lives of affected individuals. The Lieber Institute occupies a unique niche as the only institution in the world entirely dedicated to research on psychiatric disorders. Translating scientific insight into meaningful clinical progress based on causes, not symptoms, is a daunting challenge. The Institute pursues this goal by emphasizing teamwork, deliverables, and milestones alongside innovation, risk-taking, and novelty.

The Lieber Institute chose to locate in Baltimore in the Johns Hopkins Bioscience Park because of the many opportunities for collaboration and partnership with the growing bioscience community in Baltimore and throughout Maryland. The location of the Institute, on the campus of the Johns Hopkins School of Medicine and Hospital, facilitates a close relationship with the Johns Hopkins faculty and leadership. As an affiliate of Hopkins, Lieber Institute scientists and staff have full access to all research and clinical facilities of the JHU Medical Campus and additional resources, including the Kennedy Krieger Institute located within walking distance.

In addition to facilities here in Baltimore, LIBD scientists are engaged in several continuing scientific partnerships with the intramural programs of the National Institutes of Health (NIH), located only forty-five minutes from the Institute.

Located in the Rangos Building, the flagship building in the Bioscience Park, the Institute's facilities include a large fully outfitted state-of-the-art general laboratory and specialty in-house facilities for organic chemistry,

genetics, cell and tissue culture, advanced imaging and laser capture microscopy, neuropathology, molecular biology, electrophysiology, and animal physiology and behavioral testing.

The Lieber Institute is an independent, not-for-profit 501(c)(3) organization, and a Maryland tax-exempt academic research institution.

**JHU Centers and Institutes**

There are multiple centers and institutes across the JHU Schools that provide an infrastructure for bringing together faculty interested in a particular area or topic. Although each center has a "home" department or departments for administrative reasons, most involve faculty from several departments and divisions of the University. Some also involve faculty from other universities and research organizations. As a result, centers can often undertake a breadth of research and training that faculty associated with only one department cannot conduct alone. Most of the centers and institutes are research-oriented, but they may include practice and service activities; others focus primarily on practice or service Centers are funded primarily through grants from federal agencies, or from gifts and endowments from foundations and philanthropists. Here we describe several key centers that are critical to the clinical and translational research environment.

- **Welch Center for Prevention, Epidemiology, and Clinical Research** (Lawrence J. Appel, MD, MPH, Director): The Welch Center is a multidisciplinary academic unit that is co-sponsored by the School of Medicine and Bloomberg School of Public Health. As part of its mission, the Welch Center conducts patient-oriented clinical, epidemiologic, and translational research that promotes adoption of best practices in clinical settings and populations. Through patient-oriented research, the Welch Center evaluates the application of laboratory discoveries as well as the adoption of best practices in clinical settings and populations. Because biologic, environmental, and clinical factors interact in causing illness and disability, the Center's work is fundamentally interdisciplinary, relying on active collaboration among faculty members from the Schools of Medicine, Public Health, and Nursing. Welch Center faculty members employ the full range of research methodology, including longitudinal observational studies, randomized trials, and effectiveness and outcomes studies. The Welch Center has ~ 15,000 $ft^2$ of contiguous space and is located in the same building on the East Baltimore campus. The Welch Center provides a highly effective and stimulating environment as well as primary office and meeting room space for its 28 faculty members. In terms of faculty appointments, 15 have primary appointments in the Division of General Internal Medicine, 8 in the SPH Dept of Epidemiology, and 5 in other academic units. Virtually all faculty have joint or adjunct appointments in the Schools of Medicine and Public Health. The Welch Center abounds with trainees, over 100, who likewise have diverse backgrounds (medical students from SOM; masters and PhD students in Epidemiology and other SPH departments; and post-doctoral fellows from several disciplines, including Cardiology, Epidemiology, and General Internal Medicine). Research is facilitated through close, collegial affiliations with existing academic units at Hopkins. These include the Division of Cardiology, Division of General Internal Medicine, Division of Nephrology, Division of Geriatrics, Department of Epidemiology, Department of Biostatistics, the Chronic Disease Informatics Program, the ProHealth Clinical Research Unit, the Diabetes Research and Training Center, the Institute for Clinical Translational Research (ICTR), the Center for Clinical Trials, and the DEcIDE Network at Hopkins. The Welch Center offers weekly research-in-progress seminars. http://www.jhsph.edu/welchcenter

  The Welch Center also has a critical role in the ICTR education programs. KL2 scholars (masters and PhD tracks) have dedicated space that includes individual carrels and flexible conference space, and immediate access to Dr. Pete Miller and the KL2 administrator.

- **Institute of Genetic Medicine** (David Valle, MD, Henry J. Knott Professor and Director): The McKusick-Nathans Institute of Genetic Medicine is working to consolidate all relevant teaching, patient care and research in human and medical genetics at Johns Hopkins and to provide national and international leadership in genetic medicine. Created in 1999, it unifies nine Hopkins Centers and scores of physicians and scientists. It also serves as a focal point for interactions between diverse investigators to promote the application of genetic discoveries to human disease and genetics education to the public. It builds upon

past strengths and further develops expertise in the areas of genomics, developmental genetics, and complex disease genetics. In addition, it catalyzes the spread of human genetic perspectives to other related disciplines by collaboration with other departments within Hopkins. http://www.hopkinsmedicine.org/geneticmedicine/

The Center for Computational Biology is a research center in the McKusick-Nathans Institute of Genetic Medicine, includes a bioinformatics core group with Bioinformatics Engineers who are trained in a wide variety of next-generation sequence analysis methods. The Center has available a large-scale computing facility that it uses routinely to analyze and store results from analysis of exomes, transcriptomes, and whole-genome sequencing projects.

- **Institute for Computational Medicine** (Raimond L Winslow, PhD, Director)**.** Because of its inherent complexity, computational models are becoming indispensable tools for understanding the perturbed structure and function of living systems in disease. The type (molecules, molecular networks, cells, tissue, organ structure and function), quantity, and quality of data that can be collected from the individual is increasing due to advances in molecular assay and imaging technologies. Availability of these data is making it possible to develop patient-specific models for surgical planning, early detection of disease, and selection of optimal therapy. This approach is becoming known as “Computational Medicine”, and has been pioneered by the faculty of the Johns Hopkins University Institute for Computational Medicine (ICM). Chartered on July 1, 2005, the ICM marks the collaboration of two remarkable institutions, the Johns Hopkins University School of Medicine and the Whiting School of Engineering. What has emerged from this unique collaboration is a new research institute with a vision that goes beyond the sum of its parts, supported by a unique range of talent and resources. Efforts include modeling of molecular networks (computational molecular medicine), integrative, multi-scale modeling of physiological processes from cell to organ and organ systems (computational physiological medicine), and modeling anatomic shapes and their variations layered with physiological function (computational anatomy). Although modeling approaches used in each of these areas differ, the common thread is the use of quantitative models to understand altered structure and function in disease.

  The ICM brings together leading investigators in engineering, mathematics computational sciences and biomedical research on a single mission - to employ theoretical and computational technologies to reveal the causes of some of the major diseases afflicting the world today. Dr. Winslow has a joint appointment in the Division of Cardiology, and has collaborated with Cardiology investigators for the past 18 years. He as well as Dr. Trayanova have worked and published with many Cardiology faculties. This includes Drs. Brian O’Rourke (cardiac mitochondrial energy production), Gordon Tomaselli (cell electrophysiology and signaling), Joao Lima (cardiac structural imaging), Ronald Berger (ECG analysis), Robert Weiss (cardiac metabolism and structural imaging), Theodore Abraham (MR and ultrasound imaging), Roselle Abraham (cardiac electrophysiology), Katherine Wu (cardiac imaging), and David Kass (physiology of heart failure). Other ICM faculty have established more than 60 independent collaborations with faculty of the SOM and School of Public Health (SPH). As examples, Dr. Karchin collaborates with Drs. Bert Vogelstein, Ken Kinzler, and Victor Velculescu of the Institute for Genetic Medicine. Dr Miller has extensive collaborations with the SOM and Kennedy Krieger Institute including Drs. Susumu Mori of Radiology and Marilyn Albert of the Department of Psychiatry. http://www.icm.jhu.edu/

- **Johns Hopkins Biostatistics Center** (Richard Thompson, Ph.D., Executive Director): The Johns Hopkins Biostatistics Center (JHBC) provides biostatistical and information science expertise in support of health research to investigators at Johns Hopkins University and other academic health centers, government agencies and private organizations. The Center currently employs two full-time doctoral level statisticians, four full-time masters level statisticians, and two full-time data management professionals as well as part-time FTE totaling approximately 0.5 at the doctoral level and 1.5 FTE at the master level. Additionally the faculty of the Department of Biostatistics may engage in Center work. The JHBC team provides consultation on research issues related to the effective collection, management and interpretation of scientific information including the design of research studies, data collection systems and instruments, data entry and validation, data management and quality assurance, statistical analysis and data interpretation, and professional and scientific report writing. Its services are provided primarily on a fee-for-

service or percentage-effort basis, as well as through free "clinics" in which brief advice may be obtained. http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-biostatistics-center/

The JHBC has long had a Steering Committee that advises all aspects of its activities. Motivated by synergy between the JHBC and this ICTR Core, three years ago we broadened the purview of this committee to also oversee the Biostat CenTeR. The Committee meets with the JHBC/CenTeR leadership quarterly. Membership includes James Tonascia, PhD (Chair), Professor of Biostatistics and Chief Statistician for the Johns Hopkins Epidemiology Coordinating Centers; Daniel Ford, MD, MPH, Professor of Medicine, Vice Dean for Clinical Investigation, School of Medicine, and co-Principal Investigator (PI) of this ICTR; and Scott Zeger, PhD, Professor of Biostatistics, Vice Provost for Research, JHU, and co-Principal Investigator (PI) of this ICTR. The ICTR Internal Advisory Committee also oversees this core within its charge to oversee all ICTR Cores.

- **Center for Clinical Trials** (Kay Dickersin, PhD, Director): The Johns Hopkins Center for Clinical Trials at Johns Hopkins is an inter-school center devoted to the promotion of clinical trials as a method of evaluation of preventive and therapeutic approaches to health problems. Founded in 1990, the Center is a collaboration between faculty in departments and centers in the Johns Hopkins schools of Public Health and Medicine. The departments include: Department of Biostatistics, Department of Epidemiology and the Department of International Health in the School of Public Health, and the Department of Medicine, Department of Ophthalmology and the Department of Oncology in the School of Medicine. The core purpose of this center is to guide and inspire research, scholarship and intellectual engagement, in the Johns Hopkins community and globally, in the areas of clinical trials and evidence-based health care. http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-clinical-trials/

- **Johns Hopkins Center on Aging and Health** (David L. Roth, PhD, Director): The Johns Hopkins Center on Aging and Health (COAH) was established in 1998 to be the Center of Excellence for Aging Research for the Johns Hopkins Medical Institutions. It is sponsored by the Johns Hopkins Schools of Medicine, Public Health, and Nursing. Core Departmental sponsors include the Departments of Medicine, Epidemiology, Biostatistics, Health Policy, Mental Health and Population and Family Health Sciences. The Center is the home for 15 multidisciplinary research faculty from each of these departments; the Older Americans Independence Center; the Program in the Epidemiology of Aging; the Program in Geriatric Health Services Research; Training Programs in the Epidemiology and Biostatistics of Aging and in Clinical and Population-based Research on Aging; and the Bloomberg School of Public Health's Certificate in Gerontology program. The Center was mandated to provide the focal point for the Johns Hopkins Medical Institutions, to include a critical mass of interdisciplinary research activities on aging and the home and "go-to" place for collegial interaction for research on aging and research training. With this mandate, COAH aims to establish a critical mass of cutting-edge multidisciplinary science designed to optimizing health in aging and to provide the necessary expertise and infrastructure for the sustainable conduct of such research and its translation into improving the health of older adults. COAH also serves as a training ground for the next generation of researchers on aging. The goal of the center is to promote the intellectual interactions that are essential to creative approaches to solving the important health and health care problems for an aging population. The core research in COAH involves population-based and clinical research on the causes and consequences of diseases, frailty and disability in older adults, characterizing groups at risk of adverse health outcomes, identifying causes and developing methods for screening and prevention. COAH includes the full breadth of aging research, from the biology of aging to health policy, thus facilitating the translation of research discoveries into applications that will directly improve the health of older adults. COAH provides key infrastructure, such as the statistical data core, that supports clinical and population-based research and education, with expertise in research with older adults. http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-on-aging-and-health/

- **Center for Population Health Information Technology:** CPHIT is a new interdisciplinary Center at Johns Hopkins, the goal of which is to make Hopkins a global leader in population centric health IT (HIT) research and development. The Center will focus on the application of electronic health records (EHRs) and other HIT through a series of population health and integrated care domains including quality improvement, care management, public health outreach, health services effectiveness and outcomes

research using secondary data. Academically located in the Bloomberg School of Public Health, it partners with the School of Medicine and the Johns Hopkins Healthcare System. http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-population-health-information-technology/

**Other Johns Hopkins Centers and Institutes include:**

| | |
|---|---|
| **Autoimmune Disease Research Center**<br>**http://autoimmune.pathology.jhmi.edu/aboutcenter.cfm** | Basic scientists studying fundamental questions of immune disorders are located in different basic science departments of The Johns Hopkins Medical Institutions. The Johns Hopkins Autoimmune Disease Research Center offers leadership in the study and development of improved diagnosis, treatment and prevention of autoimmune diseases The Center creates the opportunity for all of these Johns Hopkins investigators to come together in advancing the battle against autoimmune diseases through research, education and better communication, resulting, eventually, in improved clinical care. |
| **Bioethics Institute**<br>**bioethicsinstitute.org** | The mission of the Johns Hopkins Berman Institute of Bioethics is to conduct advanced scholarship on the ethics of clinical practice, biomedical science, and public health, both locally and globally, and to engage students, trainees, the public, and policy-makers in serious discourse about these issues. The Berman Institute is now one of the largest centers of its kind in the world and consists of more than 30 core and affiliated faculty from the Johns Hopkins School of Medicine, School of Nursing, Bloomberg School of Public Health, and the Krieger School of Arts and Sciences. |
| **Biomolecular NMR Center**<br>**bionmr.jhu.edu** | The Johns Hopkins Biomolecular NMR Center is an inter-campus research facility, encompassing the Johns Hopkins University (JHU) and the Johns Hopkins School of Medicine (SOM). The Center comprises of six NMR spectrometers – four of which equipped with high sensitivity cryogenic probes – for carrying out liquid state high-resolution NMR studies of biological macromolecules. |
| **Biostatistics Center**<br>**jhsph.edu** | Our mission is to provide biostatistical and information science expertise in support of health research. The Johns Hopkins Biostatistics Center was officially instituted in 1997, through the efforts of Dr Scott L. Zeger, former Chair of the Department of Biostatistics. The Center was formed to begin to fill the critical need for biostatisticians across the Johns Hopkins Medical Institutions. We collaborate on projects not only from our campus, but from affiliated organizations such as Kennedy Krieger Institute and the Johns Hopkins Healthcare System. We also work with non-profit organizations and government agencies. |
| **Biostatistics Consulting Center**<br>**son.jhmi.edu/research/biostat.aspx** | Statistical support is available for Johns Hopkins University School of Nursing (JHUSON) faculty, postdoctoral fellows, and students. This includes assistance with statistical aspects of grant proposal preparation, research study design, determination of sample size, randomization, data management, statistical modeling, data analysis and interpretation, and statistical software assistance. Inquiries at any stage of a study are welcome. |
| **BRB Molecular Imaging Center**<br>**oncweb1-vm.onc.jhmi.edu** | Noninvasive imaging has become a powerful tool in the investigation of various disease processes. Spectacular advances in MR, PET, SPECT, ultrasound, optical imaging as well as other modalities now provide unparalleled opportunities for combined anatomic, functional and molecular imaging. The BRB Molecular Imaging Center and Cancer Functional Imaging Core provides state-of-the art imaging equipment, including MRI, PET, Spect, Ultrasound, Optical imaging, X-ray and CT, to support the wide range of scientific projects within the diverse research community of the Johns Hopkins University and beyond. |

| | |
|---|---|
| **Center for AIDS Research**<br>**jhuccp.org** | The Johns Hopkins team brings together world-class researchers from the three medical institutions of the Johns Hopkins University (JHU), the Schools of Medicine, Nursing and Public Health, and Jhpiego, a university affiliate, as well as researchers from three global partners: Abt Associates, Inc.; Macro International Inc.; and Social Sectors Development Strategies (SSDS). The team includes a comprehensive network of researchers from the Johns Hopkins Schools of Medicine, Nursing and Public Health that are recognized as leaders in HIV/AIDS research, especially in randomized clinical/community trials, epidemiology, behavioral research, and new technology development. |
| **Center for Bioengineering Innovation and Design**<br>**cbid.bme.jhu.edu** | The Department of Biomedical Engineering at Johns Hopkins University is internationally recognized as a leader in biomedical research and education. With a footing in both the Whiting School of Engineering and the Johns Hopkins School of Medicine, BME students have access to a wealth of clinical and scientific depth across both Johns Hopkins campuses. |
| **Center for Brain Imaging Science**<br>**brainscienceinstitute.org** | Established as a research center by Brain Science Institute, the Center for Brain Imaging Science (CBIS) is dedicated to provide state-of-the-art image analysis technologies to researchers in Hopkins community. Currently, several MRI and PET imaging centers at the university provide access to an array of modern imaging capabilities. CBIC also has close ties with Center for Imaging Science (CIS) on the Homewood campus aimed at furthering its existing cutting-edge image analysis technologies and putting them to best use. |
| **Center for Cardiovascular Bioinformatics and Modeling**<br>**ccbm.jhu.edu** | The mission of the Center for Cardiovascular Bioinformatics and Modeling (CCBM) is to develop new methods for the representation, storage, analysis and modeling of biological data, and to use these quantitative approaches to better understand cardiovascular function in both health and disease. The CCBM has formal recognition as a Center within the Whiting School of Engineering, and within the Institute for Molecular Cardiobiology of the School of Medicine. Center faculty have primary appointments in several academic departments and divisions of The Johns Hopkins University. |
| **Center for Clinical Trials**<br>**cct.jhsph.edu** | The Johns Hopkins Center for Clinical Trials was founded in 1990 as a collaborative effort of faculty from both the Bloomberg School of Public Health and the School of Medicine. The core purpose is to guide and inspire research, scholarship and intellectual engagement, in the Johns Hopkins community and globally, in the areas of clinical trials and evidence-based healthcare. This is an interschool Center devoted to the promotion of clinical trials as a method of evaluation of preventive and therapeutic approaches to health problems. |
| **Center for Collaborative Intervention Research**<br>**son.jhmi.edu/research** | The Center for Collaborative Intervention Research (CCIR) is the newest Johns Hopkins University School of Nursing initiative to advance health science by designing and testing effective health interventions.<br>Funded by an NIH National Institute of Nursing Research Center Core (P30) grant, the CCIR fosters multidisciplinary investigations and provides an environment for scientists to enhance collective productivity by building intellectual and physical resources. |
| **Center for Excellence for Cardiovascular Health**<br>**son.jhmi.edu/research** | The Center of Excellence for Cardiovascular Health in Vulnerable Populations is a National Institute of Nursing Research (NINR) and National Institutes of Health (NIH) funded Center of Excellence to build science addressing disparities in cardiovascular health (P30 NR011409-01). |
| **Center for Global Health**<br>**hopkinsglobalhealth.org** | Our mission is to facilitate and focus the extensive expertise and resources of the Johns Hopkins institutions together with global collaborators to effectively address and ameliorate the world's most pressing health issues. |

| | |
|---|---|
| **Center for Health Disparities Solutions**<br>**jhsph.edu/healthdisparities** | The Hopkins Center for Health Disparities Solutions (HCHDS) was established in October 2002 by a five-year grant from the National Center for Minority Health and Health Disparities (NCMHD), of the National Institutes of Health under the Centers of Excellence in Partnerships for Community Outreach, Research on Health Disparities, and Training Program (Project EXPORT). The Center brings together the health research and program development resources of the Johns Hopkins Medical Institutes (Schools of Public Health, Medicine, and Nursing) to demonstrate the efficacy of public health, social science and medical science in mitigating health disparities. The HCHDS leverages its resources by forming collaborations with other Johns Hopkins-based academic departments or research units, establishing partnerships with colleagues at other universities and organizations, and being active in all aspects of the University's mission: research, teaching and service. |
| **Center for Imaging Science**<br>**cis.jhu.edu** | Our guiding principle is that, while the 20th Century was focused on sensors for generating images, videos and multi-dimensional datasets, the fundamental challenge of the 21st Century is the information extraction for the generation of the metadata of understandings. Our collaborations include Kennedy Krieger Institute, Biomedical Informatics Research Network (BIRN), Washington University in St. Louis, National Center for Microscopy and Imaging Research, Center for Brain Imaging Science. |
| **Center for Inherited Disease Research (CIDR)**<br>**cidr.jhmi.edu** | CIDR provides high quality next generation sequencing and genotyping services to investigators working to discover genes that contribute to common disease. With over 14 years of experience, CIDR is a valuable national resource for cutting-edge genetic research. CIDR rapidly implements new technologies, offers new services and increases throughput while maintaining strict quality standards. |
| **Center for Integrated Health Care**<br>**jhsph.edu/lipitzcenter** | The Lipitz Center, located at the Johns Hopkins Bloomberg School of Public Health, is committed to improving the health and quality of life for people with complex health care needs by conducting research and disseminating new knowledge. The Center is also committed to preparing the next generation of leaders in this discipline. The Center strives to discover and disseminate practical, cost-effective approaches to providing comprehensive, coordinated, compassionate health care to chronically ill people and their families. The Center's multidisciplinary activities span Johns Hopkins University's Schools of Medicine, Nursing, and Public Health. |
| **Center for Interdisciplinary Salivary Bioscience Research Our Mission**<br>**son.jhmi.edu/research** | The mission of the Johns Hopkins Center for Interdisciplinary Salivary Bioscience Research is to push the cutting edge of knowledge related to discovery and application of saliva as a research and diagnostic specimen. |
| **Center for Mental Health Initiatives**<br>**jhsph.edu/mental_health_initiatives** | The mission of the Center for Mental Health Initiatives is to improve the lives of persons with mental illness by fostering the collaboration of researchers and clinicians and by providing leadership in the implementation of public mental health initiatives. Center affiliates include researchers and clinicians from the Departments of Mental Health and International Health at the Johns Hopkins Bloomberg School of Public Health, Department of Psychiatry at the Johns Hopkins University School of Medicine and the Community Psychiatry Programs at the Johns Hopkins Hospital and the Johns Hopkins Bayview Medical Center. |
| **Center for Metabolism and Obesity Research**<br>**hopkinsmedicine.org/institute_basic_biomedical_sciences** | Centralized Services for Metabolism Research (CSMR) provides access to shared equipment for rodent metabolic testing; controlled settings (temperature, humidity, light, air flow, low general human activity) required for accurate assessments of whole-body metabolism and animal behavior; and expertise of JHMI faculty who each have 15-30 years experience in rodent behavioral and metabolic testing and data analysis. |
| **Center for Mind-Body Research**<br>**jhsph.edu/mindbodyresearch/** | The goal of the CMBR is to develop and nurture the intellectual community of mind-body researchers at Johns Hopkins University. The CMBR brings together 45 faculty members representing 15 disciplines and having primary faculty appointments in the Schools of Medicine, Nursing, and Public Health. |

| | |
|---|---|
| **Center for Research on Services for Severe Mental Health** | The Johns Hopkins University of Maryland Center for Research on Services for Severe Mental Illness (SMI Center) was established in 1987 as a collaborative effort of the Bloomberg School of Public Health and the School of Medicine at the Johns Hopkins University and the Center for Mental Health Services Research of the Department of Psychiatry at the University of Maryland. It works collaboratively with the Maryland State Department of Health and Mental Hygiene and the National Alliance for the Mentally Ill (NAMI), as well as providers and payers. The Center has adopted an integrating theme, "Improving Quality of Care and Patient Outcomes," which involves the Center in further developing and refining methods to improve the match between patient needs and services, developing guidelines for the financing and organization of care that meet cost and effectiveness criteria taking into account variations in need and available resources, and testing dissemination strategies to close the gap between research and practice. |
| **Center of Cancer Nanotechnology Excellence**<br>**ccne.inbt.jhu.edu/** | The Johns Hopkins Center of Cancer Nanotechnology Excellence brings together a multi-disciplinary team of scientists, engineers, and doctors to develop nano- technology-based diagnostic platforms and therapeutic strategies for comprehensive cancer care. Faculty members associated with The Johns Hopkins Institute for NanoBioTechnology (INBT) have received a $13.6 million grant from the National Cancer Institute (NCI), to establish a Center of Cancer Nanotechnology Excellence (CCNE). The Johns Hopkins CCNE is one of several NCI-funded centers launched through a program that started in 2005. |
| **Center on Aging and Health**<br>**jhsph.edu/agingandhealth** | The Center on Aging and Health aims to lead on an international level in advancements to optimize the health and quality of life of older populations, and to see our discoveries pay off as added years of healthy life for older adults. COAH is equally committed to research on effective clinical care for an aging population and to the translation of these results to improve the health of older adults. We seek to foster interdisciplinary research and to train the next generations of research leaders, who will be essential to guiding advances in prevention and health promotion. |
| **Ci3R**<br>**hopkinsmedicine.org/ci3r** | Non-invasive imaging has powerfully augmented the investigation of various disease processes in fields such as Oncology, Infectious Diseases and Inflammation. In conjunction with the BRB Molecular Imaging Center, the Center for Infection and Inflammation Imaging Research core provides state-of-the art small animal imaging equipment, including PET, SPECT and CT, to support the wide range of scientific projects within the diverse research community of the Johns Hopkins University and beyond. |
| **Wilmer Imaging and Microscopy**<br>**hopkinsmedicine.org/wilmer/micf** | The MICF staff members are committed to provide equipment support and consultation for experimental designs involved in cell imaging, instrument selection, instrument training, sample preparation, and image analysis to its users. |
| **Deep Sequencing & Microarray Core**<br>**microarray.jhmi.edu** | Our aim is to provide cost-effective and time-efficient access to cutting-edge genomic technologies and expert assistance with experimental design and data analysis. We offer statistical and bioinformatic data analysis on primary data and downstream functional analyses. |
| **Engineering in Oncology Center**<br>**psoc.inbt.jhu.edu** | The Johns Hopkins Engineering in Oncology Center brings together experts in cancer biology, molecular and cellular biophysics, applied mathematics, materials science, and physics to study and model cellular mobility and the assorted biophysical forces involved in the metastatic process. Our scientific approach is to perform an integrated analysis using biophysical, biochemical, biological, engineering, and computational approaches to gain insight into the cellular, molecular, and physical mechanisms underlying the functional interactions critical for establishing the intracellular and extracellular conditions favorable for metastasis. |
| **ES Cell Targeting**<br>**hopkinsmedicine.org/core/ES_Targeting** | The ES Core Facility (ECF) was founded by the NINDS Core Center Grant. The mission of ECF is to effectively produce ES cell lines with a high probability of germline transmission. |

| | |
|---|---|
| **Environment, Energy, Sustainability and Health Institute**<br>**e2shi.jhu.edu** | The Institute's goals are to establish Johns Hopkins University as a world leader in, and provide a single point of contact for, integrative approaches to global environmental change, sustainability, and their related health challenges, to promote the development of interdisciplinary research collaborations and proposals, to stimulate enhancement and coordination of environmental curricula at the undergraduate and graduate levels, facilitate translation of research into sound policy, and to develop collaborative partnerships with the business sector, federal, state, and local agencies, environmental groups, and Baltimore community organizations. |
| **Evidence Based Practice Center**<br>**jhsph.edu/epc** | The Johns Hopkins Evidence-based Practice Center (JHU EPC) was established in 1997 as a charter member of the 14 EPCs currently supported by the Effective Healthcare Program (EHC) of the Agency for Healthcare Research and Quality (AHRQ) of the U.S. Department of Health and Human Services (HHS). The EPC produces comprehensive systematic reviews of important medical topics using interdisciplinary teams that integrate clinical expertise with expertise in evidence-based methods, including meta-analysis, decision analysis, benefit-harms analysis, and cost-effectiveness analysis. The EPC also collaborates with other EPCs and AHRQ programs to advance the methodology of systematic reviews, their transparency, and their use in dissemination and translation of findings. |
| **Flow Cytometry at Johns Hopkins**<br>**hopkinsmedicine.org/flowcytometry/downtown** | It is currently staffed by two full-time Flow Cytometrists with more than 13 years of combined experience to assist with acquisition and analysis of data as well as sorting specific cell groups of interest. |
| **Flow Cytometry at Bayview**<br>**hopkinsmedicine.org/flowcytometry/bayview** | The Johns Hopkins Bayview Flow Cytometry Core Laboratory is to support the research initiatives of Johns Hopkins Bayview faculty and staff. We are committed to providing state-of-the art technology and staff support to address current flow cytometry and cell sorting applications and new strategies. |
| **Fogarty AIDS International Training and Research Program**<br>**jhsph.edu/fogartyaids** | The Johns Hopkins University Fogarty AIDS International Training and Research Program (Hopkins AITRP) is a campus-wide program involving faculty and trainees in departments in both the Bloomberg School of Public Health and the School of Medicine. Primary BSPH departments participating in the program are: Biostatistics, Epidemiology, International Health and Populations & Family Health Sciences. Primary SOM departments are Clinical Investigation, Medicine, Pathology, Pediatrics and OB/GYN in the School of Medicine. Campus and School-wide centers such as the Center for Global Health, Center for Immunization Research, Center for Clinical Trials, Center for TB Research, Center for Communications Programs and the Bioethics Institute serve as resources for faculty and training programs. |
| **Genetic Resources Core Facility (GRCF)**<br>**grcf.med.jhu.edu/** | The Genetic Resources Core Facility (GRCF) is a Johns Hopkins University service center with six divisions. Collectively, these divisions produce a number of products and services to aid researchers performing studies in molecular biology and genetics. It is our mission to provide solutions to the everyday challenges of laboratory research. |
| **George W. Comstock Center for Public Health Research and Prevention**<br>**jhsph.edu/comstockcenter** | Established in 1962 in Hagerstown, Maryland, George W. Comstock Center for Public Health Research and Prevention conducts research on the prevention of disease, particularly heart disease, cancer and stroke; provides a base of operations for faculty and students who are interested in community-based research; serves as a resource for the Washington County (Maryland) Health Department in the areas of public health surveillance and assessment. The Comstock Center is expanding its activities and is engaging a wider community of scientists, students and prevention experts across multiple departments inside and outside the Johns Hopkins Bloomberg School of Public Health. |
| **GRCF Cell Center**<br>**cellcenter.grcf.jhmi.edu** | The mission of the Cell Center is to facilitate basic scientific research by providing expertise and service in all aspects of mammalian cell culture. We evaluate new products, technology, and services to enhance existing products and services. In addition to serving the Hopkins community of scientific professionals, we provide job opportunities for residents of East Baltimore and internships for local scholars. |

| | |
|---|---|
| **GRCF DNA Analysis Facility**<br>**daf.jhmi.edu** | We offer on-site DNA sequencing using both an Applied Biosystems 3730 and a Qiagen Pyromark Q24. Oligonucleotides and other synthetic DNA products may be ordered through any one of several manufacturers at very reasonable prices, directly from our company specific portals. We also provide access to Applied Biosystems and Qiagen custom assay products at slightly reduced pricing and free shipping. |
| **GRCF Fragment Analysis Facility**<br>**faf.grcf.jhmi.edu** | The Fragment Analysis Facility (FAF) was established to facilitate scientific research by providing technical assistance with genotyping and nucleic acid purification. |
| **GRCF SNP Center**<br>**snpcenter.grcf.jhmi.edu** | The JHU SNP Center is a high through-put genotyping facility featuring Illumina's BeadArray™technology, serving JHU and the scientific community at large. |
| **Health Services Research and Development Center**<br>**jhsph.edu/HSR** | The Health Services Research and Development Center was established in 1969 to provide a locus for research on the organization, financing, staffing and technology of health services and their impact on the use, cost, and quality of the care they offer and on patient outcomes. We seek to advance knowledge about effective and efficient approaches to providing health services to all people. To that end, we undertake methodological and policy-relevant research in local, regional, and national venues. While the Center is based administratively in the Department of Health Policy and Management of the Johns Hopkins Bloomberg School of Public Health, we work collaboratively with faculty from other departments in the School, the School of Medicine, the Johns Hopkins Hospital, the Faculty of Arts and Sciences, and with researchers elsewhere.. |
| **High Throughput Center** | The new High Throughput Biology Center, or HiT Center, of the Institute for Basic Biomedical Sciences is an interdisciplinary and interdepartmental effort. The five independent research labs that make up the HiT Center push the frontiers of research technologies and apply those techniques to fundamental questions of biology. |
| **Histology Core** | The Bayview Histology Core provides frozen and paraffin embedding and sectioning for basic research investigators at the Johns Hopkins Bayview Campus, including basic brightfield staining (i.e., H&E). |
| **Institute for Computational Medicine**<br>**icm.jhu.edu/mission/** | Today, biological research is entering a new and exciting phase, one in which computational methodologies and modeling will play a critical role in revealing the causes and treatment of human disease. At the forefront of this frontier is the Institute of Computational Medicine (ICM). The Institute is an extraordinary initiative that builds on groundbreaking research at both The Johns Hopkins University Whiting School of Engineering and the School of Medicine. ICM's mission is to develop quantitative approaches for understanding the mechanisms, diagnosis and treatment of human disease through applications of mathematics, engineering and computer science. |
| **Johns Hopkins Systems Institute**<br>**eng.jhu.edu/wse/systems-institute** | In April of 2011, a major new research initiative, the Johns Hopkins Systems Institute, was launched at Johns Hopkins University (JHU). This interdisciplinary research facility, based in JHU's Whiting School of Engineering, will include faculty from across the university. The Systems Institute will take a multidisciplinary approach to re-engineering entire systems of national importance, including medicine, health care delivery, network-enabled systems, information security, national infrastructure, and education. The institute will tap into the expertise of researchers from the university's three health professions schools, Medicine, Public Health, and Nursing; from the schools of Arts and Sciences, Business and Education; and from JHU's Applied Physics Laboratory, already one of the nation's leading centers of systems engineering. |
| **Lowe Family Genomic Center** | The Lowe Family contributions created the Genomics Center at Johns Hopkins Bayview. The teams of physicians are working to identify the genes that contribute to flares and remissions of vasculitis, rheumatoid arthritis, systemic lupus and other chronic inflammatory diseases. |

| | |
|---|---|
| **Microscope Facility** | Since 1989, the Johns Hopkins University School of Medicine Microscope Facility has provided light, fluorescence and electron microscopy services to over 200 users throughout Johns Hopkins University and the local area. We are one of the *largest* and *most popular* facilities in Baltimore providing microscopy and imaging services. Our imaging resources have facilitated numerous publications and grant proposals for our users throughout the local research community. Our mission is to facilitate clinical and basic science research. |
| **Microscopy/Confocal Imaging Core**<br>**hopkinspcc.org/microscopy/** | The Microscopy Core at the Johns Hopkins Bayview offers confocal laser scanning microscopy services to the Hopkins community and beyond. Located in the Johns Hopkins Asthma & Allergy Center, the Microscopy Core is available to help researchers develop technical solutions for special research needs. |
| **Mouse Forward Genetics Center**<br>**brainscienceinstitute.org** | The study of genetic mutations has driven many major discoveries in neuroscience, but the capacity to assess the effect of mutations in an unbiased way – across the entire genome – has largely been restricted to studies in worms and other invertebrates. This Center uses innovative techniques to insert tagged gene modifiers, so that large numbers of "tagged" mutations will be present in each mouse pup, greatly facilitating the assessment of the consequences of these mutations in nervous system development and function. The mouse lines developed in this Center will be available to all Johns Hopkins neuroscientists. |
| **PhenoCore (Animal Phenotyping)**<br>**hopkinsmedicine.org/mcp/phenocore** | The Phenotyping Core aims to promote functional genomics and other preclinical translational science at Johns Hopkins, by assisting and collaborating in the characterization and use of genetically and phenotypically relevant animal models of disease and gene function. |
| **Protein Microarray Core** | At the Johns Hopkins Protein Microarray Core (PMC), we help researchers conduct comprehensive, systematic analyses of proteomes, to understand how proteins interact, form complexes and create global functioning networks. |
| **Proteomics Core, Mass Spectrometry Core**<br>**hopkinsmedicine.org/msf** | The mission of the Hopkins A.B.Mass Spectrometry /Proteomic Facility is to accelerate discovery by giving Hopkins investigators access to cutting edge technologies in mass spectrometry and proteomics. |
| **Sidney Kimmel Comprehensive Cancer Center (SKCCC) Laboratory**<br>**hopkinsmedicine.org/kimmel_cancer_center/research_clinical_trials/research** | Our Cancer Center has led the world in deciphering the mechanisms of cancer and new ways to treat it. The strength of our research and treatment programs was recognized early on by the National Cancer Institute, becoming one of the first to earn comprehensive cancer center status and recognition as a "Center of Excellence." One of only 40 cancer centers in the country designated by the National Cancer Institute (NCI) as a Comprehensive Cancer Center, the Johns Hopkins Kimmel Cancer Center has active programs in clinical research, laboratory research, education, community outreach, and prevention and control. |
| **SKCCC Bioinformatics Shared Resource (BISR)**<br>**cancerbiostats.onc.jhmi.edu** | Efficient utilization of the data generated by the experiments is of strategic scientific importance and requires bioinformatics support. The bioinformatics shared resource guarantees the availability of comprehensive bioinformatics expertise to Cancer Center members. This resource comprises faculty and support staff able to support data acquisition (including study design, feasibility of objectives, availability of public-access genomic information, data storage, and data annotation), statistical quality control (including artifact detection, preprocessing, and normalization of data from genomic technologies), data analysis (including visualization, modeling, inference and interpretation), and development of innovative customized bioinformatics tools, and education. |
| **SKCCC Cancer Cytogenetics Core**<br>**hopkinsmedicine.org/kimmel_cancer_center/research_clinical_trials/research** | Cancer cytogenetics expertise is needed to provide critical data for research projects in many Programs of the SKCCC. The Cancer Cytogenetics Shared Resource has been providing such expertise to SKCCC researchers since 1986. |

| | |
|---|---|
| **SKCCC Cell Imaging Core Facility**<br>**cellimaging.onc.jhmi.edu** | Its mission has been to provide state-of-the-art cell imaging technologies to SKCCC members. The Core also provides analytical cytometry services including immunophenotyping and cell cycle analysis. All scientists have the opportunity for consultation prior to and during their experiments. |
| **SKCCC Experimental Irradiator Core**<br>**hopkinsmedicine.org/kimmel_cancer_center/research_clinical_trials/research** | The Experimental Irradiator Core, which has been in existence since 1986, maintains and operates sources of ionizing radiation for use by SKCCC members in their experimental studies. |
| **SKCCC Flow Cytometry Core**<br>**hopkinsmedicine.org/kimmel_cancer_center/research_clinical_trials/research** | Overall, this Core provides essential services for SKCCC investigators from a diverse array of disciplines who seek to more deeply understand the biology and treatment of cancer. |
| **SKCCC Microarray Core**<br>**microarray.onc.jhmi.edu** | The Microarray Core has provided services to Cancer Center members and to the Hopkins Medical Campus. The Core operates in conjunction with support from the Department of Medicine, has close links to the School of Medicine Affymetrix Core, and is seamlessly linked to the new Bioinformatics Core in the Cancer Center. |
| **SKCCC Next Generation Sequencing**<br>**Phone 410-955-8797**<br>**nextgenseq.onc.jhmi.edu/** | To maintain and build on the Sidney Kimmel Comprehensive Cancer Center's (SKCCC) record of excellence in the fields of cancer genetics and epigenetics, the SKCCC has established a new Next Generation Sequencing Center (NGSC) as a shared resource since January 2009. A product of a convergence of advances in molecular biology, engineering, computer science, and bioinformatics, Next Generation Sequencing features the ability to sequence billions of base pairs of DNA in a single run. The Center's goal is to assist researchers in exploring all aspects of cancer genetics and epigenetics. |
| **SKCCC Tissue Microarray (TMA) Lab Core**<br>**tmalab.jhmi.edu** | The TMA Core at Johns Hopkins was initially funded by the Prostate SPORE but has grown into a user-supported University Service Center/Shared Resource. Since 2005. The specific aims of this shared resource are to support and speed translational cancer research by continuing to produce TMAs for SKCCC members and others. |
| **Synthetic Core** | The Synthetic Core Facility provides an economical option for small molecule synthesis. Past projects have included the synthesis of analogs for the study of structure activity relationships (SAR); the synthesis of unnatural amino acids/chemical probes/labeled compounds and scale-up for further studies. |
| **Welch Center for Prevention, Epidemiology, and Clinical Research**<br>**jhsph.edu/welchcenter** | Founded in 1989, the Welch Center for Prevention, Epidemiology, and Clinical Research is an impressive academic unit that is affiliated with Johns Hopkins School of Medicine and the Bloomberg School of Public Health. Through its educational programs and its research, the Welch Center promotes the application of rigorous methods to conduct clinical, epidemiologic, and translational research of the highest quality. Our faculty includes physicians with a keen interest in public health and epidemiologists with a deep appreciation of clinical factors that influence health outcomes. |

## JOHNS HOPKINS MEDICINE AND JOHNS HOPKINS HEALTH SYSTEM

Johns Hopkins Medicine (JHM), which combines The Johns Hopkins University School of Medicine and The Johns Hopkins Health System, has become a laboratory for innovative strategies in community-based research. The recent addition to the health system of four community hospitals and several provider groups, each with a distinct culture and patient mix, expanded the referral base and potential sites for JHM trials.

The resulting geographic and demographic diversity among hospitals and providers makes The Johns Hopkins Health System a unique resource for an academic research partner. The six health system hospitals and the Johns Hopkins Community Physician group serve patients in three states; provider sites include both urban (Baltimore, Washington, D.C., and St. Petersburg, FL), and suburban settings. Several community hospitals in the system are very research-intensive, with two hold long-standing major contracts with NIH institutes to host and support NIH clinical research.

As the integrated academic home for Hopkins research, JHU is extending to its broader health system community the compliance oversight and best practices that are the hallmark of JHU research. Unified electronic systems for medical records (EPIC), IRB submissions, clinical research management, contracting, and conflict-of-interest disclosure (each discussed elsewhere in this proposal) are key elements of this strategy, together with an administrative structure that combines central compliance with an indispensable element of local review and accountability. Through the ICTR, and in cooperation with The Johns Hopkins Health system, JHU will shape the future of community research partnerships, in areas that range from contracting, IRB review, and insurance, to auditing, investigational drug control, and data security.

**JOHNS HOPKINS CLINICAL RESEARCH NETWORK**

Johns Hopkins has developed strong relationships with regional medical institutions to create a powerful network to facilitate discovery. The JHCRN includes the five hospitals that are part of Johns Hopkins Medical Institutions, as well as four partner sites, including:

- Johns Hopkins Hospital in Baltimore (described above)
- Johns Hopkins Bayview Medical Center in Baltimore
- Johns Hopkins Suburban Hospital in Bethesda
- Johns Hopkins Sibley Hospital in Washington, DC
- Anne Arundel Medical Center in Annapolis
- Greater Baltimore Medical Center in Towson
- INOVA Health System in Northern Virginia
- Peninsula Regional Medical Center on Maryland's Eastern Shore

The JHCRN includes both academic medical centers and community-based practices, as well as practices in urban, suburban, and rural settings. Notably, the JHCRN allows a seamless platform for efficient study conduct by using one protocol and handling all regulatory issues by the regulatory offices of Johns Hopkins Medical Institutions.

The JHCRN is designed with a formal organizational structure and governance that spans the leadership of each of the affiliate member institutions, as well as a Working Group and a Physician Investigators Committee comprised of representative leadership of each of the affiliate member institutions. Policies and procedures have also been implemented and a governing structure is in place. Each participating affiliated institution has agreed to a detailed contract outlining the responsibilities and the relationship among the institutions, including the agreement for Network protocols to use Johns Hopkins IRB, to have a single budget for Network protocols, indemnification, and a financial contribution that includes an annual fee plus half the salary of a Network Coordinator, with Johns Hopkins providing the other half of the salary. The Network Coordinators are an essential part of the process. They are experienced research nurses or clinical research associates whose employment badges represent both Johns Hopkins and the affiliate institution with whom they are working. They physically spend half time in the research office of the affiliate institution and the other half at Johns Hopkins. In addition, there is an Administrative Coordinator and Faculty representing the disciplines of Oncology, Surgery, and Internal Medicine at Johns Hopkins.

Thus, the JHCRN creates a bridge for research between Hopkins and community-based medical centers by linking physician-scientists and staff from Johns Hopkins Medicine with community-based medical centers in the region. JHCRN directly addresses the many complexities of conducting multi-site and multi-institutional trials by providing investigators with a larger patient pool and a seamless platform that uses common research protocols. Rapid start-up and timely completion of research studies are hallmarks of the JHCRN. Each of the JHCRN institutions who will participate in this study are described below.

- **Suburban Medical Center**

  Suburban Hospital Health Care System includes among other entities the Suburban Hospital, a 240 bed acute care hospital in Bethesda, Maryland. The hospital admits about 13,000 patients each year and evaluates approximately 45,000 patients in its Emergency Department including 1600 patients in its Level II Trauma Center. There are approximately1000 physicians on Suburban's Medical Staff including full time Intensivists and Hospitalists. There are large programs in joint replacement, cancer and cardiovascular diseases. There are approximately 100 research protocols active in CV disease and cancer. Suburban Hospital supports an active translational research program in collaboration with the intramural program of the National Institutes of Health; the hospital is an 8 minute walk from the NIH Clinical Center

- **Sibley Hospital**

  Sibley is a non-profit, full service 318 bed acute care community hospital serving the Washington, DC area since 1890. The mission of Sibley Memorial Hospital is to provide quality health services and facilities for the community, to promote wellness, to relieve suffering, and to restore health as swiftly, safely, and humanely as it can be done consistent with the best service we can give at the highest value for all concerned. The campus is also home to our assisted living residence, Grand Oaks, and The Sibley Renaissance, which houses our Center for Rehabilitation Medicine, skilled nursing care, and a residential Alzheimer's unit. Sibley has approximately 318 beds and sees 1100 new cancer cases annually. The medical oncology unit includes 5000 square feet with 3 exam rooms and 15 infusion chairs. Its research staff includes nurses, a data manager, pharmacy technicians, and a pharmacist.

- **Anne Arundel Health Systems (AAHS)**

  AAHS is the parent company of Anne Arundel Medical Center (AAMC) and several other entities, including the AAHS Research Institute, Pathways Alcohol & Drug Treatment Center, and Anne Arundel Diagnostics Imaging. The 324-bed facility is located on the 60-acre Medical Park campus in Annapolis, MD. AAMC has more than 23,000 annual admissions and sees 76,000 people in the emergency room each year. The DeCesaris Cancer Institute features the AAMC Breast Center, which is accredited by the National Accreditation Program for Breast Centers (NAPBC). As part of its commitment to enhanced research and ease of contracting, Anne Arundel Health Systems formed the Anne Arundel Medical Research Institute, a clearing house for clinical research trial administration including regulatory and financial aspects.

- **Greater Baltimore Medical Center (GBMC)**

  GBMC HealthCare includes Greater Baltimore Medical Center, a 285-bed acute care not-for-profit hospital which opened in 1965 and provides health, healing, and hope; Greater Baltimore Medical Associates, a group of more than 40 multi-specialty physician practices on the hospital's suburban Baltimore campus and in satellite locations across the region; Gilchrist Hospice Care, Maryland's largest hospice organization offering both in-home care as well as a 34-bed inpatient unit; and the GBMC Foundation, which raises funds to support the organization's mission. With nearly 2,000 newly-diagnosed cancer cases in 2009, and offering more than 60 research and treatment clinical trials annually, GBMC's Sandra & Malcolm Berman Cancer Institute ranks as the busiest community hospital-based cancer program in Maryland.

- **Inova Health System**

  The addition of Inova Health System and its five major hospitals provides yet another strength to the Network in terms of established research programs, patient population, and specialty collaborations, especially in the area of pediatrics, neurosciences, cardiovascular, oncology, and genomics medicine. The Inova Health System provides medical services for a catchment area covering Northern Virginia and Southwestern Maryland. Their clinical research programs are very mature with over 500 active protocols, including 239 treatment-related protocols, conducted by over 180 physicians. About 40% of this research is funded from commercial sources. Their largest volume of clinical trials involves pediatrics, oncology, cardiovascular, and advanced lung disease. The Inova Translational Medicine Institute was established in 2011 and will have a major focus on genomics medicine research.

- **Peninsula Regional Medical Center (PRMC)**

  PRMC in Salisbury, Md., offers the widest array of specialty and subspecialty services on the Delmarva Peninsula. At over 360 acute care beds, 30 transitional care beds, and 28 newborn beds, PRMC is the region's largest, most advanced tertiary care facility and has been meeting the health care needs of Delmarva Peninsula residents since 1897. Its 3,300 physicians, staff and volunteers provide safe, compassionate and affordable care designed to exceed the expectations of the nearly 500,000 patients who rely on the Medical Center team each year for inpatient, outpatient, diagnostic, subacute, and emergency/trauma services. It is the region's oldest health care institution with the most experienced team of health care professionals. Peninsula Regional is the sixth largest medical center in the state of Maryland by bed count, offering a full range of services, including neurosurgery, cardiothoracic surgery, joint replacement, emergency/trauma care, and comprehensive cancer care, that rival those offered in much larger metropolitan areas. PRMC has received over 100 national awards, certifications, and recognitions over the past five years for the safety and care it provides patients and the outcomes they experience.

## ACADEMIC ENRICHMENT RESOURCES

**Welch Medical Library** One of the leading medical libraries in the world, the library is evolving into a user-focused, service-oriented entity rather than a traditional brick and mortar repository for physical materials. The library is less a place that users actually visit, and more a large group of services. These services are provided both electronically and by library staff, are applicable to a primarily electronic collection, and are accessible by many devices, from anywhere in the world. The Welch journal collection is essentially electronic. Out of 8,500 journal titles there are subscriptions only to 88 print journals. The final 88 titles are journals that do not have an online version. Welch provides 7,000 e-books and 425 databases. In all, Welch users have access to more than a million e-resources because when any Hopkins library licenses an e-resource it subscribes for all JHU libraries whenever possible. The Welch Medical Library has moved aggressively to meet the demand for electronic resources and the need for more specialized library services provided by an information expert at the points of work and care for faculty, staff and students. This new information services delivery model is called embedded informationist services. By actively extending expert informationist services out of the library building in order to collaborate with JHMI community members in their own work environments, Welch expects to strengthen the research, teaching and clinical efforts and increase the productivity of JHMI departments, centers and institutes.

## FACILITIES FOR ADMINSTRATIVE AND SERVICE CORES

### Administration

Johns Hopkins University has health related faculty spread out over the three different campuses. Each of these campuses has clinical facilities and laboratories where our investigators do their research. We have therefore deliberately chosen to be where our faculty are, and make our services as geographically available and accessible as possible. We are a diverse institute, covering the translational pathway from the earliest pre-clinical work to knowledge translation, and it seems only appropriate to us to be physically ubiquitous as well. However, in order to optimize the interactions between Core experts and faculty seeking their advice and access to ICTR services, we have Institutional support to build The ICTR Studio that will house meeting spaces for consultations, touch down offices for research teams to develop collaborative research projects and offices for Core experts and staff so that they will be accessible to investigators. This space will be located on the East Baltimore campus, as this is the location most accessible to the largest number of faculty. In keeping with maximizing accessibility of ICTR resources to all investigators, multimedia conference call connectivity between the campuses and The Studio is planned.

The **ICTR Administrative Offices** occupy 3,644 square feet in an office building in the historic Fells Point neighborhood of Baltimore, about 10 due blocks south of the Broadway medical campus and equidistant to

Johns Hopkins Bayview Medical Center. This space is comprised of seven offices and space for five cubicles, plus a conference room. All core administrative services are housed at this location, which is reachable by a university-provided shuttle bus from the medical campus. Also housed in this same building are the Contracting and Billing functions of the School of Medicine Office of Research Administration (ORA). This has allowed for a great deal of useful interaction between ICTR and ORA staff over issues of clinical research management and study start up, particularly brainstorming around processes and barriers. The Corporate Communications offices for Johns Hopkins Medicine are also located in Fells Point, about one block from the ICTR office, and this has proven useful for ease of communication with this important office as we seek to establish a clear identity for this new Institute.

The Principal Investigator maintains a desk in Fells Point, but keeps his main office in the Vice Deans' Suite, in the Miller Research Building on the East Baltimore Medical Campus. This gives him direct access to the Dean and CEO of Johns Hopkins Medicine, the Associate Dean for Research Administration, and the executive leadership of the School of Medicine.

The ICTR also maintains ancillary administrative offices in the Carnegie building of the Johns Hopkins Hospital, on the East Baltimore Medical Campus. This 940-square-foot suite of six offices is situated close to the Clinical Research Unit resources on the East Baltimore campus, making it an ideal location for Clinical Research Unit administration. Additional administrative offices are located in the 301 Mason Lord Drive building on the Bayview Medical Campus, also adjacent to the Clinical Research Unit space of the Bayview Outpatient and Domiciliary Unit. There is office space for the Research Participant Advocate at each campus within this administrative space. Also housed at the Carnegie building location is administrative staff for the Johns Hopkins Clinical Research Network, and some of the ICTR's IT staff. This suite also contains a small computing work area for investigators or study teams to use when scanning data collection forms, or designing and building data collection tools under the instruction of one of our Biomedical Informatics specialists. At the Bayview campus 301 building, there is office space for the Clinical Research Informatics Program IT staff and a similar computing work area for investigators.

**ICTR Operations** are spread widely throughout the buildings and two campuses that make up the Johns Hopkins Medical Institutions. Our Clinical Research Unit Program resources (described more fully, below) occupy both regulated and non-regulated space within the Johns Hopkins Hospital (East Baltimore campus), and the recently built 301 Mason Lord Drive building (Bayview Medical Campus). Our Translational Science Core Programs occupy wet lab space in the oncology research buildings of the Sidney Kimmel Comprehensive Cancer Center and the Broadway Research Building, (East Baltimore campus), and the Mason F. Lord Building (Bayview Campus). Our education programs occupy space (described below) near the East Baltimore campus and the Bloomberg School of Public Health. Finally, many of our consultative services – including Informatics, Biostatistics and Clinical Research Design, Ethics and Regulatory Support, and Community Engagement operate largely out of faculty offices, located within the departments of the health-related schools of the University. This is one of the primary reasons we moved in this application to an on-campus F&A rate in our budget: to more accurately reflect the use of space by the ICTR within the university, and to provide us with maximum flexibility in our future space plans. Space is no longer a direct cost on this grant.

## ICTR Service Cores

### Translational Science Core

1. **The Drug Screening, Toxicology and Pharmacology (DTP) Program** provide the resources for: 1) Developing and testing new laboratory discoveries in "first in human" clinical trials; 2) Analyzing biomarker and other clinical correlates associated with all stages of drug development; 3) Developing new technologies in existing and developing programs; and 5) Conducting educational programs and providing consultations related to program technologies. This program is fully integrated into the other activities of the ICTR. The Program integrates the services of 2 Units –a Pharmacology Unit within the Department of Medicine, and a Pharmacology Unit within the Department of Oncology that are part of a **Drug Development and Analysis Unit**. These Units all provide services that adhere to Good Laboratory

Practices (GLP) and share an oversight committee that prioritizes projects to each facility based on the needs of the investigators and the expertise of each facility, and a quality assurance team that provides regulatory oversight.

**Drug Development and Analysis Unit**. This Unit represents the integration of two analytical laboratories, the Analytical Pharmacology Core (APC) in the Department of Oncology and the Clinical Pharmacology Analytical Laboratory (CPAL) in the Division of Clinical Pharmacology, Departments of Medicine and Pharmacology; a clinical Drug Development Unit (Clinical Pharmacology, Department of Pharmacology), and the combined clinical pharmacology expertise of the faculty in these units. This reorganization has significantly enhanced the ability to provide consultative and collaborative faculty activity for design and analysis of preclinical, and clinical (phase 0, I, and II) studies; provide staff to execute the clinical studies, and analyze numerous clinical samples for drug metabolites. Over the past 5 years, these functional units have collaborated on clinical protocol development, assay development, education, and research conferences to eliminate duplication of services. Data analysis costs have been reduced by sharing licensing fees for PK software. As part of this application, this unit will expand to include consultation services from the BSI, which will be led by Dr. Barbara Slusher. She brings expertise in preclinical study design and conduction required for initial IND preparation. The Medicinal Chemistry, Drug Screening Library, and Accelerator Mass spectrometry lab (at MIT) are also unique services provided within the Johns Hopkins University. Other mass spec laboratories exist within Hopkins, but none of them provide subsidized assay development and sample analysis support to investigators beyond the directors of these units. This ICTR Drug Development and Analysis Unit is also an example of merging the two largest mass spectrometry small molecule analytical labs at Hopkins (Oncology and Medicine) into one integrated unit. Together these units can perform cross-validation of assays across similar mass spec platforms and potentially assume reassignment of sample analysis workload when capacity is limited in one of the labs. There are also significant economies of scale that exist when these 8 mass spectrometers are part of the same unit.

**Facilities**:

The Clinical Pharmacology Analytical Laboratory in the Department of Medicine is located in Osler 500, 520, 523, 529 and Carnegie 532 which comprises 2,500 Square feet of space. Equipment includes: Sample processing (four centrifuges, two SpeedVacs, tissue microtome), sample storage (three -20°C and four -80°C freezers), reagent preparation (two fume hoods), and tissue culture (three biosafety cabinets, four incubators). *Analytical methodologies include*: Wizard II gamma counter, Liquid TriCarb2810 scintillation counter, Guilford spectrophotometer, Guava® EasyCyte Plus System flow cytometer, Kinetic Microplate reader, Nikon Labophot-2 microscope, two complete Alliance-controlled HPLC systems, one Alliance-controlled UPLC systems, inline fluorescence and radioisotope detectors. Two Applied Biosystems API4000 UPLC/MS/MS system, one Applied Biosystems API5000 UPLC/MS/MS system, and one Applied Biosystems API 5500 Qtrap UPLC/MS/MS system and their supporting nitrogen generator and computers occupy a dedicated 300 ft2 of climate-controlled lab space. We purchased a JANUS® Automated Workstation with 96-tip modular dispense technology to automate our high volume drug assay sample preparation. Analytical laboratory space is regularly utilized for investigational drug studies, and the staff adheres to Good Laboratory Practice in processing and analyzing samples. The facilities are approved by the Johns Hopkins University Biosafety Office for work involving cells and fluids from HIV-infected subjects, and are also approved for work with live recombinant *vaccinia* viruses, herpes simplex viruses, adenovirus, human cytomegalovirus, African trypanosomes and malaria parasites. All assays collected from clinical studies are based on Assay Validation Report and Standardized Operating Procedures (AVR/SOP) that is reviewed and approved by the cross-network NIH/DAIDS external Clinical Pharmacology Quality Assurance Program (CPQA).

Analytical Pharmacology Core is based in the Cancer Research Building I. The equipment includes: *Liquid Chromatography (LC)*: One Waters Alliance 2690 Separations Module with one Waters 2487 2-channel UV/Vis absorbance detectors and one Waters photodiode array (PDA) detector. The data acquisition and analysis software is Waters Empower Chromatographic Software*. LC-MS-MS Systems*: 1) Applied Biosystems API 3000 Benchtop Triple Stage Quadrupole Mass SpectrometerSystem: Agilent 1100 Series

HPLC system coupled to a Turbo ionspray source(Atmospheric Pressure Chemical Ionization and Electrospray Ionization) and a triple quadrupole mass spectrometer. The data acquisition and analysis software is Analyst version 1.5; 2) ABSciex API 5500 Benchtop Triple Stage Quadrupole Mass Spectrometer System: Waters Acquity UPLC system coupled to a Turbo ionspray source (Atmospheric Pressure Chemical Ionization and Electrospray Ionization) and a triple quadrupole mass spectrometer; Shared Instrument Grant (1S10RR026824-01) The data acquisition and analysis software is Analyst version 1.5; 3) ABSciex API 5500 Benchtop Q-trap™ Mass Spectrometer System: Waters Acquity UPLC system coupled to a Turbo ionspray source (Atmospheric Pressure Chemical Ionization and Electrospray Ionization) and a Q-trap™ mass spectrometer. The data acquisition and analysis software is Analyst version 1.5 and LightSight version 2.1 software. *Equipment for specimen processing, and derivatization of samples include*: Processing and derivatization: centrifuges, high speed microcentrifuge, two Meyer NEvap analytical evaporator, Zymark TurboVap® LV concentration workstation, homogenizers (Delta Shopmaster and Ultra Turrax T-25), mechanical shaker, sonicator, Alltech vacuum manifold, and Milli-Q Gradient ultrapure water. *Equipment for Drug Metabolism Studies include:* 1) Phase I Metabolism: Human and animal liver microsomes (BD Gentest or Celsis In Vitro Technologies) or cDNA-expressed human cytochrome P450 isoforms (BD Gentest); 2) Phase II metabolism: Human or rat liver cytosol (BD Gentest), Human UGT Supersomes™ enzymes (BD Gentest). *Equipment for Protein Binding Studies include:* 1) Equilibrium Dialysis: 96-Well Equilibrium Dialyzer™ (Harvard Apparatus) with a Plate rotator (Model 74-2334; Harvard Apparatus).

Computing Facilities for Pharmacokinetic and Pharmacodynamic Data Analysis: 1) *Computers*: multiple Dell Optiplex 980 (Intel Core i5 CPU, 3.33 Ghz processor, 3.49 GB RAM, 148 GB HD, CD-ROM); 2) *Software*: ADAPT; WinNonlin Professional version 5.3, JMP version 7, SigmaPlot version 11, Microsoft Windows XP Pro. In addition, a back-up of clinical research data on the Medical Institution LAN is performed daily with 14-day redundancy. A hard copy of all protocol-specific information is also maintained in a secure location. For larger or more complex studies, the CRU provides readily-available support at the faculty level and several collaborations have been established with faculty in the Department of Biostatistics in the School of Public Health. Advanced pharmacometric support for design and analysis of studies requiring advanced pharmacometric studies is performed by external consultant/collaborators.

**2. The Biologics Translation Program (BTP)**

**The Biologics Translation Programs** provides the resources for: 1) Consultation on study design and technologies, 2) Assay Development, and 3) Analysis to investigators designing clinical trials testing biologic agents. This program is fully integrated into the other activities of the ICTR. The Program integrates the services of 2 Units – **Good Manufacturing Practices (cGMP) Unit** and a **Clinical Immunology Laboratory** within the School of Public Health. These Units provide services that adhere to Good Laboratory Practices (GLP) and share an oversight committee that prioritizes projects to each facility based on the needs of the investigators and the expertise of each facility, and a quality assurance team that provides regulatory oversight.

**Facilities:**

The cGMP Unit is composed of three facilities located in the Cancer Research Buildings: an 1800 square foot GMP facility comprised of 4 manufacturing suites, a general processing area, storage, gown in and gown out areas; a 400 square foot Process Optimization Lab (POL); and a 400 square foot Materials Management/QC. The facility is card access controlled and access is restricted. Access to the manufacturing suites is through the gown in area, which operates under HEPA filtration and positive pressure with respect to the corridor and is classified as 100,000 (particle size 0.5u). Three of the four manufacturing suites are positive pressure, HEPA filtered class 10,000 with 80/20 single pass/recirculated air handling. The fourth suite, which operates under negative pressure, is designated for BSL 2 viral or bacterial products. This HEPA filtered class 10,000 suite operates with a separate independent air handling system, which is 100% single pass air. All manufacturing suites have at least one class 100 (class II Type A/B3) BSC for open manipulations. All manufacturing suites share a class 10,000 general processing area (GPA) which serves as a staging and storage area for released raw materials, materials for the environmental monitoring program and qualified equipment. The overall design of the manufacturing facility

permits it to offer a variety of services and simultaneously manufacture multiple products. All critical equipment in the GMP is continuously monitored by a state of the art Siemens System and can be relocated to various suites as production parameters necessitate. Critical equipment includes: nine Stericult incubators, five BSCs, four LN2 storage freezers (2 for quarantined products, 2 for released products as per cGMP), four 2 - 8C refrigerators, two –20C freezers, two –80C freezers, and a Coy anaerobic chamber. A development lab (POL) is used to optimize manufacturing strategies to ensure a successful production under GMP conditions. It is equipped with the same instruments needed in the GMP. All equipment is quality controlled with a preventative maintenance plan and schedule similar to the equipment in the cGMP. The Materials Management/QC Laboratory is a secure central receiving and quarantine area for all CPGT supplies prior to their release and transfer into the CPGT facility. The laboratory also supports the environmental monitoring (EM) program by providing a laboratory space for incubation and analysis of EM/personnel monitoring (PM) samples. It is comprised of two rooms, one designated as a QC/EM laboratory and the other is a secure materials receiving and storage location, complete with locked refrigerated and frozen storage capabilities, and a lockable cage for GMP supplies. It is equipped with a BSC, two quality control incubators, two 2-8ºC refrigerators, two ≤-65ºC freezers, and an analytical balance.

Clinical Immunology Laboratory (CIL): The CIL's virology and immunology laboratory facilities are located on the fifth floor of the Bloomberg School of Public Health building at 615 N. Wolfe St., Baltimore, MD 21205. This area (approximately 1500 sq. ft.) includes three laboratories for tissue culture and immunologic studies, one laboratory for fluorescent microscopy and PCR, an autoclave room, and an air-conditioned freezer room. The CIR also maintains an additional freezer storage area with an alarm system in the basement of the building. The laboratories are approved for work with class II (P2) agents. They contain one walk-in warm room, a walk-in cold room ($4^0$C), two autoclaves, seven $CO_2$ incubators, one water jet and one low temperature incubator, two refrigerated and one non-refrigerated centrifuge, three six-foot baker biocontainment hoods, one four-foot baker hood in the PCR lab for nucleic acid extraction, one four-foot baker hood reserved for vaccine preparation, a fume hood, three inverted light microscopes, four dual-chamber water baths, one regular light microscope, one Nikon fluorescent microscope equipped for photography, a dissecting microscope, a microtome, an auto diluter, two ELISA readers, two plate washers, a RID plate reader, a MiniMAG for nucleic acid extraction, Flexigene and Genius thermocyclers, one Applied Biosystems 7300 real-time PCR machine, equipment for sonification, including a soundproof cabinet, four aquariums equipped with heating circulator pumps, full size and mini gel apparatuses and power supplies, a gel dryer, seven computers, two printers, four refrigerators, one double door refrigerator, four $-20^0$C freezers, five $-70^0$C freezers, two liquid nitrogen tanks each with 20,000 vials capacity, and several clinical centrifuges. A Pharmacia/LKB fast protein liquid chromatography system and a standard low-pressure chromatography system are available for antigen and antibody purification. The CIR laboratories have access to two Sorvall RC5B centrifuges, an analytical ultracentrifuge, gamma and liquid scintillation counters, an electron microscope, and a spectrophotometer. The services of a fluorescence-activated cell sorter, an automated DNA sequencer, an additional kinetic ELISA reader, and seven multicolor flow cytometers are also available.

The CIR laboratory facilities have adequate space for vaccine storage, media preparation, tissue culture work and the conduct of hemagglutination inhibition, ELISA, and viral neutralization assays. These laboratories are also used for virus isolation, identification, titration and phenotyping, PCR amplification, characterization of the cell-mediated immune responses to viral antigens, and preparation of viral concentrates and/or fractions for use as in vitro antigens. The is also additional storage space with an electronic alarm system in the basement of the Stebbins building, where two additional $-70^0$ C freezers, one $-20^0$C freezer, and one liquid nitrogen tank with 40,000 vials capacity are kept.

**3. The Genetics Translational Technology Program (GTTP)**

**The Genetics Translational Technology Program (GTTP)** provides consultative services for potential new projects involving genetic technologies, and clinical grade and CLIA-certified DNA banking, sequencing, and genotyping services. This Core partners with other research Cores at Johns Hopkins to expedite the translation of genetic technologies to clinical practice. During the next 5 years this Core will

partner with the Clinical Genomics Center in the McKusick-Nathans Institute of Genetic Medicine and the Genetics Sequencing Core in the Sidney Kimmel Cancer Center at Johns Hopkins to further develop an ongoing personalized genetic medicine focus at the Johns Hopkins University. This Core is continually updated and adapting new technologies to meet the changing needs of ICTR investigators.

**Facilities:**

The Genetics Translational Technology Program laboratory includes 740 sq. ft. of lab and office space on the 10th floor of the Hoffberger Building. The DNA Diagnostic Lab (DDL) occupies 1,246 sq ft of adjacent laboratory space and shares an additional 495 sq. ft. of common equipment lab space on the 10th floor of the Hoffberger Building. The DDL is a CLIA/CAP/NY State certified clinical genetics testing laboratory that has been in operation since 1986. The lab currently offers clinical grade testing for over 40 disorders using Sanger sequencing, multiple probe ligation assay, DNA fragment analysis, mass array genotyping and bisulfite sequencing. All testing is performed using in process quality controls and lab performance (accuracy, turn-around time, client satisfaction) is closely monitored with a quality assurance program and a comprehensive proficiency testing program. Technician performance is documented by competency testing every 6 months. Major equipment includes three 3100 ABI sequencers, one 3730 ABI sequencer, one Sequenom Mass Array analyzer, one Qiagen DNA extractor. The laboratory recently completed a reproducibility study of a CFTR sequencing test using the Illumina MiSeq next generation sequencer. The project was performed under a contract with Illumina as part of a Food and Drug Administration application for the CFTR test. The DDL acquired the most recent upgrade of the Illumina MiSeq sequencer in December 2012. The laboratory has the expertise in place and familiarity with next generation sequencing (NGS) and will work in concert with Dr. Scott (Consultant to GTTP) and the Clinical Genomic Sequencing Lab (see below) to offer high capacity sequencing using Illumina HiSeq 2500s. The DDL has a program in place to verify research findings from next-generation sequencing projects with custom designed CLIA-validated Sanger sequencing tests. Clinical reports will be generated for each verified finding. *Each of these resources will be made available to the GTTP to aid in the development and performance of projects for CTSA investigators.*

Clinical Genomic Sequencing Lab: The lab is a partnership between the DDL, the Division of Molecular Pathology at Hopkins and the Center for Inherited Disease Research (CIDR) on the Bayview campus of Johns Hopkins. The CIDR lab houses a variety of major equipment used for sample receipt, sample processing, sample pretesting, SNP GWAS, SNP linkage, SNP custom genotyping, epigenetic methylation assays and NGS. Equipment for sample intake includes 1 Nanodrop ND-1000 and 1 Nanodrop 8000 Spectrophotometer, 1 BioMicroLab XL-20 and 1 BioMicroLabVolumeCheck instrument. Genotyping equipment includes 3 Illumina iScan scanners and 2 Illumina HiScan scanners with 3 autoloaders (capable of loading BeadChips on 2 scanners) for 24/7 continuous BeadChip scanning. Two Illumina BeadXpress readers are used for sample pretesting and small custom projects because this platform has lower costs per genotype for small numbers of SNPs per sample. Sequencing equipment includes 1 Covaris E210, 1 Covaris S2, 1 Caliper LabChip GX, 2 Agilent BioAnalyzers, 3 Illumina HiSeq 2000 instruments, 2 IlluminacBot instruments and 1 Illumina MiSeq that is used for validation and optimization experiments as well as to support CLIA services. Two upgrades for the HiSeq2000s to HiSeq2500 have been purchased and we are expecting installation in late 2012/early 2013. Liquid handlers include 9 modified Tecan Genesis/ Evo/EvoII/200 instruments, 2 Perkin Elmer Multiprobes, 1 Perkin Elmer Janus, 1 Agilent Bravo, 1 Beckman Biomek FX, 1 Caliper Sciclone, 2 96-well Robbins Hydras and 3 Biomek 2000 instruments. A Veriteq alarm system monitors the freezers and laboratory environment and alerts laboratory staff 24/7 of freezer failures, power failures or the presence of water on the floors. All freezers containing DNA samples or key reagents are alarmed using this system. The entire building is protected by back-up emergency generator power. Additional resources and equipment for DNA extraction, bisulfite conversion, real time PCR, Sanger sequencing and pyrosequencing are also available in separate locations (these will be co-located within the proposed JHU Clinical Genome Center).

Informatics Infrastructure*:* CIDR will make available to the GTTP a robust IT capability and custom software to manage both genotyping and sequencing studies. The principal pipeline used for NGS is CIDRSeqSuite which was developed to automate a variety of bioinformatic workflows and analyses for sequencing. It is

designed to run on 64-bit Linux and is written in Java SE 6 and Perl 5. The primary analysis workflow combines custom tools to numerous third-party secondary and tertiary analysis software including ANNOVAR ,SAMtools, Picard, BWA, the Genome Analysis Toolkit (GATK), VCFtools and Tabix. Beginning with the qseq.txt files produced from binary basecall files (BCL) files by the Illumina BCL converter, CIDRSeqSuitede multiplexes samples based on their indexes, then combines and converts them into FASTQ files. From there, independent analyses by sample are launched. This analysis includes aligning the FASTQ files with BWA to a reference genome for a paired-end sequencing run, sorting of the BAM with Picard, local realignment around Indels using GATK, synchronizing mate-pair information and flagging of molecular duplicates with Picard, recalibration of base call quality scores with GATK, variant calling with GATK UnifiedGenotyper and annotation of variants with ANNOVAR. To manage the 1,000's of files generated at each step in the pipeline, CIDRSeqSuite automatically renames and moves files by project into a central location. CIDRSeqSuite parallelizes these independent analyses across a Sun Grid Engine-managed cluster. For a single sample, a full analysis runs to completion in an average of 37 hours for whole exome samples, and 3.5 hours for small custom targeted sequencing samples. Since samples are analyzed in parallel, it is possible to analyze a large number of samples in roughly the amount of time that it takes to analyze a single sample, assuming appropriate resources are available. Because the component tools are always changing (e.g., GATK is now in ver 2.1) we anticipate that this pipeline will continue to evolve.

The primary high-performance sequence analysis platform is a cluster of 6 Dell C6100 systems running Sun Grid Engine connected to Isilon NAS via 10-gigabit ethernet. Each C6100 comprises 4 servers for a total of 24 cluster nodes, 576 cores, 2.3TBs of RAM, and 43TB of local disk. This allows us to complete analysis for sequencing runs in 24-36 hours. Additional capacity can be added in 4-server increments to meet increased demand. Two Dell C6100 systems are budgeted to support the CIDR Program sequencing infrastructure as throughput increases. It is also possible to add GPUs, which will be evaluated as popular sequence analysis software is now being adapted to support GPU acceleration (e.g., BarraCUDA). Our current compute cluster is complemented by two 384GB 48-core Sun X4640 Linux servers which are sufficient for the most demanding analyses. Two additional high-performance large-memory compute servers are planned in 2013 to support growth of the sequencing infrastructure and to provide 'non-production' dedicated servers for analytical evaluations by the technology evaluation group. All raw and analytical data is stored on a robust, high-performance Isilon network-attached storage (NAS) system, which currently consists of 720TB total raw capacity, an accelerator node and a backup node. The entire system has a total bandwidth approaching 250Gb/s. Critical data is further protected by "snapshot" backups to disk, and the backup node enables NDMP dumps at very high speed over optical fiber directly to tape on the i500 system. Server disk is provisioned from a new Xiotech Emprise 7000 storage area network system (SANS) with 53TB of fiber channel disk and multiple controllers providing redundant data access paths. Xiotech uses patented self-healing "DataPacs" of 10 disks and 2 spares, which are guaranteed not to fail for 5 years. In 2011 this storage capacity was almost doubled, and currently has the ability to nearly double again. Windows systems include 2 Dell servers running multi-threaded AutoCall genotype calling pipeline, 3 large shared fileservers, 3 directory/domain servers, 2 LIMS servers, 2 backup servers, a terminal server for thin clients used by research techs, 2 Oracle application servers for SQL*LIMS and several utility servers. Two large-memory HP workstations are available for computation of large genotyping projects and other demanding applications. There are approximately 75 other PCs, including 50 user desktop machines, all of which are centrally managed. All production computer systems and critical desktops/workstations are routinely backed up to tape on daily, weekly, and/or monthly schedules using CommVaultSympana 9 enterprise backup software. Several CommVault media servers are directly connected via fiberchannel to a Quantum i500 robotic tape system containing 10 ultra-highspeed high-capacity LTO-5 tape drives and 125 tape library slots for continuous operation. Periodic backups are rotated weekly to a secure off-site storage facility in Frederick, MD, while local copies of backup tapes (and other media, such as extras copies of projects released on portable hard drives) are kept on-site in a large fireproof safe.

Data Security**:** Sequence received from the GTTP will arrive as encrypted hard drives. At JHU, the systems and network are protected by local and NIH/CIT-managed firewalls, and are exhaustively and

continuously monitored for performance, problems and potential security compromise, with automated notification systems that contact responsible staff by telephone, email and/or text message. We are in compliance with both NIH and university data security standards.

**4. The Proteomics Biomarker Development Program (PBDP)**

**The Proteomics Biomarker Development Program** provides a wide range of services and has over the past several years opened up new scientific research areas for many PIs. It is one of a number of Proteomic or mass spectrometry centers within the Johns Hopkins University and the School of Medicine, all of which have very different roles and each meets the needs of unique group of investigators. Each center or faculty is working at maximum capacity. The others include The MidAltantic Mass Spectrometry Center, the School of Medicine Mass Spectrometry Facility and The Johns Hopkins Bayview Proteomic Center. *The MidAltantic Mass Spectrometry Center* builds and adapts mass spectrometers for a wide range of applications (including the instrument going to Mars or for military field use). In 2000, a separate fee-for-service core facility, the *School of Medicine Mass Spectrometry Facility* was established. This core was developed to meet the mass spectrometry needs of as many researchers as possible and therefore concentrates on serving smaller projects requiring established routine mass spectrometry with fast turnaround times. Both MidAltantic Mass Spectrometry Center and the School of Medicine Mass Spectrometry Facility are located at the Johns Hopkins School of Medicine on the East Baltimore campus. In 2003, Dr. Jennifer Van Eyk was recruited to Johns Hopkins University to oversee the NHLBI Proteomic Innovation contract ($18 million/7 year contract), which consisted of 10 PIs including Drs. Cotter and Cole. She also set up the Johns Hopkins Bayview Proteomic Center at the Johns Hopkins Bayview Medical Center. The two Baltimore medical campuses are located about 5 miles from each other. The *Johns Hopkins Bayview Proteomic Center* has the mandate to facilitate proteomics specifically on the Bayview campus and importantly, to provide services for projects with developmental proteomics needs rather than standard technology needs within the broader School of Medicine and throughout the Johns Hopkins University. The most recent proteomics facility also directed by Jennifer Van Eyk is the **The Proteomics Biomarker Development Program**, which focuses exclusively on de novo discovery, validation, and translation of clinically relevant biomarkers. This facility has the equipment directly aimed for these particular pipelines with higher-throughput high-end instrumentation which are extremely robust, low CV% and high degree technical reproducibility and carry out large long term projects. These projects cannot be handled by the other cores/centers due to the expertise required and the fact that they are extremely labor- and resource-intensive with large mass spectrometry requirements. It is important to recognize that each core/center serves a large but very distinct scientific community at Johns Hopkins University. *The PBDP specifically fulfills the need for clinical/translational biomarker and proteomic experiments that require higher throughput analysis of large numbers of clinical discovery samples*. However, the other Cores are integrated with this Core through the Advisory Committee that serves to triage projects to the appropriate Cores.

**Facilities**:

The PBDP is well equipped with respect to available instruments and expertise for both discovery and verification. The PBDP is housed within the Van Eyk laboratory and is based at the Johns Hopkins Bayview Campus. It is a 3000 square foot facility with 3 mass spectrometry rooms with air quality control. The PBDP has 7x 2DLC and 3 isocratic LC for the depletion of high abundant proteins for carrying out offline protein and peptide seperations required for denovo discovery; a LC (Tempo) 5800 MALDI TOF/TOF and a nano LC LTQ Orbitrap MS/MS which are used primarily in the discovery stage. For targeted discovery and verification stages which require quantitative analysis of selected proteins normally on large sample number, we use a 4000 Q-Trap and dual LC 5500 Q-Trap MS instruments for MRM assays and a MesoScale Sector 2400 ELISA platform (MSD) and DotLab platform (Alexa) for single, multplex and sequential ELISAs. The PBDP leaders and faculty are also integral to the Johns Hopkins NHLBI proteomic innovation Center (funded by a successful competitive contract following the initial successful contract, for $13 million/ 4 years). However, the true strength of proteomics at Johns Hopkins lies within the collaborative nature of the PIs. Each PI has an active and unique research focus that is brought together through collaborations. The PBDP is very much part of this community and is viewed as a critical resource.

**5. Translational Imaging Program (ITP)**.

**Translational Imaging Program** provides clinical trial consultation and data library storage services. However, to meet the increasing needs of our investigators, this Core is being expanded to include molecular imaging. The Johns Hopkins University has a large array of different imaging modalities CT, MRI, Ultrasound, Nuclear Medicine/PET imaging, cardiovascular imaging and a diverse number of imaging research centers for molecular, small animal and functional imaging (In Vivo Cellular and Molecular Imaging Center – ICMIC, Small Animal Imaging Resource Program – SAIRP, and the Kennedy Krieger Institute Neurobehavioral Research Unit –NBRU). All of these are available for clinical and translational research at the Johns Hopkins University through the ICTR, thus creating the need for navigating researchers through these vast resources and providing them with the high quality radiological consultation services to be certain the right imaging approach and resources are being used based on the goals of the specific research projects. Important criteria for matching studies to available imaging expertise and imaging modality include the organ system, disease process, available resources for the study and availability of existing imaging acquisition methods.

**Facilities:**

Translational Molecular Imaging: Radiochemistry facilities include two dedicated 200 sq. ft. rooms. One with a chemical fume hood for long-lived ($^{125}$I) work and the second with a chemical fume hood modified with two-inch lead shielded walls and sliding lead doors for intermediate and high energy radionuclides of short and intermediate half-lives ($^{64}$Cu, $^{68}$Ga, $^{124}$I, $^{99m}$Tc, $^{18}$F, etc.). Each of the radiochemistry labs is equipped with a Varian Prostar radio-HPLC system (pumps, UV detector and in-line BioScan Flow count radioactivity detector for preparative radio-HPLC) all controlled by Galaxie software, and dose calibrators. The high energy radionuclide radiochemistry lab also has a second analytical radio-HPLC (Varian Prostar System) for quality control of radiotracers and a Resonance Instruments Model 521 Radiochemistry Microwave with an Infrared Thermometer. A Wallac-LKB gamma well counter with computer for radioactivity measurements is located in the adjacent equipment bay. As the proposed imaging and therapeutic agents move to clinical translation phase, we will also have access to the 4,200 sq. ft. Center for Translational Molecular Imaging (CTMI) that is under construction at the Johns Hopkins Bayview campus, which will be dedicated to cGMP synthesis of radiopharmaceuticals, low molecular weight agents, nanoparticles such as liposomes, proteins, aptamers, gene constructs and cells for molecular imaging and therapy. This Center will be integrated with our functioning Biologic cGMP at the administrative and regulatory levels.

Nuclear imaging/PET: The Johns Hopkins Division of Nuclear Medicine has substantial positron emission tomography (PET) capability, including state-of-the-art facilities for radiochemistry, imaging and data analysis. The PET radiochemistry laboratory (renovation completing in August 2011) in the Nelson Building basement of the Johns Hopkins Hospital contains approximately 2000 sq. ft. of radiochemistry space. The laboratory has been designed and operated under a full set of documents written to comply with cGMP guidelines established by the FDA for PET radiotracers. A portion of the laboratory (approx. 900 sq. ft.) houses a combination of 4 “dual mini” hot cells (capable of housing 8 radiochemistry synthesis modules), 5 larger hot cells (2 outfitted with remote manipulators), 2 ‘sliding door’ hot cells for lower level radiochemistry research, and 2 USP 797 compliant hot cells for dose drawing. Approximately 300 sq. ft. of laboratory is devoted to a dedicated quality control (QC) area housing multiple HPLCs (including ion chromatography), dose calibrator, mass spectrometer, gas chromatograph (for residual solvent analysis), gamma spectroscopy, and a small laminar flow hood for pyrogen and sterility testing. Approx. 100 sq. ft. of the laboratory is devoted to a USP <797> compliant laminar flow hood and anteroom for preparation of dose vials and transfer of intravenous solutions, and 75 sq. ft. is devoted to housing a waste radioactive gas storage system. Approximately 100 sq. ft. of the laboratory is devoted to sterile HPLC solvent preparation. The remaining portion of the facility houses a General Electric PETtrace cyclotron and its supporting electronics. PET imaging equipment includes 2 PET scanners and 2 PET/CT scanners. A GE Advance whole-body PET scanner is dedicated for research use, as is a Siemens ECAT HRRT brain-only PET system. The HRRT is a high resolution, high sensitivity PET system, supported by a powerful cluster of dedicated servers that enable advanced image reconstruction of large data sets. The HRRT has

significantly better spatial resolution (2-3 mm FWHM) than typical whole-body PET systems due to its small detector size and ring diameter. In addition to the 2 PET-only systems, the division has 2 PET/CT systems: a GE Discovery LS and a GE Discovery VCT(RX). The Discovery LS will be replaced in 2012 with a new state-of-the-art whole-body system with time-of-flight capability. The Discovery VCT(RX) has 64-slice CT capability and is used for diagnostic CT protocols as well as low-dose CT for PET attenuation correction and localization. The PET component is based on 3 cm thick LYSO crystals (enabling high sensitivity 3D acquisition with low scatter and randoms compared to BGO systems) and supports a range of flexible acquisition modes including both 2D and 3D, list-mode, dynamic and both ECG and respiratory gating. In addition to the above PET systems, the division also has a Naviscan positron emission mammography system for optimized imaging of the breast. Related equipment includes multiple dose calibrators which have been cross-calibrated for F-18 using an NIST-traceable source. These dose calibrators are used to calibrate all PET scanners, thus ensuring accurate image calibration that is traceable to a national metrology lab. A gamma well counter is also calibrated for PET isotopes, ensuring that blood samples can be accurately related to PET-derived activity concentrations. Confirmation of quantitative accuracy and system performance is monitored with an extensive quality assurance protocol that makes use of long-lived Ge-68 sources and various community standards such as phantoms and procedures from the ACR and NEMA. PET and PET/CT systems are well integrated into the wider IT infrastructure via RIS and PACS connectivity. The division of Nuclear Medicine manages a dedicated GE Centricity Enterprise Archive PACS system and, in addition, all NM and PET data are integrated into the wider Radiology PACS. Dedicated PET and NM image analysis facilities are spread over 3 reading rooms and include multiple GE Advantage Workstations, GE Xeleris workstations, Siemens Syngo workstations and Hermes workstations. Seemless connectivity with the wider Radiology systems enables convenient access to other modalities and streamlined software tools enable image registration and display of fused images. A separate image analysis lab (IRAT lab) hosts an additional research archive (Hermes Medical Systems) and multiple advanced workstations (Hermes, GE, Siemens, Philips and others) in a dedicated research space. Single Photon Emission Computed Tomography (SPECT) instrumentation specifically dedicated for research includes a General Electric Millennium VG dual-head SPECT system equipped with a Hawkeye x-ray transmission CT unit which is located in the basement of the Jefferson building adjacent to the GE Discovery LS PET – CT. The thicker 1” crystal is especially suitable for medium and higher energy SPECT radiotracers, and the combined CT capability provides precise co-registered functional and anatomic localization in addition to rapid attenuation correction. In addition, we have two triple-head SPECT systems available for this project, a Trionix Triad and a Picker (Marconi) IRIX. In Nuclear Medicine, we have had a Trionix Triad triple-head SPECT system for several years. We routinely acquire high resolution brain SPECT studies with the following protocol: high resolution collimator, 40 views per head (120 total projections, 3 degrees per step), 128 transverse x 64 axial matrix (square pixels), and reconstruct with filtered back-projection with a Hanning filter with a cutoff of 1.3 cycles/cm. Acquisition is typically dynamic, with projection time adjusted depending on total acquisition for the frame (e.g., 7 sec per step for a 5 min acquisition). Additional clinical nuclear medicine equipment includes: 2 Siemens E.CAM dual-camera SPECT systems. Three new GE Millennium VG dual-head SPECT systems equipped with 5/8” NaI(Tl) crystal and Hawkeye x-ray transmission units are installed in the Nuclear Medicine clinic with one dedicated to research.

Neuroimaging resources of the F. M. Kirby Research Center for Functional Brain Imaging: Resources for Quantitative Functional Magnetic Resonance Imaging (MRI) and Spectroscopy (MRS) consist of an interdepartmental and interdisciplinary laboratory combining facilities of the Kirby Center (part of the Kennedy Krieger Institute), the Center for Imaging Science (CIS) at Johns Hopkins University (JHU), and the biostatistics facilities of the Bloomberg School of Public Health. Here we describe only the resources of the Kirby Center proper, but its close working relationships with those other programs represents a tangible and enormously valuable asset for the ICTR. The Kennedy Krieger Institute (KKI) was the first university-affiliated program (now known as University Centers for Excellence in Developmental Disabilities Education, Research, and Service or UCEDD). As a UCEDD, the KKI has a professional relationship with the Johns Hopkins University School of Medicine, and is an affiliated institution of the Johns Hopkins Medical Institutions. This affiliation allows for shared faculty and integrated clinical services, resources, and research.

The Kirby Center and KKI are centrally located within the JHU School of Medicine, with most buildings connected through tunnels. The Kirby Center now occupies over five thousand square feet of space at the ground level of KKI's main hospital and research building plus another 4200 square feet in the adjacent building at 716 N. Broadway, where a 7T MRI facility is housed. The Center facilities have been kept state of the art through equipment acquisition via shared or high-end instrumentation grants and through a collaboration with Philips Medical Systems. The Center's primary resources now consist of a group of Philips Achieva MRI scanners, two at 3.0 Tesla and one at 7 Tesla. The gradient strength on the 3T scanners is up to 8 G/cm, while it is up to 4 G/cm on the 7 Tesla. Coils include 32-channel head coils, 8-channel head coils, 16-channel neurovascular coil and an 8-channel knee coil (also used for neonate brain MRI). The scanners can perform all modern imaging technologies, including echo-planar (EPI), fast spin echo, navigator echoes, single-voxel MR spectroscopy (MRS) and multi-slice spectroscopic imaging (MRSI) approaches. All machines are equipped with parallel imaging capabilities (SENSE imaging), which reduces artifacts in the multi-readout sequences (e.g. EPI-type) used for fast imaging. The latest 3T scanner is equipped with dual-channel transmit body coil and a specific mammotrak setup with several coil setups for breast cancer studies (16-channel for diagnostic, 7-channel for biopsies). It has a specialized clinical data processing unit.

The Kirby Center is completely dedicated to brain research, and is especially designed to provide the environment necessary to perform structural and functional MRI studies of children and adults with impaired cognition without the need for sedation. For functional MRI experiments, stimulus delivery coordination and response recording can be accomplished using multiple computer platforms. An infra-red reflectance-based eye tracking device is available to facilitate documentation of eye movements during visually mediated cognitive tasks. The system is capable of sampling eye movement data at up to 1000 samples/sec, has an angular resolution of 0.1 degrees, and can track eye movements of up to 20 degrees off-center. In much the same way that fMRI can provide a measure of the spatial distribution of brain activity in relation to cognitive or behavioral processes, electrophysiology can afford insight into the temporal sequence of the brain activity. The F.M. Kirby Center has recently installed a *Neuroscan*64-channel MRI-compatible electroencephalographic (EEG) recording system to facilitate recording of EEG data while subjects are undergoing fMRI-based studies. Investigators will thus have the ability to gather both high spatial (fMRI) and high temporal (EEG) resolution data at the same time.

Recently, ARRA funding allowed the addition of two state-of-the-art animal scanners, and KKI has constructed a clean animal MRI facility housing these two scanners and **a state of** the art animal prep room. The clean facility allows rodents to be transported from the clean facilities in the BRB and Ross rodent facilities at JHU, and to be returned afterwards. This expansion of the Kirby Center has a modern animal surgery room with blood gas analyzer and perfusion hood. The 16.4 Tesla vertical bore Bruker MR scanner and 11.7 Tesla horizontal bore Bruker scanner are the latest Bruker Paravision 6 systems, including mouse cryocoils and phased array coils (4-channel phased-array cryocoil) and 8-channel transmit coils. The KKI laboratory and F.M. Kirby animal MRI Center are located in close proximity to the JHU animal facilities in the Broadway research Building (connected through the tunnel).

In addition to the other Kirby Center resources, NBRU investigators have access to an imaging library developed in close collaboration with Hopkins Radiology under the direction of Professor Susumu Mori. The development of this library was begun with partial support of the initial CTSA, and the significant task of characterizing stored scans quantitatively is well underway with data available to date, including standardization of segmentation and definition of indexing parameters useful for studies employing multiple imaging modalities. Further, a common protocol has been developed that now consists of three high-resolution 3D scans (T1, PD/T2, and DTI) and segments "standard" brains into 200 areas. Pediatric clinical radiology at JHH has already adopted this common protocol, which requires slightly more time to acquire and read images but allows for high-resolution scans consistent with research standards and provides clinicians with higher quality visualizations. For the next funding period, the plan is to dramatically expand the library and integrate it with the other CTSA data sharing components. For example, the Center is currently acquiring approximately 100 pediatric cases per month, including children with a variety of brain disorders (e.g., tumor, vascular disease, congenital malformation) and we have over 2,000 scans in the library's collection. Other databases will be continually growing and will cover normal reference populations

ranging from 0 - 80 years of age, as well as patients with whatever conditions they happen to have. The NBRU will also be developing XNAT database architecture to accept all clinical data (images and diagnosis), as well as quantitative analysis results. The goal is to develop a platform that can be accessed by users throughout the Hopkins community and, ultimately, throughout the world.

Kirby Center Image and Data Management: All scanners are connected to the files/computer server at the Kirby Center, which is a SunFire V800 Server (Sun Microsystems, Inc.) with 8 parallel processors and 16 GB of shared memory. Storage capability of this computer consists of 28 TB of RAID disk storage plus 2 tape libraries with 4 high-speed tape drives each and a total capacity of 20 TB. Hierarchical Storage Management (HSM) software transparently moves files between the tape storage and the disk arrays. A SunFire V880z visualization server with 2 CPUs, 4 GB RAM and XVR-4000 graphics accelerator (144 MB frame buffer, 1 GB texture memory) is available for high-performance display and rendering. Assorted Unix and Linux workstations, Windows PC's and Macintoshes are connected by Gigabit Ethernet network to the Servers. Installed software includes: AFNI, FIDAP, SPM, FSL, GIFT, Stimulate, EvIdent, AIR, Freesurfer, BrainVoyager, IDL, Matlab, MEDx, DTIStudio and SureFit.

Cardiovascular Imaging: Cardiovascular imaging is located in the Clinical Research Unit, 4 th floor of the 301 Building, on the Bayview campus. The CV Core Lab is currently using three ultrasound systems to perform echocardiograms, carotid IMT and brachial reactivity studies. These include: a) *Toshiba Artida Diagnostic Ultrasound System* (Model SSH-880CV) which has the most current software upgrade available and is used for state of the art cardiovascular imaging. The supported transducers that we use on this system include: Cardiac transducer – (PST-30BT) Sector probe for cardiac imaging with strain and speckle tracking capability (2.0 – 4.8 Mhz), 3D transducer – (PST-255X) Used for 3D acquisition imaging (2.0 – 4.0 Mhz), and Vascular transducer – (PLT-704SBT) Linear probe used for carotid and other vascular imaging (4.8 – 11 Mhz). b*) Toshiba Aplio 80 Diagnostic Ultrasound System* (Model MCM-1754TS) is currently being used for most of our carotid scanning. However, it is also equipped with the following probes: Cardiac transducer – (PST-30BT) Sector probe for cardiac imaging (2.0-4.8Mhz Vascular transducer – (PLT-704AT), linear probe for carotid IMT imaging (5-11 Mhz), and intraoperative transducer – (PLT-1202S) very high frequency probe used for brachial imaging (7-14 Mhz), c*) Hewlett-Packard/Philips Ultrasound System* (Model M2424A) can also perform both cardiac and vascular imaging. This system has the following transducers: Cardiac transducer – (21311A) is the workhorse probe for cardiac imaging (2.0-4.0 Mhz), vascular transducer – (21356A) used for carotid scanning (3.0-11.0 Mhz), and intraoperative transducer – (21390A) used for brachial imaging (6.0-15 Mhz).

Several non-invasive methods are available for vascular assessement. Endopat (periheral arterial tononmetry) (Itamar Medical) are employed for endothelial function and arterial stiffness measurements. Enothelix (Vendys) measures vascular function by monitoring fingertip temperature changes during a reactive hyperemia protocol. SphygmoCor (AtCor) provides a measure of arterial stiffness by analyzing the radial arterial pressure wave and derives the ascending aortic pressure wave, providing critical cardiovascular measurements including central blood pressure, aortic augmentation index, ejection duration and subendocardial viability ratio.

Cardiovascular Imaging Data Management: The echocardiography data reside in the secure JHBMC maintained Xcelera system. These data include all data related to the echo study (moving images, stills, entered data, measurements…). The CRU Informatics program has developed integration tools for migrating echo measurement data from Xcelera into a CRU maintained SQL database. From here, the research echo data are parsed and distributed to the appropriate protocol database for analysis.

ITP Image Data Management Services: Access to the Johns Hopkins Medical Image Research Archive Center (JHMIAC) is through the ICTR Connection Request System, ITTC office, or Radiology Help Desk. The features and scope of this data service are as follows: Secure: Access to data and images is strictly controlled; Redundant: All data and images are replicated, stored in two data centers; Project-specific ORGs: Organizational structure allows creation of individual archives for each project, ORGs allow storage and retrieval of DICOM and non-DICOM image sets, as well as other file formats such as pdf, doc, xls, avi, bmp, etc.; Migration of data from the Hopkins clinical PACS or other storage systems into research ORG and migration of ORG data to satellite workstations for analysis is provided; Study anonymization and

assistance with the addition of ORGs to satellite workstations and image generating scanners is also provided.

Animal Imaging: The JHU School of Medicine has several complete AAALAC-approved small animal care facility, such as the Broadway Research Building (BRB) Animal Facility, which contains the BRB Molecular Imaging Center within its clean area borders. The BRB Molecular Imaging Center and Cancer Functional Imaging Core provide state-of-the art small animal imaging equipment, including MRI, PET, SPECT, ultrasound, optical imaging, X-ray and CT, to support the wide range of scientific projects within the diverse research community of the Johns Hopkins University and beyond. Trained technologists assist investigators in the use of the facilities.

*BRB Molecular Imaging Center* is a 2500 square feet facility located in the Broadway Research Building (BRB, http://oncweb1-vm.onc.jhmi.edu/cischeduling/). The BRB facility is equipped with: GE eXplore Vista small animal PET scanner (beta test site), a Gamma Medica small animal X-SPECT imager, dose calibrator, lead cave and other equipment for handling positron-emitting radioisotopes, three Dell 1.8 GHz/400 MHz units with 19 in. monitors (stand-alone and interfaced with the eXplore Vista scanner), floor lamps, scale, surgical equipment and other supplies for small animal surgery and a refrigerator for temporary storage of radioactive materials. The BRB facility also houses a Xenogen IVIS 200 bioluminescence imaging device with fluorescence capability, a Kodak In Vivo Imaging System FX (X-ray and optical), a LiCor-Pearl impulse NIR imager, a Faxitron Real-Time Imaging System Model 43855C (small animal X-ray imaging), a Bruker 9.4T horizontal bore small animal MR system, and home-made trimodality (optical, SPECT and CT) and awake animal imaging systems. A Visualsonics Vivo 660 ultrasound device is also available. BRB imaging center also has Bruker 400 Ultrashield NMR, Bruker Esquire 3000 Plus mass spectrometer with Waters 2695 Separation Module for chemical characterization of synthesized compounds. Biodistribution assays and scintillation counting are performed in Ross 220 (Nuclear Medicine). We also have access to the Department of Pharmacology and Molecular Sciences UV, NMR, IR and MS instruments for routine characterization of compounds synthesized.

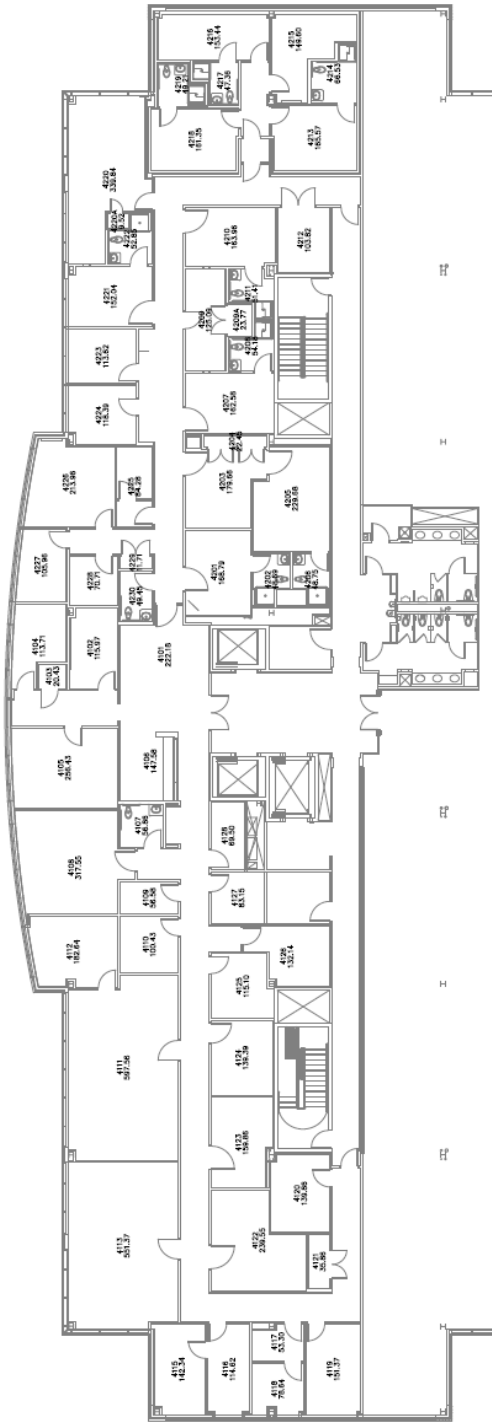
*In Vivo Cellular and Molecular Imaging Center (ICMIC)* laboratories are equipped with tissue cultures apparatus, such as sterile laminar flow hoods and incubators, an ELISA reader, a fully equipped molecular biology area, 3 spectrometer rooms, an electronic shop, a small machine shop, an acute surgical suite, and a computer room. The molecular biology laboratory contains several RT-PCR systems as well as equipment to perform protein, mRNA assays, and cloning. The MR Oncology Section also has a small animal dissection microsope (Olympus), a phase contrast microscope (Zeiss) for tissue culture studies, and an optical microscope (Olympus) for histological and immunohistochemical analysis of tissue sections. A research-grade CCD camera (Sanyo, Ltd.) is attached to the optical Olympus microscope to image histological sections. This CCD camera is directly connected to a Computer, which is part of the intra-network. Two Nikon fluorescence microscopes (Nikon Eclipse TS100, Nikon Eclipse E400) for cellular epifluorescence detection, as well as in vivo, and intact tissue fluorescence imaging are available in a separate fluorescence room. Both Nikon microscopes are equipped with digital cameras. An In vivo optical imaging system with 200V illuminator, different sets of filters, and a CCD camera is optimized to detect green fluorescent protein (GFP) or red fluorescent protein (RFP) expression in solid tumors in vivo. The laboratory is also equipped with a Microtome Cryostat HM 550 Series (Microm International GmbH, Walldorf, Germany) for cutting cryo-sections from frozen tissues, as well as with a VictorV3TM Fluorescence Multiplate Reader (Perkin Elmer, Fremont, CA) for fluorescence and absorption measurements of multiplates, and an Oxylite oxygen fiber-optic probe.

## Human Subjects Research Core

### Clinical Research Unit

The **Clinical Research Units** resources occupy space on both the East Baltimore Medical Campus and the Bayview Medical Campus. These units, their current locations, and the amount of space are described below.

*Inpatient/Overnight Services for Adult Research Participants*



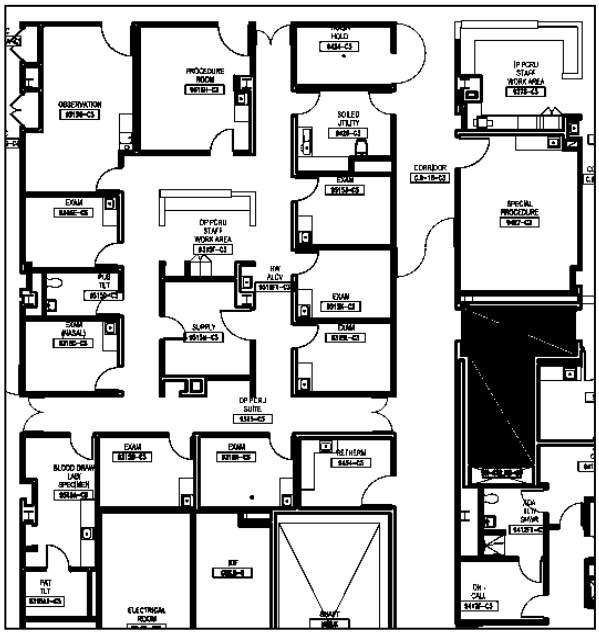
- JHH: Osler 5 is an acute inpatient general medical floor providing up to 14 beds for research. Resources include capacity for continuous cardiac monitoring and biological isolation of subjects. Unit is staffed by JHH staff nurses trained in research procedures as well as clinical practice.
- JHBMC: Hospital scatter beds are available for studies requiring overnight stays with access to immediate Code team support. JHBMC is staffed by nurses trained for specific research protocols. In 2010 the JHBMC Domiciliary Unit moved into expa nded space (13,842 sq ft) on the 4th floor of the newly constructed 301 building, which houses dedicated research space including 8 overnight study rooms that have video and audio monitoring, and can house 10 participants for overnight studies. Bariatric beds are available. Specialized and routine sleep studies including chronobiology resources are available. This unit provides 24/7 service for investigators and is staffed with 8.5 nurses (6 RNs, 2.5 LPNs), 3.6 technicians (who support overnight and outpatient visits) and 2 sleep technicians. This facility also houses facilities for Cardiovascular Imaging, the Exercise and Body Compostion Program, and the Mulitdisciplinary Sleep Program described below. The space is shared with the JHBMC Outpatient Research Unit. The floor plan of this combined unit is shown, left.

*Outpatient Services for Adult Research Participants*

- JHH Outpatient Research Unit: Located at Carnegie Building, this unit includes 11 full-service exam rooms, 2 interview rooms, a phlebotomy room, sample processing lab, -70 freezer, infusion center, and DXA scanner. Full-time staff includes 3 research nurses, a phlebotomist and technicians who assist investigators with protocol specific evaluations (e.g., vital signs, collection/processing of specimens, administration of questionnaires.) Qualified nurses administer medications for approved protocols.
- JHBMC Outpatient Research Unit provides space for phlebotomy, interview rooms, procedure rooms, gyn exam room, dental exam room, sample processing lab, -70 freezer, echocardiography and endothelial function testing, metabolic stress testing resources, DXA, Biodex for muscle strength testing. Nurses administer protocol-guided medications, including supporting insulin clamps, IVGTT, and pharmacokinetic studies.

*Inpatient and Outpatient Services for Pediatric Research Participants*

- JHH: The Pediatric CTSA team helped design a new inpatient and outpatient facility located in the Charlotte R. Bloomberg Children's Building. The floor plan of this new state-of the-art facilitity is shown, below. The inpatient unit is 20 beds, of which 7 at any one time can be reserved for ICTR-approved research. The outpatient unit, which includes 7 clinical exam rooms, an infusion facility, 2 procedures rooms, pediatric phlebotomy room, formula and research kitchen is open to investigators with CTSA-approved protocols Monday - Friday 7 AM to 6 PM. The services are supported by 1 RN, and 1 CNA. Sleep studies are conducted at the domiciliary unit with pediatric competent PSG technician support and on-site pediatrician oversight.




The NBRP (located at Kennedy Krieger adjacent and connected to JHH) supports programs related to development disorders or other conditions affecting the CNS. The resources of the Behavioral Psychology Department at Kennedy Krieger include: (1) a 15-bed Neurobehavioral inpatient treatment unit with dedicated individual therapy/observation rooms, classrooms, day programming areas, and simulated home environments; (2) a similar inpatient behavioral feeding disorders unit; (3) an outpatient suite of ten interview/treatment rooms with one-way mirrors and audio-video equipment for observation purposes. These capabilities can be made available to ICTR investigators when other CRU resources are unable to deal with the special needs of children with severe impairments or challenging behaviors.

**Research Nutrition Program**

Offices for the Research Nutrition staff are available on Osler 5 of JHH and on the Bayview domiciliary Unit. Offices are equipped with individual computers.

Research Kitchen and Formula room: The research kitchen and metabolic formula rooms are located near the Adult Clinical Research Unit on 550 Osler Building and in the Pediatric Clinical Research Unit in the new Bloomberg Children's Center. Standardized meals, specialized weighed meals for pharmacokinetic studies, feeding studies, food arrays, and double-blind placebo-controlled oral food challenges for food allergy protocols are all created and prepared in the research kitchen. Preparation of take home doses of food allergens for oral immunotherapy desensitization studies are also weighed in the metabolic formula room, in addition to any specialized metabolic formulas. Five analytical balance scales, one Sartorius CPA64 and four Ohaus Explorer, used for weighing out placebo and allergen dosing for oral immunotherapy studies, metabolic formulas and foods.

*Equipment:* One CareFusion (formerly Viasys) Vmax Encore 229N Metabolic system is used for measuring resting energy expenditure. This is used for both pediatric and adult patients. *Four licenses for the Nutrition Data System for Research* (NDSR) (developed and updated by the Nutrition Coordinating Center of the University of Minnesota) which is the most accurate and comprehensive nutrient and food group serving count calculation software for research purposes involving dietary analysis. The Research Nutrition core performs 24 hour recalls and analyzes 3 day food records using this program for various investigators across campuses and the Schools of Medicine, Nursing and Public Health.

Several *non-invasive methods are available for anthropometry and body composition assessment*. Two Bioelectrical Impedance Analysis (BIA)-RJL Systems Quantum II and Quantum X measures lean body mass, body fat, intra- and extracellular water and phase angle. Seven Lange Calipers used to measure thickness of subcutaneous fat and 2 layers of skin and correlates to total fat using various equations using multiple sites. Two bone breadth calipers (Campbell 10 and 20), one segmometer and two metal anthropometric measuring tapes for measuring bone width and segmental lengths of the body.

**Exercise and Body Composition Program**

Testing laboratories are located on the Clinical Research Unit in the 301 Building and is equipped with a CareFusion (formerly Viasys) 229 Metabolic and ECG system for exercise testing and resting metabolic rate. Exercise tests, with or without assessment of oxygen uptake and related measures can be performed on a treadmill or cycle ergometer and a Biodex System 3 Dynamometer is used for isokinetic strength testing. System can test the major muscle groups for concentric and eccentric contractions at a wide range of speeds (degrees/second) and is also capable of passive strength testing. Attachments are available for the major muscle groups for adults and children. Two Hoist multistation strength machines are available for isodynamic muscle strength training.The exercise core also performs a variety of functional tests such as the 6-minute

walk, stretch and research, hand grip, and other techniques as needed for specific protocols.GE Lunar Prodigy Encore (GE Medical Systems) Dual Energy X-Ray Absorptiometry (DEXA) machine for body composition. Software Version 13.3 is the current version. This DEXA is capable of whole body scans as well as focused scans for the spine and hips for protocols in which bone is of primary interest.

*Exercise Training.* The exercise training facility is located in the Asthma and Allergy Center on the Bayview Campus. The facility is shared with the clinical cardiac and pulmonary rehabilitation programs. The facility is full-equipped and can have 15 subjects exercising at the same time. Major equipment includes treadmills, cycle ergometers (leg only, upper body only, and dual legs and arms), upright and recumbent steppers, Ellipitical machines, Hoist multi-station strength training machines, and an assortment of handheld weights.

**Multidisciplinary Sleep Research Program**

The Multidisciplinary Sleep Research Program (MSRP) is housed in the Johns Hopkins Bayview CRU. The MSRP provides an integrated center for education, training, coordination, and support of clinical and translational research in sleep medicine. This center offers support to all investigators conducting sleep-related research and facilitates collaboration between the disciplines working in the area of sleep medicine.

The MSRP is staffed by registered polysomnographic technologists and nurses, and is supported by a dedicated sleep informatics team that assists with database management and provides round-the-clock technical support for acquisition of polysomnographic studies.

*MSRP facilities* are comprised of eight private inpatient rooms with personal full-size bathrooms and the capability of monitoring up to 10 subjects simultaneously. Bariatric beds with a weight capacity of up to 1000 lbs are available, if required. Each room has a voice-activated intercom system that allows continuous on-demand communication between subjects and the monitoring staff. High-quality infrared cameras with zooming capability are integrated within the polysomnographic recording. “Through-the wall” access allows intermittent venous blood sampling or drug administration during sleep without disturbing research subjects. In addition to standard PSG studies, a specialized chronobiology suite of five beds is available for specific protocols that require time, light and sound isolation.

*Equipment:* Polysomnographic recordings are obtained using state-of-the-art EMBLA acquisition equipment, including 32 referential channels, 8 bipolar channels, and specialized sensors (position, oximeter, airflow, effort, snoring). Specialized auxiliary equipment and services (e.g.actigraphy, advanced airway monitoring, CPAP, Pcrit determination) are also available, when requested. External sound level meters are used to display the decibel level within the polysomnographic recording. Likewise, sensitive microphones capture a broad spectrum of frequencies for post-hoc analyses. PSGs are collected using a high acquisition sampling rate, permitting spectral analysis of the EEG, when desired by MSRP PIs.

**Neurobehavioral Research Program at the Kennedy Krieger Institute**

The Kennedy Krieger Institute (KKI) has a professional relationship with the Johns Hopkins University School of Medicine, and is an affiliated institution of the Johns Hopkins Medical Institutions. This affiliation allows for shared faculty and integrated clinical services, resources, and research. The KKI is fully accredited and annually cares for more than 10,000 children, adolescents, and young adults with disorders of the brain in more than 20 outpatient clinics, 3 inpatient programs, and various home and community programs. This patient population represents an enormously valuable aid to recruitment for investigators conducting clinical and translational research focused on conditions affecting central nervous system development and functioning.

Administrative space for the Neurobehavioral Research Program (NBRP) include offices on the second floor of the KKI’s building at 707 North Broadway which is physically connected to the main Johns Hopkins Hospital complex. Resources are provided for secretarial support, budget management, filing, word-processing, database management, telephone, fax, e-mail, photocopying, meeting space and all other administrative activities needed for effective management of NBRP. In additional this space is used for consultative meetings with C-T investigators on imaging, neuropsychological assessment, and highly specialized laboratory procedures specific for persons with developmental disorders that are unavailable elsewhere within the Johns Hopkins community

Behavioral psychologists assist investigators in developing and refining measures of performance or training protocols appropriate to the specifics of the project, including training children with and without disabilities to cooperate with the demands of imaging studies. Neuropsychologists provide supported investigators with access to standardized assessments of cognition and performance, again consistent with the requirements of the specific project. In both cases, experienced faculty are available for consultation in selection of methods and research design. In addition, the NBRU provides access to an extensive library of instruments and procedures developed over many years and not available elsewhere within the ICTR.

Other specialized capabilities include the mock MRI/fMRI scanner located within the Kirby Center. This was developed by faculty in Behavioral Psychology at KKI for training participants to cooperate with procedural requirements of structural and functional MRI protocols. Equipment, computer software and behavioral protocols for training children to reliably perform behavioral and neuropsychological tasks necessary for successful participation in Center - related studies are available and can be modified to meet the changing needs of our investigators and the unique subject populations they study. This can be used to simulate fMRI and other types of neuroimaging protocols requiring specific behaviors (visual and/or auditory attention, specific motor or verbal responses). Importantly, the MRI/fMRI training equipment can detect movement in the bore as small as 0.5 mm and can provide real-time feedback regarding movement or non-movement (for durations from .5 seconds to one hour).

The equipment and capabilities for conducting specialized or customized testing of behavioral and neuropsychological characteristics, performances and learning repertoires are available in the Behavioral Psychology, Neuropsychology and F.M. Kirby Center areas. These resources include: computer interfaced adaptive input devices for use with children with disabilities (modified keyboards, touch screens, microswitches, microswitch-computer interface), video cameras, video recorders and monitors for direct observation and data coding. Computer peripherals also are available for digitizing images from videotaped observations and for customizing video displays for stimulus presentations, as are both commercially available and custom designed software applications for implementing computerized standard learning and performance tasks.

Specialized expertise is offered for testing sensory and motor function, devices and software for quantification of movement performance, and the assessment of learning of new movement patterns. KKI's Motion Analysis Laboratory has the capacity to measure all types of movements, ranging from hand control to balance and walking. The laboratory comprises two large testing areas, totaling 1800 square feet, specifically designed for quantitative, movement imaging and assessment. The Motion Analysis Laboratory is equipped with different motion recording devices, force recording devices, electromyography (EMG) amplifiers, clinical testing equipment (e.g. vibration testing), treadmill, and robotic devices. This allows us to control and quantify the performance of many different kinds of movement. Capabilities include: bilateral, 3-dimensional tracking and reconstruction of movement kinematics, force plate recording, recording of muscle activity, somatosensory and strength measurements, custom split-belt treadmill testing, calculation of joint moments (torques), a 2-D virtual reality setup, and measurement and control arm motions via a bilateral exoskeleton robot.

**Clinical Research Lab Program**

The primary function of the ICTR Clinical Research Laboratory is to provide technical support for sophisticated clinical research assays. The laboratory is a regional resource that supports clinical protocols within the ICTR, the Johns Hopkins Hospital CRU and the Gerontology Research Center of the National Institute on Aging. Within this context, the Laboratory supports approved protocols by providing facilities, technical experience and training for non-routine blood and urine biochemical analyses. The Laboratory is staffed by a Director and three full-time technicians who have extensive experience in the theory and practice of clinical laboratory assays, and in prioritizing access to laboratory resources.

The Laboratory technicians perform approximately 90 different immunoassays for the determination of proteins, peptides, hormones, and other biochemical markers. Over 60,000 samples are analyzed yearly. Since 1993, the lab has employed a bar coding system for sample labeling and tracking. The Laboratory provides standardized sample handling that minimize freeze/thaw cycles, low investigator cost and high quality control. Quality control is maintained by including in each assay run kit manufacturer's controls as well as low,

medium and high value in-house controls. In addition, ED 80, 50 and 20 values as well as each standard curve is compared with historical values and “grave yard” curves. Control values are used to maintain a database of coefficients of variance for inter- and intra-assay variability. The Laboratory is GLP and CLIA compliant. The laboratory participates in the AccuTest, Inc. (Westford, MA) Digital PT proficiency testing program for FDA-approved immunoassay kit or machine measurements and utilizes a consortium of national NIH funded CTSA Core Laboratories for internal sample swapping and proficiency testing of immunoassay kits used for clinical research.

*Space and Equipment:* The ICTR Clinical Research Laboratory includes two components that serve the diverse research needs of the ICTR CRU: (1) The Sample Processing Unit is conveniently located on the ICTR Bayview CRU, and serves as the site for collection and initial processing, labeling, and short term storage of blood and urine samples from ongoing Bayview and Hopkins Hospital CRUs clinical research projects. These samples are then distributed, as appropriate, and further processed and/or stored for specialized analysis in the Advanced Chemistry laboratory, in the individual investigator's research laboratory, or in an outside clinical testing laboratory. The Sample Processing Unit is extensively utilized by multiple ICTR investigators, with the assistance of the nursing staff; (2) The Advanced Chemistry Laboratory is located in Room 5A.64 of the Johns Hopkins Asthma and Allergy Center. This component of the Core Laboratory provides the multiple sophisticated biochemical analyses listed at http://ictr.johnshopkins.edu/CRUs/AssayCosts2011.pdf. The Core Laboratory technicians perform immunoassays for the determination of proteins, peptides, hormones, and other biochemical markers.

*CRU Sample Processing Unit (JHBMC 301 Building Rm 4112)*; This facility is centrally located in the Bayview CRU inpatient area. It provides space for the purpose of collecting, processing, alliquoting, and storing or distributing the biological samples from the protocols of multiple investigators. Housed in this facility are two Beckman glucose analyzers (Model 2) for glucose determinations during insulin clamp experiments and for the related studies IVGTT protocols. The proximity of the facility to the research subjects during such studies is an important feature. The laboratory is staffed by 1 to 2 FTE technicians (depending on demand) from the CRU Core Laboratory staff. This laboratory is also heavily used by the nursing staff for specimen processing. The 150 sq. ft. space has approximately 15 feet of chemistry bench top, and is equipped with a Beckman Accuspin FR refrigerated desktop centrifuge, Eppendorf Model 5415 microcentrifuge, GE refrigerator/ freezer, liquid handling pipettors and storage space for supplies. The laboratory is fully equipped and its staff fully trained to handle and dispose of infectious and radioactive wastes.

*Advanced Chemistry Laboratory (Johns Hopkins Asthma and Allergy Center, Rm 5A-64):* This facility is located in the Johns Hopkins Asthma and Allergy Center (JHAAC). This 600 $ft^2$ facility is located in the Johns Hopkins Asthma & Allergy Center. This laboratory performs more sophisticated biochemical analyses that support the studies of multiple investigators. The facility houses a Mesoscale Discovery Sector Imager 2400 Workstation for multiplex ELISAs, Packard Cobra II Model 5010 Gamma Counter for RIAs, two YSI glucose analyzers, Three Cholestech lipid analyzers, two hemoglobin A1c analyzers, Beckman J6B refrigerated centrifuge, a Beckman Creatinine analyzer, Wallac Victor 2 Microplate Work Station, LabSystems Multiskan MS microplate reader, three (3) Revco and Puffer Hubbard -70°C freezers, Corning model 320 pH meter, Bio-Rad Power Pak 3000 electrophoresis power supply, and Omnigene thermal cycler. In addition, a central facility containing a cold room, and a radioisotope processing and disposal lab are available. The laboratory is equipped with multiple Apple computers and printer.

**Quantitative Methodologies Core**

The **Quantitative Methodologies Core** is administratively housed in the Department of Biostatistics, Bloomberg School of Public Health. By its nature its members are spread throughout the institution. Major other locations for the Core include the McKusick-Nathans Institute for Genetic Medicine (IGM) in the Miller Research Building and Division of Biostatistics & Bioinformatics of the Department of Oncology, School of Medicine (Computational Biology Program), and the Institute of Computational Medicine (ICM) which spans the School of Medicine and the Whiting School of Engineering (WSE) and reports administratively to the WSE (Computational Medicine Program). The Biostatistics, Epidemiology and Research Design (BERD) program

has additional locations in the Department of Epidemiology in the Bloomberg School (Center for Clinical Trials), the Welch Center for Prevention, Epidemiology & Clinical Research, the Johns Hopkins Center on Aging and Health (COAH), and the Bayview Campus (Biostatistics, Epidemiology & Data Management Core) on the East Baltimore campus of the Johns Hopkins Medical Institutions.

Computer: The Johns Hopkins University maintains an extensive computing network that provides secure access from off-site locations to email and internet files. All faculty and staff of the Core have computers with networking capabilities supported by the Department or School of residence.

The main computing resources in the Department of Biostatistics consist of:

- A 64-bit AMD Opteron-based computing cluster, comprised of 44 nodes, with 376 cpu-cores and 1.78 TB total DDR-SDRAM
- 2 Sun Fire X4200 M2 servers for software share and node management
- 1 Sun Fire X4240 servers for backup
- 1 Sun Fire X2200 M2 server for login
- 1 Sun Storage 7210 system with 48 TB usable storage
- 2 Sun Fire X4540 Servers with 32 TB usable storage
- 2 Nexsan SATABoySCSI storage with 15 TB usable storage
- 1 Sun SL-48 tape library
- 1 Sun Fire X4150 system
- 3 Dell 2850 Intel-based systems
- 2 Dell R610 Intel-based system
- 58 Windows systems
- 45 Mac systems

The high performance computing cluster and various storage systems are the shared resources for research and teaching in biostatistics, statistical genetics, computational biology, and bioinformatics. They provide users with computation and storage needs. The computing cluster, backup system, 20 TB storage systems, and 2 Sun Fire X4540 servers are shared resources for the biostatistics, molecular microbiology and immunology, epidemiology departments as well as some of the studying groups in the medical school. These machines can access the storage system at the same time. The data are backed up on the dedicated backup system.

The Dell systems are configured as web servers. They serve as the department web server and faculty collaboration research servers.

Except for standard operating systems, MS Office, and adobe acrobat, major statistical and mathematical computing packages are available, including R, SAS, Stata, Matlab, and Mathematica.

Windows systems run Windows 7 or Windows XP. Except for standard MS office suite and anti-virus software, they also have secure connection installed, which allow them to access resources on the application server. The extended file sharing is though one 2850 system. A dedicated 2850 system serves as the department web server which allows users to present their achievement, class information, personal information on the Internet.

Computers and data for Quantitative Methods core in IGM includes the facilities of the Center for Computational Biology (CCB), which are housed in our data center in Bloomberg Hall, room 156, which was renovated in 2011 to create a flexible, stable environment for a high density of computing equipment that supports research and training on both the Homewood Campus and the East Baltimore (medical) campus. The 3100 sq. foot room is covered with a raised floor fed with cold air from seven Liebert air conditioners, and a dedicated chilled water line is available for water-cooled racks. Bloomberg 156 supports a steady load of at

least 450kVA, with potential expansion to 750kVA. To ensure a stable environment for data repositories, 150kVA of power has both battery and generator backup. The grant also upgraded the network infrastructure supporting the space from 1GigE to 10GigE to insure that users throughout campus can access the data center effectively. This network infrastructure includes a Cisco Nexus 7000 chassis that can accommodate 100GigE connections currently being built.

The Center for Computational Biology has over 220 TB of high-speed storage in Bloomberg 156 and the ability to expand considerably beyond this. For high-performance computing, CCB has 4 large-memory servers with RAM ranging from 256GB up to 1 TB of RAM, 48 compute cores each, and fast access to the large data storage devices. For grid-based computing, CCB has a share in the **HHPC Cluster**, a BeoWulf computing grid shared among multiple Hopkins faculty. The cluster includes over 2500 cores with 4GB per core connected via QDR Infiniband. General purpose file servers with hundreds of Terabytes are on the same Infiniband switches. The two infiniband switches are interconnected to the GrayWulf and Data-Scope through multiple 10Gb/s Ethernet links. The Deans of the JHU Schools provide funds to cover the management and operational costs of the HHPC.

The ICM operates a 2048 processor cluster with a 1 Petabyte storage area network. An 800 Terabyte capacity robotic tape library is used to perform nightly backups. Equipment is housed in a HIPAA-certified machine room within the ICM on the 2nd floor of Hackerman Hall on the Homewood campus. This machine room is designed for projects involving HIPAA-controlled, individual-level data access and Protected Health Information. The room is 1,000 net square feet, with space for 22 standard 42” x 24” racks in 3 aisles. A dedicated 300kVA transformer supplies power. Two 25-ton computer room air-conditioning units provide cooling, with facilities and space available for a third. This equipment is managed and monitored by Johns Hopkins University Plant Operations 24/7 and is configured to generate audible, visual, and cell phone alarms in cases of emergency (e.g., loss of chilled water or air conditioning failures leading to increased room temperature). These alarms are sent to the ICM Director of Networking Systems and Computing (Kyle Reynolds) and JHU Plant Operations. The ICM has a 10GbE backbone, providing 10GbE connectivity to the JHU Homewood campus core, which is one hop away. The machine room has a dedicated Cisco 4500 series switch, providing 10GbE connectivity to the equipment housed there. All networking equipment is managed and monitored by Johns Hopkins Enterprise Networking, which provides 24/7 management of support to all Johns Hopkins networks. Uninterruptible power supplies are installed in each rack as necessary. The University provides all power and machine room maintenance. This machine room has carefully controlled card key access. Systems Administrator Kyle Reynolds and Dr. Winslow have exclusive access to this facility. Others who enter the facility do so with Kyle Reynolds, who personally monitors their activities. A camera is used to maintain a visual and time-stamped record of entry and egress to the room at all times. Entry and egress using key card is recorded by the Johns Hopkins University Office of Security Management.

There are approximately 45 computer workstations (desktop and laptop) at the Center on Aging and Health (COAH). COAH is networked to facilitate the integrations of like tasks across studies and to increase efficiency. The server is dedicated solely to Center studies to ensure that data integrity is maintained and that study timelines are not impacted by lack of available computing time. The system is capable of remote transmission and upgrades to writeable / rewritable DVD drives that permit the efficient and reliable archiving of data files.

COAH currently owns a database server with 5000M storage space and a web server with 140M storage space, both of which sit on the Department of Medicine’s server (Pentium 450 server with 128GB DDR-SDRAM memory and 4TB disk storage) located offsite, remotely accessible through LAN with 10GB speed. The computing facility at the Biostatistics Group of the Center contains 6 PCs running on MS Window XP Professional, ver. 2002: 1 for data manager (Pentium IV, 80GB, 3.40GHz-3.39GHz, 0.99 GB of RAM), 3 for data analysts (Intel® Corel™ 2 Duo CPU, 80GB, 2.39 GHz, 2.00 GB of RAM) and 1 for programmer (Pentium IV, 1.99GHz, 1.99 GB of RAM), and 1 for Dr. Xue (Intel® Corel™2 CPU, 80 GB, 1.99GHz, 1.99 GB of RAM). The major statistical packages, including Splus, SATAT, SAS, are available on all PCs for data bases and analyses.

Office space for the Department of Biostatistics and Johns Hopkins Biostatistics Center is situated in the Johns Hopkins Bloomberg School of Public Health on the main campus of the Johns Hopkins Medical Institutions. The Department comprises the majority of the third floor of the East Wing of the School of Public Health and

includes the main Department office with the Chair's suite, faculty, staff and student offices, conference rooms, public areas, and a library with meeting area and work stations. The Department houses a multidisciplinary faculty of 32 primarily-appointed faculty, core staff and research infrastructure. The faculty and office administrator have stand-alone offices; staff have either an individual office or cubicle work stations; and students have desks or work-stations configured four to an office (two to an office for post-doctoral). All offices are contiguous and provide workspaces with computer (Internet), telephone, fax access, copy machine (including scanning) and library resources.

The JHU Whiting School of Engineering has provided the ICM with ~ 11,000 net square feet of space in the new Computational Sciences and Engineering Building (CSEB). Dr. Winslow's research and development team and administrative staff are located in this building. The software development team has approximately 1,200 sq feet of dedicated space with room for 6 software engineers. A dedicated 700 sq ft conference room is used for meetings of developers, students and faculty taking part in the R24HL085343 CardioVascular Research Grid Project, the R01HL103727 Minimum Information about a Cardiac Electrophysiology Experiment Project and the Tools for Cardiac Electrophysiological Data Dissemination and Management Project. The conference room has video- and web-conferencing capabilities. The CVRG Program Manager Stephen Granite has a dedicated 150 sq ft office. Graduate students and Postdoctoral fellows doing computational modeling work on RO1HL105216 Redox Modification of the Arrhythmic Substrate In Heart Failure and RO1HL105239 Calcium-Entrained Arrhythmias have 3 500 sq. ft. offices available for their use..

Library Resources: The Biostatistics Department houses a library that is an important research resource for faculty and trainees. It is physically located in the Department. The library contains major journals, some dating back as far as the 1920s. Also available are over 2700+ books covering a wide range of subjects.

**Quantitative Development / Training Opportunities in CT Research at Johns Hopkins University**

Quantitative Methodologies faculty members teach prolifically in the JHMI, both in Biostatistics degree programs and in courses targeted to CT and other health researchers in primary areas other than Biostatistics. ICTR-sponsored courses taught by Center faculty include **Methods in Clinical and Translational Research** and **Introduction to Clinical Research.** The former provides a one-day overview. The latter provides an intensive two-week experience emphasizing quantitative methods and is team-taught by the ICTR leadership.

A full listing of Biostatistics courses may be found at
http://www.biostat.jhsph.edu/academics/courses/courses03-04.shtml.

**Short courses in computational biology**

The Center for Computational Genomics offers 10 focused modules for Hopkins faculty, staff, fellows, and graduate students, as well as those outside the Hopkins community. These include:

- Statistics and Data Analysis using R -Course ME:510.707
- Algorithms/Introduction to Programming
- Introduction to Unix
- Introduction to Web-Based Bioinformatics
- Introduction to Molecular Biology
- Sequence Alignment
- Introduction to Python
- Awk, Sed, and Shell Scripting

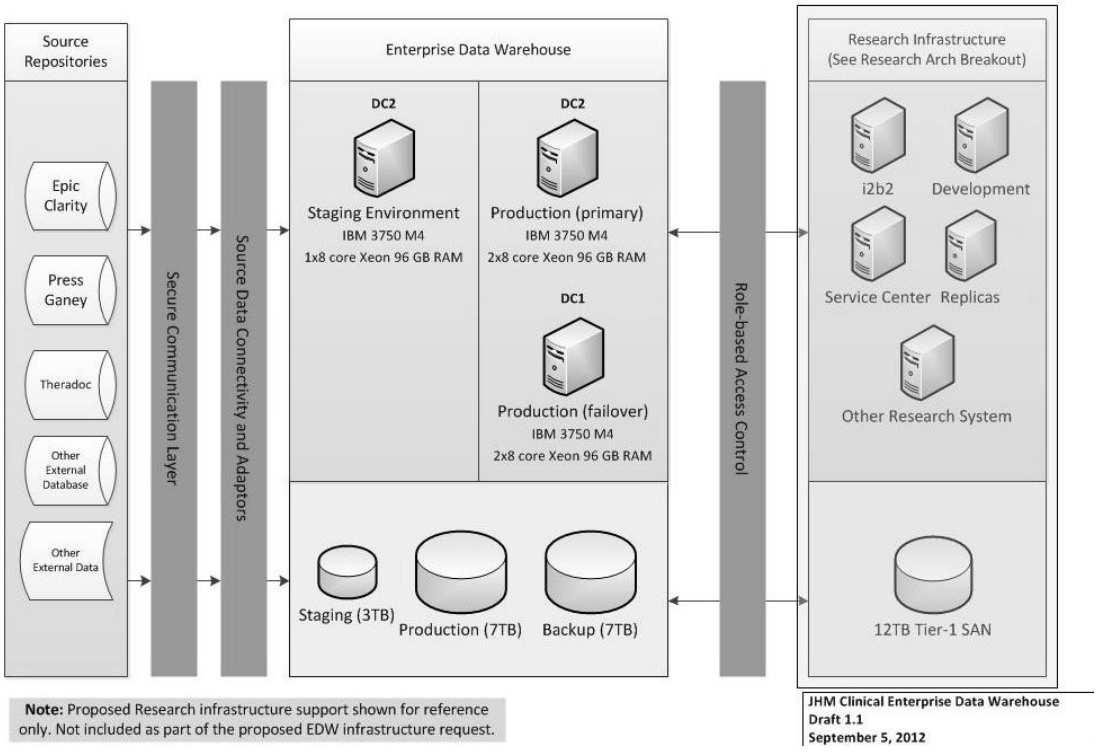
**Computational Medicine and Biology Program**

The Institute for Computational Medicine (ICM), an Institute spanning the Whiting School of Engineering (WSE) and the School of Medicine (SOM). The ICM was chartered in 2005, and reports administratively to the WSE.

The WSE has provided the ICM with ~ 11,000 net square feet of space in the new Computational Sciences and Engineering Building (CSEB). Dr. Winslow's research and development team and administrative staff are located in this building. The software development team has approximately 1,200 sq feet of dedicated space with room for 6 software engineers. A dedicated 700 sq ft conference room is used for meetings of developers, students and faculty taking part in the R24HL085343 CardioVascular Research Grid Project, the R01HL103727 Minimum Information about a Cardiac Electrophysiology Experiment Project and the Tools for Cardiac Electrophysiological Data Dissemination and Management Project. The conference room has video- and web-conferencing capabilities. The CVRG Program Manager Stephen Granite has a dedicated 150 sq ft office.

Graduate students and Postdoctoral fellows doing computational modeling work on RO1HL105216 Redox Modification of the Arrhythmic Substrate In Heart Failure and RO1HL105239 Calcium-Entrained Arrhythmias have 3 500 sq. ft. offices available for their use,

The ICM has one major dedicated machine room on the 2nd floor of Hackerman Hall. This machine room is designed for projects involving HIPAA-controlled, individual-level data access and Protected Health Information. The room is 1,000 net square feet, with space for 22 standard 42" x 24" racks in 3 aisles. A dedicated 300kVA transformer supplies power. Two 25-ton computer room air-conditioning units provide cooling, with facilities and space available for a third. This equipment is managed and monitored by Johns Hopkins University Plant Operations 24/7 and is configured to generate audible, visual, and cell phone alarms in cases of emergency (e.g., loss of chilled water or air conditioning failures leading to increased room temperature). These alarms are sent to the ICM Director of Networking Systems and Computing (Kyle Reynolds) and JHU Plant Operations. The ICM has a 10GbE backbone, providing 10GbE connectivity to the JHU Homewood campus core, which is one hop away. The machine room has a dedicated Cisco 4500 series switch, providing 10GbE connectivity to the equipment housed there. All networking equipment is managed and monitored by Johns Hopkins Enterprise Networking, which provides 24/7 management of support to all Johns Hopkins networks. Uninterruptible power supplies are installed in each rack as necessary. The University provides all power and machine room maintenance. This machine room has carefully controlled card key access.




## Informatics Core

**Epic Clinical Enterprise Data Warehouse** Epic released the Cogito Enterprise Data Warehouse (EDW) in the 2012 Epic release. In recent years, many of Epic's customers have turned to 3rd party vendors to build enterprise data warehouses that enabled information joins between Epic and non-Epic systems. The release of the Epic Cogito EDW will enable improved Ad Hoc queries and ease of use and data access over Clarity via Business

Objects Enterprise, as well as the ability to join non-Epic data sets.

A critical element for success in joining disparate data is the development and agreement of a series of acceptable data parameters and definitions, known as conformed dimensions. JHM has a range of clinical and administrative systems currently. Some analytics capabilities are possible, though there is not an enterprise set of core defined dimensions across the domain. The migration to Epic and the use of its Master File structure enables the foundation for common enterprise data standards at JHM.

While Epic has agreed to provide the Cogito EDW to JHM as part of the 2012 implementation, it is similar to other Epic applications in that it requires set up, development, and maintenance for the project to meet institutional objectives. Similar to the Clarity and Reporting Workbench teams requiring servers, training, staff, and data for implementation, the EDW requires an implementation plan and associated resources to succeed. Further, its integration to non-Epic systems and external interfaces outside the Epic Hyperspace environment adds significant levels of complexity. The selection of Epic's data models, ETL processes, and tool sets has given JHM a significant time advantage over the alternative approach of developing these same tools over time. However, Cogito EDW is a new product without a proven track record. To ensure a successful launch at JHM in alignment with the Ambulatory Go-Live, the addition of a full Systems Development Lifecycle approach to the integration of the Cogito platform into the JHM Epic implementation is recommended

**Clinical Analytics Group** operates under the auspices of the JHM Data Trust and comprises 12 FTEs with skills ranging from data extraction and analysis through advanced database and web programming to project management. Working at the direction of key stakeholders such as the CMIO and the Vice Dean for Research, this team was formed to meet increasingly complex data needs and take advantage of new and repurposed data sets. The Clinical Analytics team has a balance of infrastructure activities, sponsored research support, and architecture development for the Epic and research architectures.

The team is responsible for the Cogito and i2b2 implementations, CCDA services and a range of data acquisition and management activities to support the JHM research enterprise. These responsibilities include Extract, Transfer, and Load processes from the clinical system to the Warehouse, integration of all Epic data, integration of non-Epic data, monitoring and administration of these processes and the system in general, maintenance of the data dictionary and ontologies across these systems, specification of custom queries for quality improvement and research, maintenance of the query libraries, creation of the i2b2 versions, and de-identification of these data for general investigator use. Work over the past year has supported collaborations with JHU, the Johns Hopkins School of Public Health and Johns Hopkins Health Care. Targeted activities for the next year include machine learning support, NLP activities on structured and unstructured notes, and increasing researcher self-service access to PHI-protected clinical data to support early hypothesis generation and research concept development.

**Center for Clinical Data Analysis (CCDA)** Led by Dr. David Thiemann, the CCDA uses a trusted-intermediary model to provide one-stop shopping for a broad range of IRB-approved clinical data requests: sample-size estimates and demographics for grant preparation and statistical feasibility (using criteria such as ICD9 and CPT codes, laboratory findings, medications and diagnostic procedures); case-finding for subject enrollment, chart abstraction and/or biospecimen analysis; de-identified cohorts for epidemiologic study; and comprehensive, granular clinical data extracts for IRB-defined study populations. Through the CCDA researchers can obtain integrated data extracts with PHI from Amalga/EPR2020 and from the entire suite of Johns Hopkins transactional systems, from EHR enterprise to departmental (e.g., operating-room management). The CCDA also provides consultation about data interpretation, completeness, distribution, reliability, temporal evolution/migration, and alternate strategies.

**CRMS** CRMS, was co-developed with MDLogix, a company based in Baltimore,using a Ruby–on-Rails platform. Currently administered by JHMCIS, it is populated with study data from eIRB, reducing the need for duplicative data entry. Further efficiencies are gained via an interface with our Hopkins-developed Electronic Patient Record (EPR95). CRMS facilitates communication within the study team through the use of study registries, electronic study and patient calendars, electronic case report forms, and group access to uploaded study documents. Administrative and research data for 4,196 studies and screening data for over 100,000 individuals have been gathered in CRMS since institution-wide deployment in July of 2009; its creation,

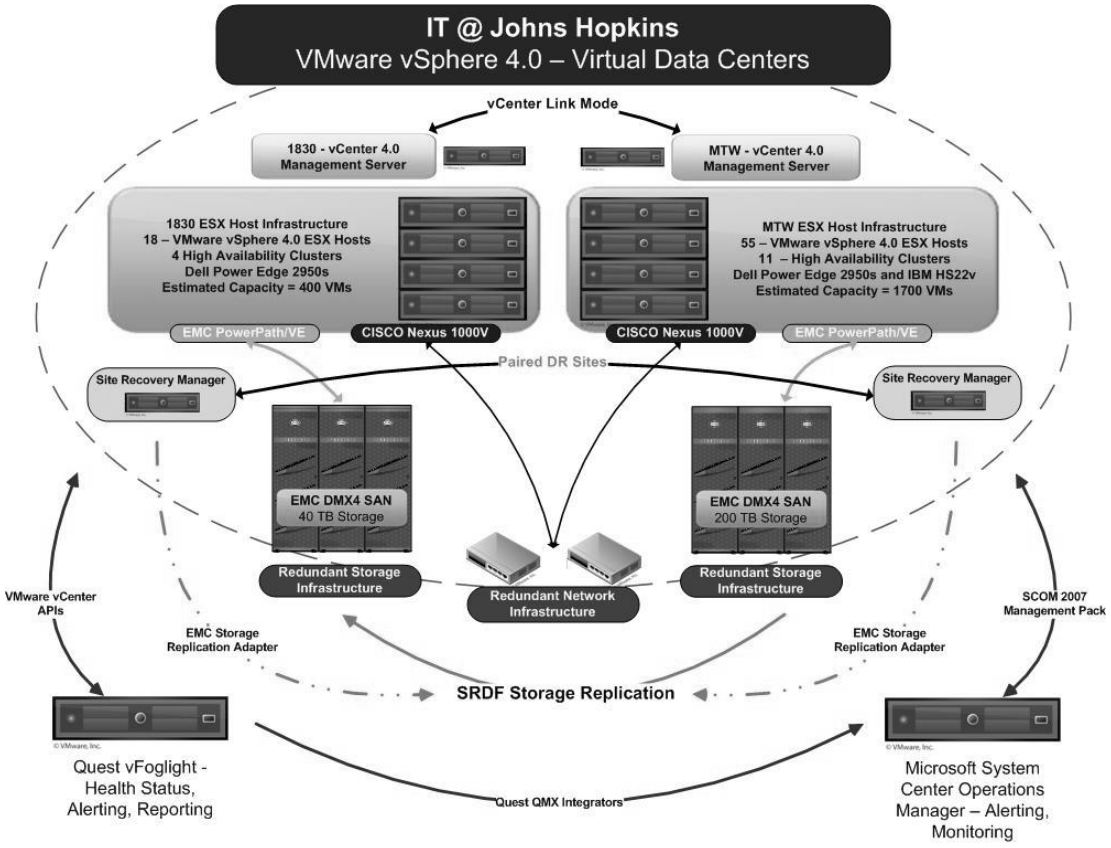
deployment, and growth has been the major focus of the past 5 years of ICTR informatics work. With 1,143 currently active studies and 23,510 enrolled participants on those active studies, CRMS is one of the largest practical systems among CTSA grantees. Other existing resources include a variety of specialized clinical sources, research databases, and external data sources, such as those from multi-center studies.

**caTissue** This suite of tools, developed as part of the caBIG endeavor, enables inventory management of biospecimen repositories. Currently jointly maintained by IT@JH and the NIDDK-supported C-T research Enhancement Core, it now includes data on 45,000 specimens, and has been used by 10 studies / grants and 20 publications in the past year. Its data on studies are linked to CRMS.

**eIRB** The eIRB, launched in 2005, is a paperless, electronic method to submit, track, and review the scientific, regulatory, and compliance information required for the safe conduct of human subjects research at the School of Medicine, School of Nursing, and School of Arts and Sciences. The system provides a platform for the IRBs and other research compliance committees together with the JHM research community to share critical information regarding the submission and review of new applications, amendments, protocol events, and continuing reviews.

Based on web infrastructure from ClickCommerce (now Huron Consulting), eIRB currently serves over 14,000 users and manages over 10,000 active protocols (including exempt and non-human subjects research). Its customizable workflow enables Hopkins leadership to interact with principal investigators to ensure compliance with federal and local regulations as well as to provide assistance in study design and execution.

In 2011 and 2012, the system was upgraded with a new data architecture and an updated infrastructure, enabling faster throughput for users and greater capacity for the institution. eIRB functions as the “source of truth” for studies using CRMS, and there is a bidirectional link between the two systems.




**IT@Johns Hopkins, Cloud Services and Virtual Desktop** Besides providing enterprise and desktop services throughout the Hopkins environment, IT@JH now provides support for 2,000 virtual servers across multiple data centers. This solution has reduced hardware and power requirements, expanded services to most applications, and increased the reliability of individual servers. For customers, it has reduced the time to provide server capacity from weeks and months, to days or even hours.

**Clinical Research Informatics Services** The Clinical Informatics Resource Core provides data management consulting serves to develop data management plans and multiple client-server data systems to accommodate a variety of data collection, storage, and data management needs. MS SQL is used as a primary data storage repository. Additionally, database tools such as FileMaker Server, REDCap (www.project-redcap.org), MS Access, and

Teleform (scantron) provide a wide and flexible selection of data collection/storage options for investigators and their protocols.

In addition to the services above, the Core provides a comprehensive array of data integration solutions. By providing integration with ITCR laboratory (e.g., DEXA, Endopat, Endothelix, metabolic stress system) and enterprise testing systems (e.g. Xcelera for echocardiography) and other external research data systems such as the Core chemistry laboratory, the CRU is able to migrate data between systems electronic and eliminates the need for study staff to enter data manually. This automation increases data quality by reducing the opportunity for the introduction of errors via manual data entry. We can move large data sets in a rapid and secure manner. Each of the different types of data sets across protocol are stored in common formats, thereby enabling data sharing among investigators. Data for each investigators protocol is exported to their study specific databases, which are also stored on our dedicated database servers.

The Core supports the collection and storage of high-quality, secure data on a hardware backbone consisting of two Dell PowerEdge servers running VMWare Sphere virtualization environments that are tied to a high-availability Dell Equalogic Storage Area Network (SAN). This virtualization environment supports multiple virtual servers (web, SQL, FileMaker...) as well as several functionally specific virtual workstations used for protocol-specific support, sleep study scoring, remote access, and testing. Our transition to a virtual environment has allowed us to deploy desktops faster, enhance security, and increase disaster recovery opportunities which reducing capital and operating system costs.

File-server services are provided via multiple NetGear ReadyNAS network attached storage (NAS) devices. These systems are RAID-enabled and provide redundant power and LAN connectivity, ensuring high data availability, with virtually no downtime in case of hardware failure.

Backup protection from data loss is provided via on-site and off-site data backup to additional NetGear NAS devices located in other buildings at Hopkins in secure locations. Twice-daily backups of primary file-servers help minimize exposure to data loss. Additional weekly, monthly, quarterly, and yearly backups are used to ensure availability of recovery data at multiple save-points.

The Clinical Informatics Core hardware leverages a 208-volt APC power-management system to maintain up-time during momentary and temporary power fluctuations/disruptions. The primary server/storage systems are housed in a temperature controlled, limited-access server room.

**Division of Health Sciences Informatics** The academic home in the School of Medicine for informatics researchers (mostly clinical and public health), the Division has a small number of primary faculty, and about 30 faculty with secondary appointments. Housing an active teaching program, it hosts 2 masters degrees, a post-baccalaureate Certificate program, and a PhD focused on clinical re-engineering through informatics. Courses available to ICTR trainees include: ME 600.903 Introduction to Biomedical and Public Health Informatics, ME 600.902 Leading Change Through Health IT, ME 600.900 Health Information Systems: Design to Deployment, ME 600.904 HIT Standards and Systems Interoperability (material from this course has been placed in opencourseware), ME 600.901 Health Sciences Informatics: Knowledge Engineering and Decision Support, ME 600.905 Clinical Informatics, ME 600.809 Topics in Clinical Informatics, ME 600.907 Database Querying in Health, ME 600.711 Health Informatics for Disease Prevention and Management, ME 600.906 Real Time Disease Surveillance. The Division also hosts a weekly Grand Rounds series, which is Web cast to an audience of about 400.

## Research Participant and Community Partnership Core

### Community Engagement

The Community Engagement Core director, Dr. Darius Tandon, is located in the David M. Rubenstein Children's Health Building. This building is on the Broadway medical campus and consists of 90,000 square feet of space and includes 10 conference rooms and two large meeting rooms. Dr. Tandon maintains his private office in this building and has access to the conference and meeting rooms where consultations and meetings related to the community engagement core can occur. Dr. Hae-Ra Han and Professor Lee Bone are the two other lead faculty in the community engagement core; they have their private offices in the Anne M.

Pinkard Building and Hampton House, respectively. These buildings are also located on Broadway Medical Campus, allowing for frequent in-person meetings among the core faculty. Each of the buildings in which the core faculty resides are equipped with state-of-the-art telecommunications, teleconferencing, and information technology capabilities. Johns Hopkins Information Technology provides support for each faculty member. The Anne M. Pinkard Building and Hampton House also have space for hosting larger trainings and workshops sponsored by the community engagement core. Both buildings have auditoriums that accommodate between 100-180 individuals that are equipped with "Mediasite" recording capabilities that allows for audio and videorecording of presentations that can subsequently be placed on the community engagement core website on the ICTR homepage.

The Division of General Pediatrics and Adolescent Medicine moved to the newly built David M. Rubenstein Children's Health Building in 2006. This building consists of 90,000 square feet of space and includes 10 conference rooms and two large meeting rooms. Dr. Tandon has a private office in the Children's Health Building and has access to these conference and meeting rooms where consultations and meetings related to the community engagement program can occur.

**Environment**

There are several institutes and centers at Johns Hopkins who work closely with the Community Engagement core related to its goal of fostering community engagement throughout the research process and promoting communities' understanding of clinical research conducted at Johns Hopkins. These institutes and centers are housed across Johns Hopkins University. Faculty, staff, and community partners from these institutes and centers have collaborated with Community Engagement in developing trainings and workshops for researchers during the last three years. These institutes and centers have also co-sponsored events and have assisted the Community Engagement core in conducting consultations for researchers needing guidance on various aspects of their community-engaged research. In the coming grant period, faculty, staff, and community partners from these institutes and centers will continue to play a central role in providing consultations and will also play a vital role in developing new initiatives related to developing community stakeholders' capacity to effectively partner with researchers.

| | |
|---|---|
| Center to Eliminate Cardiovascular Health Disparities | Medicine |
| Baltimore Diabetes Research and Training Center | Medicine |
| Memory and Alzheimer's Treatment Center | Medicine |
| Center of Excellence for Cardiovascular Health | Nursing |
| Center for Adolescent Health | Public Health |
| Center for the Prevention of Youth Violence | Public Health |
| Center for Injury Research and Policy | Public Health |
| Center to Reduce Cancer Disparities | Public Health |
| Center on Aging and Health | Public Health |
| Urban Health Institute | Public Health |
| Homewood Community Partners Initiative | Homewood |

**Johns Hopkins Urban Health Institute**

The UHI serves as an interface between Johns Hopkins and the Baltimore community in which it resides. The UHI was established in 2000 by Dr. William Brody, then president of the University, in response to a recommendation from the Urban Health Council — a group of community residents, clergy, local leaders, business representatives, city officials, and faculty, staff, and students from the Johns Hopkins Institutions (JHI). Together with its community partners, the UHI explores ways that the research, teaching, and clinical expertise of the University can be better harnessed for the benefit of the residents of East Baltimore.

The mission of the UHI is to serve as a catalyst that brings together the resources of Johns Hopkins Institutions with the City of Baltimore, and especially East Baltimore to improve the community's health and well-being, and in so doing serve as a model of community-university collaboration regionally and nationally.

The UHI:

- Serves as a bridge between JHI and Baltimore, facilitating understanding and information sharing so as to improve health outcomes;
- Facilitates collaborations between JHI and the Baltimore community around research, community projects, program planning/implementation and evaluation.
- Improves the understandings of JHI as they relate to the health needs and aspirations of the community; and concurrently, to improve the understandings of the community as to the work that JHI does that has the promise of improving the health and wellbeing of the community.
- Strengthens the capacity of the Baltimore community by bringing the knowledge and skills available through JHI to community identified needs and issues;
- Strengthens the academic offerings and opportunities within JHI as they relate to urban health and development;
- Initiates sustainable, collaborative interventions that will improve the health and well-being of Baltimore and the East Baltimore community.

**Research Ethics**

**Facilities and Other Resources**

The Johns Hopkins Berman Institute of Bioethics (BI), a University-wide entity located in East Baltimore, is the academic home for Drs. Geller, Kass, Sugarman, and Taylor. With the Institute's recent move into its own completely renovated building, the new and improved physical resources have enhanced opportunities for interaction and rapport. BI personnel now have access to a building equipped with ample offices and meeting rooms as well as state-of-the-art telecommunications, teleconferencing, and information technology capabilities. Johns Hopkins Information Technology provides support for the Institute's enterprise applications, networking, telecommunications, and various information systems and is available around the clock.

**Scientific Environment**

The BI conducts advanced scholarship on the ethics of clinical practice, biomedical sciences, and public health, as well as engaging students, the public, and policy-makers in serious discourse about these issues. Established in 1995, the BI is comprised of a large, interdisciplinary faculty from the Schools of Medicine, Nursing, Public Health, and Arts & Sciences. One of the unique features of the Institute's environment is not only the interdisciplinary nature of the faculty's work, but its collaborative arrangements with many other Johns Hopkins institutes and departments. Several BI faculty members focus on research ethics, which is particularly relevant to this project.